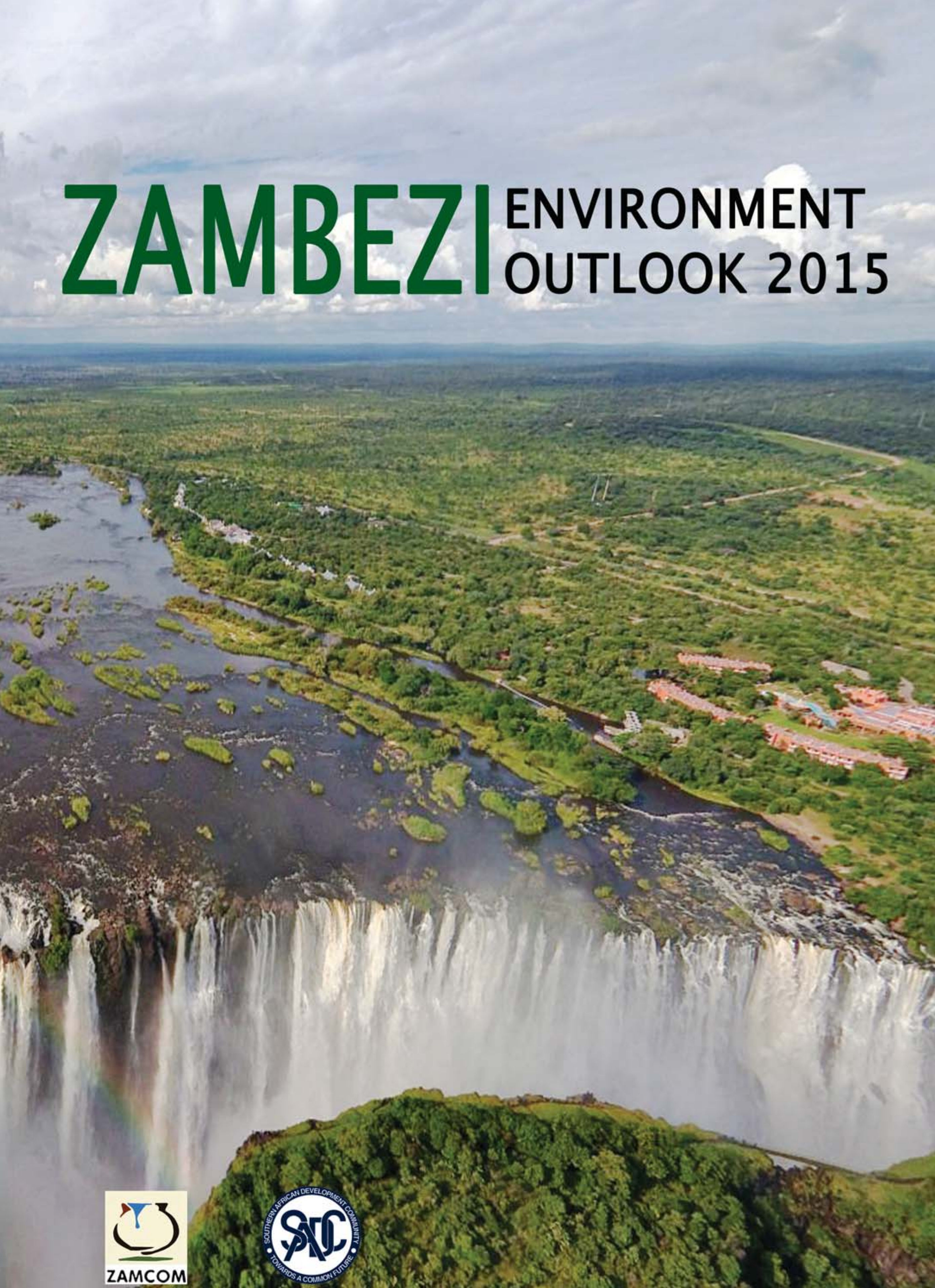
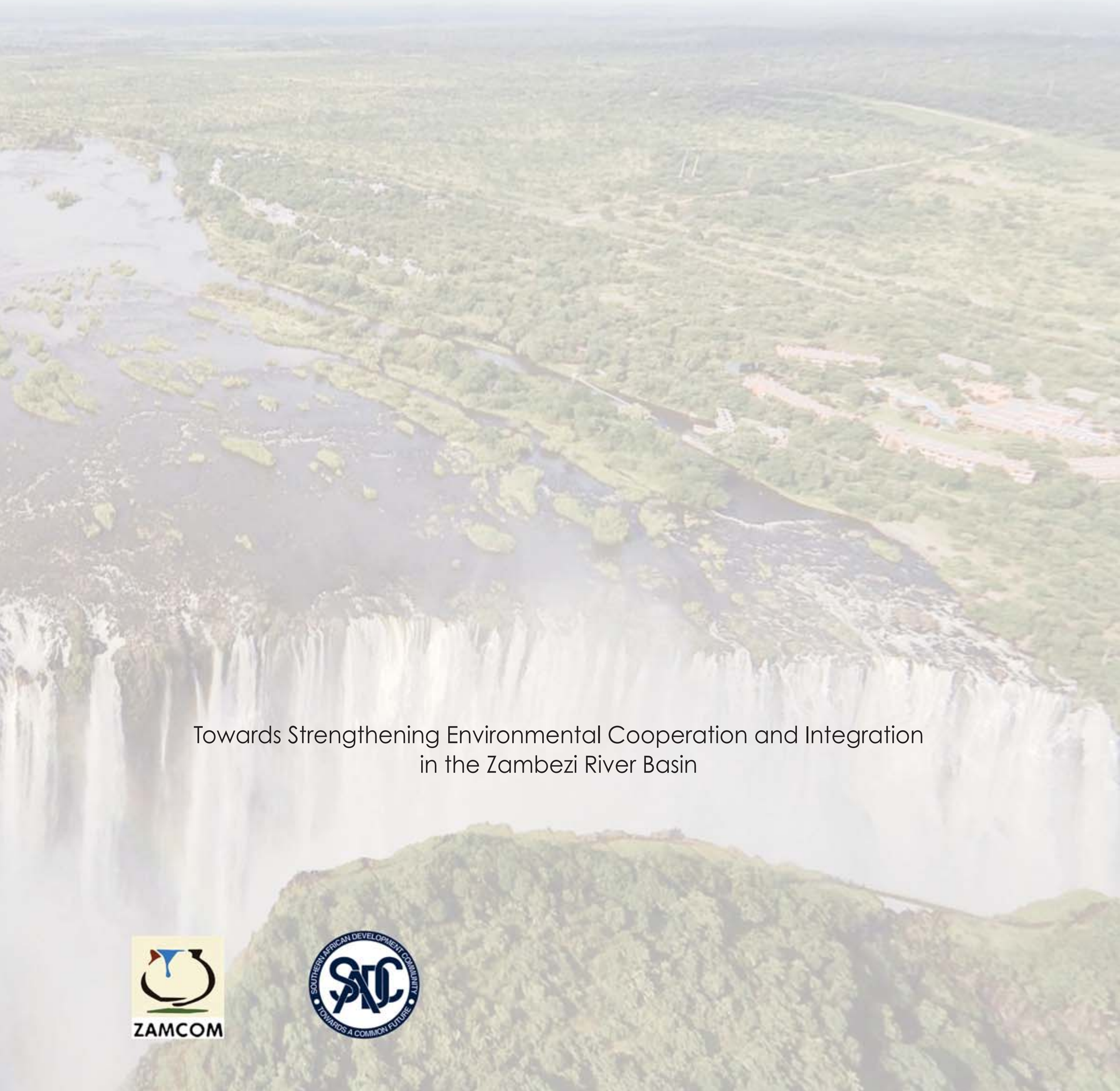
ZAMBEZI ENVIRONMENT OUTLOOK 2015



ZAMCOM

SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
SADC
TOWARDS A COMMON FUTURE

ZAMBEZI ENVIRONMENT OUTLOOK 2015



Towards Strengthening Environmental Cooperation and Integration
in the Zambezi River Basin

A report by the
Zambezi Watercourse Commission (ZAMCOM)
Southern African Development Community (SADC) and
Southern African Research and Documentation Centre (SARDC)

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FOREWORD

The Zambezi River Basin represents the best of what we have in southern Africa in terms of natural capital. The natural resources ranging from water, land, soils, forests, wildlife and the minerals that are plentiful under the soil, are critical to regional socio-economic development and poverty eradication. Since most of these are shared, achieving sustainable natural resource management requires regional cooperation, an integrated ecosystems approach, and a common understanding of the natural resource base.

As the most shared resource in the SADC region, the Zambezi Basin provides an indicator in terms of meeting one of the objectives of the SADC Treaty. Article 5 commits us all among other objectives, to "achieve sustainable utilization of natural resources and effective protection of the environment". This has to be balanced with another of the objectives articulated in the Treaty which is to "achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the people of southern Africa and support the socially disadvantaged through regional integration."

In line with the Treaty the SADC Regional Indicative Strategic Development Plan (RISDP) calls for regular environmental assessment, monitoring and reporting for the purpose of analysing regional trends. The *Zambezi Environment Outlook* is an integrated assessment of the state and trends of key environmental resources, including freshwater, land, biodiversity and forests. It covers cross-sectoral elements relating to human settlements, agriculture, energy, tourism, industry, climate change and variability. The report provides a current update and introduces new and emerging issues, following the widely acknowledged *State of the Environment Zambezi Basin 2000*, which was the first environmental assessment of a single ecosystem in southern Africa.

The *Zambezi Environment Outlook* is therefore an important milestone for socio-economic development in the Basin and the rest of southern Africa. It provides a monitoring tool for basin-wide and regional targets under the Zambezi Watercourse Commission (ZAMCOM) Agreement; RISDP; the third Regional Strategic Action Plan for Integrated Water Resources Development and Management (RSAP III); the Revised SADC Protocol on Shared Watercourses; and the Protocol on Environmental Management for Sustainable Development, approved at the 34th SADC Summit in 2014.

The running theme of the report, "Strengthening basin-wide cooperation and regional integration" speaks to our desire for a united and sustainably managed region through integration. An effective regional integration approach is one that is rooted in participation of well-informed stakeholders. As the Executive Secretary of SADC, I believe that advancing scientific research of this nature can help Member States to unpack information and share it widely with citizens to broaden the benefits of regional integration.

All of us in southern Africa depend on the natural environment for energy supplies, water, food, shelter, tourism and jobs. As a region we need to maintain the Zambezi River Basin's healthy productive ecosystems to meet the challenges of both intra and inter-generational equity.

The production of the *Zambezi Environment Outlook* is an initiative that we believe will strengthen collaboration between our policymakers and the public in our collective efforts to effectively manage our heritage. It is our hope that this initiative should not be an end in itself, but a long-term process, which should continue for many decades to come. Knowledge informs development and people need knowledge in order to make informed decisions and to act appropriately.

I applaud the longstanding partnership of the SADC Secretariat through its Directorate of Infrastructure & Services and Water Sector and the Zambezi Watercourse Commission with the Southern African Research and Documentation Centre (SARDC) through its I. Musokotwane Environment Resource Centre for Southern Africa (IMERCSA) in producing this unique product.

I take this opportunity to thank the Government of Germany in delegated cooperation with the Governments of UK (UKAid) and Australia (AusAid) managed by the German International Cooperation Agency (GIZ) for their consistent support and contribution to sustainable development in southern Africa through funding this important initiative.

The publication of this Outlook reflects the spirit of cooperation and partnership that strengthens our efforts to raise the standard of living of people in southern Africa, and achieve SADC's vision of a shared future within a regional community.

Dr. Stergomena Lawrence Tax
SADC Executive Secretary

PREFACE

The Zambezi Environment Outlook profiles Africa's fourth largest river basin, after the Congo, Nile and Niger. Stretching across eight riparian states (Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe), the Zambezi River Basin is a massive and unique ecosystem that holds potential for cooperation in areas of socio-economic development and environmental management. Cooperation among Riparian States depends on the existence of institutional structures, sound policies, a legal framework, willingness among Riparian States, and awareness of the benefits of shared resources.

In this regard, I welcome the *Zambezi Environment Outlook* (ZEO) as a report that raises the base of knowledge on the benefits of cooperation on shared resources, contributing to sound policy formulation and encouraging the Riparian States to sustainably utilize the natural resources.

The report provides an outlook on the current state of the natural resources endowment and trends in the Zambezi River Basin. It focuses on how the complex nature of natural resources can be effectively managed in the Basin in the context of the changing climate.

The *Zambezi Environment Outlook* is in line with the principal objective of the ZAMCOM agreement which seeks to "promote the equitable and reasonable utilization of the water resources of the Zambezi watercourse as well as the efficient management and sustainable development thereof." ZAMCOM takes this report as a useful tool that will act as a reference document in future ZAMCOM work.

The co-operation which this report envisages is a necessary step towards extending and consolidating the work of Riparian States in the joint management of natural resources. The report emphasises the important role the Basin plays in the integration of the SADC region.

I believe that the *Zambezi Environment Outlook* findings will inform the process of developing the Zambezi Strategic Plan. The plan will be used as a reliable and accepted basis for decision making on investments in the Basin.

By fostering greater awareness on equitable utilisation of resources, the *Zambezi Environment Outlook* assists the ZAMCOM Secretariat to operationalise some of the key provisions of the ZAMCOM Agreement. Among these are the rules of notification and prior consultation on planned measures/projects, and the collection and dissemination of information and data in support of improved planning and decision-making for the sustainable management and development of the Basin.

Information from the report supports our efforts at providing integrated information for the decision-making and planning processes in the Basin. These efforts include the improvement of the Zambezi Water Information System (ZAMWIS). The report will be accessible through various platforms including internet and print.

Fulfilling the principle of inclusivity in the ZAMCOM Agreement, the *Zambezi Environment Outlook* mainstreams gender and youth issues, highlighting the unique roles of men and women in sustainable management of natural resources. The report explains how the work of men and women is impacted differently by climate change and highlights the need to consider such differences in formulating resilience policies and strategies.

The current update on the state and trends of the environment comes at a time when the Zambezi River Basin is faced with many challenges including water pollution, land degradation, deforestation and extinction of biological resources, but there is also a responsive awareness and determination among Riparian States to address these challenges.

The Zambezi Basin has not been spared the adverse effects of climate change in the form of frequent floods and droughts. The Basin has become a major climate change hotspot in southern Africa with predictions indicating a temperature increase of 0.3 – 0.60 C over the next century according to the 5th Intergovernmental Panel on Climate Change (IPCC).

The process of producing the *Zambezi Environment Outlook* has been inclusive and consultative with SARDC IMERCSA coordinating the research and writing as well as presentation of the report, working with expert researchers drawn from the Riparian States. SADC and ZAMCOM have provided the necessary technical and policy guidance, and input to the policy implementation processes in the region. I acknowledge the valued support from our cooperating partners led by the Government of Germany in delegated cooperation with the Governments of UK (UKAid) and Australia (AusAid) managed by the German International Cooperation Agency (GIZ).

Prof. Zebediah Phiri
Executive Secretary, ZAMCOM

ACKNOWLEDGEMENT

It is widely accepted that teamwork has an ability to create high quality outcomes that are not only efficient but thoughtful and effective. This holds true in terms of the preparation of the *Zambezi Environment Outlook (ZEO)*, a unique report produced as a result of collaboration of many experts from across the Zambezi Basin and beyond.

The Southern African Research and Documentation Centre's environment institute, the I Musokotwane Environment Resource Centre for Southern Africa (SARDC IMERCSA), is pleased to present this *Zambezi Environment Outlook* report which highlights the state, trends and outlook of the environment as it relates to the socio-economic issues of the Basin since the year 2000.

In preparing this report, SARDC IMERCSA worked with a number of partner organizations and individuals drawn from all over southern Africa. Key among the partners are the SADC Secretariat led by Dr. Stergomena Lawrence Tax and the Zambezi Watercourse Commission (ZAMCOM) Secretariat led by Professor Zebediah Phiri. We applaud both the SADC Secretariat through its arm, the SADC Water Division, and ZAMCOM for their foresight in engaging in this exercise from inception to the publication of the report.

The process of producing this report was informed and guided by the valuable support of the Steering Committee, consisting of representatives from Member States at policy level, with ZAMCOM, SADC and SARDC as ex-officio members. These included representatives from the Ministry of Energy, Water and Environment, Angola; Ministry of Minerals, Energy and Water Resources, Botswana; Ministry of Irrigation and Water Development, Malawi; ARA Zambeze, Mozambique; Ministry of Agriculture, Water and Forestry, Namibia; Ministry of Water and Irrigation, Department of Water Resources, Tanzania; Ministry of Mines Energy and Water Development, Zambia; and Ministry of Environment, Water and Climate, Zimbabwe. The Committee was responsible for providing the policy guidance needed for the successful implementation of this initiative. In addition, the Committee provided liaison and linkages between the *Zambezi Environment Outlook* process and political processes happening in the Zambezi River Basin and southern Africa.

The preparation of the report was supported by a Technical Committee comprising of ZAMCOM's National Stakeholders Coordination Committee representatives (NASCs) and SARDC's National Collaboration Centres (NCCS). These include representatives from the Ministries mentioned above as well as the Centre for Development Research and Information in Southern Africa (CEDRISA), Malawi; ARA Zambeze, Mozambique; Integrated Rural Development and Nature Conservation (IRDNC), Namibia; and Zambia Environmental Management Agency (ZEMA), formerly the Environment Council of Zambia. This committee was responsible for providing the technical advice to the process. They assisted in developing the outline and shaping the structure of the report, and reviewing the manuscript.

The Coordination Committee comprising of ZAMCOM, SARDC and GIZ was responsible for the management and coordination of the project, and was instrumental in ensuring the successful publication of this report.

For the development of the report, SARDC contracted a number of authors and contributors mainly from within the Zambezi River Basin. This team was composed of multidisciplinary specialists who included civil engineers, hydrologists, geographers, gender and energy experts, specialists in indigenous knowledge systems, water resources management specialists and media experts among others. The chapters were drafted and then reviewed by experts from the sectors covered in the report, before and during the Zambezi Environment Outlook Review Workshop.

The contribution of Clever Mafuta and Dr. Washington Ochola in developing the scenarios chapter is second to none. Mr Mafuta also helped in simplifying the Driver-Pressure-State-Impact-Response framework during the review workshop which ultimately helped in the structuring of chapters.

Oliver Chapeyama was am innovative and highly regarded facilitator during sessions in most of the workshops, and he played a key role in mobilizing the ideas and cohesion that provide the foundation of the report. The process benefited a lot from him as he always posed thought-provoking questions which helped stakeholders to think in other terms and always kept them engaged.

We acknowledge with deep appreciation the creative work by the SARDC design and publishing team who worked tirelessly to ensure an engaging product that is presented in an attractive and accessible manner. A report of this caliber is only possible when design and publishing is uncompromised. We highly appreciate the hard work and long hours, and exceptional creativity, of Tonely Ngwenya and Anisha Madanhi supported by Shirley Pisirai, who gave the report its navigational tools with such a well-organized and visual impact.

We make special mention of our Executive Director, Munetsi Madakufamba who through his wisdom has been our source of inspiration in the most difficult times. To the SARDC logistics team chaired by the Financial Services Manager, Dambudzo Jambwa, and Joseph Ngwawi, a patient and supportive editorial guru who heads SARDC's Regional Economic Development Institute, we highly value your support and advice.

Phyllis Johnson, our Founding Director and Special Projects, we thank you for your active engagement thorough technical review and knowledgeable eye for accuracy that made this report a cut above the rest.

The IMERCSA staff who worked tirelessly to make this product a success, we greatly appreciate your enthusiasm, determination and commitment. A detailed list of authors, contributors, reviewers, partners and the production team is found in the introductory pages of this report.

The contribution and pivotal role of all institutions and individuals who supported the preparation of this report and may not have been credited by name is gratefully acknowledged.

The ZEO report was produced with financial support from the Government of Germany in delegated cooperation with the Governments of UK (UKAid) and Australia (AusAid) managed by the German International Cooperation Agency (GIZ).We say thank you for your essential support.

Egline Tauya
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ACRONYMS

ABS	Access and Benefit Sharing
AfDB	African Development Bank
AIDA	Accelerated Industrial Development of Africa
APINA	Air Pollution Information Network-Africa
APPSA	Agricultural Productivity Programme for Southern Africa
AFSUN	African Food Security Urban Network
ASWAp	Agricultural Sector Wide Approach
ARWR	Annual Renewable Water Resources
CA	Conservation Agriculture
CAADP	Comprehensive African Agricultural Development Programme
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resource Management
CER	Certified Emission Reduction
CFLs	Compact Florescent Lamps
CITES	Convention on International Trade in Endangered Species
CFCs	Chlorofluorocarbons
CSR	Corporate Social Responsibility
COMESA	Common Market for Eastern and Southern Africa
CoP	Conference of Parties
CSIR	Council for Scientific and Industrial Research
CFLS	Compact Florescent Lamps
DANIDA	Danish International Development Agency
DDT	Dichlorodiphenyltrichloroethane
EAPP	Eastern Africa Power Pool
ECZ	Environmental Council of Zambia
EIA	Environmental Impact Assessment
ENSO	El Niño Southern Oscillation
ESAP	Economic Structural Adjustment Programme
ESCOM	Electricity Supply Commission of Malawi
FAO	Food and Agriculture Organization
FAOSTAT	FAO Statistical Database
FCPF	Forest Carbon Partnership Fund
FGLPA	Framework and Guidelines on Land Policy in Africa
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GEF	Global Environment Fund
GHG	Greenhouse Gases
GWP	Global Water Partnership
HCB	Hydro Cahora Bassa
HWLC	Hot Water Load Control
IAS	Invasive Alien Species
IKS	Indigenous Knowledge Systems
ILO	International Labour Organization
IMERCSA	I Musokotwane Environment Resource Centre for Southern Africa
IPCC	Intergovernmental Panel on Climate Change
IRNDC	Integrated Rural Development and Nature Conservation
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
KAZA	Kavango Zambezi TFCA
LLWC	Lilongwe Wildlife Centre
NCAR	National Centre for Atmospheric Research

NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Plan of Action
NASC	National Stakeholders Coordination Committees
NEPAD	New Partnership for Africa's Development
NOAA	National Oceanic and Atmospheric Administration
MDG	Millennium Development Goals
MEA	Multilateral Environmental Agreements
MSIOA	Multi-Sector Investment Opportunity Analysis
ODS	Ozone Depleting Substances
PIDA	Program for Infrastructure Development in Africa
POPs	Persistent Organic Pollutants
PRODEL	Empresa de Produção de Electricidade
PWMAZ	Parks and Wildlife Management Authority of Zimbabwe
RDC	Rural District Council
RECs	Regional Economic Communities
RERA	Regional Electricity Regulatory Association
REDD+	Reduced Emissions from Deforestation and forest Degradation
RETOSA	Regional Tourism Organization for Southern Africa
RIDMP	Regional Infrastructure Development Master Plan
RISDP	Regional Indicative Strategic Development Plan
RSAP	Regional Strategic Action Plan
SADC	Southern African Development Community
SADCWD	SADC Water Division
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
SAPP	Southern African Power Pool
SARDC	Southern African Research and Documentation Centre
SARCOF	Southern Africa Regional Climate Outlook Forum
SE4ALL	Sustainable Energy for All
SPGRC	SADC Plant Genetic Resources Centre
SWH	Solar Water Heaters
TFCA	Trans Frontier Conservation Area
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNWTO	United Nations World Tourism Organization
WIMSA	Working Group of Indigenous Minorities in Southern Africa
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization
WTTC	World Travel and Tourism Council
WWF	World Wide Fund for Nature
ZACPLAN	Zambezi River Action Plan
ZACPRO	Zambezi Action Plan Project
ZAMCOM	Zambezi Watercourse Commission
ZAMSEC	Zambezi Watercourse Commission Secretariat
ZAMWIS	Zambezi Water Information System
ZAMTEC	ZAMCOM Technical Committee
ZELA	Zimbabwe Environmental Law Association
ZEMA	Zambia Environmental Management Agency
ZESCO	Zambia Electricity Supply Corporation
ZINWA	Zimbabwe National Water Authority
ZIMOZA	Zimbabwe, Mozambique and Zambia
ZRA	Zambezi River Authority
ZRB	Zambezi River Basin

COMMON AND SCIENTIFIC NAMES

Acacia	*Acacia mellifera, Acacierioloba,acacipolyacanthna*
African blackwood	*Dalbegia melanoxylon*
African wild dog	*Lycaon pictus*
African ebony	*Afzelia quanzensis*
African potato	*Hypoxi hemerocallidea*
African star chestnut	*Sterculia Africana*
African sugar bush/ mubondo	*Protea gaguedi*
African wattle, weeping wattle	*Peltophorum africanum*
African wild silk moth	*Gonometa*
Baobab	*Adansonia digitata*
Barotse water snake	*Crotaphopeltis barotseensis*
Beans	*Phaseoulus vulgaris*
Bird plum, brown ivory	*Berchemia discolour*
Black rhinocerous	*Diceros bicornis*
Bloodwood	*Pterocarpus angolensis*
Blue wildebeest	*Connochaetes taurinus*
Brick red ochna/ muminu	*Psorospermum febrifugum*
Bushman's hat	*Hoodia gordinni*
Bushveld bluebush,star apple	*Diospyros lycioides*
Cassava	*Manihotesculenta*
Common rye	*Setaria palustris*
Common stingless bee	*Trigona beccarii gribodo*
Depa vine	*Cissus integrifolia*
Dwarf sungazer	*Cordylus*
False mopane	*Julbernardia, Guibourtia coleosperma*
Gladde rooiopslag	*Euphorbia inaequilatera*
Groundnut	*Arachishypogaea*
Guinea grass	*Panicum maximum*
Heirloom roses	*Floribunda*
Hissing tree, mabola plum	*Parinari curatellifoli*
Honey bee	*Apis mellifera*
Kafue reed frog	*Hyperolius pyrrhodictyon*
Kapenta	*Liomnothrissa miodon*
Kariba weed	*Salviniamolesta*
Lantana	*Lantana camara*
Mukwa	*Brachystegia spiciformis,Combretum collinum*
Monitor lizard genus	*Varanus*
Monkey fingers	*Friesodielsia abovata*
Mopane	*Colophospermum mopane*
Nile tilapia fish	*Oreochromisniloticus*
Panga panga	*Parinari cuterfolia,parinarnsisi cape*
Pod mahogany	*Pterocarpus angolensis*
Pepperbark	*Walburgia salutaris*

Prince of Wales feathers	*Brachystegia boehemii*
Python	*Python natalensis*
Red water fan	*Azollafiliculoides*
Rock albizia	*Albizia brevifolia*
Savannah dwaba-berry	*Friesodielsia abovata*
Sickle bush	*Dichrostachys cinerea*
Silver cluster leaf	*Termiinalia formis*
Smooth creeping milkweed	*Euphorbia inaequilatera*
Snapdragon	*Gmelia aborea*
Snotapple	*Azanza garckeana*
Sour plum	*Ximenia caffra.*
Sugar plum	*Uapaca kirkiana*
Sweet potatoes	*Ipomeabatatas*
Tamalindi	*Terminalia sericea*
Tamarind	*Tamarindus indica*
Tsessebe antelope	*Damaliscus lunatus*
Umbrella thorn	*Acacia tortilis*
Water hyacinth	*Eichhorniacrassipes*
Wattled crane	*Bugeranus carunculatus*
Water lettuce	*Pistiastratiotes*
White rhinoceros	*Ceratotherium simum*
White thorn	*Camphlacantha*
Woodland waterberry	*Syzgium guineense*
Zambezi teak	*Ziziphus mucronata*
Zebrawood	*Baikiaea plurijuga*

INTRODUCTION

The Zambezi Environment Outlook provides an integrated analysis of the shared natural resources of the Zambezi River Basin, taking into account the ecological, social and economic issues. These three factors are critical to achieving a state of sustainability in the Basin. The rational for sustainable natural resource management is to achieve a balance between human demand on natural resources and the natural environment's ability to meet these demands.

The report, which comes 15 years after the publication of the widely acknowledged S*tate of the Environment Zambezi Basin 2000*, assesses the current state of the environment in the Zambezi Basin. It reflects on environmental trends since the last report, while looking into the future by suggesting alternative development paths.

As human activity and climate change and variability have brought drastic changes to the state of the environment in the Zambezi River Basin over the past decade and a half, impacting on socio-economic development, there is an expressed need to keep the state, trends and outlook of the environment under continuous review. The Zambezi Basin has been described as the focal point in terms of water resources such as wetlands and fisheries, energy, wildlife, biodiversity, conservation, tourism and settlement models. The *Zambezi Basin Outlook* brings these issues into focus, to enable decision makers and general public to take positive steps in reversing negative environmental change impacting on the resources.

The Outlook is produced under the project's theme of "Strengthening basin-wide cooperation and regional integration". This has been inspired by the ZAMCOM Agreement which in its preamble is conscious of the "advantages of regional cooperation with regard to the utilization and development of common water resources and the significant contribution which such cooperation could make towards the peace and prosperity of the Southern African Region". The theme resonates well with the Zambezi River Basin Integrated Water Resources Management (IWRM) Strategy of 2008, whose overall objective is "equitable sustainable utilization of water for social and environmental justice, regional integration and economic benefit for the present and future generations." This is in line with the SADC regional integration agenda. The Zambezi River Basin is an integrating factor in the SADC region, given its diverse shared and transboundary resources.

Building on the existing frameworks of cooperation and integration, the *Zambezi Environment Outlook* report profiles the Zambezi Basin's environmental resources as an asset for development, as well as a tool for regional cooperation and integration.

ZEO process

The *Zambezi Environment Outlook* was prepared as part of the Zambezi Environment Outlook project, an initiative by ZAMCOM and SADC. This was implemented by SARDC through its I. Musokotwane Environment Centre for Southern Africa (IMERCSA), with support from GIZ and its partners UK Aid and Australian Aid. The main objective of the project is to strengthen access to environmental knowledge and provide a well-functioning distribution channel, for the promotion of sustainable national and transboundary natural resources management in the Zambezi Basin among decision and policy makers at national, regional and sectoral levels.

The process of preparing the *Zambezi Environment Outlook* was highly consultative and participatory during which consensus was built around basin-wide perspectives and priorities. The preparation of the report started in early 2013 with inception meetings of the Coordination Committee and Technical Committee in Harare, Zimbabwe. The objectives of the Coordination Committee meeting were to provide guidance to the management, planning and implementation of the Zambezi Environment Outlook project, discuss the draft outline of the *Zambezi Environment Outlook* report and provide linkages between the implementing agency and the National Coordination Committees (NASCs).

At the same time, the Technical Committee met to consult partners on the draft outline of the *Zambezi Environment Outlook* report, provide technical guidance to the process of implementing the ZEO Project, ensure ownership of the project by the Zambezi Basin Stakeholders, and gain a deeper understanding of the project and methodology of implementation.

A regional Stakeholder Consultative Conference was then held in May 2013 in Windhoek, Namibia to discuss key issues in the Zambezi Basin, including climate change and other critical issues, for inclusion in the report. Participants included representatives from the ministries responsible for water and environment in the Zambezi Basin, civil society groups, community-based organizations, the academia and media, as well as ZAMCOM and GIZ.

The first Steering Committee meeting met at the time of the Stakeholder Consultative Conference to provide policy guidance to the implementation of the ZEO project, to discuss and agree on terms of reference, ensure ownership of the project by the Zambezi Basins stakeholders, and discuss the draft outline of the Zambezi Environment Outlook report.

This was followed by commissioning of writers and contributors. Each chapter had a Lead Author and Contributors. The role of the Lead Authors and Contributors was to research, analyse and draft the assigned chapter or chapter section, over a fixed timeframe, a period of three months. During collection of data and information, the project team worked with national structures and other initiatives. The draft chapters were then presented to a stakeholders review workshop held in May 2014 in Harare, Zimbabwe. The workshop was held to review and strengthen the draft manuscript of the *Zambezi Environment Outlook*. The workshop also identified key issues for development of the scenarios chapter.

Comments from the review workshop were then incorporated by Lead Authors before the chapters were technically edited by the IMERCSA and SARDC team. This involved ensuring that the report was technically sound with adequate analysis of issues, as well as checking accuracy of facts, filling in gaps identified and ensuring the flow of chapters. Final stages of the process included review of final manuscript, photo research and editorial work. The final manuscript was then approved by the Steering Committee before design and printing.

Analytical framework and approach

The *Zambezi Environment Outlook* uses the Drivers-Pressure-State-Impact-Response (DPSIR) framework. DPSIR is an integrated environmental assessment and reporting framework which aims to show the cause-effect linkages of human and natural action on the environment, and in turn, the resultant change in the state of the environment and human wellbeing.

The end result of environmental assessment is more than just knowing the state of the environment. It gives policymakers and other stakeholders guidance on how to better manage the environment. In order to achieve this, information obtained from such reports should be integrated with other social and economic data and information to assist in policy formulation.

Application of the DPSIR framework was interactive rather than linear. That means analysis could start from any of the elements of the framework as long as all the parts were discussed, forming a story line. The elements are explained in detail below.

Drivers

These are indirect or underlying driving forces and fundamental processes in society which drive activities having a direct impact on the environment. Examples of drivers and pressures include demographics, culture, technology, agriculture, consumption, industry and governance. For water availability, an example of a driver indicator is: internal renewable water resources per capita/per year.

Pressures

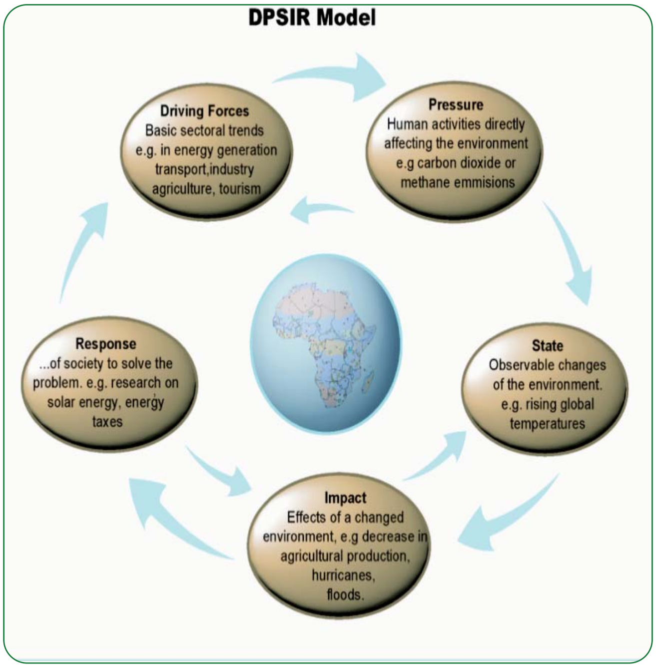
Pressures are sometimes referred to as direct drivers. They include social and economic sectors of the society. These factors are thought of as "root causes" of environmental problems and trends. Pressures are intentional or unintentional by-products of other human activities (ie air pollution). Examples include population, production and consumption, poverty, urbanization, industrialization, technological developments, governance, regional conflicts and globalization of trade. Examples of pressure indicators are: amount of water abstracted in particular sectors, eg agriculture; Change in amount of water over a period of time, such as 30 years. Drivers and pressures are starting points for tackling environmental issues.

State
State indicators show the current condition of the environment as a result of drivers and pressures, such as polluted water resources, degraded land, or deforested areas. Examples of state indicators are: fresh water available for use (household, agriculture, industry); percentage of population with water supply.

Knowledge about the state and pressures is the starting point for planning how the environment can be influenced to improve human wellbeing. Trend data is useful when assessing the state of the environment.

Impacts
Impact indicators describe the ultimate effects of changes of state, for example, percentage of children suffering from lead-induced health problems, mortality due to noise-induced heart attacks, or number of people starving due to climate-change induced crop losses. Impact indicators describe functional changes resulting from changes in the characteristics of the environment. They may be environmental, social or economic, contributing to the vulnerability of both people and the environment. Examples of impacts are: change to a forest cover, flooding, drought, food insecurity, and land degradation. Examples of impact indicators are: change in irrigated land area, number of water-related conflicts, and frequency of occurrence of natural disasters, eg floods and droughts. Understanding impacts is useful in identifying policy options and actions to mitigate and/address the issue.

Responses
Responses indicate societal or individual actions taken to overcome, reduce, correct or prevent negative environmental impacts or protect natural resources. Examples of responses include regulatory action, environmental or research expenditures, development of guidelines/standards, changes in management strategies, best practices as well as provision of environmental information. Responses may be made at different levels, eg environmental laws and institutions at national level, and Multilateral Environmental Agreements (MEAs) and institutions at the regional and international levels. Examples of State indicators are: number of water management programmes in place, and level of implementation of environmental management policies and legislation. The DPSIR framework is shown in the diagram.



Institutional framework for Zambezi Environment Outlook project

The Zambezi Environment Outlook project has three committees, each having a specific mandate. These are the Steering, Technical and Coordination committees. The Steering Committee which met twice over the project's duration, is made up of representatives from Zambezi Basin countries at policy level. The Technical Committee comprises of representatives from Zambezi Basin countries at technical level both from NASCs and from SARDC's longstanding National NCCs. The Coordination Committee comprises of ZAMCOM Secretariat, SADC Water Division, SARDC and GIZ.

Structure of the *Zambezi Environment Outlook*

The report has 10 chapters which are interlinked. It presents the basin's physical environment and how people interact with the natural resources. Crosscutting issues including gender and youth, climate change, pollution, transboundary issues, indigenous knowledge systems, and technological developments are mainstreamed in all chapters. In areas where gender disaggregated data was available it was used. Emerging issues relevant to each chapter are reviewed as well. Institutional framework and policy issues are included in each chapter, as part of response measures in the DPSIR framework. Each chapter starts with an introduction, which describes the sector/theme, value derived from the sector/theme, as well as issues/challenges and opportunities.

The main body discusses issues/challenges and opportunities in detail by applying DPSIR analytical framework. It is here where trend analysis and connection to the running theme is done. Issues are from the thematic chapters such as water resources and biodiversity while challenges and opportunities are from the sector chapters such as tourism and industrial development.

Each chapter concludes by giving an analysis of policies and institutional arrangements, measuring success in terms of reaching goals/targets.

Chapter 1 - Overview of the basin

The first chapter of the *Zambezi Environment Outlook* gives a general overview of the Zambezi Basin, including socio-economic and biophysical conditions. Specific socio-economic issues covered in the chapter are population, population density and distribution, population growth, people and culture, gender roles in the basin, urbanization and poverty and development. Biophysical features include climate and geographic conditions such as soils, topography and biomes.

Chapter 2 – Water resources

The second chapter takes a look at freshwater resources in the basin as well as its distribution and management. The issues include freshwater availability and access, water withdrawals, non-consumptive uses of water, inter-basin water transfers, water quality, aquatic invasive species, wetlands and wetlands degradation, fisheries, transboundary issues, and other freshwater resources. Gender, water and sanitation as well as youth and water issues are discussed. Challenges faced by women and girls as they collect water from afar are discussed. An analysis is made of women's access to wetland resources. Policies and institutional arrangements include Revised SADC Protocol on Shared Watercourses, Regional Strategic Action Plan Phase III, ZAMCOM Agreement and IWRM Strategy, and regional cooperation in water resources management.

Chapter 3 - Land and Agriculture

The third chapter covers land and agriculture issues in the Zambezi River Basin. Role of land as a factor for production and livelihoods is analysed, as well as trends associated with land resources. Key land issues articulated include, tenure, access and equity with emphasis to access and ownership by women as tillers of land, allocation of agricultural activities by gender, degradation, and impact that land issues have on food security. On agriculture, the chapter analyses trends in cereal production, land under agriculture and irrigation, as well as livestock production. Emerging issues discussed include largescale acquisition of land for biofuels. Regional policies on agriculture are discussed.

Chapter 4 – Biodiversity and Forests

This chapter details the basin's biodiversity and forest resources. Focus areas include biodiversity species and richness, threats to biodiversity (habitat loss and species loss), wildlife diversity, threatened species, protected areas, forest cover and change, biodiversity and forest conservation, related institutional and policy frameworks, as well as transfrontier conservation areas. The chapter discusses gender roles in forest issues such as women as basket makers, as well as involvement in biodiversity and forest conservation.

Chapter 5 – Climate Change and Variability

The chapter covers climate change and variability issues in the basin. The chapter looks at rainfall and temperatures, Green House Gas (GHG) emissions, droughts, floods, adaptation, mitigation, early warning systems, and disaster preparedness. Gender, youth and climate change issues and indigenous knowledge systems in adaptation are discussed. The chapter also focuses on related institutional and policy frameworks in place in the Zambezi River Basin as well as the global protocols and agreements such as the Kyoto Protocol and the United Framework Convention on Climate Change (UNFCCC).

Chapter 6 –Energy
The chapter analyses energy developments in the Zambezi River Basin, including hydropower, thermal energy as well as renewable energy sources such as biofuels. The chapter shows that the majority of the population still depend on biomass as energy. The chapter takes a look at institutional and policy developments in energy.

Chapter 7– Urbanization and Human Settlements
The chapter describes urbanization and human settlements in the basin, and key issues associated with them, including waste management, pollution, sanitation, and access to services such as roads and water.

Chapter 8 – Tourism
Tourism is an important income earner in the Zambezi River Basin and depends largely on good care of the environment. The chapter analyses tourism developments and trends, ecotourism, cultural tourism, as well as related developments in the sector. Policies and institutional frameworks related to tourism are analysed in the chapter. In addition, the chapter looks at threats and opportunities in the tourism sector by gender groups such as women and youth.

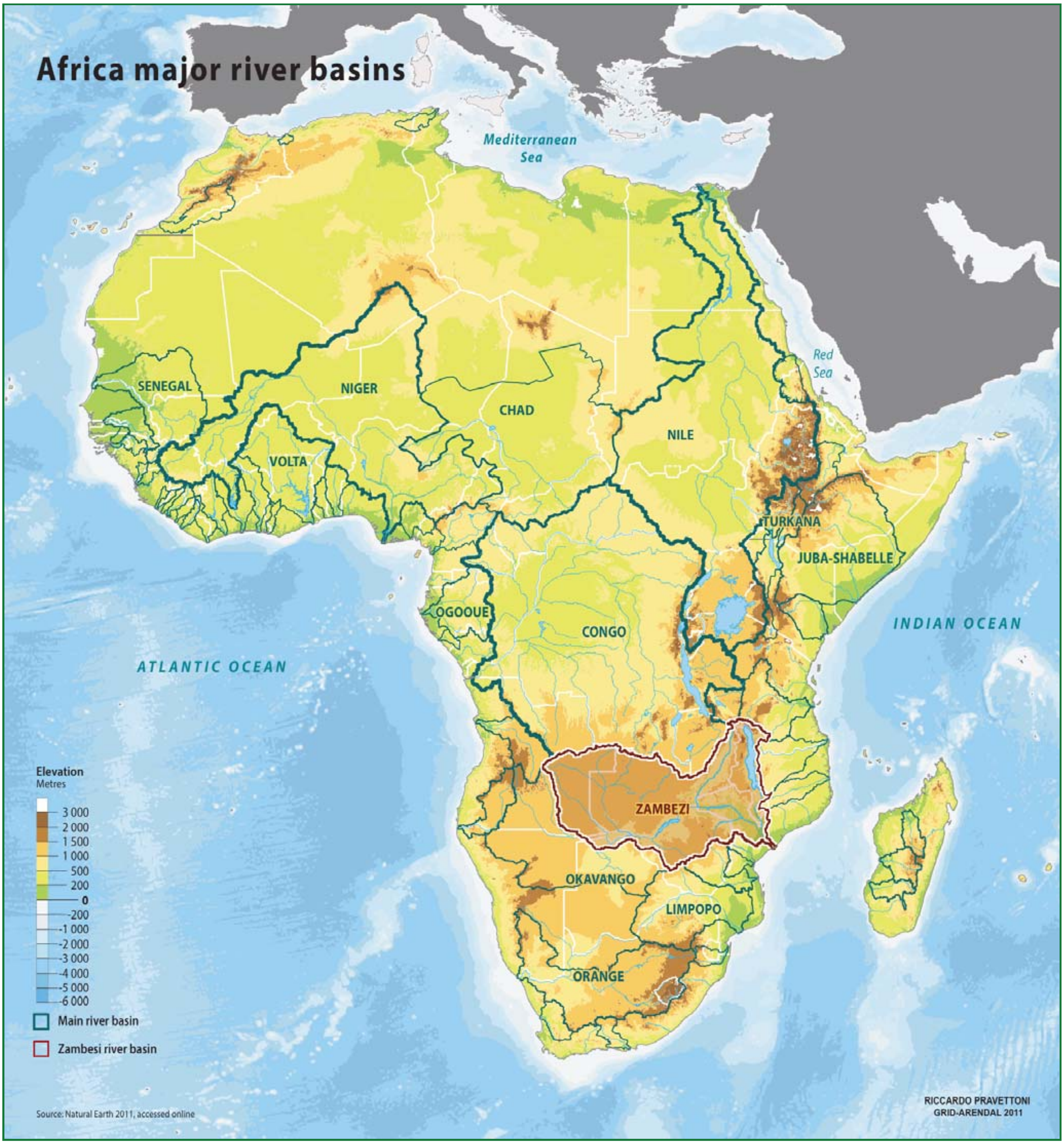
Chapter 9– Industrial Development
The chapter looks at state of industrial developments in the basin, including manufacturing and mining industries. The chapter discusses the wealth of mineral resources in the basin, and how to take care of it. The chapter looks at impacts of industrial development on the environment and the surrounding community, with particular emphasis to different gender groups, and measures being taken to address these. Women venturing into mining were also discussed. The chapter discusses chemicals and waste, and pollution as a result of industrial activity and how this is being addressed.

Chapter 10 – Scenarios
The scenarios chapter is a presentation and analysis of current and projected future trends, as they relate to the resources described in the earlier chapters. The chapter gives a 30-year forward-looking analysis of the way two possible scenarios could play out. The scenarios discussed are the Conventional World (Business as Usual), and the Sustainability World (Policy Reform). The former depicts plausible future environmental developments along a trajectory that represents a continuation of current trends without major policy shifts. The latter depicts a future where deliberate attempts are made to manage the environment in ways that meet nationally, regionally and internationally agreed development goals with clear targets for basin sustainability.

Target audience
The expected audience for the *Zambezi Environment Outlook* includes:

- Decision and policy makers at national, basin and regional level such as ministers, permanent secretaries, heads of departments and other senior officials;
- Academics and researchers on related issues, universities and research institutions;
- Media editors of newspapers, magazines, newsletters, radio/television and online as well as journalists, particularly those who write about environmental and regional issues;
- Environmental organizations including NGOs, community-based organizations, water resources and environmental specialists;
- Educational institutions including teachers, students at secondary and tertiary level;
- Private sector such as corporations, trade unions, financial institutions, industries, mining, and tourism;
- Cooperating partners, donors and development agencies; and
- The public, anyone who is interested in the issues presented here.

Map 1.1 **Major River Basins in Africa**



GRID-Arendal 2011 in SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

ZAMBEZI BASIN OVERVIEW 1

Introduction

The Zambezi River Basin represents the best of what southern Africa has in terms of shared natural capital. The river and its dense network of tributaries and associated ecosystems constitute one of southern Africa's most important natural resources. Within the basin's large expanse, there exists an integrated ecosystem of natural resources that encompasses water, land and soils, forests and wildlife.

The natural capital in the basin defines the economic activities that range from agriculture and forestry, manufacturing and mining, to conservation and tourism, as well as scientific monitoring and research. As a transboundary resource that is subject to management and use by various sectoral and national interests, the Zambezi Basin is highly prone to overexploitation and unsustainable short gains rather than long-term sustainable development. Climate change, coupled with human pressure on resources, has resulted in inevitable changes in the basin's environment. The changes have had profound impacts on women, men and children, who have different levels of capacity, skills and ability to adapt due to different roles, opportunities and access to resources.

The first chapter of this report, the *Zambezi Environment Outlook*, gives a general overview of the Zambezi Basin, including a socio-economic overview and biophysical condition of the basin. Specific socio-economic issues covered in this chapter are population, population density and distribution, population growth, people and culture, gender, urbanization, and poverty and development. Biophysical features include climate and geographic conditions such as soils and topography and biomes.

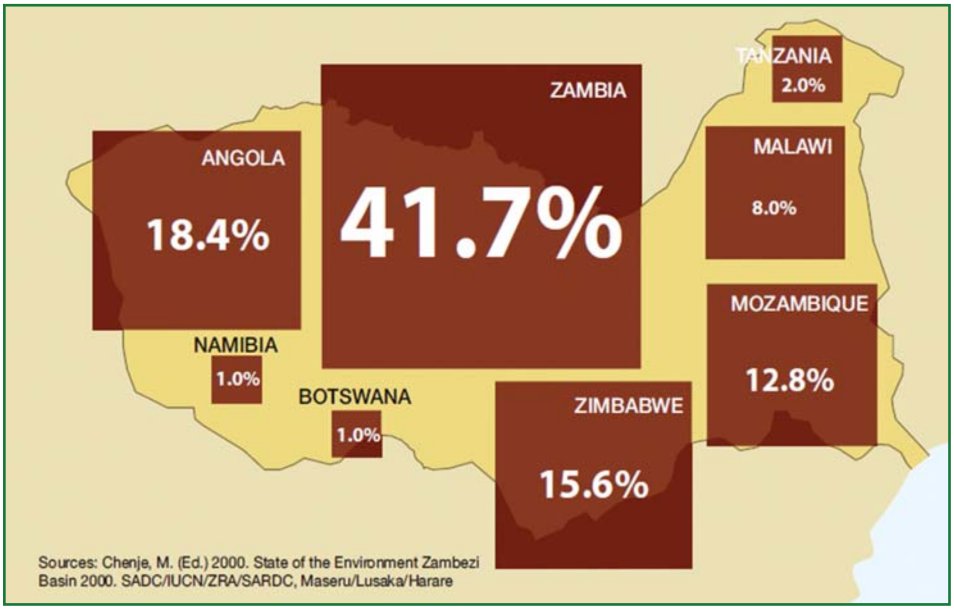
Physical Characteristics and Hydrology of the Basin

The Zambezi River, together with its tributaries, forms the fourth largest river basin in Africa after the Congo, the Nile, and the Niger River basins, covering about 4.5 percent of the continent. The Zambezi River Basin is located in central southern Africa between 8-20° S latitude and 16.5-36° E longitude. It drains an area of almost 1.4 million square kilometres, stretching across eight of the 15 Member States of the Southern African Development Community (SADC) – Angola, Botswana, Malawi, Mozambique Namibia, Tanzania, Zambia and Zimbabwe.

The Zambezi Basin covers almost all of the territory of Malawi, which at 94,080 sq km is the smallest basin state; most of Zambia; and about half of Zimbabwe, including the most densely populated urban areas. Significant portions of Angola and Mozambique are within the basin, but only small parts of Botswana, Namibia and Tanzania.

With regard to the total Zambezi Basin area, Zambia takes up the largest portion with 41.7 percent, followed by Angola (18.4%), Zimbabwe (15%), Mozambique (12.8%), Malawi (8%), Tanzania (2%), and Botswana and Namibia at one percent each.

Figure 1.1 **Zambezi River Basin – Share by Country**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

The Zambezi River flows over a distance of almost 3,000 km, dropping in altitude from its source in the Kalene Hills in the north-western district of Solwezi in Zambia at 1,585 metres above sea level, to its delta where it enters the Indian Ocean 200 kilometres north of the Mozambican port of Beira.

The topography of the river basin varies in altitude from sea level at its delta to more than 1,500 metres on the plateau, with some mountainous areas rising above 2,500 metres. The plateaus are deeply dissected by the river valleys that form the tributaries of the Zambezi River, opening out into wide floodplains and plunging more than 100 metres into the gorge at the Victoria Falls, with a volume of water up to 550 million litres a minute in full flood.

The Zambezi is the largest and most shared river basin in southern Africa. The river has three distinct stretches: the Upper Zambezi from its source to Vic-

Cahora Bassa Dam

Box 1.1 **VICTORIA FALLS**

Mosi oa tunya ***Chinotimba*** ***Mapopoma*** ***Amapopoma efolosi***

The famous Victoria Falls, shared by Zambia and Zimbabwe, is known by the Kololo inhabitants of the northern bank of the river as *Mosi oa Tunya* – *The smoke that thunders*, the Nambya people on the southern bank call it *Chinotimba* — T*he place that thunders*, and that is now the name of a nearby suburb. The Zezuru name is *Mapopoma* which imitates the sound made by the Falls, and the Ndebele description often used is *Amapopoma efolosi*. The Falls were named by the first British visitors in honour of their Queen Victoria and became widely identified by this name. The Victoria Falls is a UNESCO World Heritage Site.

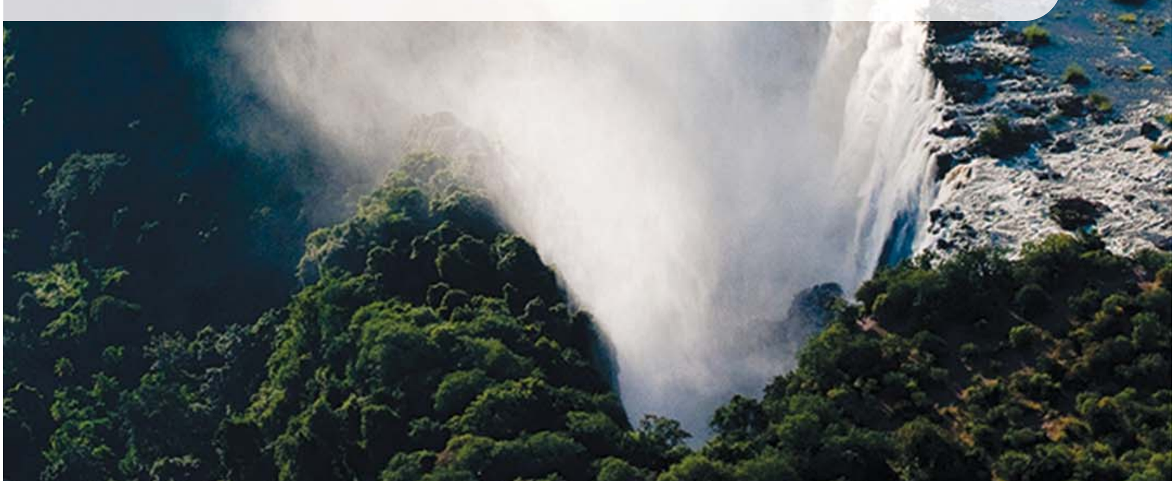
The Falls are 1.7 kilometres wide — 1,708 metres.
The depth from the highest point is 103 metres.
The volume of water is more than 550 million litres a minute in full flood.
Victoria Falls publicity says it is the "largest curtain of falling water in the world."

The Main Falls drop 93 metres into the gorge with peak water flows of 700,000 cubic metres per minute, throwing up a spray that waters the surrounding rainforest with its many unique species of trees, plants, birds and small mammals, and is visible several kilometres away, as well as from the air. The flow is at its peak from February through to June, as the waters from the vast northern catchment arrive. The clouds of spray rise ever higher and can be seen 30km away.

The whole drainage system of southern/central Africa adds a further dimension to the protracted birth and present course of the Zambezi River and the very existence of Victoria Falls. Southern Africa is like an upturned dish. The coastal belt is generally narrow and low lying. Further inland this varying width of strip gives way to an escarpment, precipitous in places, long and steep in others. Streams and rivers rise above the escarpment which is 1,000 to 1,400 metres above sea level. Some flow into lakes. Others must find their way down the escarpment to the sea. As a result, all of the main rivers in southern/central Africa have falls or rapids as they drop towards the sea. That is an inevitable part of the levelling out process. Victoria Falls is the most spectacular point in this descent.

The river has slowly but inexorably been cutting backwards, exposing one weakness after another in the basalt base and creating the zigzag pattern of gorges visible from the air. Today, imperceptibly, we are witnessing new changes in the line of the river and location of the Falls.

African Publishing Group guidebook to Victoria Falls by David Martin



toria Falls, the Middle Zambezi from Victoria Falls to Cahora Bassa, and the Lower Zambezi from Cahora Bassa to the delta.

It has tributaries along both banks. These include Luena, Luanguinga, Lungué-Bungo and Cuando in Angola; Chobe in Botswana; Shire in Malawi; Luiana in Namibia; Kapombo, Kafue and Luangwa in Zambia; and Manyame, Sanyati and Gwayi in Zimbabwe. It has 13 sub-basins, and most of these are transboundary.

Four major dams are located in the Zambezi River Basin. The Kariba Dam and the Cahora Bassa Dam are located on the Zambezi River with installed electricity generation capacity of 1,350 and 2,075 Megawatts (MW), respectively. The Kafue Dam, with an installed capacity of 900MW, and Itezhi-Tezhi, which acts as a storage dam, are located on the Kafue River. Both the Kariba and Kafue dams are being upgraded and significant work is underway towards planning new infrastructure in the basin.

Social and Cultural Environment

Population Growth and Density

The population of the Zambezi River Basin was 31.7 million in 1998. This represented about one-third of the total population of 100 million in the eight basin states at the time. Ten years later, in 2008, the basin population had reached 40 million, with 7.5 million living in the urban centres. The total population of the eight countries of the Zambezi Basin is expected to reach 168 million by 2025, of which some 51 million will be in the basin (SADC/SARDC and others 2012).

Table 1.1 **Area and Population in the Zambezi Basin**

Country	Total Area of Country (sq km)	Area of Country in Basin (sq km)	As % of Total Area of Country	As % of Total Area of Basin	Total National Population 2000	Projected National Population 2025	Population in the Basin 1998	Projected Population in Basin 2025
Angola	1 246 700	256 500	20.5	18.47	13 302 000	25 940 000	487 200	950 080
Botswana	581 730	19 100	3.3	1.38	1 651 000	2 270 000	12 000	16 500
Malawi	118 484	110 700	93.4	7.97	10 160 000	18 695 000	9 821 400	18 071 955
Mozambique	799 390	163 800	20.5	11.8	17 245 000	26 730 000	3 991 870	6 187 455
Namibia	824 290	17 100	2.1	1.23	1 817 000	2 460 000	60 890	82 438
Tanzania	945 987	27 300	2.9	1.97	32 422 000	56 090 000	1 271 920	2 200 420
Zambia	752 614	577 900	76.8	41.63	10 755 000	18 285 000	7 046 250	11 979 610
Zimbabwe	390 759	215 800	55.2	15.55	13 485 000	17 395 000	9 050 000	11 674 065
Total	5 659 054	1 388 200	24.5	100	100 837 000	167 865 000	31 741 530	51 161 960

SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Table 1.2 **Total Population of Zambezi Basin States**

(000)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Angola	13 399	13 816	14 262	14 662	15 116	15 412	15 864	16 329	16 368	16 889	17 430	17 992
Botswana	1 651	1 622	1 667	1 691	1 711	1 708	1 739	1 757	1 776	1 798	1 822	1 849
Malawi	10 475	10 816	11 175	11 549	11 938	12 341	12 758	12 900	13 077	13 520	13 948	14 389
Mozambique	17 242	17 656	18 083	18 514	18 962	19 420	19 889	20 632	21 208	21 803	22 417	23 049
Namibia	1 816	1 830	1 860	1 891	1 923	1 957	1 991	2 028	2 065	2 103	2 143	2 105
Tanzania	31 900	32 884	33 585	34 250	35 268	37 083	38 251	39 446	40 668	41 916	43 188	44 485
Zambia	9 886	10 089	10 409	10 744	11 090	11 314	11 642	11 970	12 292	12 626	13 093	13 459
Zimbabwe	11 696	11 666	11 635	11 763	11 982	11 830	12 010	12 040	12 122	12 231	12 336	12 754

SADC, SADC Statistical Yearbook, 2014

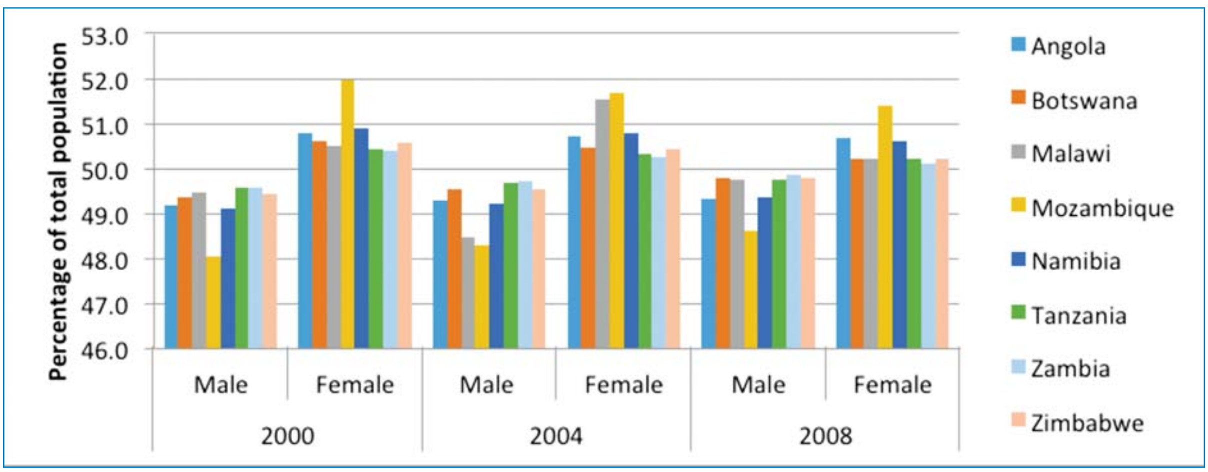
Table 1.3 **Population Growth Rate**

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	(%)										
Angola	3.02	3.13	2.73	3.00	1.92	2.85	2.85	0.24	3.08	3.10	3.12
Botswana	2.40	1.17	1.17	1.17	1.17	1.27	1.27	1.27	1.27	1.27	1.90
Malawi	3.20	3.26	3.29	3.31	3.32	3.32	3.31	2.80	3.14	3.11	3.11
Mozambique	2.37	2.38	2.39	2.39	2.39	2.39	2.75	2.77	2.78	2.79	2.79
Namibia	0.77	1.64	1.67	1.69	1.77	1.74	1.86	1.82	1.84	1.90	-1.77
Tanzania	3.10	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90	2.90
Zambia	2.05	3.17	3.22	3.22	3.17	3.13	3.06	3.01	2.96	2.80	3.10
Zimbabwe	-0.26	-0.27	1.10	1.86	-1.27	1.52	0.25	0.68	0.97	0.86	3.39

SADC 2014

Population growth rate refers to the change in population over a unit time period. A negative growth rate mean a decline in population size, largely due to outward migration.

Figure 1.2 **Population Ratios by Sex in the Zambezi Basin Countries**



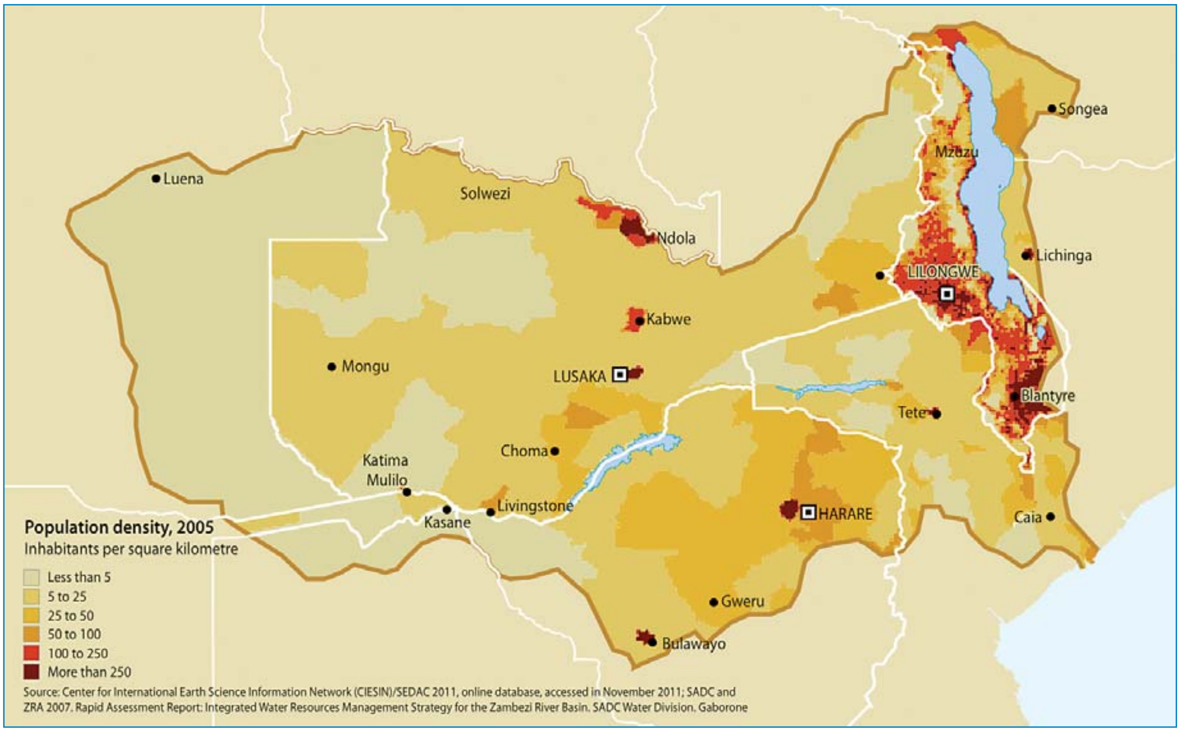
African Development Bank, African Statistical Yearbook, 2009

Table 1.3 on population growth rates of the Zambezi Basin states shows that Angola, Malawi, Tanzania and Zambia having higher growth rates while Botswana, Namibia and Zimbabwe having lower rates. The growth rate is moderate as the HIV and AIDS pandemic has particularly affected the reproductive age group (SADC and ZRA 2007). However, the situation is changing as the impact of HIV and AIDS is declining in most Zambezi Basin States.

There are disparities in population densities and distribution within countries in the basin. Population distribution is uneven, with large areas uninhabited and reserved for wildlife. In 1998, the average population density in the basin was 24 people per sq km, and this increased to 28.75 people per sq km in 2005 before reaching 30.26 people per sq km in 2008 (SADC/SARDC and others 2012).

There are more women than men in the Zambezi Basin, as illustrated in Figure 1.2. Most women reside in rural areas while men are the majority in towns. The gender-specific roles for women and men are a reflection of society's culture, religion, socio-economic, legal and development conditions. However, the roles are in constant change due to dynamic interactions.

Map 1.2 **Population Distribution in the Zambezi River Basin**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Table 1.4 **Population Density**

(population/square kilometre)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Angola	10.7	11.1	11.4	11.8	12.1	12.4	12.7	13.1	13.1	13.5	14.0	14.4
Botswana	2.8	2.8	2.9	2.9	2.9	2.9	3.0	3.0	3.1	3.1	3.1	3.2
Malawi	111.1	114.7	118.5	122.5	126.6	130.9	135.3	139.9	138.7	143.4	147.9	152.6
Mozambique	21.6	22.1	22.6	23.2	23.7	24.3	24.9	25.8	26.5	27.3	28.0	28.8
Namibia	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.5
Tanzania	33.8	34.8	38.9	39.4	40.6	41.9	43.2	44.5	45.9	47.3	48.8	50.2
Zambia	13.1	13.4	13.8	14.3	14.7	15.2	15.7	16.2	16.6	17.1	17.4	17.4
Zimbabwe	29.9	29.9	29.8	30.1	30.7	30.3	30.7	30.8	31.0	31.3	31.6	32.6

SADC, SADC Statistical Yearbook, 2014

Table 1.4 shows that Malawi has the highest population densities in the basin at 111 people per sq km in 2000, rising to 153 people per sq km in 2011. Tanzania follows with 34 people per sq km in 2000 and 50 people per sq km in 2011. Botswana and Namibia have the lowest population densities of 2.8 and 2.2 people per sq km in 2000; and 3.2 and 2.5 people per sq km in 2011, respectively.

Increasing population densities often result in unsustainable water management practices and over-exploitation of accessible freshwater resources.

People and Cultures

The Zambezi Basin has a rich cultural diversity. More than 30 ethnic groups live in the basin, with at least a third of these located in Zambia. Many groups live along at least two national boundaries sharing common cultural traits and vocabularies across borders, although dialectical differences exist. The colonial boundaries demarcating countries were arbitrary and often split people and families across borders.

The ethnic groups in the Zambezi Basin include the Lundas, Luchazes and Tchokwes in Angola; the Tswana in Chobe, Botswana; the Chewa, Tumbuka, Yao, Ngoni, Nyanja and Sena cultures in Malawi; the Sena and Makua in Mozambique; the Bemba, Tonga, Lozi, Luyana, Lunda, Bunda and Chewa/ Nyanja in Zambia; and Shona, Ndebele and Tonga cultures in Zimbabwe, as well as Nambya in Zimbabwe and Namibia (SADC/SARDC and others 2012). People of many different ethnic groups live in urban centres as well as rural areas, and many reside in a different country from their country of origin, often marrying across borders.

Traditional socio-economic activities include fishing, hunting, basket-making and beekeeping. Many plants are used traditionally as medicine. Some of the important medicinal plants include moringa, which many medical practitioners accept as an immune booster, and the African potato *Hypoxis hemerocallidea*, a dark, bulbous and fibrous root of the hypoxis plant. The moringa bush and African potato are now grown and sold commercially, thus reducing the impact from harvesting in the natural habitat. Although these plants are commonly used for their potential health benefits, experts caution that medicinal plants can be toxic if used improperly (SADC and SARDC 2008).

International Nyau Dance Festival, Vila Ulongwe, Tete Province

Antonio Klaus Kaarsberg, 2007

Gender and Youth

Gender equality is firmly rooted in SADC's regional integration agenda and Member States support the fundamental principle that both women and men must be equally engaged in decision-making at all levels and in all positions of leadership (SADC and SARDC 2013). SADC thus recognizes that the equal and meaningful participation and representation of women, who constitute more than half of the populations of Member States, is an important democratic advancement for the region. This is reflected in the SADC Protocol on Gender and Development signed and adopted by SADC Heads of State and Government in August 2008, which was ratified by the requisite two-thirds of signatories and entered into force in 2013. The Protocol has eight clusters with 28 targets which are monitored through the *SADC Gender Monitor*, of which one is 50 percent women representation in political and decision-making positions in the public and private sectors by 2015.

In the Zambezi Basin, as in the rest of southern Africa, there are gender-specific roles for women and men in socio-economic activities such as water resources development and management, agriculture, mining, fishing, hunting and gathering, forestry, tourism, recreation, crafts, transport, and environmental management. Men of all ages are generally responsible for attending social and political meetings as well as hunting, fishing and animal husbandry. Men often make decisions on what crops to grow, what land preparation procedures to use, when to harvest, and how much crop is to be sold, although that varies from culture to culture and has changed in areas where the men were away for a long time as migrant workers.

Women are generally responsible for cooking, tilling gardens, fetching fuel, wood and water, and keep small stock such as goats. Within the fishing industry, both men and women fish but the methods and fishing grounds vary by gender.

Methods also differ for collecting firewood and water. Men use mainly wheelbarrows and/or scotch carts, while women carry the firewood and water buckets on their heads. Women also harvest renewable resources such as thatching grass, reeds, and other grasses to make mats, bowls, and crafts that are sold both in the communities and on the commercial market. Women have other obligations which fall within their domestic domain such as food preparation and the reproductive role, including childcare (SADC and SARDC 2013).

Women play a major role in natural resource management and utilization in the Zambezi Basin. A study in the lower Kafue River Basin showed that water use in Zambia's rural households is strongly determined by the work of women. This includes water collection, domestic water use decisions, irrigation of orchards and fields, and other practices are a primary responsibility of women. The presence of more women in the household implies larger amounts of water collected, since it is mainly the women's role to collect water. The higher the number of women in the household, the higher is the water availability and use (Casarotto and Kappel 2003). Young women and girls are often married at a young age and are expected to provide children, water and wood.

Women mining gold in the Zambezi Basin

Despite significant role of women in agriculture, very few women own land in the Zambezi Basin. Although current laws do not discriminate against women or youths to own land in Zambia, for example, women still lack access to land due to customary practices that encourage male dominance (Environment Council of Zambia 2008). This is the situation in most basin states.

Urbanization

Most countries in the basin are urbanizing rapidly, putting pressure on finite resources as well as on infrastructure. People migrate from rural areas to urban areas in search of better opportunities for employment, health care and education, as well as expecting an improvement in their standard of living. For this reason, large populations of youth live in urban areas, working or looking for work. Major urban areas in the Zambezi Basin include Luena in Angola; Kasane in Botswana; Tete in Mozambique; Katima Mulilo in Namibia; and Mbeya in Tanzania; as well as most urban centres in Zambia including the capital city of Lusaka, all urban areas in Malawi and most in Zimbabwe, including Harare (SADC and ZRA 2007).

The Basin's Natural Capital and Productive Resources Base

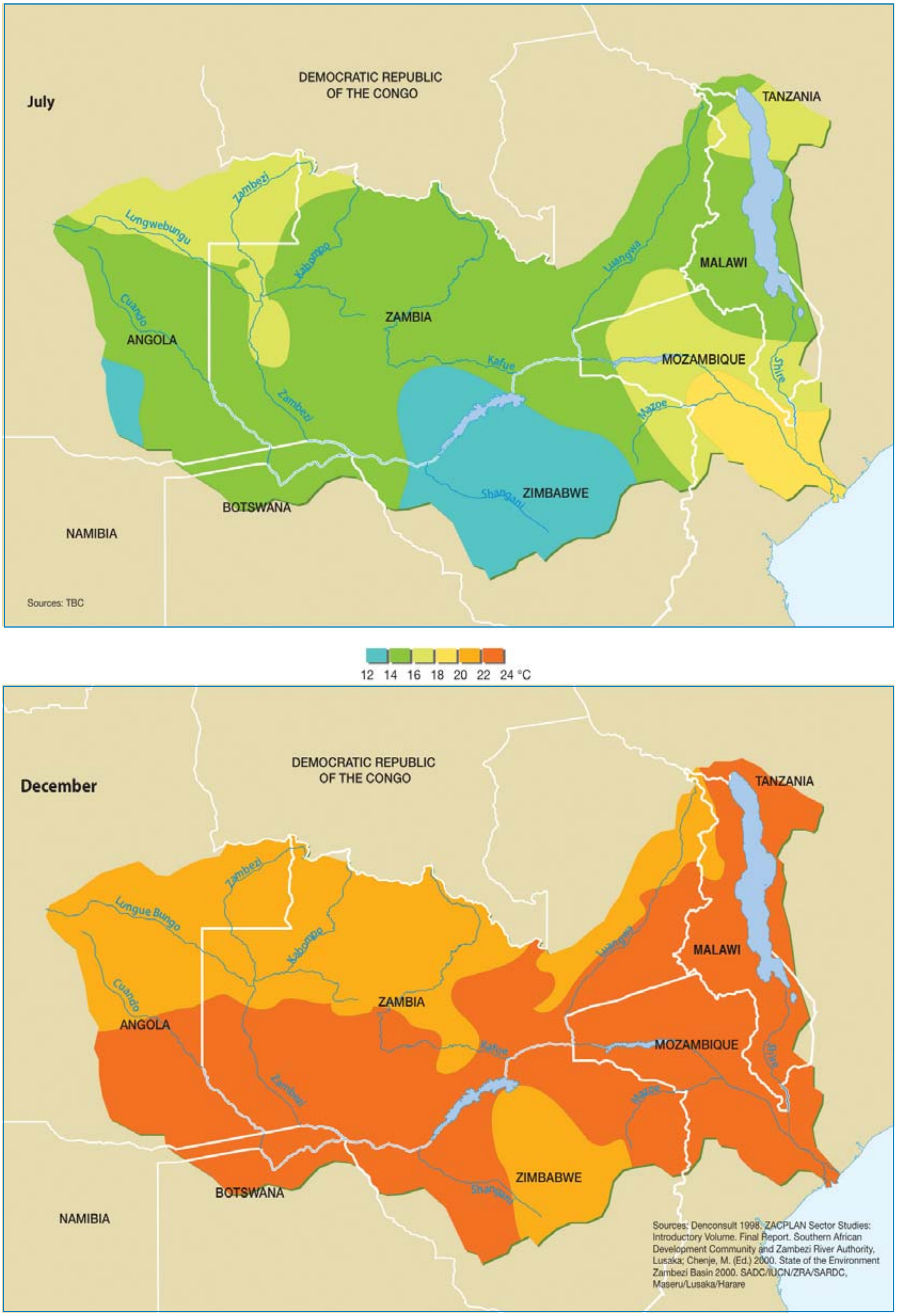
Climate

The Zambezi River Basin's climate is much influenced by the prevailing wind systems that include the south-easterlies, Congo Air, the north-easterlies, and the Inter-Tropical Convergence Zone. Related to these climatic features is the presence of large water bodies, which play a role in modifying weather conditions (SADC/SARDC and others 2012).

The temperatures across the river basin vary according to elevation, and to a much lesser extent, latitude. Mean monthly temperatures for the coldest month, July, vary from around 13°C for higher elevation areas in the south of the basin to some 23° C for the low elevation areas around the delta in Mozambique. The map shows that the coolest area is the south-eastern part, some of which is in Zambia and the rest in the extreme south-eastern area of the basin in Zimbabwe. Ground frost occurs locally in some parts of the basin during June/July as daily minimum temperatures in some higher elevation areas can fall below 0°C.

Large water bodies modify weather conditions

Map 1.3 **Zambezi River Basin Average Temperatures**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

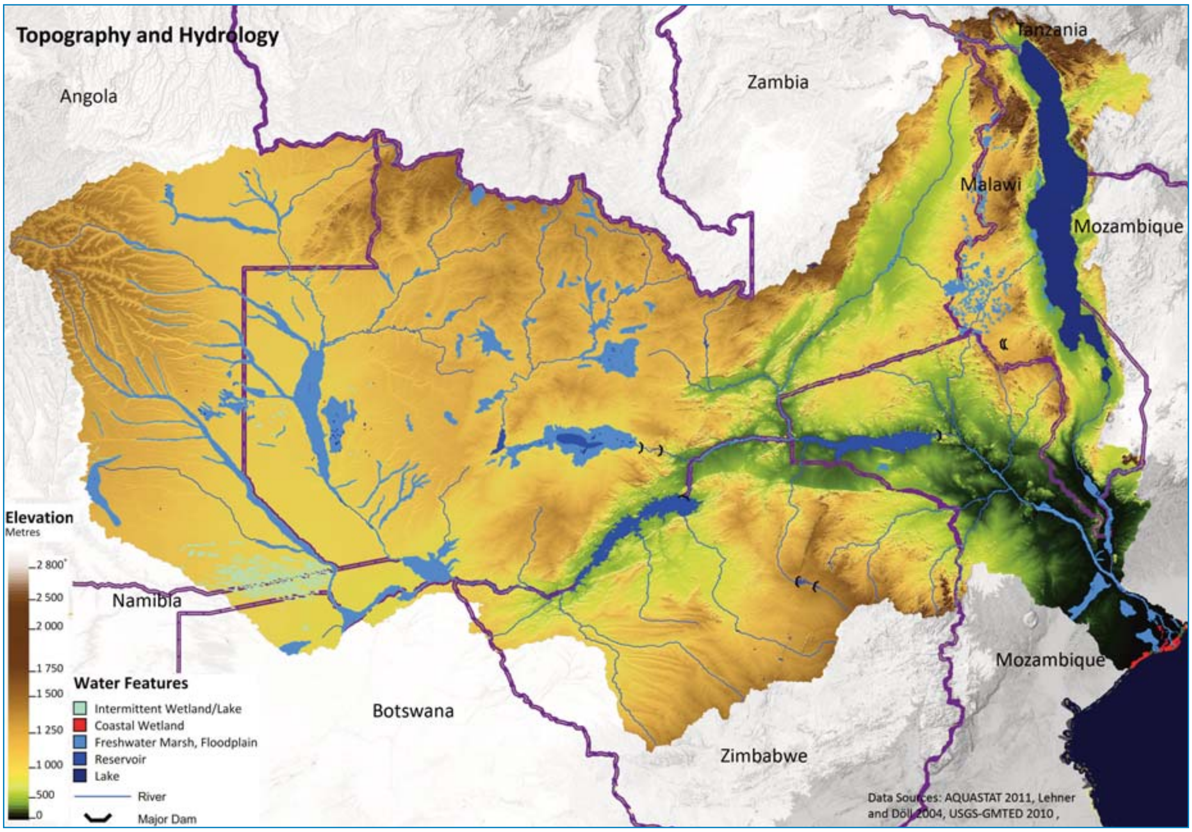
Mean daily temperatures for the warmest months (October and November) vary from 23° C in the highest elevation areas to 31° C in the lower parts of the Zambezi valley (Chenje 2000).The basin experiences a high daily range of temperatures, an average of about 10° C in the rainy season and as much as 20° C in the dry season in the southern parts of Zambia and Zimbabwe. The annual total evaporation ranges between 1,800 and 2,000 mm averaging about five mm per day but can be as high as 9-10 mm per day in September and October. As a result, about 65 percent of all the rain evaporates as soon as it falls, 20 percent is lost through evapotranspiration, and an average of 14 percent is available as surface runoff (Chenje 2000).

Water Resources

The Zambezi River and its dense network of tributaries discharges an average of 2,600 cu m/s of water into the Indian ocean, in the same range as the Nile at 2,830 cu m/s and the Rhine at 2,200 cu m/s (Beck and Bernauer 2011).

The available surface water resources originate from rainfall. Less than 10 percent of the mean annual rainfall in the basin contributes to the flow of the Zambezi River into the Indian Ocean. Thus more than 90 percent of mean annual rainfall in the basin evaporates and returns to the earth's atmosphere. There are significant variations and uneven distribution in the available water resources from one area to another and over time.

Map 1.4 **Zambezi River Basin Topography and Hydrology**



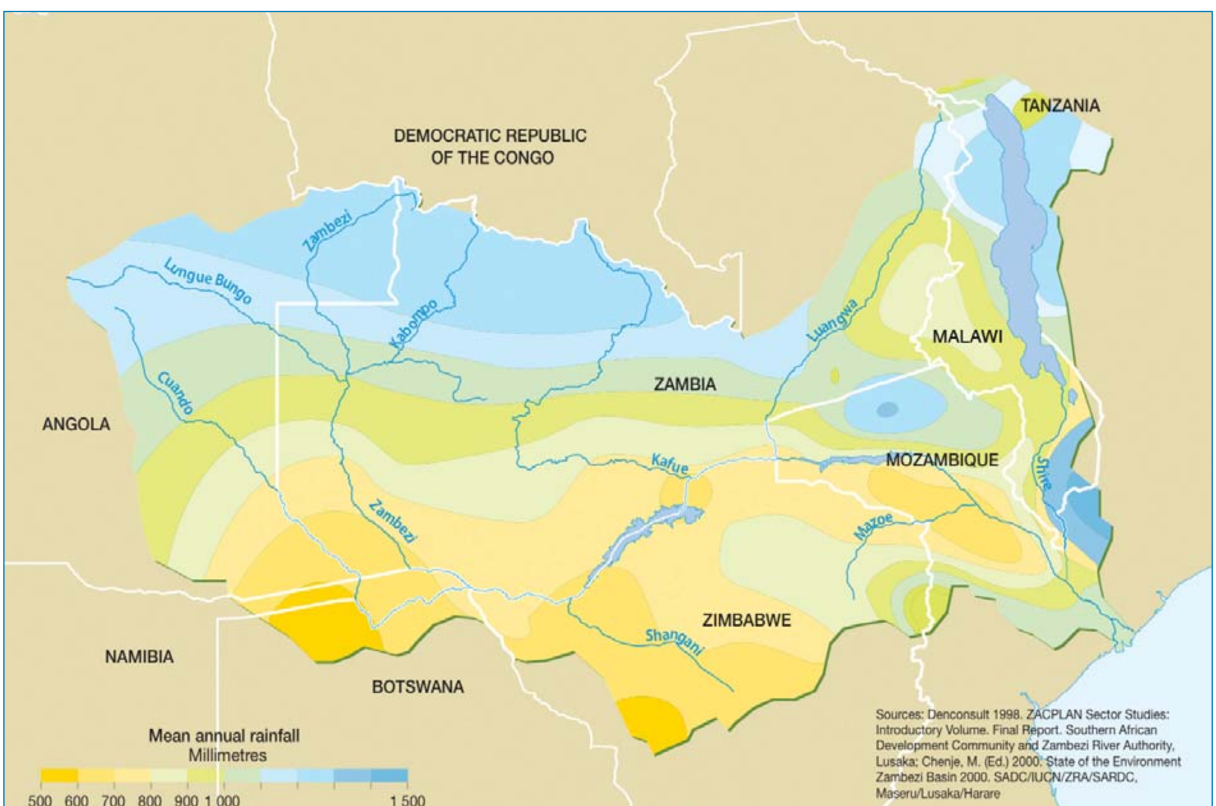
SARDC IMERCSA, I. Musokotwane Environment Resource Centre for Southern Africa, 2015

Rainfall is greatest in the north, with an extensive area receiving over 1,000 mm per year, and declines towards the south, where most areas receive less than 700 mm per year (SADC and ZRA 2007). In general, there is a single rainy season in the year. Rainy seasons are longer in the north and northeast, and much shorter in the southwest (SADC/SARDC and others 2012). Average annual rainfall across the river basin varies from 500 mm per year in the extreme south and southwest part of the basin to more than 1,400 mm per year in the Upper Zambezi and Kabompo sub-basins, at the northeastern shores of Lake Malawi/Niassa/Nyasa in Tanzania, and in the southern border area where Malawi meets Mozambique (Chenje 2000).

About 20 percent of the total basin runoff is used, mainly by evaporation from hydropower reservoirs, followed by irrigation and environmental use. Domestic and industrial water supply, though important, presently constitute less than 0.2 percent of available surface water resources (Euroconsult-Mott-MacDonald 2008).

Navigation on the Zambezi River is both international and local. The main international transport routes are the Kazungula and Luangwa-Kanyemba, while major national routes are in the upper Zambezi River and on Lake Malawi/Niassa/Nyasa. There are also small crossings that provide access to major markets. There are major crossings on the Kabompo, Kafue and Chobe Rivers in Namibia and Botswana,

Map 1.5 **Average Rainfall in the Zambezi River Basin**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

and on the Shire River in Mozambique and Malawi. Malawi, Mozambique and Tanzania, which share Lake Malawi/Niassa/Nyasa, all use the lake for navigation. The section of the Zambezi running 570 km from Mphanda Nkuwa in Mozambique to the Indian Ocean is the longest navigable portion of the river (SADC/SARDC and others 2012).

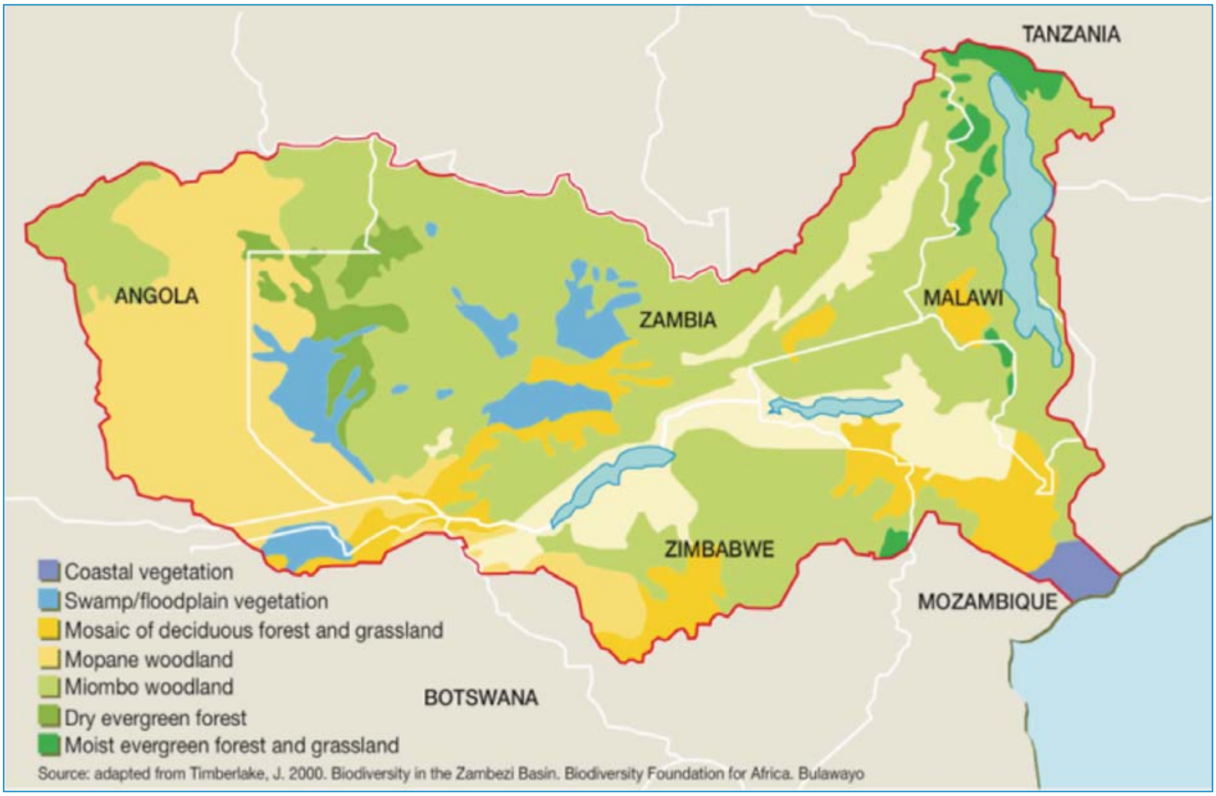
Land and Forest Cover

Almost 75 percent of the land area in the basin is forest and bush. Cropped land with mostly rain-fed agriculture covers just 13 percent of the land area, and grassland covers about 8 percent of the land area (SARDC 2012).

Almost half of the basin is classified as wetter or drier miombo woodland, part of the Zambezian biome. Miombo is dominated by trees of the genera *Brachystegia, Julbernardia* or *Isoberlinia* with a well-developed grass layer. Other widespread vegetation types are mopane woodland dominated by mopane, mosaics of various types of woodland, dry forest, including that

Landcover along Blantyre-Chikwawa road in Malawi

Map 1.6 **Zambezi River Basin Vegetation**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

dominated by economically important hardwoods such as Zambezi Teak, with grassland and open woodland dominated by various species of Acacia.

Land cover and land use have great impacts on water resources, as they affect how precipitation translates into runoff, infiltration, evaporation, and the quality of the water (Hirji and others 2002).

Biodiversity

The Zambezian biome covers 95 percent of the total basin area while the Montane, Coastal and Congolian biomes cover the remainder (Timberlake 2000). The Zambezi Basin is home to more than 6,000 species of flowering plants, 650 species of birds, and 200 species of animals. In addition, 165 species of freshwater fish are recorded in the basin and more than 500 endemic species (mostly cichlids) in Lake Malawi/Nyassa/Niassa (SARDC 2003).

The Zambezi Basin is renowned for its assemblage of large mammal species such as elephant, buffalo, giraffe and lion, and its dwindling rhino population. There is a preponderance of browsers rather than grazers as the basin is mostly woodland rather than the highly productive grasslands associated with the East African Rift Valley. Some species, such as the Colobus monkey, Samango monkey, Blue duiker and various rodents, are restricted to moist forests in the eastern part of the basin, while the tree pangolin is found only in the gallery forests of the Zambezi headwaters. A group of particular interest, almost endemic to the palaeo-basin, is the Lechwe antelope. Although often considered as a subspecies, it is likely that the three existing groups should be considered full species (F. Cotterill, pers. comm). The Black lechwe is endemic to the Lake Bangweulu area in northern Zambia, as was the now-extinct Roberts lechwe, which was part of the palaeo-Upper Zambezi, and the Kafue lechwe is restricted to the Kafue Flats in southern Zambia.

The Zambezi Basin has several large transboundary protected areas where two or more countries participate in managing shared natural resources. The creation of Trans Frontier Conservation Areas (TFCAs) in the basin is regarded as one of the anchors for regional economic integration, socio-economic development and poverty reduction through multi-destination and cross-border tourism (SADC and SARDC 2008). The TFCAs in the Zambezi Basin are at different stages of development with some Memoranda of Understanding (MOU) signed to facilitate their establishment while other conservation agreements are still at the conceptual phase. Among those with MOUs in the Zambezi River Basin are the Kavango-Zambezi TFCA, covering Angola, Botswana, Namibia, Zambia and Zimbabwe, and the Malawi-Zambia TFCA. Those still at conceptual stage include the ZIMOZA covering areas in Zimbabwe, Mozambique and Zambia; the Selous-Niassa TFCA, covering parts of Mozambique and Tanzania; the Lower Zambezi-Mana Pools between Zambia and Zimbabwe; and the Liuwa Plain-Kameia TFCA which includes areas in Angola and Zambia (SADC/SARDC and others 2012).

The threats to biodiversity in the basin are numerous including the expansion of cropland that closely followed the eradication of tsetse fly (*Glossina* sp.) into areas that had been occupied predominantly by wildlife. In the Zambezi Valley the tsetse eradication has paved way for expansion of areas under cultivation mainly with the introduction of cotton, which led to land cover changes and wildlife habitat loss (Cumming and Lynam 1997; Murwira and others 2010). The other threats include land clearance for agriculture and expansion of human settlement, dam construction, fires, and invasion by alien species (SADC/SARDC and others 2012). The invasion of pines and wattle trees into the montane grasslands of Mt. Mulanje, the introduction of the Nile tilapia fish (*Oreochromisniloticus*) to the waters of the Middle Zambezi, and Kariba weed (*Salviniamolesta*) into the Chobe system and Lake Kariba are key examples of invasion (Timberlake 2000).

Soils

The dominant soil types in the Zambezi Basin are acid, leached out tropical soils of low fertility known as tropical red soils (*ferralsols*) derived from biologically old or ancient rock types characteristic of the basin. Fertile soils are located in areas where younger geological strata form the base or where humic materials are found. Some of the good quality soils are often found in the river valleys. The fertility of the basin soils is inherently low. However, soils such as black cotton that are of very high quality are also found in the basin. Soil classification in the basin is often difficult because the basin states use different terminology and classification systems.

Mineral resources

The Zambezi Basin is endowed with diverse mineral deposits, including copper, diamonds and gold.

Red soils in Gokwe, Zimbabwe

Areas around the towns of Chegutu, Kadoma and Kwekwe in Zimbabwe are heavily involved in mining gold and platinum, while all the urban areas in Zambia's Copperbelt are involved in copper mining (SADC/SARDC and others 2012). In Zambia, large-scale mining is concentrated in the Copperbelt province.

Socio-Economic Characteristics

Agriculture

The economies of many African countries are agro-based and depend largely on rain-fed agriculture. Agriculture plays a critical role in socio-economic development in the basin. Malawi, Zambia and Zimbabwe together have 86 percent of the estimated 5.2 million hectares of the land area cultivated annually in the basin (Euroconsult-Mott-MacDonald 2008). Zimbabwe has 56 percent of its cultivated area in the Basin, Zambia 76 percent and Malawi 90 percent. The most commonly farmed crops are maize (*Zea mays L.*), sorghum (*sorghum bicolor L.*), grain legumes such as common bean (*phaseoulus vulgaris L.*), groundnut (*arachishypogaea*), cassava (*manihotesculenta*), sweet potatoes (*ipomeabatatas* L.) and a variety of vegetables.

The likely benefits from farming are threatened by frequent crop failures due to unreliable climatic conditions charac-

Conservation agriculture systems improve crop yields.

terised by frequent droughts. Good crop yields depend on the availability of adequate moisture in the soil particularly during the sensitive stages of a crop's life cycle. Deprivation of the required soil moisture to plants during the critical growth periods may lead to stressed crop development resulting in reduced crop yields which will in turn increase the vulnerability of the poor.

Research indicates that there is an increased need for more resilient, water-conserving, productive and sustainable agriculture cropping systems (Thierfelder and others 2010). The use of conservation agriculture systems as practised in Zambia is known to lead to higher rainfall infiltration, soil moisture, a gradual increase of soil carbon and improvements in crop yields in comparisons with conventional systems over time.

The total area under irrigation in the Zambezi Basin was 171,621 hectares in 1995, and more recent data for the basin seems unavailable. Although UN FAO figures show that total irrigation in southern Africa increased by some 25 percent in the decade from 1994 to 2,063,427 hectares in 2004, this would vary so much from country to country as to make it difficult to project data solely for the basin. A later study in Zambia, which makes up almost 42 percent of the basin, shows that less than 30 percent of agricultural land suitable for irrigation has been developed and recommends investment in this sector due to considerable potential (UN FAO 2014). More than 90 percent of irrigated agriculture is concentrated in the four sub-basins, that is, Tete, Shire, Kariba and Kafue. The irrigation potential in the basin is more than 3 million hectares, of which only 5 percent is already developed (Tilmant and others 2012).

Mining

The mining sector plays a significant role to the economies of most of the basin countries. Minerals include cop-

Table 1.5 **Agricultural Land in the Zambezi Basin**

Country	Agricultural rea in 2007 (sq km)	% change since 1990	% of total land area in2007 (sq km)	Arable land in 2007 (sq km)	Land under permanent crops in 2007 (sq km)	Land under permanent meadows and pastures in 2007 (sq km)
Angola	575 900	0.3	46.2	33 000	2 900	540 000
Botswana	258 520	-0.6	45.6	2 500	20	256 000
Malawi	49 700	17.8	52.8	30 000	1 200	18 500
Mozambique	488 000	2.3	62.1	44 500	3 500	440 000
Namibia	388 050	0.4	47.1	8 000	50	380 000
Zambia	255 890	10.4	34.4	52 600	290	203 000
Zimbabwe	154 500	18.8	...	32 300	1 200	121 000
Total	2 170 560			202 900	9 160	1 958 500

UNSTATS 2007

per, gold, chrome, diamonds, coal and asbestos. The principal mining countries in the basin are Angola, Zambia and Zimbabwe; while Botswana, Malawi, Mozambique, Namibia and Tanzania have little or no mining activity within the basin.

Apart from contributing revenues to the basin's economies, mining has played a major role in providing and extending infrastructure, boosting other sectors of the economy (Chenje 2000). Railways, roads, power generation facilities, and water supply plants have been built primarily to service mining operations in different parts of the basin.

There is significant small-scale mining in sub-basins such as the Luangwa River, Lake Kariba, and the Kafue and Kabompo Rivers. This includes gold panning, a poverty-driven activity that is estimated to support the livelihoods of about 2 million people in the riparian states of the Zambezi Basin (Hirji and others 2002).

Despite the contribution to national economies, mining activities contribute to serious environmental problems. The impacts can either be chemical or physical. Physical impacts include salinization, siltation, changed patterns of water use, excavation of large pits, diversion of river streams and deforestation (Ashton and others 2010). The surface trenching using picks and shovels results in hazards for humans, domestic and wild animals as well as reducing river frontage. (Shoko and Love 2005).

The chemical impacts include changes in acidity or alkalinity, and release of arsenic, mercury and other heavy metals in rivers causing water pollution (Euroconsult-Mott-MacDonald 2008). All the streams that drain mining areas in the Copperbelt region release waste into the Kafue River or its tributary, the Kafubu River. These are the main sources of drinking water for most towns in the Copperbelt.

Lumwana copper mine in Zambia

Energy

The bulk of the basin's total energy needs is derived from biomass. The wood fuel energy is used mainly for domestic purposes, including cooking and lighting. Other rural industries that consume significant amount of woodfuel include brick making, lime production, fish smoking, beer brewing, coffee, tea and tobacco drying.

Renewable energy resources such as hydroelectric power are available in the basin, as are non-renewable resources such as thermal power, petroleum and natural gas. New technologies such as wind and solar energy are also gaining prominence.

The Kariba and Cahora Bassa dams and Kafue Gorge provides the bulk of basin's hydropower generating 2,075 MW, 1,470 MW and 990 MW, respectively (SADC/SARDC and others 2012). The live storage of Kariba Dam accounts for more than 50 percent of the total live storage of the existing reservoirs, while Kariba and Cahora Bassa dams together account for about 95 percent.

Cahora Bassa Dam

Tourism

The wide variety of landforms and vegetation zones has resulted in a remarkably high diversity of ecosystem and species in the Zambezi River Basin. The major tourist attractions are therefore associated with natural resources, and the potential for other attractions such as historic sites has not yet been tapped.

The major tourism areas in the Zambezi Basin are national parks and nature reserves, with wildlife and scenery as the major attractions. The Big Five mammals among the major tourist attractions include elephant, buffalo, rhinoceros, leopard and lion, and there is also an abundance of other animals such as giraffe, zebra, painted dog, and a wide variety of antelope. Tourism, especially game viewing, sport hunting, and fishing is an important economic sector in Zambezi Basin states.

Some areas with high tourism potential such as Victoria Falls already have extensive access infrastructure such as airports and road linkages that could be expanded to be a regional and international tourism gateway; while others such as Lake Malawi/Niassa/Nyasa lack infrastructure in all three countries that share the lake – Malawi, Mozambique and Tanzania. These areas offer an attractive opportunity to potential investors. Such a transformation would require that the governments provide investors with appropriate infrastructure support and incentives. The Zambezi riparian governments recognize the economic benefit of tourism and have therefore made it a priority.

Implementation of strategies relating to Joint Marketing of the Region as a single destination continues under the auspices of the Regional Tourism Organization of Southern Africa (RETOSA), and SADC Member States continue to showcase the region at international exhibitions. The slow pace of the proposed UNIVISA continues to be seen as an impediment to tourism growth and the region's competitiveness as an attractive destination (SADC 2013), although Zambia and Zimbabwe have begun implementation in 2014.

Industrial Development

Most countries in the Zambezi Basin are urbanizing rapidly, and this has resulted in an increase in industrial activities, leading to generation of waste discharges into river systems. Industries in most of the urban areas dispose hazardous waste into rivers, thereby compromising water quality. Although it is

Wildlife is one of the major tourist attractions in the Basin.

difficult to assess the amount of pollution originating from industries on the Zambezi tributaries, there is clear evidence that highly urbanised sub-basins such as Kafue and Kariba are discharging waste into the Zambezi river system (Euroconsult-Mott-MacDonald 2008). In Zambia, annual waste generation from industrial, commercial and domestic activities was estimated at 2 million tonnes in December 2006 (Environmental Council of Zambia 2008).

Effluent discharge is also a matter of concern in the Zambezi Delta. The Sena Sugar industry at Marromeu releases high amounts of biodegradable waste and high amounts of wastewater into the Zambezi water system. The effluents are likely to increase organic loading in the Zambezi River, thus negatively affecting the aquatic ecosystem. In Harare, the Mukuvisi River that drains into Manyame is generally considered the most heavily polluted river system in Zimbabwe. The river flows through both industrial and residential areas of Harare.

In the Tanzanian part of the basin, the quality of water is generally good except for the pollution of Kiwira River by the Kiwira Coal Mine and Songwe River by Mbeya Cement (Ministry of Water, Energy and Minerals 2008).

Current Threats

Climate Change Vulnerability

The Zambezi Basin is no exception when it comes to climate change, but the level of vulnerability differs as there is a diversity of impacts across the basin, including the occurrence of the disasters. For example, the water sectors Angola, Malawi, Mozambique, Tanzania and Zambia are not as vulnerable to water scarcity as Botswana, Namibia, and Zimbabwe. Although Malawi and Namibia have sufficient resources, much is inaccessible to most parts of the country. The level of vulnerability is impacted by both natural and human factors, and there is a relationship between vulnerability due to climate change and poverty.

Poor people are often the ones to suffer injury, loss, death, or harm from droughts, floods, or other extreme events and they have less capacity to recover. This is due to lack of resources to cope with the climatic challenges. Vulnerability to climate change is therefore a combination of factors that render some people and communities vulnerable to even small changes, especially those who are unable to diversify to other means of survival and livelihoods. Also vulnerable are those who lack access to productive land, and those who have been displaced from their homes due to floods, conflicts, or famine without receiving adequate humanitarian assistance (SARDC and HBS 2010).

Water Scarcity

There has been growing consensus that demand for water is outgrowing existing means of supply and it is likely that climate change may inject yet greater uncertainty into future water availability. The total water supply is constant at global level, though local supply is subject to various factors including climatic change and uncertainties in rainfall. Various factors that further compound the likelihood of water scarcity at basin level

Climate change can cause increase in the frequency of droughts.

Over-exploitation of water resources can cause water scarcity.

are increasing population density, economic activity, and unsustainable water management practices, similar factors to those that have caused over-exploitation of the more easily accessible freshwater resources around the globe (Vörösmarty and others 2010).

The current consumptive water use in the Zambezi River Basin is estimated around 15-20 percent of total runoff (SADC and SARDC 2008). Based on user types, the largest consumptive water users are dams – evaporation through impoundment, about 13 cubic kilometres per year; and irrigated agriculture at about 1.5 cubic kilometres per year. This implies many development possibilities, particularly for irrigated agriculture and hydropower production. Development plans of the riparian countries in fact suggest that consumptive water use might increase to up to 40 percent of total runoff by 2025 (SADC and SARDC 2008).

There is a wide diversity of projected water scarcity among basin states, with Botswana, Malawi and Namibia being the most likely to experience serious water stress within the next decade, and water demand is likely to develop unevenly across the basin over the next few decades (Hirji and others 2002).

Disaster Risk

The increase in the frequency, complexity and magnitude of natural disasters increases the vulnerability of communities in the basin. Southern African is characterized by an extreme variability in rainfall which has been associated with a steady rise in the number of drought events over the past century, resulting in a more frequent drought cycle. Between 1988 and 1992 the region experienced more than 15 droughts and these had negative impacts on the human population (Tirivarombo 2011).

Although year-to-year droughts have been experienced, especially in the last decade, the current decade has seen floods of unprecedented magnitudes (SARDC and HBS 2010). Historical records indicate that extensive droughts affected the Zambezi Basin in 1981-82, 1986-87, 1991-92, 1994-95, 2001-02 and 2012-13, while floods ravaged parts of the Basin in 1999-2000, 2005-06, 2007-09 and 2014-15 (SADC and SARDC and others 2008, ZAMCOM and SARDC 2015).

Storms due to tropical cyclones from the Indian Ocean also affect the Zambezi River Basin, and cyclone-induced floods have become more frequent. This aligns with predictions by the Intergovernmental Panel on Climate Change (IPCC), based on a range of models indicating that tropical cyclones will become more intense, with larger peak wind speeds and heavier precipitation associated within increases in tropical sea surface temperatures (IPCC 2008). While the Zambezi Basin experiences seasonal and variable rainfall, resulting in cyclical spells of drought and intermittent floods, the recent increase in the variability and intensity of drought and floods is attributed to climate change (SARDC and HBS 2010).

Impact of Flooding and Droughts

There has been concerted effort within the basin to mitigate against disasters through initiatives for disaster risk reduction, but these are often different perspectives on how to do this. The government of Mozambique, for example, embarked on a resettlement programme following the 2007 flood that affected 170,000 people in lower Zambezi. About 110,000 people (56,000 households) were displaced, but the re-

Floods in Mozambique

settlement programme prompted debate from international donors who promoted a "Living with the Floods" strategy which proposed flood-management practices that allow people to continue to live in flood-prone areas and take advantage of the fertile soils that result from the floods. The development of early warning systems and generating awareness about timely evacuation were elements of the strategy. It was argued that living in flood-prone areas in Mozambique is not a matter of choice but a matter of poverty.

The government of Mozambique, however, favours a "flood-free" approach to risk reduction which stresses the need to resettle people elsewhere who are living on the floodplains, arguing that continued habitation would pose higher risks to human life and that recurrent costs would eventually outweigh the costs of permanent resettlement. In January 2008, another 334 families (about 1670 people) from Mozambique were forced into displacement camps in neighbouring Malawi, after flooding of the Shire River, one of the main tributaries of the Zambezi River (SARDC and HBS 2010).

Pollution

The infestation of the Zambezi Basin by aquatic weeds is a problem of regional scale, which has occurred in several sub-basins, such as Kafue, Lake Kariba, Lake Chivero, Kwando-Linyanti and the Lower Shire.Waterweeds thrive when nutrients are present in comparatively high concentrations and are therefore a problem closely related to eutrophication. In some watercourses, eg Lake Chivero in Zimbabwe, Kafue Gorge Reservoir in Zambia and Lake Kariba, this problem had reached critical levels until pragmatic mitigation measures were undertaken. Attention is therefore now focused on causative factors such as land use on the upstream catchment.

There is growing evidence that aquatic weed infestation is seriously affecting rural livelihoods around Lake Malawi/Niassa/Nyasa. The lake is home to 800-1,000 endemic fish species that could seriously suffer from such an event. In the Shire sub-basin the cover of weed has made lagoons and marshes dry out faster, exacerbating low water-levels during droughts. This reduced fish stock and deprived local people of a major source of livelihood. The weed mats also harbours crocodiles and snakes, making it difficult for women to fetch water and do washing in infested places. The problem of aquatic weeds is not unique to the Zambezi Basin but has occurred throughout the SADC region.

Interventions for Basin Development

Greater cooperation between basin states is needed to ensure sustainable utilization of shared resources and to achieve regional and basin objectives of economic development and poverty reduction. An analysis of the Zambezi Basin reveals that the yearly average cost of non-cooperation could reach US$350 million per year, which is 10 percent of the annual benefits derived from the system (Tilmant and Kinzelbach 2012).

To advance sustainable management and utilization of the basin's resources, several bilateral and multilateral agreements have been put in place at regional level to manage transboundary waters, notably the Revised Protocol on Shared Watercourses in the Southern African Development Community (SADC) concluded in 2000. This facilitated the Agreement on the Establishment of the Zambezi Watercourse Commission, concluded by the basin riparian states in 2004. Another institution established previously is the Zambezi River Authority (ZRA) founded in 1987 through a bilateral agreement between Zambia and Zimbabwe. These and other policies and institutional arrangements are discussed briefly below.

Revised SADC Protocol on Shared Watercourses

Fifteen major watercourses in the SADC region are shared across borders by two or more Member States, a situation that demands their cooperation for sustainable development of these precious resources. To this end, SADC Member States approved a Protocol on Shared Watercourses in the SADC in August 1995 which was revised in August 2000. After ratification, the Revised Protocol on Shared Watercourses in the SADC Region entered into force on 22 September 2003.

The Protocol aims to foster closer cooperation among Member States for the protection, management, and use of shared watercourses in the region. Member States agreed to cooperate on policy and projects, and exchange information on shared watercourses, consulting each other and collaborating on initiatives that balance development of the river basins with conservation of the environment. The Protocol contains an institutional framework that sets out a Water Sector Organ, its committees and units, and its duties for the joint protection and development of shared watercourses in southern Africa (SADC 2013c).

Zambezi Watercourse Commission

A key intervention area resulting from the Protocol was the establishment of the Zambezi Watercourse Commission (ZAMCOM) by the basin states that share the Zambezi River. The ZAMCOM agreement entered into force in June 2011. As agreed by the basin states, the headquarters was formally established in Harare, Zimbabwe in 2014.

ZAMCOM was established "to promote the equitable and reasonable utilization of the water resources of the Zambezi watercourse as well as the efficient management and sustainable development thereof", as stipulated in the ZAMCOM agreement and in accordance with the revised protocol on shared watercourses. The main ZAMCOM objective is to assist the riparian states to achieve regional cooperation and integration through sharing benefits from the cooperative development and sustainable management of the water resources of the Zambezi River. The envisaged promotion of such cooperation is significant towards peace and prosperity of the basin and southern Africa as a whole.

ZAMCOM is governed by three main organs – the Council of Ministers, the ZAMCOM Technical Committee (ZAMTEC), and the Secretariat (ZAM-

SEC). The Council of Ministers is the decision-making arm, while ZAMTEC is a technical advisory body. The ZAMCOM Secretariat, headed by an Executive Secretary, provides overall management, supported by a Project Implementation Unit and working groups components (SARDC and ZAMCOM 2013). To ensure effective participation by stakeholders, the National Stakeholders Coordination Committees (NASCs) have been established in each of the eight riparian states. NASCs fall under the working groups of the ZAMCOM structure to ensure that decisions at national level reach the basin-level discussions.

SADC Regional Water Policy

The Regional Water Policy for the SADC (2005) is aimed at providing a framework for sustainable, integrated and coordinated development, utilization, protection and control of national and transboundary water resources in the SADC region. This policy is intended to support the SADC Common Agenda of socio-economic development and regional integration and improvement of the quality of life of all people in the region (SADC 2013d).

The policy includes nine thematic areas, addressing key water resources management issues and challenges, such as regional cooperation in water resources management, water for development and poverty reduction, water for environmental sustainability, security from water-related disasters, as well as integrated water resources management and development. Within each of these areas, activities are identified which contribute to the achievement of the strategic objectives: Water Resources Information and Management, Water Resources Development and Management, Regional Water Resources Institutional Framework, Stakeholder Participation and Capacity Building, and Financing Integrataed Water Resources Management (IWRM) in the Region (SADC 2013d).

SADC Regional Strategic Action Plan

The SADC Regional Strategic Action Plan for Integrated Water Resources Development and Management (RSAP III) is the SADC Water Sector's implementation plan, which gives practical effect to application of the Revised SADC Protocol on Shared Watercourses. RSAP III (2011-2015) focuses on three strategic areas, which are water governance, infrastructure development and water management (SADC 2013c).

IWRM Strategy for the Zambezi River Basin

The Integrated Water Resources Management (IWRM) Strategy and Implementation Plan for the Zambezi River Basin is a set of medium-to-long-term measures in support of integrated water resources management. These measures address the main issues and challenges for the development and management of the water resources of the Zambezi River to enable the sustainable socio-economic development of the Basin in particular and the region as a whole (SADC 2013a).

The Regional Indicative Strategic Development Plan

The Regional Indicative Strategic Development Plan (RISDP) is a comprehensive development and implementation framework established to guide the SADC regional integration agenda over a period of fifteen years (initially 2003-2018) and to provide clear strategic direction with respect to SADC programmes, projects and activities in line with the SADC Common Agenda and strategic priorities, as enshrined in the SADC Treaty of 1992. The ultimate objective of the plan is to deepen regional integration to accelerate poverty eradication and attain economic and non-economic development goals (SADC, 2013b). The revised RISDP was approved in 2015 after a period of region-wide consultation and review.

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WATER RESOURCES 2

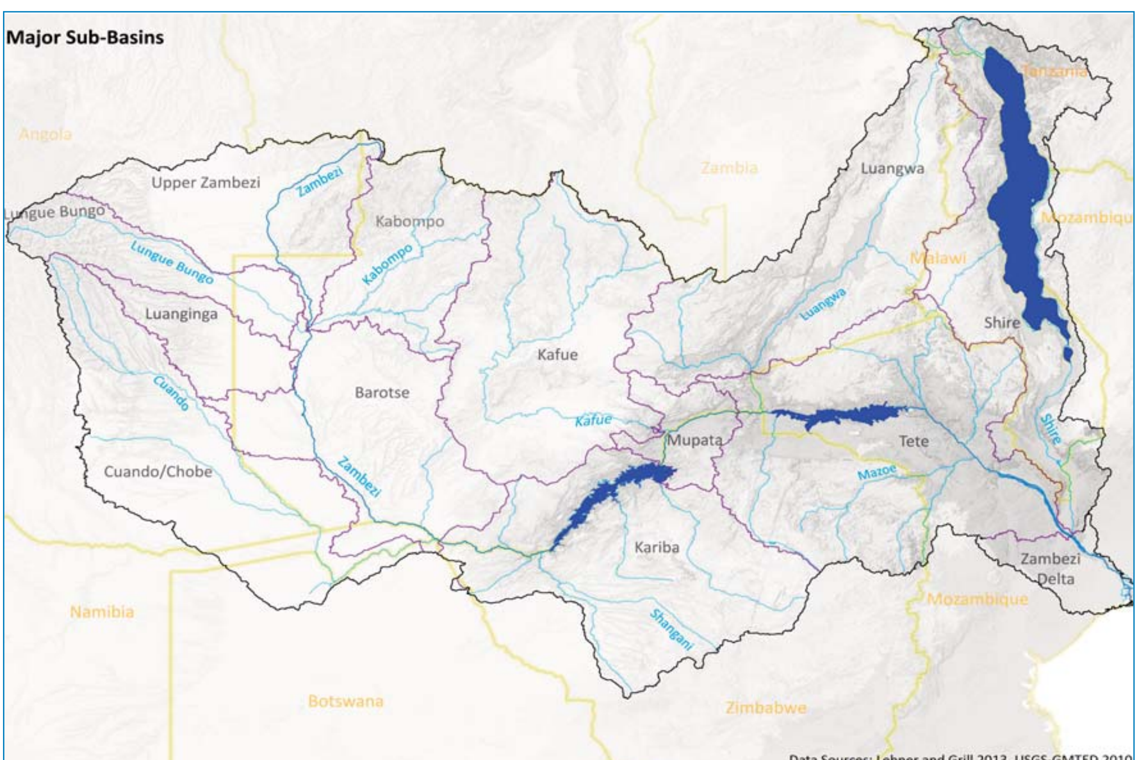
Introduction

Water is a key strategic natural resource in the Zambezi River Basin. The presence of water governs the location of homes and cities. It is a necessary input for most productive activities including agriculture, forestry, mining, commercial, and livestock development, energy production, tourism, and wildlife conservation, among others. Too much water or a shortage of water can result in deaths among people, animals and plants.

Water is also the driving force in wetland ecosystems, playing a critical role in the biosphere. The distribution, occurrence and availability of water resources varies across the basin and its availability depends on rainfall. The basin's water resources are stored in natural lakes such as Lake Malawi/Niassa/Nyasa and other smaller lakes, and in artificial lakes such as Lake Kariba and Cahora Bassa, and many rivers and streams.

The key issues related to water resources in the basin are water availability, water use and access, water quality, groundwater depletion, and wetland degradation. The contribution of women to water resources management is an essential factor in the basin, as women are both managers and primary users of water. Policies and institutional arrange-

Map 2.1 **The Zambezi River Basin**



SARDC IMERCSA, I. Musokotwane Environment Resource Centre for Southern Africa, 2015. Lake Malawi/Niassa/Nyasa is shared by Malawi, Mozambique and Tanzania with national boundaries in the lake, which is known by a different name in each country.

ments include the Revised SADC Protocol on Shared Watercourses, the Regional Strategic Action Plan Phase III, the ZAMCOM Agreement, and other regional cooperation instruments in water resources management.

Water Availability

Water availability in the Zambezi Basin is largely determined by rainfall occurrence. The average annual rainfall over the Zambezi River Basin is about 950 mm per year, but varies from more than 1,400 mm per year in the northern parts to less than 600 mm per year in the low lying south/southwestern portion of the Basin. It is characterized by considerable variation across the Basin and over time. Droughts of several years' duration have been recorded almost every decade and large floods occur with similar frequency.

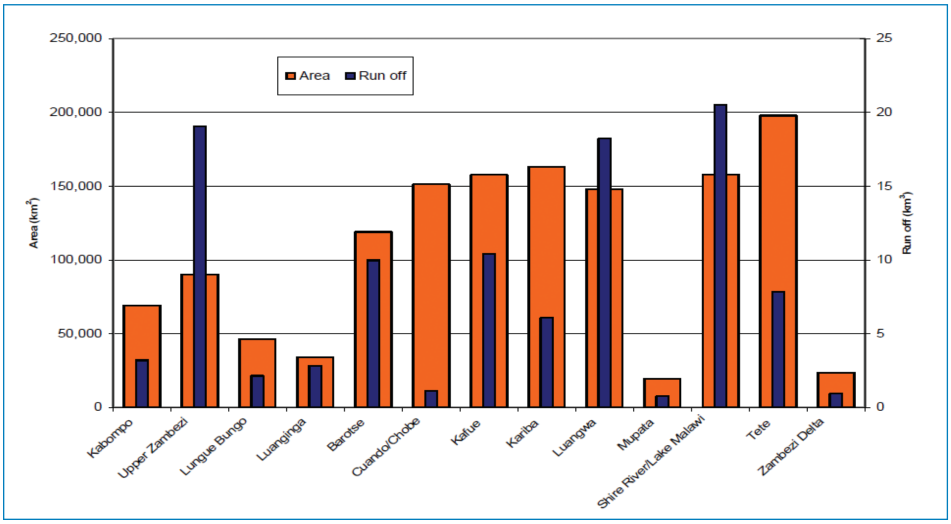
The sources of surface water resources available in the Zambezi River Basin are shown in Table 2.1 and illustrated in Figure 2.1. Current and projected consumptive use is shown in Table 2.2 in relation to the available mean annual runoff.

Table 2.1 **Sources of Surface Water Resources in the Zambezi River Basin**

Name	Annual (cu m/s)	Wet season (cu m/s)	Dry season (cu m/s)	Catchment area (sq km)
Zambezi River in Angola	670	900	150	76 000
Zambezi River at Kariba	1 350	1 500	900	664 000
Kabombo River Basin	260	400	120	67 000
Kafue River Basin	350	450	100	152 000
Luangwa River Basin	620	1 500	90	144 000
Shire River Basin	500	550	360	150 000
Zambezi River at Indian Ocean	3 600	5 000	1 500	1 300 000

Shela, O.N., Management of Shared River Basins: The Case of the Zambezi River, 2000

Figure 2.1 **Sources of Surface Water Resources**



Euroconsult Mott MacDonald, Integrated Water Resources Management and Implementation Plan for the Zambezi River Basin. 2008

Table 2.2 **Current and Projected Consumptive Use and Mean Annual Runoff**

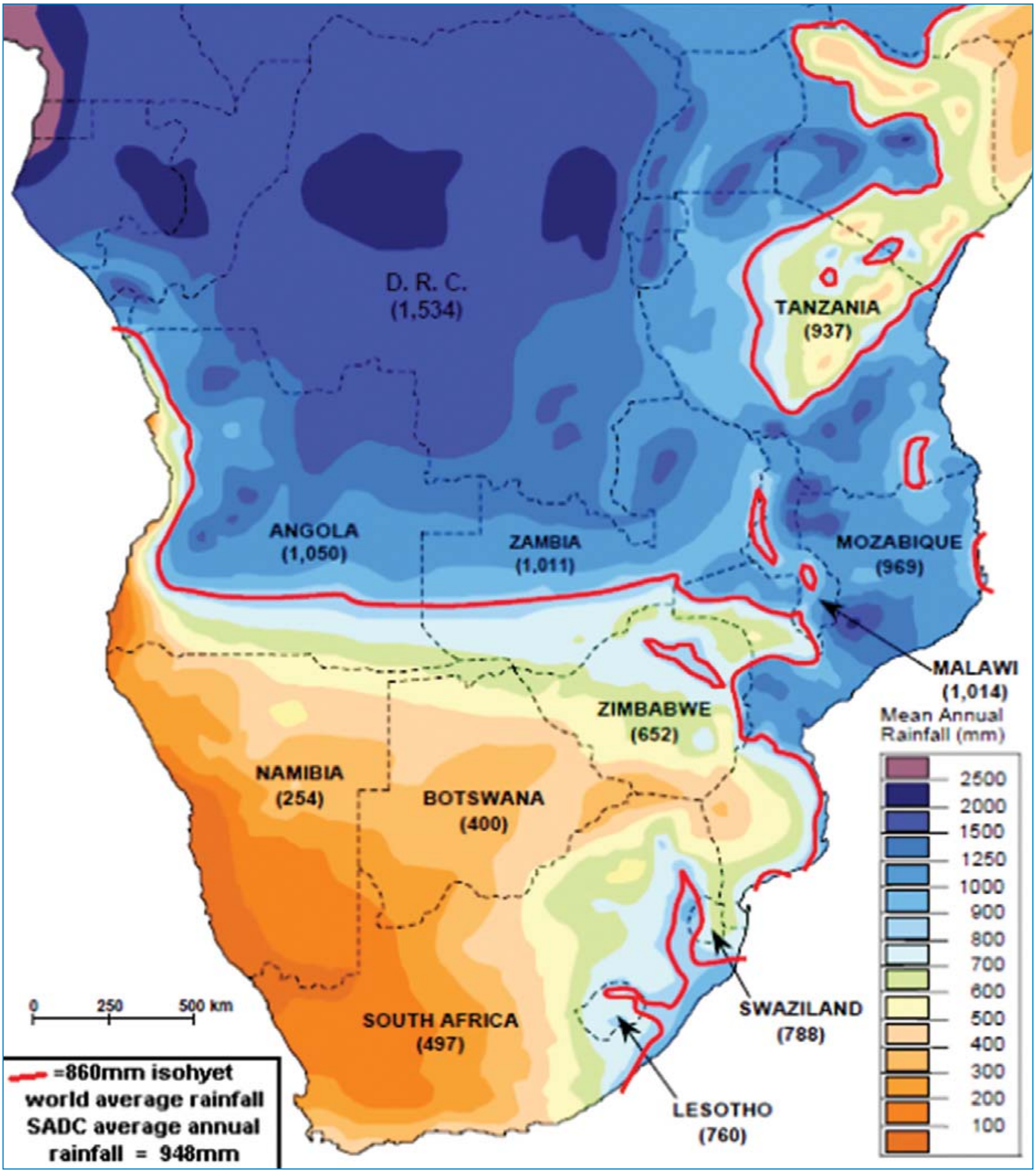
	Current (million cu m)	Current (% of available mean annual runoff)	Projected to 2025 (million cu m)	Projected to 2025 (% of available mean annual runoff)
Available runoff	103 224	100	103 224	100
Rural domestic consumption	24	0.02	43	0.04
Urban domestic consumption	175	0.17	676	0.65
Industrial consumption	25	0.02	85	0.08
Mining	120	0.12	408	0.40
Environmental/flood releases	1 202	1.16	6 445	6.24
Irrigated agriculture	1 478	1.43	4 635	4.49
Livestock	113	0.11	167	0.16
Hydropower(evaporation)	16 989	16.46	24 598	23.83
Total consumptive water use	20 126	19.50	37 057	35.90
Unspecified uses and discharge to the ocean	83 098	80.50	66 167	64.10

SADC/ZRA, Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin, 2008

Rainfall Trends

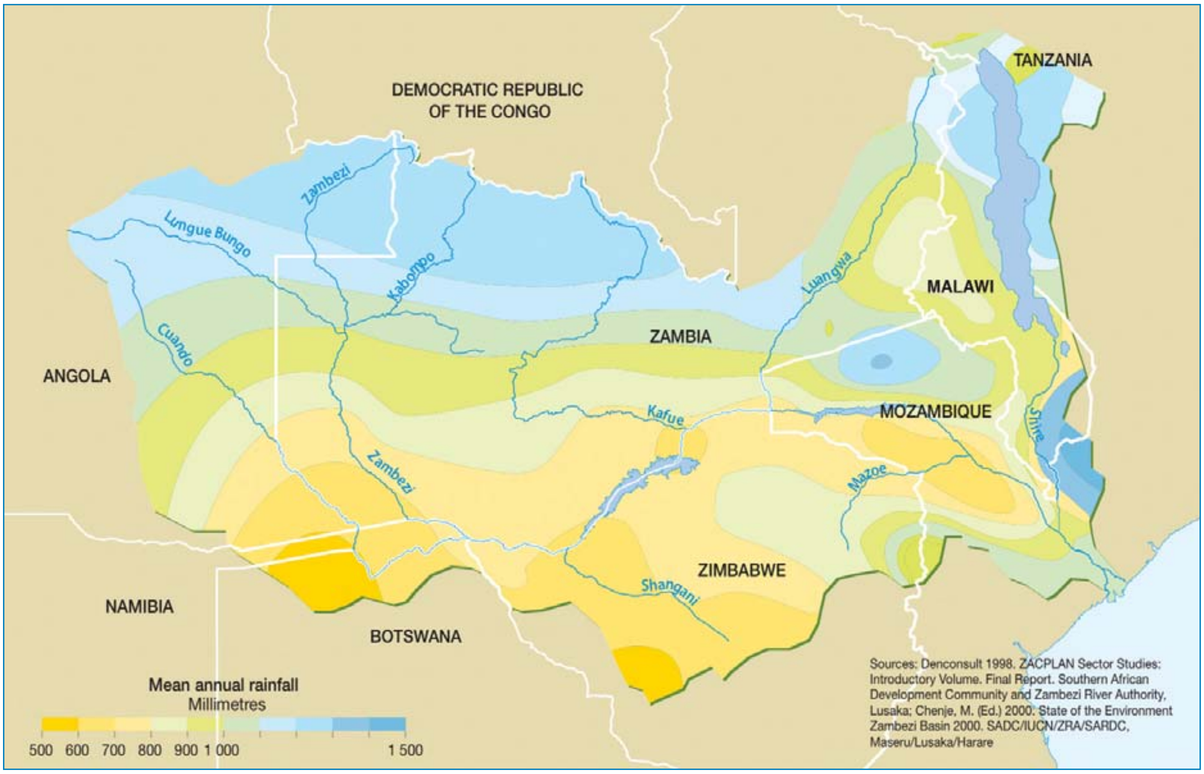
Map 2.2 presents the mean annual rainfall distribution across the SADC region while Map 2.3 gives the mean annual rainfall distribution over the Zambezi River Basin. Mean Annual Rainfall, and generally the resultant runoff, is higher in the north and east, and lower to the south and west of the SADC region. Consequently, rainfall varies significantly between the eight countries in the Zambezi River Basin. The Basin is subject to frequent periods of prolonged drought, particularly in the southwestern parts, while the northern and eastern parts are vulnerable to floods, often with devastating impacts.

Map 2.2 **Mean Annual Rainfall Distribution Across the SADC Region**



SADC, Regional Water Strategy, 2007

Map 2.3 **Mean Annual Rainfall Distribution Across The Zambezi River Basin**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Evaporation

In most parts of southern Africa including the Zambezi River Basin, potential evaporation is twice as high as rainfall totals and this plays a dominant role in the overall water balance, with the consequence that generally less than 15 percent of the rainfall contributes to runoff, river flow and infiltration to groundwater (Hirji and others 2002).

Table 2.3 shows the rainfall, evaporation and surface runoff ranges in the Zambezi Basin. All the determinants of the hydrological process mentioned have a direct influence on the occurrence and distribution of water in the basin.

Table 2.3 **Rainfall and Evaporation Statistics**

Country	Rainfall range (mm/yr)	Average rainfall (mm/yr)	Potential evaporation range (mm/yr)	Total surface runoff (mm/yr)
Angola	25-1600	800	1300-2600	104
Botswana	250-650	400	2600-3700	0.6
Malawi	700-2800	1000	1800-2000	60
Mozambique	350-2000	1100	1100-2000	275
Namibia	10-700	250	2600-3700	1.5
Tanzania	300-1600	750	1100-2000	78
Zambia	700-1200	800	2000-2500	133
Zimbabwe	350-1000	700	2000-2600	34

Hirji, R., Johnson, P., Maro, P. & Matiza-Chiuta, T. (Eds), Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa, 2002

Natural Lakes

Lake Malawi/Niassa/Nyasa is the largest natural lake in the Zambezi River Basin and is the second deepest lake in Africa after Lake Tanganyika which lies outside the Zambezi Basin. Lake Malawi/Niassa/Nyasa is the third deepest lake in the world. This massive water body is shared by Malawi, Mozambique and Tanzania and each country has a different name for the lake.

There are other smaller natural lakes such as Lake Chilwa (Malawi) and Lake Liambezi (Namibia). These natural lakes are used for various purposes such as domestic and industrial water supply, hydropower generation, fisheries, recreation and lake transportation.

Artificial Lakes and Dams

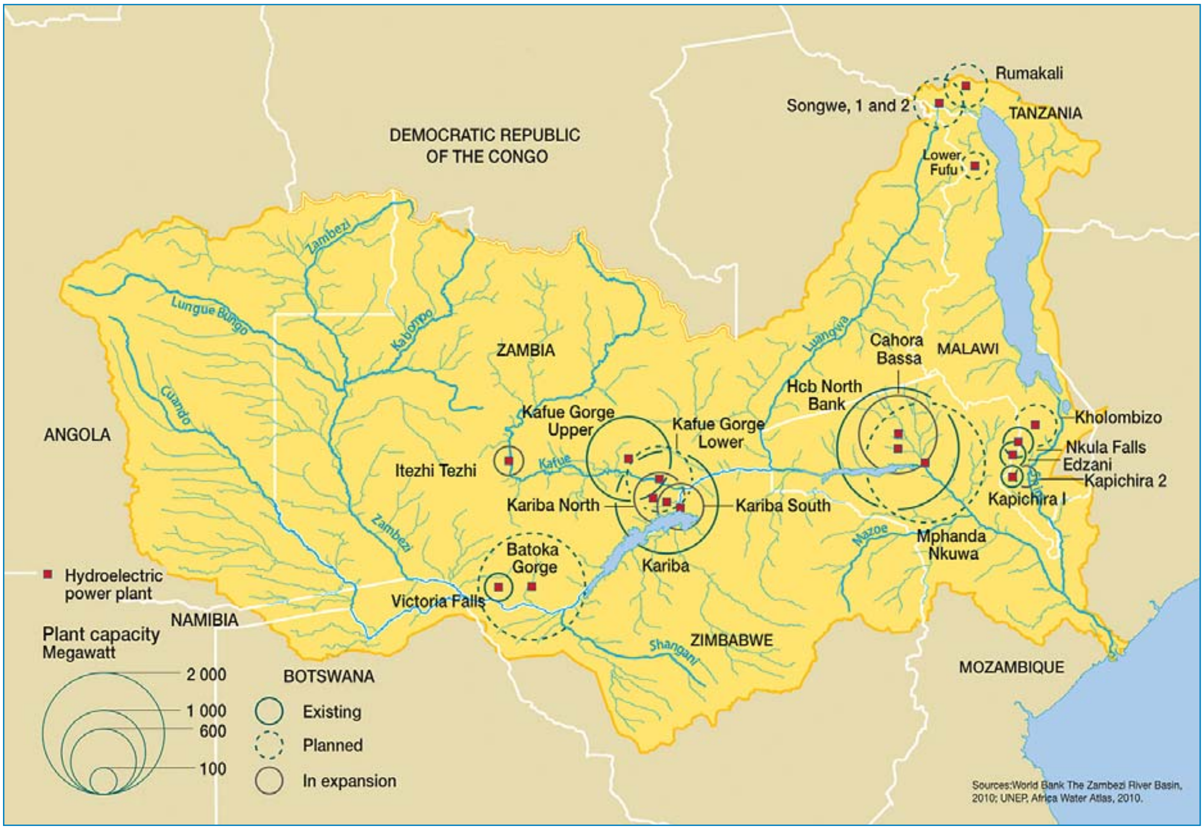
Lake Kariba is the largest artificial lake and reservoir in the world in terms of water storage capacity, holding 185 cubic kilometres of water at full supply level. The other major artificial lake in the Zambezi River Basin is Cahora Bassa with a holding capacity of 55.8 cubic kilometres.

There are a lot of other small, medium and large dams in the Zambezi River Basin which are used for various purposes such as irrigation, wildlife water supply, mining, and flood and drought management. Threats to artificial lakes and dams include invasive alien weed infestation, poor water quality due to discharge of untreated effluents from sewerage treatment plants, mining and industry wastes, pollution from agriculture, and siltation due to soil deposition into the artificial lakes and dams.

Map 2.4 shows the dams in the Zambezi River Basin that are used to store water for various purposes such as for hydropower generation (Kariba, Cahora Bassa, Itezhi Tezhi, Kafue, Tedzani). The map also shows planned expansion and new facilities. Dams play a major role in flood and drought management and one of the indicators of the level of development of a country or region is the per capita water stored. These and many smaller dams are also used for irrigation and domestic water supplies. A higher per capita of water stored indicates better development and access to the water resource. Due to large surface areas of artificial lakes and dams, evaporation losses tend to be high, particularly in the lowlands of the Zambezi River Basin where temperatures are generally high throughout the year, with low rainfall.

Lake Kariba is the largest artificial lake and reservoir in the world in terms of water storage capacity.

Map 2.4 **Hydropower Facilities in the Zambezi River Basin**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Water Availability and Security

Table 2.4 shows water availability per person in the Zambezi River Basin riparian states for the years 1995 and 2000, projected to the year 2025. It can be seen that by 2025, it is projected that Tanzania and Zimbabwe will be water stressed while Malawi will experience water scarcity despite the volume of water available in the lake, due to distribution challenges. Data on availability represent average annual freshwater resources, as actual supply will vary from year to year. Box 2.1 presents the factors of vulnerability and management in water security.

Table 2.5 and Figure 2.2 show five water-sector indicators that demonstrate the level of development of a country or region and, using these indicators, provide a comparison between the Zambezi River Basin, the SADC region, the world average and the status of industrialized countries. This indicates that the Zambezi River Basin still needs to do more to reach the world averages in respect to water abstractions, irrigated land and the provision of safe and adequate domestic water supplies. However, the Zambezi River Basin is generally performing better than the SADC Region.

Water Demand and Use

The Zambezi River Basin's human population continues to grow at an average rate of about 2.36 percent per annum (SADC/SARDC and others 2012). Con-

Table 2.4 **Water Availability in the Zambezi River Basin**

Country	Total annual renewable fresh water available (cu km/yr)	1995 population (000)	1995 Per capita water availability (cu m)	2000 population UN medium projection (000)	2000 Per capita water availability (cu m)	2025 Population UN medium projection (000)	2025 Per capita water availability (cu m
Angola	184	11 558	15 920	13 302	13 832	25 940	7 093
Botswana	14.7	1 459	10 075	1 651	8 904	2 270	6 476
Malawi	18.7	9 374	1 995	10 160	1 840	18 695	920
Mozambique	216	15 400	14 026	17 245	12 525	26 730	8 080
Namibia	45.5	1 590	28 616	1 817	25 041	2 460	18 496
Tanzania	89	28 400	3 134	32 422	2 745	56 090	1 587
Zambia	116	9 100	12 747	10 755	8 275	18 285	6 345
Zimbabwe	20	11 526	1 735	13 485	1 483	17 395	1 030

WATER STRESS Availability less than 1700 cu m/capita/year
WATER SCARCITY Availability less than 1000 cu m/capita/year
Namibia values are high due to the Orange and Okavango river allocations but faces distribution challenges
Note that despite improvements in monitoring technology, estimates of water availability are approximations, and the average annual figures mask large seasonal, inter-annual and long-term variations. Geographical variations are also a factor, for example in Namibia and Malawi.

Hirji, R., Johnson, P., Maro, P. & Matiza-Chiuta, T. (Eds), Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa, 2002; Tumbare, M.J. The Management of the Zambezi River Basin and Kariba Dam, 2010

Table 2.5 **Comparison of Zambezi River Basin Water Sector Status with other Benchmarks/Indicators**

Sector	Zambezi River Basin status	SADC status	World averages	Industrialized countries
Water abstraction	102 cu m/capita/year	170 cu m/capita/year	570 cu m/capita/year	1 330 cu m/capita/year
Surface water storage	140% of ARWR stored	14% of ARWR stored	25% of ARWR stored	70% to 90% ARWR stored
Irrigated land	13% irrigated of available irrigable land	7% irrigated of available irrigable land	20% irrigated of available irrigable land	70% irrigated of available irrigable land
Water supply	77% of the ZRB population (2008) has access to an adequate and safe water supply	61% of the SADC population has access to an adequate and safe water supply	87% of the World population (2006) has access to an adequate and safe water supply	100% of the population has access to an adequate and safe water supply
Sanitation	60% of the ZRB population (2008) has access to an adequate sanitation service	39% of the SADC population has access to an adequate sanitation service	62% of the World population (2006) has access to an adequate sanitation service	100% of the population has access to an adequate sanitation service

ARWR Annual Renewable Water Resources

Hirji, R., Johnson, P., Maro, P. & Matiza-Chiuta, T. (Eds), Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa, 2002; Tumbare, M.J. The Management of the Zambezi River Basin and Kariba Dam, 2010

Box 2.1 WATER SECURITY

A country's water security results from a combination of its inherent vulnerability and the way in which it responds to and manages that vulnerability.

Water vulnerability consists of three factors:

Water Availability
The basic amount of long-term water available to a country from surface and groundwater inflows and rainfall compared to the demand for water is a fundamental determinant of water security.

Water Variability
The extent to which the water is available when and where it is needed also heavily influences the water security of a country. Countries that are neither water scarce nor water stressed may still be vulnerable because of a mismatch between the location of the water and the location of the demand. Highly fluctuating seasonal demands or a highly variable climate can also create vulnerability.

Water Dependence
The structure of a country's economy and the dependence of its sectoral output on water will influence its security. More industrially developed countries generally have sectors that are less dependent on water than less-developed countries. Their productive output is less dominated by water-dependent sectors, such as agriculture, and there are multiple sources of energy for the industrial sector apart from hydropower.

Management response consists of two factors:

Water Infrastructure
Water storage helps to buffer against temporal variability; inter-basin transfers can buffer against spatial variability; levees and embankments protect against flooding; and pans, dams and boreholes provide access to water during drought in arid and semi-arid zones.

Management Environment
The way in which a country's water resources are managed in the face of limited endowments and high variability can greatly influence its water security. Investment in forecasting and monitoring capabilities; laws and regulations that provide equitable access to water; involvement of stakeholders in water management; pricing policies that encourage water conservation and re-use; pursuit of conjunctive management of surface and groundwater; and treaties that promote regional water sharing all enhance efficient and equitable use of a country's water resources.

World Bank 2004

Figure 2.2 **Comparison of Zambezi River Basin Water Sector Status with Other Benchmarks/Indicators**

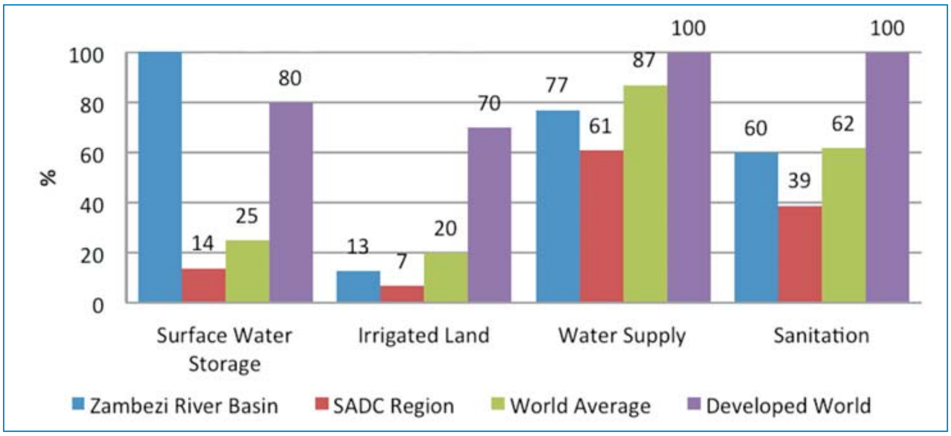


Table 2.5

sequently, the need for water will increase with the requisite increase in infrastructure development. This will become more complex as countries utilize the most economically viable sources first and as these get exhausted, and then the more expensive sources have to be utilized. These sources might be from trans-boundary or inter-basin sources. In short, the competition for water by users will become fiercer as the water resource becomes scarcer (Tumbare 2010).

Table 2.6 and Figure 2.3 show the current water use patterns in Zambezi riparian states for three sectors of Agriculture, Domestic and Industry.

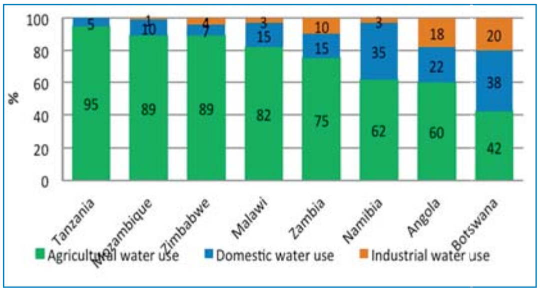
Table 2.7 shows the area under irrigation in Zambezi Basin countries and its share in arable land and permanent crops. For Botswana, although the area under irrigation increased from one thousand hectares in 2001 to about two thousand in 2006, it still remained the lowest as compared to the area

Table 2.6 **Current Water Use Patterns By Sector for Zambezi Riparian States**

Country	Current volume per capita (cu m/capita/year)			
	Total	Domestic	Industrial	Agriculture
Angola	27	6	5	16
Botswana	83	29	18	35
Malawi	96	14	5	77
Mozambique	35	4	1	30
Namibia	139	46	5	87
Tanzania	58	3	1	54
Zambia	173	29	13	131
Zimbabwe	203	19	9	174
Average	101	18	7	76

World Bank, Strategic Role of Water in SADC Economies, 2004

Figure 2.3 **Water Use By Economic Sector**



Aquastat, FAO Information System on Water and Agriculture, 2008

under irrigation in other riparian states. In 2008, Zimbabwe had the largest area of land under irrigation although its percentage share in arable land and permanent crops (4.5) was lower than that of Zambia (6.5).

Hydropower generation is one of the most important in stream uses of water in the basin and the region as a whole because most countries rely heavily on hydroelectricity for domestic and industrial use as well as for pumping water and other agricultural uses. Although hydropower generation is normally considered non-abstractive, there are evaporation losses associated with storage and in some cases, diversion of water for hydropower generation away from other uses such as tourism and the environment exemplified by the diversion of water on the Zambian side of the Zambezi River at Victoria Falls for hydropower generation at the Victoria Falls North Bank Power Station.

Competing uses of water arise from the demands of competing users, whether in the public or private sector, domestic or commercial use. Some of the major challenges for water sector stakeholders in the Zambezi River Basin are:

- water scarcity as demand exceeds supply due to natural causes, population growth, increased mining activities, emerging demands for bio-fuels, growing economies or distribution of the water resources;

Table 2.7 **Irrigated Land in the Zambezi Basin and Share in Arable Land and Permanent Crops**

Country	IRRIGATED LAND 000 Ha					SHARE IN ARABLE LAND AND PERMANENT CROPS %				
	1999-2001	2003-2005	2006	2007	2008	1999-2001	2003-2005	2006	2007	2008
Angola	80	80	80	80	80	2.4	2.2	2.2	2.2	2.2
Botswana	1	1	2	2	2	0.4	0.5	0.8	0.8	0.8
Malawi	51.7	56	56	59	59	1.8	1.8	1.8	1.9	1.6
Mozambique	115	118	118	118	118	2.7	2.5	2.4	2.5	2.5
Namibia	7.3	8	8	8	8	0.9	1.0	1.0	1.0	1.0
Tanzania	163	184	184	184	184	1.6	1.7	1.7	1.7	1.7
Zambia	133.3	156	156	156	156	6.0	6.9	6.3	6.4	6.5
Zimbabwe	174	174	174	174	174	5.2	5.0	4.7	4.7	4.5

SADC 2012a, SADC Statistical Yearbook 2012

- lack of access to adequate safe water and sanitation facilities due to financial and infrastructure constraints;
- water quality deterioration arising from large volumes of effluent from urban, mining, industrial and agro use;
- fragmentation of water resources management policies and practices at national, river basin or regional levels.

Impact of Climate Change

While climate change and variability research is ongoing, both globally and locally, researchers generally agree that average temperatures in the Zambezi River Basin are rising and that the northeast of the SADC region will become wetter while the southwest will become drier. Table 2.8 gives a summary of the main indicators.

Water Access

The Annual Renewable Water Resources (ARWR) in the Zambezi River Basin are shown per capita by country in Figure 2.4. A high ARWR figure indicates higher availability of water resource but does not necessarily mean high accessibility of the water resource. Access to water resources requires construction of appropriate water storage and water supply infrastructure. Due to the poor water storage infrastructure de-

Table 2.8 **Climate Change Findings for the Zambezi River Basin**

Thematic Area	Findings
Temperature and Evaporation	Available studies predict that: 1. Temperatures in the Zambezi Basin will increase in the range of +0.3ºC to +0.6ºC per decade. 2. Summer temperatures will increase by a maximum of +0.8ºC per decade. 3. Evaporation is estimated to increase by 10% to 25% by 2050.
Rainfall and Runoff	Available studies predict that: 1. The Zambezi River Basin will become generally drier. 2. Rainfall pattern changes will occur over the entire Zambezi River Basin. 3. Rainfall over the Zambezi River Basin will decrease by 10 - 15% by 2050. 4. There will be drier droughts and wet years will be wetter. 5. There will be a shift in the wet season, which may have already begun.
Dam Management	1. Existing dam operating rules in the Zambezi River Basin consider one-year rule curves. A shift to a longer operating window, which is desirable, brings major challenges to Dam Operators because of the expected higher weather variability. 2. The low storage/MAR ratios of all current dams in the Zambezi River Basin, except for Kariba, suggests that these dams cannot store major floods. 3. Due to high weather variability, perceptions with regard to dam operations are that there will be incremental, unpredictable increases in flow discharges resulting in flooding, with losses of lives and livelihoods.
Forecasting	1. Sustainability of automatic flow gauges in the Zambezi River Basin is a significant challenge at present due to: • Ageing equipment/Lack of spares; • Loss of trained staff/Brain drain; • Thefts/vandalism; • Flood/lightning damage. 2. The existing density of rainfall gauges in the sub-basins is generally below the requirements for accurate forecasting.

SADC 2011b, Climate Change Adaptation in SADC: A Strategy for the Water Sector, 2011 velopment in the Zambezi River Basin, most of the Zambezi riparian states are dependent on rainfall.

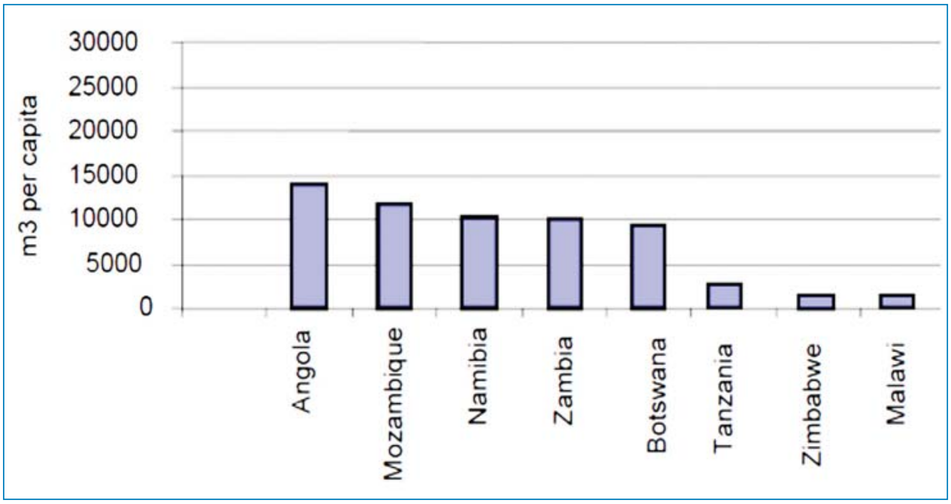
In the planning horizon of up to year 2030, the water sector infrastructure development interventions should target three main water user areas of agriculture, hydropower generation, and domestic water supply and sanitation services in line with the SADC Vision (SADC 2012b). The agriculture and hydropower generation sub-sectors are the main catalysts or drivers for food security, poverty eradication and economic development while an adequate domestic water supply and sanitation service to the residents of the Zambezi River Basin not only ensures healthier citizens, but should be considered as a human right. Other water sector users such as mining, aquaculture, navigation, tourism and the environmental, will also benefit from the provision of the water infrastructure.

Access to Safe Water and Sanitation

Access to safe water and adequate sanitation is one of the most effective ways of improving human health (UNEP 2013). However adequate safe water and sanitation facilities are not available to the majority of the Zambezi River Basin riparian states due to financial constraints, and when made available, there can be resistance to use the safe water and sanitation facilities due to unreliability of the services. The financial constraints could be a direct result of poor national economic performance or poor resource allocation.

Due to environmental degradation and deforestation, women in the region now spend more time looking for fuelwood, water and food, forcing them to cut back on the number of cooked meals and their nutritional value (SADC 2011b). In Mozambique, women spend 15.3 hours per week during the dry season and 2.9 hours per week during the wet season in drawing and carrying water. In Malawi, each household spends five percent of all days and nights collecting water (SARDC and HBS 2010). Women and girls in the rural areas of the Basin traditionally fetch water and wood, and

Figure 2.4 **Per Capita Annual Renewable Water Resources**



SADC 2012b, Regional Infrastructure Development Master Plan -- Water Sector Plan

Box 2.2 **CASE STUDY ON CHOLERA OUTBREAK**

A cholera outbreak in 55 of Zimbabwe's 62 districts between August 2008 and May 2009 resulted in some 4,000 fatalities. The following factors were responsible for the cholera outbreak:

- Consumption of contaminated underground water from wells;
- Drinking water from unprotected sources (river, wells);
- Contact with someone with diarrhoea at home; and
- Absence of a toilet at home.

The following measures were taken in response to the outbreak:

◦ Rehabilitation of boreholes; and
◦ Distribution of non-food items, including water urns, aquatabs, oral rehydration sachets, soap and awareness pamphlets on cholera prevention.

The following extra measures were also recommended:

◦ Boiling water before drinking;
◦ Treating water before using; and
◦ Practicing good personal hygiene.

UNEP 2013

also look after the sick, thus putting them at greater risk and vulnerability if safe and adequate water supplies and sanitation services are not at their disposal.

Water quality deterioration reduces water availability which induces water stress or scarcity. Available renewable water resources, once polluted, are no longer immediately available for use or become more costly to use. The water resources in the Zambezi River Basin are becoming increasingly polluted due to large effluent discharges from the urban areas, mining activities and agro-industries as countries become more industrialised.

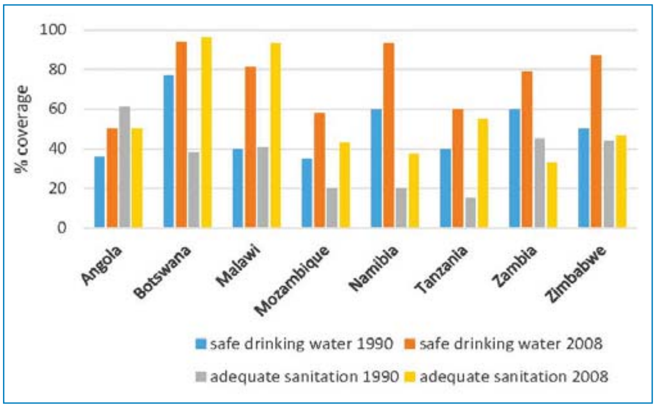
Water is a key driver for sustainable growth and poverty alleviation in the Zambezi Basin, and many people in the rural and peri-urban areas do not have access to adequate water for basic human needs and for economic production. Figure 2.5 shows trends in water and sanitation coverage in the Zambezi Basin.

Although safe drinking water and adequate sanitation is generally improving across the Zambezi River Basin as shown in Figure 2.5, low levels of access to both safe water and sanitation are adversely impacting on the livelihoods, health and productivity of the most vulnerable members of society. Poverty is a relative word with several definitions, but the main causes of poverty in the Zambezi River Basin are:

- lack of infrastructure including roads;
- inadequate access to land and capital;
- lack of access to modern technology;
- diminishing access to traditional technology; and
- natural disasters (droughts, floods).

In the context of the Zambezi River Basin, poverty relates to lack of resources for production that can enable

Figure 2.5 **Water and Sanitation Coverage in Zambezi Basin States**



Data for Malawi is 2010, Mozambique 2009, Namibia 2007, Zambia 2008 and 2010

National MDG reports; SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

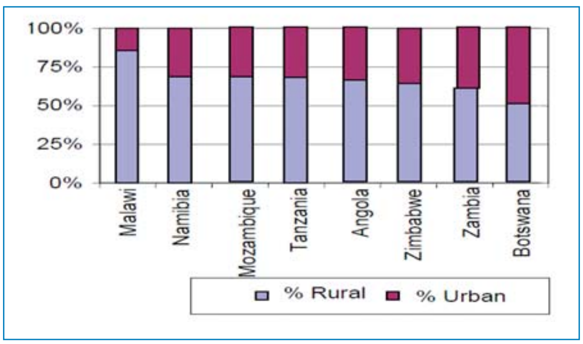
or empower the populace to afford a better standard of living. This lack of resources includes access to information, health facilities, education and other services, generally resulting in the affected population being vulnerable and dependent (Tumbare 2010). Information related to water resources includes: rainfall patterns for cropping, seasonal water availability, floods, droughts, seasonal rainfall variations, climate variability and change.

Poverty is a threat to the sustainable integrated water resources management of the Zambezi River Basin because of the following, among other reasons (Tumbare 2010):

- The persistence of poverty and deprivation is pervasive and results in high birth rates, crime and corruption. High birth rates increase demands on food production, employment, and health services, which are already inadequate, creating a vicious circle;
- On average, 70 percent of the population of the Zambezi River Basin is rural and poor. The rural economy of the Basin countries is principally subsistence agriculture. With limited agricultural inputs, equipment and land, poor

agricultural practices are prevalent resulting in land degradation. This land degradation accelerates soil erosion leading to siltation and pollution of water sources and water bodies;
- The lack of access to alternative energy sources results in reliance on firewood and charcoal. Forests are being destroyed to meet this demand, leading to a cycle of deforestation and land degradation.

Figure 2.6 **Distribution of Population in Urban and Rural Areas in Zambezi Basin States**



World Bank, Strategic Role of Water in SADC Economies, 2004

Population Growth and Water Supply

As the economies of the Zambezi River riparian states continue to grow, so will urbanization and industrialization resulting in pressure points for resource availability in urban centres. There is an increasing urbanization trend in all the eight Zambezi River riparian states. This will require large water sector infrastructure investments to meet the water supply and sanitation needs of the growing urban population since urban area services are more centralised than those for the rural areas where the population densities are lower. Figure 2.6 portrays another population dynamic. Malawi has the highest rural population while Botswana has the lowest.

The population of the Zambezi River Basin continues to grow, growing at an average rate of 2.36 percent per annum. Due to the increase in population, water resource availability is declining due to increased demand resulting in pressures on existing water supply infrastructure. An increasing

Box 2.3 **POPULATION OF THE ZAMBEZI RIVER BASIN**

The population of the Zambezi River Basin grew from 31.7 million in 1998 to 38.4 million in 2005, before reaching 40 million in 2008. It is projected that by 2025, the population will reach 51 million.

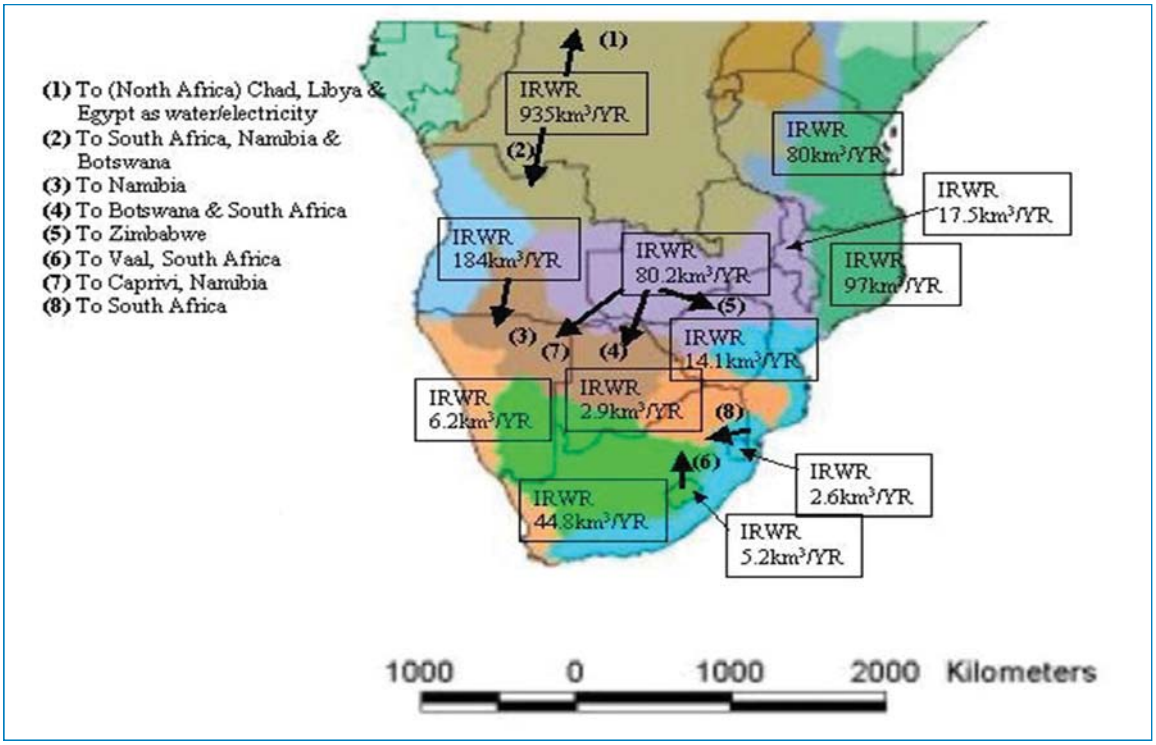
Although sparsely populated, average population densities in the Basin show a consistent shrinkage in per capita land availability, which is projected to decline to 2.56 hectares/person in 2025 from as much as 4.16 hectares/person in 1998.

Population distribution is uneven in the Basin, with large areas uninhabited and reserved for wildlife. In 1998, the average population density in the Basin was 24 people per sq km, and this increased to 28.75 people per sq km in 2005 before reaching 30.26 people per sq km in 2008.

There are disparities in population densities between countries in the Basin, with Malawi being the most densely populated country. In 2008, Malawi's population density was 125.3 people per sq km. Tanzania had an average of 45 people per sq km, Zimbabwe had 31.9, and Zambia had 16.8. In 1998 Malawi had an average of 105 people per sq km; Tanzania had 36; Zimbabwe had 28.5; and Zambia had 13.

Chenje (ed). 2000, SARDC and HBS 2010, UN Statistics 2011 in SADC/SARDC and others 2012

Map 2.5 **Internal Renewal Water Resources and Inter-Basin Water Schemes**



Tumbare, M. J., Equitable Sharing of the Water Resources of the Zambezi River Basin, 1999; and Management of Shared Watercourses in Southern Africa, 2005

population requires increasing food supply. This requires more food to be grown on limited available land, utilising a finite water resource. Conflicts in water resource allocation will inevitably increase.

Production and consumption have to increase in an environment of increasing population resulting in additional demands and pressure on a finite water and land resource. With an increasing population on limited land in some areas, population densities are resulting in over-utilization of natural resources including water. Due to the continued increase in human population, competition for habitats with wildlife also increases resulting in conflicts and an unsustainable environment.

Inter-Basin Water Transfers

Due to continued population and economic growth within the SADC Region and the Zambezi River Basin, the demand for water will continue to grow and the need to transfer water from areas of abundance to shortage areas will arise necessitating the implementation of the proposed inter-basin water transfer schemes. Map 2.5 and Table 2.9 give some details on some existing and proposed inter-basin water transfer schemes within the SADC region and the Zambezi River Basin respectively.

Some of these schemes provide investment opportunities for economic growth for the Zambezi River Basin. Those that have been implemented elsewhere such as the Lesotho Highlands Water Transfer Scheme have benefited both contracting parties, Lesotho and South Africa. Such schemes bring closer ties and co-operation between the contracting parties.

Table 2.9 **Inter Basin Water Transfers In Southern Africa**

River	Country	River/Area	Country		
Cunene Okavango	Angola/Namibia Angola/Namibia	Cuvelai Central Namibia	Namibia Namibia	E E	Primary Primary/Irrigation Primary/Environmental
Zambezi/Chobe	Angola/Zambia/ Namibia/ Zimbabwe/ Botswana	Selibe- Pikwe/ Gaborone	Botswana	P	Mining/Industrial
Zambezi/Chobe	Angola/Zambia/ Namibia/	Central Namibia	Namibia	P	Primary/Irrigation Primary/Environmental
Zambezi	Angola/Zambia/ Namibia/ Zimbabwe/Botswana	Caprivi Strip	Namibia	P	Irrigation
Zambezi	Angola/Zambia/ Namibia/ Zimbabwe/Botswana	Vaal/Pretoria	South Africa	P	Irrigation
Zambezi	Zambia/Zimbabwe	Gwayi/Bulawayo	Zimbabwe	P	Primary/Irrigation Industrial/Primary
Congo	Democratic Republic of Congo	Okavango	Namibia	P	Primary/Industrial
Congo	Democratic Republic of Congo	Zambezi	Namibia/Botswana/ South Africa/Zimbabwe	P	Primary/Industrial/ Irrigation/Mining

Tumbare, M. J., Management of Shared Watercourses in Southern Africa, 2005; and The Management of the Zambezi River Basin and Kariba Dam, 2010

Water Management Challenges

A summary of the key challenges and issues in the water sector of the Zambezi River Basin is presented in Table 2.10.

Governance Issues

Some governance issues and resultant challenges are shown in Table 2.11. These have an impact on the management of the water resources of the Zambezi River, which consequently affects the wellbeing of the environment.

Groundwater Depletion

Various studies of the weathered and fractured Precambrian Basement Complex aquifers of southern Africa were undertaken by the British Geological Survey (BGS) staff primarily in Botswana, Malawi and Zimbabwe during 1985 to 1993, including the installation of collector well systems. BGS staff also studied the impact of drought on groundwater resources in Malawi, South Africa and Zimbabwe during 1996-97 (BGS 2015).

SADC-related policy studies of the regional water resources followed the publication of the Protocol on Shared Watercourse Systems in SADC in 1998

Table 2.10 **Key Challenges and Issues in the Water Sector in the Zambezi River Basin**

CHALLENGE/ISSUE	SUMMARY
Data	Access to reliable data, both in the water resources and water services sectors, inadequate infrastructure and information systems for water resources monitoring, unreliable data on water use and water loss in municipalities and other different sectors, and inadequate data on access to water and sanitation.
Capacity	Limited human resource capacity in both the technical and managerial fields to deliver sustainable water services and to manage water resources effectively.
Water Sector Infrastructure	The infrastructure challenges can be summarised as follows: There is limited water resources storage infrastructure at local levels, making countries vulnerable to droughts, floods and to the impacts of climate change; Water resources and water services infrastructure, including large dams, irrigation canals, pumps, water and waste water treatment works, and reticulation systems are often poorly maintained, resulting in safety issues and water wastage; Large numbers of people with inadequate access to water and sanitation infrastructure and related services impacts negatively on health and livelihoods; High levels of illegal connections result in water theft, reduced revenue and high rates of water loss.
Financing	Inadequate financial resources is a challenge to infrastructure development and expansion, and for operations and maintenance. Poor revenue collection for water services remains a major challenge that impacts on the ability to deliver sustainable services.
Climate Change	Considerable work is required to understand the likely impacts of climate change, at the catchment level in particular. This requires further research and investment, including improved flood and drought management, extended hydrological gauging networks, improved hydrological modelling, improved groundwater modelling, improved data processing, appropriate drought and flood management systems, enhanced disaster/risk management and improved communication and transfer of information.
Managing Water Quality	There are two critical aspects to managing water quality that need to be addressed: o protecting the water quality in surface and groundwater resources, and o ensuring the quality and safety of drinking water. The former links to issues of pollution control and treatment, including pollution from municipal, agricultural, industrial and mining waste. The latter requires effective treatment of water to potable standards, in urban and rural areas.
Sanitation	Sanitation delivery has lagged behind the delivery of water services in the Zambezi River Basin riparian states. There are a number of challenges around ensuring appropriate sanitation, including issues of sustainable, waterless or low water use sanitation that are appropriate to the local context. A further challenge that should be addressed by the Basin states is how to manage productive and safe wastewater, excreta and faecal sludge for nutrient re-use in agriculture and aquaculture and how this can enhance resilience to climate change. This includes understanding the science, the business models, the social change required, as well as establishment of safety standards for reusing wastewater in agriculture.

Adapted from SADC 2011b, Climate Change Adaptation in SADC: A Strategy for the Water Sector, 2011

and the Southern Africa Water Vision for Action in 2000. Various strategic action plans followed during 2000-2005. Those related to the production of a hydro-geological map with reviews of country specific data (2002) and the regional situation analysis of drought and its impact upon groundwater supply management (2005) were the most significant drivers of hydro-geological studies. Emphasis has also been placed upon integrated water resources management especially within transboundary settings (BGS 2015).

About 70 percent of the population of the Zambezi River Basin lives in the rural areas where groundwater is of critical importance to the livelihoods of this rural population. This is because groundwater is a more suitable and ap-

Table 2.11 **Summary of Governance Issues and Impacts in the Zambezi River Basin**

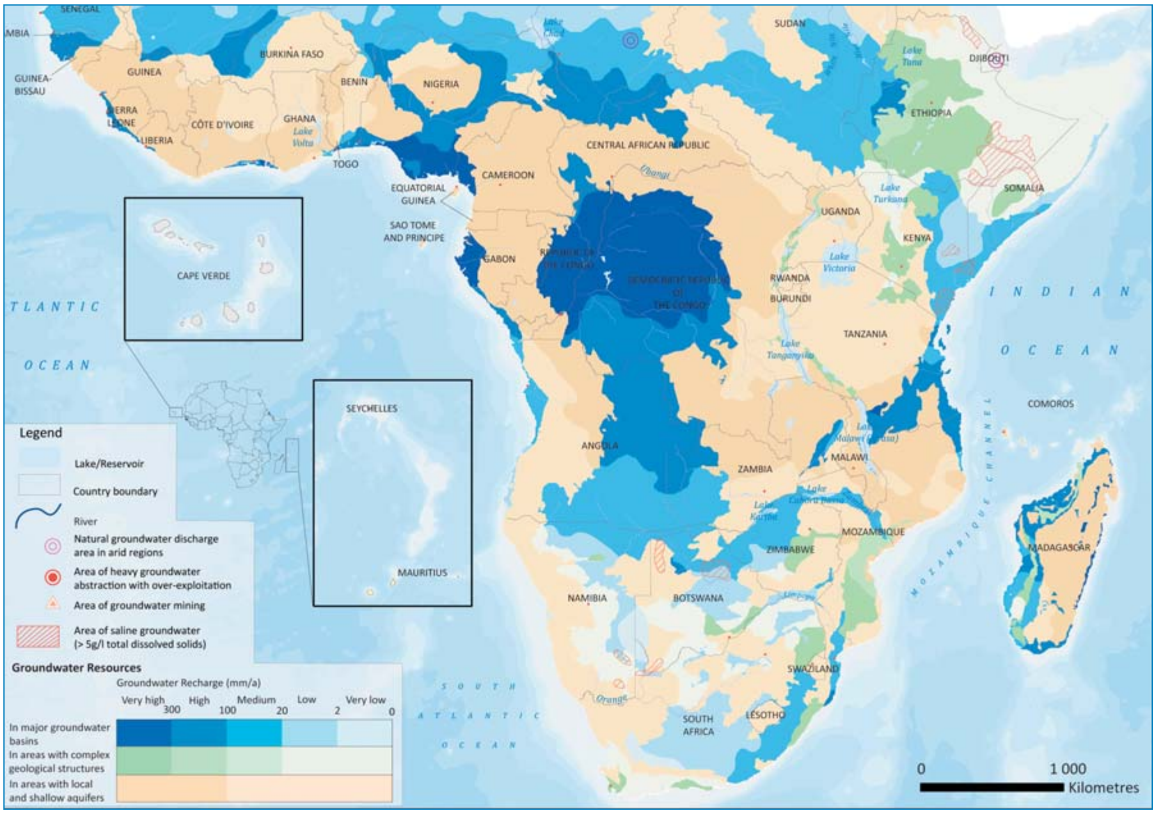
ISSUES	IMPACTS
Policies and Laws in the water sector of riparian states are not harmonised with each other and/or with the SADC Regional water sector protocols and policies	Different water quality standards Different assignment of the value of water Slow realization of regional integration goals
Ineffective basin-wide management of the water resources of the Basin	Fragmented water infrastructure development Low optimization of conjunctive operation of water infrastructure Poor resource mobilization, allocation and utilization Low level data/information sharing, inadequate synchronization of water infrastructure operation and management Duplication of effort and resource wastage Difficulty in accounting for responsibilities in cases of problems Water sector users confused as to who to be answerable to Delays in disaster management/mitigation response Lack of common understanding of baseline status and priority issues in basin level water management
Institutional capacity constraints	Weak national water management institutional capacity to perform river basin management tasks Limited water resources knowledge base for basin-wide development and management Inadequate effective stakeholder participation in water resources planning, development and management Communication limitations in some Zambezi River Basin institutions Inadequate utilization of resource opportunities towards implementation of cooperative basin initiatives
Lack of trust and confidence	Low confidence in the Basin's Precipitation and Flow Forecasting System Prolonged decision-making and debate on priority and urgent water management issues – prioritizing sovereignty over transboundary cooperation
Lack of investments in water infrastructure	High vulnerability to extreme weather impacts Low water use efficiencies and poor maintenance of existing infrastructure
Poor project monitoring and evaluation systems	Lack of knowledge on project impacts and outputs Lost opportunities to learn from project lessons.
Corruption	Increased project costs Resources diverted from intended purposes Sustained or increased poverty levels

Adapted from SADC 2011a, Dam Synchronization and Flood Releases in the Zambezi River Basin

propriate water supply source for low population areas requiring minimal reticulation. The rural communities rely on groundwater for their domestic water supply, stock watering, and horticulture.

Groundwater is important particularly in arid and semi-arid regions of the Zambezi River Basin and augments surface water supplies particularly in drought seasons. However, across the Zambezi as a watercourse, very little groundwater information is readily available for planning purposes and for understanding how surface and groundwater interface for sustainable utilization and conjunctive use. Consequently, there is insufficient capacity and knowledge to implement effective management of groundwater to result in the sustainable use of this water resource of the Zambezi River Basin.

Map 2.6 Groundwater Resources in Southern Africa



UN, Water a Shared Responsibility - United Nations World Water Development Report 2, 2006

Box 2.4

ARTIFICIAL GROUNDWATER RECHARGE

Artificial recharge is the process whereby surface water is transferred underground to be stored in an aquifer. Underground water storage is an efficient way to store water because it is not vulnerable to evaporation losses and it is relatively safe from contamination.

Windhoek, the capital city of Namibia, has a water requirement of about 21 million cubic metres per year. Most of this water comes from 3 dams but some is sourced from an aquifer and from fully treated recycled water. The Windhoek water banking scheme involves banking surface water in the aquifer as security against droughts. This allows for the dams to be used at greater risk levels, as security lies in sub-surface storage where evaporation and aquifer losses are negligible. The overall aim of the scheme is for the aquifer to be able to supply virtually the entire city's current water use when it is full, and then for it to be rapidly and fully recharged afterwards.

One of Windhoek's injection boreholes

Some of the main reasons for implementing artificial groundwater recharge are:

- Artificial recharge is usually cheaper than conventional surface water schemes.
- The aquifer offers storage opportunity where surface storage is not possible.
- The augumentation of existing groundwater supplies is necessary.

Groundwater Strategy 2011

Map 2.6 shows groundwater resources in southern Africa. It is difficult to map groundwater resources due to the inter-linkages of groundwater aquifers as well as inadequate data and information on groundwater to accurately depict a Zambezi River Basin perspective.

The above scenario, coupled with the predictions of extreme weather patterns caused by climate change, calls for efforts to store available water resources. This can be realised through construction of dams, groundwater recharge (Box 2.4) and water harvesting.

Wetland Degradation

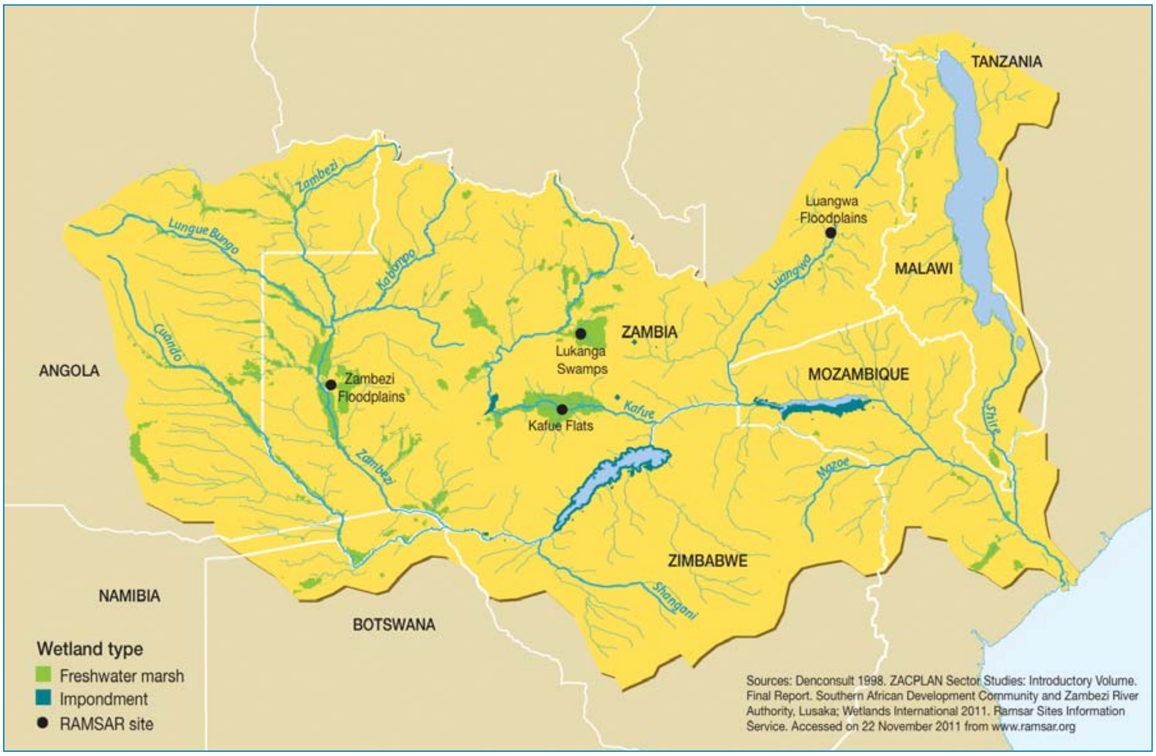
The Zambezi River and its tributaries have large wetlands, the largest being the Barotse Floodplains in western Zambia and the Kafue Flats in central Zambia. Wetlands provide a wide variety of resources for wildlife, flora and fauna as well as a number of products and services that benefit community livelihoods. Wetlands also provide hydrologic advantages to flood control by reducing the water flow velocity caused by flooding and in the process, storing some floodwaters within the wetland, thus reducing the flood peak.

Almost 20 million people, which is more than 50 percent of the population in the Zambezi River Basin, are concentrated around wetlands and most communities continue to be dependent on hand-dug wells for the supply of potable water. Women and children usually cultivate in wetland ecosystems since these provide enough moisture and fertile soils for agriculture. However, like all large artificial and natural lakes, the wetland surface area results in high evaporation losses.

Major causes of wetland degradation in the Zambezi River Basin include:

- unsustainable wetland resource utilization such as over-fishing and water abstraction;

Map 2.7 **Wetlands of the Zambezi River Basin**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

- siltation of wetlands resulting in loss of mangroves and alteration of the ecosystem habitats;
- pollution of wetlands from mining, sewerage and other industrial effluents;
- conversion of wetlands to other land uses such as construction of houses; and
- undervaluation of wetland goods and services.

In Zambia, charcoal production and slash-and-burn agriculture have led to the deterioration of the Lukanga swamp ecosystem, resulting in soil erosion, the turbidity of the water and siltation (ZEMA and others 2012). As a way of conserving wetlands, local farmers from the Simlemba Wetlands in Malawi, of which the majority are women, have developed sustainable strategies that allow the community to use the surrounding dambos and vleis without destroying the productive ecosystems, as manifested in many different wetland ecosystems throughout the basin (SARDC 2013). Map 2.7 shows the wetlands of the Zambezi River Basin.

Aquatic Invasive Species

Aquatic plants, mostly free-floating species such as Water Hyacinth (*Eichhorniacrassipes*), Water Lettuce (*Pistiastratiotes*), Red Water Fern (*Azollafiliculoides*), and Kariba Weed (*Salviniamolesta*) are dominant in the Zambezi River Basin (Turpie and Zyl 2002). Of all the aquatic invasive weeds found in the Zambezi River Basin, water hyacinth growth poses the most challenges throughout the Basin and is most prolific on Lake Chivero, the Kafue Flats, Lake Kariba, and the Lower Shire.

Box 2.5 **INVASIVE WEEDS ON LAKE KARIBA**

The two main species of invasive aquatic plants on Lake Kariba are the water hyacinth *(Eichornia Crassipes)* and the Kariba weed *(Salvinia Molesta)*. The proliferation of these invasive plants on Lake Kariba poses operational problems for hydropower production if the weeds get into the hydropower or domestic water supply intake. Lake navigation and fisheries are also negatively affected.

The Kariba weed was prevalent on Lake Kariba during the period it was filling in the early 1960s. A grasshopper from South America, Paulina, was introduced in 1969 as part of a biological weed control strategy and also a sardine species commonly known as Kapenta *(Liomnothrissa miodon)* from Lake Tanganyika. The grasshopper helped to reduce the Kariba weed growth while the Kapenta helped to reduce the lake's nutrients. As the lake's ecological balance was gradually achieved, the weed died out and is now rarely observed on the lake.

The water hyacinth on the other hand, became a real nuisance in 1994 when the lake remained at levels lower than normal due to the prolonged below-normal water inflows. The Zambezi River Authority (ZRA) implemented a programme for reducing and controlling the proliferation of the water hyacinth through an extensive aerial spraying in August 1998, using the phenoxy herbicide 2,4-D at the rate of 6 litres/ha. Water and fish samples were taken before, during and after the spraying exercise to determine any detrimental effects. None were detected and this spraying exercise is well-documented (ZRA1999). The spraying of the water hyacinth with 2,4-D was very effective and caused the death and submergence of the treated water hyacinth within one week. A total of 1,671ha were cleared of the water hyacinth.

This was followed by a biological control programme using weevils *(Neochetina spp.)* on the remaining areas invested by water hyacinth which could not be sprayed, such as at domestic water intake works. This strategy worked well and the water hyacinth growth and proliferation is well under control. ZRA has produced a "Management Tool Box" for the control of invasive weeds on Lake Kariba.

Tumbare 2008a

The weight of the water hyacinth is mainly water and the plant can double its mass every four days or so given warm eutrophic conditions. Thus, the plant actively pumps water through its tissues and releases it into the air in the process of evapotranspiration. Through this process the water loss from the surface of water bodies with invasive species is more than triple that from the same water bodies without these plants. Box 2.5 discusses the growth and control of aquatic invasive weeds on Lake Kariba.

Declining Water Quality

Pollution of surface and groundwater resources results in the deterioration of water quality, which causes major negative human health and environmental impacts, higher costs of water treatment and loss of immediate access for use. The increase in pollution discharges is largely attributed to urbanization, increased industrial and agricultural activities, mining and soil erosion. The urban centres produce sewage effluent while industries produce toxic wastes. The agricultural sector uses fertilisers and other pesticides which all contribute

Box 2.6 CURRENT STATUS AND IMPACTS OF EUTROPHICATION – LAKE CHIVERO

Lake Chivero is a tropical impoundment created in 1952 primarily to supply water to the capital city, as well as satisfying downstream irrigation needs. The lake is now hyper-eutrophic. Mean total phosphorus concentrations for the period March to April 2003 ranged between 1.98 mgl^{-1} and 2.99 mg l^{-1} at three sampling sites on the lake, with a mean of 2.24 mg l^{-1}.This is about three orders of magnitude higher than the 1967 value (0.04 mg l^{-1}), during which the lake was already hyper-eutrophic, and over 20,000 times the mean value during the recovery period .Chloride levels ranged between 71.03 mgl^{-1} and 174.78 mgl^{-1}.

Studies by Magadza showed the existence of thermohaline stratification and declining oxygen levels, to the extent that the lake suffers from frequent anoxia leading to fish kills. Health studies showed the presence of microcyst in levels well above the limit set by the World Health Organization (WHO). In the period 1991 to 2001 the incidences of gastroenteritis and liver cancer have increased, with liver cancer incidences doubling between 1998 and year 2000. A rise in bloody diarrhoea incidences among five-year-olds in Harare during the rainy season was noted. This is explained by the mingling of rainwater runoff with breached sewer outflows, rendering children who play in the puddles susceptible to gastroenteritis infections.

Nuisance invasive aquatic weeds (*Eichhornia crassipes* and *Hydrocotyl*) have become pervasive, with *Hydrocotyl* increasingly replacing *Eichhornia*. The cost of treating the Lake Chivero water to potable standards has escalated and the water authority is no longer able to supply adequate water for the urban population, with several suburbs going without piped water supply for weeks and months, although the lake storage is high.

What Can Be Done?

The current management strategy is to seek more funds to construct more wastewater treatment works. A total of 255 ML capacity expansion is planned, at a cost of approximately US$353 million. This is indeed a priority, but such funding is unlikely to be available from local resources in the present economic circumstances. It has been shown earlier that the non-point source of phosphorus and nitrogen can maintain the lake in a hypereutrophic state given that the sum total of this source of nutrients exceeds the 1967 levels when the lake was hypereutrophic. Thus the high-technology wastewater treatment strategy now needs to be complemented by other strategies.

One such strategy is the implementation of the Seven Principles recommended by the World Lake Vision Committee (2003). This requires a major shift in mindset by the management authorities as to the rights and obligations of stakeholders. Examples from other countries have shown that the involvement of citizens at grassroots level can yield very satisfactory results, which could not have been achieved by a top-down management style. On the part of the citizens it requires a sustained educational and awareness programme about how they impact on their water resources.

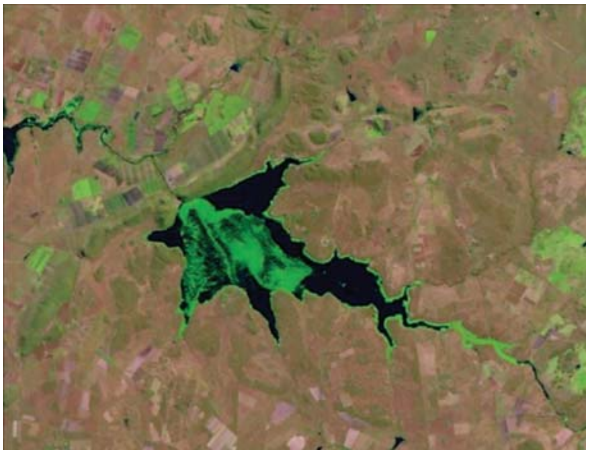
The other strategy is use of ecological methods for runoff water quality control. Studies on the Mukuvisi River, one of the major nutrient contributors to the lake, have shown that the wetlands associated with this river have considerable water quality restoration (self purification) capacity. Prior to 1980, the urban wetlands were left undeveloped as "ecological lungs" to the city, but now these wetlands are being increasingly converted for property development. It is recommended here that the State develops a clear policy and implementation strategy for wetlands conservation.

Within the urban areas of Harare and surrounding urban settlements, there is need for authorities to develop and implement an extensive programme of wetlands management, such as constructed wetlands. In this respect it should be noted that the UN Environmental Programme (UNEP) International Environmental Technology Centre (IETC) has case studies of ecological technologies for sound environmental management of water resources, such as "Planning and Management of Lakes and Reservoirs: An integrated approach to eutrophication".

Extracted from Magadza 2008

Images show the spread of invasive weeds on Lake Chivero over 25 Years

August 1986



June 1990

September 2000

June 2011

to the pollution of the surface and groundwater resources. In the Zambezi River Basin, gold panning is prevalent resulting in soil erosion and water resources pollution. Mine wastes, if not disposed and managed properly, result in heavy metal water pollution. The situation is worsened by the fact that the riparian states of the Zambezi River do not have harmonised water quality and effluent standards. Some of the main causes of deterioration in water quality are summarised in Table 2.12.

Water pollution is a threat to the water resources of the Zambezi River because it:

- negatively affects aquatic life and ecosystems in general by degrading the water quality;
- worsens eutrophication of lakes and reservoirs, which then increases the growth of evasive aquatic weeds causing further negative impact on the utilization of the water body;
- impairs reproduction and fish growth;

Table 2.12 **Causes of Water Quality Deterioration in a Watershed and Associated Problems**

Cause	Sources in a Watershed	ASSOCIATED PROBLEMS
Suspended sediments	Runoff, resuspensions from bottom sediments	Turbidity, colour deterioration
Human and animal organic waste	Runoff, septic tanks, human contact and point loadings of effluents	Health effects eutrophication
Industrial waste disposal and wash-off of agriculture (rural and urban), chemicals	Runoff, diffuse and point loadings of effluents and urban storm water	Toxic pollution, eutrophication
Atmospheric deposition of sulphates (SO4) and nitrogen oxides (NOx)	Coal-fired power stations and industrial emissions, washout by rain, diffuse washout in basin and particulate deposition on land and water	Acidification, loss of biodiversity
Changes in water balance	Runoff, diffuse and point loadings of irrigation outflows and urban and industrial wash-off	Salinization
Modification of natural flow	Release policy and regime	Downstream effects
Algal blooms and macrophyte weeds	End-products of eutrophication	Water transparency, de-oxygenation Loss of biodiversity

Chidumayo, E.N. in Hirji, R. and others (eds), Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa, 2002

- results in acid rain, which comes from air pollution from industries, leaches soil nutrients while increasing solubility of other soil minerals resulting in poor soil fertility and lower crop yields;
- increases costs of purification of water supplies for domestic, industrial or agricultural use; and
- increases the likelihood of waterborne diseases.

Impact of Industrial Growth on Water Quality

Water is an input to almost all production activities including agriculture, manufacturing, energy, transport, health and sustaining ecosystems. Due to economic growth in the Zambezi riparian states as well as growing populations and urbanization, the pollution of water bodies and the environment is increasing which in turn increases costs for water purification and thus production of goods and services.

As the land area under irrigation increases due to population growth, emerging demand for bio-fuels and decline in soil fertility, for example, more fertilisers and pesticides are being used with residues finding their way into underground and surface waters. This results in eutrophication of water bodies requiring expensive remedies (SADC/SARDC and others 2012). Mining activities, both formal commercial mining as well as the informal small-scale (artisanal) mining ventures such as gold panning, are also on the increase, with toxic wastes finding their way into the ground and surface waters (Box 2.7).

This affects the sources of domestic water supplies as the water purification costs increase, resulting in higher unit cost of domestic water to the consumers. The manufacturing sector also produces effluents which if not treated at source, pollute both the air and the water bodies. Inadequately treated wastes from cities (municipalities) and other large settlements, also pose a risk to the water resources integrity.

Another dimension of industrialization relates to population migration from rural to urban areas. This results in increased pressures on the water resources and water service infrastructure. Waterborne diseases emerge from inadequate treatment and unsafe disposal of effluent from informal settlements that arise on the periphery of cities, towns

Box 2.7 **FORMALIZING THE ARTISANAL MINING SECTOR**

Artisanal mining is defined by Hentschel and others (2003) as mining by individuals, groups, families or cooperatives with minimal or no mechanization. Artisanal mining activities can be as simple as panning for gold in a river, or as complex as developing underground workings.

An estimated 13 to 20 million men, women, and children in developing countries are directly engaged in the artisanal mining sector. A further 80 to 100 million people are affected by artisanal mining activities. In Zimbabwe, these small-scale miners are mostly involved in the extraction of gold, diamonds, tantalite and chrome.

All forms of artisanal mining are illegal in Zimbabwe. However this has not always been the case.

In 1991, Parliament gazetted Statutory Instrument 275, the *Mining (Alluvial Gold) (Public Streams) Regulations* as a measure to recognize gold panning and incorporate it in national development policies. This statutory instrument allowed Rural District Councils (RDCs) to apply for special grants for particular streams from the Secretary in the Ministry of Mines and Mining Development or a Mining Commissioner who would consult with the Department of Natural Resources.

After acquiring the grant, the RDC would demarcate a public stream into 50-metre sections for use by approved local persons, cooperatives and partnerships in consultation with the Mining Commissioner.

The regulations specified the areas where panning is legally permitted, and prohibited panners from mining in an environmentally degrading manner, stating that no mining should be carried out within three metres of the river bank and not deeper than 1.5 metres. However this Statutory Instrument was later repealed with the effect of making gold panning, which constitutes 90 percent of artisanal mining activities, an illegal activity.

Due to a lack of regulation and a lack of incentive for the artisanal miners to operate in an environmentally friendly manner, artisanal activities result in serious environmental degradation as evidenced by water contamination with heavy metals such as mercury and cyanide, as well as deforestation, soil erosion, sedimentation of reservoirs and water pollution as mining populations increase without provision of sanitation.

Mukwakwami, N., Formalising Zimbabwe's Artisanal Mining Sector, 2013 and industrial areas. At times, crime and other undesirable practices arise with increases in population density and unemployment. Additional infrastructure such as schools, health facilities, food markets, and other service provisions may also increase.

The mining sector is a large consumer of water and also a source of large-scale pollution and environmental degradation. The major minerals produced in the Zambezi River Basin are copper, cobalt, platinum, gold, coal, asbestos, nickel and tin. The mining sector has been a driver to infrastructure development as reliable water supplies, energy, roads, railways, and other infrastructure and services are required. If mine wastes are not treated at source, pollution to both surface and underground water resources occurs. Rehabilitation of mined areas is also required to restore the forests and make the mined area safe for humans, livestock and wildlife.

The manufacturing sector is also a large water consumer. Usually raw materials and chemicals are used in the manufacture of goods and if the resultant wastes are not properly disposed of, pollution of surface and ground water resources occurs. Major manufacturing activities in the Zambezi River Basin include production of sugar, textiles and garments, leather products, beer and soft drinks, dairy products, cement, fertilisers and steel.

Environmental Risks Associated with Advances in Technology

Technological advances have affected the environment in a number of ways, positively and negatively. Many technological processes produce unwanted by-products and wastes. However, innovative technologies in agriculture are allowing farmers to grow more crops using fewer resources and less land.

As new technologies are introduced, other challenges arise, such as the dumping of old technologies on countries in need. The disposal of obsolete technology products poses environmental risks, if recycling of such resultant waste is not done in an environmentally sustainable manner. There is need for introducing technologies that improve the efficiency of production of goods and services while avoiding or reducing the production of harmful wastes to the environment.

The use of renewable energy sources such as wind, solar or tidal needs a lot of technological advancement and availability so that such renewable energy sources are affordable and accessible to residents of the Zambezi River Basin.

Some Traditional Practices Impact on Water Quality

The majority of the population in the Zambezi River Basin lives in rural areas, and relies on traditional and available methods of agriculture and livestock development. Some practices have emerged for various reasons that now impact negatively on the environment and quality of water resources, and are no longer sustainable in their traditional form. Some of these traditional practices are:

- ***Shifting cultivation*** was initiated to avoid over-using the land, at a time when populations were lower and farmland was plenty. This involves clearing of forests for subsistence farming and moving to a new location in the next season, allowing the soil to rest but resulting in deforestation and soil erosion when trees to not have time to recover. The eroded soils add silt to water bodies.
- ***Charcoal production*** for commercial use is a threat in most Zambezi riparian states. Established initially for domestic use, this did not have a major impact, but reliance on sales to urban dwellers as a livelihood as caused serious deforestation around some cities and town as forests are cut down and the firewood converted into charcoal. Charcoal burns hotter and longer, but

production on a large scale is an inefficient use of the resource, and results in deforestation, soil erosion and siltation of water bodies.
- ***Overstocking*** without adequate consideration of carrying capacities, results in damage to grazing lands and negative environmental impacts such as loss of species diversity and vegetation cover, soil erosion and siltation of water bodies. Yet most rural communities measure their wealth in number of livestock that they own, particularly cattle and goats.
- ***Fish poisoning*** is practiced mainly in pools in rivers and wetlands, thus destroying fish species, and also affecting species diversity when implemented on a regular or large-scale basis using modern poisons.
- ***Veldt fires*** abound in most rural areas of the Zambezi Basin before the onset of a new rainfall season. These are started deliberately for various reasons, including to bring out new green grass quickly for livestock grazing, for ease of hunting, destroying agricultural pests, and as part of clearing the agriculture harvest waste. This not only destroys the ecosystem balance, but destroys trees and other vegetation, causes air pollution and may result in soil erosion as a result of the land being left barren.

Changes in State of Water Resources and Resultant Impacts

The effects of changes in state of the water resources and the anticipated impacts are summarised in Table 2.13.

The climatic challenges, the vulnerable sectors and the vulnerability context of each of the Zambezi River riparian states is presented in Table 2.14

Responses / Actions

Stream Flow and Meteorological Data Collection

For sustainable water resources management, data on rainfall, evaporation, wind speeds, stream and river flows as well as the water quality should be collected, analysed and the resultant relevant information disseminated to the stakeholders. The importance of data collection and analysis is vital as future planning is informed by this data. It should be remembered that even if a reading is "zero", it is still an important reading as it tells that there was no rainfall, or the river dries up and it is possible to know for how long and thus plan for these dry spells.

The collected data and information should be stored in databases for the river basin where it is easily accessed, processed and disseminated. For the Zambezi River Basin, a database called the Zambezi Water Information System (ZAMWIS) has been put in place. Map 2.6 shows the stream flow gauging stations that have data in ZAMWIS and those still to be entered. A lot of work still needs to be done to bring the ZAMWIS database up-to-date and to include all recording stations in the basin as well as having a meta-database, advising the respective national institutions together with their electronic databases, where data and information can be sourced.

Water Resources Management Institutions

The national or bi-national institutions' governance structures vary from country to country in the Zambezi River Basin.

Zambezi River Authority (ZRA) was established by Zambia and Zimbabwe in 1987 in Lusaka and operates through the ZRA Acts of 1987 which provide the mandate to manage the water resources of the common Zambezi River between Zambia and Zimbabwe.

Table 2.13 **Effects of Changes in the State of the Water Resources and the Anticipated Resultant Impacts**

EFFECT	IMPACT
Increase in temperatures due to climate change	Evaporation in water bodies is estimated to increase by 10% to 25% by 2050 increasing water losses to the environment and increasing competition between users and uses. Warmer temperatures lead to the proliferation of disease vectors such as ticks, mosquitoes and rodents leading to livestock and human diseases and possible deaths. Warmer temperatures lead to the proliferation of disease vectors such as ticks, mosquitoes and rodents requiring costly veterinary and other medical interventions.
Decrease in rainfall due to climate change	Decreased rainfall patterns result in lower food and livestock production causing malnutrition and poor health for humans and loss of grazing and forests for livestock. Decreased rainfall patterns result in reduced infiltration rates causing poor groundwater yields that support the majority of the rural population. Dams do not fill up due to reduced runoff resulting in water shortages for energy, agriculture and industry.
Seasonal shifts in rainfall due to climate change	Requires introduction of new seed varieties. Low confidence in scientific and Indigenous Knowledge Systems as weather patterns change.
Increase in extreme weather events (floods, droughts and cyclonic events) due to climate change	Frequent flooding increases incidences of waterborne diseases such as cholera, typhoid and bilharzia. Frequent flooding increases incidences of crop losses, population displacements and infrastructure damage. Severe droughts lead to conflicts over scarcer natural resources such as water, forests and pastures. Severe droughts also reduce/diminish capacity of rivers to dilute pollution.
Inaccessible and inadequate safe drinking water and sanitation facilities	Loss of time and energy spent by women and girls in collecting water from distant sources. Reliance on unsafe water sources resulting in diseases such as bilharzia, cholera, typhoid, dysentery and intestinal worms. Poor hygiene and human waste disposal leading to diseases such as diarrhoea, cholera, typhoid, dysentery and intestinal worms. Resultant diseases cause: Loss of productive time for workers and school children due to illness; Loss of productive time attending to the sick; Premature deaths; Increased number of orphaned children; Poor educational and academic progress supporting the persistence of poverty; Increased fiscal burden due to medical care requirements.
Lack of surface water storage infrastructure	With predicted reduced rainfall, increased rainfall variability and reduced runoff, there will be: Higher frequency of water shortages impacting negatively on food production and food security; Reduced assurance of supply to all water users; Higher frequency of water shortages impacting negatively on energy production; Higher frequency of water shortages impacting negatively on sustained industrial production and growth accentuating the prevalence of poverty; Poor groundwater recharge resulting in early drying up of wells and boreholes; Poor response to and mitigation of drought and flood events due to lack of adequate surface water storage infrastructure; Impacts of droughts will be more severe as there is no fallback position (alternative source of water);
Increased urbanization and industrialization	Stress- induced criminal activity. Increased pressure on already over-stretched water supply and sanitation services. Pollution of water bodies and the environment will increase resulting in increased costs of water purification and thus increased costs of production of goods and services.
Limited human resource capacity in both the technical and managerial fields	Inability to deliver sustainable water resources services. Inability to deliver adequate sanitation services. Poor management of water resources and water resource infrastructure resulting in safety issues and water wastage.

UNEP 2013; SADC/SARDC and others 2012; UNEP 2009; Tumbare, M.N. 2008b, 2010 and 2013

Table 2.14 **Summary of Climatic Challenges, Vulnerable Sectors and Vulnerability Context by Country**

		Angola	Botswana	Malawi	Mozambique	Namibia	Tanzania	Zambia	Zimbabwe
Climatic Challenges	Increase in temperature	■	■	■	■	■	■	■	■
	Increased incidence of drought	■	■	■	■	■	■	■	■
	Decrease in rainfall		■	■	■			■	■
	Seasonal shifts in rainfall	■	■	■	■	■	■	■	■
	Cyclones				■				
	Localised floods	■	■	■	■	■	■	■	■
	Overflowing of large rivers				■				
	Lakeshore flooding						■		
	Decline in lake levels						■		
	Decrease/Varying river flows	■	■	■	■	■	■	■	■
	Wildfires	■	■	■	■	■	■	■	■
	Sea level rise	■			■	■	■		
	Saltwater intrusion	■			■	■	■		
	Coral reef bleaching				■		■		
	Landslides in mountainous areas			■					
Vulnerable Sectors	Water scarcity		■			■			■
	Biodiversity loss	■	■	■	■	■	■	■	■
	Health/disease outbreaks	■	■	■	■	■	■	■	■
	Coastal ecosystems, cities				■	■	■		
	Infrastructure	■	■	■	■	■	■	■	■
	Fisheries	■		■	■	■	■	■	
	Agricultural and food security								
	Livestock		■		■	■	■		■
Vulnerability Context	Urbanization	■		■	■		■		
	Poor infrastructure	■		■	■		■	■	
	Gender inequality	■	■	■	■	■	■	■	■
	Dependence on climate-sensitive resources	■	■	■	■	■	■	■	■
	Poor water access by population	■			■		■	■	
	Poor health status	■		■	■		■	■	■
	HIV and AIDS		■	■	■	■	■	■	■

Adapted from *Global Environment Change and Human Security* 2008. Based on assessment of available information, which varies in quality between countries. There may also be large geographical variables within countries.

SARDC and HBS, Responding to Climate Change Impacts: Adaptation and mitigation strategies as practised in the Zambezi River Basin, 2010

National Institute for Water Resources (INARH), the national water resources authority in Angola, was established by Presidential Decree 253/10 and is mandated to manage all the water resources of the country which include the Zambezi River Basin in Angola.

Administração Regional de Águas do Zambeze (ARA Zambeze) was established in 2002 in Tête, Mozambique to manage the water resources of the Zambezi River in Mozambique.

Zambia Electricity Supply Corporation (ZESCO) is a Zambian national electricity utility located in Luanshya and mandated to manage the water resources of the Kafue River, a major tributary of the Zambezi River.

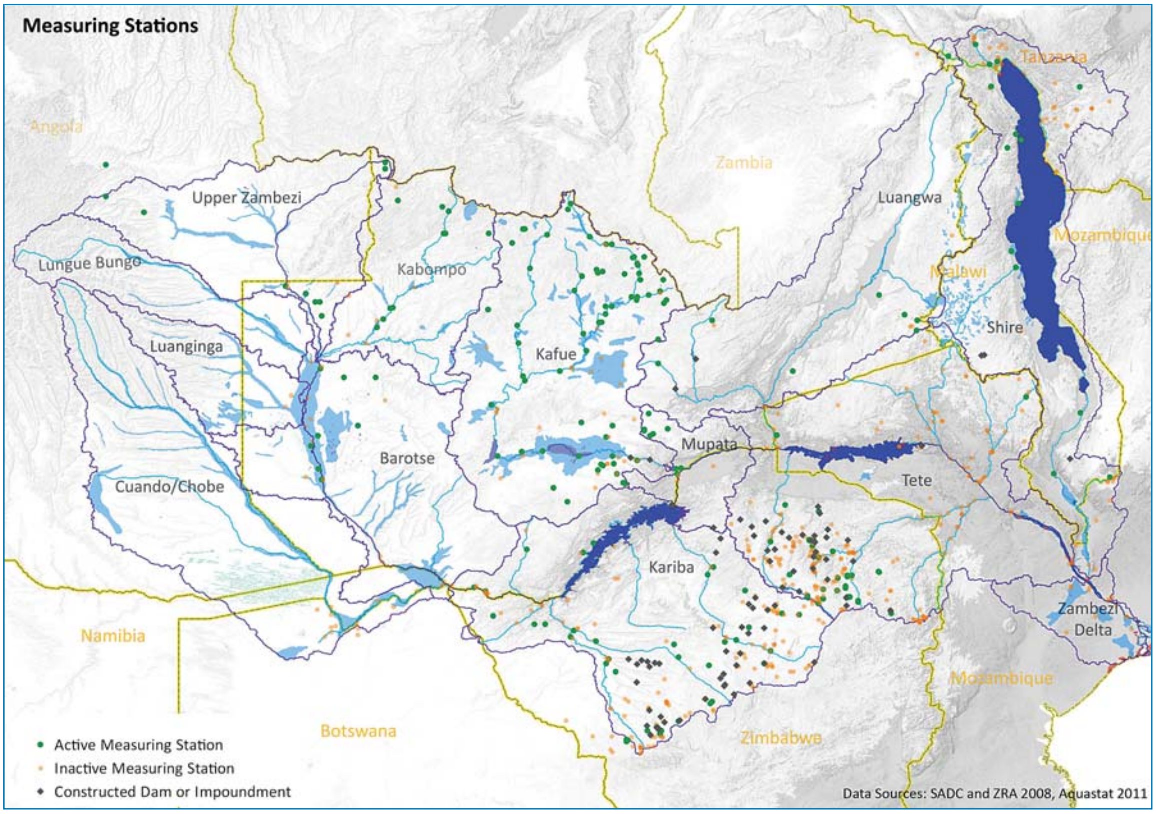
Zimbabwe National Water Authority (ZINWA), the national water authority in Zimbabwe established by an Act of Parliament, is mandated to manage all the water resources of Zimbabwe including the major tributaries of the Zambezi.

Hydroélectrica de Cahora Bassa (HCB) is mandated to manage the hydrology of, and operate the Cahora Bassa Dam, for hydropower generation in Mozambique;

Electricity Supply Commission of Malawi (ESCOM) is a Commission established by the Malawian Government and mandated to manage the water resources of Lake Malawi and the Shire River, a major tributary of the Zambezi River, for hydropower generation.

Government Departments. Each of the eight Zambezi riparian states has a national government department with

Map 2.8 **Stream Flow Measuring Stations**



SARDC IMERCSA, I. Musokotwane Environment Resource Centre for Southern Africa, 2015

various responsibilities to manage the water resources nationally and internationally, including the water resources of the Zambezi River Basin. Some of these institutions still use inherited colonial legal instruments and water laws so many years after independence.

Water Resources Management Instruments

The Zambezi riparian states are guided by the following documents and study outputs at Zambezi River Basin level.

ZAMCOM Agreement (2004)

In response to the challenges of water resources management, the Zambezi riparian states signed the Zambezi Watercourse Commission (ZAMCOM) Agreement to facilitate the efficient basin-wide development and management, equitable and reasonable utilization of the water resources of the Zambezi River Basin. The ZAMCOM Agreement came into force in September 2011, when six of the eight riparian states ratified the agreement. The ZAMCOM Secretariat is hosted by Zimbabwe in Harare.

Zambezi River Basin IWRM Strategy and Implementation Plan

The Integrated Water Resources Management (IWRM) Strategy provides a set of medium-to-long-term measures to address the main issues and challenges in the development and management of the water resources of the Zambezi Basin for socio-economic development of the Basin and the region as a whole. The strategy is a vital tool for cooperative and sustainable management of the water resources of this important Basin. One of the remaining challenges is to continue strengthening coordination of this strategy with other ongoing programmes in the Basin (SADC 2008).

World Bank Zambezi Multi-sector Investment Opportunities Analysis Study (2010)

The overall objective of the Zambezi River Multi-Sector Investment Opportunity Analysis (MSIOA) is to illustrate the benefits of cooperation among the riparian countries in the ZRB through a multi-sectoral economic evaluation of water resources development, management options and scenarios—from both national and basin-wide perspectives.

Dam Synchronization and Flood Releases in the Zambezi River Basin Study (SADC 2011a) and the ***WMO Final Report on the Zambezi Basin*** (2009) are other outputs that guide the Zambezi Basin States in water management.

Policy Options

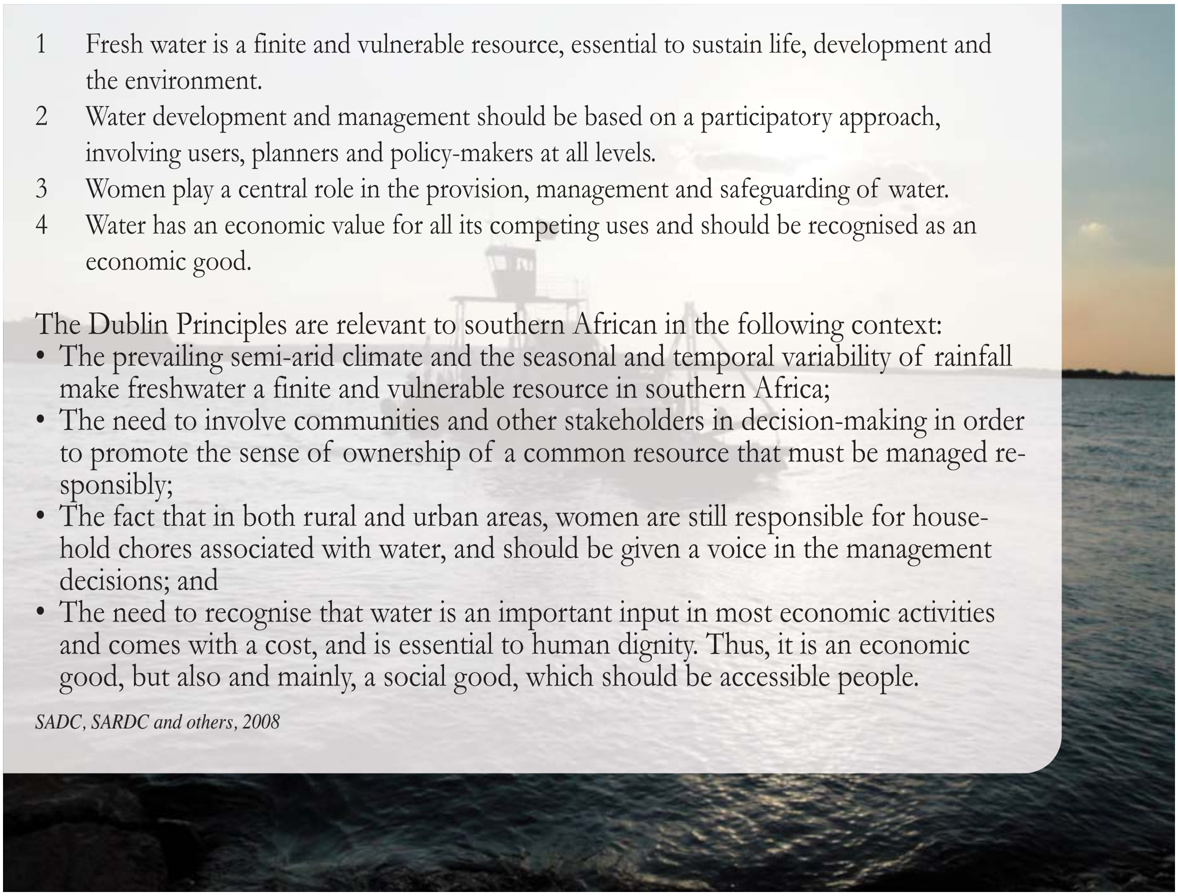
Policies and Strategies at Regional Level

At SADC regional level, the Zambezi riparian states are guided by the following documents which contain policies, principles and strategies that are fundamental to managing water infrastructure and the water resources of the Zambezi River Basin. The main policies are explained here.

Revised SADC Protocol on Shared Watercourses

The SADC Protocol on Shared Watercourses was initially passed in 1995 and revised 2000 before entering into force in 2003. The main objective of the Revised Protocol on Shared Watercourses is to foster close and coordinated cooperation in the management, protection and utilization of shared watercourses and to advance SADC agenda of regional integration and poverty reduction (SADC/SARDC and others 2012).The Protocol calls for the establishment of the shared watercourse agreements and Shared Watercourse Institutions (SWI) to facilitate and coordinate the joint management of shared watercourses. It is the first sector-specific legal instrument to be developed by SADC and creates an overarching framework for the management of the 15 shared river basins in the

Box 2.8 **INTEGRATED WATER RESOURCES MANAGEMENT (IWRM) IS BASED ON THE RIO/DUBLIN PRINCIPLES**



1 Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2 Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
3 Women play a central role in the provision, management and safeguarding of water.
4 Water has an economic value for all its competing uses and should be recognised as an economic good.

The Dublin Principles are relevant to southern African in the following context:

- The prevailing semi-arid climate and the seasonal and temporal variability of rainfall make freshwater a finite and vulnerable resource in southern Africa;
- The need to involve communities and other stakeholders in decision-making in order to promote the sense of ownership of a common resource that must be managed responsibly;
- The fact that in both rural and urban areas, women are still responsible for household chores associated with water, and should be given a voice in the management decisions; and
- The need to recognise that water is an important input in most economic activities and comes with a cost, and is essential to human dignity. Thus, it is an economic good, but also and mainly, a social good, which should be accessible people.

SADC, SARDC and others, 2008

SADC region. Since the Protocol came into force, SWI have been established on all shared watercourses in the region. To date one such major achievement of the Protocol in the basin is perhaps the signing of the ZAMCOM Agreement by seven riparian states with six of them having already ratified the agreement. Other achievements include the agreement on managing Lake Malawi/Niassa/Nyasa and the sub-basin of the Shire River, shared by Malawi, Mozambique and the United Republic of Tanzania and also the accord which was put in place to set up a joint commission between Malawi and Mozambique on water resources of common interest(SADC and SARDC 2008).

RISDP and SADC Regional Water Policy

The Regional Indicative Strategic Development Plan (RISDP), which was launched in March 2004 and updated at an Extraordinary SADC Summit on Industrialization in 2015, is a blueprint for the socio-economic development of southern Africa through the Southern African Development Community (SADC). Water is recognised in the RISDP as having a key role in the development of the region, with special attention given to development that is integrated and ensures that all other sectors benefit from the contribution of the water sector. As a result of this important recognition of water, SADC in 2005 moved a step further to develop a regional water policy for the region.

The SADC Regional Water Policy provides a framework for sustainable, integrated and coordinated development, utilization, protection and control of national and transboundary water resources in the SADC region. This policy is intended to support the SADC Common Agenda of socio-economic development and regional integration, and improvement of the quality of life of all people who live in the region. This policy is being implemented through a regional strategy adopted in 2006, premised on the SADC Treaty, the Revised SADC Protocol on Shared Watercourses, the SADC Vision for Water, Life and the Environment in the 21st Century, and the Dublin Principles. It was developed to facilitate the implementation of the Revised SADC Protocol on Shared Watercourses, and to ensure a focused, coordinated management of regional water resources (SADC and SARDC 2008).

The policy recognises Integrated Water Resources Management (IWRM) as the basic approach to achieving these objectives. Appropriate tools for implementing IWRM are proposed, including:

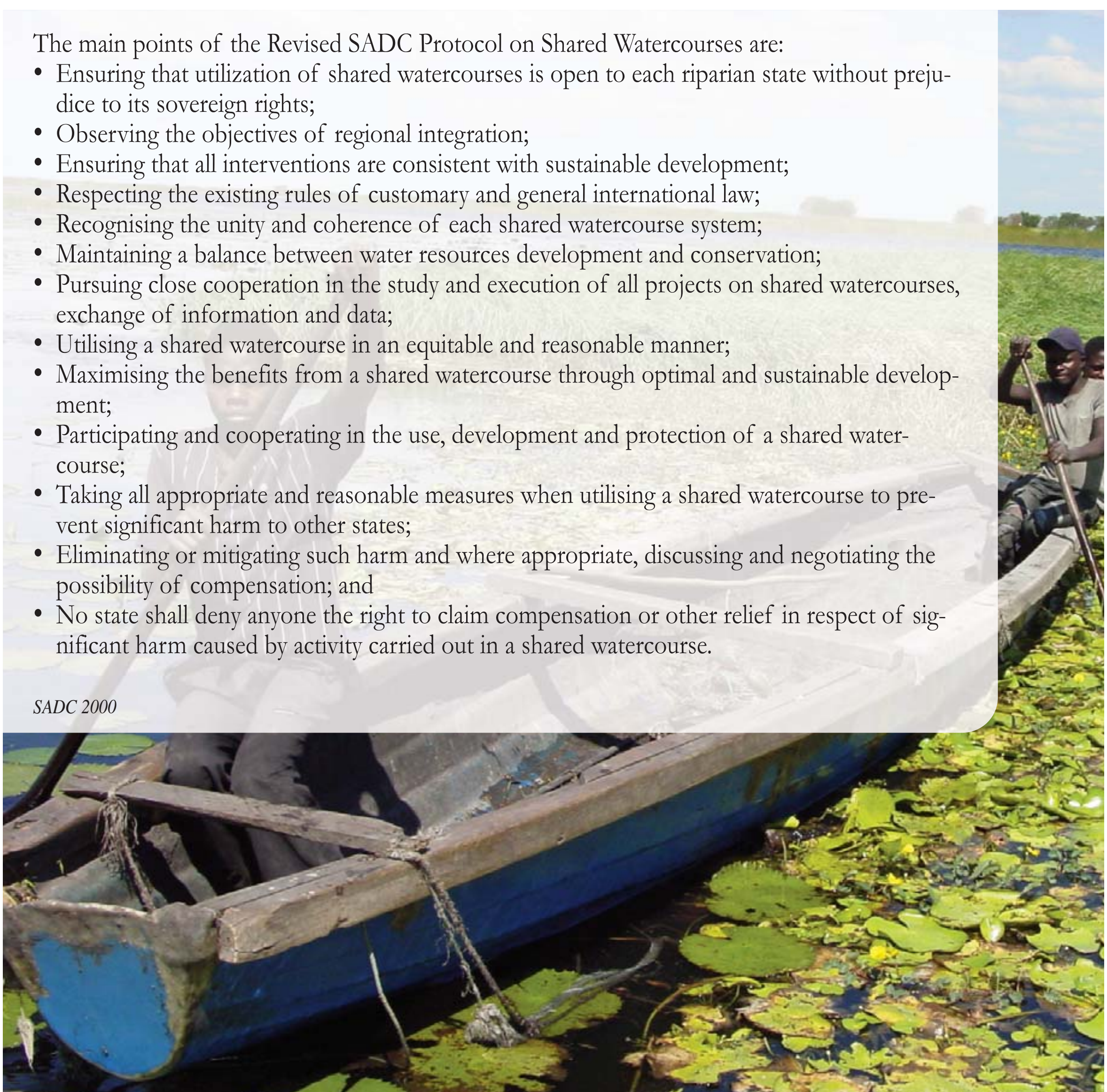
- establishment of institutions at national and regional levels;

Box 2.9 **PRINCIPLES OF THE REVISED SADC PROTOCOL ON SHARED WATERCOURSES**

The main points of the Revised SADC Protocol on Shared Watercourses are:

- Ensuring that utilization of shared watercourses is open to each riparian state without prejudice to its sovereign rights;
- Observing the objectives of regional integration;
- Ensuring that all interventions are consistent with sustainable development;
- Respecting the existing rules of customary and general international law;
- Recognising the unity and coherence of each shared watercourse system;
- Maintaining a balance between water resources development and conservation;
- Pursuing close cooperation in the study and execution of all projects on shared watercourses, exchange of information and data;
- Utilising a shared watercourse in an equitable and reasonable manner;
- Maximising the benefits from a shared watercourse through optimal and sustainable development;
- Participating and cooperating in the use, development and protection of a shared watercourse;
- Taking all appropriate and reasonable measures when utilising a shared watercourse to prevent significant harm to other states;
- Eliminating or mitigating such harm and where appropriate, discussing and negotiating the possibility of compensation; and
- No state shall deny anyone the right to claim compensation or other relief in respect of significant harm caused by activity carried out in a shared watercourse.

SADC 2000



- capacity building;
- stakeholder participation;
- water resources information management;
- implementation of IWRM plans;
- conflict resolution; and
- environmental management.

Climate Change Adaptation in SADC -- A Strategy for the Water Sector

The Climate Change Adaptation Strategy was crafted in 2011 to improve climate resilience in southern Africa through integrated and adapted water resources management at regional, river basin and local levels. In presenting the various dimensions of adaptation, the strategy promotes the adoption of a comprehensive and multi-dimensional approach, aligning with IWRM. The strategy presents measures to be taken over the next 20 years and recommends that work should start immediately as this would benefit the sectors under present climatic conditions. The strategy calls for the implementation at different levels, at different stages of the adaptation process and in different areas of interventions (SADC 2011b).

The strategy notes that climate change adaption in the water sector is multi-faceted thereby making this a transboundary process with adjustment of societies and economies at different levels, from the grassroots up to the river basin and regional levels. The framework emphasises that adaptation is not only a matter of water management, but an issue of governance as well as infrastructure development. While it involves disaster preparedness, the strategy should also provide recommendations on ways to respond to and recover from climate-related extreme events such as floods and drought. (SADC/SARDC and others 2012)

SADC Regional Awareness and Communication Strategy for the Water Sector

SADC developed a Regional Awareness and Communication Strategy for the Water Sector that fulfils the call for establishing sector specific strategies ad well as crafting, packaging and disseminating messages and themes that should be based on but not limited to SADC's priority intervention areas. The goal of the strategy is to improve awareness and understanding on water issues and initiatives in the SADC region, contributing to poverty eradication and regional integration. The strategy is a broad framework of what needs to be communicated and possible target audiences, as well as communication tools.

This communication strategy for the Water Sector has three main target users: the SADC Water Division, the SADC Member States, and the regional organizations working in the Water Sector such as River Basin Organizations (RBOs), Basin Water User Communities (BWUCs) and other non-state actors (SADC 2010a). The importance of these institutions is recognized in implementing regional instruments and initiatives, and also the need for capacity-building to enable them to effectively carry out their functions. The strategy recognizes the key role of women as the custodians of water and water management, and specifies that this role must be recognized through effective participation in decision-making and implementation (SADC 2010a).

Regional Strategic Action Plan

The Regional Strategic Action Plan on Integrated Water Resources Development and Management (RSAP) seeks to ensure that this sector contributes adequately to poverty eradication, regional integration and socio-economic development in a sustainable manner. The RSAP III which runs from 2011-2015 has 15 programmes, including Infrastructure and Project Preparation, Water Supply and Sanitation, Communication and Awareness, Research and Education, Groundwater Management, and Environmental Water Management (SADC /SARDC and others 2012).

The formation of the Zambezi Watercourse Commission (ZAMCOM) falls within the programme on River Basin Organizations (RBOs) which seeks to strengthen the organizational and institutional mechanisms for river basin management. The priority intervention areas include: Development and strengthening of RBOs, Development of RBO guidelines, Networking and sharing of best practices, Establishment of Basin-wide stakeholder forums to address issues of transboundary water management, and Training of RBO representatives (SADC 2011c).

An assessment of the previous RSAP II noted that while the plan was comprehensive and highly relevant to the needs of IWRM and development in SADC, greater emphasis should be placed on emerging issues such as climate change adaptation, ecosystem approach and the human-rights-based approach to water (SADC/SARDC and others 2012).

Legal Instruments at National Level

The main legal instruments used nationally by each of the Zambezi riparian states are presented in Table 2.15.

Table 2.15 **Main Water Sector Legal Instruments**

Country	Main Water Sector Legal Instruments
Angola	Environment Act (1998) Water Act (2002) Land Act (2004)
Botswana	Boreholes Act (1956) Water Act (1968) Water Utilities Corporation Act (1970) Public Health Act (1981) Draft Water Bill (2005) to repeal the 1956 Boreholes Act and the 1968 Water Act
Malawi	Water Resources Act (1969) Water Works Act (1995) Irrigation Act (2001)
Mozambique	Water Act (1919) Water Act (1991) repealing the 1919 Water Act
Namibia	Water Act (1956) Water Resources Management Act (2013)
Tanzania	Water Utilization Act (1974) Water Resources Management Act (2009) Water Supply and Sanitation Act (2009)
Zambia	Water Act (1948) Bureau of Standards Act (1982) Zambezi River Authority Act (1987) Environment Protection and Pollution Control Act (1990) Local Government Act (1991) Public Health Act (1995) Water Supply and Sanitation Act (1997) Draft Water Bill (2006) to repeal the 1948 Water Act
Zimbabwe	Zambezi River Authority Act (1987) Water Act (1998) ZINWA Act (1998) Environmental Management Agency Act (2003)

Adapted from SADC 2011a, Dam Synchronization and Flood Releases in the Zambezi River Basin

Indigenous Knowledge Systems
Indigenous Knowledge Systems (IKS) are an essential factor in the management of water resources, especially in rural areas, and need to be better understood and integrated, rather than being lost. Box 2.10 gives an insight into IKS and the management of water resources.

Summary of Response Areas and Interventions
A summary of the main response areas and the proposed interventions and actions to be taken in the Zambezi River Basin are presented in Table 2.16.

Conclusion

As discussed in the chapter, effective management of water resources remains a challenge across the Zambezi River Basin. The transboundary nature of water, though with greater benefits, requires a multi-faceted and integrated approach to enable efficient management and use of water. It is therefore essential that all stakeholders are involved in the management of water resources, which also promotes basin-wide integration and co-operation. There is an adequate policy framework at regional level, although strategies need to be engendered, and regional policies need to be incorporated and domesticated at national level for harmonisation of water resources management. Indigenous knowledge systems should be incorporated, used and acknowledged. Gender mainstreaming and involved of women in leadership and decision-making needs to be strengthened in the basin as water reform institutions, policies and processes take cognisance of a host of fundamental sectors of society except the strategic role of women in this sector. The SADC Regional Water Policy of 2005 notes that the pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources.

Box 2.10 **INDIGENOUS KNOWLEDGE SYSTEMS AND WATER**

Water custodianship is a millennia-old facet of African peoples in the Zambezi River Basin. The interface between water resources and indigenous knowledge is intricate. Water is a culturally integrative resource among the indigenous communities. It is a common pool resource and everyone's right. No one can be denied it traditionally.

When there is a threat to the water resource, it is managed communally as in flood management by the Lozi in Zambia. There, an intricate system of canals, developed over two centuries, is managed under the traditional authority of the Litunga. Flood management unifies people of the sub-basin within the rhythms of the flood levels of the Zambezi. The same is true of flood management in the Lower Zambezi in Mozambique (Beilfuss and others, 2002).

The Zambezi has sustained civilizations for long. As part of oral history, the story is told of the Kariba gorge as the most sacred site in the region (Mutwa, 1964). The famous Nyaminyami, the guardian spirit of the Zambezi, is told as taking revenge for the translocation of the Gwembe Tonga people from their ancestral home to construct the Kariba dam (Chenje and Johnson 1996). The notion of river guardianship is told in most of the tributaries of the Zambezi.

As a transboundary resource, the Zambezi divides the Lozi between Namibia and Zambia resulting in complicated traditional fishery management arrangements under two national river management systems (Abbot and others 2007).

Other traditional water resource management systems include:

- Water as an enduring common-pool resource issue (Mujwahuzi 2002). In most places, wells are communally managed with privatization discouraged in the interest of public safety (Derman 2003).
- Intensive crop cultivation, fisheries, livestock grazing, and extraction of materials such as reeds are all part of traditional systems in the basin. There are many large scale wetlands, such as the Barotse, Kafue, Luangwa, Lukanga, all in Zambia, Chobe in Namibia and Elephant Marsh in Malawi (SADC/SARDC and others 2012).
- Also traditionally managed is a special kind of wetland, the *dambos,* providing local spaces and niches for growing traditional food crops.
- Historically, rainmaking ceremonies have been common in the Zambezi Basin. Rainmaking rituals reflect intricate community social institutions that underlie equity principles and group responsibility. Everyone must contribute to the ceremony because when the rains come, they nourish everyone's fields (Matowanyika 1991).
- Water sources such as springs are special sacred sites protected by local rules.
- Traditionally, the collection of domestic water is by women. Wells have been important social assembly points for women from time immemorial.
- Riverine woodlands regulate local water availability and are designated sacred sites (Matowanyika 1991). As well, specific tree species are linked to reliable water sources.
- Among the Budja people in Mutoko, Zimbabwe, visitors are welcomed with a cup of water. Acceptance means the visit is amiable. Otherwise it has a hostile intent.
- The greeting *Pula* is used in Botswana, meaning rain, and this is also the name of the currency. When a leader arrives, the Setswana greeting is *A pula e ne* – "Let it rain – may blessing come". (Matiza Chiuta and others 2002)
- There are local rules prohibiting washing cooking pots in running water. People must also kneel to fetch water in deference to the spirits.

Table 2.16 **Response Areas and Interventions**

RESPONSE AREA	INTERVENTIONS
Governance	• Basin-wide flow forecasting, resource modelling and exchange of information between stakeholders will result in improved management of the water resources. • Deliberate involvement of women groups and representatives in consultations and leadership roles for decision-making will improve social and economic returns of management interventions. • Establishment of an effective ZAMCOM will support the implementation of IWRM and best practices of water resources management in the Zambezi River Basin. • Harmonisation of National Water Sector Policies and Legislation with the SADC Water Sector Protocols, Policies and Strategies and among those of the Zambezi riparian states. • Extending the role of the Climate Services Centre to coordinate short, medium and long-range seasonal precipitation forecasting in the SADC Region.
Data and Information	• In order to ensure that data is effectively received, stored and shared, a centralized form of data sharing and management system should be adopted by the Zambezi riparian states. Attempts have been and are being made through ZACBASE and ZAMWIS. • The ZAMWIS system should be improved and integrated with recent information and metadata on sources of national data. There should be a mechanism to regularly update the database with geographic data, and reports, as well as maps. ZAMWIS should be hosted and managed by the ZAMCOM Secretariat.
Dam Management	*Floods and Droughts* • The low storage to mean annual runoff ratios of most current dams in the Zambezi River Basin, except for Kariba, suggests that such dams cannot store major floods. This requires additional water storage infrastructure to be built for drought and flood mitigation and climate proofing/resilience. • Implementation of a basin-wide flood and drought (emergency and) risk management framework. • Establishing communication Protocols for flood and drought management (early warning). • Formulate, formalise and implement policies and practices that focus on "living with floods". • Building zones/buildings and other multi-purpose flood protection infrastructure where people can find refuge/protection in times of disasters and which also serve other purposes in times when there are no disasters. *Climate Change* • Promote research that leads to better understanding of the impacts of climate change and the possible adaptation and resilience mechanisms that can successfully be implemented in the Zambezi River Basin. • Evaporation is estimated to increase by 10% to 25% by 2050 resulting in loss of water for energy and food production. Improved and efficient energy and food production systems, that use less water resources, should be put in place. • The Zambezi River Basin will become drier. Rainfall over the whole Zambezi River Basin will overally decrease by 10% to 15% by 2050. This calls for additional water-storage facilities and the cropping of drought-resistant crops. • A shift in the wet season is expected. The Zambezi River Basin communities need to be informed about this phenomenon and a new cropping calendar produced with new mapping of arable agricultural areas relative to rainfall. • Research and implementation of groundwater recharge opportunities as alternative water storage facilities in arid and semi-arid zones of the basin. *Synchronization of Dam Operations* • New dams in the Zambezi River Basin will contribute to more effective dam synchronization and improved flood management for the whole system. • Large flows can be released for ecosystems maintenance if the Zambezi River Basin dams are operated conjunctively. • Dam operations should be synchronised to optimise livelihood activities.
Precipitation and Flow Forecasting	• A comprehensive flow and precipitation monitoring network is required to provide real-time data for a Zambezi Basin-wide flow forecasting system. • Establish a basin-wide Precipitation and Flow Forecasting Centre located at the ZAMCOM Secretariat and linked to the energy production strategies of the Southern African Power Pool (SAPP).
Investments	• Prioritise construction of small and medium-sized dams, each designed to optimise site conditions, as they have less impact on the environment and are most suited for livelihood enhancement. • Small and medium-sized dam development, primarily for irrigation, water supply and/or hydropower generation, should also be constructed for flood control with local attenuation impacts while creating alternatives for livelihoods. • Mobilise private sector for joint investment in infrastructure development and maintenance as well as reduction of water losses in municipal supply systems.

Adapted from SADC 2011a, Dam Synchronization and Flood Releases in the Zambezi River Basin

CHAPTER LINKAGES

Overview

The demand for water will certainly continue to rise in the basin as a result of increasing populations and the growing industries. Therefore, common policies and closely aligned strategies are essential, and all stakeholders must be involved in the management of water resources. Women must play a leading role as decision-makers and implementers, and indigenous knowledge must be incorporated, according to the principles of integrated water resources management, that ensure sustainable management, with consideration also for needs of the environment.

Land and Agriculture

Agriculture is mostly associated with soils, seed and water availability. In the Zambezi Basin, the level of agricultural production depends mainly on the rain for rain-fed agriculture and the water available through storage for irrigation. Irrigated agriculture accounts for the largest portion of the water withdrawals in almost all the riparian states. Therefore, water demand and supply is a critical factor in this sector.

Biodiversity and Forests

Water supports all life forms in the Zambezi River Basin including people, animals, birds, fish, amphibians and reptiles, as well as plants and other vegetation, and trees. Indigenous trees, plants and animals are well suited to their environment and should be encouraged to grow in the Basin. Water resources are vitally important in sustaining both individual species and ecosystems.

Climate Change and Variability

One of the threats to water availability in the Zambezi Basin is climate change and variability. The Zambezi Basin countries have in the previous years suffered from frequent droughts resulting in drying up of water and wetland ecosystems, or from floods that cause damage to people and property. Adaptation to the changing climate is an essential factor in water resources management in the ZRB.

Energy

Hydropower generation provides cheaper and more environmentally friendly sources of electrical energy to the basin, despite having some negative impacts on the environment, and is considered a valuable form of renewable energy. The reservoirs also store water that is available for agriculture and other uses. However, water flows are essential to power generation and thus require regular and current information on this aspect of water resources management.

Urbanization and Human Settlements

One of the factors governing the location of settlements and urban areas in the Zambezi River Basin is water availability, thus urban areas and other human settlements in the Basin are mainly located close to reliable water sources. The provision of clean water and sanitation is key to urban planning and human life in the city, due to the many additional pressures placed on water resources, such as domestic and industrial pollution, among others.

Tourism

As tourism partly depends on water and wetland resources, poor management of water resources will have a negative impact on the tourism industry. Apart from tourists required safe water and sanitation when they visit the area, almost all of the tourist attractions in the Zambezi River Basin are water-based or rely on water resources, including the Victoria Falls, river tours and animals viewing, as well as other activities on the river.

Industrial Development

The high level of water pollution in the Zambezi River Basin is directly linked to industrial development within and outside the Basin. Water quality is under threat due to pollution coming from agriculture, mining and manufacturing industries, and yet these are essential to economic development of the Basin. Environmental and water management must have greater awareness and enforceable regulations.

Scenarios

Current projections of water availability in the basin indicate a high likelihood of water stress in some riparian states. This situation calls for integrated planning and management of the demand, use and replenishment of water resources, and involvement of all stakeholders including marginalized groups. Efforts should be geared towards economic development that reduces poverty in the Basin in an environmentally sustainable manner, and incorporates modern technologies with indigenous knowledge systems.

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LAND AND AGRICULTURE 3

Introduction

Land, as an essential resource supporting agriculture in the basin, is recognised as a major intervening factor in advancing food security and economic growth. Agriculture is a major activity in the Zambezi Basin, directly or indirectly supporting livelihoods for all of the population, and contributes significantly to the economies of basin states.

The importance of land and agriculture development to poverty reduction, economic growth, food security and gender equity in the Zambezi Basin therefore, remains central. The economic significance of agriculture is further underlined by contribution to the macro-economy at national level and for most of the Zambezi River Basin States, the contribution has been substantial over the years. Despite declining harvests in recent yearsdue to droughts or floods, the sector remains the engine of growth. It is the single most important sector in the Zambezi River Basin from the perspective of survival of people and animals, and arguably the sector with the largest potential to help people out of poverty.

Despite the significant contribution of the land and agriculture sector to the economic development of the riparian countries and to livelihoods of its predominantly rural population, the sector faces a number of challenges. The challenges include declining productivity due to declining soil fertility and low use of improved technologies and inputs, land degradation as a result of poor land-use practices, deforestation, overdependence on rain-fed agriculture which is vulnerable to negative impacts of climate change, a growing population that increases demand on the limited land-based resources, insecure land tenure, and gender inequalities in access to productive assets such as land.

The chapter discusses these issues in detail and gives an overview of the state of land and agriculture in the Zambezi Basin. Policy options for promoting agriculture, food security, and sustainable land management are discussed.

Land Area and Availability

The total land area of the basin is almost 1.4 million sq km (1,388,200) representing 24.5 percent of the total land area of the eight riparian states, which together cover about 5,659,054 sq km.

The Zambezi Basin constitutes significant portions of the land area of Malawi (93.4 percent), Zambia (76.8 percent) and Zimbabwe (55.2 percent).

The countries that have the largest portion of the Basin within their boundaries are Zambia (41.6 percent), Angola (18.5 percent) and Zimbabwe (15.5) percent, as shown in Table 3.1 below.

Table 3.1 **Land Area Distribution in the Zambezi Basin**

Country	Total area of country	Area of country in basin (sq km)	As % of total area of the country	As % of total area of basin (sq km)
Angola	1 246 700	256 500	20.5	18.5
Botswana	581 730	19 100	3.3	1.4
Malawi	118 484	110 700	93.4	8.0
Mozambique	799 390	163 800	20.5	11.8
Namibia	824 290	17 100	2.1	1.2
Tanzania	945 087	27 300	2.9	2.0
Zambia	752 614	577 900	76.8	41.6
Zimbabwe	390 759	215 800	55.2	15.5
Total	5 659 054	1 388 200	24.5	100.0

SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

The population of the Zambezi River Basin was 31.7 million in 1998 (Chenje 2000), about one-third of the total population of some 95 million in the eight riparian states (SADC 2014). Ten years later, in 2008, the basin population had reached 40 million of the total 118 million people living in the eight countries. The total population of the eight countries is expected to reach 168 million by 2025, with some 51 million living in the Zambezi Basin (SADC/SARDC and others 2012).

The average population density in the Basin was 24 people per sq km in 1998, and this increased to 28.75 people per sq km in 2005 before reaching 30.26 people per sq km in 2008 (SADC/SARDC and others 2012).

Malawi has the highest national population density, that is the most people per sq km of land area, at 152.6 in 2011, followed by Tanzania at 50.2, and Namibia has the lowest at 2.5 people per sq km in 2011.

Access to Land

Land issues vary from country to country due to socio-economic, political, historical, cultural, and geographical differences. However, the key land issues facing the countries in the Zambezi Basin are primarily those of land tenure and use, distribution, utilization and administration.

In most Basin countries, the land issues concern inequitable access among different social groups, gender disparities, and skewed ownership. In countries or societies where the right to use land is guided by customary law, high population densities and pressures on arable land have contributed to increasing tensions. This has resulted in increased encroachment on protected forests for farming, causing long-term changes in land-use practices. There is an increase in the privatization of state-owned land in some countries to induce foreign investment, and this has pushed some citizens to more unsuitable lands. Thus, most land-use issues relate to poor land-use planning, poor agricultural practices, and encroachment of agriculture into environmentally fragile areas and protected areas.

Women account for the greater proportion of food production in the agriculture sector and conduct the bulk of related activities (SADC 2004). However, few women own land and are often side-lined in decision- and policy-making processes. Table 3.2 shows land allocation by gender in Zimbabwe in 2002, after the initial phases of the land reform programme.

Table 3.2 **Land Allocation by Gender in Zimbabwe during Land Reform Programme**

Province	Model A1 Number of Males	Model A1 %	Model A1 Number of Females	Model A1 %	Model A2 Number of Males	Model A2 %	Model A2 Number of Females	Model A2 %
Midlands	14 800	82	3 198	18	338	95	17	5
Masvingo	19 026	84	3 644	16	709	82	64	8
Mash.Central	12 986	88	1 770	12	1 469	87	215	13
Mash.West	21 782	81	5 270	19	1 777	89	226	11
Mash. East	12 967	76	3 992	24	*	*	*	*
Mat. South	7 754	87	1 169	13	215	79	56	21
Mat. North	7 919	84	1 490	16	574	83	121	17
Manicaland	9 527	82	2 190	18	961	91	97	9
Total	106 986	82	22 723	18	6 043	88	796	12

Utete, C.M.B., Report of the Presidential Land Review Committee on the Implementation of the Fast Track Land Reform Programme 2000-2002

This data, drawn from the Report of the Presidential Land Review Committee (Utete 2003), shows that only 18 percent of beneficiaries were women for allocation of land under the smallholders A1 model, and 12 percent of beneficiaries under the commercial A2 model.

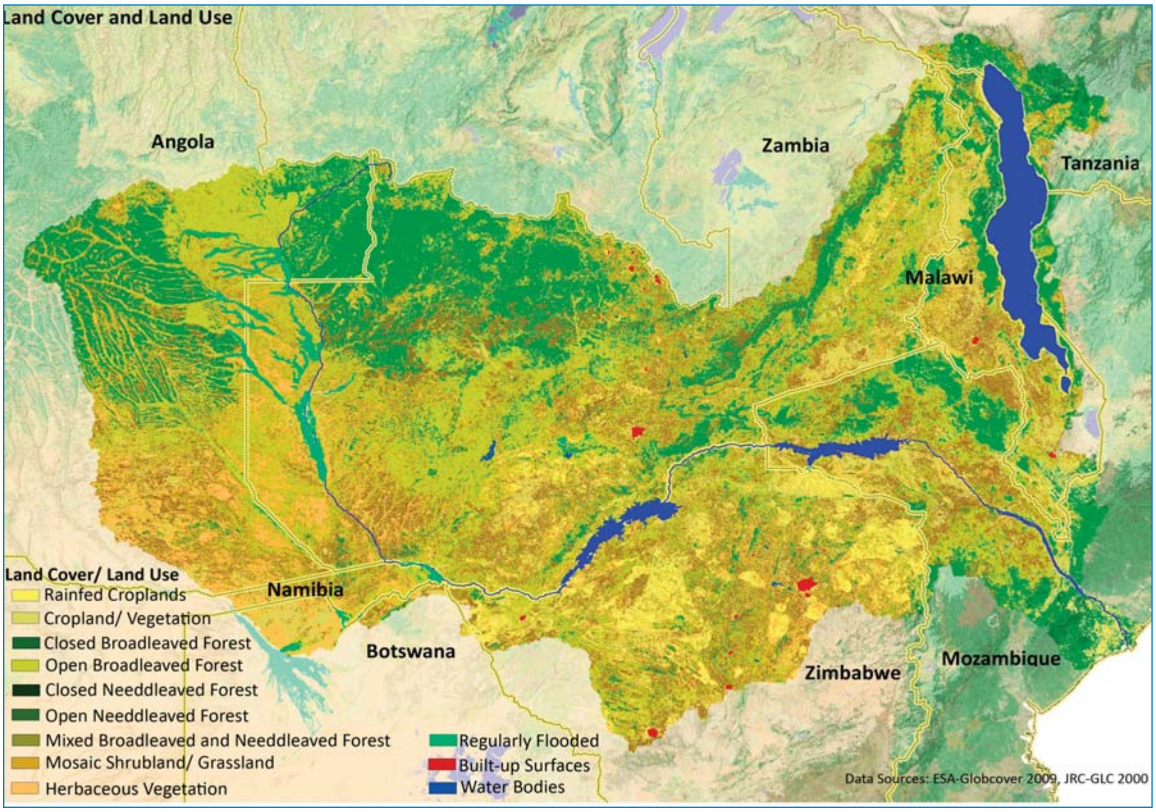
Land Use Changes

Land Cover Changes

Land Cover refers to the actual coverage of the surface of the earth with natural or human-made environment — forests, grass, crops, water bodies (lakes, rivers), marshes, rock, sand dunes, roads, urban settlement. Land Use refers to the usage of the land cover. Commercial forestry, pastures, irrigated farming, rain-fed cropping, recreational areas, game reserves, mining, urban areas and industrial estates are examples of types of land use. Map 3.1 shows Land Cover and Land Use in the Zambezi Basin.

Most parts of the basin are covered by forests and bush land (almost 75 percent of the land area) (SADC/SARDC and others 2012). Cropped land, mostly rain-fed agriculture, covers 13 percent of the land area, and grassland covers approximately eight percent of the land area. Table 3.3 shows that changes in individual countries have varied since 2002 for agricultural land with some registering negative changes in some years.

Map 3.1 **Land Cover and Land Use in the Zambezi River Basin**



SARDC IMERCSA, I. Musokotwane Environment Resource Centre for Southern Africa, 2015

Table 3.3 **Change of Agricultural Area Per Year (%)**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Angola	-0.17	-	0.16	0.35	-	-	-	0.17	-	1.04	0.17	-
Botswana	0.43	-0.58	0.17	-0.19	0.12	0.06	-0.15	-0.07	0.38	0.14	-0.22	-
Malawi	0.96	2.12	-	3.11	-	4.02	2.03	-5.69	8.04	1.95	1.83	-
Mozambique	-0.08	0.21	0.93	0.1	0.21	-0.21	0.62	-	-0.1	0.82	-	-
Namibia	-	-	-	-	-	-	-	-0.03	-	-	-	-
Tanzania	-	0.29	0.29	0.21	2.6	0.57	-	0.82	3.72	0.61	0.27	-
Zambia	0.42	0.25	0.27	1.3	-0.05	-0.59	1.26	-0.28	0.45	1.29	1.5	-1.26
Zimbabwe	1.48	1.2	1.51	1.16	2.24	0.63	0.93	-	1.23	-0.79	-	-
Total	3.04	3.49	3.33	6.04	5.12	4.48	4.69	-5.08	13.7	5.06	3.55	-1.26

FAOSTAT 2013

The figures in Table 3.3 show minimal annual changes in areas under agriculture for most basin states, although data is incomplete. Malawi experienced significant annual changes between 2006 and 2008 with a massive decrease between 2006 and 2007 followed by an even bigger increase between 2007 and 2008. Some countries such as Zambia and Zimbabwe had years of decreasing area under agriculture, while others showed little change. This may be due to various socio-economic factors that impacted the capacity of farmers in the following season.

Food Production and Food Security Trends

Agriculture remains the single most important sector in the Zambezi River Basin from the perspective of people's survival and arguably the sector with the largest potential to help people out of poverty.

Agriculture contributes significantly to basin economies, given low levels of industrialization in the area. The importance of land and agriculture development to poverty reduction, economic growth, food security, gender equity and nutrition in the Zambezi Basin therefore, remains central. The sector accounts for 54 percent of employment in the entire SADC region and for an average of 58 percent in the eight countries of the Zambezi River Basin.

The economic significance of agriculture is further underlined by its contribution to a country's macro-economy and for most of the Zambezi Basin riparian states, the contribution has been substantial over the years. The sector remains the engine of growth, accounting for more than 20 percent of national Gross Domestic Product (GDP) for some countries in the basin such as Malawi, Mozambique, Tanzania, and Zambia during the period 2007 to 2011 (Table 3.4). In Zimbabwe, the decline from 21.3 percent in 2007 to 15.5 percent in 2011 can be attributed to recent economic challenges.

By 2010 the agriculture contribution to GDP increased to 30.1 percent for Mozambique while for Tanzania and Zambia this decreased to 27.8 percent and 20.1 percent, respectively (Table 3.4). Only Zambia has consistent data on the share of agriculture in employment, but this has been growing rapidly in the past decade and may be indicative for neighbouring countries.

Apart from its contribution to national GDP, agriculture is also a major export commodity in most Basin states (Table 3.5). Malawi has the largest share of agricultural commodities in its exports while Botswana has the least. However, as explained later, in Chapter 9, there is little value addition for most agricultural commodities which are exported in a raw state, resulting in low export earnings.

Table 3.4 **Share of Agriculture in Gross Domestic Product and Employment**

	GDP Share (%)					Employment Share (%)				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Angola	8.0	6.8	10.5	10.1	10.2					
Botswana	2.1	2.0	3.0	2.5	2.5					
Malawi	29.8									
Mozambique	27.0	28.5	28.8	30.1						
Namibia	9.2	7.9	7.8	7.8	7.8					
United Republic of Tanzania	29.6	29.4	28.4	27.8						
Zambia	19.8	19.8	20.8	20.1	19.4	64	66	73	79	85
Zimbabwe	21.3	23.7	19.3	17.7	15.5					

SADC, SADC Statistical Year Book 2014

Area Under Cultivation

Subsistence and commercial agriculture in the basin largely depend on rainfall, which is variable across the region making rain-fed agriculture risky.

The vast land and water resources in the Zambezi River Basin present opportunities to increase food production for domestic use and export. Land under irrigation is estimated at just 3.6 percent of its 5.2 million hectares of land under cultivation (SADC and ZRA 2007). This shows that the Zambezi Basin is yet to fully utilise its irrigation potential and decrease its dependence on rain-fed agriculture. Table 3.6 shows irrigated land by country, and its share in arable land and permanent crops. As seen in Table 3.6, there has been no remarkable increase in the area under irrigation. There is need for Basin states to invest in irrigated agriculture as the area will face increased incidence of droughts as a result of climate change.

Table 3.5 **Share of Agriculture in Exports (%)**

	2006	2007	2008	2009	2010	2011
Angola	-	-	-	-	-	-
Botswana	1.0	2.9	3.1	5.2	5.2	2.4
Malawi	95.2	91.8	89.3	89.5	78.3	79.3
Mozambique	13.3	12.2	12.4	42.8	18.4	20.4
Namibia	11.2	9.5	7.5	11.5	12.1	12.0
Tanzania	29.3	29.0	31.4	35.3	25.5	29.5
Zambia	8.6	8.6	6.8	8.7	6.6	9.1
Zimbabwe	53.5	23.0	24.3	29.7	22.4	29.4

SADC, SADC Statistical Year Book 2014

Table 3.6 **Irrigated Land in the Zambezi Basin by Country and Share in Arable Land and Permanent Crops**

Country	1999-2001 (000 ha)	2003-2005 (000 ha)	2006 (000 ha)	2007 (000 ha)	2008 (000 ha)
Angola	80.0	80.0	80.0	80.0	80.0
Malawi	51.7	56.0	56.0	59.0	59.0
Mauritius	20.3	21.3	21.0	21.0	21.0
Mozambique	115.0	118.0	118.0	118.0	118.0
Namibia	7.3	8.0	8.0	8.0	8.0
Tanzania	163.0	184.0	184.0	184.0	184.0
Zambia	133.3	156.0	156.0	156.0	156.0
Zimbabwe	174.0	174.0	174.0	174.0	174.0

SADC, SADC Statistical Year Book 2014

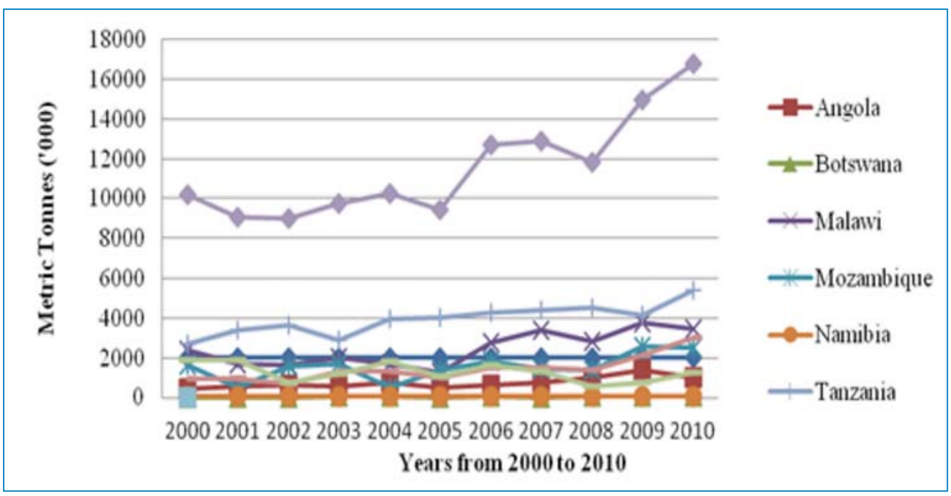
Cereal Production and Food Security

The Zambezi River Basin faces a deficit in all cereal crops (sorghum, millet, wheat and rice) except maize. In 2012/2013 most countries in the Basin experienced cereal deficits, except Malawi, Tanzania and Zambia.

At SADC level, the cereal production in 2013 was estimated at 35.11 million tonnes, up from 31.47 million tonnes in 2012 and 34.59 million tonnes in 2011. The 2013 regional cereal production represents a five percent increase over the average SADC cereal production for the last five years, indicating continued above-average cereal production in the region in recent years compared to the past five-year average cereal production (2007-2011).

Most countries in the basin recorded decreases in cereal production in 2012, with only Namibia and Tanzania increasing harvests in 2012 over 2011 (SADC 2012d; SADC2013). Tanzania has registered a significantly high and increasing trend in cereal production in the past six years. However, as a Basin there has been a net cereal deficit. Figure 3.1 shows trends in cereal production by country.

Figure 3.1 **Cereal Production Trend**



SADC 2012d; 2013. Food Security Updates July 2012 and July 2013

Table 3.7 **Maize Production by Country**

	(000 tonnes)										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Angola	458.7	546.9	618.7	530.6	720.3	526.1	615.9	702.4	970.2	1 320.8	969.8
Botswana	9.3	2.4	2.0	1.3	6.2	2.6	10.5	0.9	10.6	16.6	17.6
Malawi	2 290.0	1 589.4	1 485.3	1 847.5	1 608.3	1 225.2	2 611.5	3 226.4	2 634.7	3 582.5	3 233.0
Mozambique	1 180.4	0.0	1 114.8	1 178.8	0.0	941.5	1 395.5	1 133.9	1 167.0	1 932.0	1 878.0
Namibia	49.2	28.3	27.6	31.0	64.8	52.9	63.6	55.5	58.1	57.3	58.0
Tanzania	2 009.3	2 578.6	2 704.8	2 322.0	3 157.4	3 218.5	3 423.0	3 302.1	3 555.8	3 326.0	4 475.4
Zambia	850.5	801.9	601.6	1 157.9	1 213.6	866.2	1 424.4	1 366.2	1 211.6	1 887.0	2 795.5
Zimbabwe	1 619.7	1 526.3	604.8	1 058.8	1 686.2	915.4	1 484.8	1 161.6	496.0	700.0	1 192.4

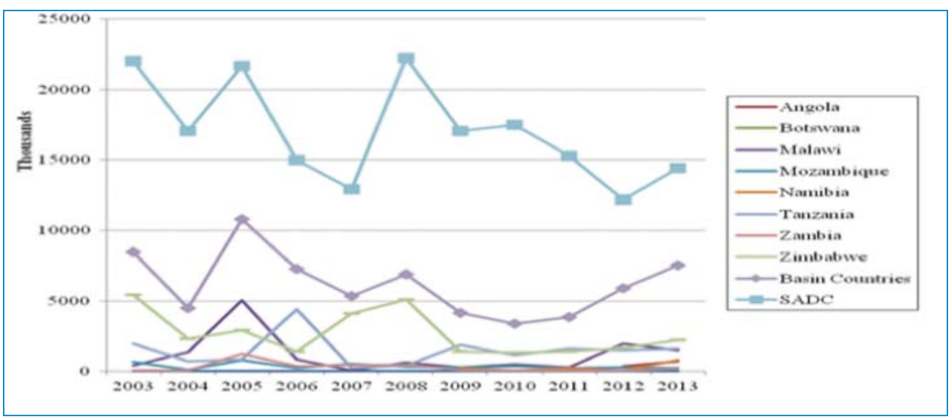
SADC, SADC Statistical Year Book 2014

Maize is the staple food crop in most of the countries in the Basin, but maize production has not shown significant growth over the years to align with population growth, despite the growing demand for food. Table 3.7 shows trends in maize production by country in the Zambezi Basin.

Figure 3.2 shows the trends in the population at risk of food insecurity, comparing the eight riparian countries and the SADC region as a whole. This shows that from 2005 to 2010 the food insecure population in the eight countries within the basin has been declining and from 2011 it started increasing again while in the SADC region as a whole, the declining trend continued up to 2012 and only increased in 2013. This may be an indication that the countries in the Zambezi River Basin are more vulnerable to food insecurity than the other SADC member states.

At the local level, women are traditionally responsible for producing food for their families, especially in rural areas. In the SADC region, women contribute more than 60 percent to total food production (SARDC 2008). Agricultural activities are not only a means to produce food, however, as studies in Western Zambia have shown that women also rely on farming for income due to limited economic opportunities in other sectors (Kent and MacRae 2010). Food security is linked to the social and economic livelihoods of many women thereby increasing vulnerability to food insecurity. Population at risk of food insecurity by country is shown in Table 3.8.

Figure 3.2 **Trend in Food Insecure Population**



SADC, Food Security Update July 2013

Table 3.8 **Population at Risk of Food Insecurity in the Zambezi Basin by Country**

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Angola	-	-	-	-	-	-	-	-	367 190	700 000
Botswana	-	-	-	-	-	-	-	-	-	372 479
Malawi	1 340 000	5 055 000	833 000	63 234	613 291	275 168	508 089	271 502	1 972 993	1 461 940
Mozambique	108 203	801 655	240 000	520 000	302 664	281 300	350 000	245 000	270 000	212 000
Namibia	-	-	-	-	-	224 795	42 100	243 474	74 711	778 504
Tanzania	688 360	850 023	4 418 503	216 142	425 313	1 849 497	1 141 214	1 618 795	1 472 127	1 615 445
Zambia	39 300	1 232 661	380 537	440 866	444 624	110 000	53 629	74 804	62 642	209 498
Zimbabwe	2 300 000	2 884 800	1 392 500	4 100 000	5 100 000	1 400 000	1 287 937	1 390 000	1 668 000	2 206 924
Basin Countries	4 475 863	10 824 139	7 264 540	5 340 242	6 885 892	4 140 760	3 382 969	3 843 575	5 887 663	7 556 790
SADC	17 037 503	21 675 129	14 992 597	12 897 708	22 255 264	17 042 661	17 484 132	15 289 336	12 174 095	14 426 487

SADC, Food Security Update July 2013

Land and Agriculture Challenges

Declining Per Capita Land Availability

There is a consistent shrinkage in per capita land availability in the Zambezi Basin, and this is projected to decline to 2.56 hectares/person by 2025 from as much as 4.16 hectares/person in 1998 (SARDC/SADC and others 2012). In Sub-Saharan Africa, the average farm size has declined over the past decade, from 2.42 hectares in 2002 to 2.16 hectares in 2008 (CGIAR 2013). The decline in farm size has been driven primarily by growing rural populations and sub-division of land upon inheritance.

The proportion of the population who live in the rural areas varies from country to country – from about 50 percent in Zambia to as high as 85 percent in Malawi. Population density and per capita land area in the Zambezi River Basin are shown in Figure 3.3.

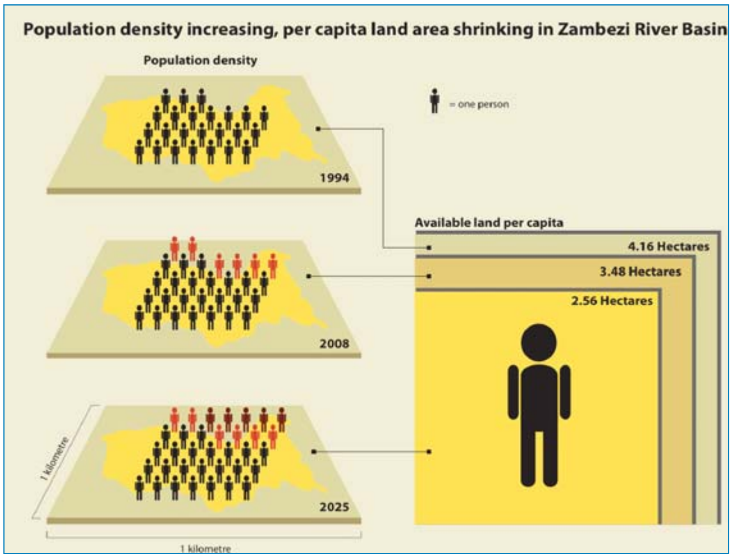
Declining land per capita can result in land shortages, often leading to encroachment into marginal lands and environmentally sensitive areas such as wetlands and protected areas, although some wetlands such as *dambos* have been farmed traditionally and sustainably for centuries using Indigenous Knowledge Systems (IKS). In Malawi, for example, land appraisal studies done in the early 1990s indicated that some 16 percent of cultivation was being done in marginal and unsuitable areas (Green and Nanthambwe 1992).

Declining land per capita can have an impact on food production, depending on cropping methods and access to irrigation. The increase in population density results in increased pressure on the finite natural resource such as land, and this can lead to conflicts, especially where land rights are not clearly defined.

Besides the expansion of cropland, deforestation and land degradation present major challenges to most countries in the Zambezi River Basin. Reports by the UN Food and Agriculture Organization (2009) and United Republic of Tanzania (2006) show that in Tanzania alone, the rate of deforestation is about 412, 000 hectares per annum. Population growth and economic necessity are cited as some of the underlying causes of forest degradation and loss in Tanzania, a situation not dissimilar to other Basin states. A 2010 UNDP report shows that 1 to 25 percent of the population in Angola, Botswana, Malawi, Mozambique, Namibia and Tanzania, and 26 to 50 percent of the population in Zambia and Zimbabwe live on degraded lands.

In addition to increased pressure on finite natural resources, a growing population results in increased demand for food. This puts pressure on available land to produce more crops and animals. With time, the overuse of land reduces its fertility, leading to a decline in yields. This then leads to the use of artificial fertilizers and pesticides, which have a negative impact on natural resources, particularly on freshwater resources. However, the intensification of crop and animal production through the use of production-enhancing technologies as a response to the decline farm sizes has led to improvements in productivity, increased yields and increased animal productivity.

Figure 3.3 **Population Density and Per Capita Land Area in the Zambezi Basin**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Deforestation

The growing population and increased demand for agricultural products within the Zambezi River Basin has impacted on several land-based natural resources, including a reduction in forest cover thereby exposing the land to forms of degradation.

Table 3.9 shows that 33,000 hectares, 50,000 hectares and 125,000 hectares of forests in Malawi, Mozambique and Angola respectively were cleared every year between 1990 and 2000, representing a rate of 0.9, 0.3 and 0.2 percent for these countries (Syampungani and others 2012). In the years 2000 to 2005 the annual forest loss remained the same. For Zimbabwe, Zambia and Tanzania the loss between 2000 and 2005 ranged from 313,000 to 445,000 hectares per year representing annual rates of 1.7, 1.0 and 1.1 percent respectively.

These rates are lower than those from other studies. For instance, studies conducted in Malawi between 1973 and 1991 showed that during this period the country lost about 2.5 million of its 4.4 million hectares of forest cover, representing an annual deforestation rate of 2.8 percent (Yaron and others 2011). Official estimates of forestry resources decline are put at 2.6 percent per annum in the country (GoM 2008). The differences in the rate of deforestation from various studies, and also in Table 3.9, indicate the data gaps that exist on the estimation of deforestation in the basin.

These national deforestation rates mask a great deal of local variations within the countries and across the basin as a number of human activities such as agriculture, urbanization, industrialization, mining, communication infrastructure and others continue to remove the land cover through deforestation, thus exposing the land to massive degradation.

Soil Erosion and Fertility Decline

Soil erosion is the loss of top soil through agents such as wind and water. It is made worse by human impacts such as poor cultivation practices, deforestation, fires, cultivation of marginal and unsuitable areas and other activities that disturb and expose the soil. Soil erosion has impacts which are both on-site (at the place where the soil is detached) and off-site (wherever the eroded soil ends up).

Cultivation in much of the Zambezi River Basin area has encroached into environmentally fragile areas such as steep slopes, river banks, shallow soils and wetlands often without appropriate conservation measures put in place and this has led to increased soil erosion. This coupled with small per capita landholding sizes, forces smallholder farmers to use the land continuously without fallow and rotation. This leads to continual tilling of

Table 3.9 **Deforestation in the Zambezi River Basin**

	Annual Rate of Change				
	Total Forest (2005)	1990 to 2000		2000 – 2005	
Country	Hectares	Hectares / year	%	Hectares / year	%
Angola	59 104 000	-125 000	-0.2	-125 000	-0.2
Botswana	-	-	-	-	-
Malawi	3 402 000	-33 000	-0.9	-33 000	-0.9
Mozambique	19 262 000	-50 000	-0.3	-50 000	-0.3
Namibia	-	-	-	-	-
Tanzania	35 257 000	- 412 000	-1.0	- 412 000	-1.1
Zambia	42 452 000	-445 000	-0.9	-445 000	-1.0
Zimbabwe	17 540 000	-313 000	-1.5	-313 000	-1.7

Syampungani and others, Deforestation of East and Southern African Woodlands, 2012 the soil often without returning nutrients back to the soils through application of inorganic and organic fertilizers. As a result, continuous cultivation leads to the soil structure and texture being distributed, leading to loss of soil fertility hence declining crop yields.

The offsite impacts of soil erosion include sedimentation of water bodies and loss of breeding grounds for fish, destruction of infrastructure such as roads and bridges, among others. In the Shire River sub-basin, where in some catchments the soil erosion is estimated at more than 25 tonnes per hectare per year, it is attributed to the disruption caused by hydropower generation along the Shire River which provides more than 95 percent of Malawi's hydro generation (World Bank 2012). The threat posed by soil erosion in the Shire River Basin to the social and economic development of Malawi has led to several initiatives to address the problem supported by a number of donors including the World Bank, JICA and UNDP.

Good crop management practices are at the centre of improved plant protection and production. The yield gaps between research and smallholder farm levels can be explained by inadequacies in crop husbandry such as poor land preparation, untimely planting, incorrect plant population, poor fertility management techniques, weed management and plant protection. The other husbandry practices such as intercropping with legumes, rotation and fallowing are not widely practiced. The small farm sizes have contributed to reducing fallows to zero as smallholder farmers are forced to intensify production to meet their requirements.

Early planting is often challenged by the unpredictability of effective planting rains that may result from erratic drought cycles made worse by climate change and variability that make farmers miss the first planting opportunity. In general, the untimely husbandry operations are as a result of labour constraints, lack of knowledge, limited mechanization, general lack of resources, and under-resourced agricultural extension systems.

Land Degradation

Human pressure on land resources is causing widespread environmental degradation in the Basin states. As shown in Table 3.10, about 70 percent of the region's land surface is degraded. Of this figure, 55 percent is lightly to moderately degraded while the remainder is severely to very severely degraded and associated with high human and animal population densities. Land and soil disturbances associated with land degradation reduce the water-holding capacity of soil, as well as soil fertility and the population of beneficial soil-inhabiting, micro-organisms. This has adverse effects on agriculture and food security.

Table 3.10 **Severity of Land Degradation in the Zambezi Basin**

Country	Total land area (sq km)	No degradation (% of total land area)	Light to moderate degradation (% of total land area)	Severe to very severe degradation (% of total land area)
Angola	1 247 000	61	26	13
Botswana	582 000	31	57	11
Malawi	118 000	39	61	0
Mozambique	799 000	31	68	0
Namibia	824 000	57	21	23
Tanzania	945 000	12	62	25
Zambia	753 000	7	65	17
Zimbabwe	390 000	7	92	0

SADC and SARDC, Southern Africa Environment Outlook, 2008

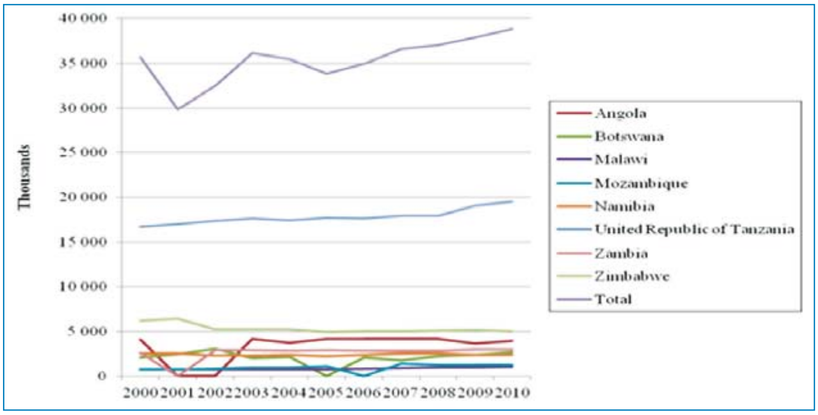
The increasing population of cattle and other livestock is an ongoing trend in the Zambezi Basin over many years (Figure 3.4 and 3.5). The total cattle population was estimated at 35 million in the year 2000, increasing to 41.4 million by 2011, an increase of 17.7 percent over those years and a growth rate of about 2 percent per year (SADC 2011). Thus there are almost as many cattle as people in the Basin. The concentration of animals including goats per cropped land has been increasing, and this has implications on the environmental impact as goats are browsers and can degrade the environment if not properly managed.

This growing animal population has increased pressure on land, leading to overgrazing particularly in areas where stocking rates outstrip the carrying capacities. In areas where large herds are confined to small spaces in rural areas, where land availability is limited and intensive management is not practiced, the livestock cause soil compaction and dislodging, and loss of biodiversity leading to land degradation.

Soil Salinization

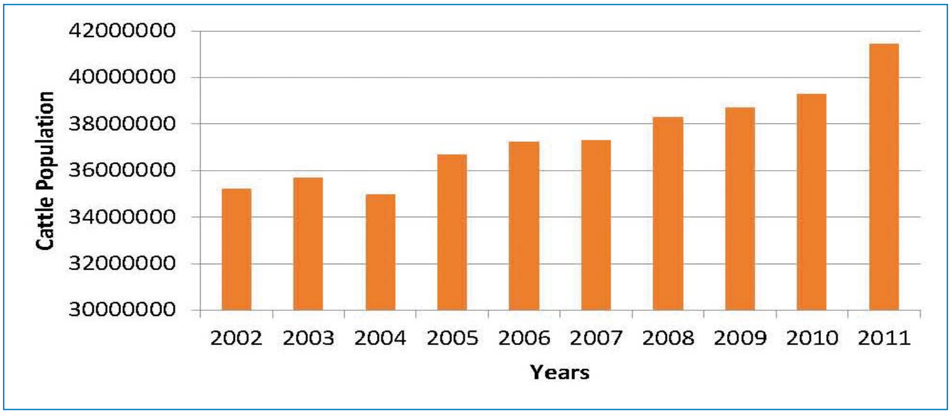
Soil salinization is the accumulation of excess salts in the root zone resulting in partial or complete loss of soil fertility affecting crop growth and causing the eventual disappearance of vegetation. The presence of soluble salts adversely affects the growth of most plants. This

Figure 3.4 **Cattle Population in the Zambezi Basin**



SADC, Food Security Update July 2013

Figure 3.5 **Cattle Population in the Basin Countries**



SADC Livestock Information Management System 2014 is widespread in the arid and semi-arid regions and thus, in the Zambezi River Basin, the problem is particularly serious in Botswana and Namibia, although it also occurs to some extent in Tanzania, Zimbabwe and other countries (Sommer and others 2013).

In Africa the extent of salinization is estimated to cover 3.8 million hectares. Table 3.11 shows the distribution of areas affected by soil salinization in Basin states.

Table 3.11 **Soil Salinization in the Zambezi River Basin**

Country	Saline/ Solonchaks (000 hectares)	Sodic/ Solonetz (000 hectares)	Cumulative Total (000 hectares)
Angola	581	81	662
Botswana	6 765	906	7 671
Malawi	69	0	69
Mozambique	1 203	113	1 316
Namibia	3 478	1 657	5 135
Tanzania	1 963	325	2 288
Zambia	0	2 838	2 838
Zimbabwe	349	957	1 306
Total	14 408	6 877	21 285

Sommer and others, Profitable and Sustainable Nutrient Management Systems for East and Southern African Smallholder Farming Systems, 2013; FAO Integrated Soil Management for Sustainable Agriculture and Food Security in Southern and East Africa, 1999

Salinization is a more serious problem in Botswana, Namibia, Zambia and Tanzania, and to some extent Botswana and Mozambique, as shown in Table 3.11. The major cause of soil salinization in the Basin is the scarcity, variability and unreliability of rainfall and the high potential evapotranspiration that affects the water and salt balance of the soil.

Disease Outbreaks / New Strains

Livestock is an important sub-sector of agricultural production in the Zambezi River Basin. At SADC level it accounts for 20 to 40 percent of the Agricultural GDP and holds a high social value for rural communities in the region.

The animal disease which has had a great impact on livestock in the Basin is Food and Mouth Disease (FMD). The underlying problem is that most healthy populations of African buffalo harbour the Foot and Mouth virus on a continuous basis. This means that only localities where buffalo do not occur (or alternatively those few where the buffalo are free from infection) qualify for recognition as being free from FMD.

Largescale Land Acquisition

Largescale commercial land acquisition by foreigners for investment purposes has been reported in some countries in the Basin and elsewhere Africa. A study released in September 2010 identified 45 million hectares under negotiation for allocation in 2009, of which 70 percent (about 32 million hectares) was in Africa (Future Agricultures Consortium 2011). In recent years, biofuels have rapidly emerged as a major issue for agricultural development, energy policy, and natural resource management. Growing demand for biofuels is being driven by recent high oil prices, energy security concerns, and global climate change (Sulle and Nelson 2009). There is overwhelming investment interest and land alienation in the name of biofuels production in African countries, driven largely by the low cost of land and labour in rural Africa (FAC 2011; Kachika undated).

Most reported acquisitions in the Zambezi Basin are in Tanzania, Mozambique and Zambia (FAC 2011; Chikopa 2012). In Tanzania, 640,000 hectares have been allocated for the production of biofuels – for *Jatropha curcas*, sugar cane and palm oil. Potential investors have applied for a total of 4 million hectares. In Mozambique it is reported that the government is striving to become a regional agro-fuel hub. Agro-fuel investors applied for rights to 5 million hectares in the country in 2007 alone (Kachika undated). In such a scenario, the security of land tenure and access or use rights on the part of local resident communities across rural landscapes is potentially at risk. Such acquisition of land and resources in the form of development projects has been termed by Benjaminsen and Bryceson

(2012) as "green or blue grabbing". In many African countries, land alienation by foreign investors is supported by government policies and laws, occasionally combined with the use of violence to enforce laws (Chikopa 2012).

The extent of largescale acquisition and its impact in the Zambezi Basin is not well documented. The question to be asked is whether these foreign demands and promises can be met while observing sustainability guidelines and without marginalizing the land rights of local communities. Investment and acquisition of farm land need not always be foreign to have a negative impact on local communities however, and there are examples of the acquisition of large chunks of land by local elites and emerging elites in Basin states.

Interventions on Land and Agriculture

National agricultural policies that determine access to agrarian resources and services have traditionally assumed that commercial, large-scale farmers and landowners are men. Such thinking has resulted in institutional decisions that increase the gender gap. Focusing national resources and efforts to promote cash crops comes at the expense of food crops including vegetable production in which the majority are farmed by women, thereby increasing their vulnerability.

Indigenous Knowledge Systems

Farmers use their local knowledge to address some of the challenges they face on land and agriculture. This local knowledge is part of an Indigenous Knowledge System (IKS) that has helped communities to address disaster risk reduction for centuries. One example is the slash-and-burn system, called *chitemene,* practiced in Zambia's extensive miombo woodlands. This entails coppicing trees, burning the piled biomass to create ash which is left in-field to raise soil pH, fumigate soils, kill weed seeds, creating a fine tilth in the topmost soil layer.

In addition, intercropping practice has been used by farmers in the Zambezi Basin for crops that include maize, finger millet, and pumpkins for three to five years without the use of external fertilizers. There are various forms of *chitemene*. Indigenous methods to improve productivity include the introduction of mounds (heaps) as practiced in Mambwe, Northern Province, Zambia (Siame 2006). Mound cultivation is also significant in Angola (Musonda 1994) and in some of the districts in northern Malawi where cassava is the staple food.

Farmers in Muzarabani, Zimbabwe have developed adaptation strategies to flooding. In a traditional practice commonly known as *mudzedze,* crops are grown during both wet and dry seasons in flood recessional areas. During the wet season, farmers grow drought-resistant crops such as millet, rapoko and early maturing maize removed from the floodplain (Mavhura and others 2003). In southern Malawi, farmers adapt through measures including crop diversification, using local fruits, applying organic manure, intensifying mixed animal and crop systems and improving irrigation (Magombo and others 2011).

For livestock, ethno-veterinary strategies have managed tsetse fly in some of the riparian countries. Ecological approaches were used until

the1960s. These included smoking cattle by burning cow dung to chase away insects, moving cattle at night, smearing lion fat as repellent, opening up fields between tsetse areas and settlements, using herbs to protect cattle, and several other methods (Machila 1999).

The land is considered to be sacred by most of the traditional communities in the Zambezi River Basin. Land has been held and used in trust by present generations on behalf of ancestors for the benefit of future generations. Consequently, there exist many traditions around land such as sacred sites, special resource niches, burial sites and community sites. Most traditions agree that all people in principle should share in the land resource as they need it to survive.

There have been a number of strategies developed to address challenges on the land and agriculture subsectors in order to achieve sustainable agricultural intensification and achieve optimal contribution of land resources to poverty reduction, improved livelihoods of resource dependent communities, economic development of national governments and sustainable environmental management. These interventions are being implemented at different levels – continental, sub regional, basin wide, national and local or community levels.

In southern Africa, including the Zambezi Basin, poverty is mostly associated with low agricultural productivity. As a result, most governments have put in place poverty reduction strategies that include vision statements and a number of policies, strategies and programmes. Some countries have developed specific agricultural policies and strategies for sustained economic growth. These agriculture policies aim at promoting diversification in relation to climate change, commercialization and increasing productivity. Thus, agriculture is seen to be the engine of income generation and poverty reduction for the rural poor. Some countries in the basin such as Malawi, Zambia, Tanzania and Zimbabwe have designed programmes that aim at subsidizing production through the provision of inputs such as fertilizers, seeds and machinery with varying successes.

Multilateral Environmental Agreements

The relevant policy interventions at international level applicable to land and agricultural issues in the basin include the various Multilateral Environmental Agreements (MEAs), in particular the three Rio de Janeiro Conventions; the United Nations Convention on Biological Diversity; the UN Convention to Control Desertification; and the UN Framework Convention on Climate Change. These instruments have a bearing on land management and agriculture and environmental sustainability. All countries in the Zambezi River Basin are party to these MEAs and have developed national strategies and action plans towards meeting their obligations. However, implementation of the national strategies is said to be constrained by lack of adequate resources in most Basin states.

African Union Policies

A number of instruments guide African Union member states in ensuring sustainable land and environmental management and agricultural development. These include the New Partnership for Africa's Development (NEPAD) Comprehensive African Agricultural Development Programme (CAADP); the Action Plan of the Environmental Initiative of NEPAD; and the Framework and Guidelines on Land Policy in Africa (FGLPA) spearheaded by the African Union Commission/UN Economic Commission for Africa/African Development Bank. CAADP comprises four mutually reinforcing pillars:

- Sustainable land and water management;
- Improved market access and integration;

- Increased food supplies and reduced hunger; and
- Research, technology generation, dissemination and adoption.

CAADP aims at increasing agricultural productivity by at least six percent and commits countries to increase investment in the agricultural sector by allocating at least 10 percent of national budgets to the sector. FGLPA on the other hand provides voluntary guidelines on land policy reforms and management including addressing gender imbalances in access and sharing of benefits from land, considering the centrality of land in the social and economic development of African countries.

SADC Level Interventions

Regional Indicative Strategic Development Plan

In 2004 SADC adopted the Regional Indicative Strategic Development Plan (RISDP) which is a 15-year roadmap for deeper regional integration and poverty reduction. The RISDP has eleven priority intervention areas, and directly relevant to land and agriculture are the areas dealing with sustainable food security (production, availability and food safety) which also addresses issues of sustainable natural resources management (fisheries, forestry and wildlife). Another intervention area that is directly relevant to this sector deals with environment and sustainable development, promotes environmental mainstreaming and the integration of environmental and sustainable development issues into sectoral, national and sub-regional development planning.

The RISDP has been revised and updated for 2015 to 2020. The major achievements from the previous RISDP targets for agriculture include:

- An Agricultural Information Management System (AIMS) was established to facilitate the collection, analysis, dissemination, archiving of information and integration of various information systems within the region. A website has been developed to allow Member States to access timely information on agricultural trade figures, disease outbreaks, food security, environment, animal health, production and marketing from Member States.
- Early Warning Units were established in 12 Member States to collect, analyse, and disseminate early warning information covering seasonal rainfall and crop development, harvest forecasting, import and exports, food stocks, price and market monitoring. This information is published regularly at both national and regional levels. Similarly, Vulnerability Assessment and Analysis Committees (VAACs) were also established in 12 Member States to assess food availability, undertake livelihood profiling and vulnerabilities, and assess emergency and response needs. The assessments are used by Member States to inform policy formulation, developing programmes and emergency interventions that lead to reduction of vulnerability in the context of food security.

Relevant Protocols and Declarations

SADC has developed and signed a number of protocols and declarations that are relevant to land management and agriculture in the Zambezi River Basin. These include the Revised SADC Protocol on Shared Watercourses which provides the framework for management of river basins, as well as wildlife management and law enforcement, gender, energy, mining, forestry and fisheries. These agreements provide for sustainable use of natural resources. The Basin being a shared resource, it is important that its management conforms to the provisions of the Revised SADC Protocol on Shared Watercourses and other protocols for the benefit of all riparian countries. The main objectives of some of the protocols and declarations are summarized in Box 3.1.

Box 3.1

SADC PROTOCOLS AND DECLARATIONS

SADC Protocol on Wildlife Conservation and Law Enforcement, 1999
The protocol provides policy, administrative and legal measures for promoting conservation and sustainable wildlife management practices in SADC Member States.

Revised SADC Protocol on Shared Watercourses, 2000
This provides for close cooperation among Member States for the protection, management, and use of shared watercourses in the region, including the Zambezi River Basin. It calls for collaboration on initiatives that balance development of watercourses with conservation of the environment, and it establishes the legal framework for appropriate institutions to guide the implementation of the provisions of the protocol.

SADC Protocol on Forestry, 2002
These promotes the development, conservation, sustainable management and utilization of all types of forests, trade in forest products, and protection of the environment to safeguard the interests of both present and future generations.

Dar es Salaam Declaration on Food and Agriculture, 2004
The declaration reaffirms commitments of the SADC Member States to implement short, medium and long-term measures to address food insecurity through provision of key agricultural inputs, agro-industrial development and processing, crop and livestock pests and disease control, and improvement in water management and irrigation.

SADC Declaration on Poverty Eradication and Sustainable Development, 2008
This aims at achieving food security and provides for the establishment of a Regional Poverty Observatory and a SADC Development Fund to support actions in the priority areas of poverty eradication and sustainable development.

Regional Land Reform Support Facility

Realizing the importance of developing and implementing pro-poor land reform policies and programmes in SADC Member States, a Regional Land Reform Support Facility was established at the Secretariat in 2007 following an institutional study (SADC 2007). The Facility was to work with member states through facilitation of best practices and provision of technical and financial support to member states. The facility faced a number of challenges including capacity and funding and its activities could not be sustained.

Regional Agricultural Policy

SADC is developing a legally 'binding' instrument to stimulate sustainable agricultural development and food security in the region. Once approved the RAP will define common agreed objectives and measures to guide, promote and support actions at regional and national levels in the agricultural sector in support of regional integration and in contribution to the attainment of the SADC Customs Union and Common Market. It is envisaged that the SADC RAP will:

- create a framework for harmonizing and integrating policy objectives, strategies and programmes of the Member States;
- provide opportunities to capitalize on the trade benefits of improved resource allocation and greater competition;
- permit a wider range of projects to be implemented under the RISDP;
- provide improved market access to the other countries;

- promote the objectives of multilateralism, facilitate implementation of politically difficult domestic policies; and
- strengthen multilateral bargaining power in international fora.

Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA)

This is a new sub-regional research institution that coordinates the implementation of agricultural research and development in the SADC region. CCARDESA's goal is to sustainably reduce the food insecurity and poverty in the region, including the Zambezi Basin states, as pronounced in the SADC RISDP, the Dar es Salaam Declaration on Food and Agriculture, and the AU's Comprehensive African Agricultural Development Programme (CAADP). The strategic objective of CCARDESA is to increase smallholder productivity and competitiveness through the implementation of Pillar 4 of CAADP on "Agricultural research, technology dissemination and adoption" for the SADC region, based on the Framework for African Agricultural Productivity. This will define and coordinate the research agenda in various aspects for southern African countries including the ZRB states.

SADC Seed Centre

Building on the achievements of the former SADC Seed Security Network (SSSN) project, a SADC Seed Centre has been established with the objective of facilitating the co-ordination and implementation of the regional Harmonised Seed Regulatory System. The SADC Seed Centre has the following functions:

- Quality assurance for regional variety release, certification and phytosanitary regulations;
- Coordination and quality assurance of seed-related capacity development;
- Development of an effective information exchange system;
- Coordination of seed programs in SADC region; and,
- Resource mobilization.

This is addressing the challenge of seed quality and availability among member states including the ZRB countries.

SADC Plant Genetic Resource Centre

The SADC Plant Genetic Resources Centre (SPGRC) is a SADC institution whose objectives are to:

- conserve and guarantee safe conservation of crop and wild plant genetic resources;
- document the plant genetic resources of the region to ensure their efficient and sustainable use;
- provide a forum for exchange of scientific, cultural, traditional and indigenous knowledge and experiences;
- train personnel in plant genetic resources management; and,
- co-ordinate plant genetic resources activities in the SADC region.

SPGRC was set up as a network activity to promote and coordinate a regional network for plant genetic resources management through the National Plant Genetic Resources Centres. The activities of the network include the collection, conservation, documentation, evaluation and utilization of regional plant germplasm, thereby contributing to raising the standard of living and welfare of people in the region and the Basin.

SADC / COMESA Regional Projects

SADC and COMESA through their relevant institutions and with support from cooperating partners coordinate a number of regional projects and programmes in livestock development, crop development, wildlife, forestry and fisheries, and in environment and sustainable development. Some of the livestock initiatives include:

- Promotion of Regional Integration in the Livestock Sector;
- Strengthening institutions for management of Transboundary Animals Diseases (TADs); and
- SADC Foot and Mouth Disease programme.

Other projects are in crop production, early warning systems, forestry and environmental education. Jointly COMESA, SADC and the East African Community are implementing a Tripartite Climate Change Programme that will look at sustainable land-management practices including conservation agriculture.

The Agricultural Productivity Programme for Southern Africa (APPSA) that seeks to promote a regional approach to agricultural technology generation and dissemination is supported by the World Bank, and currently being implemented in Malawi, Mozambique and Zambia. Another regional initiative is the promotion of conservation agriculture, driven by the UN Food and Agriculture Organization (FAO) for capacity building, research and extension through the National Conservation Agriculture Task Forces in SADC member states, including the Zambezi Basin states.

Projects in the Zambezi River Basin

Due to the economic importance of the Zambezi River Basin, there are a number of projects addressing various aspects in the riparian countries. In Malawi for example, which is almost entirely in the Zambezi Basin, there are a number of basin-wide initiatives that include the Sustainable Land Management Project supported by UNDP/GEF, the Shire River Basin Management Programme supported by the World Bank, the Environment Management Action Plan supported by the United States and implemented by the Millennium Challenge Account –Malawi. Other projects in the Zambezi Basin include the Zambezi Watercourse Commission (ZAMCOM), Zambezi Basin Development Project in Zambia and Zimbabwe, the Zambezi Basin Initiative, and many others. These projects address the challenges in food security, environmental degradation and climate change at basin level. ZAMCOM is an institution set up by countries that share the Zambezi River Basin with the objective of promoting the equitable utilization, efficient management and sustainable development of the shared water resources.

Gazetted and Protected Areas

There are many protected conservation areas in the Zambezi Basin states, including national parks, game reserves and forest reserves. In Tanzania, for example out of 94.3 million hectares of the total land surface, almost 30 percent (29.44) is reserved. Benjaminsen and others (2007) conclude that as much as 40 percent of the land area of Tanzania is under some form of environmental protection, including more recently announced areas under community-based conservation. These are established by most Basin states to partner local communities in conservation of resources and avoid encroachment into these protected areas. Tanzania is one of the top countries in Sub-Saharan Africa with the largest extent of land resources allocated as reserves. However, as a proportion of total land area, Tanzania is surpassed by Zambia and Botswana registering 36.6 percent and 31.7 percent respectively on reserved land (FAOSTAT, 2013). See Table 3.12.

The Zambezi Basin has several Trans Frontier Conservation Areas (TFCAs) incorporating some of Africa's finest national parks and safari areas. These include:

- Kavango/Zambezi TFCA involving Angola, Botswana, Namibia, Zambia and Zimbabwe;
- Malawi/Zambia TFCA;
- ZIMOZA TFCA covering areas in Zimbabwe, Mozambique and Zambia;
- Selous/Nyasa TFCA covering parts of southern Tanzania and northern Mozambique;
- Lower Zambezi Mana Pools between Zambia and Zimbabwe; and,
- the Liuwa Plain Kameia TFCA which includes areas in Angola and Zambia.

National Initiatives

National Land Policy and Law Reforms

A number of basin countries have developed or are developing national land policies and laws that aim to address the inequalities in land distribution and also improve land administration systems.

Table 3.12 **Protected Terrestrial Areas as % of Total Land Area**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Angola	12.48	12.48	12.48	12.48	12.48	12.48	12.48	12.48	12.48	12.48	12.48
Botswana	31.72	31.72	31.72	31.72	31.72	31.72	31.72	31.72	31.72	31.72	31.72
Malawi	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93	18.93
Mozambique	14.91	14.91	15.92	15.92	15.92	15.92	15.92	15.92	15.92	15.92	15.92
Namibia	14.53	14.53	14.53	14.53	14.53	14.53	14.53	14.53	14.53	15.01	15.01
Tanzania	28.87	28.87	29.02	29.02	29.03	29.05	29.05	29.44	29.44	29.44	29.44
Zambia	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64	36.64
Zimbabwe	18.31	18.31	28.42	28.42	28.42	28.42	28.42	28.42	28.42	28.42	28.42
Average	22.05	22.05	23.46	23.46	23.46	23.46	23.46	23.51	23.51	23.57	23.57

FAOSTAT 2013

Most reforms are towards improving food security, regulating access to land, addressing gender inequalities and improving transparency and accountability in land transactions. These reforms are at different stages in the Zambezi River Basin countries. Most national land policy reforms undertaken in the last decade recognise the legitimacy of customary land rights and provide for some form of registration, and a role for local and community-based institutions in land management, alongside that of the state. They also try to address the gender inequalities in access and control over land and land-based resources.

Agriculture and Related National Policies

Angola

Angola is endowed with vast reserves of oil, diamond, iron ore, copper, gold and other minerals. However, 60 percent of its population lives in the rural area and depends on agriculture for survival (SADC 2012c) which means that attainment of food security and poverty reduction cannot be achieved if the agricultural sector is ignored. Government is giving priority to development of the agricultural sector and good progress has been made. However, there are still challenges such as lack of access to credit and insecurity over land tenure.

The major policy document that contains the objectives of the Ministry of Agriculture is the 2009 Executive Programme on the Agro-Sylvio and Forestry-based Activities in Angola. Its objective is to promote sustainable and integrated socio-economic development of the agricultural sector taking advantage of its potential for increased production, productivity and competitiveness while at the same time creating employment and income to ensure food security. There are a number of programmes in support of this policy in areas of food security, irrigation, and emergency and disaster preparedness.

Botswana

The Government of Botswana supports diversification of the agricultural sector and has put in place a number of supporting policies and programmes. All agricultural programmes and projects are aimed at achieving the objectives of the 1991 National Policy on Agricultural Development which was elaborated in the later National Development Agricultural Plan 9 that includes objectives on mainstreaming gender and youth issues into agricultural programmes.

Other supporting policies include the National Land Policy; Tribal Grazing Land Policy; Arable Land Development Programme; Integrated Support Programme for Arable Agriculture Development; and the National Master Plan for Arable Agriculture and Dairy Development, which has a component to promote irrigated crop production.

Other related policies include the Revised National Policy for Rural Development; the National Strategy for Poverty Reduction; and the revised National Food Strategy. These have objectives relevant to agriculture in general and crop production in particular.

Malawi

The agriculture sector in Malawi contributes significantly to national development in several ways – as an economic activity, source of livelihoods and provider of environmental services. The sector contributes about 36 percent (value added) to the GDP, employs about 85 percent of the work force, and contributes about 70 percent of the country's foreign exchange earnings through exports.

The agricultural sector is guided by the Agricultural Sector Wide Approach (ASWAp) which is a framework for investment in the sector. The ASWAp identifies three focus areas, two key support services and two cross-cutting issues. The focus areas are:

- Food Security and Risk Management;
- Commercial Agriculture, Agro-processing and Market Development; and,
- Sustainable Agricultural Land and Water Management.

  The two key support services are:
  - Technology Generation and Dissemination; and,
  - Institutional Strengthening and Capacity Building.

  The cross-cutting issues are:
  - HIV Prevention and AIDS Impact Mitigation; and,
  - Gender Equity and Empowerment.

Other agricultural programmes being implemented in the country include: the Farm Input Subsidy Programme; Institutional Development Across Agrifood Sector Programme; Improving Coordination of ASWAp in the Ministry of Agriculture (ICAM); and, the Green Belt Initiative (GBI) that aims to increase area under irrigation to one million hectares. The land subsector is guided by the 2002 National Land Policy that aims at addressing the challenges in that sector but implementation is hampered by the lack of a supporting legal framework.

Mozambique

The key challenges in the agricultural sector include:

- Low productivity;
- Limited access to improved seeds;
- Limited access to fertilizers;
- Limited access to credit and financial services; and,
- Poor input distribution network.

Within the present agricultural policy framework the emphasis is on addressing some of these bottlenecks and the strategies aim at improving production and productivity, rehabilitation of service such as roads and communication, rehabilitation of irrigation schemes, and providing training to extension officers, among others. Policies, strategies and institutional arrangements have been put in place to address agricultural problems and support services to promote fertilizer availability, mechanization, research, extension and trade-related issues.

Namibia

The National Agricultural Policy of 1995 has provided guidance to agricultural development but suffered a number of setbacks including weak implementation mainly due to the lack of appropriate budgetary provisions for that purpose.

The third National Development Plan (2007/2008-2011/201212) is a systematic translation of Namibia's Vision 2030 and is aimed at accelerated economic growth and deepening rural development. There are a number of land-related laws in support of the land reform initiatives that aim at broadening access to productive land. These laws include the Agricultural (Commercial) Land Reform Act of 1996, the National Land Policy of 1998, the Communal Land Reform Act No. 5 of 2002 and the National Land Policy of 1995.

Tanzania

The Tanzania Vision 2025 aims at achieving a high quality of livelihood for its people. The national organizing framework focusing on economic growth and poverty reduction is the National Strategy for Growth and Reduction of Poverty, and agriculture is firmly anchored in this strategy.

The Agricultural Sector Development Strategy aims at achieving agricultural sustainable growth rate of 5 percent per annum through the transformation from subsistence to commercial agriculture. The current land policy and strategies aim to:

- Promote equitable distribution of and access to land;
- Ensure existing rights to land; and,
- Improve land management.

Zambia

Vision 2030 is Zambia's general framework of all developmental planning in the different sectors of the economy including agriculture. Specifically for agriculture there are a number of policies, but inconsistencies in their implementation is the major constraint. Examples include subsidy provision, poor marketing strategies, poor irrigation and infrastructure, and low financial support to key areas such as research and extension.

The Poverty Reduction Strategy focuses on the need to reduce poverty and food insecurity. To go with this strategy the Agricultural Commercialization Programme was developed to promote targeted agricultural growth, but was not fully implemented. The National Agricultural Policy provides guidelines for the period 2004 to 2015 and emphases liberalization, commercialization and provision of effective services. Another policy instrument is the Fifth National Development Plan that clearly identifies irrigation development, agricultural infrastructure and land development as key areas for investment.

Zimbabwe

The Zimbabwe agricultural sector went through major changes following the Fast Track Land Reform Programme of 2000 that sought to address the inequalities in land resources emanating from the colonial era. The widely accepted Land Review report of 2003 recognises the need to enhance agricultural production in resettled areas and communal areas by suggesting various strategies that involve strengthening of institutions such as banks, state-owned enterprises, research centres and capacity building at all levels. This involves irrigation, mechanisation and the appropriate technologies required to boost production; and encouraging gender equality in land ownership. Another key driver to production is the pricing policy and the need to create a robust market that does not constrain investment. This has seen several initiatives through the national economic development blueprint for 2013-2018, the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZIM ASSET).

Policy Options

Land and agriculture will continue to form the basis for the social and economic development of countries within the Zambezi River Basin. However, the land and agriculture sectors face a number of challenges that threaten their ability to sustainably contribute towards economic growth, poverty reduction and food security in the riparian countries as well as in the SADC region. Based on some of the issues discussed in this report, the following policy options have been advanced:

- Basin-wide initiatives to strengthen and transform agriculture through implementation of regional initiatives that promote sustainable production and intensification of both livestock and crops to reduce food insecurity while at the same time diversifying the economies away from agriculture to services and manufacturing so as to relieve pressure from the land resources.
- Support innovative land-tenure reforms that improve land-tenure security and ownership among vulnerable groups, particularly women who contribute significantly to agricultural production in the riparian states.
- Implement the various conventions, protocols, declarations and guidelines agreed upon at different levels with the aim of improving land governance, gender equality and food security, while at the same time providing strategies for addressing issues of biodiversity loss, climate change, land degradation, desertification and mitigation of the effects is of drought.
- Despite the existence of huge irrigation potential in the Basin, crop production continues to rely on rain-fed agriculture and is therefore vulnerable to the impacts of climate variability and climate change. Countries in the Basin should endeavour to increase areas under irrigation by promoting irrigation infrastructure development and supporting research and extension in irrigation agriculture.
- Agriculture production continues to be constrained by non-accessibility to various factors which include production-enhancing improved technologies such as inputs because of their scarcity and high pricing. Therefore, the riparian countries through relevant regional economic blocks should continue to explore ways of increasing fertilizer production in the SADC region with the aim of making it affordable to smallholder farmers and reduce barriers in improved seed production.
- Systems of agriculture that aim to minimize soil disturbance and maximize soil cover have the potential to improve the resilience of food production systems from the negative impacts of climate change, however the adoption is still low in the Zambezi Basin. Given the vulnerability of the SADC region, the riparian countries should continue to increase efforts in promoting conservation agriculture and other climate-smart agricultural practices through deliberate policies that support research and extension in conservation agriculture.
- Policies and strategies for addressing gender gaps exist at Continental, SADC, COMESA, National and Basin levels. Most constitutions enshrine gender equity, yet gender disparities continue unchanged. Therefore, nations and regional bodies should intensify implementation of measures to bridge the gender gaps including affirmative actions in the achievement of poverty eradication and sustainable development objectives;
- The Zambezi Basin riparian states should document and disseminate indigenous knowledge in agriculture and land management that contributes to sustainable environmental management.

LINKING AGRICULTURE AND LAND TO BIODIVERSITY CONSERVATION IN THE ZAMBEZI VALLEY, ZIMBABWE

The Zambezi Valley area in Zimbabwe is located in the middle-Zambezi between Lake Kariba and Cahora Bassa. The area is generally characterised by a dry tropical climate, with low and very variable annual rainfall. Two seasons are clearly defined: a rainy season from December to March and a long dry season from April to November.

Natural land cover throughout the Valley is typified by deciduous dry savannah, dominated by Mopane trees with the presence of a rich flora and great species diversity (Gaidet and others 2003; Poilecot and Gaidet 2010). It is an area of global importance for the emblematic mega-fauna of Africa with large portions of its ecosystem being set aside in protected areas, which has been altered over the past 30 years by various agricultural activities and land policies (Baudron and others 2011; Coid and others 2003). Studies throughout the 1980s and 1990s revealed that the Zambezi Valley hosts some of the densest populations of indigenous wildlife (Nemarundwe 2005).

More recent studies showed remarkable levels of species richness and large portions of uninhabited areas within the Valley (Gaidet and others 2003). A huge factor for the largely undisturbed landscape was the presence of the deadly tsetse fly which limited human activity. Successful tsetse fly eradication efforts resulted in changes in human activities such as an increase in agricultural practices by the early 2000s. A study looking at changes in two areas in the valley (Dande Communal Area, Mbire District) noted increases in human population; increases in cattle population (and the expansion of associated plough-based agriculture); and the expansion of cotton farming (Baudron and others 2011). Nemarundwe (2005) noted that following the eradication of the tsetse fly, cotton became the main cash crop with agriculture remaining the major land-use in the district.

In some cases this expansion has increased grazing and water resources competition between wildlife and livestock (Coid and others 2003). Water sources, and modify wildlife migratory routes causing wildlife population to decline posing a threat to the overall health of the local biodiversity. The harsh climatic conditions encouraged many people to concentrate agricultural activities near major rivers such as the Angwa River, further threatening the wildlife population (Baudron and others 2011). In some administrative wards the drilling of boreholes has helped to improve water access and decrease land degradation near floodplains and river banks.

Introducing farming methods that improve yield without increasing the land area will be crucial to reducing habitat and biodiversity loss. In other parts of the Basin, conservation agriculture has been used to improve yields while using less fertilizer and less land (SARDC and HBS 2010). This type of land intensification can be adapted to the local conditions in the Zambezi Valley.

CHAPTER LINKAGES

Overview

Land is an essential asset to life in the Zambezi Basin. Agriculture is a land-use activity. Pressures on land-use are increasing due to various factors, and there is less arable land available per capita. There is need for effective management of land and environmental resources to achieve sustainable development.

Water Resources

Land shortages result in wetland degradation as these are turned into cropland in an unsustainable manner. Agriculture, especially irrigation agriculture, takes a large share of the available water resources. The use of agro-chemicals contributes towards pollution of freshwater resources, affecting the health of ecosystems. This needs adequate policy frameworks, stakeholder involvement and strategies to strengthen the role of women in access, management and decision-making.

Biodiversity and Forests

Agriculture expansion and land development targets forests causing deforestation. Habitat for wildlife is modified causing loss of biodiversity. Inclusive policy frameworks are needed that incorporate these key issues of sustainability, and local communities should be encouraged to apply their knowledge systems that support sustainability.

Climate Change and Variability

Deforestation due to agricultural expansion reduces the Basin's contribution towards reducing global warming through carbon sequestration. Burning of forests contributes to atmospheric pollution.

Energy

Smallholder farmers in the Basin rely on biomass for tobacco curing and tea drying. This may cause deforestation and air pollution. The production of charcoal as an energy source is widespread and having a serious impact on land-use through removal of large tracts of forest cover.

Urbanization and Human Settlements

Land provides resources for human activities, including shelter for settlements. In some areas of the Basin, arable land is in high demand from local and foreign investors, as well as individuals and communities. In urban areas land is in high demand, and therefore expensive.

Tourism

Land supports a wide range of natural resources which are important components of the tourism sector in the Basin. Clearing of land for agriculture and other developments may lead to degradation and loss of biodiversity. While infrastructure development is necessary, it should be well-regulated.

Industrial Development

Agriculture is one of the important industries in the basin contributing raw materials to other industries, and agro-industries should be encouraged to locate in the Basin for value addition. This must be well-regulated as land clearance for agricultural expansion can lead to soil degradation and environmental damage.

Scenarios

Agriculture will continue to be a core factor in developing the Basin economy and reducing poverty, and can be expanded through value addition with appropriate regulation. All sectors require land for their activities and it is essential that systems are put in place to protect the environment and biodiversity, reduce deforestation and increase planting of indigenous species. Policies must address the gender gap in land management and incorporate indigenous knowledge systems as well as appropriate technology.

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BIODIVERSITY AND FORESTS 4

Introduction

Biodiversity has been defined by the Convention on Biological Diversity (CBD) as the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems. This includes diversity within and between species. It exists at three main levels — the combination of species that make up different ecosystems; the number of different species; and the different combinations of genes within species (Chenje 2000; UNEP 2007). All the three levels help to sustain biological systems, as well as to ensure their productivity.

Biodiversity drives the economy of Zambezi River Basin through the economic resources and ecological services it provides. Key issues in the Zambezi Basin include the loss of biological diversity as a result of habitat loss, proliferation of invasive alien species, uncontrolled veldt fires and climate change, among others. Given the economic and ecological services that the Basin derives from biodiversity, its maintenance, restoration and enhancement is therefore not an end in itself but a means to achieve the basin's socio-economic development.

The Zambezi Basin is rich in biological resources, some of which have global significance. It has a large and diverse heritage of flora and fauna, including domesticated crops and animals (Table 4.1; SADC 2006). They occur in the basin's varied environments that include arid and semi-arid ecosystems, freshwater ecosystems, and mountain ecosystems. Of the 82 sites globally chosen for their species' richness and endemism in sub-Saharan Africa, 26 fall within the Southern African Development Community (SADC). More than 40 percent of the species found in southern Africa are endemic (Griffin and others 1999).

Table 4.1 **Species Diversity in the Zambezi Basin**

Country	Area (000 sq km)	Mammals	Birds	Fish	Reptile	Amphibians	Flowering plants
Angola	1 247	276	765	268	227	78	5 000
Botswana	582	164	386	81	133	20	2 000
Malawi	118	195	521	1 000	108	46	6 000
Mozambique	799	179	498	500	195	52	5 500
Namibia	824	250	469	97	215	31	3 159
Tanzania	946	316	1119	250	335	116	11 000
Zambia	753	233	605	156	143	57	4 600
Zimbabwe	390	270	532	132	180	31	6 000

SADC and SARDC, Southern Africa EnvironmentOutlook,2008; SADC Regional Biodiversity Strategy, 2006

The Value of Biodiversity

The contribution of forests to the Gross Domestic Product (GDP) of riparian states is underestimated because the captured figures consist of income receipts from exotic and commercial indigenous timber, thus misrepresenting the contribution of forests as the bulk of their products and services are not captured in national accounts. Studies have estimated that forest-based products such as wild foods, wood, medicinal plants, grass, reeds, honey and leaves contribute over 35 percent of the average rural incomes in some parts of Zimbabwe and that 20 percent of the daily needs of some rural communities come from forests (SADC/SARDC and others 2008).

The key forest products and services are industrial timber and timber products, fuel wood, Non Timber Forest Products (NTFP) such as fruit and medicinal plants, wildlife habitats, and environmental services. The latter include the provision of clean water, climate regulation, soil and biodiversity conservation, watershed protection, climate stabilization through carbon sequestration, and nutrient recycling. Forests are also culturally important as sacred burial

sites. They are therefore an important component of the basin's stock of economic and social assets.

With respect to carbon sequestration, very little is known about the underground carbon stocks associated with dry Miombo woodlands. However, they have the least above-ground living biomass across a number of African regions (Table 4.2). This is due to the inherently slow growth rate and high level of utilization of their tree species. Because of the low above-ground carbon stocks, little attention has been paid to these woodlands compared to rainforests (Zahabu and others 2007). However, new opportunities for compensating reduced emissions through reversing deforestation now exist under Reduced Emissions from Deforestation and Forest Degradation (REDD+) hence the need for basin states to take advantage of the global focus on REDD+ (Marunda and others 2010).

Table 4.2 **Trends in Carbon Stocks in Forest Biomass**

Sub-region	Carbon in living biomass (Giga tonnes)		
	1990	2000	2005
Eastern and Southern Africa	15.9	14.8	14.4
Northern Africa	3.8	3.5	3.4
Western and Central Africa	46.0	43.9	43.1
Total Africa	65.7	62.2	60.9

FAO, State of the World's Forests, 2005 Giga tonne=1 billion tonnes

Large wild mammals are a unique economic resource in the sense that they make better use of vegetation compared to livestock and have many marketable uses in addition to meat production (SADC/SARDC and others 2008). They are used for consumptive and non-consumptive tourism purposes. The major activities include game and trophy hunting, and game viewing. In addition, local communities hunt wildlife mainly for subsistence requirements.

The bulk of the population of the Zambezi Basin depends on agriculture for food, income and employment, and agricultural output strongly influences the basin's economic growth (Hirji and others 2002). Agro-biodiversity (in terms of the variety in crops and livestock) provides consumptive and productive benefits to the economies of Basin states. The former involve the direct use of biodiversity products that are harvested and consumed directly such as grain and meat. The latter encompasses products that are raw materials for agro-based industries (SADC 2006).

Throughout centuries, people of the Zambezi Basin have depended on the basin's rich biodiversity for survival. They have developed strategies to protect and conserve this natural heritage for the benefit of their own and future generations. For example, some cultures often designated areas rich in biodiversity as sacred or protected sites. However, many of these conservation-sensitive traditional beliefs have broken down due to population pressure and changes in the socio-economic environment, including urbanization (SADC 2006).

Drivers of Biodiversity and Forest Loss

Major drivers of biodiversity and forestry loss in the Zambezi Basin are population growth and poverty, agricultural expansion, overreliance on wood energy, uncontrolled veldt fires, socio-economic development, and emerging issues such as climate change and invasive alien species.

Population Growth and Poverty

Riparian states of the Zambezi Basin are at different stages of economic development. The region's economic performance has remained fragile as countries continue to be exposed to natural disasters and adverse external shocks. This is partly because most of the economies depend on primary sectors of production, underpinning the overriding importance of biological resources for their socio-economic development. The basin's human population is estimated at over 40 million people and is growing at an average rate of 2.9 percent per year. The population is expected to increase to 51 million by 2025 and urbanization is also expected to grow (SARDC and HBS 2010).

Almost all Basin states face economic challenges such as external debt, terms of trade and market access, and dependence on single commodities which combine to create an adverse macroeconomic climate. Some socio-economic statistics on the Basin are shown in Table 4.3.

The majority of people in the Basin live in rural areas and depend on unreliable rain-fed agriculture, livestock rearing, and the exploitation of natural resources for survival. However, increasing urbanization is affecting consumption patterns and increasing the demand for commercial services. All these factors contribute to land degradation, biodiversity loss and poverty. In Botswana, Malawi, Zambia and Zimbabwe, rural communities supplement their incomes through Community Based Natural Resources Management (CBNRM) initiatives based on wildlife, non-timber forest products and ecotourism. However, the economic returns from such initiatives are highly variable due to limited product range and institutional and policy constraints (SADC 2006).

Table 4.3 **Some Socio-Economic Statistics on Riparian States**

State	GDP ($ billions)	GDP per capita ($)	Population (millions)	Urbanization (%)
Angola	9.76	696.9	14.0	42.4
Botswana	6.50	2 796.0	1.7	46.4
Malawi	2.28	198.0	11.5	15.0
Mozambique	4.09	226.0	18.1	23.0
Namibia	2.82	1 667.0	1.8	27.0
Tanzania	9.74	266.0	33.6	30.0
Zambia	4.34	392.0	10.7	35.0
Zimbabwe	2.20	1 891.0	11.6	33.6

SADC, Regional Biodiversity Strategy, 2006

Agricultural Expansion

The economies of Basin states are agro-based. The countries have many small-holder farmers who depend on rain-fed agriculture, use very few inputs and realize very low crop yields. To achieve food self-sufficiency and become food secure, the farmers resort to the cultivation of marginal land that is less productive. Agricultural expansion results in deforestation, land degradation and biodiversity loss (SADC 2006).

Table 4.4 shows the link between agricultural expansion and deforestation in five riparian states. Malawi and Zimbabwe experienced large increases in land allocated to agriculture and corresponding reductions in the forest area between 1990 and 2005. However, the correlation between agricultural expansion and deforestation was weaker in Mozambique and Tanzania.

Over-reliance on Wood Energy

Biomass, especially firewood, is the main energy source for more than 80 percent of the population of riparian states. The use of charcoal is also widespread, especially in urban areas in

Table 4.4 **Relationship between Agricultural Expansion and Deforestation**

Country	Percentage change: 1990 to 2005	
	Agricultural land area	Forest land area
Malawi	19.8	-12.7
Mozambique	2.2	-7.6
Tanzania	2.2	-14.6
Zambia	9.8	-4.7
Zimbabwe	20.7	-22.1

Dewees and others, 2011

Malawi, Mozambique, Tanzania and Zambia. Access to modern energy sources is limited for both rural and urban households. For example, access to grid electricity averages only 18.5 percent. It is eightpercent in Malawi and 40 percent in Zimbabwe (GoM, 2009; GoZ, 2009). Tobacco is a major cash crop for smallholder farmers in Malawi and Zimbabwe, and this requires significant quantities of wood for curing. Another energy related cause of deforestation is fish drying along river banks and lakesides in Malawi, Zambia and Zimbabwe. Communities in these areas also cut trees for the construction of canoes, and temporary fishing camps during the rainy season.

Table 4.5 gives examples of wood energy needs for firewood, charcoal production, tobacco curing and brick firing, which are among the major causes of deforestation in the Basin.

Table 4.5 **Wood Energy Requirements for Selected Energy Uses in Basin States**

Wood energy use	Wood requirements (tons)
Annual household firewood consumption in Zimbabwe	4.2
Wood to produce 1 ton of charcoal	10.0
Wood to cure 1 ton of tobacco (depending on barn design)	6.0
Wood to fire sufficient bricks to build a standard three-room house	2.0

SAFIRE, 2013; Grundy and others, 1993

Table 4.6 **Incidents and Impact of Uncontrolled Veldt Fires in Zimbabwe**

Year	Fire incidents	Area affected (ha)	% of country affected	Lives lost	Value of infrastructure damaged ($)*
2009	7 409	950 905	2.4	10	1 984 560
2010	9 361	1 152 413	3.0	25	974 376
2011	6 780	713 770	2.0	5	227 214
2012	1 861	1 320 325	3.4	16	479 723

*Includes forest plantations, livestock, farm produce, buildings, electricity poles, vehicles and farm equipment

Environmental Management Agency reports 2009-2012

Uncontrolled Wildfires

People have used fire as a land management tool and for agricultural purposes for thousands of years. However, uncontrolled wildfires have become a major threat to the Zambezi Basin's forests and biodiversity, adversely affecting the bio-physical, social and economic environment due to their trail of destruction that impacts on all sectors of the economy (Nyamadzawo and others 2013). Table 4.6 shows incidents and impact of uncontrolled fires in Zimbabwe.

Economic Development

Large-scale infrastructural development and the expansion of settlements into woodland and forest areas are part of national development. However they contribute to deforestation and land degradation. Particular forms of habitat destruction and fragmentation include infrastructure such roads, buildings, settlements and development corridors, dams and mines that are being established in the Basin.

Fragmented habitats caused by infrastructure development and high human population densities increase contact between people and wildlife. This fuels human and wildlife conflict. Free-flowing rivers are threatened by the prospect of damming to provide drinking water, irrigation water and power generation. Industrial expansion increases water pollution leading to the poisoning of aquatic life and the proliferation of invasive alien species such as water hyacinth. A new sector of economic development that has impacted upon the basin's biodiversity during the last decade is the cultivation of bio-fuel feedstocks.

Emerging Drivers

Emerging drivers of the loss of biodiversity and forestry include climate change, bio-fuel feedstocks, and proliferation of invasive alien species. These are discussed in this section.

Climate Change

Climate change refers to a shift in climate that takes place as a result of human activities (Wigley 1999). The activities result in an increase in greenhouse gases such as carbon dioxide, methane and nitrous oxide (IPCC 2007a). Climate change models indicate that there will be a 1.5° C to 2.5° C temperature increase across the Zambezi River Basin within the coming 40 years (WWF 2012). However, rainfall predictions across the Basin vary. Four main regions with different rainfall predictions are considered relevant for the Basin, as follows:

- The south region (southern Zambia, Botswana, Namibia, Zimbabwe and Mozambique) is expected to receive less rainfall and a condensed summer rainfall season (with little change in total summer rainfall). Some projections suggest decreased mean annual rainfall of up to 10 percent by the end of the 21st century.
- The northeastern part of the Basin (eastern Zambia including part of Kafue and Luangwa, and central and north Malawi) will experience an increase in mean annual rainfall as a result of a wetting trend emanating from Tanzania. Besides the increase in annual rainfall that could reach as high as10 percent, the intensity of rainfall events is projected to increase, with longer dry spell duration intra-seasonality. Shifting onset of the rains and marked rainfall variability in the early rainy season is anticipated.
- The northwest (western Zambia, Angola Upper Catchment and Kafue) will experience opposing wetting and drying instances based on the movement of the Inter-Tropical Convergence Zone (ITCZ).
- The coastal portion of the Basin (southern Malawi and coastal Mozambique including the Lower Shire and the Delta) will experience opposing wetting and drying instances and increased cyclonic activity of higher intensity and possibly higher frequency.

Climate change is becoming a global challenge to biological diversity and human wellbeing. Projections show that an increase in average global temperature of only 1.5° C to 2.5° C will endanger the existence of up to 30 percent of all animal and plant species. Rising temperatures will result in extreme weather events whose effects are droughts and frequent floods, crop failures, food insecurity, other natural catastrophes, and water scarcity. In southern Africa, temperatures are expected to increase by 1.5° C between 1990 and 2050 (Hulme 1996). Such warming will result in lower rainfall and a change in vegetation distribution across the region as follows (Prentice and others 1992):

- Under the "dry" (20 percent less moisture) scenario, there could be a 10 percent increase in sub-humid forests derived from moist evergreen forests;
- A 30 percent increase in Acacia semi-arid bushland and wooded grasslands at the expense of warm dry forests; and,
- A significant change in the distribution of warm dry woodland types and those in the semi-arid region.

Most developing countries, including those in the Zambezi Basin, are very low emitters of greenhouse gases, but are expected suffer the most from climate change due to low adaptive capacity (IPCC 2007b). Vulnerability to climate change varies greatly among riparian states, sectors and social groups.

For example, in the water sector, Angola, Malawi, Mozambique, Tanzania and Zambia are not as vulnerable to water scarcity as Botswana, Namibia and Zimbabwe (SARDC and HBS 2010). The most vulnerable people are often those who are unable to diversify to other means of survival hence they resort to the overexploitation of natural resources for survival.

Forests play an important role in reducing global warming through carbon sequestration – as "sinks" for carbon dioxide. Thus, the destruction of tropical forests accounts for 20 percent of global carbon emissions. This underscores the need to maintain as much forest cover as possible andidentify the economic activities that compete with forestry. Unfortunately, there have been very limited incentives for sustainable forest management at both local and national levels in the Zambezi Basin largely because most forest products have low economic value. Consequently, the emergence of forest carbon trading through the Reduced Emissions from Deforestation and Forest Degradation (REDD+) mechanism is a welcome incentive for good forestry stewardship and governance.

REDD+ creates economic value for carbon locked up in standing forests. Its key dimensions include forest conservation, sustainable forest management and enhancement of forest carbon stocks (Kowero and others 2011). Once operational, REDD+ will be an important incentive for rural communities, governments and other forest land owners to practice good natural resource stewardship and to reverse some of the economic drivers of deforestation. Box 4.1 gives some policy and related issues on REDD+ in Africa.

Box 4.1 **KEY ISSUES ON REDD+ IN AFRICA**

Key policy and related decisions on Reduced Emissions from Deforestation and Forest Degradation (REDD+) in Africa will invariably focus on:

- How to reduce or avoid deforestation and forest degradation;
- Level of deforestation and degradation permissible for socio-economic development;
- How to handle the opportunity costs of forest conservation, that is, the compatibility of forest conservation and livelihoods of communities that depend on the same resources, as well as income that could accrue to other stakeholders from the same resources;
- Introduction of sustainable forest management to the majority of African forests, its improvement where it is nascent, and compatibility with the many expectations on forest resources by various stakeholders; and,
- How to enhance forest carbon sinks.

Many of the components of REDD+ are not new to the forest sector in Africa. Therefore, as a point of departure it is first necessary to look at policies and experiences of activities and programmes that deal with deforestation and forest degradation, forest conservation, sustainable forest management, and enhancement of carbon stocks in the forest sector.

Kowero and others 2011

Cultivation of Bio-Fuel Feedstock

Some industrialized countries have committed to measurable levels of bio-fuel use in response to adverse impacts of greenhouse gas emissions from fossil fuels on ecosystem health and human wellbeing. For example, the European Union has binding targets for member states to ensure that 10 percent of all road transport fuel comes from renewable energy by 2020 (Lamers and others 2011). This has opened avenues for bio-fuel investments in developing countries with suitable land and water resources for feedstock production.

Such investments offer opportunities to reduce global carbon emissions and allow participating countries, including those in the Zambezi Basin, to benefit from the resultant financial inflows. In addition, this can reduce the Basin's dependence on imported petroleum products, stabilise fuel prices, advance fuel security, promote rural development and investment, reduce poverty, and create employment (Chundama 2008; Nhantumbo, 2008; Sibanda 2008; Shumba and others 2009). The bulk of current and planned investments in the Basin are in bio-ethanol and bio-diesel production for the transport sector. The former is made from vegetable materials such as maize, sweet sorghum, sugarcane and cassava; and the latter from oilseed crops such as soya beans, groundnuts, sunflower and jatropha.

A major argument against bio-fuels is that they require large tracts of land for feedstock production hence they are perceived as an emerging driver of habitat alteration, biodiversity loss, food insecurity and community displacement and disenfranchisement. Consequently, such investments might not yield desired results if not properly guided and responsibly implemented through formulation and enforcement of appropriate policies.

This is vindicated by FAO which states that "there is as yet no country in the world where the bio-fuels industry has grown to commercial scale without a clear policy or legislation in place to support the business" (FAO 2008). Several Basin states have committed considerable areas of land to bio-fuel feedstock production (Table 4.7). However, most of them have not yet put in place the enabling bio-fuel policies and strategies (Shumba and others 2013).

Proliferation of Invasive Alien Species

Invasive Alien Species (IAS) are those introduced deliberately or unintentionally outside their natural habitats where they have the ability to establish themselves, invade, out-compete natives and take over the new environments (SADC, IUCN, SARDC 2000). Such species are found in all categories of organisms and all types of ecosystems and some of them have significant environmental and economic impacts. The problem and impact of IAS is likely to increase as more plants move across borders and destabilize natural vegetation (Hamilton and Hamilton 2006), especially in areas where phytosanitary

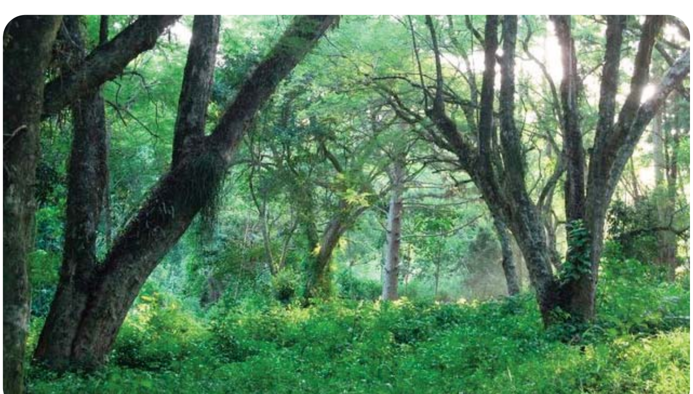
Table 4.7 **Involvement of some Zambezi Basin States in Bio-Fuel Production**

Country	Existing/Ongoing projects	Planned projects
Botswana	A feasibility study on bio-fuel production and use was commissioned in 2007. The study identified jatropha and sweet sorghum as suitable feedstocks.	There are plans to establish 100,000ha of jatropha and sweet sorghum feedstock through outgrower schemes in the central district of the country.
Malawi	Malawi has been involved in sugarcane cultivation for sugar and ethanol production for a long time through large-scale plantations and smallholder outgrower schemes. The country started to produce bio-ethanol commercially from molasses for blending with petrol in the 1970s. Toleza Farm Ltd has planted 250 ha of jatropha for bio-diesel production in Balaka district.	Energen Resources Inc plans to establish 10,000 ha of jatropha through large plantations and outgrower schemes.
Mozambique	Mozambique has large sugarcane plantations for sugar production. The resultant molasses is exported. Renewable Alternative Energies Ltd is producing biodiesel from coconut and has a plant capacity of 40,000 litres per annum. Some largescale plantations of jatropha have been established.	Energen Resources Inc was allocated 60,000 ha of land for jatropha cultivation. The ESV Group plans to establish the largest single plantation of jatropha in Africa in Inhambane province. Sun Bio-fuels purchased five former tobacco farms for jatropha production in Manica province.
Zambia	A few sugar companies are involved in sugarcane production through largescale plantations and outgrowers. The molasses is used as livestock feed. Conservation Agriculture project is promoting the production of jatropha as hedges for biodiesel production by 2,500 farmers.	D1 Oils-UK plans to establish 189,000 ha of jatropha through outgrowers.
Zimbabwe	Zimbabwe has a well-established sugar industry supported by large estates and smallholder outgrowers. The country started to commercially produce bio-ethanol for blending with petrol in the 1960s. Finealt Biodiesel and NOCZIM (both government companies) have been promoting jatropha cultivation throughout the country under the outgrower arrangement. There is established processing capacity of 10,000 and 60,000 litres per day at the Mutoko and Mt Hampden Biodiesel plants respectively.	ZBE, a private company, plans to develop and plant 100,000 ha of sugarcane for sugar and bio-ethanol production in Masvingo province.

Jumbe and others 2007; Chundama, 2008; Nhantumbo. 2008; Sibanda 2008; Ramaano 2009; Mughogho and others 2009; Shumba and others 2009 regulations are lax. In its compilation of the Red Data List of threatened species, IUCN cited alien species as directly affecting 15 percent of all threatened plants (Calton 1998). They disturb nutrient recycling, pollination and the regeneration of soils and energy, among other things; and threaten the integrity of natural systems. For example, the snapdragon tree (*Gmeliaaborea*) common in Malawi makes the soil too acidic for the growth of many other plants (SADC, IUCN, SARDC 2000).

Aquatic weeds, mostly free-floating species such as the water hyacinth (*Eichhorniacrassipes*) and water lettuce (*Pistiastratiotes*) are among the dominant IAS in the Zambezi Basin (Hirji and others 2002). The former has invaded water bodies with adverse effects on ecosystem health, and threatens the integrity of ecosystems.

The invasion of some of the region's water bodies by the water hyacinth has modified fish habitats, as the weed changes and degrades aquatic water systems, outgrows local water plants and takes over. When massive quantities of the plant die, they sink to the bottom and their decomposition deoxygenates the water, resulting in the death of fish. Their debris also affects drainage systems and watercourses. The weed's dominant cover absorbs sunlight, thereby seriously affecting the biodiversity of fauna and flora beneath the water level. The water hyacinth is a major problem in Malawi, Tanzania, Zambia and Zimbabwe (SADC 2006).



The Lantana (*Lantana Camara*) was first introduced as an ornamental plant and is found throughout Africa. The allelopathic capacity of the plant prevents other plants from growing near or under it forming dense impenetrable stands which impede foraging of animals and are not suitable for breeding. Lantana continues to invade more land affecting agriculturally productive areas as well as rural and urban settlements. One study noted that Lantana poisoned ostriches at a farm on the outskirts of Harare, ingestion of sufficient amounts causes photosensitization and liver damage. It severely affects the facial and nasal areas of the animal's skin leaving these areas inflamed and susceptible to secondary bacterial infections.

Although the plant negatively affects livestock and pastoral communities, the plant is widely used as a herbal medicine in East Africa. Some communities use lantana as an alternative for firewood and mulch. It has also been used as a source of microbicides, fungicides, nematicides and insecticides. Extracted Lantana oil is used as an ointment for the treatment of skin itches and an antiseptic for external wounds (UNEP 2013; UNEP 2006; SADC, IUCN, SARDC 2000).

Status of Biodiversity and Forests

Forest Biodiversity

The SADC Technical Committee on Forests and Woodlands defines forests as having a tree canopy cover of above 80 percent while woodlands have a canopy cover of between 10 and 80 percent (SADC/SARDC and others 2008). The Zambezi Basin has diverse forest ecosystems dominated by undifferentiated Miombo and Mopane woodlands and semi-arid shrubland (White 1983). These ecosystems are discussed in this section.

Undifferentiated woodlands consist of teak (Baikiaeaplurijuga) and acacia. Other associated commercial timber species *Pterocarpusangolensis* and *Guibour-*

tiacoleosperma. *Baikiaea*woodland areas are found on Kalahari sands in parts of Angola, Botswana, Namibia, Zambia and Zimbabwe. The woodland has a long history of management for commercial timber exploitation, wildlife utilization, cattle grazing and water catchment.

Miombo woodlands are the most extensive forest type in the Basin. Dominant tree species are *Brachystegiaspiciformis*, *Julbernardiaglobiflora* and *Isoberlinia* found in areas with over 700mm of annual rainfall and on nutrient-poor soils.

The dry Miombo is found in areas where rainfall is less than 1000mm per annum and tree canopy is less than 15 metres high. The dominant species are *Brachystegiaspiciformis, B. boehmii, Julbernardiaglobiflora, Parinaricuterfolia* and *Uapacakirkiana*.

The wet Miombo occurs in areas of more than 1000 mm per year and tree canopy exceeds 15 m in height. It is found in parts of Angola, the Democratic Republic of Congo, Malawi, Mozambique, Tanzania and Zambia. The dominant species are B. floribunda, B. longiflora, J. paniculata and Isoberlinia.

Miombo woodlands hold very little merchantable timber but have a wide range of non-timber forest products that include grass, caterpillars and medicinal plants. A significant proportion of the woodland has been converted into intensive and extensive agricultural areas hence it is difficult to locate pristine woodlands.

Table 4.8 **Some Uses of Plant Species from Mopane Woodland**

Botanical name	Common name	Local use
Acaciapolyacantha		
Sub. Camphlacantha	White thorn	Treating snakebite and gonorrhea
Adansoniadigitata	Baobab	Edible fruit
Anthericumpterocaulon		Leaves eaten as vegetables
Azanzagarckeana	African chewing gum, snot apple	Edible fruit
Cissusintegrifolia		Boiled leaves eaten as vegetables
Colophospermummopame	Mopane	House, bridge and tobacco barn construction, wood carvings, pestles and mortars, firewood, charcoal Powder from leaves is a cure for sores and wounds Leaves are fed to livestock House construction and wood carvings
Dalbergiamelanoxylon	African blackwood	
Dichrostachyscinerea	Sickle bush	Antidote to scorpion bite and snakebite
Sub. Africana	Smooth creeping milkweed	Fishing by poison, especially in stagnant water
Euphorbia inaequilatera	Savannah dwaba-berry	Stem used for weaving food stores
Friesodielsiaabovata	Guinea grass	Fruit is edible by humans and snakes Fed to livestock
Panicum maximum	Common rye	Grass commonly used as thatch for houses, stables
Setariapalustris	African star chestnut	Filtrate of burnt fruit used as potash for cooking
Sterculia Africana		Vegetables Seeds are roasted, pounded to powder and added to vegetables as substitute for groundnuts Bark is stripped for string fibre Oil is extracted from roasted seeds
Tamarindusindica	Tamarind	Edible fruit, wine production Fruit abundance is a drought indicator

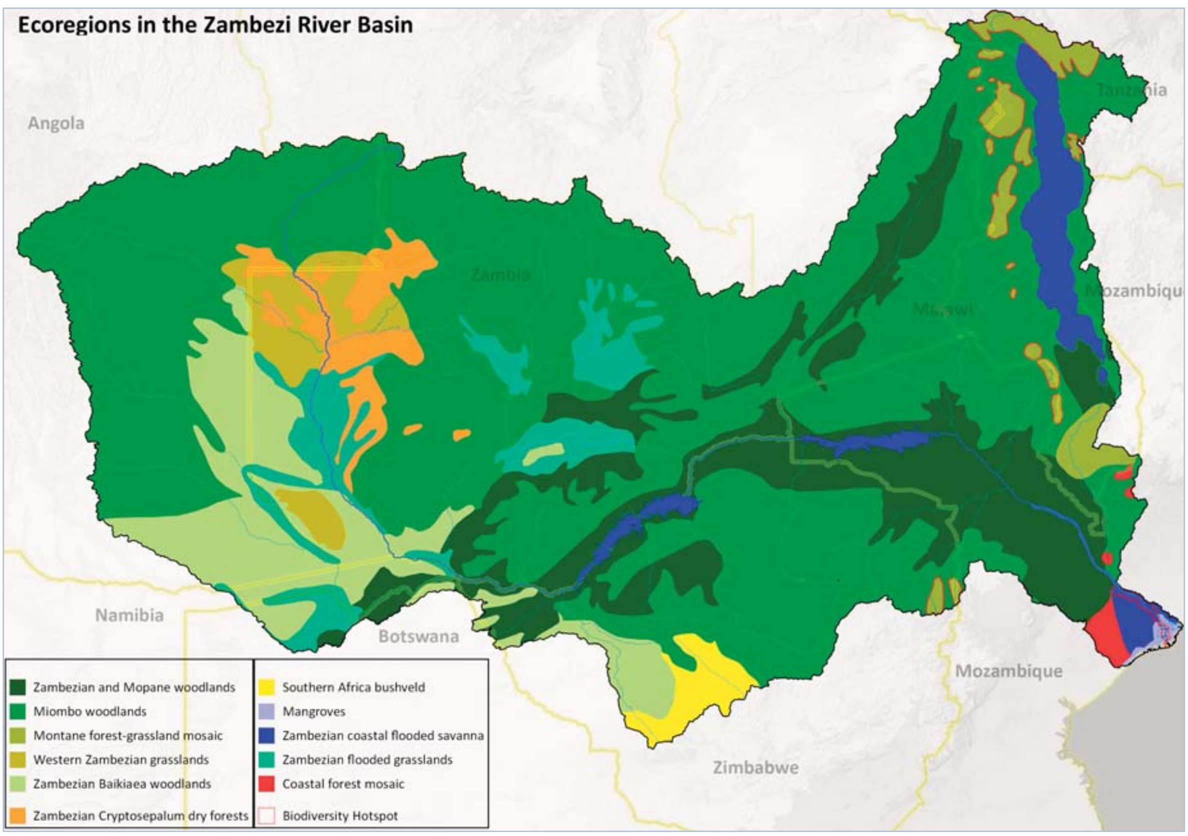
SADC, IUCN, SARDC. Biodiversity of Forests and Woodlands in Southern Africa 2000

Mopane woodland is mostly confined to lower lying areas with clay and nutrient rich soils. Mopane is found in parts of Angola, Botswana, Zimbabwe, Zambia, Malawi and Mozambique. Rainfall in these areas ranges from 400 mm to 700 mm per annum. The dominant tree is *Colophospermummopane*. The woodland assumes economic importance, especially as a source of browse for both domestic and wild animals. In addition, the tree's coppicing abilities render the woodland economically important for subsistence wood fuel, construction poles and mopane worms (caterpillars).

Semi-arid shrubland is found in the low rainfall areas. Due to water stress, it has a sparce tree canopy of 5-8 metres. Characteristic species of the wooded grassland include various *Acacia* (eg *Acaciaerioloba* and *A. tortilis*), *Terminaliasericea* and *Combretumcollinum* and *Ziziphusmucronata*. The shrubland is suitable for extensive livestock rearing and wildlife.

Forest cover information varies with source both within the riparian states and at regional level. Table 4.9 gives country-level forest cover statistics for the Basin, from the Food and Agriculture Organization (FAO) whose FAOSTAT is one of the most accurate sources of such information as it usually works closely with national agencies to acquire local data. The table shows that forests cover about 36 percent of the total land area of the Basin, ranging from 9.3 percent in Namibia to 56.2 percent in Zambia. Some 99.9 percent of the cover consists of natural forests and the remainder exotic plantations. The largest exotic timber plantation area is in Zimbabwe, followed by Angola, Malawi and Tanzania. Natural forests are being lost at rates ranging from

Map 4.1 **Eco-regions of the Zambezi Basin**



SARDC IMERCSA, I. Musokotwane Environment Resource Centre for Southern Africa, 2015

Table 4.9 **Forest Cover Information for Basin States**

Country	Total land area (000 ha)	% forest cover	Area under exotic plantations in 2009 (000 ha)	% change in annual forest cover
Angola	124 700	56.0	140.0	
Botswana	58 200	20.2	1.0	-0.2
Malawi	11 800	29.6	93.0	-0.9
Mozambique	79 900	31.7?	50.0	-2.2
Namibia	82 400	9.3	0.4	-0.2
Tanzania	94 500	37.4	81.0	-0.8
Zambia	75 300	56.2	75.0	-0.2
Zimbabwe	39 000	45.3	141.0	-2.1
Total	565 800	35.7	581.4	-1.4

FAO 2005; FAO 2006; FAO 2007

0.2 percent per year in Angola, Mozambique and Tanzania to 2.2 percent per year in Malawi. Such losses reduce ecosystem goods and services and translate into missed economic opportunities for both present and future generations.

At the species level, there has been a marked decrease in the abundance of certain plants due to various human-induced pressures. For example, the over-reliance on traditional medicinal plants for primary health care by the majority of the Basin's inhabitants has contributed to the overexploitation of species such as *Walburgiasalutaris* in Zimbabwe and *Albiziabrevifolia* in Namibia. *W. salutaris* is considered endangered under the IUCN Red Data List (Hilton and others 1998).

The commercialization of crafts such baskets and wood curios has led to the decline in tree species such as *Berchemiadiscolor*, which is used as a palm leaf dye in Botswana and Namibia. There has also been overharvesting of *Afzeliaquanzensis* and *Pterocarpusangolensis* in a number of countries in response to the flourishing woodcraft industry (Cunningham and others 2005).

The overexploitation of plant resources is a growing threat to biodiversity in the dry forest and woodland countries of sub-Saharan Africa. For example, of the 13 tree species on the Convention on International Trade in Endangered Species (CITES) list, about 90 percent of the threat comes from overexploitation and 10 percent from habitat loss (IUCN 2009).

Table 4.10 shows changes that took place on selected land-cover types of the Basin between 1990 and 2006. The greatest changes occurred to primary woodlands and wet grasslands that were reduced by 9.2 percent and 7.5 percent respectively. The greatest expansion was in rain-fed agriculture, mixed woodlands and settlement areas. The loss of vegetation cover contributes to biodiversity loss, increased runoff, soil erosion, decreased base flow and increased siltation of water bodies, and reduced tourism opportunities.

Forest tenure systems impact on access, use patterns and ecological sustainability of forests and woodlands throughout the region (SADC/SARDC and others 2008). The major forest tenure systems found in the region are state, private and communal forests.

Table 4.10 **Total Number of Endemic Plant Species in Basin Countries**

Country	Endemic
Angola	1260
Botswana	17
Malawi	49
Mozambique	219
Namibia	687
Tanzania	1122
Zambia	211
Zimbabwe	95

UNEP, Africa Environment Outlook 2, 2006

Table 4.11 **Land Use Change within the Zambezi Basin**

Land cover type	% change 1990-2000	% change 2000-2006
Primary woodland	-6.5	-2.7
Mixed woodland	+5.9	+2.5
Built up area	+5.7	+2.3
Rain-fed agriculture	+6.2	+3.4
Irrigated fields	+3.4	+0.9
Wet grasslands	-6.1	-1.4
Open grasslands	-4.2	-0.7
Deep water bodies	-2.0	-0.9
Rivers	-1.3	-0.1

WWF Southern Africa Regional Programme Office, 2007

However, the southern African region is characterised by a variety of land property rights and differential access to resources such as finance, technologies and administration of the land creating disproportionate use of forest resources (SADC, IUCN, SARDC 2000).

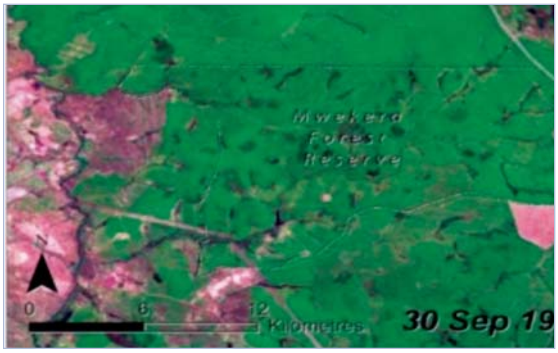
The highest rates of deforestation tend to be found in communal forest tenure systems although this can be attributed to high population densities in these areas as a result of colonial policies that independence governments inherited (SADC/SARDC and others 2008). The colonial legacy that created privately owned forests resulted in forest policies that focused more on plantations in order to meet the demands of the different specialised markets.

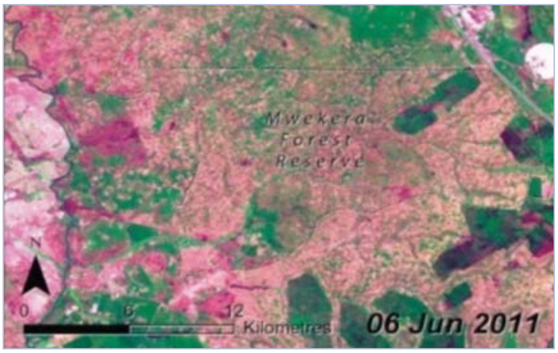
A number of Basin states such as Zimbabwe, Zambia, Malawi, Tanzania and Mozambique established exotic timber plantations to reduce pressure on indigenous/natural forests for various products and services. However, because of their fast growth rates, exotic timber species such as eucalyptus, pines and wattle take up more water than indigenous tree species. These forests caused the erosion of species diversity as indigenous trees were substituted with a monoculture of exotic tree species. This can disrupt microclimates and hydrological cycles of affected areas as well as downstream. Furthermore, some of the exotic timber species have become invasive and are adversely impacting on indigenous vegetation and other biodiversity in ways that are only starting to become clear. For example, the introduced trees on private and state plantations in the Nyanga mountains in Zimbabwe have invaded indigenous grasslands and even reduced the biodiversity of the surrounding forest reserves. Such impacts are likely to increase in severity in coming years due to climate change (SADC, IUCN, SARDC 2000; Masters and others 2004).

Wildlife Biodiversity

The Zambezi Basin is rich in wildlife, fish, plants and insects found in terrestrial, freshwater and marine ecosystems. Species such as Lake Malawi's cichlids and the Mulanje cedar are endemic to the Basin. The concentration of wild mammals in the Basin is spectacular, with some 200 mammal species

Loss of Forest in Mwekera Forest Reserve, Zambia





SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Box 4.2 **DIFFERENT FOREST TENURE SYSTEMS**

State Forests

These are reserved areas, including gazetted forest reserves, game reserves and national parks, managed by governments for environmental protection, conservation of biodiversity, water catchment functions, wildlife reservoirs, commercial exploitation of natural timber, and for aesthetic value.

Communal Forests

Communal forest areas provide open access to communities that reside in them. The communities usually manage the areas through communal user rights and traditional rules. The essential features of communal property regimes are common interests, common cultural norms, indigenous authority systems and some interaction among community members. In many communities, leaders such as the chiefs and kraal heads can allocate user rights on portions of lands although being guided by the traditional rules. Once these rules are established access to forests and forest-use practices are determined. These rules determine which type of trees can be cut, methods of harvesting fruits and tree by-products and access to sacred groves, wetlands or mountains. Women in the local community are a critical element in the management and use of communal forests and are a reservoir of knowledge about the surrounding forests.

Private Forests

Private forests occur in areas with freehold tenure systems that are characterised by individual land ownership. The registered landowner has exclusive property rights and full control and responsibility over the land and everything attached to it except to the extent that statutory provisions may limit ownership and exclusive control over the land and some natural resources. In most Basin countries, the state is the owner of all land and leases out land to private owners. This was exemplified when some private forests were targeted for land redistribution programmes in Mozambique, Namibia and Zimbabwe, most recently during the decade post-2000.

SADC, IUCN, SARDC. Biodiversity of Indigenous Forests and Woodlands in Southern Africa, 2000; SADC/SARDC and others, Southern Africa Environment Outlook, 2008

(SADC/SARDC Chenje 2000). Some of these species such as the Colobus monkey, Samango monkey and Blue duiker are restricted to moist forests in the eastern parts of the Basin. The Black lechwe is endemic to the Lake Bangweulu in northern Zambia.

The diverse and unique collection of the basin's eco-regions and landscapes makes it an important area for the global conservation of mammals and carnivores (Purchase and others 2007). Compared to East Africa there is a preponderance of browsers rather than grazers as the Basin is mostly woody. Large herbivores such as buffalo, kudu, zebra and antelopes are present in large numbers, and between 200,000 and 250,000 elephants are supported throughout southern Africa (SADC/SARDC and others 2008). The Zambezi Basin also has important carnivore species such as the African wild dog, Cheetah, Lion, Leopard, Spotted hyena and many other smaller carnivores.

Bird species in the Basin are well recorded. Of the 700 known species of birds, 15-20 are endemic to the Basin including the Black-cheeked lovebird and the Slaty egret. A good number of mammal and bird species are confined to montane areas or are inextricably connected to wetlands indicating the ecological importance of such eco-regions.

More than 500 endemic species of fish (mostly cichlids) have been recorded in Lake Malawi/Niassa/Nyasa. Forty-two percent of those are found only in the Upper Zambezi while 36 percent are found only in the Middle to Lower Zambezi, and the rest can be found throughout. The distribution of fish species has been altered by the construction of dams including the Kariba and Cahora Bassa reservoirs. Fish that normally inhabit the slower flowing water found in the upper portions of the Basin are now resident in the Kariba and Cahora Bassa lakes (Timberlake 1998). Throughout southern Africa and especially in the Basin, fish are used for subsistence and commercial purposes and contribute significantly to the socio-economic development of the region (SADC 2006).

Knowledge of reptiles and amphibians in the Zambezi River Basin is comparatively good, and earlier studies have recorded 200 species of reptiles and 90 species of amphibians (SADC/SARDC Chenje 2000). Species include the Nile Crocodile, which is the largest reptile found in numerous in low-altitude perennial rivers and forms the basis of a commercial industry (Timberlake and Chidumayo 2011). Recent studies have shown endemism in the Barotseland region (five endemic reptiles and two endemic frogs) and high levels of diversity in Hwange National Park with 81 species of reptile and 25 amphibian species (Timberlake and Chidumayo 2011). The Zambia/Namibia border west of Katima Mulilo has very rich fossorial reptile fauna, including six species of amphisbaenians, probably the largest number of sympatric species recorded worldwide (Timberlake and Childes 2004).

All of the species in the lizard genus *Cordylus,* including the Monitor lizard genus *Varanus* and the *Python natalensis* found in KAZA-TFCA are listed on CITES Appendix 2, meaning that trade of such species must be controlled to prevent extinction (Timberlake and Childes 2004). Reptiles and amphibians are sensitive to environmental changes. Global warming that brings erratic rainfalls and higher temperatures will restrict the ranges of species and affect breeding. In the wetlands of Namibia's eastern region (former Caprivi), human activities such as burning of the dry swamps which alters the Linyati/Chobe river flows and overgrazing of cattle destroy important habitats, adding more threats to the survival of the species (Timberlake and Childes 2004).

Invertebrate species of special social and economic interest are the most commonly recorded in the Basin, in-

Table 4.12 **Endemic Mammals and Birds in Basin Countries**

Country	Mammals	Birds
Angola	7	12
Botswana	0	1
Mozambique	2	0
Tanzania	15	24
Zambia	3	2

UNEP, Africa Environment Outlook 2, 2006

Table 4.13 **Some Amphibian and Reptile Species**

Species	Status
Barotse Water Snake (Crotaphopeltisbarotseensis)	A small back-fanged snake that seems to be restricted to papyrus and Phragmitesswamps of the Palaeo-Upper Zambezi system. Its status seems secure unless any way of removing papyrus on a large scale is developed.
Kafue Reed Frog (Hyperoliuspyrrhodictyon)	This is a frog endemic to the Kafue Flats and environs that could be at risk during the tadpole stage due to pollution from agricultural fertilisers and insecticides.
Southern African Python (Pythonnatalensis)	Africa's second largest snake ranging from east to southern Africa, it is frequently killed by people and has been locally exterminated in some areas. The python is most common in waterside habitats, where it can ambush waterfowl and mammals coming to drink.

Timberlake and Chidumayo 2011; Timberlake and Childes 2004

cluding agricultural pests (army worm), parasitic or vectors of diseases (mosquitoes, tsetse flies), edible (*amacimbi/madora*) and charismatic insects (butterflies, dragonflies). The full number of existing species is unknown but is most likely to be in the thousands. For example, a study in the Namibian wetlands recorded just over 800 species of macro-invertebrates. Invertebrates are responsible for much of the nutrient cycling in aquatic ecosystems and form the basis for complex food chain systems that fish and other larger aquatic species depend on (Timberlake and Childes 2004).

Edible insects are a highly nutritional alternative source of protein for local people. Throughout the Basin caterpillars harvested from forests are consumed or sold in the market thereby supporting livelihoods. The most common species of *amacimbi/madora* (Mopane worm) feed on mopane leaves and are usually collected by women or children. Caterpillar harvesting can have devastating effects if not accompanied by sustainable practices that leave the trees intact and maintain healthy populations of the mopane caterpillar species. In Zimbabwe, soldier termites are roasted and used to snack on as an important source of protein (SADC, IUCN and SARDC 2000).

Bees are an essential part of the environment because they pollinate plants and crops, and are sources of honey and wax. The rearing of bees (apiculture) is a traditional occupation throughout the miombo zone (SADC, IUCN and SARDC 2000). Important nectar-producing *genera* include *Acacia, Brachytsegia, Julbernardia, Syzgium* and *Combretum* (SADC, IUCN and SARDC 2000). In some communities such as in the Eastern Highlands of Zimbabwe, this is used as a tool for community development because products from the bees increase sources of household income. In some areas com-

Table 4.14 **Nutritional Value of Mopane Caterpillar Compared to Other Foods**

Species	Energy Content (calories)	Protein (g)	Fat (g)	Carbohydrates (g)	Calcium (g)
Caterpillar	444	56.8	16.4	13.8	458
Cooked Beef	172	22.6	8.0	0	16
Raw Chicken	146	20.5	6.5	0	10
Whole Milk (cow)	79	3.8	4.8	5.4	95
Whole Milk (goat)	85	3.4	4.9	7.0	-

SADC, IUCN, SARDC. Biodiversity of Forests and Woodlands in Southern Africa, 2000 munities collect wild honey or construct beehives which are then placed in surrounding forests. This curbs rates of deforestation as the communities are engaged in protecting the forests for the production of honey. Ownership of beehives in natural forests also gives a sense of ownership and stewardship of the forests themselves, hence activities that threaten the forests will be seen as a threat to potential income.

Table 4.15 **Insects that Produce Commercial or Edible Products**

	Species	Product
Honey bee	Apismellifera	Honey and wax
Common stingless bee	Trigonabeccariigribodo	Honey in mopane woodlands
Common stingless bee	Trigonabeccarii	Honey underground
African wild silk moth	Gonometa	Wild Silk

Feresu, 2010

Wildlife resources in the Basin are under tremendous pressure from a variety of sources that include habitat loss, poaching and invasive alien species; and some species have become extinct in recent times. These include the blue wildebeest (*Connochaetestaurinus*) in Malawi (probably wiped out by rinderpest), the Tsessebe antelopes (*Damaliscuslunatus*) in Mozambique and the Kob (*Kobus kob*) in Tanzania (SADC and SARDC 2008). Other species face a high risk of extinction, and the number of threatened or endangered species across the Basin continues to rise (Table 4.16).

In terms of extinction, the blue antelope and the quagga are the only mammalian species known to have become extinct in the region in recent times. On the other hand, the population of a few wildlife species such as the elephant have increased or stabilized, in partial response to trade restrictions imposed by CITES and the manipulation of water points in protected areas (SADC 2006). In Angola the overall number of threatened species spiked after the end of civil

Table 4.16 **Threatened Animal Species in Zambezi River Basin Countries**

	Mammals				Birds				Reptiles				Amphibians			
	2000	2003	2008	2014	2000	2003	2008	2014	2000	2003	2008	2014	2000	2003	2008	2014
Angola	18	19	14	15	15	15	18	24	4	4	4	4	0	0	0	0
Botswana	5	7	6	7	7	7	7	10	0	0	0	0	0	0	0	0
Malawi	8	8	6	8	11	11	12	16	0	0	0	1	0	0	5	5
Mozambique	15	15	11	12	16	16	21	27	5	5	5	8	0	0	3	3
Namibia	14	14	11	12	9	11	21	25	1	3	4	1	1	1	1	27
Tanzania	43	41	34	36	33	33	40	42	5	5	5	19	0	0	49	58
Zambia	12	11	8	10	11	11	12	16	0	0	0	1	0	0	1	1
Zimbabwe	12	11	8	9	10	10	11	14	0	0	0	3	0	0	6	6

	Fishes				Molluscs				Other Invertebrates			
	2000	2003	2008	2014	2000	2003	2008	2014	2000	2003	2008	2014
Angola	0	N/A	22	40	15	15	18	24	4	4	4	4
Botswana	0	N/A	2	2	7	7	7	10	0	0	0	0
Malawi	0	N/A	101	102	11	11	12	16	0	0	0	1
Mozambique	3	N/A	45	54	16	16	21	27	5	5	5	8
Namibia	3	N/A	21	27	9	11	21	25	1	3	4	1
Tanzania	15	N/A	138	175	33	33	40	42	5	5	5	19
Zambia	0	N/A	10	20	11	11	12	16	0	0	0	1
Zimbabwe	0	N/A	3	3	10	10	11	14	0	0	0	3

Note: changes in number do not necessarily mean improvement or decline of species status as more species are being recorded and observed. This table excludes species that are extinct and species which still need to be assessed.

IUCN 2014; SADC/SARDC and others 2008; UNEP 2002; Vié, Hilton-Taylor and Stuart 2009.

Table 4.17 **Total Number of Threatened Species including Plant Species**

	2000	2003	2008
Angola	62	71	89
Botswana	12	31	15
Malawi	41	41	154
Mozambique	82	108	189
Namibia	34	46	82
Tanzania	379	390	589
Zambia	37	36	43
Zimbabwe	38	40	49

IUCN 2014; SADC/SARDC and others 2008; UNEP 2002; Vié, Hilton-Taylor and Stuart 2009

Box 4.3 **WILDLIFE SPECIES IN THE BASIN WITH HIGH RISK OF EXTINCTION**

White Rhinoceros (*Ceratotherium simum*) and Black Rhinoceros (*Diceros bicornis*)
Critically close to disappearing altogether, although decisive conservation action is allowing some populations to revive

Wattled Crane (*Bugeranus carunculatus*)
Endangered partly due to controlled flooding in the Kafue Flats which has reduced its nesting sites

African Wild Dog (Lycaon pictus)
Endangered and only found in large protected areas

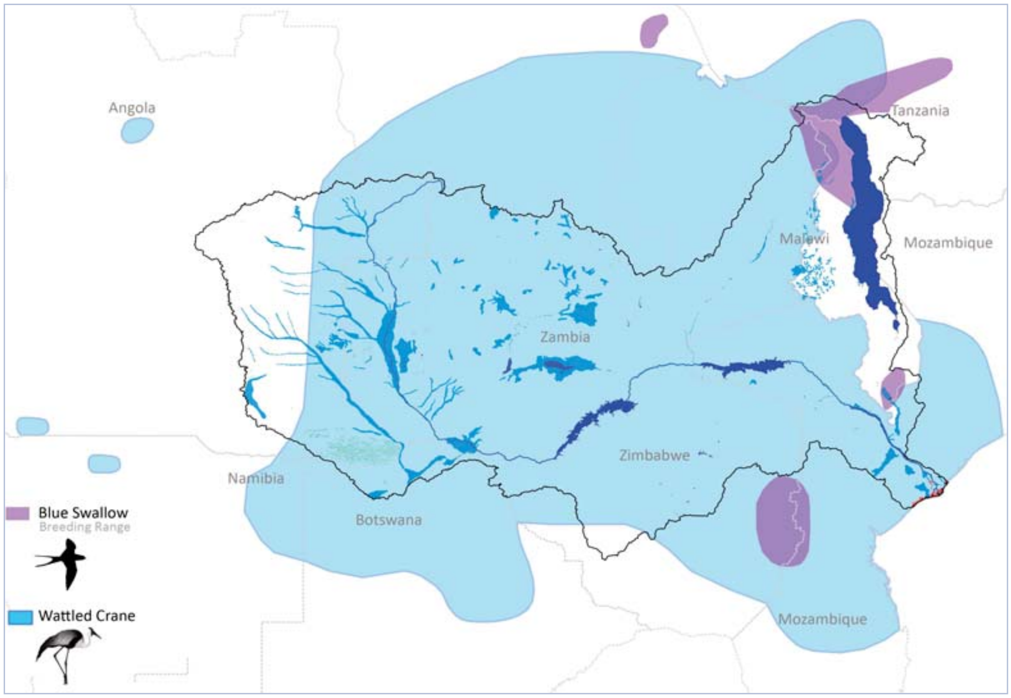
SADC/SARDC and others 2008

unrest as areas became more accessible and counts resumed (SADC/SARDC and others 2012).

The fast growing economies of Mozambique and Angola has seen development activities in many parts of the country. However, these activities may not always be compatible with biodiversity conservation which often is not integrated into development planning due to a lack of information. The big increases in the number of threatened species in Mozambique, Tanzania and Malawi, for example, are revealed due to more studies and assessments being done (SADC/SARDC and others 2012).

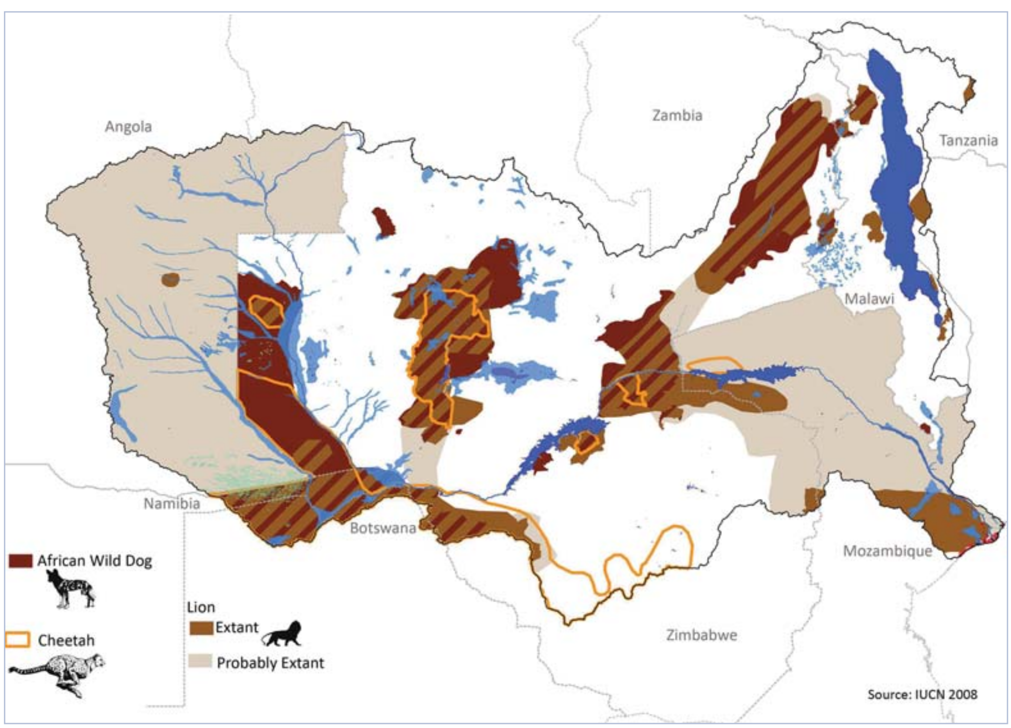
The diversity and populations of fish species in major water bodies in the Basin are declining due to overfishing, water pollution, drying of water bodies and the introduction of invasive alien species of fish (SADC 2006). In Tanzania the main centres of threatened fish species are within Lake Victoria and Lake Malawi/Niassa/Nyasa due to combined impacts of invasive species, eutrophication and overfishing (SADC/SARDC and others 2012). Figure 4.1 shows a steady decrease in the fish catch on Lake Kariba which has been largely attributed to overfishing.

Map 4.2 **Extent of the Wattled Crane and Blue Swallow in the Zambezi River Basin**

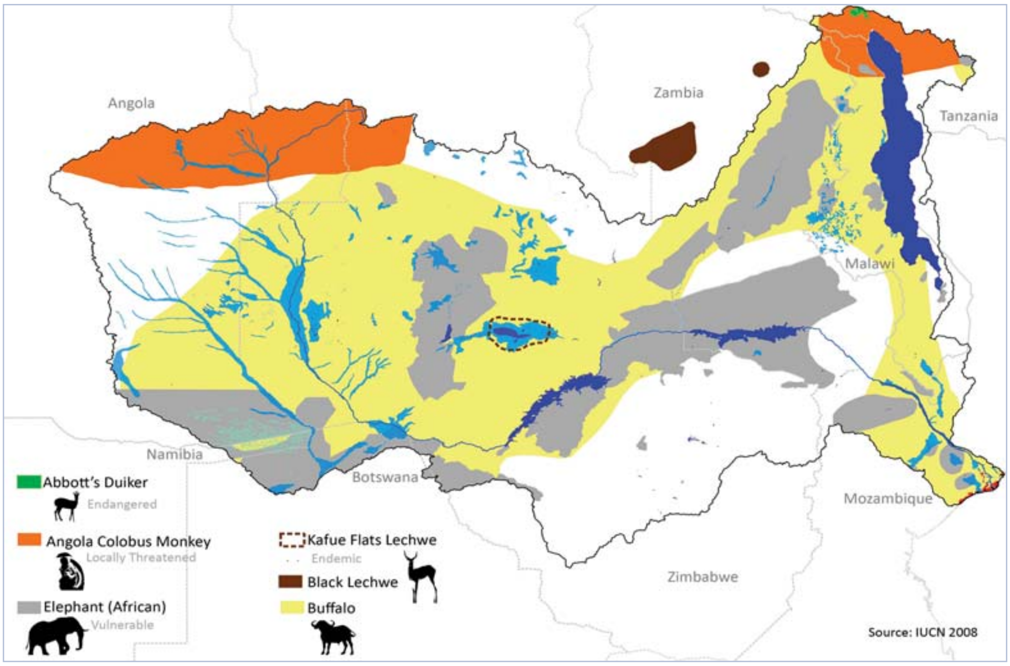


SARDC I. Musokotwane Environment Resource Centre for Southern Africa, 2015

Map 4.3 **The Range of Top Predators (Lions, Cheetahs and African Wild Dog) in the Zambezi River Basin**

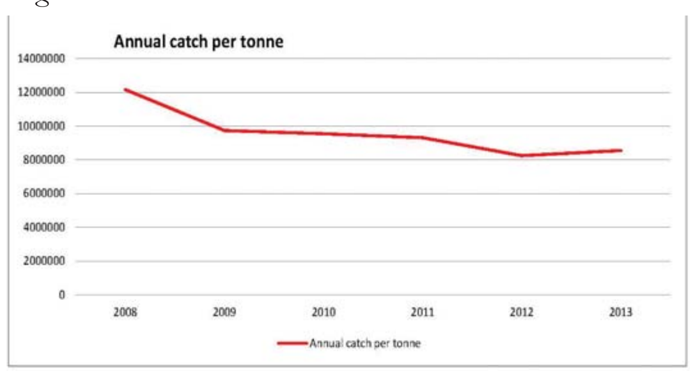


Map 4.4 **Range of Selected Herbivores in the Zambezi River Basin**



Box 4.4 gives a detailed account of how the crayfish, an invasive species, has spread in Lake Kariba over the years and threatens the fishing industry as it feeds on other fish species.

Figure 4.1 **Trends in Fish Catch on Lake Kariba**



SADC/SARDC and others 2012; SADC 2013

Agro-Biodiversity

The Zambezi Basin's tropical location coupled with variations in altitude, rainfall, and evaporation makes it suitable for the production of agricultural products found in most parts of the world. However, agro-genetic diversity is generally higher in traditional than commercial farming systems (ECZ, 2008). Furthermore, there is a continuous erosion of traditional agro-germplasm partly due to the following:

- The gradual commercialization of agricultural production by the Basin's smallholder farmers who were hitherto subsistence farmers; and,
- Urbanization and the emergence of a middle class with a preference for more refined and affluent foods.

Women in the Basin, as in other regions, are key players in the management of biological resources as their role as food producers and providers links women directly to the conservation and sustainable utilization of genetic resources for food and agriculture.

Responses to Biodiversity and Forest Loss

A number of measures have been put in place or are being considered to address biodiversity and forest loss in the Basin. These include community par-

Box 4.4 INVASIVE AUSTRALIAN CRAYFISH SPREADING FAST IN LAKE KARIBA

An invasive Australian crayfish is spreading and multiplying in the Lake Kariba waters at a faster rate than previously thought, according to a recent study titled "Invasive Australian crayfish *Cheraxquadricarinatus* in the Sanyati Basin of Lake Kariba: A preliminary survey". The study indicates that the invasive predator is has also been found in the Bumi Basin, about 80 kilometres to the west.

It is reported that the red claw Australian crayfish introduced into the lake after escaping from fish farms in Zambia in 2002 could be inflicting more damage than previously thought, as it hunts shoals of the small Tanzania sardines commonly known as Kapenta, a dominant source of fish protein in Zimbabwe. Crayfish eat almost anything, including plants, invertebrates, snails, small fish, fish eggs and even its own offspring.

The alien species have been breeding out of control, devouring food sources of all fish breeds, including bream, whose population has also been extensively decimated. Over the past 10 years, it has outpaced other aquatic populations, knocking out weaker species and piling pressure on the delicate ecosystem, which has to adapt to its new aggressive occupiers that have no natural predators. Even crocodiles do not eat crayfish. Ecologists are worried that the alien omnivore could have spread into other dams across Zimbabwe and migrate downstream of Lake Kariba where they could destroy fisheries.

The report says the possible introduction of this species into other Zimbabwean waters is a matter of concern as there are already unconfirmed reports that it has been introduced into other waters in the country. The potential to migrate downstream from Lake Kariba into the Zambezi River is also of major concern, as it may spread further in the region.

The exploding population could destabilise the reservoir's decades-old ecosystem, as it is a highly invasive species that can alter the ecosystem structure and processes of invaded waters. According to reports, the Parks and Wildlife Management Authority of Zimbabwe said that kapenta output plunged to 8,746 tonnes in 2013 from 19,957 tonnes in 1993.

www.financialgazette.co.zw; African Journal of Aquatic Science,Volume 39, Issue 2, 2014

ticipation in natural resource management, enhancing community level incentives, rewarding local communities for their indigenous knowledge on natural resources, establishing protected areas and Transfrontier Conservation Areas (TFCAs), signing Multilateral Environmental Agreements (MEAs), and policy interventions aimed at slowing down drivers of biodiversity and forest loss.

Community Participation in Natural Resource Management

For more than two decades, some Basin states have been implementing strategies that support human livelihoods through the sustainable use of biological resources within the context of Community Based Natural Resource Management (CBNRM). CBNRM is an incentive-based conservation and development model that is adaptively implemented by and for people who live with and directly depend on biological resources and who therefore have the greatest impact on such resources. In this model, communities are given rights of access to resources from the wild and legal entitlements to benefits that accrue from using the resources in order to create positive social and economic incentives for people to invest their time and energy in natural resource conservation. The success of this approach has largely depended on the level of devolution, donor commitment, policy changes and links to tourism and hunt-

ing. The key economic driver of CBNRM has been wildlife (large mammals), mostly through hunting and photographic safaris. Box 4.5 highlights Zimbabwe's experience with CBNRM.

Community Level Incentives for Sustainable Biodiversity Management

The SADC Regional Biodiversity Strategy identifies value addition and the commercialization of biological resources as necessary for such resources to effectively contribute to the region's socio-economic development (SADC 2006). Most biological resources of the Zambezi Basin have low economic value in their natural state and thus local communities derive very little economic value from them. They are consumed or sold in raw or semi-processed form at source. The bulk of

Box 4.5 **ZIMBABWE'S EXPERIENCE WITH THE CAMPFIRE MODEL**

The Community Areas Management Programme for Indigenous Resources (CAMPFIRE) is a community management model that enables communities to benefit from wildlife hunting revenue streams in their areas. Part of the money has traditionally been used to build schools, clinics and roads in targeted areas by the respective Rural District Councils. This created positive social and economic incentives for communities to invest their energy in natural resource conservation.

Under the programme, wildlife-producing wards in 53 of the country's 57 districts contributed 56,135 sq km of land towards formal wildlife management, thus expanding the wildlife range. This is equivalent to 12.5 percent of the country's total land area and held about 12,000 elephants and 14,000 buffalo in 2003 (Child and others 2003).

Unfortunately, the effectiveness of CAMPFIRE declined significantly in the late 2000s due to the prevalence of adverse socio-economic conditions that contributed to the loss of wildlife habitat, increases in human and wildlife conflict and unprecedented wildlife poaching. However, opportunities for reviving the programme and improving livelihoods of thousands of rural households now exist in the country.

Equally important is the need to ensure that both men and women equally benefit from these programmes. Research done in Masoka area revealed that the opportunities created by CAMPFIRE benefited more men than women. Of the total CAMPFIRE-related jobs in the area comprising almost 80 percent of wage employment, only three percent of these were taken up by women (Nabane 1995).

the resultant benefits accrue to outsiders such as local traders and developed countries who add value to them through further processing and packaging. Consequently, some CBNRM initiatives focusing on resources such as veldt products have had limited success partly because communities see little benefit in their continued participation in such projects due to relatively low returns. Nevertheless, CBNRM experiences in southern Africa have influenced global thinking on sustainable use.

There is growing interest in adding value to and commercializing biological resources. For example, the Southern African Natural Products Association (Phyto Trade Africa) developed commercial opportunities from natural products derived from indigenous plants. This was done through investment in research and market development, and facilitating linkages between rural producers and private sector processors and manufacturers. Phyto Trade Africa leveraged significant private sector investment in research and development of these resources, one of the few cases in which favourable conditions for private sector investment have been created and should continue to be promoted (SADC 2006).

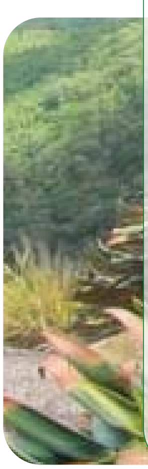
Another example is research and development work on the lesser known timber species. Commercial natural hardwood timber species in the Basin are largely confined to teak wood. Other forest ecosystems in the Basin such as the vast Miombo woodland have very limited merchantable timber species as the physical and mechanical properties and uses are little known. Research and development work on some of these tree species has shown promising results (Box 4.6). The success of such an initiative could reduce pressure on indigenous timber species currently harvested unsustainably.

Rewarding Local Communities for Indigenous Knowledge

Zambezi Basin states continue to confront bio-piracy. Multinational corporations, research institutions and others have taken out patents on active ingredients of plant and animal species, some of which are based on indigenous uses of these biological resources, with little or no economic benefits accruing to the Basin and its people. This is partly because:

- the global and national intellectual property systems do not recognize and legally protect traditional knowledge as it has not been properly documented; and,

Box 4.6 **RESEARCH AND DEVELOPMENT OF LESSER KNOWN TREE SPECIES IN MOZAMBIQUE**



Efforts have been made to market lesser known timber species in Mozambique. For example, *Brachystegiaspiciformis* was introduced to the European market for parquet strips for floors. Although *Combretumimberbe* has been considered a secondary species with low commercial value, it was recently exported to China as logs. This was followed by a log export ban because of unsustainable harvesting, but demonstrates the potential value of lesser known species if properly managed.

With respect to other products, strong boards of *B. spiciformis* mixed with *Pinuspatula* have been produced at a laboratory scale. The technical feasibility of using some Mozambican secondary species to manufacture wood cement composites was also assessed. This study resulted in the identification of species such as *B. spiciformis*, and *B. bohemii* that are compatible with cement without requiring any treatment.

Sitoe and others 2010

- some countries do not have inadequate institutional capacity to effectively regulate access to genetic resources and equitable sharing of benefits (SADC 2006).

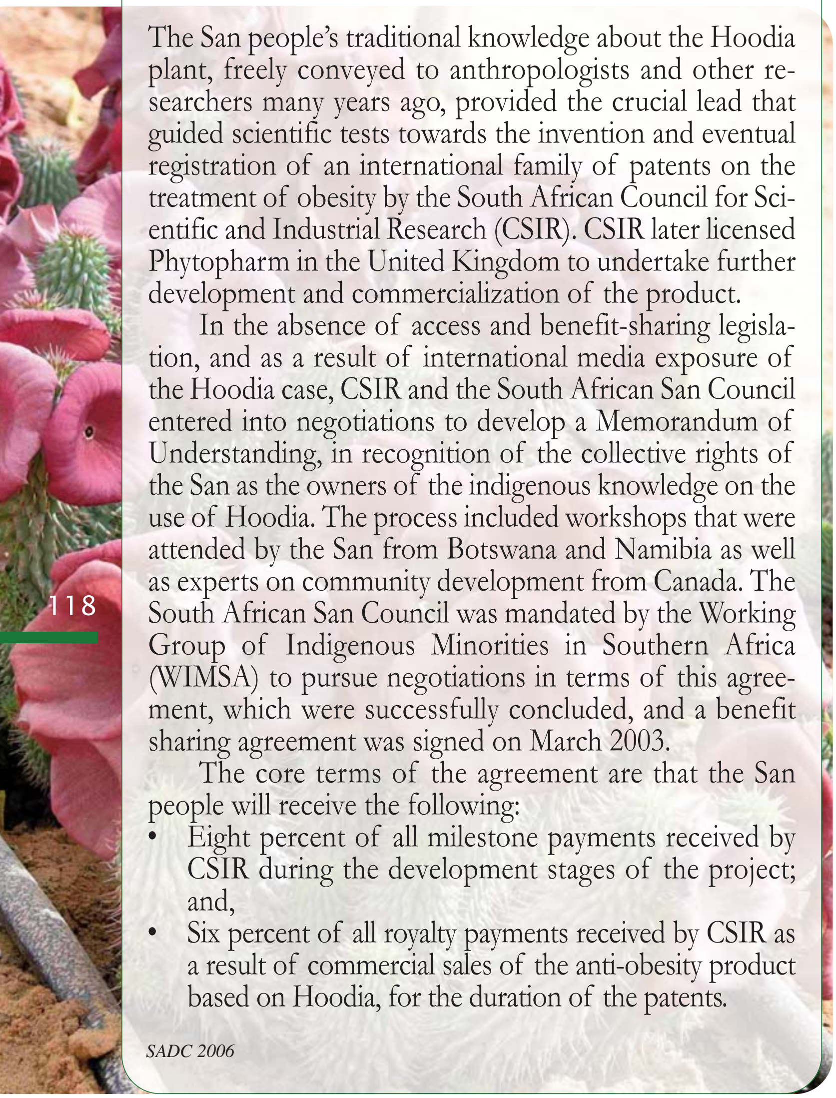
Therefore, SADC has fully supported the need for a legally binding international instrument on Access and Benefit Sharing (ABS) that would regulate access to genetic resources, their products and derivatives, as well as protect the knowledge, innovations and practices of local communities. This was discussed at the Eighth Conference of Parties of the Convention on Biological Diversity (CBD) held in Brazil in 2006 (SADC 2006). The instrument would recognize traditional knowledge and appropriately reward its holders when it is exploited for commercial gain by outside parties. Although, there was no consensus on the instrument and it is not yet established, it is considered to be work in progress with a long term process.

According to Article 15.1 of the CBD, provisions related to ABS in a legally binding international instrument cannot be a substitute for national legislation on ABS in countries of origin of genetic resources but should serve as a means to reinforce the implementation of such laws. In addition, an international regime must recognize the sovereignty of states to determine access to genetic resources. It is therefore important to agree on conditions and measures to guarantee that national regimes on ABS are observed in countries using those resources, and that the rights of countries of origin of the genetic resources are respected.

Most Basin states have no effective national legislation and institutional arrangements to regulate access to genetic resources and ensure equitable benefit sharing. In addition, there is no regional legal mechanism on ABS to underpin national legislation. This is important given that a number of biological resources and their associated traditional knowledge transcend national boundaries. Thus, without a coordinated regional approach, Basin states risk marginalizing countries and/or communities in the exploitation of trans-boundary genetic resources when competing for bio prospecting and biotrade investments (SADC 2006).

Some Basin states are using elements of the Bonn Guidelines such as Prior Informed Consent (PIC) and Mutually Agreed Terms (MAT) to negotiate Material Transfer Agreements (MTA) with outside parties. However, this has had limited success as the guidelines are not legally binding. Some countries are also regulating access to their biological resources and sharing associated benefits through specific ABS agreements, albeit on an opportunistic basis.

This is illustrated by the case of the leafless spiny succulent plant, *Hoodia gordonni*, with appetite suppressant qualities. The discussion of this plant arose during a debate on bio-prospecting and intellectual property rights (Box 4.7). Although not perfect, the Hoodia Benefit Sharing Agreement reached between the South African Council for Scientific and Industrial Research (CSIR) and the San people (collective owners of the indigenous knowledge on the plant) provides useful insights into the development and implementation of ABS legislation in the Basin and beyond. This highlights the need for strong national and regional legislation and institutional frameworks on ABS to underpin such agreements (SADC 2006).



Box 4.7 **THE HOODIA SUCCULENT PLANT AND THE SAN PEOPLE**

The San people's traditional knowledge about the Hoodia plant, freely conveyed to anthropologists and other researchers many years ago, provided the crucial lead that guided scientific tests towards the invention and eventual registration of an international family of patents on the treatment of obesity by the South African Council for Scientific and Industrial Research (CSIR). CSIR later licensed Phytopharm in the United Kingdom to undertake further development and commercialization of the product.

In the absence of access and benefit-sharing legislation, and as a result of international media exposure of the Hoodia case, CSIR and the South African San Council entered into negotiations to develop a Memorandum of Understanding, in recognition of the collective rights of the San as the owners of the indigenous knowledge on the use of Hoodia. The process included workshops that were attended by the San from Botswana and Namibia as well as experts on community development from Canada. The South African San Council was mandated by the Working Group of Indigenous Minorities in Southern Africa (WIMSA) to pursue negotiations in terms of this agreement, which were successfully concluded, and a benefit sharing agreement was signed on March 2003.

The core terms of the agreement are that the San people will receive the following:

- Eight percent of all milestone payments received by CSIR during the development stages of the project; and,
- Six percent of all royalty payments received by CSIR as a result of commercial sales of the anti-obesity product based on Hoodia, for the duration of the patents.

SADC 2006

Protected Areas and TFCAs

Protected Areas

Basin states have set aside some 18 percent of their total land area as protected areas consisting of gazetted forests and national parks. Protected areas are rich in biodiversity; provide habitat for endangered species of flora and fauna, such as the crowned crane and bearded vulture, and thus play an important role in the *in situ* conservation of a wide range of genetic resources.

More than 70 percent of the protected areas lie across international boundaries, thus providing opportunities for initiatives on the management of transboundary natural resource within the Basin. Most Basin states are close to achieving the Aichi 2020 Biodiversity Target of setting aside 17 percent of their land area for deliberate protection (CBD, undated). Angola proclaimed two new protected areas in 2011 — Mawinga and Luengue-Liuana (Lisboa 2013).

Regarding wetlands, Zimbabwe became a Party to the Ramsar Convention during the review period. Its accession came into force in May 2013 with seven sites being designated as wetlands of international importance (EMA 2014). Six of the sites fall within the Zambezi Basin and most of them are important for biodiversity conservation. Notwithstanding the foregoing developments, the total land area of the Zambezi Basin under protection has remained fairly stable since 2000. However, the effectiveness of park management across Basin states declined largely due to reduced government funding. For example, government funding for the protection and development of the national park estate in Zimbabwe fell from \$200/sq km in 1980 to less than \$10/sq km in 2009. A comparative figure for Kruger National Park in South Africa is \$2,000/sq km (Cumming 2009).

Transfrontier Conservation Areas

Transfrontier Conservation Areas (TFCAs) are protected areas where two or more countries participate in managing a shared conservation area. TFCAs are regarded as one of the anchors for regional economic integration, socio-economic development and poverty reduction through multi-destination and cross-border tourism (SADC/SARDC and others 2008), and there has been an increase in TFCA initiatives in the Basin in recent years. The Basin has six TFCAs that are at different stages of development, as shown in Table 4.19 and Map 4.4.

Table 4.18 **Extent of Protected Areas in the Zambezi Basin**

	Extent of protected areas in the Zambezi Basin (sq km)						
	1998	2000	2001	2002	2003	Country Size	% of Total
Angola	81 812	81 812	81 812	81 812	81 812	1 246 700	7
Botswana	104 988	10 4988	104 988	104 988	104 988	581 730	18
Malawi	10 585	10 585	10 585	10 585	10 585	118 484	9
Mozambique	66 020	66 020	67 300	67 300	67 300	802 000	8
Namibia	112 160	112 160	112 160	112 160	112 160	824 269	14
Tanzania	263 141	263 791	263 791	263 791	263 791	945 087	28
Zambia	236 919	236 919	236 919	236 919	236 921	752 614	31
Zimbabwe	46 504	46 504	46 504	46 504	46 504	390 759	12

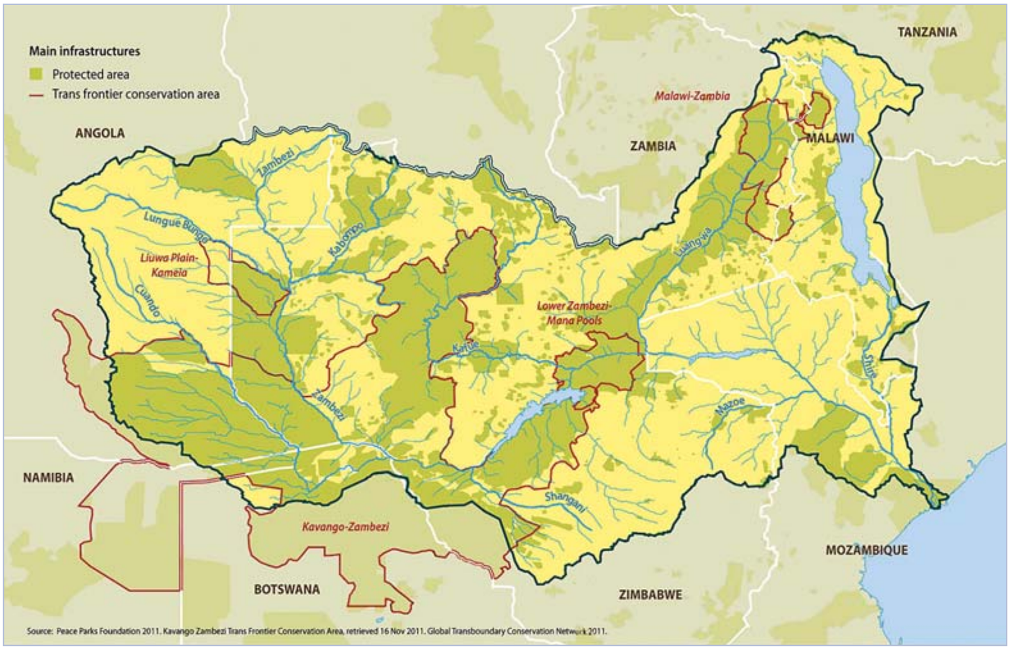
SADC/SARDC and others, Southern Africa Environment Outlook, 2008

Table 4.19 **Transfrontier Conservation Areas in the Zambezi Basin**

TFCA	Brief description
Kavango-Zambezi (KAZA). Angola, Botswana, Namibia, Zambia and Zimbabwe	Governments of Angola, Botswana, Namibia, Zambia and Zimbabwe signed an MOU establishing the TFCA in 2006. The TFCA covers 287,000 sq km which embrace 36 projected areas including national parks, game reserves, community conservancies and game management areas. One of its main objectives is to merge fragmented wildlife habitats into an interconnected mosaic of protected areas and trans-boundary wildlife corridors to facilitate and enhance free movement of wildlife across international boundaries. The area has at least 3,000 species of plants, 100 of which are endemic to the Basin, as well as more than 600 bird species.
ZIMOZA. Zimbabwe, Mozambique and Zambia	In 2009 an agreement was reached by tourism authorities in Zimbabwe, Mozambique and Zambia to establish the TFCA. The joint venture covers the management of the cultural heritage of local communities, hunting and fishing and wildlife conservation.
Selous-Niassa. Tanzania and Mozambique	This TFCA is still in the planning phase. It is intended to protect an extensive migration corridor for elephants in southern Tanzania and northern Mozambique. The TFCA will cover the Selous Game Reserve in Tanzania (47,000 sq km) and Niassa Game Reserve in Mozambique (42,400 sq km).
Malawi /Zambia.	The TFCA includes the Nyika conservation area and the Kasungu/Lukusuzi. It is famous for wild flowers and orchids, especially during summer.
Lower Zambezi-Mana Pools. Zambia and Zimbabwe	The TFCA is still at the planning stage between Zambia and Zimbabwe. It lies in the Zambezi valley and has long been used by wildlife as a thoroughfare between the Zambezi escarpment and the Zambezi river. The two national conservation areas lying opposite each other will combine to create a massive wildlife sanctuary on both sides of the Zambezi river.
Liuwa Plan-Mussuma. Angola and Zambia	The TFCA is between Angola and Zambia. It projects the third largest migratory population of blue wildebeest in Africa. Massive herds of wildebeest migrate from Zambia to Angola and back, traversing the plains in their thousands and mingling with zebras on migration.

SADC/SARDC and others, Southern Africa Environment Outlook, 2008; SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012; ZELA 2009

Map 4.5 **Zambezi Basin Transfrontier Conservation Areas**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Biodiversity Dynamics in the Basin

This section describes the African Wild Dog in the Kavango Zambezi Transfrontier Conservation Area; and the water hyacinth on Lake Chivero in Zimbabwe.

African Wild Dog in the Kavango Zambezi Transfrontier Conservation Area

The African Wild Dog (*Lycaonpictus*) is a predator and tourism asset of ecological and economic significance. Wild dogs live at low densities with an average home range of 400-800 sq km. They average two adults per 100 sq km and their behavioural ecology requires large landscapes for them to survive and prosper. African Wild Dog pack members are cooperative hunters of medium-sized antelope although they also take smaller and larger antelope. They are less abundant in situations of high prey density possibly because of their limited ability to compete with larger predators (Woodroffe, 2013).

Under normal circumstances only one female and one male breed within a pack (the basic unit of a wild dog population) and all pack members help to care for pups. Most young wild dogs leave the natal pack during their second year as single-sex groups. New packs form when opposite sex dispersal groups meet one another. Dispersal groups may travel hundreds of kilometres and sometimes show up as vagrants in countries or areas with no resident populations. Wild dogs are territorial and communicate their boundaries by scent, and range in response to the presence of neighbours/boundaries.

The global population of the African Wild Dog is in decline. It is listed as endangered in the IUCN Red List of threatened species (Woodroffe and others 2012) and its global population is estimated at less than 700 packs. Within Africa, the dogs are now restricted to the eastern and southern part of the continent. The KAZA TFCA is home to the world's largest wild dog population (about 24 percent) and offers unrivalled opportunities for wild dog conservation (Woodroffe 2013). Recent genetic work demonstrated connectivity across about 400 km of the TFCA which has the highest recorded genetic diversity of wild dogs and no evidence of inbreeding (Marsden and others 2012).

The African Wild Dog is under pressure from conservation and socio-economic related threats that include habitat fragmentation; human and wild dog conflict; road kills/mortalities; accidental trapping/snares; and diseases.

Major land use systems in the KAZA TFCA include: protected areas, private farms, communal areas and state land. Smallholder farmers on communal land practice subsistence agriculture in the form of crop and livestock production while private farms engage in commercial livestock ranching. Agricultural expansion has resulted in habitat fragmentation and increased contact between wild dogs and humans leading to human and wild dog conflict. As a result of the perception of this species as a threat to livestock, wild dogs are not tolerated by farmers. This is despite observations that they only regularly prey on livestock in situations where the latter is abundant and wild prey is scarce.

Table 4.20 **Incidents of Reported Livestock Loss by Predators in Three Districts of Botswana**

Predator	Ngamiland 2008-2011 (average %)	Central 2010-2011 (average %)	Kgalagadi 2005-2010 (average %)
Wild dog	20	15	20
Cheetah	2	5	2
Leopard	28	60	31
Lion	47	9	29
Jackal	1	0	7
Hyena	2	11	11

Dipotso 2013

Table 4.20 shows the proportion of predator and livestock cases reported in three districts of Botswana. Incidents of human and wild dog conflict were consistently high across the three districts compared to those attributed to other predators. This partially explains the retaliatory and sometimes indiscriminate killing of wild dogs by livestock farmers and the general negative perceptions towards wild dogs by the public. It is however worth noting that there could be some over-reporting of wild dog incidents at the expense of livestock kills by other predators such the jackal and hyena for which there is no government compensation. The need for independent confirmation of the predator in conflict reports received from farmers can therefore not be over emphasized (Dipotso 2013).

Snaring is a major problem for wild dog packs, especially in some game management areas of Zambia. For example, over 500 snares were found in the Luangwa Valley in 2011 (Sichone 2013). Diseases are also a serious threat to wild dogs. These include rabies, canine distemper and anthrax. The wild dog is also very prone to being killed by vehicles on roads.

The focus on large transboundary landscapes such as the KAZA TFCA provides opportunities for the creation of wildlife corridors that can minimize human and wild dog conflict. Individual TFCA countries have or are developing wild dog national action plans, the majority of which are yet to be implemented. Zambia and Zimbabwe have gazetted statutory instruments banning the hunting of wild dogs (Sichone2013; Makuwe 2013). See Table 4.21.

Some Basin states including Botswana, Zambia and Zimbabwe have launched public awareness campaigns on the ecological and socio-economic value of the wild dog; and on changing people's attitude towards the species. They have targeted programmes such as schools outreach. Furthermore, instead of having only elephant warning road signs, there has been motivation to add wild dog warning signs in key places to encourage the public to reduce speed and minimize the wild dog road carnage. There are also opportunities to "rebrand" the species as a tool for attracting tourists to their areas of domicile both within and outside protected areas. The Government of Botswana compensates farmers for livestock killed by certain predators including wild dogs. This is intended to reduce retaliation on the wild dogs by the affected farmers.

Table 4.21 **Status of the Wild Dog National Action Plans in KAZA TFCA Member States**

Riparian state	Plan exists	Draft produced	Not in place
Angola			X
Botswana		X	
Namibia		X	
Zambia	X		
Zimbabwe	X		

Taylor 2013

Water Hyacinth on Lake Chivero-Zimbabwe

Water hyacinth (*Eichhorniacrassipes* (Mart) Solms) originates from South America and is one of the world's most widespread invasive aquatic plants. The plant grows very fast and rapidly depletes nutrients and oxygen from water bodies, adversely affecting flora and fauna. It normally forms

thick, intertwining mats due to its fast reproductive rate and intricate root structure (Mitchell 1976). Shoeb and Singh (2002) reported that the weed can achieve a growth rate of 17.5 tons/ha/day under favourable conditions.

The water weed first occurred in Zimbabwe in 1937 and was noticed on Lake Chivero by 1952. Between 1956 and 1990 it infested the lake's 25 sq km by between 15 percent and 35 percent (Chikwenhere and Phiri 2010). A carpet of the dried up plant is so dense that people can walk on it while water flows beneath it on parts of the lake. The weed can rapidly dominate natural areas and drastically alter species composition, structure and function of native plant and animal communities. Large, intense water hyacinth mats can corrupt water quality and obstruct water ways. Plant respiration and biomass decay leads to oxygen depletion and fish kills.

Temperature and nutrient levels are the strongest determinant factors for water hyacinth growth and reproduction (Wilson and others 2005). The high rate at which Lake Chivero's water is polluted with chemical nutrients, especially phosphates and nitrates creates conditions for the weed to flourish. The major pollutants include:

- Raw effluent and domestic and industrial waste from Harare, Chitungwiza and Chinhoyi city/town municipalities and factories; and,
- Inorganic fertilizers and pesticides from stream-bank cultivation within the lake's catchment.

Chemical, biological and mechanical methods have been used to control the water hyacinth on Lake Chivero with limited success. Once established, the weed is difficult to eradicate. Consequently, most management efforts focus on reducing economic costs and ecological impacts associated with the weed. The herbicide 2,4-D was used to control the weed on the lake with great success. However, its use was discontinued after studies showed that the chemical was harmful to both humans and aquatic life. Consequently, the weed resurfaced around 1986 but efforts to control it using glyphosate failed.

Government then changed its strategy to biological control by importing 150,000 insects from Australia to feed on the weed. The pest eliminated about 95 percent of the plant but died out as the feed source

dwindled, paving way for the weed to reappear. The Zimbabwe National Army was then deployed to the lake and cleared some 100,000 tons of the plant. However, the army's efforts failed to match the weed's rapid growth rate hence it withdrew from the lake. The national economic challenges of 2007 and early 2009 coupled with the absence of effective control strategies enabled the weed to re-establish and flourish (Mukarati 2012).

Box 4.8 **AICHI BIODIVERSITY TARGETS**

Aichi Biodiversity Targets

Goal A – Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

Goal B – Reduce the direct pressures on biodiversity and promote sustainable use.

Goal C – Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.

Goal D – Enhance the benefits to all from biodiversity and ecosystem services.

Goal E – Enhance implementation through participatory planning, knowledge management and capacity building.

CBD 2010

Multilateral Environmental Agreements

Basin states have signed and/or ratified and acceded to a number of international instruments related to biodiversity, as shown in Table 4.22. The countries are at different stages of implementing provisions of these instruments.

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development in Brazil (Rio Earth Summit), entered into force on 29 December 1993 and all Basin states have ratified the agreement (CBD 2011). The Convention has three objectives: conservation of biological diversity, sustainable use of its components, and the fair and equitable sharing of benefits arising from the utilization of genetic resources (UNEP 2006). Successful programmes that spoke to and forwarded the CBD initiative include CAMPFIRE in Zimbabwe and the Wetlands Programme in the Kafue and Bangweulu Flats in Zambia (SADC, IUCN and SARDC 2000).

The tenth meeting of the Conference of the Parties adopted a revised Strategic Plan for Biodiversity including the Aichi biodiversity targets for 2011 to 2020 period (CBD 2010). The Aichi Biodiversity Targets address the underlying causes of biodiversity loss by mainstreaming biodi-

Table 4.22 **Status of Riparian States on International Instruments**

Country	Convention on Biological Diversity (CBD)	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Cartagena Protocol on Biosafety	International Treaty on Plan Genetic Resources for Food and Agriculture (ITPGRFA)	Ramsar Convention on Wetlands	UN Convention to Combat Desertification (UNCCD)	Kyoto Protocol	World Intellectual Property Organization (WIPO)
Angola	r	a	-	s	-	r	-	m
Botswana	r	a	r	-	r	r	a	m
Malawi	r	a	-	r	r	r	r	m
Mozambique	r	a	r	-	s	r	a	m
Namibia	r	a	r	s	s	r	a	m
Tanzania	r	r	a	s	r	r		m
Zambia	r	a	a	s	r	r	-	m
Zimbabwe	r	a	-	s	r	r	r	m

Key r - ratified; s - signed; a - acceded; m - member

SADC Regional Biodiversity Strategy, 2006

Table 4.23 **Major Wetlands and Ramsar Sites** (September 2014)

Country	Wetland	Area (ha)	Utilization	Date of designation
Botswana	Okavango Delta System	5 537 400	Hunting, tourism, subsistence farming, fishing, and livestock grazing	9 Dec 1996
Malawi	Lake Chilwa	224 800	Fishing, agriculture (rice and dimba cultivation), and livestock grazing	14 Nov 1996
Mozambique	LagoNiassa e ZonaCosteira	1 363 700	Fishing, agriculture, animal rearing, hunting, trade and handicrafts	26 April 2011
	Marromeu Complex	688 000	Wildlife, fishing, agriculture	3 Aug 2004
Namibia	Etosha Pan, Lake Oponono and Cuvelai drainage	600 000	Farming, fishing domestic water supply, wildlife	23 Aug 1995
Tanzania	Orange River Mouth	500	Restricted recreation	23 Aug 1995
	Sandwich Harbour	16 500	Fishing, guano collection, hunting, tourism	23 Aug 1995
	Walvis Bay	12 600	Wildlife, recreation, salt production	23 Aug 1995
	Kilombero Valley Floodplain	796 735	Fishing, tourism, agriculture	25 April 2002
	Lake Natron Basin	224 781	Semi-nomadic pastoralism, tourism, planned soda ash exploitation	4 July 2001
Zambia	Malagarasi-Muyovozi Wetlands	3 250 000	Hunting, honey gathering, harvesting forest products and cattle grazing	13 April 2000
	Rufiji-Mafia-Kilwa Marine Ramsar site	596 908	Fishing, cultivation (especially rice), seaweed farming and tourism	29 Oct 2004
	Bangweulu Swamps	1 100 000	Ecotourism	28 Aug 1991
Zimbabwe	Busanga Swamps	200 000	Wildlife, fishing, tourism	2 Feb 2007
	Kafue Flats	600 500	Wildlife, fishing, grazing, tourism	28 Aug 1991
	Luangwa Flood Plains	250 000	Wildlife	2 Feb 2007
	Lukanga Swamps	260 000	Wildlife, reeds for basket making	2 Feb 2007
	Mweru waNtipa	490 000	Wildlife, fishing	2 Feb 2007
	Tanganyika	230 000	Fishing, forest products	2 Feb 2007
	Zambezi Floodplains	900 000	Wildlife, fishing, reeds and sedges for handicraft, rice cultivation	2 Feb 2007
	Chinhoyi Caves	8	Tourism, UNESCO heritage site, cultural significance	2011
	Lake Chivero and Manyame	29 260	Wildlife, Urban, fishing, tourism, research	2011
	Cleveland Dam	2500	Wildlife, Urban, agriculture, fishing, tourism	2011
	Driefontein Grassland	20 000	Wildlife, subsistence agriculture, grazing,	2011
	Mana Pools	200	Wildlife, tourism	2011
	MonovaleVlei	34	Urban water use, Wildlife,	2011
	Victoria Falls	2 340	Toursim, Wildlife, Hydro Energy,	2011

Ramsar 2014

versity across all sectors (SARDC/SARDC and others 2012). The objective of the strategic plan is to "take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human wellbeing and poverty eradication" (SARDC/SARDC and others 2012).

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) tackles the problem of protection of endangered species by controlling the international trade market of fauna and flora especially those species that are most threatened (Chenje 2000). In some cases CITES bans the trade of species such as the Black Rhino and African Elephant, which was met by some opposition from SADC countries such as Namibia, Botswana and Zimbabwe, which have strong elephant protection systems and more elephants than the carrying capacity of the habitat (SADC/SARDC and others 2012).

The biggest challenge for CITES is that species that are banned or restricted from trading become highly lucrative in illegal trading markets, CITES has been met with mixed success throughout the Basin. In Zimbabwe the listing of the black rhinoceros in Appendix 1 in the 1970s failed to revive the rhinoceros population, however restricted trade and sound management helped to improve elephant populations (Feresu 2010). This increase of elephant populations saw several areas surpass the carrying capacity for these mega-herbivores thus causing ecological damage, hence the opposition to the continual listing of the African Elephant (Feresu 2010).

Although it must be noted that in order for CITES to be effective ongoing assessment of local situations and innovations that allow controlled trade such as the Southern Africa Centre for Ivory Marketing established by Botswana, Malawi, Namibia, South Africa and Zimbabwe and sanctioned by CITES (Government of Botswana 2006). Such initiatives allow sustainable trade and harvesting of species.

Ramsar Convention on Wetlands

The Ramsar Convention on Wetlands signed in 1971 provides a framework for national action an international cooperation for the conservation and wise use of wetlands and their resources (Chenje 2000). The criteria for listing an aquatic ecosystem as being of international importance include the uniqueness of the wetland system and its role in supporting populations of endangered species (Hirji and others 2002). All Basin states are signatories of the Ramsar Convention after Zimbabwe became the latest signatory in 2011. Such regulatory instruments help to enhance ecosystem diversity within the region. By 2000 only two sites were recognized in Zambezi Basin, but that number has grown significantly as shown in the table below.

A number of regional programmes and projects related to some of these instruments are being implemented. Basin states have also signed and/or ratified several SADC regional biodiversity related protocols. The protocols provide legally binding frameworks for regional collaboration among riparian states and demonstrate the region's political and technical will to mainstream the environment into its development strategies. These include regional protocols on:

Shared Water Course Systems; Trade; Education and Training; Culture, Information and Sport; Energy; Mining; Development of Tourism; Health; Wildlife Conservation and Law Enforcement; Fisheries; and Forestry (SADC 2006).

Conclusion

Addressing Drivers of Biodiversity Loss

The major drivers of biodiversity loss and deforestation in the Basin include:

- over-reliance on wood energy;
- agricultural expansion into marginal land; and,
- poor land-use planning.

There is therefore need to implement the following measures buttressed by appropriate legislative provisions:

- Promotion of efficient and sustainable energy solutions such as renewable energy; and the use of technologies that improve the production efficiency and use of traditional biomass.
- Improvement and stabilization of agricultural productivity through the promotion of conservation agriculture and the establishment of strategic alliances between agriculturalists and conservationists.
- Promotion of integrated land-use planning that places natural resources at the centre of a national social, political and economic development agenda, focuses on empowering the country's citizens to understand the value of natural resources, and ensures that citizens derive tangible benefits from a country's biological resources at different levels.

Data on Biodiversity Trends

Most biodiversity assessments in the Basin have focused on species and habitats of economic importance and have largely been irregular. This makes it difficult to establish biodiversity trends for planning and decision-making purposes. It is therefore critical that Basin states endeavour to undertake regular biodiversity inventories that cover the whole range of species and habitats. In the case of TFCAs, wildlife surveys should be synchronized to reduce the risk of double counting by neighbouring Basin States.

Community Participation in Natural Resource Management

A number of Basin states have enacted legislation that enables rural communities to participate in and economically benefit from biodiversity in their areas of domicile through CBNRM initiatives. Such economic incentives encourage communities to sustainably manage their biodiversity. However, such benefits can be enhanced by broadening CBNRM beyond wildlife. This should embrace the following:

- Eco-tourism ventures;
- Commercialization of and value addition to other non-wildlife biodiversity resources such as veldt products; and,
- A regionally coordinated and rationalized approach to the development of *sui generis* legislation on Access and Benefit Sharing in the SADC. This will reduce unnecessary competition among Basin states as outside parties will not be able to move from one country to another in pursuit of more favourable access conditions on genetic materials (SADC, 2006).

It is also important that issues of gender are integrated into the current and future policies governing the management of biological resources as women have remained absent at all levels of policy formulation and decision-making in natural resource and environmental management, conservation, protection and rehabilitation. In addition, local level institutions that deal with biological resources have been weak, especially under communal land tenure systems, and there has been limited participation by women in existing institutional structures (WWF 2012).

CHAPTER LINKAGES

Overview
Forests and woodlands are an important source of livelihood, providing basic needs such as food, energy and shelter. Forests have essential environmental functions through watershed protection and clean air provision. The Basin has a variety of ecosystem, habitat, species and genetic resources that are critical for the human development and wellbeing.

Water Resources
Freshwater and wetlands constitute major ecosystems that sustain aquatic species through habitat and nourish terrestrial ecosystems. Forests are essential to water retention and flow, so these resources are mutually dependent and produce better if both are healthy.

Land and Agriculture
Land supports the growth of forests and woodlands, while forests and woodlands protect land from degradation. Land clearance is a major threat to biodiversity through loss and modification of habitat.

Climate Change and Variability
Forests and woodlands regulate the nitrogen and carbon cycles. The carbon cycle is a factor in climate change. Forests act as carbon sinks, and are credited with helping to maintain or lower global temperatures.

Energy
Activities in the energy sector have implications for biological diversity in the Zambezi Basin. Energy developments, such as construction of dams for hydropower have major impacts on biodiversity through modification of habitat and flooding.

Urbanization and Human Settlements
Forests and woodlands support people in various ways, including food, medicine and the provision of timber for construction of settlements. However, the same forests and woodlands tend to be cleared to make way for new settlements, and many urban areas in the basin are ringed with deforestation due to charcoal production.

Tourism
Tourism in the Zambezi Basin is reliant on the rich fauna and flora of the Basin, and helps to protect biodiversity due to its role in income generation. Nature-based tourism is a fast-growing industry that depends on healthy ecosystems rich in biodiversity.

Industrial Development
Industrial development in areas that are rich in biodiversity can contribute to the destruction of ecosystems and reduction in species distribution, and needs appropriate control systems.

Scenarios
The Basin's forests will continue to be depleted as long as human needs continue to grow. The growth of the forestry and woodlands sector depends on policies and practices, and awareness

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CLIMATE CHANGE AND VARIABILITY

5

Introduction

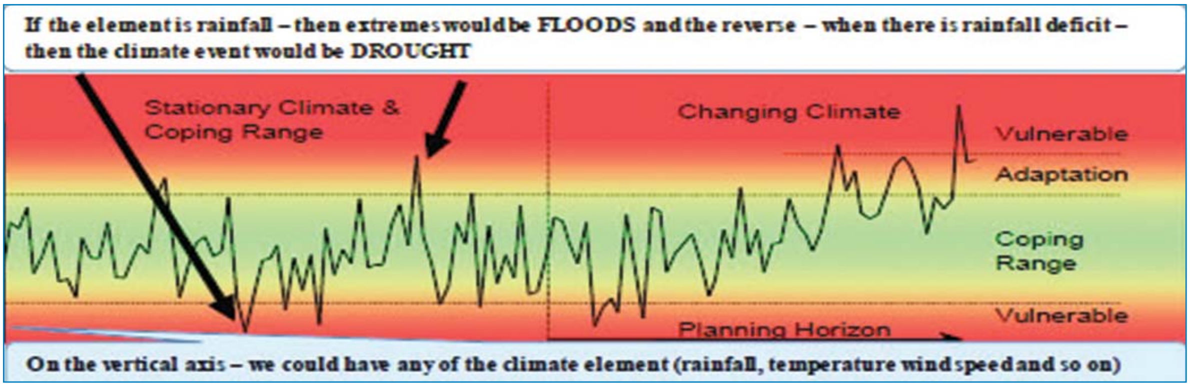
Climate in the Zambezi River Basin and the rest of Africa is changing and the impacts are already being felt. The Fifth Assessment Report of the Intergovernmental Panel in Climate Change (IPCC) 2014 asserts that further change in climate is inevitable in the coming decades and will pose greater challenges to growth and development. Average temperatures in southern Africa have risen by 0.5°C over the last century, with the 1990s deemed the warmest and driest decade ever (SADC/SARDC and others 2008). As adaptation brings immediate benefits today and in the future, the Basin states are embarking on several adaptation strategies to reduce the impact.

Climate Change describes alteration in the state of the climate (mainly temperature, rainfall, radiation, wind and cloud cover) that persists for an extended period, typically decades to centuries and does not necessarily return to the original state. In contrast, Climate Variability is the temporary phenomena that occur on timescales ranging from a few minutes to a decade or more. Climate variability results from mechanisms within the climate system and results in properties that eventually go back to where they were (IPCC 2014). For example, it is difficult to know whether a climate event such as a drought, is the result of climate change or climate variability.

An approach called "single-event attribution" as well as improved statistical approaches are making it easier to know if an event results from climate change or variability. Examples of climate events related to climate variability include ocean or atmosphere fluctuations such as the El Niño/Southern oscillation, the North Atlantic Oscillation, and the Pacific Decadal Oscillation while those related to climate change include rapid atmospheric warming over the last century, the shrinkage of mountain glaciers worldwide, and changes in sea level.

Climate change and variability has historically posed challenges related to extreme weather and climate events such as droughts, floods, heat waves, spread of climate-related diseases and rise in sea level. Under a warmer atmosphere, the intensity and frequency of extreme weather and climate events is expected to increase and become the new norm (Figure 5.1).

Figure 5.1 **Coping Range, Climate Change Adaptation and Vulnerability to Climate Change**



Lesolle, D., SADC Policy Paper on Climate Change: Assessing the Policy Options for SADC Member States, 2012

The impacts of climate change are felt differently by men, women and children who do not have same vulnerability levels and capacities to adapt due to the differing roles, cultural restrictions, opportunities and access to resources. The climate change challenge therefore, while serious and urgent, brings with it enormous opportunities for the Zambezi Basin to advance efforts towards sustainable development, basin-wide co-operation and integration.

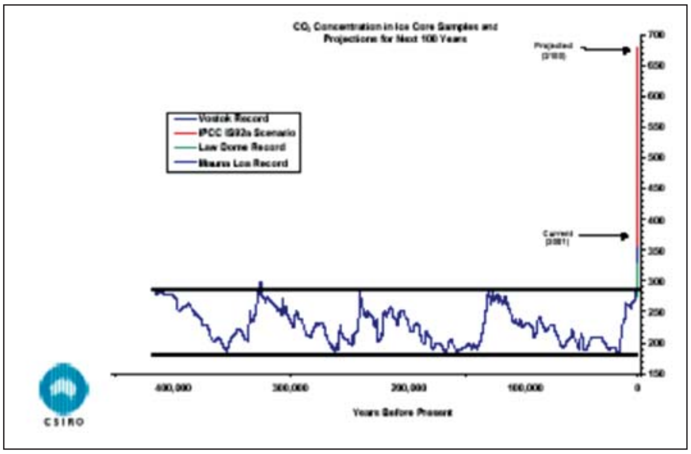
What Causes Climate Change?

The IPCC Fifth Assessment Report 2014 finds with 95 percent certainty that human activity has been the dominant cause of the observed warming since the mid-20th century, largely by increasing the concentrations of greenhouse gases in the atmosphere. Human activities that lead to the warming of the earth's atmosphere include the burning of fossil fuels such as oil, coal and petroleum. The use of some agricultural and industrial chemicals also leads to the build-up of greenhouse gases. Greenhouse gases such as carbon dioxide, methane and nitrous oxide as well as water vapour, trap heat in the atmosphere causing global warming. The atmospheric concentration of greenhouse gases increases when emissions outweigh the removal processes.

As a result of historical consumption patterns, the atmospheric concentration of greenhouse gases has increased from 287 parts per million by volume (ppmv) at pre-industrial level to more than 400 ppmv in 2013 (Figure 5.2). The change in concentration has altered the radioactive energy balance of the atmosphere and consequently more sunlight energy is trapped and retained by the atmosphere. If no action is taken, it is estimated that by 2100 the concentration of greenhouse gases would reach 700ppmv (IPCC 2007).

The changes in the intensity and frequency of weather and climate in the Zambezi River Basin is therefore attributable to global warming and climate change, and depicted as an increase in the minimum temperatures, changes in the rainfall intensity, timing (onset and cessation) of the rainfall season, and increase in the wind characteristics.

Figure 5.2 **Atmospheric Concentrations**



Australia's national science agency CSIRO

Box 5.1 **ATMOSPHERIC SYSTEM**

Increased greenhouse gas emissions from human activities over the past 60 years have caused increases in global average temperatures, according to expert reports (Boko 2007). Once heated, the atmospheric global warming and climate change adds on to natural climate variability observed over comparable time periods. The identified changes in climate are discernible in the averages as well as in the variance.

The atmosphere like any energy system, will attempt to stabilise and attain equilibrium by using up the additional energy through other forms of energy – such as kinetic energy (wind); electric and sound energy (thunderstorms); latent heat in condensation and evaporation leading to aridity and downpours leading to flooding (Lesolle 2012).

Greenhouse Emissions and Sinks

The main drivers for climate change related concerns in the Zambezi River Basin are not emanating from within the basin itself. The increased concentration of greenhouse gases in the atmosphere is a result of large-scale historical emissions from the industrialised north and is exacerbated by emissions from some of the larger emerging economies.

The climate drivers shown in Figure 5.3 have a direct impact on the earth systems including changes in temperature, precipitation and sea level, and in the intensity and frequency of extreme climate events.

The Zambezi Basin States are not major emitters of greenhouse gases. The emissions in 2000 were about 100 million tons, according to national reports of the parties to the UN Framework Convention on Climate Change (UNFCCC). This constitutes only 0.01 percent of Africa's emissions, which are about 3.7 percent of all global emissions.

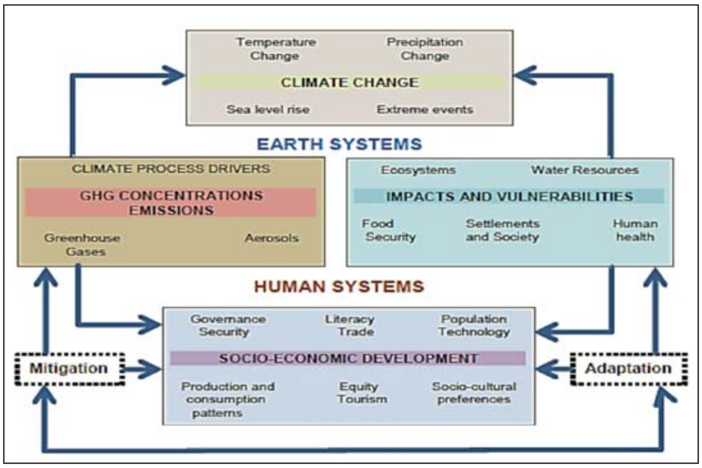
The Zambezi Basin states have a substantial "sink" capacity for greenhouse gases in their forests. Forests absorb carbon dioxide as "carbon sinks". Communities in the Basin rely heavily on firewood, which accounts for almost 80 percent of the total energy requirements among the Basin's rural population and urban poor. Experts predict that wood use in Africa will double by 2020 (ProBEC 2014).

Climate Conditions of the Zambezi Basin

The climatic condition of the Zambezi River Basin varies spatially from arid in the west (Botswana and Namibia) through semi-arid and sub-humid areas in central zones and to the east. Closer to the equator, in Angola and coastal Tanzania, it is largely humid.

The climate is influenced by air masses of different origins. Three prevailing wind systems have a strong influence on the region's climate, and these are the

Figure 5.3 **Climate Drivers, Impacts and Responses**

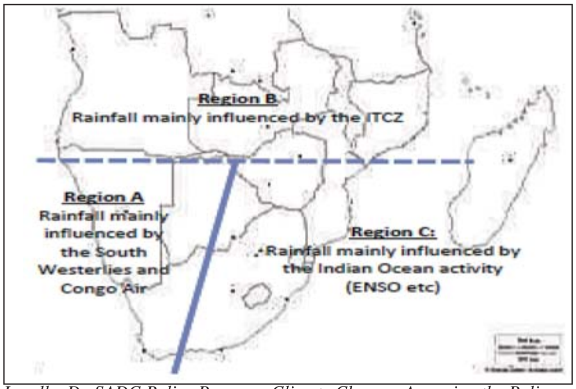


Bernstein and others, 2007

sub- tropical eastern continental moist maritime (with regular occurrence of cyclones); the south-easterly wind system that brings rainfall from the Indian Ocean, and the Inter-Tropical Convergence Zone (ITCZ). See Figure 5.4. The ITCZ is a zone close to the equator where massive rain-bearing clouds form when the South East Trade Wind (from the south east of the continent) meets the North East Monsoon Winds.

The ITCZ changes position during the year, oscillating between the equator and the Tropic of Capricorn, and its southward movement usually marks the beginning of a rainy season. The further south the zone moves, the more promising this is considered to be for the rainy season. In a normal season, the ITCZ can exert an influence between mid-Tanzania

Figure 5.4 **Rainfall Determining Systems for the Zambezi River Basin**



Lesolle, D., SADC Policy Paper on Climate Change: Assessing the Policy Options for SADC Member States, 2012

and southern Zimbabwe and is associated with favourable rainfall. Another system, the Botswana High, often tends to push the ITCZ away, resulting in periods of drought.

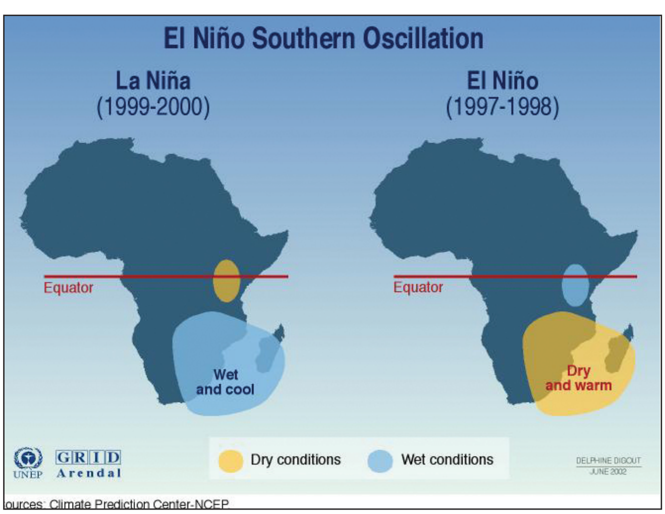
The southeastern part of the Zambezi Basin can be influenced by the El Niño Southern Oscillation (ENSO) phenomenon, which is triggered by changes in the sea surface temperatures in the Pacific Ocean. The ENSO can bring heavy rains, often accompanied by severe floods as in 1999/2000 when Mozambique was hit exceptionally hard, or drought, as in 1982/83 when much of southern Africa was severely affected. ENSO can manifest itself as either El Niño or La Niña associated with warm and cool seas surface temperatures respectively in the tropical Pacific (SADC/ SARDC and others 2008).

During an El Niño, the southeastern region is likely to receive below average rainfall. A La Niña event is very likely to result in the opposite impacts, when the region would receive significant amount of rainfall. There has been an increase in the frequency and intensity of El Niño episodes. Prior to the 1980s, strong El Niño events occurred every 10 to 20 years on average. However, since 1980 strong El Niño occurrences have become more frequent, particularly 1982 and 1983; 1991 and 1992; 1994 and 1995; and 1997 and 1998 (Glantz 2001; SADC/SARDC and others 2008).

The warm climate of the Zambezi Basin makes it attractive as a tourist destination, bringing in the revenue that will help in facilitating basin-wide cooperation and regional integration. The rich biodiversity in the basin is linked to the conducive climate that supports growth of fauna and flora.

Although identification of ENSO has improved over the years, a lot remains to be done before scientists are able to predict spatial patterns of impact with certainty to allow adaptive responses to be developed. See Figure 5.5.

Figure 5.5 **Impact of ENSO on Rainfall in the Zambezi River Basin**



Observed Changes in Climate in the Zambezi Basin

According to the IPCC Fifth Assessment Report (2014), warming over land across the Zambezi Basin and the rest of the continent has increased during the last 50 to 100 years. Data from 1950 onwards suggests that climate change has changed the magnitude and frequency of some extreme weather events in the Basin. The health, livelihoods and food security of people in the Basin have been affected by climate change.

Observed Changes in Temperature

Southern Africa including the Zambezi Basin has had a warming trend over the past few decades. This is consistent with the global trend of temperature rise in the 1970s, 1980s and 1990s. Instrument observations from several SADC member states show an increase in temperatures, especially the minimum temperatures.

Table 5.1 **Observed and Predicted Temperature Changes**

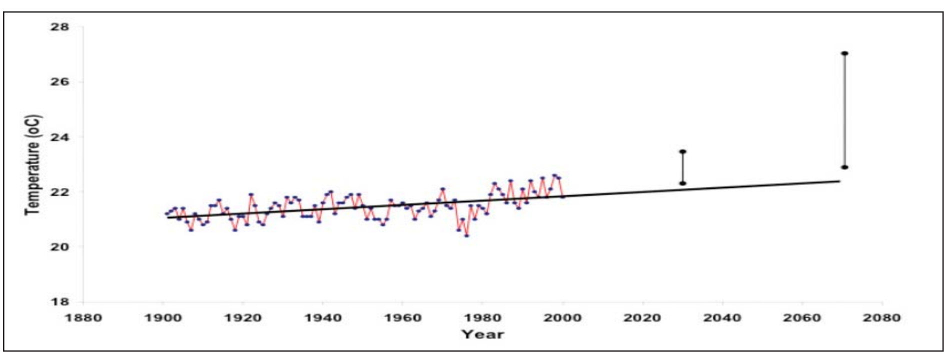
Country	Change in °C per decade 1960-2006	Projected changes in °C	
		2030	2060
Angola	0.33	1.5	2.7
Malawi	0.21	1.3	2.5
Mozambique	0.13	1.2	2.3
Tanzania	0.23	1.3	2.3
Zambia	0.29	1.5	2.6

Young and others, 2010

The observed trend in some southern African countries between 1960 and 2006 indicates an increase in mean annual temperature, as shown in Table 5.1. For example, in Angola the mean annual temperature has increased at an average rate of 0.33°C per decade, while in Malawi the average rate of increase was 0.21°C per decade in the same period (SADC RCCP 2010). The same report notes that the average annual temperature for Angola is projected to increase by 1.5°C by 2030, 2.7°C by 2060 and 3.6°C by 2090. This upward trend is projected for all the five countries studied.

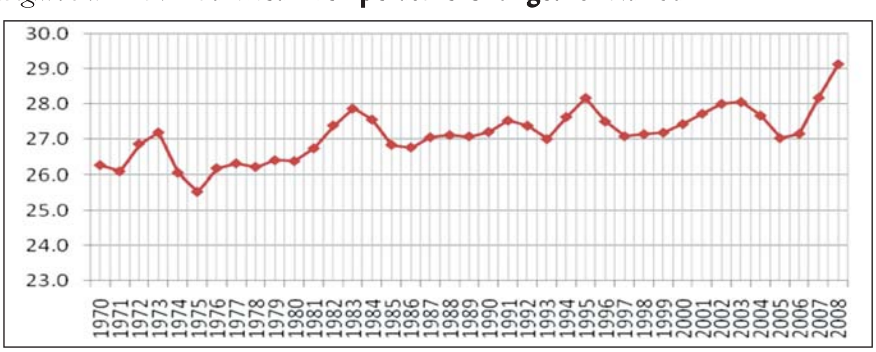
Other studies say that Botswana had an increase in warming at a rate of 0.017°C per year between 1910 and 2000 (Lesolle 2012). See Figure 5.6.

Figure 5.6 **Changes in Minimum Temperature for Gaborone, Botswana**

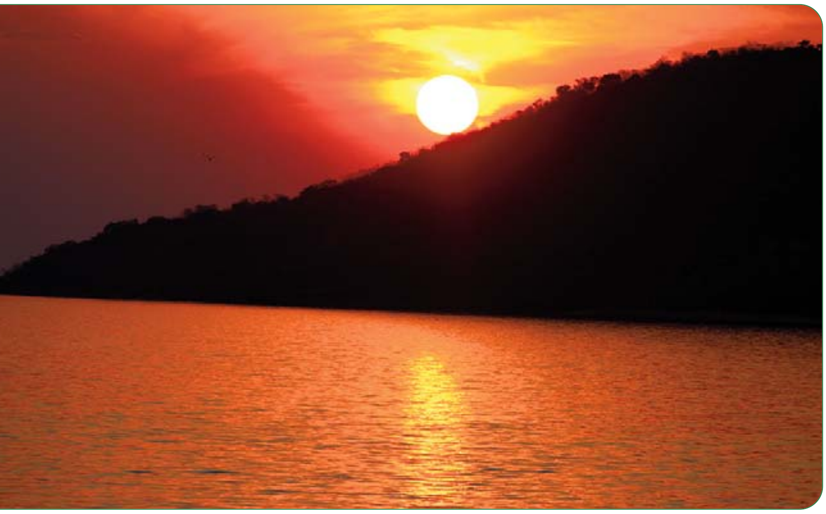


Red line shows actual data for 1910 to 2000. Projection is based on the IS92a IPCC climate change scenario.
Lesolle, D., SADC Policy Paper on Climate Change: Assessing the Policy Options for SADC Member States, 2012

Figure 5.7 **Annual Mean Temperature Changes for Kariba**



Meteorological Services of Zimbabwe, 2009



For Mozambique, the mean annual temperature increased by 0.6°C between 1960 and 2006, with an average rate of 0.13°C per decade (INGC 2009). Other noticeable changes in temperature are in Namibia. Between 1950 and 2000, the country experienced warming at a rate of 0.023°C per year. It is predicted with a high degree of certainty that Namibia will become hotter throughout the year, with a predicted increase in temperatures of between 1°C and 3.5°C in summer and 1°C to 4°C in winter in the period 2046 - 2065. Maximum temperatures have been getting hotter over the past 40 years, as observed in the frequency of days exceeding 35°C. Equally, the frequency of days with temperatures below 5°C has been getting less, suggesting an overall warming (Government of Namibia 2011). For Zimbabwe, a rise in temperature is noted at Kariba where mean annual temperature rose from 26.3°C in 1970 to 29.1°C in 2008 (SARDC and HBS 2010). See Figure 5.7.

The trend shows an increase in the number of warm spells and a decrease in the extreme cold days in southern Africa between 1960 and 2006 (Boko and others 2007). As shown in Table 5.2, the observed frequency of hot days per decade between 1960 and 2006 has been increasing ranging from 0.61 percent per decade for Tanzania to 3.11 percent per decade for Angola. For cold days the frequency is showing a decrease, with Angola decreasing by 4.9 percent per decade while Malawi decreased by 1.01 percent per decade in the same period.

Projected trends for the five countries studied shows continuous increase in frequency of hot days with Mozambique showing a 28 percent increase by 2060 and 42 percent by 2090. A similar trend is projected for the other countries (see Table 5.2).

The increase in temperatures is expected to continue even if the greenhouse gas emissions were to be stopped today. The temperatures in the region are expected to warm by between 1.0°C and 3.0°C by 2080 (IPCC 2014).

This means the Zambezi River Basin will continue to experience warmer temperatures. As a result, the agricultural seasons may change and planting times could vary for different crops. The Basin area could attract more pests, and malaria could spread to places where it is not endemic. Hotter temperatures could mean heat stress and changes in natural ecosystems. This can change the productivity of the rangeland, grazing, and food production. There will be challenges for agriculture, water, health and other key socio-economic sectors if they do not adapt to these changes.

Table 5.2 **Observed and Projected Changes in Frequency of Hot and Cold Days**

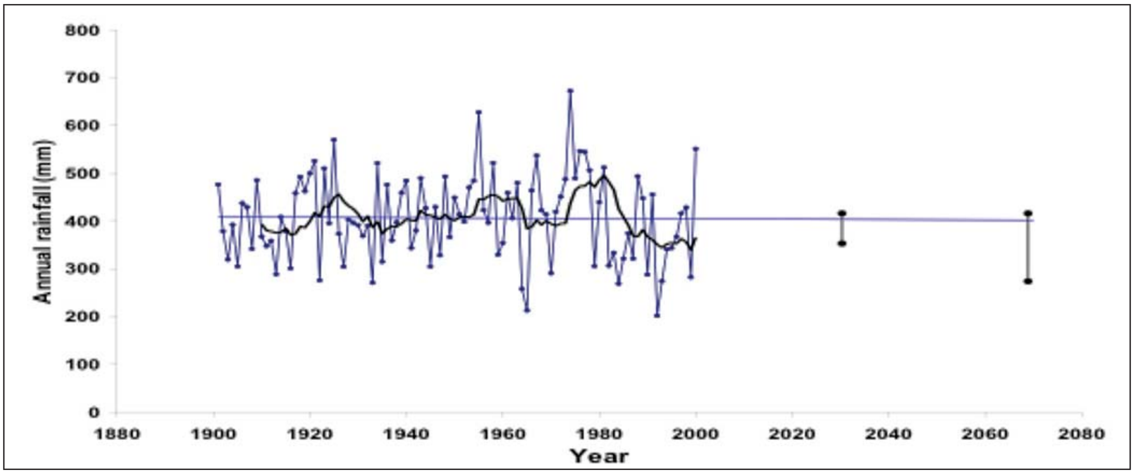
Country	Observed change in frequency per decade between 1960-2006 (%)		Projected changes in frequency of hot and cold days			
			% Frequency 2060		% Frequency 2090	
	Hot days	Cold days	Hot days	Cold days	Hot days	Cold days
Angola	3.11	-4.9	30	1	40	0
Malawi	1.94	-1.01	22	2	31	0
Mozambique	1.58	-0.9	28	2	42	1
Tanzania	0.61	0.03	27	2	40	0
Zambia	2.73	-1.4	22	2	31	1

Young and others, 2010; SADC RCCP, 2010

Observed Changes in Rainfall Characteristics

The changes in rainfall are best expressed as changes in intensity, extreme rainfall events (storms) and changes in the rainfall season (onset, cessation and

Figure 5.8 **Actual and Predicted Future Rainfall in Gaboron, Botswana**



Actual data for 1910 to 2000 and projection based on the IS92a IPCC climate change scenarios for the period up to 2080.

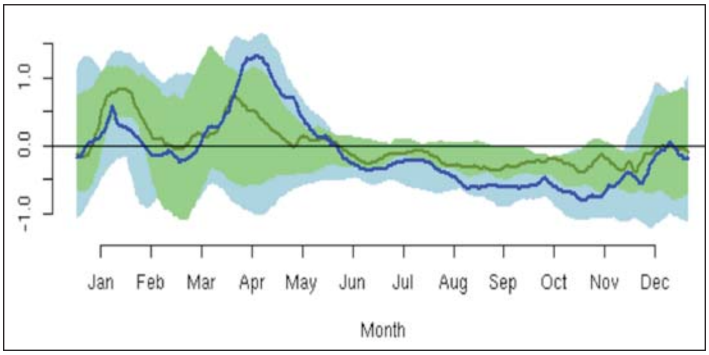
Lesolle, D., SADC Policy Paper on Climate Change: Assessing the Policy Options for SADC Member States, 2012

length). Overall, since 1950, the countries in the Zambezi Basin have witnessed a downward trend in rainfall. This is in line with the findings of the IPCC Fifth Assessment Report (2014) which indicates that rainfall years identified as "below normal" are becoming more and more frequent.

Among the most notable climate changes predicted to occur are a decrease in rainfall across the Basin, which is estimated at 10–15 percent. Also predicted is an estimated decrease in run-off and significant changes in the seasonal pattern of rainfall across the Basin, including delayed onsets, as well as shorter and more intense rainfall events, implying an increase of frequency in floods and droughts (SARDC and HBS 2010; Beilfuss 2012). The beginning of the rain season is becoming less predictable. Heavy rain events are more frequent and intense but episodes of drought occur as well. In Botswana, rainfall is expected to decrease by a significant amount as shown in Figure 5.8.

Heavier rainfall will result in an increased incidence of flooding in many areas. Reduced runoff aggravates existing water stress, reduces land quality, lowers quantity of water available for

Figure 5.9 **Decrease in Water Availability June-December in the Zambezi River Basin Region in Mozambique**

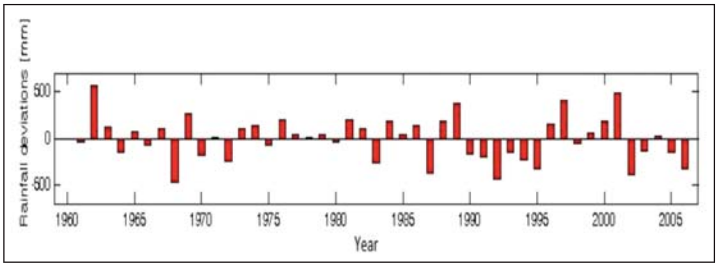


INGC, 2009

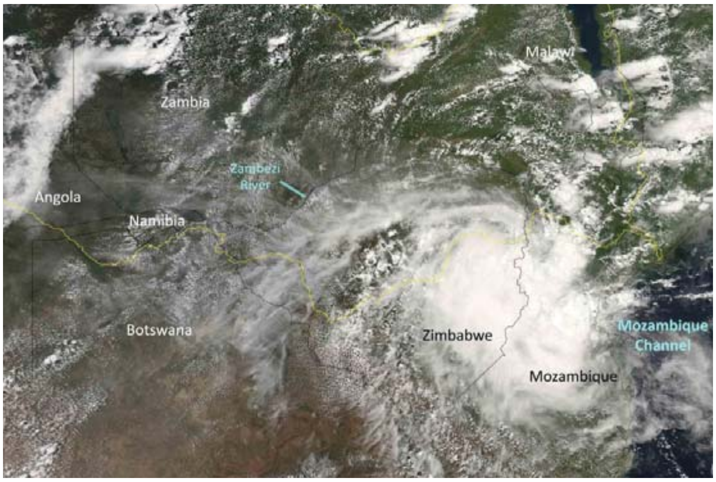
domestic and industrial use, and limits hydropower production.

In the Zambezi Basin region in Mozambique, the rainfall varies considerably within annual cycles with 60-80 percent of the annual precipitation falling in the period from December to March. The mean annual rainfall has decreased at an average rate of 2.5mm per month per decade, or 3.1 percent between 1960 and 2006. This annual decrease is largely due to a reduction in December, January and February rainfall, which has decreased by 6.3 mm per month, or 3.4 percent per decade (INGC 2009). See Figure 5.9.

Figure 5.10 **Rainfall Anomalies Across Central Mozambique where Zambezi Basin is Located**



INGC, 2009



NASA-EO, 2007

The unpredictable beginning of rain season and the decrease of rainfall during December-February, which is the peak crop season in Mozambique, has significant implications on the agricultural sector which is mainly rain-fed and practiced by smallscale, subsistence farmers. This high variability in rainfall (Fig 5.10) leads to recurrent floods and droughts with heavy impacts on agricultural sectors, roads and rural livelihoods in general. The coping capacity of the communities is low therefore most of extreme events associated with climate variability become a disaster risk in many parts of the Zambezi valley.

Despite a late start to the season, most of southern Africa received heavy rains from December 2011 into 2012, resulting in flooding in several countries. Tropical Cyclone Favio came ashore on the coast of Mozambique on the morning of 22 February 2007 and as it travelled further inland, the storm brought heavy rains to Zimbabwe (SANF 2012).

Observed and Predicted Changes in Sea Level

While the melting of continental ice sheets results in a rise in sea levels, the primary contributor is thermal expansion due to increasing temperatures, and this is well quantified. According to the 5th IPCC assessment report (2014), over the period 1901-2010 the global mean sea level rose by 19 centimetres and will continue to rise during the 21th century. The high scenario shows a rise of 10mm by 2030, 100mm by 2060 and 500mm by 2100 (IPCC 2007 in SARDC and HBS 2010). This can cause permanent flooding of the sea coasts, estuaries and deltas including the Zambezi Delta.

Sea level rise will present a threat to the basin through salt water intrusion. In the Zambezi Delta more than 240 sq km of land could be impacted with inland saltwater penetration of about 28km by 2030 (Brundrit and Mavume 2009). Drinking water supplies for coastal communities will be affected, thus increasing the burden of women who will have to fetch water from afar, unless modern methods are put in place for sustainable access to clean piped water. Coastal infrastructure such as roads and buildings will be at risk of damage.

Marshland vegetation in the delta could provide some natural resistance to the intrusion. High flows from annual flooding of the Zambezi River could help to wash back some of the salt water. Conservation measures of the marshland vegetation and eco-hydraulic management of the Cahora Bassa reservoir releases are required to ensure that these restorative processes occur.

Observed Changes in Climate Related Extreme Events

Frequency and severity of droughts, floods and cyclones have increased in the

Zambezi Basin since the 1950s. Between 1988 and 1992 the sub-region experienced more than 15 drought events (Boko 2007). Some notable droughts and floods are shown in Table 5.3 below.

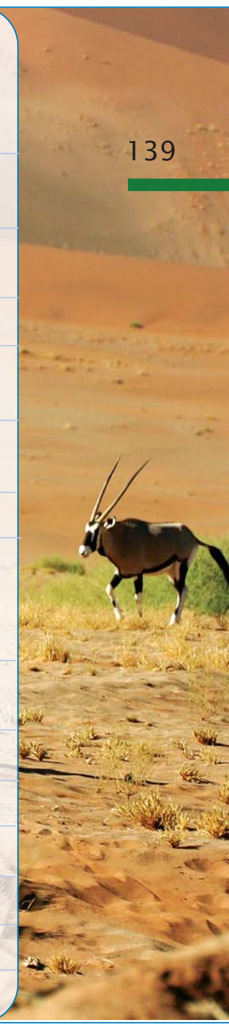
Map 5.1 shows that dry periods have been frequent in the northern parts of the basin in Angola and Zambia between 1995 and 2013, and also in Malawi and northern Mozambique.

Map 5.1 shows that for the past 18 years most of the basin has witnessed below average rainfall at least once during the first quarter of the year. The Basin is expected to face drier and more prolonged drought periods. According to several studies cited by the Intergovernmental Panel on Climate Change, rainfall is expected to decrease by 10-15 percent over the Basin during the next century (Beilfuss 2012).

As a result, a significant reduction in the amount of water flowing through the river system is expected and this affects all eight basin countries. The water that feeds the Zambezi River is expected to decrease by between 26 and 40 percent in another four decades, the study revealed. High evaporation rates have reduced the level of water reservoirs in most parts

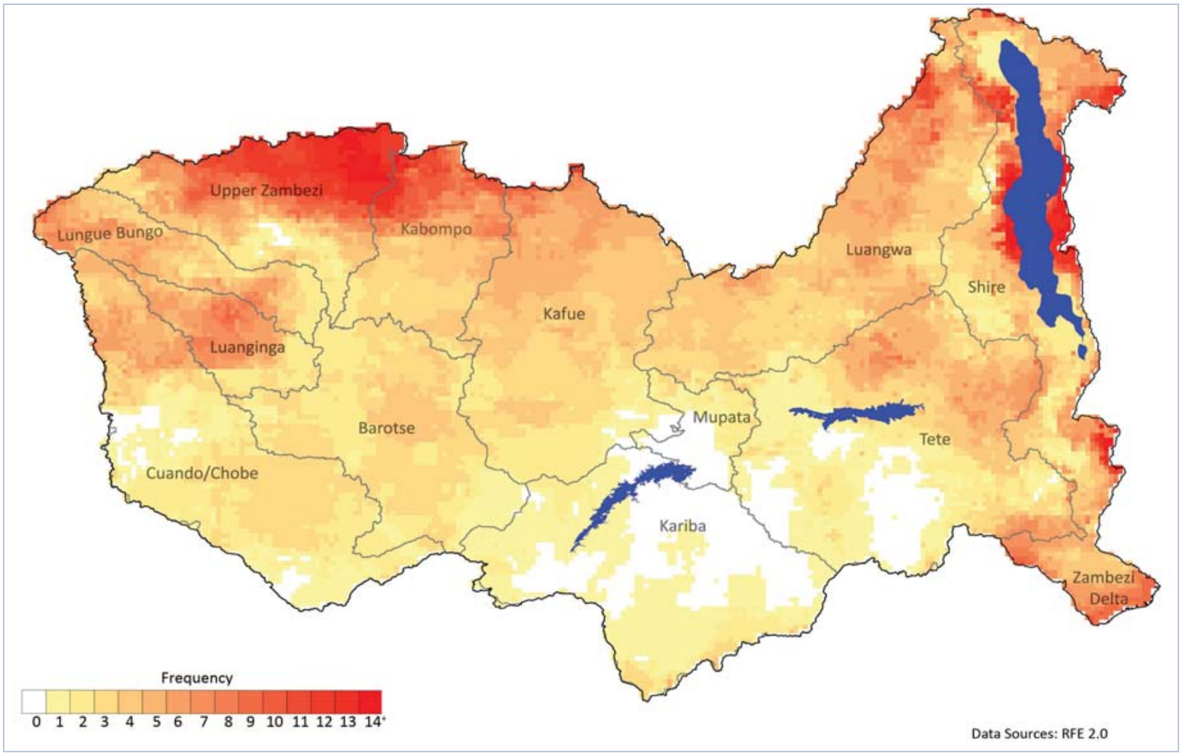
Table 5.3 **Occurrence of Extreme Events in the Zambezi Basin**

2014-2015	Tens of thousands of people in Malawi, Mozambique and Zimbabwe have been severely affected by floods caused by Tropical Storm Chedza, which started in December and continued through February 2015. Malawi has been hard hit by the current floods. More than 200 people have died and 500,000 people displaced. In Mozambique more than 150,000 people have been affected and about 6,000 in Zimbabwe.
2012-2013	Following poor performance in November, good rains were received in the first 10 days of December but dry conditions resumed late January through to May in the southern parts of the Zambezi Basin.
2008-2009	The basin experienced flooding, which displaced thousands of people in Angola, Botswana, Malawi, Namibia and Zambia.
2007	Floods induced by Cyclone Favio impacted on Mozambique and parts of Zimbabwe.
2005-2006	Parts of southern Africa received very heavy rains resulting in flooding that caused considerable infrastructural damage, destroying schools, crops, roads and telecommunications.
2004-2005	Many parts of the Zambezi Basin received below-normal rainfall during the agricultural season. Several riparian states declared national disasters.
2001-2003	Severe drought in the SADC region.
1999-2000	Cyclone Eline hit the region and widespread floods devastated large parts of the Limpopo basin (southern and central Mozambique, southern-eastern Mozambique, parts of South Africa, Botswana and Zimbabwe). In Mozambique alone this affected 2 million people with 650,000 forced to abandon their homes.
1994-1995	Many countries in the SADC region were hit by a severe drought, surpassing the impact of the 1991-1992 droughts.
1991-1992	Worst drought in living memory experienced in southern Africa, excluding Namibia.
1986 – 1987	Drought conditions returned to the region.
1983	This year saw a particularly severe drought for the entire African continent.
1982	Most of sub-tropical Africa experienced drought.
1981 – 1982	Severe drought occurred in most parts of southern Africa.
1967 – 1973	This six-year period was dry across the entire region. Some records show a severe drought.



ZAMCOM, SADC and SARDC 2015, updated from SADC/SARDC and others, Southern Africa Environment Outlook, 2008; SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012; and SADC-FANR 2013.

Map 5.1 **Occurrence of Severe Dry Periods during First Quarter of Year 1995-2012**



SADC/SARDC and others 2012

of the Basin, including the Kariba and Cahora Bassa dams.

When the rains do fall, this will be more intense, triggering extreme flood events. Recent floods and their impact on the existing dams offer a possible view of future challenges. In 2007, heavy rains over the Zambezi basin threatened the dam structure, forcing authorities to open the sluice gates of the Cahora Bassa Dam, affecting up to half a million people, some displaced and others had their crops destroyed.

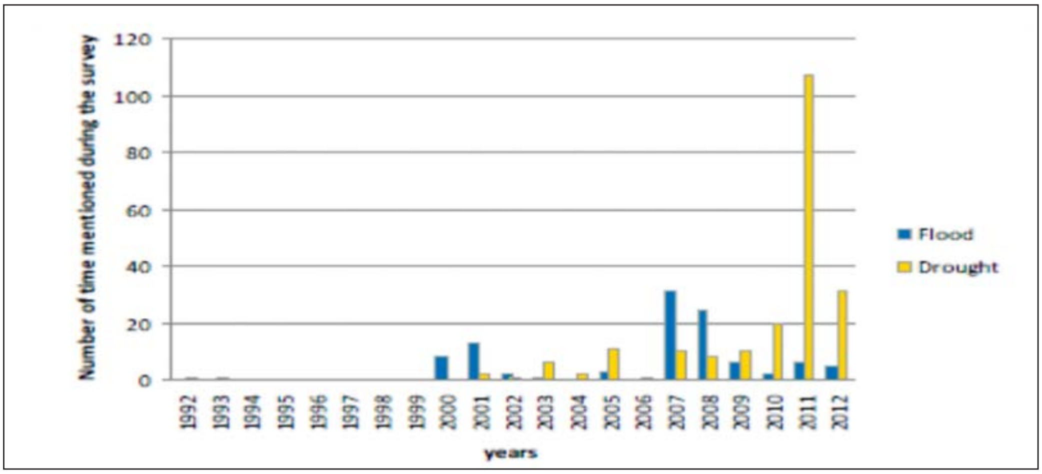
In a case study on the floods and cyclones that struck Mozambique in 2000, the Overseas Development Institute warned that Cahora Bassa and Kariba, which are the biggest dams on the Zambezi River, do not have the spillway capacity to cope with the very large floods that occur on the river every 5-10 years (Beilfuss 2012).

Contrary to the expected droughts in parts of Botswana, Namibia and Zimbabwe, Mozambique was dealing with heavy rains and cyclones that frequently hit the country. The consequence is fast-rising river levels causing more harmful floods to farmers and their valuable farmland along the lower Zambezi shores.

With its long coastline and about 40 percent of its population living and working in coastal districts, Mozambique is particularly vulnerable to tropical storms. The results are already visible with serious erosion destroying local infrastructure and farmland.

Some parts of the Zambezi River Delta frequently report alternating droughts and floods over the past two decades. A study by Brida and Sokona (2013) reported that during the first part of the century, Mozambique was domi-

Figure 5.11 **Flood and Drought Events in the Zambezi River Basin - Mozambique Case**



Brida and others, 2013

Table 5.4 **Changes in Activity of Cyclones in Categories 4 and 5 for the South West Indian Ocean Basin**

Basin	Period			
	1975–1989		1990–2004	
South West Indian	Number	Percentage	Number	Percentage
	23	18	50	34

www.wmo.int

nated by flooding, particularly the 2000/01 season, followed by a period of drought with a peak in 2005 (see Figure 5.11 below).

Other observed changes are in the frequency of tropical cyclones. The tropical cyclone season for the South West Indian Ocean is from November through April, with the highest frequency of occurrence expected in January and February. The presence of cyclones in the region leads to extensive flooding, resulting in economic losses and destruction of infrastructure, crops and livelihoods. The future looks similar as observed data shows an increase in the cyclone activity (Table 5.4).

Key Risks Predicted for the Zambezi River Basin over the Next Century

- The Zambezi Basin can expect a significant warming trend of 0.3 - 0.6°C.
- Temperature increases across the Basin will increase open-water evaporation.
- Multiple studies cited by IPCC estimate that rainfall across the basin will decrease by 10–15 percent.
- Significant changes in the seasonal pattern of rainfall across the Basin are predicted, including delayed onsets, with shorter and more intense rainfall events.
- All Zambezi Basin countries will experience a significant reduction in average annual stream flow.
- Multiple studies estimate that the Zambezi runoff will decrease by 26–40 percent by 2050.
- Increasing water stress is a serious concern in the semi-arid parts of the Zambezi Basin (Beilfuss 2010).

Impacts of Climate Change in the Zambezi Basin

The Intergovernmental Panel on Climate Change (IPCC) has categorized the Zambezi as the river basin exhibiting the worst potential for effects of climate change among 11 major river basins in Africa, due to the resonating effect of the increase in temperature and decrease in rainfall. Coupled with a rise in sea level and extreme events such as increased frequency and severity of droughts and floods, the impacts of change in temperature and rainfall are already being felt in the Zambezi Basin. These impacts cut across all sectors including on water resources, human health, food security, energy, biodiversity, tourism, and livelihoods in general.

Health Impacts of Climate Change

The Zambezi Basin is vulnerable to a number of climate-sensitive diseases which climate change and variability is likely to exacerbate. These diseases include malaria, meningitis, cholera associated with floods and drought, and heat stress.

Malaria

Climate plays a key role in the geographical distribution and seasonal abundance of vector species that are responsible for the transmission of human diseases such as malaria. Changes in temperature, precipitation, humidity, and wind patterns directly affect the reproduction, development, and longevity of vector species. In the Zambezi Basin, malaria is a major public health concern that has claimed many lives, and statistics indicate an increasing trend in that direction. This is especially acute in Malawi, where cases increased from 3.7 million in 2000 to more than 5 million in 2009; Mozambique, from 3.2 million to more than 4 million in the same period; and Angola, from 1.6 million to more than 2 million (WHO 2011). See Table 5.5.

Climate experts have also predicted an expansion of malaria to zones which have been too cool for malaria, such as the high veldt of Zimbabwe and highlands of Zambia, due to climate change related rises in temperature (SARDC and HBS 2010). It is predicted that the malaria-carrying *Anopheles* female mosquito will spread to parts of Botswana and Namibia where it has not been found before (Lesolle 2012; SADC/SARDC 2008).

A more positive scenario is predicted in that regard for areas such as Kariba in Zimbabwe where current temperatures are hot but are likely to push above the range at which mosquitoes can survive. Scientists note that most mosquitoes cannot survive above 40°C (Chen 2006).

The impacts on health are felt differently by men and women due to the perceived gender roles. Women tend to be more exposed to heat stress than men due to different roles. For example, farming activities, firewood and water collection are mostly done by women.

Pregnant women are also more sensitive to temperature increases than those who are not pregnant, and they

Table 5.5 **Reported Malaria Cases in the Selected Countries in the Zambezi Basin**

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Angola	1 635 884	1 249 767	1 862 662	3 246 258	2 489 170	2 329 316	2 283 097	2 295 136	2 151 072	2 221 076
Botswana	71 403	48 237	28 858	236 774	22 404	11 242	19 000	16 983	17 886	14 878
Malawi	3 774 982	3 823 796	2 784 001	3 358 960	2 871 098	3 688 389	4 204 468	4376870	4 580 226	5 455 423
Mozambique	3 278 525	3 947 335	4 592 799	4 863 406	5 610 884	5 896 411	6 335	6 155 082	4 831 491	4 310 086
Namibia	519 113	538 512	445 803	468 259	610 799	339 204	265 595	172 024	128 531	81 812
Tanzania	-	324 584	369 394	1 1379 411	11 898 627	1 1441 681	10 566 201	5 769 646	3 812 350	3 812 350
Zambia	3 602 564	3 838 402	3 760 335	4 346 172	4 078 234	4 121 356	4 731 338	4 248 295	3 080 301	2 976 395
Zimbabwe	1 533 960	680 900	1 348 137	1 820 835	1 815 470	1 496 896	1 535 877	1 154 519	1 008 846	736 897

WHO, Climate Change and Health, 2011

tend not to cover themselves with mosquito nets, thus exposing themselves to mosquito bites. A study carried out in Mozambique established that pregnant women are particularly vulnerable to malaria as they are twice as "appealing" to malaria-carrying mosquitoes as non-pregnant women (WHO 2005). The study noted women in advanced stages of pregnancy (above 28 weeks) produce more exhaled breath (21 percent more volume on average) than their non-pregnant counterparts. Strong human breath helps mosquitoes to detect a host.

Meningitis

Another disease which has expanded beyond its historical boundaries due to climate change is meningitis. The meningitis belt now includes Tanzania and Zambia. Meningitis epidemics have been reported in Angola, Mozambique, Namibia and Zimbabwe (UNEP 2013). Droughts are associated with low humidity and high temperatures, conditions that favour the transmission of meningitis.

Implications of Extreme Events — Floods and Droughts

Associated with floods and cyclones are health challenges including anxiety, post–traumatic stress disorders and depression, mental health resulting from loss of loved ones and property, and displacement. Cyclone Eline in 2000 was the worst in living memory, with its associated floods. Southern parts of Mozambique, Zimbabwe, South Africa and Botswana were hardest hit, with two million people affected in Mozambique and 650,000 forced to abandon their homes (Dube and Chimbari 2009; SARDC and HBS 2010).

An IUCN report (2008) notes that women and children are 14 times more likely than men to die in a disaster such as flooding. During Cyclone Eline, the death rate was higher among women than men (Brekke and others 2009 in SARDC and HBS 2010). The reasons given were that most women could not swim and therefore drowned. In addition, some cultural norms inhibit women's movement without men present, and therefore many women could not move early enough. The lack of early warning information is another impediment.

Increased floods, droughts and rise in sea level may lead to movement of people. Such nature-induced migrations may lead to break up of families and psychological stress, particularly where families are displaced and have to live in emergency or transitional housing. Overcrowding, lack of privacy and the collapse of regular routines and livelihood patterns can contribute to anger, frustration, violence, and high risks of sexually transmitted diseases, with children and women the most vulnerable (IUCN 2008). See Table 5.6.

Table 5.6 **Impact of Climate Change Induced Floods 2000-2009**

Country	Killed	Total Affected
Angola	297	591 509
Botswana	3	148 392
Malawi	91	1 223 435
Mozambique	1 012	6 225 126
Namibia	148	474 300
Tanzania	162	96 750
Zambia	60	3 024 633
Zimbabwe	112	331 000

INGC 2009; Southern Africa Flood and Drought Network 2010; International Disaster Database EM-DAT 2011

As the frequency and severity of floods increased over the past decade, Mozambique has experienced a devastating situation with over 6 million people affected, while in Zambia more than 3 million were impacted in various ways.

Apart from the forced migration and the consequence health impacts, cancerous diseases are also expected to increase during heavy floods when toxic contamination leaks from storage facilities or runoff into water from land containing toxic pollutants. Very little is known about how such transfers will affect people's exposure to these chemicals—some of which are known carcinogens—and its ultimate impact on incidence of cancer. Coastal populations such as in Mozambique are likely to be affected as they use marine water and the fish they eat would be contaminated and toxic.

Table 5.7 **Impact of Climate Change Induced Drought 2000-2009**

Country	Killed	Total Affected
Angola	58	25 000
Malawi	500	8 449 435
Mozambique	-	3 239 500
Namibia	-	34 500
Tanzania	-	8 854 000
Zambia	-	1 200 000
Zimbabwe	-	8 100 000

INGC 2009; Southern Africa Flood and Drought Network 2010; International Disaster Database EM-DAT 2011

Other challenges in the aftermath of a disaster such as floods include food insecurity. WHO (2005) reports that nutritional status partly determines the ability to cope with the effect of natural disasters. Women are more prone to nutritional deficiencies because of unique nutritional needs, especially when pregnant or breastfeeding. In addition, women in southern Africa usually carry greater loads than men yet they have a lower intake of calories as the cultural norm is that men receive food first and usually have more food than women (WHO 2005).

The same report notes that for girls and women, poor nutritional status is associated with an increased prevalence of anaemia, pregnancy and delivery problems, increased rates of intrauterine growth retardation, low birth weight and pre-natal mortality. Due to iron deficiency the risk of women dying at childbirth can be increased by as much as 20 percent (FAO 2009).

While declining per capita food production in the Zambezi Basin is largely attributed to declining land holdings as well as land degradation, climate-induced drought has also contributed to a significant decline in per capita food production.

This inadequate per capita food production has led to health impacts and in worst cases, death. In Malawi, 500 people were killed and more than 8 million affected between the period 2000 and 2009 (Table 5.7).

Food security could be affected directly by an increase in global average temperatures. Even small increases in mean temperature of between 1° and 2°C are projected to lead to variations in crop productivity (Davis 2011). The temperature changes could also affect growing locations, the length of the growing season, crop yields, planting and harvest dates. In addition, higher temperatures are likely to impact negatively on organic matter, thereby reducing soil nutrients as well as favouring the spread of pests and pathogens.

Higher than normal temperatures could result in reduction in livestock productivity by increasingly exceeding the temperature thresholds above the thermal comfort zone of livestock, which could lead to behavioural and metabolic changes such as altering growth rate, reproduction and ultimately mortality, as well as increased prevalence of new animal diseases (Davis 2011). The vulnerability to climate change in the Zambezi Basin is exacerbated by many factors including low capacity to adapt and heavy reliance on agriculture for livelihoods.

Climate Change Induced Water Scarcity and Related Impacts

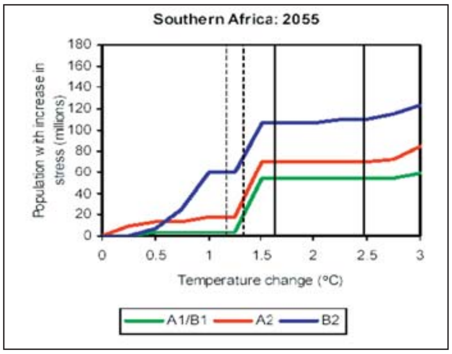
IPCC records predict that almost all southern African countries are likely to experience a reduction in stream flow (Boko and others 2007). This results in reduced groundwater recharge, and drying of wetlands and springs which are source of water for most communities in southern Africa. Water-related diseases could be made worse by increased rainfall variability and high evaporation rates due to increased temperatures. An average of about 65 percent of the rainfall in the Zambezi Basin evaporates soon after it occurs (Chenje 2000). The rate is likely to increase with the predicted increase in temperature in the area.

As climate change is expected to bring more drought conditions in most parts of southern Africa, the burden of fetching water from long distances several times within a day will increase unless provision of infrastructure is accelerated. According to a gender and health analysis for southern Africa (SARDC WIDSAA 2008), 30 percent or more of women's daily energy intake is spent on fetching water. The same report notes that carrying heavy loads over long periods and distances causes cumulative damage to the spine, the neck muscles and the lower back, leading to early aging of the vertebral column. An average household in most parts of southern Africa use 100kg weight of water which will be stressful to obtain considering that the water shortage is expected to increase.

More than 120 million people will be water stressed by 2055 with a temperature change of 5 ºC in the worst-case scenario, while the least-case scenario indicates that 60 million will be affected at the same temperature (Dube 2009). The three colours in Figure 5.12 illustrate the different scenarios.

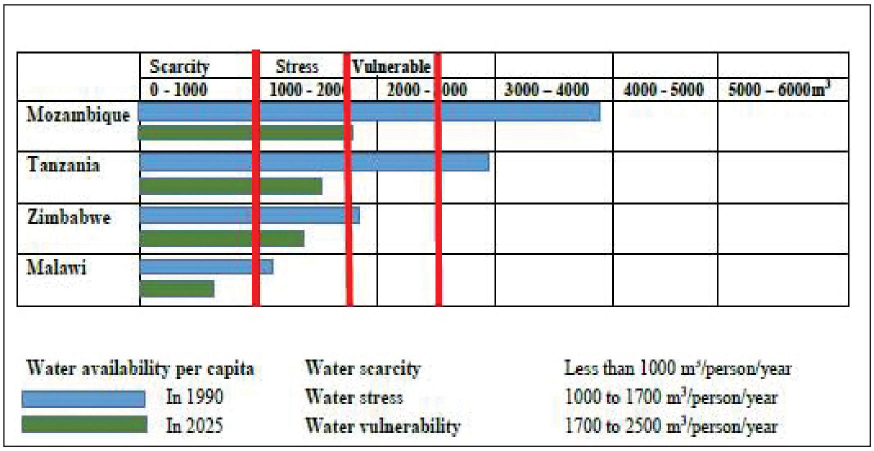
The Zambezi River Basin economies are therefore at risk of significant episodic shocks and chronic water scarcity and security. These can have direct and severe impacts on the economy, poverty, public health and ecosystem viability. Figure 5.13 shows the state of water availability in 1990 and the projected availability in 2025 for selected Zambezi Basin States. Mozambique, Tanzania and Zimbabwe are projected to have water scarcity by 2025 if temperatures continue to rise.

Figure 5.12 **Population with Increasing Stress**



Dube and Chimbari, 2009

Figure 5.13 **Current and Future Water Scarcity, Stress and Vulnerability in some ZRB States**



Digout, Delphine, based on a sketch by Philippe Rekacewicz; UNEP GRID-Arendal 2013; UNECA

Box 5.2 **FACTORS THAT EXACERBATE AFRICA'S VULNERABILITY TO CLIMATE CHANGE AND CLIMATE VARIABILITY**

Key factors that increase the vulnerability of Africa's population to the impacts of climate change and climate variability include:

- Heavy reliance on agriculture and other natural resources for livelihoods;
- Limited technologies to cope with the impacts of climate change, such as irrigation technologies that would make farmers less reliant on rain-fed agriculture;
- The prevalence of dry lands, which may experience reduced yields or be pushed out of production by changes in rainfall patterns or shorter growing seasons;
- Changes in rainfall patterns may transform additional productive land into dry land;
- Countries with water shortage or poor water infrastructure may become water-stressed as weather patterns become more erratic;
- Limited capacity of governments and institutions to deal with the impacts of climate change and to strengthen resilience of the population, especially vulnerable groups who are less resourced to deal with the impacts of climate change.
- The brain drain of qualified people can limit the ability of governments and institutions to respond; and,
- Lack of access to capital, insurance cover and other safety nets following disasters.

UNEP 2013

Implications of Reduced Water Flow and Increased Evaporation
According to IPCC (2007), it is estimated that the Zambezi River Basin will experience changes in precipitation (decreasing by 10-20 percent), potential evaporation (increasing by 10-25 percent), and runoff (decreasing between 26-40 percent). These hydrological changes will directly affect the potential output of hydroelectric facilities – existing and possible future projects. For example, the water level of the Kariba Dam dropped by 11.6 metres between 1981 and 1992, resulting in a reduction of the dam's capacity to generate hydropower. A reduction in flow levels over the Victoria Falls of 35 percent would cut annual power production by 21 percent and dry season production by 32 percent (SADC and SARDC 2006).

Climate change simulations for the Batoka Gorge hydroelectric scheme on the Zambezi River projected a significant reduction in river flows (a decline in mean monthly flow from 3.21×10^9 cubic metres to 2.07×10^9 cu m) and declining power production (a decrease in mean monthly production from 780 GWh to 613 GWh (SADC/SARDC and others 2012).

Increasing evaporation rates impact on the sustainability of wetlands. The loss of deltaic wetlands in the Zambezi River Basin is estimated at15,845 sq km over a 14-year period (Boko 2007). The same report projects an increase of 5-8 percent of arid to semi-arid land in southern Africa by 2080 using a range of climate scenarios. Crop yields can be affected, dropping by as much as 10-20 percent in some parts of the sub-region. See Box 5.2 on vulnerabilities.

Due to the limitations noted in Box 5.2, the Zambezi Basin is expected to experience the challenges summarised in Table 5.8.

Table 5.8 **Climate Change Related Challenges, Vulnerable Sectors and Vulnerability in the Zambezi Basin**

	Global warming and climate change impacts and vulnerabilities	Angola	Botswana	Malawi	Mozambique	Namibia	Tanzania	Zambia	Zimbabwe
Challenges associated with climate variability, global warming and climate change	Increased incidence of droughts	■	■	■	■	■	■	■	■
	Decrease in rainfall		■	■	■			■	■
	Seasonal shifts in rainfall	■	■	■	■	■	■	■	■
	Increase in impacts by cyclones				■				
	Localised floods	■	■	■	■	■	■	■	■
	Overflowing of large rivers				■				
	Lakeshore flooding			■			■		
	Decline on lake levels			■			■		
	Decreased / Varying river flows	■	■	■	■	■	■	■	■
	Wildfires	■	■	■	■	■	■	■	■
	Landslides in mountainous areas			■					
	Sea level rise	■			■	■	■		
	Salt water intrusion	■			■	■	■		
	Coral reef bleaching				■		■		
Vulnerable sectors	Water scarcity		■			■			■
	Biodiversity loss	■	■	■	■	■	■	■	■
	Health / Disease outbreaks	■	■	■	■	■	■	■	■
	Infrastructure	■	■	■	■	■	■	■	■
	Coastal ecosystems, cities				■	■	■		
	Fisheries	■		■	■	■	■	■	
	Agriculture and food security	■	■	■	■	■	■	■	■
	Livestock		■		■	■	■		■
	Tourism	■	■	■	■	■	■	■	■
Vulnerability context	Urbanization	■		■	■		■		
	Poor infrastructure	■		■	■		■	■	
	Gender equality	■	■	■	■	■	■	■	■
	Dependence on climate sensitive resources	■	■	■	■	■	■	■	■
	Poor water access by population	■			■		■	■	
	Poor health status	■		■	■		■	■	■
	HIV and AIDS		■	■	■	■	■	■	■

Adapted from Global Environment Change and Human Security 2008; National Adaptation Plans of Action

Responses to Climate Change Impacts

Adaptation Strategies

The 5th IPCC assessment report notes that regardless of future emissions, the world is already committed to further warming due to past emissions by developed countries. Due to the vulnerability of the Basin to climate change impacts, adaptation is a necessity and this position has been adopted by SADC. Adaptation to global warming requires both short- and long-term approaches to managing climate risks. In the short term, integrating climate adaptation and disaster risk reduction will help to withstand shocks to human security and economic development from which recovery can be costly (IPCC 2014). Communities of the Zambezi Basin have a long history of adapting to climate-related events such as floods and droughts. These however need to be revived and strengthened as the frequency and severity of the events have exceeded the usual coping ranges. There is need to compliment the traditional strategies with new technologies suitable to vulnerable communities, combining this with indigenous knowledge systems.

Most Basin States have adopted increasingly comprehensive development plans with ambitious social and economic development objectives. They have attempted to move beyond the narrow objective of poverty reduction to encompass wider objectives of accelerated growth, employment creation, provision of water, sanitation, health and education needs within the framework of sustainable development. Several countries have adopted national climate resilience strategies, and some initiatives are underway to reduce the impact of the spread of malaria, as shown in Box 5.3.

Box 5.3 **RESPONSE TO MALARIA OUTBREAK**

Partners in the Roll Back Malaria initiative (WHO, UNICEF, UNDP and the World Bank) have developed a new early warning and response approach that includes seasonal forecasts and climate monitoring as well as vulnerability assessment, case surveillance, and response planning (Connor and others 2007). The four components allow planning and preparedness for epidemics, so that response activities can be implemented in the right place at the right time.

The Roll Back Malaria initiative aims to identify stakeholders, consolidate research, and strengthen malaria control through support for the development of strong national and regional health systems. Under the initiative's targets endorsed by African countries in 2000, national malaria control services are expected to detect 60 percent of malaria epidemics within two weeks of onset and to respond to 60 percent of epidemics within two weeks of their detection.

The early warning system for malaria has been introduced in Botswana, Mozambique, Namibia and Zimbabwe. In Botswana, routine vulnerability monitoring and regular assessments of drug efficacy are done at key sites. With this early warning system, if an epidemic looks likely ahead of malaria season, emergency containers with mobile treatment centres and necessary medical supplies are prepared. Zambia has reduced incidences of reported malaria cases by reviving the indoor residual spraying programme as well as provision of insecticide-treated nets.

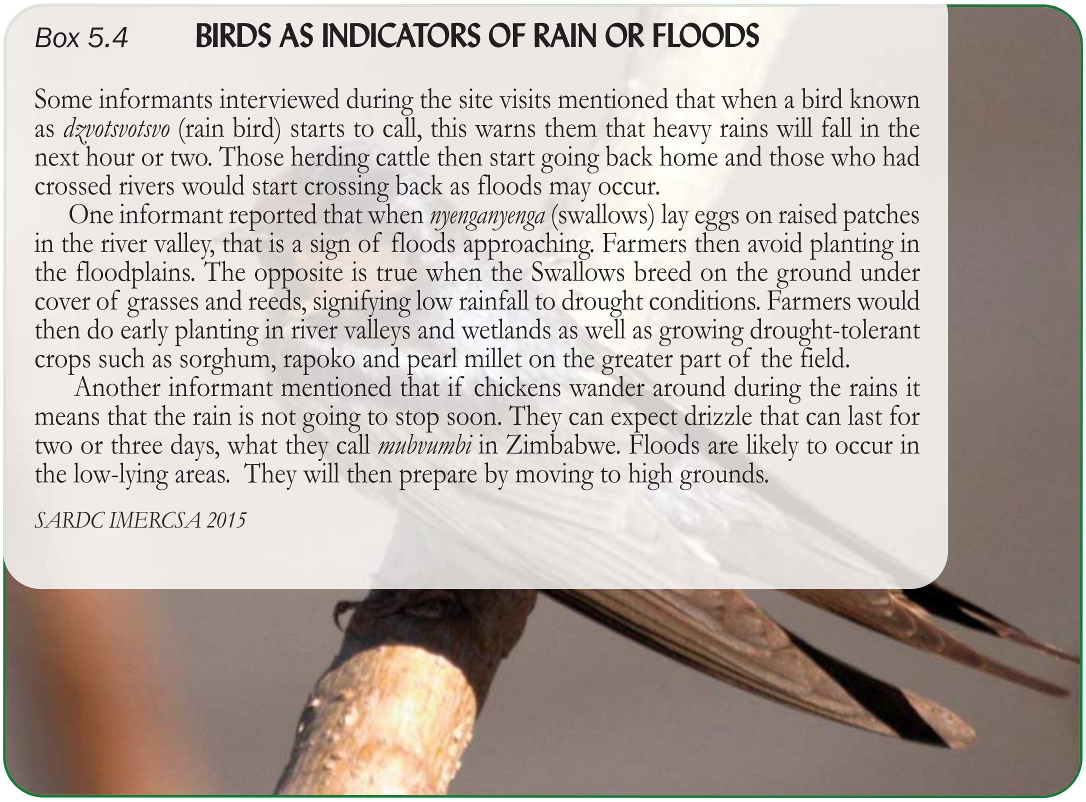
Current malaria control strategies rely mostly on individuals and communities taking action themselves to reduce mosquito breeding sites, sleep under mosquito nets, welcome spray teams, and treat symptoms of malaria with anti-malaria drugs, either at home or at nearby health facilities. These strategies succeed only when communities understand the causes of malaria and how to prevent and treat the disease.

SARDC and HBS 2010

Disaster Risk Reduction in the Management of Climate Change Induced Extreme Events

The Zambezi River Basin has many communities living in flood-prone areas such as the lower Shire in Malawi, Eastern Region in Namibia, the Zambezi delta in Mozambique, the Muzarabani district in Zimbabwe, and the Kazungula district in Zambia. In these areas both structural and non-structural measures of flood management strategies are being practiced (SARDC and HBS 2010).

Structural measures include as the construction of dams and weirs. Plans are underway to build the Batoka dam mainly for hydroelectric power but also to serve as a flood management structure. The non-structural measures range from flood forecasting to rescue operations, defining areas to settle as well as traditional ways of flood management. Data collection of rainfall and discharge from rivers is done



Box 5.4 **BIRDS AS INDICATORS OF RAIN OR FLOODS**

Some informants interviewed during the site visits mentioned that when a bird known as *dzvotsvotsvo* (rain bird) starts to call, this warns them that heavy rains will fall in the next hour or two. Those herding cattle then start going back home and those who had crossed rivers would start crossing back as floods may occur.

One informant reported that when *nyenganyenga* (swallows) lay eggs on raised patches in the river valley, that is a sign of floods approaching. Farmers then avoid planting in the floodplains. The opposite is true when the Swallows breed on the ground under cover of grasses and reeds, signifying low rainfall to drought conditions. Farmers would then do early planting in river valleys and wetlands as well as growing drought-tolerant crops such as sorghum, rapoko and pearl millet on the greater part of the field.

Another informant mentioned that if chickens wander around during the rains it means that the rain is not going to stop soon. They can expect drizzle that can last for two or three days, what they call *mubvumbi* in Zimbabwe. Floods are likely to occur in the low-lying areas. They will then prepare by moving to high grounds.

SARDC IMERCSA 2015

by the relevant national agencies. Other sources of information are satellite observations, forecasts from other institutions, information from the local communities and local authorities.

Dissemination of information is normally through newspapers, radio, television, telephone, internet, and awareness programmes by governments and non-governmental organizations. Multi-sectoral meetings on flood management, coordinated by the civil protection agencies are well attended and positive contributions are made.

According to a mapping survey carried out by a SARDC research team in flood-prone areas of Muzarabaani in Zimbabwe, Kazungula in Zambia and Katima Mulilo in Namibia, communities suggested the need for an integrated approach to incorporate traditional knowledge in disaster risk reduction (SARDC 2015). Communities use effective indicators such as birds, insects and atmosphere conditions as very effective means of early warning and forecasting. Box 5.4 presents some of the indicators used by communities in the Zambezi Basin.

Another effective traditional flood management strategy is the *Kuomboka* practiced in Western Zambia (Box 5.5). Here the Lozi King leads the people in an annual migration out of the floodplains to higher ground.

Box 5.5 **KUOMBOKA CEREMONY**

Kuomboka — "moving out of the water" — is an annual ceremony where thousands of people gather to dance, feast and watch the royal barge rowed by dozens of oarsmen beneath a giant replica elephant, signifying the start of the flooding season. This is the traditional signal for local people to follow the king in escaping the rising waters in the Barotse floodplains (SARDC and HBS 2010).

Table 5.9 **Main Adaptation Activities, Interventions and Delivery Methods**

Adaptation goal/ Expected outcomes	Main line intervention and delivery
Minimize physical exposure to climate hazards	• Flood control measures such as dams, levees, early warning systems, improved drainage, river re-routing, improved land management, eg watershed afforestation to manage runoff, preservation of wetland systems to manage runoff • Coping with drought measures such as improved water management/water harvesting • Frost control measures such as watering or covering crops/plants at night • Migration or relocation away from flood zones, coastal areas
Avoid or reduce potential for adverse impact	• Improved water treatment to avoid contamination from floodwaters, salinization • Reducing dependence on rain-fed agriculture
Enhance adaptive capacity and resilience (address determinants of adaptive capacity)	• Increase wealth/income especially of rural poor through economic diversification, access to micro-finance • Modify climate-system relationship such as through manipulation of thresholds or coping ranges, dependence on climate (eg reducing dependence on rain-fed agriculture) • Improve ecosystem integrity through reduced siltation and erosion control, fire control, eradication of invasive species, avoid overgrazing, rehabilitate degraded areas
Improve planning to take changing climate into account to avoid an adaptation deficit and remove any barriers to adaptation	• Modify planning process to integrate climate change and adaptation into sectoral and national plan (mainstreaming) • Remove barriers through policy review and/or development of new policies to facilitate adaptation
Create and manage information to facilitate adaptation	• Build knowledge bases through research, monitoring, extension and outreach, early warning systems to improve adaptation planning and implementation • Build capacity in communities to take climate change into account

Global Environment Fund, 2007

For drought, both traditional and conversional strategies are being used, including drought insurance. In Malawi the index-based weather insurance against drought for smallholder farmers has proved successful. In the first year, 892 farmers bought insurance as part of a bundle that included a loan for inputs for groundnuts production. The following year the scheme took in maize farmers, bringing the total to 1,700 and stimulating interest among banks, finance, processing and trading companies, and input suppliers (IPCC 2015)

This is similar to the safety net used traditionally in Zimbabwe to cushion communities in times of drought, called *zunde ramambo* (the chief's granary). This is a traditional concept that boosts the chief's grain reserves which can then be used to help those in need, and also feed visitors when the chief hosts a function at the compound. The concept was disrupted by the colonial policies of land apportionment and the undermining of the traditional leaders' authority in the communities. However, *zunde ramambo* has remained an active preparation and response to drought years, and a very important factor in disaster risk reduction. Some common interventions and responses to impacts of climate change are shown in Table 5.9.

Policy Options

In response to the impacts of global warming and resulting changes in climate, the Zambezi River Basin countries have begun to apply a number of policy response options. These include the establishment of disaster risk reduction and disaster management programmes, early warning systems, crop research into drought-resistant varieties, and development of actions plans for climate change adaptation and greenhouse gas mitigation.

Box 5.6 **DISASTER RISK REDUCTION IN MOZAMBIQUE**

The establishment of the National Disaster Management Institute (INGC) was a change in approach to disaster management, from reaction to preparedness and risk reduction.

Under the national disaster policy, preparedness for floods is facilitated by a flood early warning system. This provides forecasts of flood risk, detects and monitors flooding, and puts out flood warnings when necessary, to ensure a coordinated response.

The flood early warning system is coordinated by the National Directorate of Water, together with the National Institute of Meteorology and the National Disaster Management Institute. This collaboration reflects the essential integration of hydrologic and climate information needed to understand and predict floods and to manage an effective response.

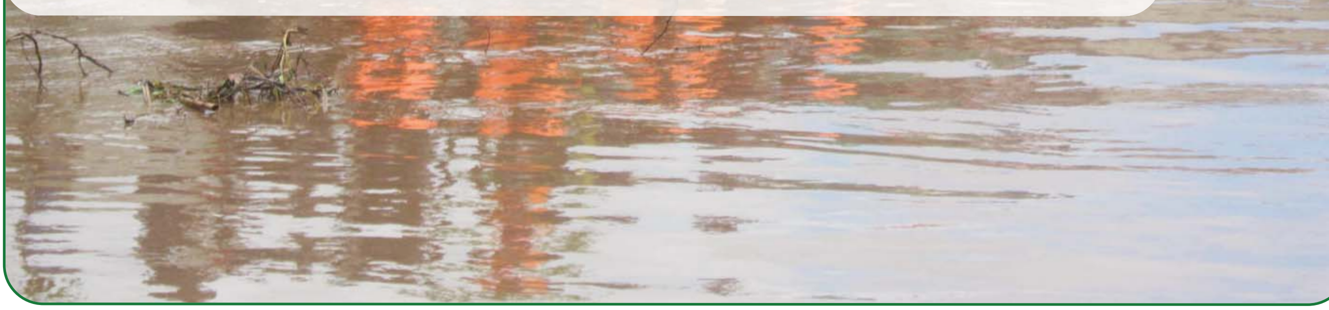
If flooding is expected, a flood team is mobilized whose role is to monitor the situation, receive and analyze information, recommend responses, ensure collaboration between the different bodies involved, and coordinate activities at central and local levels.

The INGC works closely with the SADC Climate Service Centre (formerly Drought Monitoring Centre). This centre works with Regional Water Administrations (RWAs), which monitor water levels and provide data to the National Institute of Meteorology.

The RWAs issue flood warnings when necessary, to district and local authorities and also to the media (radio, television, and newspapers). District and local authorities, civil protection units, in collaboration with the Red Cross and other non-government organizations are responsible for the dissemination of information, and in particular warnings, at the local level, and for the evacuation of people before floodwaters rise.

Mozambique now has a tropical cyclone warning system, distinct from the flood early warning system. This informs people of the probable arrival of a tropical cyclone at least 48 hours in advance. Color-coded messages, including flags, are used to warn the population. A TV studio devoted to weather forecasting is also in use.

SARDC and HBS 2010; INGC 2013



Malawi, Mozambique, Namibia, Zambia and Zimbabwe now have National Disaster Management programmes in places. While other places also face significant impacts during floods, Mozambique is often hit the hardest due to its geographical position being at the lower receiving end of the Zambezi and other rivers. Box 5.6 explains how the Mozambique disaster management programme operates.

Besides national, regional and global approaches to deal with climate change issues, the coordination of adaptation strategies at Basin level will be handled by the permanent Zambezi Watercourse Commission (ZAMCOM) which was established in 2014, resulting from the SADC Protocol on Shared Watercourses. The main objective of ZAMCOM is to promote equitable and reasonable utilization of the water resources of the Zambezi Watercourse as well as the efficient management and sustainable development thereof.

ZAMCOM, whose secretariat is based in Harare, Zimbabwe, is expected to strengthen cooperation by member

Table 5.10 **Mitigating Greenhouse Gas Emissions from the Agricultural Sector**

Crop rotations and farming system design	Improving crop varieties; Featuring perennials in crop rotations; Making greater use of temporary cover crops between successive crops or between rows of plantations; Avoiding bare fallows; Enhancing plant and animal productivity and efficiency; Adopting farming systems with reduced reliance on external inputs such as rotations that include legume crops.
Nutrient and manure management	Improving nitrogen-use efficiency, reducing leaching and offsite N2O emissions; Adjusting fertilizer application to crop needs through synchronization and using slow-release fertilizers; Applying N when crop uptake is guaranteed; Placing N into soil to enhance accessibility; Avoiding any N-surplus applications; Managing tillage and residues; Reducing tillage or no-till.
Livestock management, pasture and fodder supply improvement	Reducing lifetime emissions; Breeding dairy cattle for lifetime efficiency; Breeding and management to increase productivity; Implementing deep rooting species; Introducing legumes into grasslands to enhance productivity; Preventing methane emissions from manure heaps and tanks; Producing biogas; Composting manure.
Maintaining fertile soils and restoration of degraded land	Initiating re-vegetation; Improving fertility by nutrient amendment; Applying substrates such as compost and manure; Halting soil erosion and carbon mineralization by soil conservation techniques such as reduced tillage, no tillage, contour farming, strip cropping and terracing; Retaining crop residues as covers; Conserving water; Sequestering Co2 into the soil as soil organic matter.

IPCC 4th Assessment Report

states in the sustainable utilization of resources and this includes monitoring implementation of disaster management strategies.

Several policies and plans are in place to support the Zambezi Basin's resilience to climate change, such as the Regional Strategic Action Plan on Integrated Water Resources Management (RSAP III). The objective of RSAP III (2011-2015) is to strengthen the enabling environment for the governance, management and development of SADC regional water resources through the application of Integrated Water Resources Management (IWRIM) at regional, river basin, national and community levels. RSAP IV is being developed to cover the period 2016-2020.

Other SADC programmes that contribute to studies on climate change and water are relevant to the Zambezi River Basin, such as those of the Water Demand Management (WDM) programme and civil society institutions.

While SADC prioritises adaptation, which provides immediate benefits to the already vulnerable communities, mitigation strategies are also being explored. Supporting adaptation, the 4th IPCC Assessment Report made important recommendations on how agriculture could mitigate greenhouse gas emissions (Smith and others 2007). These recommendations include crop rotation and farming system design; nutrient and manure management; livestock management, pasture and fodder supply improvement; maintaining fertile soils; and restoration of degraded land. See Table 5.10.

Regional and Global Climate Agreements

A SADC climate change strategy for the water sector was developed in 2011 that recommends adaptation actions (SADC 2011). In response, SADC member states have developed or are developing specific climate change strategies and policies that with the regional and global instruments.

The SADC Climate Services Centre (CSC) was established in 1990 (formerly the Drought Monitoring Centre) as part of an initiative by African Governments to address calamities arising from the re-

Table 5.11 **Adaptation and Mitigation Initiatives in Basin States**

Adaptation	Mitigation	Supporting Measures	Others
Risk and Disaster Management **Malawi** Implementing the National Framework on Climate Change Adaptation. **Namibia** An overview of the vulnerability of Namibia to climate change; **Climate** Change Risk Assessments such as Cuvelai Drainage project. **Tanzania** Development of climate change scenarios; Analysis of rainfall and temperature trends; Evaluate policy options to analyse the feasibility, viability, cost and benefits of the alternative options. **Zimbabwe** Finalising the Climate Change Response strategy and discussions for a climate change policy are underway.	**Energy** **Malawi** Implementing the National Framework on Climate Change Mitigation; Developing and implementing projects on Clean Development Mechanism; Formulating National Appropriate Mitigation Actions. **REDD** **Tanzania** National REDD Programme to establish financing mechanisms and monitoring and verification systems; REDD policy development and inclusion into UNFCCC framework **Land Use, Land Use Change, Forestry (LULUCF) and Carbon Markets** **Malawi** Developing a National Framework on Management of future climate change in agriculture, forestry, land, water, fisheries; Planned Activities include carbon sequestration and carbon trading programmes. **Tanzania** Greenhouse Gas inventory for five modules – energy, agriculture, waste, LULUCF, and industrial processes.	**Capacity Building** **Malawi** Planning capacity-building for implementation of the Convention and Kyoto Protocol **Namibia** Capacity development, research, monitoring, public awareness and technology needs; Identification of financial and technology needs required for adaptation and mitigation actions; Participation National CC awareness raising and capacity development workshop **Tanzania** Assess the capacity of the national meteorological agency to participate in systematic climate data observation and station networks; Programme on awareness for policy makers and the general public on impacts of climate change. **Zambia** National Mitigation Analysis and Institutional Capacity Building Programme; National capacity self-assessment for implementation of Rio Convention for effective implementation of UNCBD, UNCCD and UNFCCC; Comprehensive national climate change awareness program.	**Malawi** Formulation of a Climate Change Policy. **Namibia** Studies on assessments of the source and sinks of greenhouse gases in Namibia. **Zambia** National Implementation Plans (NIPS) and Management of Persistent Organic Pollutants (POPs) under the Stockholm Convention
Sectoral Planning and Implementation			
Malawi	Climate Adaptation for Rural Livelihoods and Agriculture- - Adaptation activities in agriculture, water, forestry, fisheries, energy. National Framework on Management of future climate change in Malawi in agriculture, forestry, land, water, fisheries.		
Namibia	Scoping to mainstream Climate Change Adaptation considerations throughout the existing support programmes.		
Tanzania	Development of National Action Plan on Climate Change. Assess Vulnerability and Adaptation and also focus on assessing the impact of climate change on economic sectors.		
Zambia	Address adaptation priorities in the food security and public health sectors; impact of climate change to short, medium and long term development priorities in the FNDP; and Designation of a CDM national authority.		
Zimbabwe	A project was established to develop and pilot a range of long-term adaptation measures in the agriculture sector to reduce the vulnerability of smallholder farmers and pastoralists in rural Zimbabwe to current and future climate change related shocks. This also seeks to develop long-term policy-oriented approaches for adaptation to climate change among rural men and women in agriculture.		

IPCC 4th Assessment Report

current extremes of climate variations. This centre has contributed significantly to the reduction of negative impacts of adverse climate. According to the SADC regional strategic plan, the RISDP, the target beneficiaries of CSC include diverse end-users, who are expected to apply climate and hydro-meteorological information and products in the various weather-sensitive economic sectors such as agriculture, health, energy, water resources management, disaster management, transport and others. Decision-makers and policy-makers in various government departments, the private sector and NGOs are also expected to use the products and services to devise strategies for addressing the impacts of climate extremes.

The Southern Africa Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL) has been launched as a joint initiative by Namibia, Angola, Botswana, South Africa and Zambia. Its objective is to support cross-border research and enhance regional scientific capacity in order to increase the capacity of SADC countries to respond effectively to the challenges of climate change. The initiative includes land degradation as this compromises the wellbeing of the region and its people, especially in rural areas.

SADC is implementing a five-year programme on Climate Change Adaptation and Mitigation jointly with the Common Market for Eastern and Southern Africa (COMESA) and the East African Community (EAC). The programme aims to address the impacts of climate change in the COMESA-EAC-SADC region through adaptation and mitigation actions that are people-centred, reduce vulnerability, and foster regional integration. This tripartite programme is expected to support member states in their efforts to mitigate and adapt to climate change impacts.

All Zambezi Basin states are Parties to the United Nations Framework Convention on Climate Change (UNFCCC), and the Convention to Combat Desertification (UNCCD), and have ratified or acceded to the relevant protocols related to these conventions.

Governments have undertaken mandatory activities pursuant to obligations under the UNFCCC. These include participation in UNFCCC processes; Initial communication on greenhouse gas inventories; mitigation and adaptation measures; and development of National Adaptation Programmes of Action. Governments are in different phases of implementing national policy and communication strategies (Brida, 2013). Botswana Malawi, Namibia and Zimbabwe are at advanced stages of development of national climate change policies, strategy and action plans.

An assessment of the national communications to the UNFCCC suggest that countries are already applying a suite of measures to improve their energy efficiency and reduce carbon intensity.

Other Non-Policy Strategies

Adequate and reliable data and information

Evidence-based decision making is possible only if adequate and reliable data exist on the issues at stake. Strengthening the data and information base on environment and health linkages, including gender disaggregated data and information, would therefore enable adequate assessment and subsequent use of the findings to inform planning, budgeting, reviewing policy performance and evaluating progress towards the desired environment and health outcomes.

Capacity building in climate science

The Zambezi Basin and the rest of southern Africa relies heavily on global models for predicting future impacts of climate change. The main challenge is the unavailability of local data as well as limited capacity to develop the climatic models at local level. There is therefore need for capacity-building in climate science in the Zambezi Basin states.

Strategies to fit within national priorities
Adaption or mitigation strategies such as low carbon pathways have to fit into the specific national circumstances, as the nature of these pathways will depend on resources, capacities and governance realities.

The need to carefully manage mitigation options
Mitigation options should be carefully managed so that they do not introduce new risks to development. For example the adoption of new technologies or crops to reduce or sequester carbon can undermine the development opportunities and climate resilience of vulnerable social groups. Hence a robust decision-making process is needed to avert these risks.

Integration of water, energy, and food nexus in view of climate change
As climate change impacts on all sectors, there is need for integration of water, energy and food security in the strategies to address climate change impacts. Climate change challenges have prompted calls from stakeholders for a greater role for river basin organizations such as ZAMCOM to enable them to drive the water-energy-food nexus approach.

The need for climate-proofing of development strategies
Current development strategies must be climate-proofed. There is no single approach to adaptation. Countries in the Zambezi Basin and the rest of southern Africa have little climate data information to use in assessing the overall risks and vulnerabilities triggered by climate factors. Data and information are essential to develop accurate and robust climate-resilient strategies and policies, and national and sectoral development plans. Another challenge is that development planning tends to take place at a national level and may not take account of the impacts of climate change and variability in particular localities. National policies can inadvertently disregard or undermine cultural, traditional and context – specific practices that support local adaptation to climate change.

Need for financial support and technology transfer
Funding support and technology transfer are needed to improve the current level of adaptation in the Zambezi Basin, and to protect rural and urban livelihoods, societies and economies from climate change impacts.

CHAPTER LINKAGES

Chapter 1 Overview
Climate change and variability is increasingly contributing to the threats to human and environmental health through atmospheric pollution and other impacts, including damage to the natural environment.

Chapter 2 Water Resources
Climatic factors resulting in droughts and floods concern the Zambezi River Basin where disparities in the temporal and spatial variations in water supply are a common feature. Integrated water resources management becomes increasingly important as a strategy to conserve and manage water.

Chapter 3 Land and Agriculture
Climate change can impact on food security and cropping as temperatures change, unless this is recognized and methodologies reassessed. Agriculture is a major source of pollution through the use of herbicides, fertilizers and pesticides, which find their way into the soil and the air, especially when applied as aerial sprays, hence contributing in a small way to global warming.

Chapter 4 Biodiversity and Forests
The Zambezi Basin is under threat of species and habitat loss due to climate change. Natural resources are changing and relocating under the impacts of climate change, as their habitat alters, animals migrate, vegetation relocates, coral reefs and other species are lost. Forests and woodlands provide an important sink for greenhouse gases such as carbon dioxide. One of the efforts towards climate change abatement is to maintain and establish forests and woodlands.

Chapter 6 Energy
Renewable energy plays a critical role in resilience to climate change, but reduced flow resulting from climate-induced change of rainfall patterns also impacts on hydropower generation.

Chapter 7 Urbanization and Human Settlements
Settlement patterns are to a large extent determined by weather and climate patterns. With sea level rise caused by climatic change there are fears that stretches of coastal settlements will be inundated.

Chapter 8 Tourism
The impacts of climate change on the tourism sector could intensify as global greenhouse gas emissions increase. Reduced flows over the Victoria Falls due to the changing climate would affect plant and wildlife, but also diminish the visual appeal of the world heritage site impacting negatively on the site's vibrant tourism activities.

Chapter 9 Industrial Development
Air pollution that arises from economic activities of industrial development has affected air quality throughout the basin.

Chapter 10 Scenarios
Atmospheric pollution is a worsening problem in the basin. There is need for timely interventions through appropriate policy and strategic interventions.

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ENERGY 6

Introduction

The Zambezi River Basin is endowed with numerous sources of energy such as coal in Botswana, Mozambique and Zimbabwe; gas in Mozambique, Namibia and Tanzania; hydro in Angola, DRC, Mozambique, Zambia and Zimbabwe; oil in Angola; and uranium in Namibia. Oil exploration is underway in the Basin countries with high prospects in Lake Malawi/Niassa/Nyasa and offshore in the Atlantic and Indian oceans. Uranium exploration is underway in Botswana and Zimbabwe. Non-conventional renewable energy resources such as wind, solar, biomass, geothermal and small hydro are also distributed across the region (Musaba and others 2013).

Energy plays a pivotal enabling role in the development agenda of any region and the Zambezi Basin is not an exception. The post-2015 global agenda includes initiatives such as Sustainable Energy for All (SE4ALL) which seeks to achieve universal access to sustainable and environmentally friendly energy services by 2030. Lack of reliable energy sources is often cited as a handicap to growth and poverty reduction in any country or region (NEPAD and AU 2011).

This chapter discusses energy issues in the Zambezi River Basin. Responses at national and regional levels are also analysed in order to provide recommendations on the appropriate policy and institutional arrangements. Issues discussed in the chapter include energy security, energy equity as well as environmental sustainability.

Pursuant to a decision of the 12th Assembly of Heads of State and Government of the African Union (Declaration Assembly/AU/Decl.1 (XII), the Program for Infrastructure Development in Africa (PIDA) was launched by the African Union Commission working with the UN Economic Commission for Africa (ECA), the African Development Bank (AfDB), and the New Partnership for Africa's Development (NEPAD). This recognizes the fact that energy and other infrastructure unlock opportunities to strengthen agricultural, mining and industrial development, trade facilitation, and improved quality of life for both urban and rural communities (AfDB 2012). PIDA provides a framework for addressing the infrastructure deficit in Africa through integrated planning and development at regional and inter-regional levels.

Box 6.1 **ENERGY DEFINITIONS**

Energy Security is the effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand

Energy Equity means the accessibility and affordability of energy supply.

Environmental Sustainability encompasses the achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources.

World Energy Issues Monitor 2014

Energy Security

The Zambezi Basin is facing a daunting task of bridging the energy access gap, and has been experiencing a power supply deficit since 2007. Table 6.1 shows

Table 6.1 **Total Energy Production and Use for Basin States**

Country	2000 Use	2000 Production	2002 Use	2002 Production	2004 Use	2004 Production	2006 Use	2006 Production	2008 Use	2008 Production	2009 Use	2009 Production
	Kilotonnes of Oil Equivalent											
Angola	7 429	43 680	8 180	51 434	9 530	57 610	9 886	79 993	11 375	105 777	11 896	100 958
Botswana	1 836	1 127	1 916	1 119	1 857	1 018	1 962	1 055	2 171	1 037	2 048	938
Mozambique	7 173	7 258	7 645	7 763	8 375	9 045	8 742	10 698	9 389	11 528	9 766	11 918
Namibia	1 019	286	1 169	298	1 399	323	1 538	313	1 840	324	1 713	329
Tanzania	13 390	12 691	14 928	13 939	16 190	15 053	17 841	16 360	18 957	17 470	19 616	18 046
Zambia	6 247	5 925	6 636	6 215	6 998	6 436	7 388	6791	7 612	7 034	7 856	7 241
Zimbabwe	9 886	8 618	9 710	8 643	9 287	8 611	9 653	8 678	9 506	8 533	9 514	8 530
SADC Average	18 080	24 272	18 321	25 193	15 987	27 591	16 306	30 274	23 596	33 633	23 219	33 194

SADC 2012

that most Basin states use more energy than they produce, suggesting that many countries rely on energy imports. The SADC region as a whole has suffered shortages and the energy gap is widening as demand grows, although their are many initiatives to increase supply. The main uses of energy in the Basin include domestic (cooking, heating and lighting), industry (heating and cooling), and agriculture (tilling, irrigation).

The biggest source of energy for the Zambezi Basin is biomass fuel derived from living organisms but traditionally from wood (used directly as fuel wood or as charcoal), dung and agricultural residues. Natural forests, which comprise 75 percent of the land area in the Basin, provide the bulk of the fuelwood and charcoal used by the majority of the population. FAO (2000) notes that households and communities in rural areas in developing countries typically rely on diverse sources of energy – using one fuel for heating, another for cooking or lighting, and others for agricultural and other productive activities. FAO further notes that biomass fuels are locally "free" in cash terms, but have a cost of much time and physical effort, usually by children and women.

Table 6.2 shows the energy mix for basin states at household level, highlighting the heavy reliance on fuelwood. Increasing poverty in urban areas has forced many people to turn to charcoal and fuelwood to meet their domestic household needs (UNEP 2002). At the beginning of the millennium, studies showed that the majority of Zambia's fuel wood was converted into charcoal, some 430 sq km of woodland every year produced more than 100,000 tonnes of charcoal (Chenje 2000). The 2008 statistics for Malawi showed that about 90 percent of the population used wood for fuel and charcoal production, accounting for 88.5 percent of the country's energy requirements (Gregory and others 2012).

Table 6.1 **Fuels Used for Cooking and Access to Modern Fuels (as % of Total Population**

Country	Electricity	Gas	Kerosene	Charcoal	Wood	Dung	Coal	Other	Modern Fuels	Year
Angola	0.2	51.9		18.7	28.6	0.4		0.2	52.1	2006-07
Botswana	7.2	45.8	3.3		43.4	0.1	0.1	0.2	56.2	2006
Malawi	1.2	0	0	7.2	91.4	0	0	0.2	1.2	2006
Mozambique	0.8	1.4	0.5	0.4	84	0.2	12.6	0.1	2.7	2003
Namibia	29.3	5.7	0.1	0.6	62.3	0.3	0	1.7	35.1	2006-07
Tanzania	0.3	0.2	2.3	19	77.6	0		0.5	2.8	2007-08
Zambia	15.8	0	0	24.5	59.5	0.1	0.2	0	15.8	2007
	16.8	0	0	37.4	54.3	0	0	0.2	16.8	2010
Zimbabwe	32.6	0	0.2	0.1	66.8	0.1	0.1	0.1	32.8	2005-06

SADC 2012

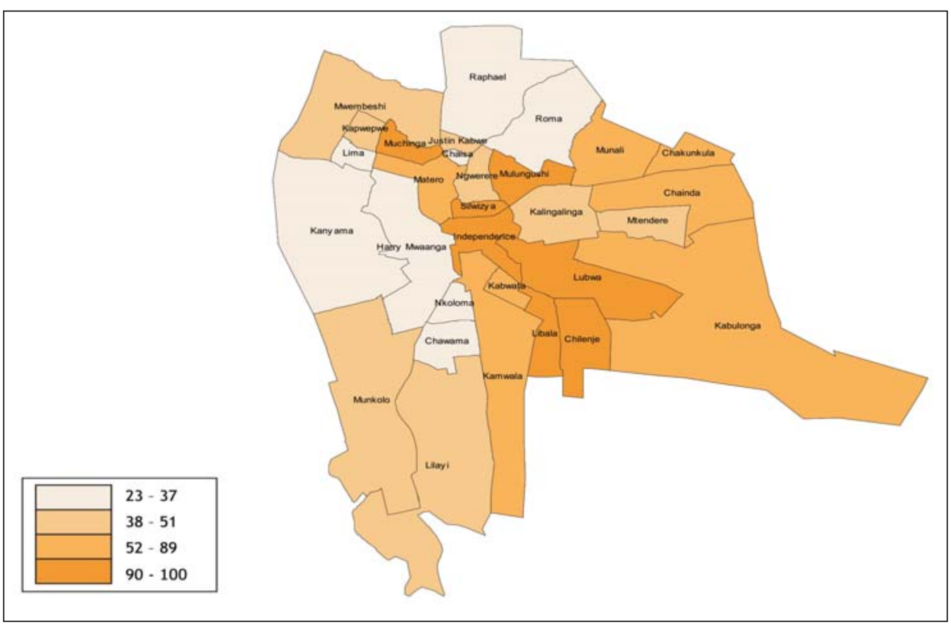
Box 6.2 LUSAKA ENERGY OUTLOOK

In Lusaka energy sources for the industrial sector include coal, wood, diesel and electricity while residential sector relies on fuelwood and electricity. Throughout Zambia urban and industrial use of fuelwood and charcoal make the greater portion of biomass demand, most of the charcoal is used in urban centres.

In the 1980s in order to meet energy demand, almost 2,000 ha of forest were felled annually. Lusaka experienced almost 100 percent increase in electricity demand during the 1994 to 2004 period. During 2004/05 the domestic sector was the major energy consumer.

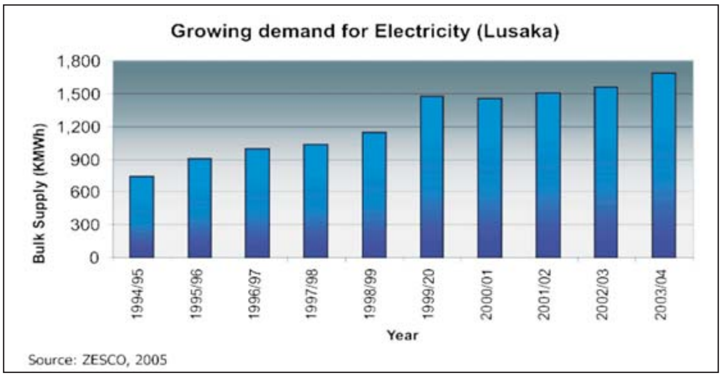
Of over 200,000 households, 54 percent used charcoal and 44 percent used electricity while the remainder relied on fuelwood and kerosene. Burning of biomass is a major source of stationary air pollution in the city.

Figure 6.1 **Distribution of Households with to Access Electricity in Lusaka by Ward**



SAPP Annual Report 2013

Figure 6.2 **Growing Demand for Electricity in Lusaka 1994-2004**



Considering the heavy demand by the domestic sector for electricity, the latest *Lusaka Environment Outlook* report has recommended promoting community awareness of electricity use and encourages the use of solar alternatives where possible. Lusaka industries can also benefit from adopting cleaner technologies.

ECZ 2008

Main Energy Issues in the Zambezi Basin

Accessibility and Affordability of Energy Supply across the Population
Electricity in the Zambezi River Basin is generated mainly from coal and hydro-electric resources. Hydropower production is an important economic sector and hydropower production is dominated by Cahora Bassa and Kariba. The Zambezi Basin is therefore an important source for hydropower in the region. The only river in southern Africa that has the potential to surpass the Zambezi in power production is the Congo (Chenje 2000).

The hydropower production sector is a major water user due to the evaporation from hydropower reservoirs (SADC and ZRA 2007).

A total capacity of 4,684MW has been developed in the Zambezi Basin, of which 75 percent is on the Zambezi River, producing an average of almost 33,000GWh per year. Of the total developed capacity, five percent is in Malawi, 45 percent in Mozambique, 36 percent in Zambia and 14 percent in Zimbabwe (SADC and ZRA 2007).

Natural gas is increasingly a key energy source, especially in Mozambique, Namibia and Tanzania where investments are being made in developing the gas fields.

Table 6.3 shows the current power installed capacity by members of Southern African Power Pool (SAPP). Approximately 57,000MW or 57 Gigawatts (GW) is the SAPP-installed capacity against a suppressed demand of 54GW, with an available capacity of 52GW. With a 10 percent reserve requirement, the region has a shortfall of 7.7GW.

Table 6.3 **Installed and Available Capacity in SAPP with Demand Forecast**

Country	Utility	Installed Capacity MW Jan 2013	Available Capacity MW Jan 2013	Suppressed Demand and Forecast Demand	Capacity Shortfall including Reserves MW	Calculated Reserve Margin %
Angola	PRODEL	1 515	1 480	1 341		
Botswana	BPC	442	322	604		
DRC	SNEL	2 442	1 170	1 398		
Lesotho	LEC	72	72	138		
Malawi	ESCOM	287	287	412		
Mozambique	EDM/HCB	2 624	2 279	636		
Namibia	NamPower	393	360	635		
South Africa	Eskom	44 170	41 074	42 416		
Swaziland	SEC	72	70	255		
Tanzania	TANESCO	1 124	1 124	1 444		
Zambia	ZESCO/CEC/LHPC	1 812	1 812	2 287		
Zimbabwe	ZESA	2 045	1 600	2 267		
	TOTAL SAPP	56 998	51 650	53 833	(7 766)	-4.2%
	Total Interconnected SAPP	54 072	48 759	50 636	(7 114)	-3.8%

SAPP Annual Report 2013

Therefore, the SADC region is currently running at 7.7GW power deficit.

The Zambezi Basin states account for only 18 percent of total power generation in the SADC region despite making up two-thirds of the SAPP membership. The bulk of the region's generation capacity (78 percent) comes from South Africa.

Most of the 57GW of current power generation capacity in SADC is from coal (70 percent), mainly in South Africa; hydropower (21 percent), mainly in the Zambezi and Congo River basins; distillate oil (5 percent); nuclear (3 percent); and gas (1 percent).

Power generation technology by country is illustrated in Table 6.4.

The regional power system operates with no reserve margin on many days and so the slightest disturbance is amplified. The diminished generation capacity is attributed to the following key factors (Musaba and Naidoo 2008):

- ***Economic growth***. Economic growth of more than five percent per annum for most SADC Member States has resulted in unprecedented growth in electricity consumption and demand. Sustainable economic growth requires adequate electricity supply. The shortage of power has affected the economic and social development of the entire region. Few countries are now expected to grow above five percent from 2008.
- ***Demand for base metals***. Increase in base metal demand on the world market has resulted in huge mining companies opening up in southern Africa. In Zambia, for example, most of the copper mines, which were closed at one time and deemed unprofitable then, are now back in operation and making profits. At the same time, new mines have been opened in most countries, contributing to high demand for power.
- ***Insufficient investment***. There has not been sufficient investment in generation and transmission infrastructure over the last 20 years. The region had excess capacity two

Table 6.4 **SAPP Generation Mix for 2012/13**

	Technology										
Country and (Utility)	**Coal**		**Hydro**		**Nuclear**		**CCGT**		**Distillate**		**Total**
	MW	**%**	**MW**	**%**	**MW**	**%**	**MW**	**%**	**MW**	**%**	**MW**
Angola (PRODEL)	492	32	833	55	-	-	190	13	-	-	**1 515**
Botswana (BPC)	282	64	-	-	-	-	-	-	160	36	**442**
DRC (SNEL)	-	-	2 442	100	-	-	-	-	-	-	**2 442**
Lesotho (LEC)	-	-	72	100	-	-	-	-	-	-	**72**
Malawi (ESCOM)	-	-	286	100	-	-	1	-	-	-	**287**
Mozambique (EDM and HCB)	-	-	2 573	97	-	-	-	-	51	3	**2 624**
Namibia (NamPower)	132	34	240	61	-	-	-	-	21	5	**393**
South Africa (ESKOM)	37 831	86	2 000	5	1 930	4	-	-	2 409	5	**44 170**
Swaziland (SEC)	9	12	63	88	-	-	-	-	-	-	**72**
Tanzania (TANESCO)	-	-	561	50	-	-	485	43	78	7	**1 124**
Zambia (ZESCO)	-	-	1 802	99	-	-	-	-	10	1	**1 812**
Zimbabwe (ZESA)	1 295	63	750	37	-	-	-	-	-	-	**2 045**
Total MW	**40 041**		**11 622**		**1 930**		**676**		**2 729**		**56 998**
%	**70**		**21**		**3**		**1**		**5**		**100**

IRENA 2014, Analysis from SAPP Annual Report 2013 decades ago and electricity was cheap. Some power stations were actually closed in some countries at the time as they were expensive to run and operate. Only recently did SAPP members start investing in generation projects. In 2007, for example, a total of about 1,700MW was commissioned by the SAPP and a further 1,700MW was commissioned the following year. This trend has now continued.

The case for increased investment in energy infrastructure and the search for sustainable energy sources in the Zambezi Basin have strengthened over the past decade due to the power deficit situation experienced in the region since 2007. The shortfall has been due to a number of factors, including growing demand against limited expansion in generation capacity.

Power demand in the Zambezi Basin and the rest of the SADC region has expanded at an estimated rate of three percent per annum during the past 10 years, and in 2007 the growth accelerated to 4.6 percent. This has resulted in demand exceeding supply and there is load shedding in most countries in the Basin. This has seen a greater role for the Southern African Power Pool (SAPP), established in 1995.

At the time of SAPP's formation, the region had generation surplus capacity and the reserve margin was well over 20 percent. In the last 10 years, the reserve margin has been reduced considerably and currently the region is operating at less than five percent (SAPP annual reports 2011-2013). Based on global practices, SAPP requires a 10.2 percent reserve margin at any time. This desired reserve margin is required to guarantee system reliability and allow for unexpected surges in demand for power that may occur from time to time.

Electrification programmes have partly contributed to the current power supply challenges. From 2005, most SAPP members embarked on massive rural electrification projects aimed at increasing accessibility to electricity in a region where on average 70 percent of the population have no access to electricity. This has seen the level of electrification increasing by more than 100 percent in Tanzania and almost doubling in Angola, Malawi and Zimbabwe between 1999 and 2007 (Table 6.5). Electrification levels in the Zambezi Basin ranges from five percent in Malawi to nearly 40 percent in Zimbabwe.

Despite rural electrification programmes in some Basin states, access to modern energy is still severely constrained, as a large percentage of the population is not connected to the grid. The percentage of rural population with access to electricity ranges from less than five percent in Mozambique to about 30 percent in Zimbabwe (Figure 6.3). Low levels of access to electricity are a factor in urban areas as well. Comparison with other SADC member states such as Mauritius and South Africa show that THE Zambezi basin countries need to strengthen efforts to extend access to electricity for the majority of the population.

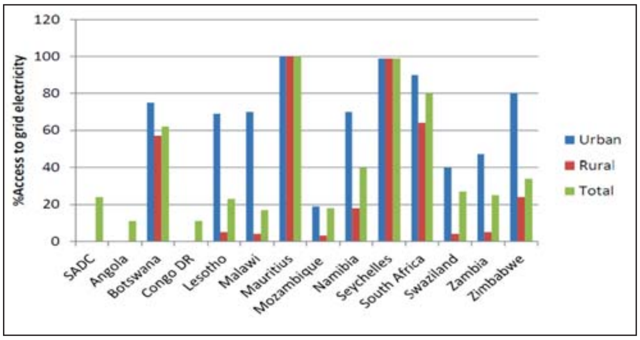
Poverty and the lack of access to fuel options mean that most of the Basin population (75 percent) relies primarily on biomass to meet its residential needs, and biomass supplies more than 80 percent of the energy consumed in the region (Hall and Scrase 2005). In Tanzania, Mozambique and Zambia, for example, nearly all rural households use wood for cooking and more than 90

Table 6.5 **Levels of Electrification in the Zambezi Basin**

Country	% Population with Access	
	1999	2007
Angola	8.0	15.0
Botswana	15.0	22.0
Malawi	3.0	5.0
Mozambique	6.0	7.2
Namibia	26.0	34.0
Tanzania	5.0	10.5
Zambia	12.0	20.0
Zimbabwe	20.0	39.7

SADC 2010

Figure 6.3 **Access to Grid Electricity in SADC Region**



SADC 2010

Table 6.6 **Contribution of Biomass Fuels to Energy Supply in 2000**

Country	Total Energy Supply	Energy Supply per capita	Biomass	Electricity Access
	Million tons of oil equivalent (Mtoe)	*Tons of oil equivalent (Toe) per capita*	*%*	*% Population*
Angola	7.67	0.58	73.6	12
Botswana	-	-	-	22
Malawi	-	-	-	5
Mozambique	6.98	0.40	87.1	7
Namibia	1.03	0.59	18.7	34
Tanzania	15.39	0.46	93.6	11
Zambia	6.24	0.62	78.8	12
Zimbabwe	10.22	0.81	56.5	40

The biomass values shown include only commercial biomass (that which is traded). One ton of fuel oil contains about 44,700 MJ of energy, which is equivalent to about 2 tons of oven dry wood.Energy supply and Population show weighted average

No data

Scholes and Biggs 2004

percent of urban households use charcoal (IEA 2002; van Jaarsveld and others 2005).

Dependence on Biomass

Due to limited access to electricity in the Zambezi River Basin, as discussed above, most people rely on burning biomass for domestic needs such as cooking, lighting and heating. Communities in the Basin rely heavily on firewood, which accounts for almost 80 percent of the total energy requirements among the rural and peri-urban populations (SADC/SARDC 1994). Experts predict that wood use in Africa will double by 2020 (ProBEC 2014).

Biomass was estimated to account for 74 percent of energy requirements at the start of the millennium (Chenje 2000), but there are data gaps on current biomass contribution to energy needs. However, due to increasing electricity shortages in both urban and rural areas, it is expected that there has been an increase in the number of people dependant on biomass for their energy needs.

Increased Deforestation as a Result of Overdependence on Biomass

The major threat to the Basin's forests is caused by the high dependence on fuel wood and charcoal. As mentioned

SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Deforestation as a result of increased biomass demand is shown in these images of areas surrounding Lilongwe, Malawi. The city began as a village beside the Lilongwe River. By 1977 the village had grown to a city with a population estimated at 99,000, and 35 years later, in 2012, the population had grown to 781,500. Expansion of the city has resulted in the deforestation of surrounding areas due to the high demand for firewood and land for farming. Lilongwe was founded as an agricultural market centre for the fertile Central Region Plateau of Malawi.

above, biomass is a major source of energy in rural areas and is expected to continue contributing about 80 to 90 percent of the residential energy needs of low-income households (IEA 2002).

Several studies and assessments over the past decade have indicated that some areas in central Mozambique, Malawi, eastern Zambia and Zimbabwe had rates of deforestation estimated at 0.4 percent per year during the 1990s (Simms and Schock 2007, Biggs and others 2004). This points to the vulnerability of the energy sector as one of the impacts of global warming could be drier conditions in the basin, thus reducing biomass growth while also reducing flow rates for hydropower.

Yields and costs of biomass energy depend on local conditions such as land and biomass waste availability and production technology. At present, advanced biomass conversion technologies as well as biomass plantations are in their infancy in the Basin and require further research and development to become technically mature and economically viable.

Apart from domestic use, wood fuel energy is used by some rural industries that consume significant amounts of firewood and these include brick making, lime production, fish smoking, beer brewing, and the drying of coffee, tea and tobacco (Chenje 2000; SADC/SARDC and others 2012).

Human Health Complications Caused by Indoor Pollution

The use of biomass has negative effects on public health, particularly on women and young people who are forced to inhale smoke for long hours while cooking. Some studies have found a link between biomass use for cooking and low birth-weight of children.

Biomass smoke is a complex mixture of pollutants including various gases and respirable particles. Several of these chemicals are known hazards to human health, including Carbon Monoxide (CO), nitrogen dioxide, benzene, formaldehyde, polycyclic organic compounds, and Particulate Matter (PM).

Of these, CO and PM may pose the greatest risk to infant mortality. CO reduces oxygen delivery to vital tissues and has been associated with low birth-weight

Box 6.3 **ENERGY INFRASTRUCTURE AND INDIGENOUS KNOWLEDGE SYSTEMS**

In the evolution and contemporary status of the savannah biome in southern Africa, fire and fire management have existed as a source of energy for more than a million years. The traditional use of fire in rural societies that guides natural resource management in daily livelihood activities includes burning pastures to improve forage, clearing croplands, apiculture, hunting and many other uses.

The *chitemene* system of agriculture in Zambia uses fire to create ash in the cropping programme of communities (Musonda in SADC/SARDC 1994). Small fires are used to cook, smelt iron, make pottery, hoe handles and other utensils. When allowed to get out of control, however, fires induce long-term deleterious results. Fire management and renewable biomass energy sources are intricately linked.

Daily energy supplies are intertwined with daily needs as illustrated in this case from Mhondoro Communal Land in Zimbabwe (Nabane quoted in Bradley and McNamara 1994).

"She prefers wood from mubondo (*Protea gaguedi*), musasa (*Brachsytegia spiciformis*), mususu (*Terminalia formis*) and muminu (*Psorospermum febrifugum*) because these species burn for a long time and produce charcoal she needs for ironing her family's clothes.

"She used to prefer mopane wood (*Colophospermum mopane*), but it is no longer available since people cut it all for firewood and for poles for roofing their huts. Because of the general scarcity of firewood, she is forced to collect species like mutimutema (*Diospyros lycioides*), muzeze (*Peltophorum africanum*) and muchava (*Monotes glaber*) which burn quickly and create too much smoke. She sometimes cuts dry muhacha branches (*Parinari curatellifolia*) for firewood. This was unheard of in the past because people performed their traditional rites under these trees.

"While she is collecting firewood, she also collects wild fruits like hute (*Syzgium guineense*) hachapasi (*Parinari capensis*) tsvanzva (*Ximenia caffra*). She also collects medicinal plants."

Clear gender roles are evoked at the family micro-level and complex, as noted in northern Malawi.

Nationally, electricity is from large dams, often at the expense of indigenous peoples. The most notable are Kariba and Cahora Bassa dams on the Zambezi, the ItezhiTezhi, Kafue Schemes, Zambia and the Lower Shire in Malawi. These large engineering projects paid little attention to displaced indigenous people. Kariba Dam displaced 70,000 Gwembe Tonga people in the late 1950s with serious social, economic and ecological impacts that still exist today and into the future (Magadza 2006).

Their traditional life, religion and belief that the Kariba Gorge itself was the "navel of the world", was replaced with poverty, for example in the Binga area of Zimbabwe.

Similarly, the Tawara people downstream of Cahora Bassa in Mozambique were herded into strategic hamlets, uprooted from their ancestral homes and from their ways and means of using the Zambezi River for their survival, a process they had known for centuries, to make way for Lake Cahora Bassa (Isaacman and Sneddon 2003).

The message is that all major infrastructure projects must ensure that people displaced by necessary national developments are protected and that they benefit from the project, so that their lives are made better than before.

This applies to national roads, railway lines and other large projects, including national parks. Otherwise, bitterness lingers on in people's new narratives of their histories, becoming inter-generational and often costly to national progress. Indigenous systems and peoples should not be lost in this manner, and should not be a cost but a boom to development.

Conversely, the indigenous Lozi built an intricate canal infrastructure to navigate the Upper Zambezi floodplains over a century ago, directed by the Litunga Lewanika. They are managed under traditional systems of the Barotseland Royal Establishment (SADC/SARDC and others 2012). More of this is needed in the river basin area.

Table 6.7 **Estimates of Renewable Energy Potential**

Country	Small Hydro MW	Solar Thermal TWh	Solar PV TWh	Biomass MW	Wind 20% CF MW	Wind 30% CF MW
Angola	300	97.9	133.2	500	230	0
Botswana	0	130.7	137.6	10	11179	1152
Malawi	100	44.7	52.1	200	2267	1159
Mozambique	300	168.5	220.2	1000	12335	1526
Namibia	200	297.2	261.8	50	17347	1910
Tanzania	200	314.8	388	1000	21068	11737
Zambia	300	156.9	178.9	1000	15102	4416
Zimbabwe	300	118.7	156.8	1000	13855	3986

TWh – Terawatt hours CF – Capacity Factor *IRENA and SAPP 2013*

(American Society of Tropical Medicine and Hygiene 2007). Even a small amount of PM can penetrate deep into the lungs, compromising host defence mechanisms and increasing the risk for respiratory infections.

Addressing Energy Challenges in the Zambezi Basin

Dependence on biomass must be reduced through provision of clean and sustainable energy alternatives such as solar, wind and natural gas. Biofuels present a great potential as well, as discussed below. There is also need to increase electricity supply through new power generation projects.

Biofuels

There is great potential for biofuel feedstock production, processing and utilization in the Zambezi River Basin and the rest of southern Africa, and the region has attracted substantial interest in large-scale biofuel investments. Biofuels are considered as a readily available, highly promising, innovative energy solution – provided their social, environmental and financial benefits can be optimised.

Several countries have plans to integrate biofuels in their energy diversification strategies (as other emerging economies have done) and to design a biofuel industry that maximises socioeconomic benefits. With the expansion of the SADC Free Trade Area (FTA), biofuels are expected to become a regionally traded commodity included in the FTA agreement.

Malawi and Zimbabwe have a long history of biofuel production and use, while other countries are in a planning or early implementation phase. Malawi and Zimbabwe have already mandated blending for ethanol, while others are preparing legislation or undertaking studies and assessments (SADC 2010). Ethanol processing facilities have been operating in Malawi for more than 25 years, and Zimbabwe produced ethanol for blending in the 1980s for a period, now resumed.

High prices of hydrocarbons relative to the cost of producing biofuels have created a strong incentive to expand production of biofuels in the Basin. Besides ethanol, the other biofuel produced in the region is biodiesel, which is made from vegetable oils. Production of biodiesel has been introduced on a small-scale in

Malawi, Zambia and Zimbabwe. A bioenergy company has developed 174,000 hectares of land in Zambia for the cultivation of vegetable oil crops for production of biodiesel.

The agro-ecological characteristics of the whole of southern Africa can accommodate most biofuel crops. In some countries, potentially productive land is still in relative abundance, for example in Angola, Mozambique, Zambia and Zimbabwe. Thus, the increased production of bioenergy feedstock, if carefully planned, would not disturb food production and could, if integrated into national agricultural development strategies, contribute towards increasing food crop production and agricultural productivity. Most Basin states are conducting agricultural mapping exercises to identify suitable land for biofuel feedstock production. Using existing and current climatic and soil data, crop suitability maps are being developed to identify areas most suited to biofuel production. Land zoning is considered to be a critical component for informed decision-making in biofuel programmes in the region.

With regard to impact on food security, production of biofuels in the Basin has so far not had a serious impact on the production of food because cereal food crops have not been used as the relevant feed, and because production has been on a small scale, thus avoiding competition for land with food crop production. However, the situation could change in future as biofuel production increases as this represents a big demand on the land resources of the country.

The shift towards the development of national biofuels programmes could have environmental, social and economic positive spinoffs for Basin states. Environmental benefits are expected from a reduction in air polluting compounds compared to the combustion of fossil fuels. Biofuel crop production, if appropriately planned and properly utilized, can offer an alternative and cheaper environmentally friendly fuel that can support rural development and poverty reduction (SADC 2009). This also has the potential to reduce land degradation and spread of invasive species – both common problems associated with unmanaged land. An emerging biofuel sector has the ability to improve farming practices and avoid environmental degradation associated with modern farming practices if guided by a set of sustainability criteria sensitive to production methods and operational scale.

Socio-economic benefits can be derived from employment and skills development throughout the value chain of biofuel refining and marketing. Biofuel feedstock production can provide an additional cash crop for farmers supporting a diversified cropping system. Biofuel production can increase rural incomes and if well managed, can empower women through development of farming skills for biofuel feedstock. However, the ability of rural women to take advantage of these opportunities depends on an enabling legislative environment and investment in extension services and skills training.

Economic benefits are expected from savings on importation costs of fossil fuels and through the marketing and distribution of refined products within the country.

Solar Energy

Solar thermal-electric systems have the long-term potential to provide a signifi-

cant portion of the Basin's electricity and energy needs. Research has shown that most countries in the SADC region receive more than 2,500 hours of sunshine per year, because this region and in fact the whole of Africa has sunshine all year round (SARDC 2010). Knowledge about solar energy is widespread in the Zambezi Basin, especially on its efficient results and low operating costs, although its use is still limited to small-scale cooking and water heating technologies.

Utility-scale solar plants are being developed in South Africa and piloted in Namibia. Solar water heaters are used throughout the region as a demand management measure to reduce pressure on the electricity networks. Solar PV has potential for mini-grids which can provide a solution for rural irrigation pumps and electrification for areas that are remote from the main grid.

The potential for the expansion and widespread use of solar energy in the Zambezi Basin will depend on innovative measures to reduce the initial cost while improving performance of solar electric technologies. With all the advantages and declining production costs, solar systems delivered to the end user are currently not cheap to install; a typical home system in the region costs anywhere between US$500 and US$1,000, according to the African Development Bank. The use of innovative financing schemes, such as fee-for-service arrangements, is one way to overcome these high up-front costs. Installing solar panels to power multiple houses at once can also cut down on costs. Botswana, Namibia and Zambia have developed solar markets, in many cases with special funds to support consumer credit.

Wind Energy

As the need for cleaner energy sources gains momentum, some countries in the Zambezi Basin are slowly turning to wind power to boost production and meet the ever-growing demand for electricity. Wind is regarded as a reliable and clean form of power generation that does not pollute the environment, although some environmental impacts are beginning to emerge from studies conducted on large-scale wind farms. Wind power on a large grid can contribute substantially to annual electricity production without special arrangements for storage, backup and load management.

Wind farms are relatively easy to construct and it is estimated to take about a year to build one with a capacity of 100 MW. Wind energy is also emerging as one of the sources of "carbon financing" under the international Clean Development Mechanism. Namibia has announced plans to build a wind farm at Walvis Bay to generate 300MW of electricity. Mozambique is planning to develop a wind farm in Matutuíne district, north of the capital, Maputo, with capacity to produce more than 20MW of power. Tanzania plans to build a 50MW wind farm in the central region of the country.

Petroleum and Natural Gas

Angola is currently the only significant oil producer in southern Africa, producing more than 1.25 million barrels per day (a figure that has quadrupled over the past 20 years), with estimated crude reserves of 5.4 billion barrels. This constitutes 96 percent of SADC's total proven reserves of crude oil. Smaller proven reserves of oil are found offshore in Mozambique. The Basin's refineries are concentrated in Angola, Tanzania and Zambia.

Natural gas is becoming more significant to the region's energy sector as Mozambique, Namibia and Tanzania develop natural gas fields.

The main infrastructure challenge for the Basin has been the absence of adequate storage facilities and pipelines to transport oil between countries. For example, fuel destined for Botswana and Zimbabwe is ferried by truck and rail from Mozambique or South Africa, a mode of transport that is uneconomical and unsafe.

In April 2008, the Ministers responsible for energy in the SADC region met in the Democratic Republic of Congo (DRC) to discuss short, medium and long-term measures to mitigate the power challenges in the region (SADC 2008). It was noted that power projects are capital intensive and take time to implement. The Ministers agreed to have an interim solution that could be implemented immediately and deliver the required power while at the same time allow the SAPP to work on the implementation of medium- and long-term projects.

The interim measures that the Ministers approved for SAPP to implement are the following.

Demand Management based on Other Regional Experiences

Peak Demand describes the period in which power is provided for a certain period at a higher than average supply level. All SAPP members including Zambezi Basin states have experienced a general trend in peak demand increase. Zambia and Zimbabwe have traditionally had the highest demand rates, but recently Angola has experienced a substantial increase in peak demand.

Demand management and energy conservation are an important part of the energy sector, and SAPP was instructed to implement a Power Conservation Programme (PDP) for the SADC region. From July 2008, SAPP started trials for PCP within South Africa with the expectation that these can be expanded to other utilities.

The other demand management option that the SAPP considered was the implementation of a virtual power station which would be achieved by:

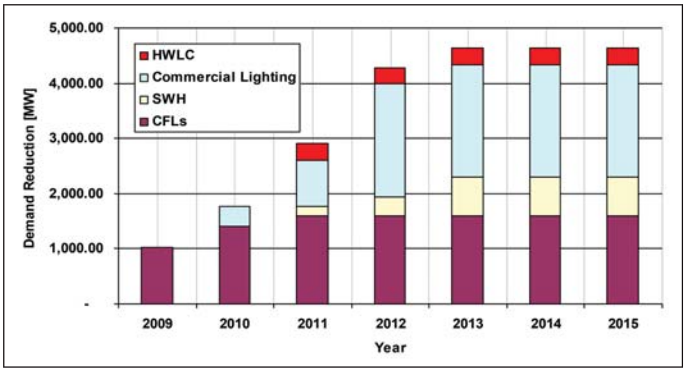
- Replacing the current incandescent lamps with Compact Florescent Lamps (CFLs);
- Use of Solar Water Heaters (SWH) in new buildings, especially residential areas;
- Addressing commercial lighting; and,
- Use of Hot Water Load Control (HWLC) instruments where applicable.

Table 6.8 Peak Annual Demand

MW	1998	2000	2002	2004	2005	2006	2007	2010	2011	2012
Angola	209	250	330	374	397	476	476	1 100	870	1 072
Botswana	239	285	362	402	434	434	434	553	542	578
Malawi	190	205	236	227	242	251	251	300	277	278
Mozambique	245	231	250	266	285	320	320	560	616	706
Namibia	292	320	362	393	491	490	490	564	611	611
Tanzania	368	426	474	509	531	563	563	833	890	900
Zambia	1 126	1 085	1 118	1 294	1 330	1 393	1 393	1 600	1 562	1 681
Zimbabwe	1 950	1 986	2 028	2 069	2 066	1 904	1 904	2 100	1 836	2 029
SAPP Average	2 788.83	2 925.83	3 168.42	3 416.92	3 375.92	3 494.92	3 494.92	3 810.08	3 770.25	3 760.33

SAPP statistical reports 2004 to 2013

Figure 6.4 **Demand Side Management**



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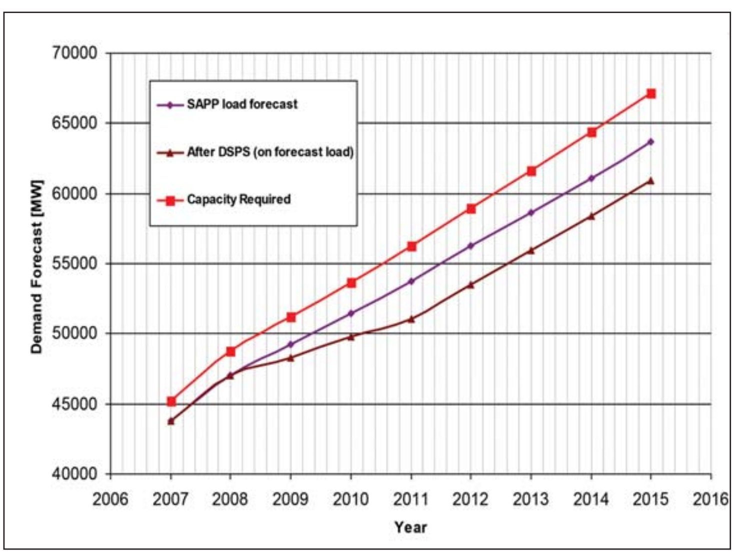
It was estimated that up to 1,000MW could be saved in the first year (2009) and this could be increased to over 4,000MW by 2015 when all the DSM options have been implemented, as shown in Figure 6.4.

The overall effect of the implementation of DSM on the SAPP demand would be a reduction in the load forecast for the SAPP region as illustrated in Figure 6.5.

A mechanism to provide financial support is being considered by SAPP members for the development and implementation of DSM, and there is also need to develop a local manufacturing capability, especially for CFLs, to support the initiative. SAPP members have agreed to develop a policy for efficient use of electrical energy and specific policies to address incandescent lamps versus CFLs, and the minimum efficiency standards for new connections.

Figure 6.5 **Impact of DSM on the SAPP Load Forecast**



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Supply Side Measures

On the supply side, the SAPP was directed by members to:

- Maximise the use of installed supply options by re-capitalising the power utilities. Most of the utilities are government-owned, and this would require an injection of capital into the utilities to ensure their viability;
- Create an enabling environment for renewable energy; and
- Develop a structure for the implementation of a least-cost SAPP generation facility.

Provision of Investment Incentives

Investments into the SADC power sector have not been forthcoming in the last few years. SAPP members agreed that in order to attract investment into the sector, there is need to provide incentives to investors, both local and foreign. They also agreed to address policy issues with regard to legal and regulatory frameworks, and to allow exemptions for Value Added Tax (VAT) and import tax for power generation equipment. Some countries have already implemented this initiative.

- ***Creation of an Enabling Environment***

The creation of an enabling environment for investors in the power sector is essential, and SAPP members agreed to address policy, legal and regulatory frameworks, which vary from country to country.

- ***Implementation of Cost Reflective Tariffs and Time of Use Tariffs***

The cost of electricity in the SADC region still varies widely among member states. For many years, the region has enjoyed excess supply capacity, a situation now reversed. As the current tariffs are not sufficient to attract investment into the power sector, it was agreed to implement cost-reflective tariffs by December 2013 and at the same time adopt regulatory principles that would enhance those tariffs. At the meeting of SADC Energy Ministers held in Maseru in 2013 it was noted that most member states were unlikely to achieve the target.

SAPP Planned Generation Projects

Projects in the Short Term

In 2005, the SAPP Management Committee agreed to develop criteria that should be used to select priority generation projects to be implemented on a regional basis. At the SAPP Executive Committee meeting held in October 2011 in Lesotho, the power pool decided to review and update the criteria for prioritizing generation and transmission projects. The new criteria were to consider environmental concerns such as the impact of generation projects on climate change (SAPP 2011 Appendix 6.1)

For general projects, the following categories were identified as a priority:

- Generation projects with secured funding;
- Rehabilitation projects as a different category to expansion projects;
- Short-term generation projects with completed Environmental and Social Impact Assessment (ESIA) and feasibility studies done; and,
- Medium and long-term generation projects to cover a period of more than five years.

For transmission projects, the following categories are to be considered:

- Outstanding transmission interconnectors whose aim is to interconnect ***non-operating members*** of the SAPP to the SAPP grid, such as Angola, and the Mozambique-Malawi, Zambia-Tanzania-Kenya interconnectors;
- Transmission interconnectors aimed at ***relieving congestion*** on the SAPP grid; and,
- New transmission interconnectors aimed to ***evacuate power from generating stations*** to the load centres.

The starting point for the analysis was the establishment of a basket of generation projects that had not yet secured funding. The key factors used in selecting the generation projects included:

- Fuel diversity;
- Geographical spread of the projects;
- Regional impact; and,
- Project readiness.

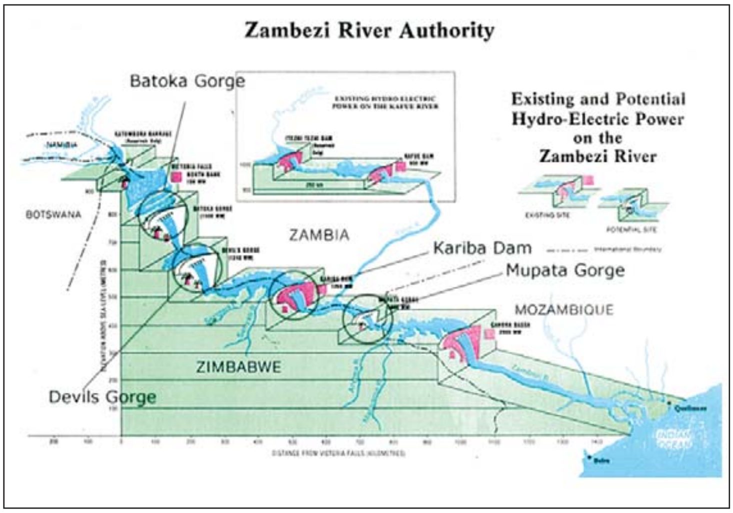
The listing of all the generation projects with the above characteristics were then separated into two categories of projects with generation capacity greater than 1000MW and those with generation capacity less than 1000MW. The reason for this was that generation projects with capacity above 1000MW have greater regional impact. The projects that scored below 50 percent were not included in the list of the SAPP priority projects.

Table 6.9 **SAPP Committed Generation Projects**

Country	2013	2014	2015	2016	TOTAL	
	MW	MW	MW	MW	MW	%
Angola	389	640	550	1 246	2 825	16
Botswana	600	-	-	300	900	5
DRC	55	-	580	-	635	4
Lesotho	-	-	35	-	35	-
Malawi	64	-	-	-	64	-
Mozambique	-	150	300	300	750	5
Namibia	-	-	120	50	170	1
South Africa	923	3 105	2 543	1 322	7 893	46
Swaziland	-	-	-	-	-	-
Tanzania	60	160	500	1 110	1 830	11
Zambia	230	315	600	164	1 309	8
Zimbabwe	-	300	30	300	630	4
TOTAL	2 321	4 670	5 258	4 792	17 041	100

SAPP Annual Report 2013

Figure 6.6 **Hydro Power Projects on the Common Zambezi River**



SADC and ZRA 2007

After the selection criteria were applied to projects submitted by members, the following project generation portfolio was created in 2011 and updated in 2013.

About 17,000 MW of electricity generation was planned for the period 2013 to 2016, of which three percent would be from Non-Convention Renewable Energy (NCRE) sources, particularly solar and wind.

Projects in the Medium Term

In the medium term, the Zambezi River Basin will become very important as most of the hydropower generation needed by the region can be generated from the Basin. By far, the largest portion is in Zambia (about 40 percent). Zambia and Zimbabwe, which jointly operate the Zambezi River Authority, want to achieve the greatest possible benefits from the efficient use of the abundant water of the Zambezi River for the production of energy and other mutually beneficial economic, industrial and social developments.

These developments are guided by a five-year Strategic Action Plan, with the development of the Batoka hydropower station as one of the priorities.

Figure 6.6 shows some of the project ZRA plans to implement.

The power generation projects along the Zambezi River Basin as listed in Table 6.10 are planned by the ZRA and by the Government of Mozambique. A total of about 8755MW is expected to be commissioned by 2018 (Tumbare 2005).

The commissioning of these hydropower generation projects in the Zambezi Basin will have massive environmental impact on the basin. One of the main environmental impacts of the increasing number of hydropower projects in the basin is the impact on ecosystems. The drive for more hydropower comes at a time when many freshwater ecosystems are already in crisis, partially due to the development of dams and related activities such as water withdrawals for irrigation. According to the United Nations, 60 percent of the world's 227 largest rivers are already severely fragmented by dams, diversions and canals, leading to the degradation of ecosystems (UN 2003).

A particular problem is the cumulative impacts of several dams on the same river. A report by WWF (2004) identified 20 rivers where ecosystems are at risk from the large number of dams planned or under construction.

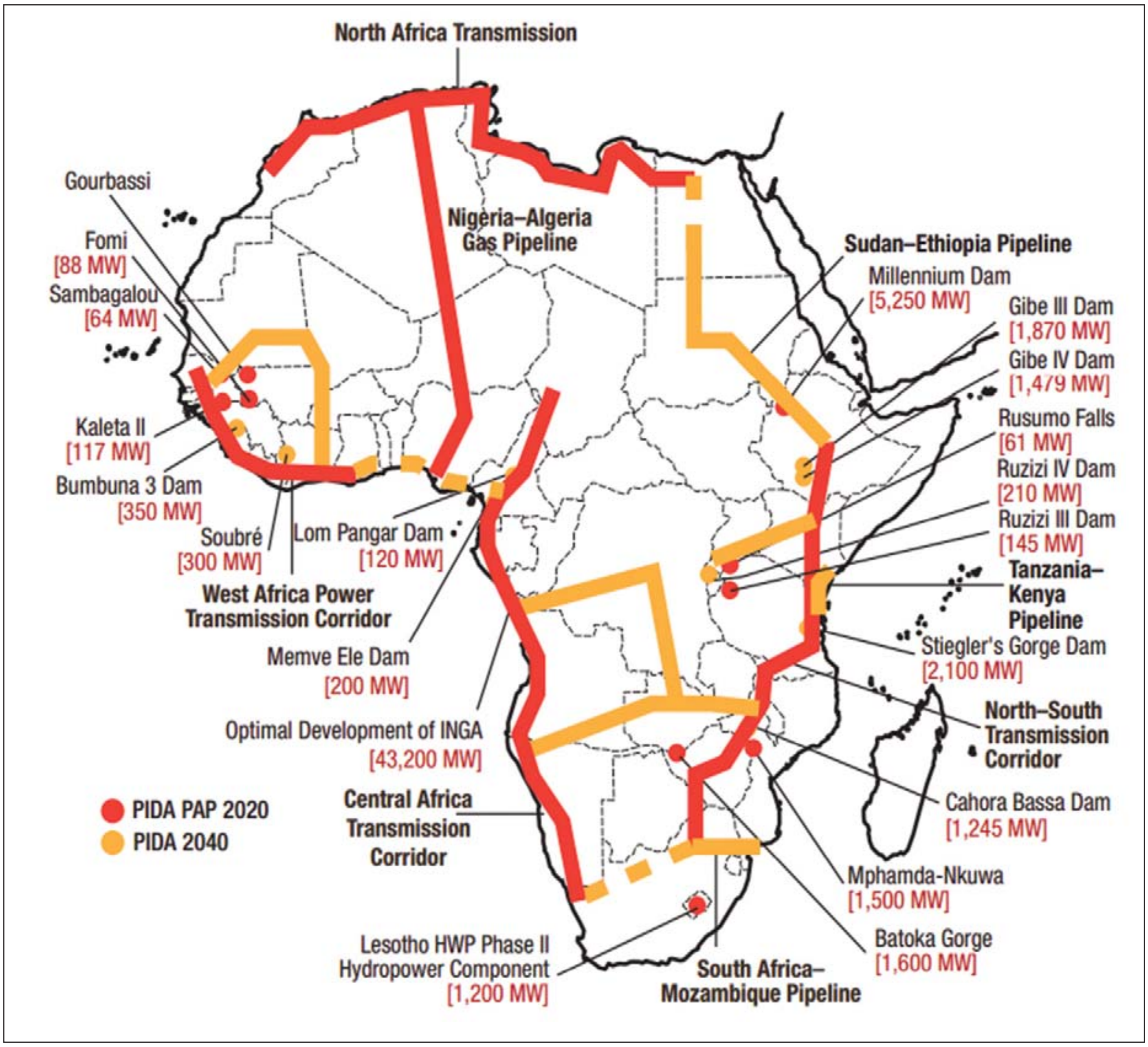
Ecosystem impacts are often very closely linked to social impacts. Freshwater ecosystems provide people with essential services, including water supply and purification, fisheries, flood control and floodplain fertility. Specific ecosystem impacts caused by hydroelectric projects depend largely on the following variables:

- the size and flow rate of the river or tributary where the project is located;
- the climatic and habitat conditions that exist;
- the type, size, design, and operation of the project; and,
- whether cumulative impacts occur because the project is located upstream or downstream of other projects.

The impacts have to be addressed before the projects are implemented. The two biggest projects that will be implemented along the Zambezi River are Batoka and the Mpanda Nkuwa (NEPAD and others 2010).

Batoka Hydropower Project is located on the Zambezi River between Zambia and Zimbabwe, 50 km below Victoria Falls. The design involves construction of Roller Compacted Concrete (RCC), a 181-metre gravity dam, and the installation of 1600MW to be shared equally between Zambia and Zimbabwe, with a plant of 800MW (4 x 200MW units) on the south bank in Zimbabwe and 800MW

Figure 6.7 **Priority Energy Projects for PIDA**



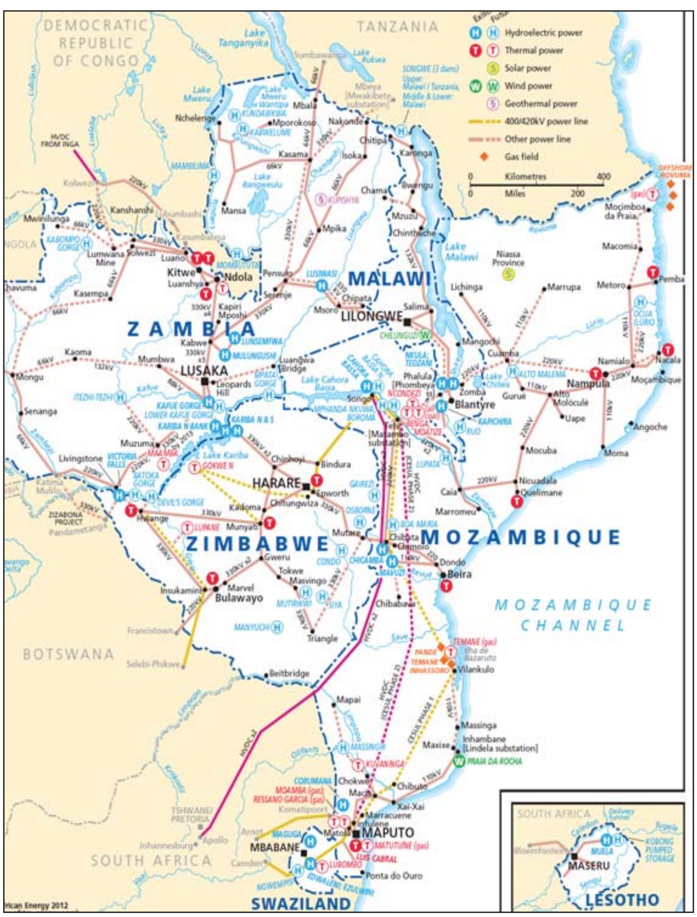
African Development Bank 2012

Table 6.10 **Zambezi River Basin Planned Hydropower Generation Projects 2013-2018**

No	Country	Project Name	Capacity MW	Expected Date
1	Zambia	Kariba North Extension	360	2013
2	Mozambique	HCB North Bank	1 245	2015
3	Mozambique	Lurio	150	2015
4	Zimbabwe	Kariba South Extension	300	2015
5	Zambia/Zimbabwe	Devils Gorge	1 200	2017
6	Mozambique	Mphanda Nkuwa	1 500	2017
7	Mozambique	Lupata	550	2017
8	Mozambique	Ruo	100	2017
9	Zambia/Zimbabwe	Batoka	1 600	2018
10	Zambia/Zimbabwe	Mupata	1 200	2018
11	Mozambique	Boroma	160	2018
12	Zimbabwe	Victoria Falls	390	No data
TOTAL			8 755	

Tumbare, M.J. 2005

Figure 6.8 **Existing and Proposed Transmission Grid around the Zambezi Basin**



Africa Energy (undated)

on the north bank in Zambia. Total energy produced will be 8,739GWh. The reservoir will be 4.8 million cubic metres with an area of 25 sq km. The project will also increase the production capacity of Kariba plant by 300 MW. Transmission lines, access roads and other facilities are also included in the project design. Production cost is estimated at US cents 5.2 / Kilowatt hour (KWh).

MphandaNkuwa hydroelectric development project is located on the Zambezi River in

Mozambique, about 60 km downstream from the Cahora Bassa Dam, and it is an investment that will further exploit Mozambique's enormous hydro potential on the Zambezi River. The first phase of Mpanda Nkuwa is planned to generate 1500 MW (four turbines of 375 megawatts each) or 8600 GWh of energy. In a subsequent phase, the capacity would be increased to 2400MW. The associated transmission lines are 1,540 km to Maputo and 60 km to connect to the Cahora Bassa substation at Songo. The dam will be 700 metres long and 86 metres high, with 13 floodgates. The size of the reservoir is 2.3 billion cubic metres with an area of 9,500 ha. The number of persons to be resettled is 1,400.

These two major projects have been submitted to the African Union's Program for Infrastructure Development in Africa (PIDA) for financial support. The priority energy projects for PIDA are highlighted in Figure 6.7, of which Batoka and Mphanda Nkuwa are prominent.

The Zambezi Basin is along the central transmission corridor of the SAPP. With the coming of hydropower projects indicated previously in Table 6.10, an enhancement of the central transmission corridor would be required. Both generation and transmission projects that would be required to evacuate power from the basin to load centres will have an environmental impact on the region. Figure 6.8 shows the existing and proposed transmission grid around the Zambezi Basin.

Box 6.4

SADC COUNTRIES EMBARK ON BIOMASS ENERGY CONSERVATION

An ambitious regional programme for biomass energy conservation has been launched in southern Africa with a vision to satisfy the energy requirements of the region.

The programme targets mainly the lower-income population groups who often depend on wood fuel and plans to ensure the protection of millions of hectares of forest resources while ensuring social equity.

Through the Programme for Biomass Energy Conservation (ProBEC) established by SADC, German Technical Co-operation (GIZ) is supporting the training of metal fabricators and engineers in the region to construct efficient energy-saving stoves.

The ProBEC project is active in eight SADC countries: Lesotho, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe.

In Zambia, the ProBEC project trained 13 regional entrepreneurs in the production of improved "Rocket Cook Stove" in the capital, Lusaka. The stove is environmentally friendly as it produces minimal carbon dioxide, making it safer for indoor cooking.

Biomass energy is fuel derived from any living organism, traditionally it comprises wood, charcoal, dung and agricultural residues. These are burned in simple fires throughout the region for food processing and for heating.

There is need for households in the region to adopt the use of the energy-efficient stoves, said Coordinator of the ProBEC project in Zambia, Ngula Mubonda. However, she noted that although the technology is good for the environment, it is costly for the ordinary households.

Experience in Malawi has shown that half a drum of cooking local maizemeal (*nshima*) can use up to 170 kg of firewood on an open fire, while preparation of the same quantity of *nshima* can use only 14 kg when prepared on a Rocket Stove, accounting for 60 percent energy efficiency.

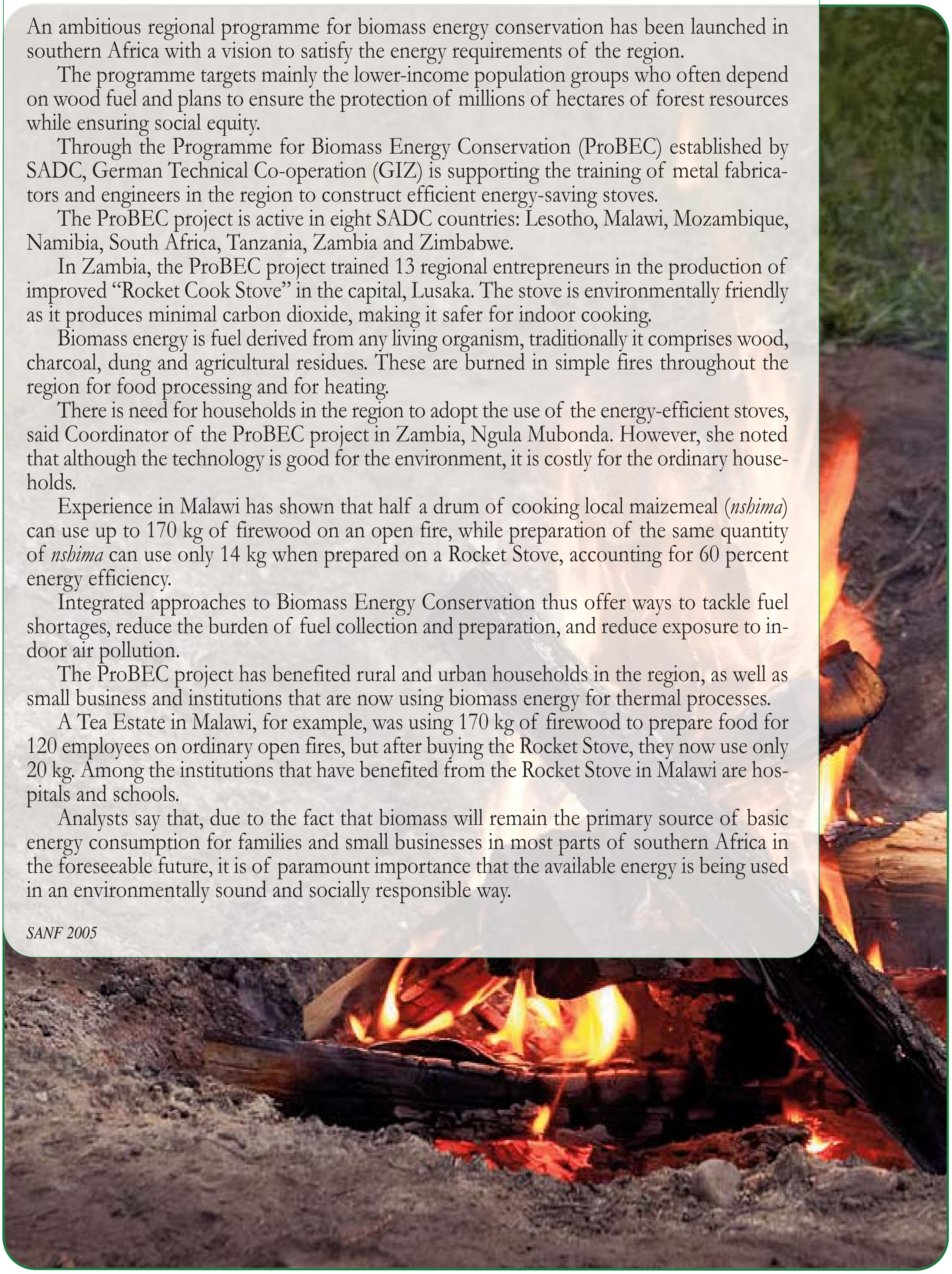
Integrated approaches to Biomass Energy Conservation thus offer ways to tackle fuel shortages, reduce the burden of fuel collection and preparation, and reduce exposure to indoor air pollution.

The ProBEC project has benefited rural and urban households in the region, as well as small business and institutions that are now using biomass energy for thermal processes.

A Tea Estate in Malawi, for example, was using 170 kg of firewood to prepare food for 120 employees on ordinary open fires, but after buying the Rocket Stove, they now use only 20 kg. Among the institutions that have benefited from the Rocket Stove in Malawi are hospitals and schools.

Analysts say that, due to the fact that biomass will remain the primary source of basic energy consumption for families and small businesses in most parts of southern Africa in the foreseeable future, it is of paramount importance that the available energy is being used in an environmentally sound and socially responsible way.

SANF 2005



Challenges in Implementation of Power Projects

The Regional Infrastructure Development Master Plan noted that "the SADC region is still facing a number of challenges with regard to energy availability, delivery, access and price." Pertinent indicators revealed that:

- In some SADC countries, rural access to electricity is below eight percent;
- The SADC region lags behind other Regional Economic Communities (RECs) in respect of overall access to electricity as 24 percent of SADC residents have access to electricity compared to 36 percent in the Eastern African Power Pool (EAPP) and 44 percent in the West African Power Pool (WAPP);
- The SADC region has been facing an electricity deficit since 2007 and the identified gap is expected to be closed by 2015. However, the implementation of projects has often lagged behind the planned dates due to lack of funding and the time taken to conclude power purchase agreements.

Policy Responses and Targets

Harmonization of energy sector policies, legislation, rules, regulations and standards to facilitate energy market integration. So far, 11 of the 15 SADC Member States including the Zambezi Basin States have introduced electricity regulation. The Regional Electricity Regulatory Association (RERA) has been formed by 10 of the SADC national electricity regulators in order to address cross-border electricity regulations and to harmonise policy and standards.

Development of a Renewable Energy Strategy and Action Plan.

Establishment of energy data banks and planning networks. The extension of the regional grid has facilitated the creation of a regional electricity market through the Southern African Power Pool which was created to coordinate regional electricity infrastructure development and electricity trading. All of the nine interconnected power utilities have signed the Day Ahead Market governance instruments and have been trading electricity on a competitive basis. In addition, SAPP has coordinated the design and development of power generation plants in order to address the current power supply shortfall in the region.

Identification and strengthening of Centres of Excellence for energy research and technology development.

Achievement of 100 percent connectivity to the regional power grid for all Member States. Five of the eight Member States in the Zambezi River Basin are connected to the SAPP grid, and the exceptions are Angola, Malawi and Tanzania. Progress has been made to achieve the RISDP target of 100 percent connectivity to the regional grid by all Member States; and several interconnecting transmission lines are under preparation, including the Malawi-Mozambique, Zambia-Tanzania-Kenya, Malawi- Tanzania, Namibia-Angola, Kafue-Livingstone upgrade, Zimbabwe-Zambia-Botswana-Namibia, DRC-Zambia, Central Transmission Corridor, Second RSA-Zimbabwe Interconnector, and the Second Mozambique-Zimbabwe Interconnector.

Seventy percent of rural communities should have access to modern forms of energy by 2018.

CHAPTER LINKAGES

Overview
The growing economies in the Zambezi River Basin demand more energy for industrialization and human development. Increasing demand for energy oversupply can lead to environmental degradation if not carefully managed.

Water Resources
Economic performance of the Zambezi Basin states depends on adequate and reliable energy, and hydropower offers an opportunity to realise this goal. While there are negative impacts on the environment as a result of hydropower schemes, countries should strive to minimise these. One challenge for the planning and development of hydropower schemes is the separation of authority between ministries responsible for energy and for water resources.

Land and Agriculture
People are often displaced by large hydropower generation projects and land that was previously available for agriculture and other uses is taken up by the reservoirs created by dams that generate hydroelectric power.

Biodiversity and Forests
Activities in the energy sector have major impacts for biological diversity in the Zambezi Basin. Construction of hydropower plants lead to loss of wild lands, wetlands and wildlife habitat because animals migrate to new areas, where new equilibrium may favour some species over others. Plants and trees are unable to migrate and therefore they drown. These aspects must be fully considered when planning new projects.

Climate Change and Variability
Global warming and the resultant changes in climate are due mainly to the combustion of fossil fuels in the generation of electricity and fuel for transportation, as well as inefficient factories and consumptive rather than sustainable habits, mainly in the North. The main contributor in the Zambezi Basin is deforestation.

Urbanization and Human Settlements
Urbanization is a major demographic driver of energy demand. The expansion of urban infrastructure creates demand for iron, steel, cement and other industrial goods that are energy intensive, in addition to the concentration of domestic consumption.

Tourism
Biomass is the most used source of energy in the Zambezi Basin, and this is destructive to the environment through deforestation. The loss of biodiversity through human activities and climate change can impact negatively on the tourism potential in the Basin.

Industrial Development
Energy is essential to industrial activities and to the economies in the Zambezi Basin, and causes a significant increase in demand that can have serious environmental impacts if not well managed.

Scenarios
The energy sector is a key factor in emerging opportunities for socio-economic development in the Basin.

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URBANIZATION AND HUMAN SETTLEMENTS

7

Introduction

The population of the Zambezi River Basin is predominantly rural, although rural-to-urban migration is increasing due to the socio-economic opportunities in urban areas. There also challenges in migration to urban areas, particularly when the increase in urban population does not correspond to service delivery.

The rate of production of goods and services such as housing, water supply and sanitation, waste management, energy, jobs, and infrastructure development is often slower than the urban population growth. The urbanization process affects men and women differently, and men tend to benefit more than women due to the subordinate role that women play in society, particularly in access and control of productive resources (capital, finance and economic resources).

This chapter seeks to examine the nature and pattern, challenges and opportunities of urbanization and human settlements in the Zambezi River Basin, drawing connections between population migration, urban growth, service delivery and urban environments. Policies and institutional frameworks are ex-

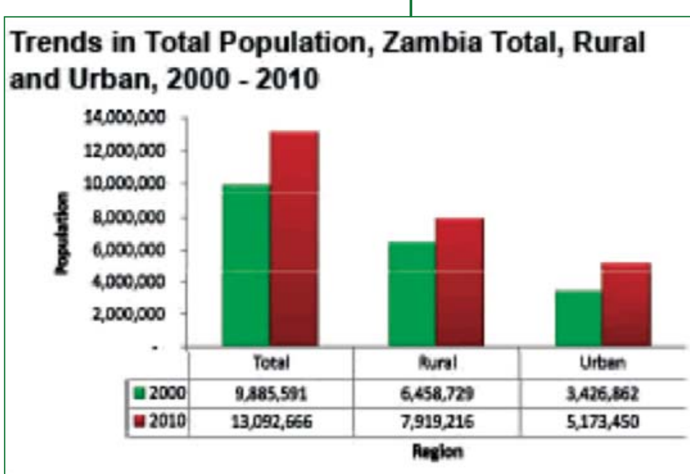
Box 7.1 **URBAN CENTRES AND URBANISATION**

The movement of people from rural areas to towns and cities known as urbanization has been a constant feature for at least a century. Africa's pace of urbanization is the fastest in the world at a rate of 3.5 percent -- with southern Africa urbanising at a rate of three percent.

The Zambezi River Basin hosts many urban areas such as Luena in Angola, Kasane in Botswana, Tete in Mozambique, KatimaMulilo in Namibia and Mbeya in Tanzania, all urban areas in Malawi, almost all urban centres in Zambia including the capital city Lusaka, and most in Zimbabwe, including capital Harare. Recent census figures show that Harare and Lusaka are the largest urban areas in the Basin by population, with metropolitan populations of just over 2 million and 1.7 million respectively.

Trade corridors, transport routes and other infrastructure influence settlement patterns with many urban settlements concentrated around nodes of economic activities as exemplified in Zambia where 85 percent of urban residents are concentrated in the Copperbelt and Lusaka provinces. Some urban areas such as Tete, Kasane and Kazungula are located near major transboundary routes.

SADC/SARDC and others 2008; UNEP 2013



www.zamstats.gov.zm

plored, and recommendations offered for strengthened basin-wide cooperation and integration in urbanization and human settlement.

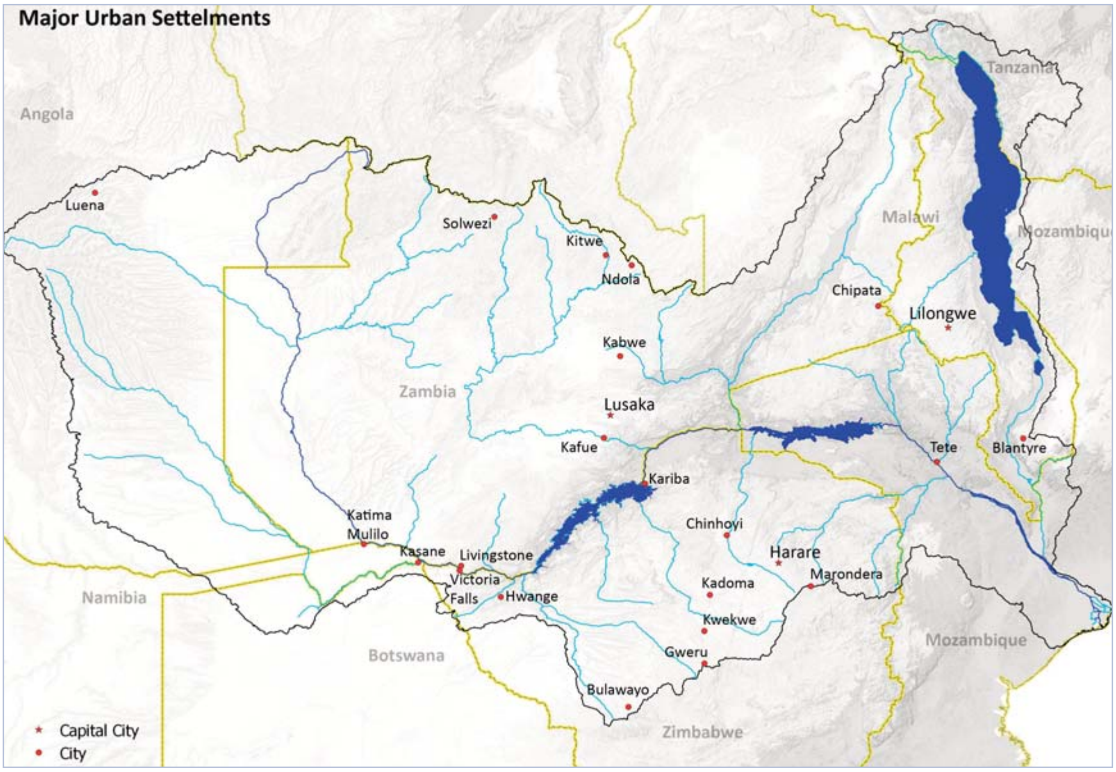
Settlement Patterns and Growth Rates

The eight riparian states of the Zambezi River Basin have varied rural and urban population densities which also characterize the settlement patterns. The rural settlements are sparsely populated and tend to have poorly developed infrastructure, lacking in basic services that are found in urban settlements. Economic and social services such as schools, hospitals and shopping centres are few and the rural residents often walk long distances to access the basic amenities. Rural communities rely on the natural resources and productivity of the land, and the main economic activities tend to be agriculture, fishing, mining and forestry (SADC/SARDC and others 2008). The dwelling units are traditional semi-permanent and permanent structures grouped together in villages.

Urban centres in the Zambezi Basin are generally densely populated. Angola and Botswana have highest proportion of people living in urban areas (Table 7.1). Botswana's urban population grew from 1.7 percent of the country's total population in the 1970s to more than 60 percent in 2010 and the projections show that this will exceed 80 percent by 2050 (SADC/SARDC and others, 2008; 2012). Malawi remains the least urbanized country in the Basin. However, its projected rate of urban growth is the highest at 6.3 percent per annum. The majority of Malawi's urban residents live in the cities of Blantyre, Lilongwe, Mzuzu and Zomba.

Eight-five percent of the urban residents in Zambia are concentrated in two provinces – Copperbelt and Lusaka. Historically these are the provinces with the

Map 7.1 **Major Cities and Towns in the Zambezi River Basin**



SARDC I. Musokotwane Environment Resource Centre for Southern Africa, 2015

Urban centres in the Zambezi Basin are densely populated.

highest migration rates due to the mining and agro-industrial activities. The urban population in Zambia grew at a rate of 4.2 percent per year in the period 2000-2010, compared to 1.5 percent per year during the period 1990-2000. The rural population grew at a rate of 2.1 percent per annum during the same period 2000-2010, a drop from the annual rate of three percent during the period 1990-2000. Lusaka Province was the fastest growing province with an annual population growth rate of 4.6 percent, followed by Northern Province at 3.2 percent per annum and the newly created Muchinga Province at 3.1 percent per annum (Central Statistical Office 2014).

The estimated total population of the Zambezi Basin was over 40 million in 2008 with some 7.5 million residing in urban areas (SADC/SARDC and others 2012). Several of the Basin's major urban areas have population of more than one million people. Figure 7.1 shows the percentage of urban population per country.

Causes and Implications of Rapid Urbanization

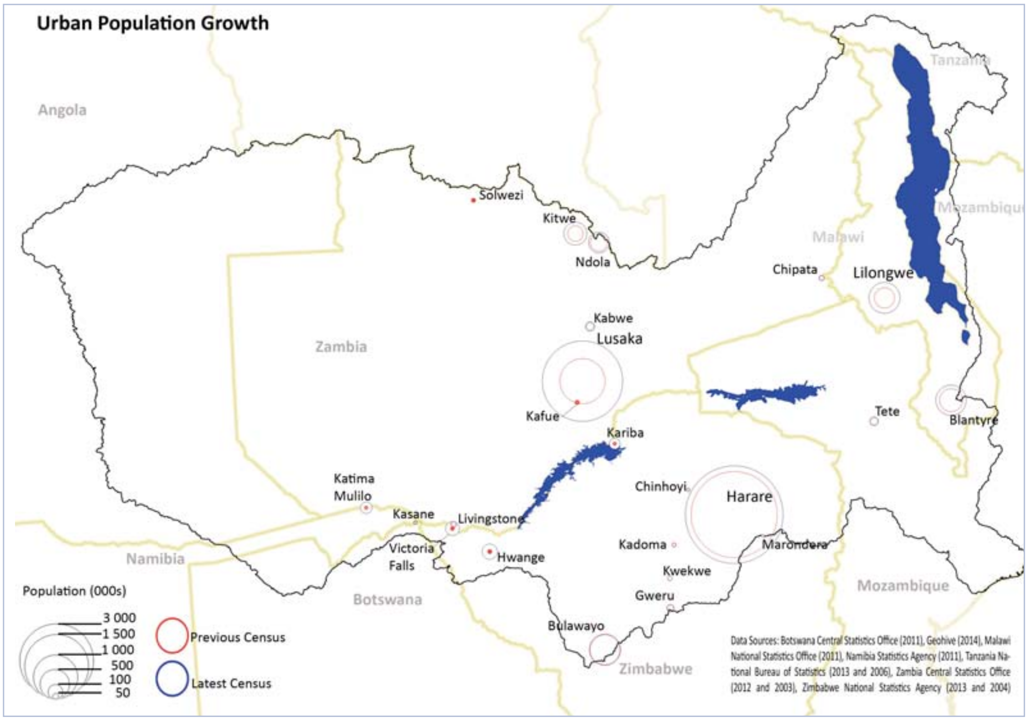
The high rates of urbanization are a result of push factors from rural areas such as poverty, shortage of land, declining returns from agriculture and natural disasters such as floods and droughts; as well as pull factors that attract people to the cities. Available and perceived better services in education, health facilities, employment opportunities and the bright lights

Table 7.1 **Urban and Rural Populations in Basin States (%)**

	2000		2002		2004		2006		2008		2009		2010		2011	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Angola	49.0	51.0	51.0	49.0	53.0	47.0	54.9	45.1	56.7	43.3	57.6	42.4				
Botswana	53.2	46.8	54.8	45.2	56.5	43.5	58.1	41.9	59.6	40.4	60.3	39.7				
Malawi	15.2	84.8	16.0	84.0	16.9	83.1	17.8	82.2	18.8	81.2	19.3	80.7				
Mozambique	29.5	70.5	30.2	69.8	30.7	69.3	31.3	68.7	30.5	69.5	30.7	69.3	30.8	69.2	31.0	69.0
Namibia	32.4	67.6	33.5	66.5	34.6	65.4	35.7	64.3	36.8	63.2	37.4	62.6			42.0	58.0
Tanzania	22.3	77.7	23.1	76.9	24.1	75.9	24.9	75.1	25.6	74.4	25.6	74.4	26.3	73.7	26.7	73.3
Zambia	34.8	65.2	34.9	65.1	35.0	65.0	35.1	64.9	35.4	64.6	35.6	64.4	39.5	60.5		
Zimbabwe	33.8	66.2	34.6	65.4	35.5	64.5	36.4	63.6	37.3	62.7	37.8	62.2				

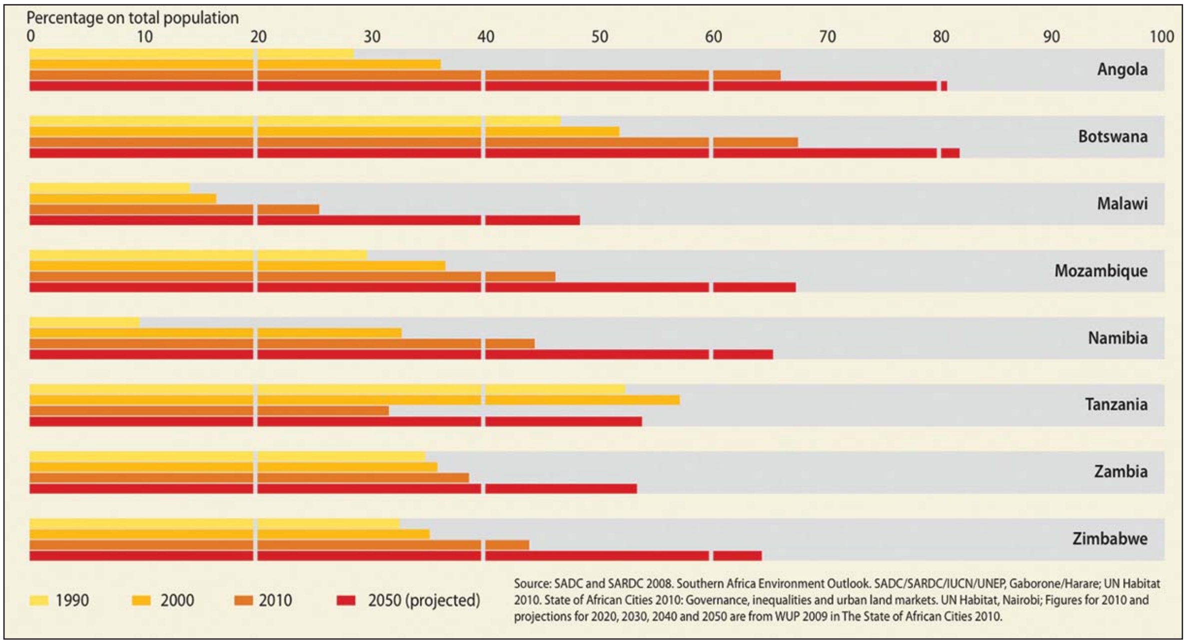
SADC 2011. Climate Change Adaptation in SADC: A Case of the Water Sector

Map 7.2 **Urban Population Growth**



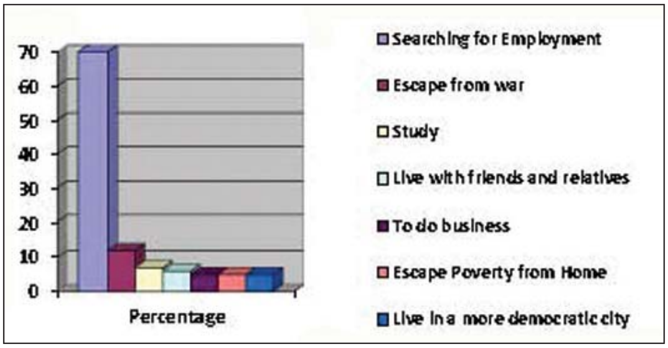
SARDC I. Musokotwane Environment Resource Centre for Southern Africa, 2015

Figure 7.1 **Urban Population in Zambezi Basin States**



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Figure 7.2 **Common Reasons for Urban Migration in Angola**



UN-Habitat 2008

Luena town in Angola

are often an attraction to urban areas. However, the post-independence growth of urban populations outpaced expansion of the economy and formal employment opportunities.

Figure 7.2 shows some common reasons for urban migration in Angola. The most common reason is the search for employment and other economic opportunities. This was followed by the need to escape from war or conflict during the civil war (12 percent); a small number come to the urban centres to study (7 percent); or to live with friends and relatives (6 percent). An equally small number come to urban centres to do business (5 percent); or to escape poverty at home (5 percent). The pattern is more or less similar in the other basin countries, where the rural populations are attracted by the economic opportunities in the urban centres.

Urbanization is being accelerated by global economic integration and the struggle to attract investments and tourists. However, this creates pressure on land available for production, urban goods and provision of services such as housing, water and electricity, as well as exerting pressure on the natural ecosystem. The resultant pressure on the environment has given rise to challenges of sanitation and pollution which directly compromise human health and quality of life, especially in low-income urban settlements.

The urban poor reside in unplanned settlements located in peri-urban areas in which the opportunities are largely for self-employment in the burgeoning informal sector. In urbanization, as in other socio-economic processes, women are more negatively affected as there is less access to resources as well as social and economic goods and services. Other challenges associated with urbanization are inadequate waste disposal, limited access to potable water and sanitation, high levels of air and water pollution, unemployment and homelessness.

Long-term planning is not an immediate priority for many urban local authorities as they are operating in a crisis mode to try to maintain the required levels of services to meet the expectations of residents. Current urban realities pose several governance and financial challenges, including the need to address increasing poverty and unemployment, and declining service delivery.

The crafting of new policy responses has been overtaken in many cities by the informalization of service delivery, as municipal governments struggle to meet the needs of a rapidly growing population.

Urban infrastructure development and services cannot keep up with population growth. When services are inadequate, women and girls bear the brunt of an environment devoid of services and the burden of provision. Studies have shown that there are more male migrants to cities than females, especially in the 16-to-30-year age group. With increased urbanization, gender roles change while gender inequities and inequalities intensify due to unequal access to goods and services and to basic social and economic services available in cities. As competition over scarce resources increases, women find it difficult to access social and economic facilities due to social and political marginalisation. Policy interventions need to be formulated to minimize the negative impacts of these dynamics.

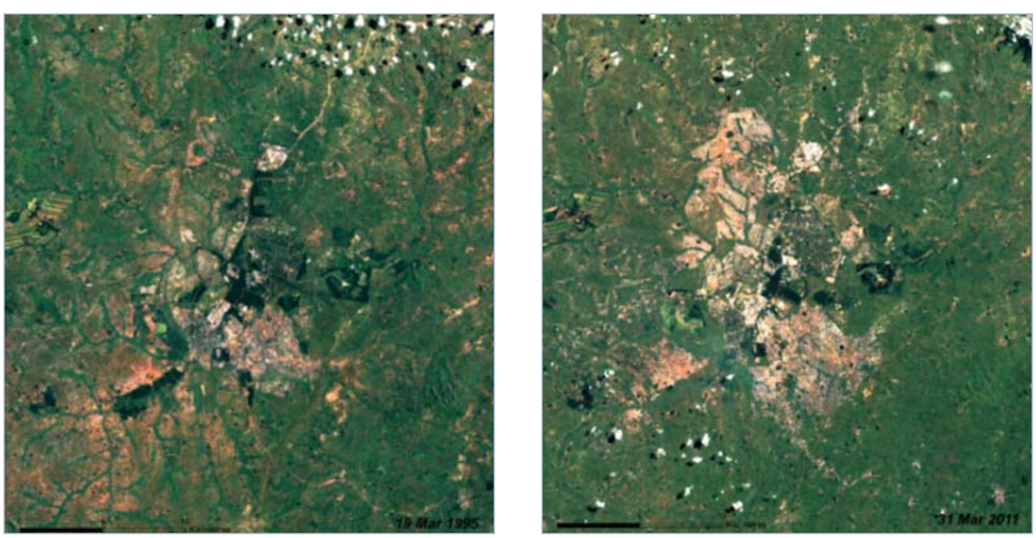
Over the past 20 years migration patterns from and within the Zambezi Basin have changed considerably as work opportunities for men in the South African mines have decreased while work opportunities for women have increased. While urban migration by women is increasing, it remains a very much smaller phenomenon than male migration because structural challenges and patriarchal values that have impeded female migration in the past have not been overcome.

Expansion of urban centres results in a depletion of the agro-economic base thereby leading to the reduction of land available for food production and other agricultural activities. It has also led to the loss of biodiversity in flora and fauna, which is vital for the survival of species, as forests and woodlands are food reserves, places of worship, entertainment and religious ceremonies.

Challenges of Rapid Urbanization

Rapid urban growth has an adverse effect on the environment and human livelihoods as it disturbs the resilience of ecosystems through deforestation, water and air pollution and depletion of the quantity and quality of the water resources. This also reduces productive land for agriculture and creates unhealthy conditions, especially for the urban poor, with inadequate housing and shortage of other basic amenities such as safe water and sanitation services. Other impacts are the loss of natural habitats, changes and losses in biodiversity.

Lilongwe, Malawi in 1995 and 2011



SADC/SARDC and others, Zambezi River Basin Atlas of the Changing Environment, 2012

Lilongwe is the capital city of Malawi, shown in these remote sensing images in 1995 and 2011. The city started as a small village along the Lilongwe River, founded as an agricultural market centre for the fertile Central Region Plateau. In 1977 the population was estimated at about 99,000 and this grew to 781,500 in 2012. Expansion of the city has resulted in the deforestation of large surrounding areas due to the high demand for firewood and land for farming by the growing population.

Urban centres are the major generators of economic activity and they provide employment opportunities and infrastructural services including housing, water and electricity. However, the cities and towns are also the main consumers of natural resources and the main producers of pollution and waste. Urban consumption patterns contribute to environmental degradation and natural resource depletion. Urbanization also impacts on the roles of men and women, as the proportion of women increases in the productive sector and in the decision-making positions in both rural and urban centres. As the men migrate to towns, the women remain as heads of households in the rural areas; and in urban centres the women take on roles that were previously dominated by men.

Increased Demand for Housing

Rural-urban migration is causing pressure in urban areas through increased demand for housing and natural resources used in the construction of housing, such as timber, sand and water. During times of conflict populations tend to move from rural areas into cities, which are generally perceived to be safer and do not only offer safe havens but also opportunities for employment. For example, about 4.5 million Mozambicans were displaced to urban areas between the mid-1980s and the year 2000. The resettled areas bordering conflict zones have higher population densities and are the most degraded, causing further pressure on land and basic services and generally reducing the productive capacity of the land.

Changes in the consumption patterns also occur where the city dwellers have resorted to unsustainable forms of consumption. Urban residents consume more renewable resources than rural people thereby placing heavy demands on the environment. As the urban environment deteriorates, pressure on city and municipal authorities to provide the needed services increases, this in turn is a strain on the already depleted municipal resources. Service provision and environmental protection have been adversely affected by rapid urban growth occurring at a time of weak institutional frameworks and responses to deal with the urbanization process.

Access to formal housing is beyond the means of the urban poor due to housing and land costs that are increasing at a time when the purchasing power of incomes has diminished. In most countries of the Basin, the provision of housing is failing to meet demand due to high population growth and poor economic performance. The urban migrants hence turn to informal housing which is often unsafe and sub-standard, and located in over-crowded areas. Unplanned settlements have mushroomed mostly in the peri-urban zones. The settlements often lack legal status and the provision of basic services such as clean water and sanitation.

Box 7.2 **HUMAN SETTLEMENTS**

Well-planned human settlements are important for effective and efficient provision of services and infrastructure such as roads, schools, telecommunications, hospitals or clinics and other supporting services. The nature of human settlements portrays the economic status of individuals, countries and the region. While most of the settlements are planned, increasing populations create challenges for the provision of adequate health and education facilities, housing, sanitation, safe water, electricity, waste disposal, roads and other social services. As a result, the urban centres have to grapple with issues of informal settlements and homeless people. All types of human settlements impact on the natural environment, although traditionally this was a mutually beneficial impact. *SADC/SARDC and others 2008*

Housing has a direct effect on economic growth of individuals. The urban economy and livelihood systems are centred on the income-earning ability and productive capacity of the surrounding environment. That vulnerability is made worse by the inhabitants' insecure, low-wage employment and unemployment status. The vast majority of the urban poor work in the informal sector in a variety of activities, including vending and street trading activities.

In 1996 the housing backlog in Zambia was 846,000 units and projections indicate that by 2020 the figure will have risen to five million if present trends persist (CSO 2010). In Zimbabwe the government's 2005 urban renewal programme, Operation Murambatsvina, left over 700,000 people homeless and this worsened the country's housing crisis, despite a rapid increase in the construction of low-cost urban housing. Estimates show that by 2013 the national housing deficit in Zimbabwe was 1,250,000 units (GoZ 2013).

In Malawi, more 100,000 people were waiting to be allocated housing through the Malawi Housing Corporation in 2010, and government estimates indicated that 21,000 houses would be needed every year to meet the rising demand for housing by 2020 (GoM 2010).

Lack of affordable housing compels many urban dwellers to live in informal settlements.

Informal Settlements and the Informal Economy

Informal settlements and the informal economy were until recently a phenomenon of the urbanising process. Rural centres are slowly coming into the informal economy. The informal sector spans across environmental, spatial, economic and social aspects of human settlements ranging from business activities, markets, employment and settlements.

Informal settlements within the region continue to be a common sight due to several factors, including high population growth and poor economic performance (SADC/SARDC and others 2008). The lack of affordable housing compels many urban dwellers to live in informal settlements, usually on the outskirts of cities, vacant land and backyard shelters. Such settlements are often illegal and the official response is to try to destroy them. Even when the settlements are permitted, urban local authorities tend not to provide services. Provision of basic services has led to upgrading of slums as was done in Old Naledi in Gaborone during the 1990s. Policy changes to permit private ownership and protect property rights have had a significant impact, in some instances stimulating small-scale private enterprise. In Zimbabwe and Botswana the local authorities have had considerable success in providing affordable housing through "site and service" arrangements, which allow residents to upgrade as and when they can afford to do so.

Poor access to decent shelter is one important environmental problem associated with urban growth because this has direct effects on health, especially poor inhabitants. Most urban centres have areas with localised pollution problems from sewage effluent that can be transported by local river networks, and the inhabitants tend to live in slums consisting of shacks and makeshift material or in dilapidated housing, thus presenting enormous challenges to public health officials.

Environmental degradation in peri-urban areas has contributed to the process of impoverishment by affecting people's health and thus limiting the capacity to earn income. Urban poverty is often concentrated in ecologically vulnerable areas, such as squatter settlements built in flood-prone and environmentally degraded locations, or unplanned settlements in peri-urban areas. More than 90 percent of urban population in Malawi in 2001 lived in slums characterised by overcrowding, lack of potable water and poor sanitation facilities (GoM 2010), and these areas were the hardest hit by loss of life and property during heavy flooding in early 2015.

Current urban realities pose a number of governance and financial challenges, including the need to address growing levels of poverty and unemployment, and improve service delivery. A visible effect of the current economic hardships has been the massive expansion of the parallel economy, especially street trading, petty-commodity production and personal services. The growth of urban poverty has manifested itself in:

- the proliferation of backyard accommodation, partly because of the inability of city authorities to provide enough housing and partly because many people can no longer afford to rent formal accommodation;
- the emergence of a variegated fabric of street trading activities in the central business districts of most cities;
- the growth of the phenomenon known as "street kids".

The parallel economy has become the sponge of most of the urban economies, a "safety net" for unemployed youth and redundant civil servants, and a useful "cushion" for softening the impact of economic shocks. The parallel economy has expanded to absorb increasing numbers of people, often vendors and cross-border traders, but many of the economic opportunities yield limited returns. The parallel economy usually involves the setting up of markets which can deliver food and services at a lower cost compared to the formal sector. This includes the provision of informal housing, informal markets and informal service provision.

The informal sector provides a conducive environment for ease of entry by both men and women into varied economic activities where individuals can be self-employed with very little education and low capital inputs, flexible hours and indigenous or adapted technology. The informal sector also offers opportunities to acquire skills informally and links to the formal sector. However, the sector has low returns on investment and is characterised by low incomes and ubiquity, but still offers a form of survival and livelihoods, especially for the informal settlement dwellers.

Inadequate and unstable income reduces the capacity of poor households to access formal housing and many households resort to living in overcrowded conditions in areas which are not only prone to disasters but are also devoid of services and infrastructure. Such accommodation is prone to flooding and other extreme weather events such as mudslides. Inadequate provision of public infrastructure such as piped water, sanitation, drainage roads and foot paths, increases the health and work burden and the high levels of risk from contamination.

Waste Management

The amount of waste generated by cities and towns in the Zambezi River Basin far exceeds the capacity for collection, treatment and disposal. Most urban centres are still using crude dumping methods at official dumpsites as the most common form of solid waste disposal.

In Botswana and Zimbabwe, the problem of urban waste, whether municipal, industrial, or commercial, has become one of the biggest challenges facing local authorities. The urban waste stream in these countries contains unpleasant, potentially dangerous substances, which, if improperly managed, could cause harm to health and the environment. Only 58.6 percent of the urban households in the region have access to garbage collection services. One of the greatest challenges facing waste management in Zimbabwe has been that waste production is increasing at a time when the local authorities responsible for waste management are financially overstretched. In Zambia less than seven percent of urban households have garbage collection facilities (Lusaka City Council 2008). Even where the garbage is collected by municipal authorities, disposal is generally inadequate.

Lusaka has a population of more than 1.7 million inhabitants and the city produces 1,400 tonnes of solid waste daily of which only 10 percent is collected by the city council (UN-Habitat 2010). About 16 percent is collected by private companies and the remainder of the solid waste is not being collected due to a number of factors, including lack of human, financial and material resources. Within the residential areas and main markets collection points have been designated and the garbage is supposed to be collected. This does not usually happen and garbage remains for days. Table 7.2 shows some of the benchmarks on garbage collection.

Table 7.2 **Waste Disposal in Lusaka City**

Key benchmarks (2006)	
Total Municipal Solid Waste (MSW) generated per year	381,840 tonnes
Generation per capita per year	201 kg
Percentage coverage	45%
Percentage disposal in environmentally sound landfills or controlled disposal sites	26%
Percentage municipal waste incinerated	None
Percentage diverted and valorised of total waste generated	6%

GTZ/CWG, Lusaka City Report, 2007

The problem of solid waste disposal is further compounded by the increase in unsustainable consumption and production habits, the growing production and consumption of plastics and products made of highly toxic chemicals and substances that are difficult to recycle. The indiscriminate dumping creates unhygienic conditions in the urban areas giving rise to the proliferation of disease vectors such as mosquitoes and other pathogens that cause cholera and other diseases. There have been outbreaks of cholera due to polluted water resulting from dumping into rivers and streams, releasing of toxic industrial and domestic waste, and contaminated waters.

Leachate is produced as the result of percolation of water or other liquids through the waste matrix and the squeezing of wet waste due to the weight of the waste above it. Part of the precipitation that falls on a landfill will react both chemically and physically with the waste and the decomposition products. During the percolation process, the leachate dissolves some of the chemicals and carries them along through the waste.

The impacts of poor solid waste collection and disposal are felt more by the urban poor in the informal settlements who suffer the deterioration of the living environment. The uncollected garbage pollutes the industrial and domestic water sources, thereby causing diseases and increasing the already stressed and burdened health-care system. Women suffer more as the care-givers who look after the sick, especially children and elderly, ensuring that surroundings are safe and clean for their families.

The major constraint in the management of solid waste in cities is inadequate finance, made worse by the lack of systems for collection of revenue from the informally settled households, many of whom don't have steady incomes. The disposal or dump sites have remained an eyesore with scavenging and fires being some of the most serious problems.

In most urban areas in Zimbabwe, the main criterion used for selecting landfill sites has not been on any environmental consideration but the need to reclaim land by filling up old pits. For example, when Golden Quarry and Teviotdale waste disposal sites in Harare, Zimbabwe were selected, no feasibility studies or environmental impact assessment studies were done. In Zimbabwe, studies on dump scavenging indicate that there is significant waste scavenging at almost all the dumpsites in the country. This is a serious health hazard when all types of waste are co-deposited and scavengers use bare hands to sift through waste piles that contain some sharp objects and broken glass as well as toxic materials. People who live around the dumpsites make a living from scavenging and recycling the rubbish from the site. The scavenging continues despite the fact that the air around the dumpsites is highly polluted with unpleasant and toxic odours some of which may cause respiratory and skin diseases.

The entry of the private sector through public private partnerships has improved the solid waste management situation in the Basin. The residential areas that have the ability to pay for the services can have access to solid waste and disposal services. There is also an increase in community-based initiatives supported by the local authorities and private companies. The privatization of waste collection and disposal services has to some extent worsened the problem of improper waste dumping, since such companies at times avoid using designated dumping sites where they have to pay a fee.

The households who cannot afford the services of waste disposal companies have no alternative but to dump. The municipal authorities are running out of land for dumpsites as the designated sites are in the peri-urban areas where most of the informal settlements are situated. There is, however, hope in recycling which is being taken on by a number of municipalities in the region.

Water and Sanitation

In a number of SADC countries, many urban settlements can claim to have total or near total coverage in terms of the population's access to safe water and sanitation. However, these data mask the disparities between the urban formal and informal settlements. Angola has made remarkable progress in expanding its drinking water coverage but still needs to raise the level. In the period 1990 to 2008 access to safe drinking water increased from 36 to 50 percent of the total population while sanitation dropped from 61 to 50 percent in the same period, mainly resulting from the growth of slums (ZAMCOM and SARDC 2014). The same report notes that access to safe drinking water in Botswana increased from 77 percent in 1990 to 94 percent of total population in 2008, while improved sanitation rose from 38 to 96 percent of the population over the same period. This

Box 7.3 **PROBLEMS OF IMPROPER HANDLING OF WASTE**

- Risks to air- and water-borne diseases;
- Blockage of drains and sewers with waste;
- Contamination of surface and groundwater by seepage from landfills and uncontrolled dumps;
- Risk of disease to people who make a living by sorting waste; and,
- Unpleasant odours and sights of uncontrolled garbage.

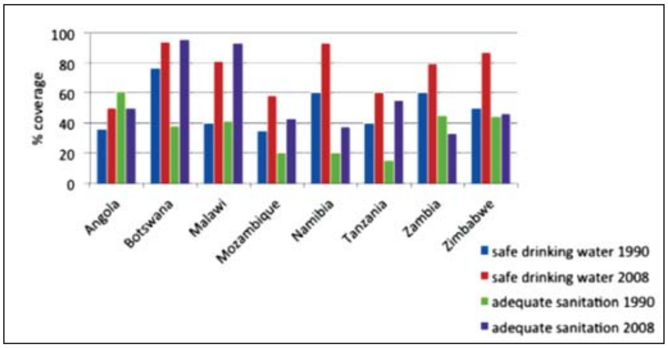
SADC/SARDC and others 2008

positive development is attributed to the policy decisions and strategic action over a period of several years.

Figure 7.3 illustrates the proportion of urban residents per country with access to improved water and sanitation, while Table 7.3 shows access to sanitation coverage by country in urban and rural areas.

Most basin countries have improved the water supply and sanitation facilities but have not yet met the MDG sanitation targets (Table 7.4). The proportion of the population with access to safe water and sanitation is still very low in most basin states, with less than 40 percent of the population having access to safe water (AMCOW/WHO and UNICEF 2010).

Figure 7.3 **Percentage of Urban Residents With Access To Improved Water And Sanitation**



ZAMCOM and SARDC. The Zambezi.2014

There is need for renewed effort and investment in these areas.

Although governments in the region have taken steps to improve water supply, the sanitation facilities still remain insufficient, thus adding pressure to the health services and increasing the vulnerability to disease. The highly urbanising areas have the poorest sanitation conditions because the waste disposal and sanitation in the informal settlements is inadequate. Water contamination in the basin is widespread due to industrial pollution, seepage of shallow wells and through discharges of untreated sewage into surface and groundwater. Urban residents use this same contaminated water as it is the only available source.

The provision of clean water to urban communities is essential to maintain certain standards of hygiene and health. However, every household or institution produces waste and it is indispensable that sanitation services be adequately provided to cope with levels of waste produced. Even in countries where a high proportion of urban residents have adequate sanitation, there are indications that local authorities are failing to cope with the related volume of sewerage to be treated.

Cholera has become endemic in a number of countries, including Angola, Malawi, Mozambique, Zambia and Zim-

Table 7.3 **Sanitation Coverage**

Country	Sanitation Coverage 2010 (%)						
	Urban		Rural		Total		Population (000) gaining access 1990-2010
	Improved	Unimproved	Improved	Unimproved	Improved	Unimproved	
Angola	85	9	19	30	58	17	8 031
Botswana	75	18	41	10	62	15	709
Malawi	49	5	5	9	51	8	3 866
Mozambique	38	41	5	36	18	37	2 679
Namibia	57	4	17	7	32	6	400
Tanzania	20	58	7	73	10	70	2 956
Zambia	57	17	43	22	48	20	2 632
Zimbabwe	52	2	32	10	40	6	744

AMCOW Snapshots 2012. Drinking water and sanitation in Africa.2012

Table 7.4 **MDG 7 – Ensure Environmental Sustainability**

Millennium Development Goal 7
Target 7C Halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation
Indicators 7.8 Proportion of population using an improved water source 7.9 Proportion of population using an improved sanitation facility

babwe, which in turn has led to the recording of high cholera morbidity and mortality. In these five countries, an estimated 318,400 cases of cholera have been reported between 2006 and 2012, according to data from respective Ministries of Health and the World Health Organization (WHO, UNICEF and OCHA 2013). The sanitation situation in the Zambezi Basin is far from meeting the required standard, with the occurrence of cholera and other waterborne diseases recorded year after year. The region needs to do more of prevention measures than mitigation in order to reduce the incidence of cholera.

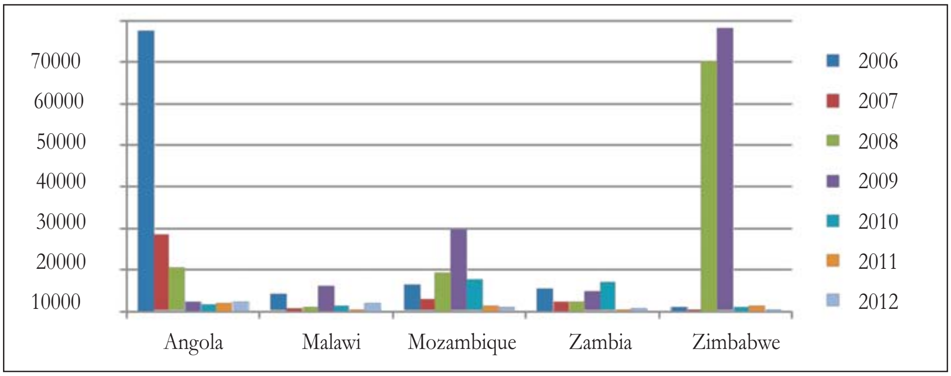
There have been significant outbreaks over the past decade. Angola experienced a serious national outbreak between February 2006 and May 2007, when 82,204 cases with 3,092 related deaths were reported. The worst outbreak of the past decade occurred in Zimbabwe between August 2008 and July 2009, when 98,592 cases and 4,288 deaths were recorded. Eight other countries in southern Africa were also affected by cholera during 2008/09.

In Zambia several innovations have been adopted to address water shortages in peri-urban areas. Provision of water and sanitation services is the responsibility of different government departments. In some urban areas at the community level, provision and management has been undertaken with input from Resident Development Committees, water vendors and community-based organizations such as neighbourhood health committees and other entities (Mwandawande 2005). These initiatives between government and community organizations tend to target low-income communities in peri-urban areas.

Pollution Patterns and Effects

Urbanization is probably the biggest polluter in the Zambezi River Basin because of the challenges of sewage affluent and its disposal, but other major sources of

Figure 7.4 **Reported Cholera Cases in Selected Countries**



Ministry of Health (Members States)/WHO and compiled by Ben Henson pollution are industrial and domestic waste and emissions, vehicle exhausts, use of inappropriate domestic fuels and inappropriate waste disposal of both solid and liquid waste. This is particularly the case where environmental management measures and institutions are weak. Inadequate investment in cleaner production and incentives to minimise pollution exacerbate the problems.

Most urban centre have localised pollution problems, including sewerage affluent, industrial activities and processes, power generation (oils leakages), and mining activities. Other sources are natural pollution through stormwater runoff, agricultural activities, leakages from landfills, agricultural activities (fertilizers and chemicals, especially now with the increase in urban agriculture), and seepage from landfills and pit latrines.

Domestic and industrial effluent in most urban centres is channelled through some kind of sewage treatment works consisting of septic tanks, oxidation pond systems, conventional treatment works, and/or activated sludge types of works. The sewage treatment works are limited to the planned areas of cities and towns, the unplanned areas have to devise their own ways of disposing of affluent. The quality of effluent produced depends on the type of works, but in general the pollution problems such as eutrophication of water bodies are being caused by the high concentrations of phosphorous and nitrogen in the effluent. The facilities for water reticulation, purification and treatment are still largely inadequate.

The pollutants travel over great distances and reach the rivers. The severity and impact of this pollution is not well documented, but there is evidence of the effects of the pollution on the quality of vegetation, soils and water.

Urban centres such as Harare and Lusaka are facing serious problems of air pollution caused by industries and other human activity, and the over-dependence on fossil fuels. Sulphur dioxide, suspended particulate matter, nitrogen oxides, carbon monoxide and lead were in the recent past the most common, as well as most harmful, air pollutants in the Basin. These have since reduced with the phasing out of leaded fuels in SADC member states and the introduction of non-sulphur diesel.

Underdeveloped public transportation and facilities for non-motorised forms of transport is causing serious traffic congestion throughout the Zambezi Basin, with the central business districts of most major cities having inadequate parking space. The region has also seen a significant rise in the volume of vehicles on the roads, including imported second-hand vehicles. Some of cars on the road are very old and emit poisonous gases, and the maintenance also generates a lot of waste.

Box 7.4 **WATER KIOSKS FOR PERI-URBAN DWELLERS IN ZAMBIA**

Zambia's National Water Supply and Sanitation Council (NWASCO) requires $20 million to set up water kiosk systems in peri-urban and low-cost residential areas to ensure the availability of clean water. NWASCO estimates that approximately 1.9 million of the 4.5 million people in peri-urban and low-cost areas do not have access to clean water. The council wants to introduce a water kiosk system to be run by water utility companies in targeted areas. Under the system, consumers will be required to pay K20 (less than US$0.01) for a 20-litre container of water. The system will provide services to peri-urban and low-cost dwellers who walk long distances to fetch water, mainly women. Water kiosk systems have been set up as a pilot project in Ndola under the management of Kafubu Water and Sewerage Company, and in Western province under the Western Water and Sewerage Company.

Times of Zambia/SADC Today 2005

Water

The high rates of urbanization and industrialization in the Basin, which are not matched with adequate waste treatment facilities, have resulted in water pollution in some of these areas. Nearly every town and city in the

Box 7.5

URBANIZATION AND POLLUTION

Livingstone in Zambia, Victoria Falls in Zimbabwe and Kasane in Botswana are some of the urban settlements close to the Zambezi River and these have a combined population of almost 200,000 people. Apart from industrial activities related to tourism, other industrial activities have been on the decline. Livingstone has six wastewater oxidation ponds that were commissioned in 1995, and prior to that raw sewage was being discharged into the Zambezi River. Despite the ponds, some limited discharge into the Zambezi River still occurs.

As a heritage site Victoria Falls is one of the most popular tourist destinations in southern Africa, with a monthly visitor population averaging 32,000. Environmentalists believe that the Victoria Falls has reached its full infrastructural and population potential and any further development will lead to environmental degradation. By the year 2000, Victoria Falls town was discharging 8,000 cu m of wastewater into the Zambezi River. The discharge of effluent by the town into the Zambezi River was condoned under the Water (Effluent and Waste Water Standard) Regulations because the town's population was until 1998 considered small. The town's sewage treatment facilities then became overloaded and subject to frequent breakdowns,
forcing the town to discharge raw sewage into the Zambezi River through the Masume River. The town has taken measures to improve this situation through planned infrastructure development, although current figures are not available.

Chitungwiza town, south of Harare, has high levels of pollution due to poor disposal of sewage. The town has grown rapidly since 1980, with annual population growth rates of 3.5-7 percent, resulting in serious overload of sewage treatment facilities. The town is a significant pollution threat to the Manyame River. In the copper-producing areas of Zambia, the two major mining towns of Ndola and Kitwe are heavy polluters of the Kafue River.

Zambezi Basin has some form of sewage treatment works, but most of these are limited to the planned areas of cities and towns. The unplanned areas have to devise their own ways of disposing of effluent. The quality of effluent produced depends on the type of works, but in general pollution problems such as eutrophication of water bodies are being caused by the high concentrations of phosphorous and nitrogen in the effluent.

Water pollution is a health hazard because pathogens found in polluted water are harmful to human health, especially when the water is used for domestic, recreational, industrial or agricultural purposes. These pathogens are the cause of waterborne diseases and in the basin the most common are dysentery, cholera, malaria and bilharzia. Pathogens that cause cholera and dysentery are found in water contaminated with faecal matter from open defecation, seepage from pit latrines into shallow wells, and poorly treated sewers. Polluted water attracts aquatic weeds, such as the Kariba weed and the water hyacinth which cause ecological problems if not controlled. These are the most problematic aquatic weeds within the Zambezi River Basin. The pollution of water bodies can impair reproduction in fish, retard their growth or kill them.

Air

Air is polluted largely by industrial and domestic activities that emit toxic gases. These affect human health and can cause cardiovascular and respiratory diseases especially for children and those who work directly in the industries. The introduction of ozone-depleting substances into the atmosphere puts people at the risk of skin cancer and eye cataracts. This pollution also has ecological effects as the pollutants degrade water quality and harm aquatic life by interfering with photosynthesis, respiration, growth, and reproduction.

Urban centres such as Harare and Lusaka are facing serious problems of air pollution caused by industries and other human activity, and the over-dependence on fossil fuels. Sulphur dioxide, suspended particulate matter, nitrogen oxides, carbon monoxide and lead were in the recent past the most common, as well as most harmful, air pollutants in the Basin. These have been reduced with the phasing out of leaded fuels in SADC member states and the introduction of non-sulphur diesel.

Underdeveloped public transportation and facilities for non-motorised forms of transport is causing serious traffic congestion throughout the Zambezi Basin, with the central business districts of most major cities having inadequate parking space. The region has also seen a significant rise in the volume of vehicles on the roads, including imported second-hand vehicles. Some of cars on the road are very old and emit poisonous gases, and the maintenance also generates a lot of waste.

Domestic

Domestic pollution caused by the use of inappropriate domestic fuel is a continuing cause of indoor pollution, especially in low-income and informal settlements. Women and girls are more affected by indoor pollution than men by virtue of their traditional role of cooking food and caring for families, often in a smoky environment. Women are affected by the pollution from domestic activities that use cooking fuels such as charcoal, animal dung, crop residue and other items, including the incomplete combustion of plastics. There has been a general improvement in cleaner energy technologies, encouraging energy conservation and other general environmental conservation measures. However, indoor air pollution from heating and cooking activities is worsening, due to lack of cheap alternatives to firewood and cow dung. Pollution affects all populations within the polluted area, however some people are more exposed to pollution than others due to livelihoods or roles in society.

Industrial

The Zambezi Basin is witnessing worsening pollution problems, including increased levels of uncontrolled waste dumping, mainly in urban and tourist areas as well as growing pollution which is industrial and energy related, although improvements in efficiency have also been noted in industry and agriculture. Urbanization contributes to pollution and the most affected populations are the urban poor who often live in informal settlements which are close to industrial areas, and in densely populated areas, often close to dumping sites.

Oils and grease released into water bodies can also suffocate aquatic organisms. Heavy metals are toxic to aquatic life and can contaminate ground and surface water. These pollutants threaten fishery breeding grounds and recreation sites. The water hyacinth threatens to choke the river system, making it unusable for transport, fishing, recreation, electricity generation and other activities. In the Kafue River in Zambia, the water hyacinth has caused problems in the turbines that generate electricity and the weed invasion of the river has also affected fisheries. The same has been experienced in Lake Chivero, near Harare.

In Kabwe (Zambia), copper smelting releases hundreds of thousands of tonnes of sulphur dioxide and dust containing traces of zinc, lead and copper that affects people and vegetation. Half of the children in cities with copper-smelting facilities suffer from respiratory diseases. Vegetation is affected by the release of sulphur dioxide. Air quality is affected by emissions from smelters, and to a lesser extent the refineries of compounds of carbon, sulphur and nitrogen, and toxic metal particles. There are indirect emission effects from the use of fossil fuels as energy sources and from potentially hazardous dusts and gases released in the workplace. Air pollution levels in the region are high, affecting mainly urban areas, which have heavy concentrations of industrial development.

Another area of concern is air and water pollution from the mining sector. Gaseous pollution from mining is found on the open cast coal mines due to the spontaneous combustion of coalfaces initiated from the high sulphur content of mudstones above the main seams which may be as much as five to seven percent sulphur. The mining sector is also responsible for water pollution through the discharge of highly toxic metals such as mercury, which is used to separate gold from sand, but whose use can lead to serious illnesses and death if washed into watercourses and later consumed.

Control and Monitoring

New instruments have been put in place by the Environmental Management Agencies of most of the riparian states to control the levels of air, land and water pollution. Among such instruments are measures to monitor the level of pollution, public education and awareness, environmental production standards, legal policies, waste treatment requirements, and provision of disincentives to pollute.

The levels of pollution need to be monitored from the level of substances entering the environment, their quantity and quality, sources and distribution. The effects of these substances on the environment and on humans and animals should be measured and monitored. The cost of reducing the effect is also an important factor in pollution control. Pollution control and prevention consists of systems of measurement, criteria, standards, laws and regulations, which are directed at the sources and causes of the various forms of pollution. Monitoring of most air pollutants is generally not conducted in most of the cities in the Zambezi River Basin. The scale, effect and impact of the various factors differs from country to country.

Unemployment

The rate of population growth in Zambezi Basin cities and towns has fallen below the capacity to create jobs. Economies are not growing as fast as expected, and this has affected job creation, with the expanding informal sector turning largely to self-employment and trading, including cross-border trading. As a result of the slow rate of

growth in formal employment over the years, informal employment has grown to an average of 36 percent of the total labour force. The declining chances of getting formal employment for most populations, especially women and youth, comes against a backdrop of an industrial base that could hardly support 11 percent of the total population two decades ago.

One of the drivers of the slow rate of economic growth is the failure by industry to absorb the labour force. The rates of growth of the labour force exceed rates of growth of formal sector wage employment in most riparian states, making unemployment and underemployment rates very high. The graduates are often unattractive to the labour market as inexperienced and over-priced, giving unequal /disparities between the skills acquired through formal education and the skills required in the labour market. Informal sector activities are not regulated and very difficult to monitor despite providing positive social support for the communities and contributing significantly to the national economy, although uncalculated in national accounts.

Urban Agriculture

Urban agriculture produces food for family consumption and the urban market, and is largely made up of small plots or market gardens on land around the homesteads and open spaces and infrastructural servitudes within cities and towns.

Urban agriculture is a common practice in the Basin, undertaken by about 37 percent of urban households in Mozambique, while 45 percent of low-income households in Zambia grew horticultural crops or raised livestock around the home or on the city periphery in 1996. In Zimbabwe close to 70 percent of urban residents in the capital Harare practiced some form of urban agriculture during the same year (SADC/SARDC and others

Box 7.6 **URBAN AGRICULTURE IN MZUZU CITY, NORTHERN MALAWI**

Mzuzu is located in Northern Malawi and has a relatively small population and density relative to other urban areas in the country. The official population is 128,000 although unofficial estimates put the figure at double that figure due to widespread informal settlement on the fringes of the city's jurisdiction.

Covering an estimated area of 76 sq km, Mzuzu is a regional economic and political hub. It has a specialist hospital, tobacco auction floors, a fledging industrial and financial sector, a beverage company and a flea market. The city has several secondary schools, tourist and recreational facilities, vocational colleges, and a public university. The city's residents depend on food produced in neighbouring northern districts (maize, beans, cassava) and from far-off central region districts, such as Ntcheu (Irish potatoes).

However, Mzuzu is increasingly reliant on foods produced within the city or within the vicinity (chicken, milk, vegetables, and maize) to meet the food needs of its expanding population, small businesses, education institutions and hospitals. Much of this farming takes place within the city in zoned spaces or in backyards.

Institutional responses to urban agriculture indicate that there is a glaring mismatch between the officially stated land-zoning code and the responses of the city assembly with respect to expanding agricultural activities in Mzuzu. Because the city's urban infrastructure plan has no provision for agricultural uses, all farming in the city is technically illegal. Official policies prohibit any forms of land use other than those prescribed by zoning codes. Although authorities are aware of increased farming activities in the city, officials generally do not take action against them. Even when residents overtly violate bylaws that only allow for ancillary agriculture such as livestock or backyard farming, city officials have been reluctant to invoke penalties.

Officials interpret recent land-use changes, especially the growing presence of farming within the city space, as evidence of the need for changes to the existing policy to better regulate farming, which is understood by the authorities, as residents of this city. However, they also appreciate the challenges that poorly managed urban agriculture can present. The city is planning to designate a large area of land for farming, close to the Lunyangwa agriculture research station.

Arku and Others.Africa's Quest for Food Security: What is the role of Urban Agriculture?, 2012

2008). The extensive and reasonably successful practice of urban agriculture is due to positive efforts that have been made by cities to facilitate urban agriculture, especially in South Africa, Tanzania and Zimbabwe.

Urban farming has environmental hazards including stream-bank cultivation, destruction of wetlands, and the improper use of pesticides. Data from Zimbabwe indicate that in Harare, 8.6 percent of urban farming outside of residential properties occurred near stream banks, with an additional 7.3 percent of this activity taking place on wetlands (SADC/SARDC and others 2008). The literature shows that women tend to cultivate smaller plots that are nearer to the homesteads than those of men. Women grow produce mainly for home consumption and food security, while only the excess is sold, whereas men have bigger plots used for commercial sales, a little further away from the place of habitation.

Urban agricultural activities have conflicted strongly with conservation activities. In many African cities open spaces in the residential areas have been taken up by agricultural activities, which have played an important role in supplementing the dietary needs of urban dwellers, notably the urban poor. However, the impact of some of these agricultural activities on the environment has been negative. Thus there is need to review urban planning policies so they recognise the existence of urban agriculture but also consider the environmental conditions for sustainability.

The national food security agenda in the Basin has an evident rural bias and insufficient attention is given to the specific challenges of feeding the residents of urban areas, despite the fact that the locus of poverty is shifting to cities and most of the urban poor are facing food security challenges. It is vital for city and national policies that address urban food security to appreciate the complex relationship between household food security and an entire range of variables such as income, gender and household size.

Policy Issues and Options

A number of policies and strategies have been put in place in the SADC region in response to the challenges presented by the region's settlement patterns (SADC/SARDC and others 2008, including those that address housing and human settlements in respective Basin states. For example, Malawi formulated the National Land Policy and National Housing Policy that address housing issues (GoM 2010). Mozambique's first housing policy and strategy was approved in 2011, and this specifies the government's commitment to build 100,000 houses and service 300,000 plots of land by 2014 (Centre for Affordable Housing Finance in Africa 2014). The Zimbabwe National Housing Policy (2012) recognises the importance of providing adequate, quality housing and outlines a multi-sectoral approach to address housing challenges and improve security of the urban poor. (GoZ 2012).

Access to housing and plots is connected to land tenure and accessibility to land. Housing policies should speak to land policies and related environmental policies to ensure improved livelihoods. This is important if local governments are to consider regularization of informal sectors as many of these settlements are in peri-urban areas that are not recognised by other pieces of legislation that facilitate the delivery of much-needed basic services.

Basin countries are putting in place several policy instruments to address challenges presented by rural-urban migration. There is need to address factors leading to the migration of skilled professionals (social, economic, political, environmental) and assess the contribution of each of these factors in influencing migration decisions. Policy options should take into account the contribution of each of these factors.

Initial public policy responses to the rapid urban population growth have generally been negative, premised on the notion that urbanization has to be curbed. However, in recent years there has been a policy shift whereby government increasingly began to see cities not only as engines of economic growth and sources of service sector employment, but also as major sources of national and local tax revenue.

Urban management in the Zambezi River Basin faces several challenges. First, most countries do not have national urbanization policies to guide macro-economic development. Second, the highly centralised nature of decision-making has rendered many urban local authorities ineffective and has left them with limited powers for local revenue generation to supplement the limited allocations from the centre.

It is evident that urbanization is a threat to environmental sustainability in the Zambezi Basin therefore strategies have to be put in place to minimise the impact on the environment.

Ensuring urban water supply requires interventions at sub-regional and local levels. At sub-regional level, the well-managed, inter-basin transfer schemes and good catchment land-use management upstream and downstream of cities are likely to contribute favourably to long-term water supply. At local level, ensuring sustainability of the urban water supplies requires moving towards higher levels of water conservation, including grey-water reuse, recycling and decentralized rainwater harvesting. Reducing water loss by fixing leaks and instituting better maintenance regimes in urban systems can contribute greatly to savings, indicating that improved efficiency measures can make a significant contribution to urban water security.

For wastewater and sanitation, semi-decentralized and decentralized waste-to-energy systems that produce gas for heating and cooking (as well as compost) are far more desirable than traditional flush toilet infrastructures that incur large costs to produce large amounts of water and energy to transport and process wastewater in centralized infrastructure. However, achieving successful integration of decentralized wastewater sanitation infrastructure requires close engagement with local communities and inclusive, transparent processes through which these technologies are deployed.

More localised solutions are required for dealing with solid waste, and the potential exists to create small to medium-scale industries engaged in waste-value chain and simultaneously to create the much needed semi-skilled and skilled jobs. There are numerous opportunities to transform informal recycling and re-use activities towards greater relevance in Zambezi Basin cities that could be carefully considered in urban waste strategies.

- Creation of eco-efficient cities;
- Effective pollution control through institutions, legislation, regulation and enforcement;
- Improvement in rural investments and strengthening the economic base so that rural populations have incentives;
- Measures to reduce poverty in the cities through small-scale industries, conducive policies for production, and sustainable consumption;
- Make data available for planning and policy making;
- Improve urban infrastructure and services to facilitate access for all city inhabitants for economic development;
- Reduce rural-urban migration through investment in both rural and urban areas;
- Provide adequate facilities and service delivery in urban areas;
- Exercise greater control in the management and protection of the common goods of land, air and water.

Efforts to decrease the levels of poverty are needed, by identifying local initiatives for revitalising and diversifying the local economies and increasing possibilities for the informal sector, especially for women and the youth. The Basin should adopt policies that maximise the benefits of urbanization and respond to the interconnectivity of the river basin states.

Clearly, there is need for city councils to support livelihood strategies, especially those pursued by the poor, such as urban agriculture, in order to strengthen food security. Also, there is need for citywide policies that aim to strengthen targeted safety mechanisms for urban households who are food insecure.

Gender disaggregated data is not easily available and this makes it difficult to analyse the impact of various aspects of urbanization, including degradation of the environment on men and women. More research, data and indicators are needed to facilitate the identification and mainstreaming of relevant gender policy options in the Zambezi River Basin.

CHAPTER LINKAGES

Basin Overview
Well-planned human settlements can provide roads, schools, telecommunications, hospitals or clinics and supporting services. Increasing populations create challenges for the provision of adequate health and education facilities, housing, sanitation, safe water, electricity, waste disposal and other social services The Zambezi River Basin contains significant urban areas with high growth rates through rural-urban migration, and grapples with challenges of informal settlements. The urbanization puts additional pressure on infrastructure, goods and services, and often degrades the environment in peri-urban areas. Rapid urbanization increases the demand and consumption of natural resources, availability of water resources, and increases the loss of biodiversity. Water pollution, and poor water and sanitation, are a health hazard. There is pressure on the available quantities by competing users including industry, agriculture, mining and domestic. All types of human settlements impact on the natural environment, although traditionally this was a mutually beneficial impact.

Water Resources
Provision of clean water and sanitation services in urban areas requires good planning, and this is disrupted by rapid growth in urban populations due to migration from rural areas. Urbanization creates demand for water for domestic use and from competing urban productive activities.

Land and Agriculture
Land use is not sufficiently well planned in the Basin with availability of credit facilities to provide livelihoods that retain the population in rural areas, although progress has been made in some areas. Urban development absorbs peri-urban land previously available for agriculture and food production, although urban agriculture can support food production if well-planned. Agriculture can be polluter in the form of herbicides, fertilisers, pesticides and other chemicals find their way into river systems and other water bodies.

Biodiversity and Forests
The growth of urban centres involves the clearance of land and deforestation, which impacts on the environment through pollution, biodiversity loss, and a reduction in the flora and fauna. The common cooking fuel among low-income households is wood or charcoal which is resource inefficient and unsustainable, causing deforestation and loss of biodiversity.

Climate Change and Variability
Urban centres consume the most natural resources due to concentration of population and provision of services. The main source of energy is electricity, and generation of thermal energy can be a source of pollution, including carbon dioxide, nitrogen dioxide and sulphur dioxide. Per-urban communities mainly collect fuel wood because they cannot afford other energy sources. The Zambezi Basin weather patterns are changing due to industrial and human activity, as forest depletion leaves the land with no cover, cultivating on river beds allows for flooding, etc.

Energy and Infrastructure
The growth of the urban centres increase the demand for energy for industrial and domestic use, and for irrigation of agriculture to provide food for large concentrations of people. Inappropriate energy sources or over-use of unsustainable resources can be detrimental to the environment. Renewable energy is widely promoted as an alternative to other sources, and measures are taken to increase supply and reduce demand through energy-saving devices.

Tourism
The main tourist attractions in the Zambezi Basin are the wildlife in protected areas, especially trans-frontier conservation areas, and the scenic areas such as the Victoria Falls, Kasane, Kariba and Lake Malawi/Niassa/Nyasa. The aesthetic value of such scenic sites can be degraded by over-opulation and pollution, but tourism can reduce poverty levels through various means, including inclusive employment, cultural tourism, provision of crafts and services by communities, and community-based wildlife management. Settlements near the tourist areas need to have adequate goods and services and well-functioning infrastructure.

Industrial Development
Industrial development has positive and negative impacts, which need to be balanced in human settlements. Industry provides employment to urban populations, but is also a source of pollution. Industries often discharge affluent into the environment. Due to poorly planned waste collection and disposal facilities, waste may be disposed of close to habitats, including hazardous waste, putting the residents at risk.

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TOURISM

8

Introduction

Tourism is an important economic and social activity that has become an integral development tool for many countries including those of the Zambezi River Basin. The tourism industry is one of the key drivers of socio-economic development in the region due to its strong multiplier effect (SARDC 2013). The SADC tourism sector sees this industry as having a "catalytic influence for widespread economic and social progress and as a means of promoting sustainable development", based on untapped resources, such as unique natural, cultural and historic resources including wildlife, wilderness areas, natural wonders, pristine beaches, mountain ranges and round-the-year sunshine (SADC/SARDC and others 2008).

Riparian countries within the Basin host hundreds of thousands of tourists annually who visit places such as Victoria Falls, Lake Malawi/Niassa/Nyasa or the many national or recreational parks or transfrontier conservation areas. Almost 365 days of sunshine in the basin is a prime driver for northern tourists as they seek to escape the cold weather and travel for reasons of health and relaxation. The Zimbabwe, Zambia and Malawi Tourism Strategic Plans outline scenery and good weather as some of the tourist motivations to visit these countries (Retosa 2010). An examination of the online promotion of some leading tourism agencies shows that scenery and weather are essential tools in enticing visitors to the Basin.

According to the United Nations World Tourism Organization (UNWTO) and the World Travel and Tourism Council (WTTC), global travel and tourism grew by 3.1 percent in 2013 and contributed about US$2.2 trillion of global Gross Domestic Product (GDP), accounting for more than 100 million jobs (WTTC 2014; UNWTO 2014).

In terms of its multiplier effect, the tourism industry outperformed the traditional sectors such as financial and business services, retail and distribution in 2014, accounting for over $7 trillion, 266 million jobs, $754 billion in investment and $1.3 trillion in exports (WTTC 2014). The sector is expected to grow by an average of 4.2 percent between 2014 and 2024, and provide over 74.5 million additional jobs, of which 23.2 million will be direct jobs and the reminder indirect due to tourism's multiplier effect (WTTC 2014).

Box 8.1 **DEFINING TOURISM**

Tourism is a generic term, which encompasses a multiplicity of definitions. However, it is generally accepted that tourism is about people travelling away from their homes on temporary visits for particular purposes of touring other places. This definition captures the essential characteristics of tourism, which include the temporary movement of people to destinations outside their normal places of work and residence, activities undertaken and facilities utilised at the destination, mode of transportation used, length of stay and distance travelled among others. The term "tourism" includes at least a 24-hour stay away from a normal place of residence. Anything less than 24 hours is described as an "excursion" and the participants are excursionists, not tourists. The two main purposes associated with travelling, which makes people tourists, are leisure and business. Other reasons for tourist travel are for medical purposes, religious reasons and for education.

Nyakunu in Chenje, M. 2000. State of the Environment Zambezi Basin 2000.

Some key indicators showed that 2013 and 2014 were good years for tourism with higher demand and occupancy rates for all regions, and increased demand for air travel, among others. The southern part of Africa including the Zambezi River Basin showed some steady growth due to the overall political stability, and the prospects continue to look promising. Expected positive growth in key indicators at global level is also expected to spill over to the Zambezi Basin which is characterised by a wide variety of landforms, vegetation zones, wildlife and cultural landscapes that offer many spectacular tourism attractions. Availability of supportive infrastructure such as hotels, roads and airports is essential to a robust tourism sector. In addition, facilitation of easy movement of people, goods and services, and improvements in technology, are important factors in tourism development. Being a labour intensive industry, tourism offers many jobs and livelihoods to companies and individuals, and makes a significant contribution to the economy of the Zambezi River Basin at local and national levels.

The Zambezi Basin has a diverse range of tourism products from natural, cultural and built products for travellers. It provides opportunities for game viewing, bungee jumping, white water rafting, canoe trips and river cruises, botany and birdlife viewing, fishing and boating, as well as beautiful scenery and striking sunsets, wilderness landscapes and many natural resources that are of exceptional value (SARDC 2013a). The major tourism destinations in the Zambezi Basin are national parks and nature reserves, with wildlife and scenery as primary attractions (SADC/SARDC and others 2012). Other destinations include the lakes, rivers and mountains, and traditional sites that have been preserved and maintained for centuries.

This chapter analyses tourism developments and trends, ecotourism and cultural tourism as well as other related developments in the sector. The chapter further analyses the policies and institutional frameworks that have an impact on tourism, as well as the threats and opportunities, and examines the impacts on gender and the youth.

Box 8.2 **TOURISM PRODUCTS IN THE ZAMBEZI RIVER BASIN**

Natural Attractions. The Zambezi Basin has products such as protected areas, including national parks, game and forestry reserves, mountains, hills and valleys, and fresh air.
Water Bodies. The Basin has both natural and artificial water bodies in form of lakes, dams, rivers and waterfalls, and wetlands that also support other tourism activities.
Cultural/Heritage. The Zambezi Basin has a diverse cultural heritage, offering a unique product for both external and domestic tourism. Culture or social life within the Basin area includes historical sites and museums, handicrafts, language, traditions and gastronomy; visual arts and non-tangible culture, including a wide range of music concerts and festivals, paintings and sculpture, local cuisine, legends, world heritage sites, dress and leisure. The uniqueness of natural and cultural assets in the Basin has led to recognition of some places by UNESCO as World Heritage Sites. These include both natural and cultural sites such as Chongonic Rock Art in Malawi and Lake Malawi/Niassa/Nyasa, the Victoria Falls, Mana Pools/Sapi /Chewori; and the Middle Zambezi Biosphere Reserve. The World Heritage Sites provide a unique opportunity for conservation and the development of carefully planned, high-value tourism facilities and sustainable tourism, cultural and environmental management.

Nyakunu in Chenje, M. 2000. State of the Environment Zambezi Basin 2000.

Key Drivers of Tourism Development

Globalization

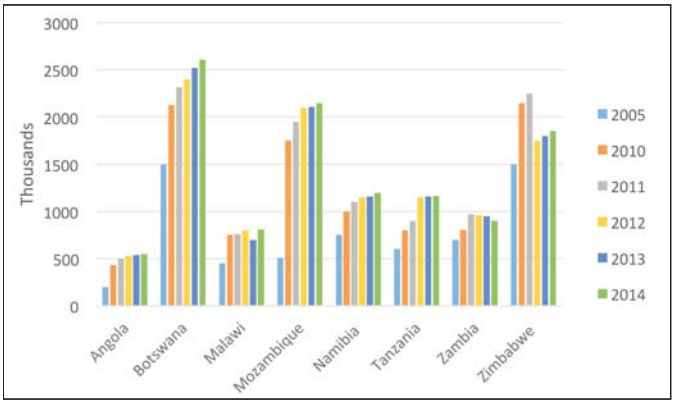
Globalization remains a modern and key driver for tourism. The historical analysis of arrivals within the region shows a growing number of travellers from the industrialised northern and emerging eastern economies (Retosa 2010). As disposable income of tourists from the source markets remains a key factor for travel, it follows therefore that impacts on those incomes will affect the number of tourists visiting the region and the amount of income earned from this sector, as well as jobs created and revenue from taxes. This was evident during the 2008-2009 financial global crisis (UNWTO 2009) which saw reduced long-haul travel and holidays and reduced investments in the sector leading to consequent losses in benefits from tourism.

Another area related to globalization is the issue of conflict. According to the UNWTO (2014), conflicts in the Middle East and north Africa have pushed tourists to other destinations such as southern Africa which, although further from Europe, has remained relatively stable in recent years. This implies that conflicts in a globalised setting can drive tourists to other destinations and it is expected that the Zambezi River Basin will see an increase in tourist arrivals due to security concerns in other parts of Africa and the world (UNWTO 2014).

Arrival figures for eight countries that share the Zambezi Basin showed significant variations over the period under review. The growth from 2000 to 2012 represents an increase of 208 percent although this trend varied among by country as shown in Figure 8.1.

As issues of globalization will continue to impact on tourism, efforts such as joint marketing, sharing of best practices and information, advancing tourism as a smart growth sector that creates clean energy jobs, and prioritising the inclusion of tourism in economic recovery plans should be embraced and pursued (UNWTO 2009).

Figure 8.1 **Tourist Arrival Trends for Zambezi River Basin Countries**



UNWTO 2013; WTTC 2013; RETOSA 2012

Employment

A major justification for tourism development is its capacity to create employment for local communities in areas that are visited. Consequently, where rewards from other activities such as agriculture appear to dwindle or economic opportunity seems limited, local populations may resort to tourism-related employment. During major tourism events and festivals within the Basin, generally from May to November, more informal and seasonal employment is available from tour guiding, porters, interpretation services to events management.

The Zambezi Basin still lags behind in women employment, and the travel and tourism sector has tended to create different roles for male and female workers. Whilst actual data to determine patterns of employment within the Basin for this sector is scanty and not disaggregated, observations indicate a dominance of male employees to females. For example, the proportion of official figures of employment within the Department of National Parks and Wildlife in Malawi shows that for every one female employee, there are 15 male employees (GoM 2012).

By the year 2000 only Botswana and Namibia had more than 50 percent women employed in the services sector including tourism, at 67.4 percent and 63.3 percent, respectively. Tanzania and Zambia had 14.8 percent and 18.4 percent respectively of women employed in the sector (SADC 2012a), although this may have changed in the period to date. Therefore, while the industry is growing, the number of women employed remains low on average.

The youth from ages 15 and above work in the tourism sector in the Basin, usually as casual labour. From tour guides in the Victoria Falls, Mount Mulanje, Chobe areas and elsewhere, the youth have taken up employment either casually or seasonal in such areas as boating, interpretation services and porters in some areas. It is common to see a significant proportion of youth involved in the arts sector through the production and selling of various artworks and souvenirs.

Infrastructure

Development of the tourism sector depends to a large extent on the provision of infrastructure as an enabler. Infrastructure such as roads, airports, and direct tourism investment in the sector through upgrades or new hotels and lodges in the Basin has seen growth in an upward trend since the year 2000. The SADC Regional Infrastructure Development Master Plan (2012) has noted that infrastructure is essential to the development and growth of meaningful tourism within the region.

In the basin countries, physical infrastructure and tourism development projects have been implemented since 2000. Most notable is the improvements in access roads connecting Tanzania, Malawi, Mozambique and Zambia which allows for smooth road access,

and the upgrading of the airports at Livingstone/Victoria Falls allowing more international airlines to access the area and its national and local destinations.

In addition, one-stop border posts are being established at key crossings in the Zambezi Basin to facilitate the easier movement of people, goods and services between countries. This type of border crossing was piloted at Chirundu border post between Zambia and Zimbabwe in 2009. Infrastructure such as bridges are being developed or expanded, including the plans for construction of the Kazungula Bridge, and the Katima Mulilo Bridge across the Zambezi between Namibia and Zambia which opened in 2005 (SADC and ZRA 2007). These key developments coupled with the UNIVISA initiative will improve travel and tourism within the Basin.

Modern advances in aviation have further made it possible to fly into the Basin that in the past took longer access. An increase in multi-destination packages between riparian states in the Basin, has seen operators flying in tourist groups from South Luangwa to Lake Malawi/Niassa/Nyasa, Victoria Falls, Cahora Bassa, Okavango, Inhambane, Lake Kariba, Caprivi-Kavango and many other places (Retosa 2010). Efforts to increase air access into and within the Basin need a firm and bold step, as the adoption of the Open Skies Policy alone is not enough. Governments need to put in place favourable incentives and policies that support air access and further allow for local partnership in the aviation sector to limit leakages to international airlines.

The issue of sustainable investment in improving travel and tourism infrastructure remains a challenge in the Zambezi Basin. This can make it difficult for tourists to access certain areas, with potential loss of revenue as well as encroachment of protected areas and environmental degradation. However, significant growth was recorded in capital investment for the Zambezi Basin states from a negative growth of -1.2 percent in 2010 to almost 26 percent growth in 2012 accounting for almost US$1.2 billion and estimated to grow further to US$1.6 billion in 2013.

One way to support infrastructure development is through partnerships and commercialisation of state enterprises to make them more efficient and responsive to industry needs. For example, according to the Malawi Privatization Commission (2012), most of the government-owned lodges have graduated into top-end properties with further expansion of their facilities. Botswana and Zambia have increased the role of the private sector in managing wildlife and safari-related activities government responsible for law enforcement and regulatory aspects (Peace Parks 2012).

Information Communication Technology

The growth of technology in all its forms is a driver of the leisure industry and has had an impact on tourism at local and basin levels. The emergence of e-tourism through the internet has exposed the region’s attractions and culture to the world and enabled people to have quick access to information that is needed to make decisions about travel. Use of technology through online bookings and international payments

has improved the way international, regional and local tourists select destinations. The use of devices such as smartphones, tablets and computers enable travellers to quickly upload pictures and images in real-time and send to their friends back home (Retosa 2013).

Another aspect that has played a significant role in raising awareness of the region is the use of social media. The use of social media to interact with tourists provides real-time and updated information to consumers, which was not possible a decade ago. Another technological development that is driving tourism is the use of mobile telephone technology such as mobile banking that is now available to residents of the basin and visitors. The likelihood of interaction by potential visitors with operators in the region has increased significantly due to recent multiple functions of mobile devices for internet, social messaging, mobile banking and voice calls.

As shown in Table 8.1, Zambezi Basin states have registered a sharp increase in the number of mobile cellular phone subscribers. The number of mobile cellular subscribers in Angola, for example, rose from just over 3 million subscribers in 2006 to almost 9 million subscribers in 2010, an increase of about 34 percent (SADC 2012a).This has had a positive impact in the tourism industry.

Table 8.1 **Mobile Cellular Subscribers, Number of Subscriptions**

Country	2006	2007	2008	2009	2010
Angola	3 054 620	4 961 536	6 773 356	8 109 421	8 909 200
Botswana	3 122 051	4 133 794	5 212 258	7 055 535	7 703 198
Malawi	620 163	1 050 852	1 507 684	2 374 051	3 037 469
Mozambique	2 339 317	3 079 783	4 405 006	5 970 781	7 224 176
Namibia	608 846	800 270	1 052 000	1 217 000	1 534 528
United Republic of Tanzania	5 609 000	8 252 000	13 006 793	17 469 486	20 983 853
Zambia	1 663 328	2 639 026	3 539 003	4 406 682	4 946 900
Zimbabwe	849 146	1 225 654	1 654 721	2 991 000	7 500 000

SADC. SADC Statistical Yearbook 2012

Performance and Trends in the SADC Region and Zambezi Basin

The tourism sector in Zambezi Basin states has shown positive growth from 2000 to 2013 in the key variables under consideration. These variables include the contribution of travel and tourism to the GDP, the number of people employed in the tourism sector, the amount of capital investment resulting from tourism and tourism receipts (SADC 2012a). UNWTO (2013) says the number of tourists per sq km to the number of locals, or the "tourism carrying capacity", for Angola was 0.2 between 2008 and 2011 but rose to 0.3 in 2012. For Botswana this stood at 1.09 in 2008 but rose steadily to 1.68 in 2010. For Zambia it was 0.04 in 2008 rising to 0.08 in 2010 and 0.13 in 2012. Elsewhere in the Basin, the tourist/population ratio has also been increasing.

Variables such as contribution to GDP, employment and capital investment are major motivations for countries investing in tourism. The total travel and tourism contribution to the combined regional economy of the Southern African Development Community (SADC) rose from a total of US$14.4 billion in 2000 to $58.8 billion in 2012, and was estimated to grow by 5.2 percent in 2013, rising to an estimated $63.2 billion. During the same period, the revenues generated from tourism rose from $5.6 billion in 2000 to $17.2 billion in 2010 and increased further to $19.6 billion in 2012, with growth estimated at 2.8 percent or almost $20.9 billion for 2013.

See Table 8.2 for these trends in the SADC region.

Figures compiled from WTTC, Travel and Tourism Research 2013, including estimates for 2013

The contribution of the travel and tourism sector to GDP specifically in the riparian states of the Zambezi River Basin was just over $3 billion in the year 2000, which was about 21 percent of the SADC total. This signifies an impor-

Table 8.2 **SADC Region Travel and Tourism Trends**

SADC	2000	2003	2006	2009	2010	2011	2012	2013*
Travel and Tourism Total Contribution to GDP								
US$ billion	14.4	21.6	38.2	44.1	52	57.2	58.8	63.1
Real growth (%)	36.2	5.2	15.5	9.7	-2.8	3.4	4.7	5.2
% share	5.2	7	5.3	4.9	5.1	5.1	5.3	5.4
Travel and Tourism Total Contribution to Employment								
Real growth (%)	34.6	1	13.1	7.9	-5.5	1.7	3.5	3.1
% share	10.2	11	13.6	14.4	13.3	13.1	13.2	13.2
(000)	2 802.60	3 412.70	4 627.80	4 989.20	4 722.30	4 889.70	5 097.80	5 183.80
Visitor Exports								
US$ billion	5.6	9.8	14.4	14.7	17.2	18.5	19.6	20.9
Real growth (%)	6.8	21.5	11.9	8.1	3.6	2	3.7	2.8
% share	12.2	12.4	14.1	13.5	12.6	11.6	11.6	11.4
Capital Investment								
US$ billion	1.74	2.53	6.05	7.77	8.03	8.93	9.12	9.73
Real growth (%)	-8.04	8.53	28.15	-0.34	-2.58	6.59	6.63	5.13
% share	5.98	7.33	7.79	9.05	7.66	7.84	8.03	7.93

Figures compiled from WTTC, Travel and Tourism Research 2013, including estimates for 2013

tant economic driver for employment and capital investment in the Zambezi Basin. The contribution of the travel and tourism sector grew to over $9 billion by 2012 and was expected to reach $10.9 billion in 2013.

The figures further show that countries in the Zambezi River Basin experienced higher gains in terms of employment from travel and tourism between 2000-2013 which averaged almost 42 percent of all employment in this sector for the SADC Region. See Table 8.3 for the travel and tourism contribution to the economy of the Zambezi River Basin.

Table 8.3 **SADC Region Travel and Tourism Trends**

	2000	2003	2006	2009	2010	2011	2012	2013*
Travel and Tourism Total Contribution to GDP								
US$ billion	3.02	3.54	4.66	4.93	6.28	7.28	9.09	10.90
Real Growth (%)	6.94	14.41	17.05	9.33	29.33	14.68	23.23	11.74
% Share	7.44	8.08	8.71	9.35	10.03	10.44	12.09	12.18
Travel and Tourism Total Contribution to Employment								
Real growth (%)	5.96	3.43	5.15	1.54	28.70	8.88	22.16	4.55
% share	8.25	8.50	8.84	9.24	10.03	10.36	12.76	12.73
000	1 365.90	1 582.10	1 635.30	1 732.50	1 956.70	2 184.90	2 411.00	2 576.70
Visitor Exports								
US$ billion	1.49	1.68	1.81	2.31	2.94	3.09	3.69	4.26
Real growth (%)	-4.75	8.13	-0.31	33.96	54.44	5.08	15.70	22.68
% share	13.03	13.09	12.89	13.55	14.20	13.05	14.23	12.85
Capital Investment								
US$ billion	0.38	0.38	0.48	0.72	0.82	0.97	1.25	1.57
Real growth (%)	-7.58	1.26	36.25	11.76	-1.23	25.68	25.66	19.34
% share	5.65	5.46	5.84	6.04	5.94	6.16	6.58	6.96

Figures compiled from WTTC, Travel and Tourism Research 2013, including estimates for 2013

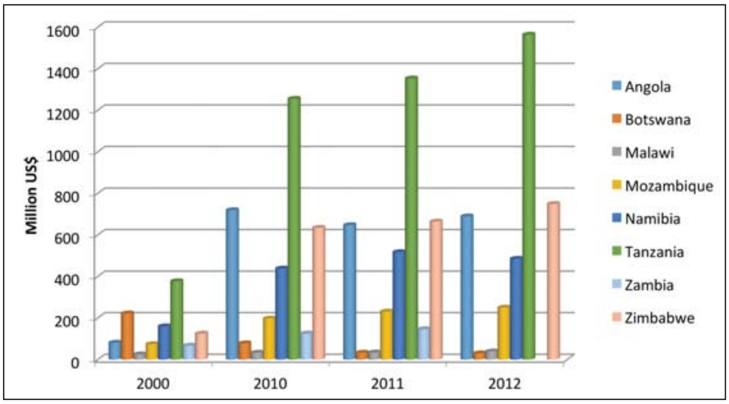
Table 8.3 Travel and Tourism Trends for the Zambezi River Basin

Figure 8.2 shows trends in the travel and tourism contribution to the Zambezi Basin economy.

Whilst all basin member countries are fully independent, tourism may have formed a new dependency in terms of relationships with the developed countries. Colonial ties still tend to reflect commerceial and trade linkages. The trading patterns, including tourism, have reinforced and represent the old colonial ties with primary target markets and investment patterns built upon old colonial networks in many cases. In the tourism sector almost all the Basin states have the former colonial power as their primary source market for international tourism due to history, language and economic ties, although they also attract a significant number of tourists from South Africa. For example, Botswana, Malawi, Zambia and Zimbabwe have the United Kingdom and other English-speaking countries as their major tourism-generating markets, while Angola and Mozambique derive the majority of travellers from Portugal. Tanzania has both the UK and Germany, as does Namibia.

However, new economic and political powers are also coming into play (Bianchi and Clarke 2000; UNWTO 2013). Countries such as the People's Republic of China with an estimated potential outbound travelling contingent of over 100 million annually, India and other BRICS countries (Brazil, Russia, India, China, South Africa) are playing

Figure 8.2 **Travel And Tourism Contribution To Zambezi River Basin By Country**



UNWTO World Barometer, August 2013; WTTC, Travel and Tourism Research, 2013 an important role in investment and travel within the Zambezi River Basin. In some cases, the tourism product has been shaped to accommodate expectations of tourists including the type of food, design of lodging units and décor, even the mode of transport and presentation of activities.

In order to make travelling easier the model of a Universal Visa (UNIVISA) for SADC countries was conceptualized with a view to allow seamless travel of tourists from the region's main source markets. This implies that if one member country issues a tourist visa, the tourist will not need to obtain another visa to visit the other SADC member states, thus facilitating ease of access to other destinations within the region and the Basin. According to SARDC 2013, while modalities for implementation are still being finalised by some Member States, some countries have started this collaboration, as demonstrated by Zambia and Zimbabwe.

Domestic tourism has proved important to Basin economies as a way of cushioning the impact on operations during lean periods. According to UNWTO (2014), domestic travel is important for economies as it enables business to operate during periods when international tourist volumes are low and also in cases where international conflicts or poor economic performance affects travel decisions. In almost all Basin countries, locals accounted for over 75 percent of occupancy rates in most lodging units which shows that this market segment is important and needs to be a key factor in marketing strategies (Retosa Travel Barometer 2010). The Basin outlook indicates a sustained growth in domestic tourism due in part to improvements in regional and national economies, and a growing young population in the middle-to-high-income bracket with higher propensity to travel.

Tourism cuts across most economic sectors, and has a key role in national budgets and economic planning. Its impact on jobs, taxes, and social strata is enormous and the Basin states should encourage domestic and local tourism to address the effects of cyclical fluctuations often associated with international tourism. According to WTTC (2014), this sector impacts on the natural and cultural environment in a positive way and provides benefits to all sectors of society including young people, women and indigenous peoples.

Culture and Community Development

The SADC tourism body, the Regional Tourism Organization of Southern Africa (RETOSA), recognizes culture as an important tourism opportunity and attraction. Culture forms a key component of the region's tourism products and is used as a marketing tool for the attractions. RETOSA also acknowledges that culture and Indigenous Knowledge Systems (IKS) are influential resources in tourism.

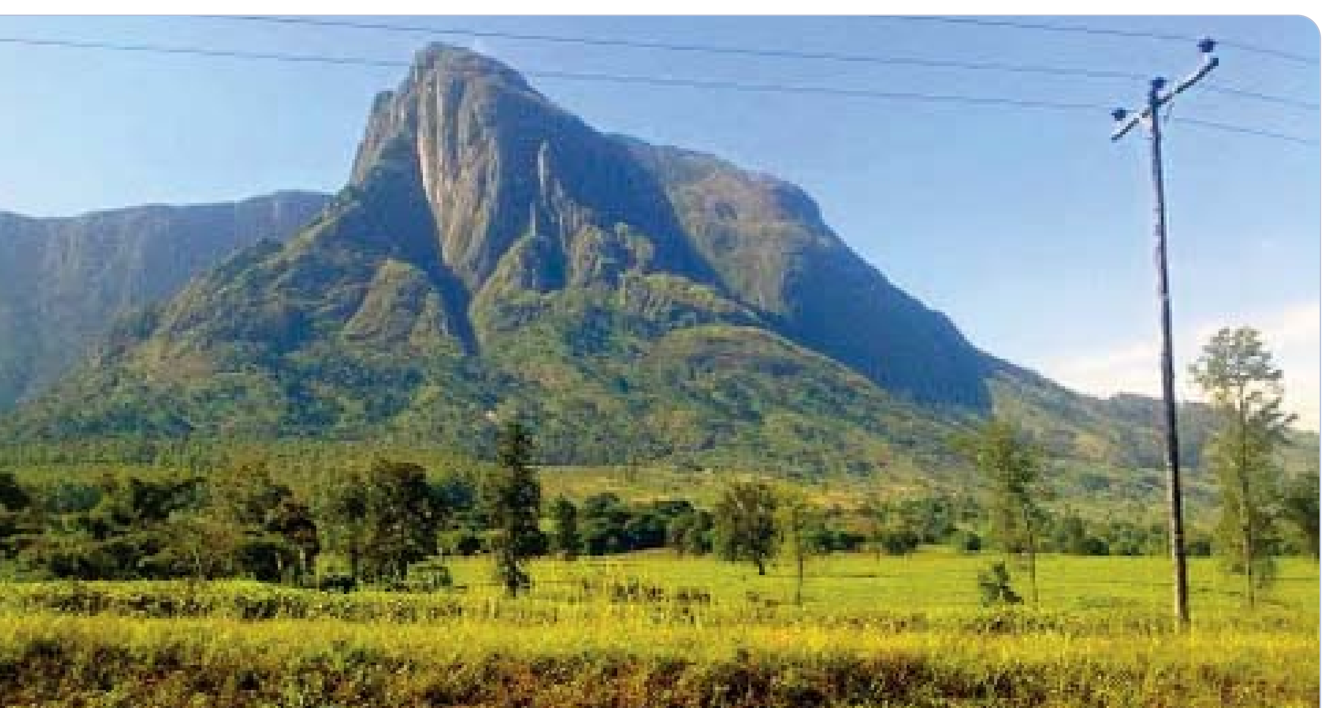
The Zambezi River Basin has diverse cultures which attract tourists, including indigenous groups such as the Khoisan of the Kalahari, the Ovahimba and Herero of Namibia, and many others with a unique way of life. The extent to which this asset can be properly recognised, involved and protected

within the policies of tourism development is still yet to be fully realised as it has not been adequately addressed in many cases (Bianchi and Clarke 2000). The UNWTO and United Nations Educational, Scientific and Cultural Organization (UNESCO) recognise the importance of protecting indigenous people and their respective cultures. However, there is little evidence to suggest that tour operators and destination management officials and related government bodies in the Basin have undertaken a consultative process with such groups in the promotion of tourism.

Events, cultural rituals, and festivals within the basin such a Kuomboka and Kulamba in Zambia and the Lake of Stars International Music Festival on the shores of Lake Malawi/Niassa/Nyasa have over the last 10 years drawn domestic and international visitors to the region (RETOSA 2010), creating opportunities for seasonal jobs, linking locals to markets for artwork and crafts, and supporting various social and community projects. For example, the Lake of Stars International Music Festival in Malawi supports communities around the venue with teaching and learning materials, improvements in potable water, and supporting rural women for savings groups or village banks. Food is a fundamental cultural element that has an impact on tourism, including unique types of food and local delicacies consumed in the area of the Zambezi Basin. Consumption patterns are determined by a number of factors such as individual member states per capita, disposable income, culture and seasonality, among others. Whilst the predominant consumption is from agriculture produce through subsistence farming, tourism has been noted to affect consumption patterns in some areas. In places like Victoria Falls, Chobe, Cape Maclear and others, average prices of some essential items tend to be higher compared to the rest of the geographical areas outside the tourist resortss. At the same time through observing what tourists like, local consumption patterns can be affected such as locals moving away from their usual consumption of maize or sorghum to "fast foods" often preferred by tourists. Over time the popular local dishes are less featured on restaurant menus (Gartner and Cukier 2012).

Cultural Tourism

Cultural tourism is concerned with the lifestyle of the people in the area visited, their history, art, architecture, religion, and other elements that shape their way of life. This can also include tourism in



rural areas showcasing the traditions of indigenous cultural communities (festivals, traditions, rituals), and their values and lifestyle, and it has a strong relationship with the natural environment. For example, the Mulanje Mountain Biosphere Reserve in Malawi is viewed by locals as a God-given sacred reserve that benefits them.

Regular traditional rainmaking rites are an attraction for tourists and offer opportunities to maintain and support indigenous systems through income from visiting tourists, whether domestic or international. Other attractions are Iron Age sites at Victoria Falls on the Zambian side, fossilised footprints on the Zimbabwean side of the Middle Zambezi valley, and rock paintings found throughout the Basin (Chenje 2000).

The Khulubvi Sacred Shrine located in Nsanje District in the Lower Shire Valley of Malawi is an important shrine for the Mang'anja people. They pay homage to Mbona, a legendary ancestral figure. Several other sites in the area have sprung over the centuries and the amalgam has been proposed for World Heritage Site status, raising indigenous tourism opportunities (UNESCO 2013b).

Box 8.3 COMMUNITY PARTICIPATION IN TOURISM

The establishment of Magoe National Park in Mozambique is aimed at meeting the objective of increasing the land for conservation and wildlife management for tourism as an economic activity, while ensuring benefits to the local community. The park covers 355,852 hectares on the South Bank of the Zambezi River near Cahora Bassa in Tete province.

The Tchuma Tchato (Our Wealth) initiative works with the communities to help them to realise that they benefit from the sustainable use of the wildlife in the park when they protect and manage the resources together with the government and private sector operators. Tchuma Tchato is made up of six villages near the corner where Mozambique, Zambia and Zimbabwe meet. They operate a campsite with seven chalets under local management but monitored by Provincial Directorate of Agriculture and Fisheries. The villagers work as chalet staff and game scouts. The income from hunting and campsites is shared as follows – 35 percent government, 32.5 percent regional government, and 32.5 percent to the Tchuma Tchato project.

Another example of community conservation is the Community Area Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe which initiates tourist activities linking communities to wildlife management and conservation. These are land-based activities in areas relatively rich in wildlife, and is based on a management system that includes local traditions such as in conflict management alongside introduced systems of management.

These projects offer tourism opportunities and hold vast potential for community-based tourist activity, thus creating opportunities for the youth and women in such areas to get involved in baking, cookery, art and crafts, interpretation and tour guiding among others, thus improving their lifestyle and that of their dependents.

Women and the youth stand a better chance for involvement through provision of economic services such as food preparation, provisions of vegetables and other agricultural produce, production of artwork and crafts, and performances of music and dance or storytelling for visitors (Lingwalanya 2000). These activities, though small, should be encouraged throughout the Zambezi River Basin to ensure that women and the youth benefit from this form of tourism.

zambezitraveller.com; Filimao and others 2002; SARDC Chenje 2000

While tour operators and hotel chains have emphasised the need to respect local norms and culture, some "sacred or secret traditions" are staged for tourist consumption. In nearly all lodges and hotels, local dances are performed for guests. This depiction and staging of traditional events has been criticised by some individuals as an element of "commoditization" or "commercialization" of culture (Gunn 1994; Burns and Holden 1995) arguing that such performances erode the authenticity of cultures. Although national agencies within the basin are mindful of cultural commercialization, it is difficult to invoke protective legislation at national level and the communities themselves have to choose modalities to project and protect their culture while reaping the benefits. The recognition by UNESCO of some traditional dances and cultures as unique heritage may help to protect this cultural heritage, and it is also important for the Basin states to adopt a transboundary cultural and heritage management programme that could promote and protect cultural heritage and reduce cases of theft of "living culture", while advancing economic development through joint collaboration (ZEO workshop, May 2014).

The argument against tourism in certain circles has been that youth would want to imitate certain lifestyles that are not acceptable within local communities. At a Basin level, it is therefore important to continue placing emphasis on the application and implementation of acceptable codes of ethics and conduct by travellers prior to and during their visits. To ensure that local traditions including behaviour are not impacted negatively by tourism activities, efforts to manage such negative impacts need to be established at the early stages of any tourism development in a given community (Munanura and others 2013. The code of conduct and ethics should be adopted by operators, local communities and national governments. However, there is still need for a detailed impact analysis for the Basin about tourist behavioural impact on local communities as standard practice principles applicable elsewhere may not be applicable in this area.

Though recognised as a key tourism resource, the growth of cultural tourism is hampered by the fear of cultural erosion, thus community-based tourist activity remains stunted. Dixley (2005) notes a number of 0ther constraints in Zambia including short-term donor funding, low finance capital base, intra-community conflicts, undeveloped marketing strategies and several others. Chiutsi and Mudzengi (2012) note similar constraints for community-based tourism in Zimbabwe. The potential remains high nonetheless, as there is growing international demand for cultural tourism. UNESCO's recognition of indigenous people, and the potential economic gains that their indigenous knowledge systems can bring to communities, is evident in the Zambezi Basin.

The increasing numbers of people who travel to learn and experience local cultures and who in turn bring positive economic and social impacts should be considered as part of a wider basin strategy, as culture is dynamic. Joint efforts to market cultural tourism using indigenous knowledge systems throughout the Zambezi Basin should be adopted and coordinated.

One growing element of tourism is volunteer tourism where holidays are incorporated into an aspect of volunteerism in that people travel to specific destinations to offer their technical skills in research, help to build infrastructure or support poverty-reduction initiatives in communities. This involves aiding in material and technical shortfalls, restoration of the environment or research into aspects of society or environment (Tomazos and Butler 2010). As a result of volunteer tourism, the basin has seen notable initiatives through technical and research support towards conservation and wildlife management for local communities. The ultimate positive impact is shared knowledge and skills transfer to local communities, and direct support for some rural schools and health centres.

Community Development

Community development initiatives have been part of tourism discussions in the Zambezi River Basin, as most governments have prioritized community development as a key policy requirement for any tourism investment. In line with sustainable tourism principles (UNWTO 2010), strong community-based approaches are central to many tourism developments in the Basin. There is also a growing realization that local cooperation, trust and networking are essential in providing the right mix for successful tourism experiences that also benefit the receiving community (Milne and Ateljevic 2001.

In line with modern tourism sustainable practices (UNWTO 2010), most operators have incorporated a community development aspect, and almost all protected area operators have a local community component in their operations. Over the years, they have built schools and health centres, as well as providing potable water to communities (RETOSA 2010). They have also provided both seasonal and permanent jobs to local communities, and directly and indirectly created other economic opportunities that support local families and communities.

In rural areas where women have to perform many household tasks such as fetching water and collecting firewood, some tourism developments such as fencing off beach and river fronts, limiting access to forestry and wildlife reserves which are a source of firewood, are a threat to women, youth and their respective communities. Such limitations to access and use of natural resources forces women to travel long distances, leaving little time to engage in other productive activities.

Box 8.4 **CASE STUDY OF TOURISM BENEFITS FOR LOCAL POPULATION**

Kuti Community Ranch in Salima, Malawi located some 100 kilometres from the capital, Lilongwe, was originally a government-owned ranch. In 1996 when the Malawi government embarked on a privatization drive for some of its operations, Kuti Ranch was handed over to a consortium of private managers. The ranch, measuring some 2,000 hectares of savannah bush land and indigenous forests, served the purpose of forestry conservation but is also one of the success stories about public, private and people partnership.

Malawi is heavily deforested, but the partnership between government, the operators and the local community has brought tangible benefits. The ranch promotes responsible tourism, sustainable wildlife conservation, environmental education and community outreach programmes that benefit people and wildlife. The project also provides jobs for over 40 local staff, showcasing Kuti is a model for environmental conservation and community development in the lakeshore district of Salima. The partnership with the Lilongwe Wildlife Centre has seen a number of volunteers imparting their knowledge about tourism, environmental conservation and community development and has helped to increase community ownership of the project, leading to reduced poaching, increased household involvement in communal projects and increased local and international visitations.

Over the last four years, 25 boreholes have been sunk in the neighbouring villages, three community school blocks have been constructed; and the ranch is implementing reforestation projects, encouraging local communities in the use of eco-stoves and fuel briquettes to reduce the use of firewood, bee-keeping, fish farming and various infrastructure projects.

Ecotourism

The term "ecotourism" is most commonly used to describe any recreation in natural surroundings (Chenje 2000), combining travel and conservation. Most Basin states are encouraging the development and promotion of ecotourism due to its various economic, social, preservation and conservatory elements.

Ecotourism emerged from the global trend to "go green" as a reaction to the perceived negative impacts caused by mass tourism. Modern tourists want more authenticity in the products other than what they read in various promotional materials (SADC 2012c; UNWTO 2012) and the growing number of visitors want to experience the local way of life of people within the Basin. Tourists are "increasingly becoming sophisticated in their preferences for travel, which include aspects such as natural life, contact with communities, learning about special ecosystems and their conservation" (Eagles 2002 cited in Kostopoulou and Kyritsis 2006. Culture, therefore, remains a key driver of tourism within the Zambezi River Basin.

Box 8.5 FOUR STRATEGIC ROLE PLAYERS IN ECOTOURISM

Ecotourism is defined as purposeful travel to natural areas to understand the culture and natural history for the environment, taking care not to alter the integrity of the ecosystem, while producing economic opportunities that make the conservation of natural resources beneficial to local people.

Ecotourism is a dynamic interaction between four strategic role players, each of whom has an important part in the overall plan, hence the adjective "strategic". The four role players are:

- The Ecotourist;
- The Authorities;
- The Tour Operator; and,
- The Local Community.

The Eco Tourist

Ecotourism starts with the ecotourist, which is a person who pays to see and experience the unique natural environment and cultural heritage that is offered in a particular area. The ecotourist should be a responsible tourist, sensitive to how the natural environment and the culture of the local inhabitants can suffer as a result of tourist activities.

The Authorities

These are the government departments and agencies whose task it is to see that the relevant laws and regulations are followed. To accomplish this, conservation officers and guides are appointed to educate the public, funded by the taxpayers. There are also non-governmental organizations such as the Worldwide Fund for Nature (WWF) that educate the public, using funds raised through public and corporate donations, and work with governments to advise on laws and regulations.

The Tour Operator

The main responsibility of the tour operator is to put together an environmentally sound tourism product. The operator should then educate the visitors about how to be responsible tourists in such a way that negative impacts on the environment and local cultures with are minimised. They also brief ecotourists to ensure their health and safety. Tour operators should understand that unless they operate in a sustainable way, they are threatening their own livelihood.

The Local Community

These are the people who live in the area promoted by the tour operator and visited by the ecotourists. The local community should be involved and informed at all levels of the tourism process, from the initial planning of the tour to the actual running of the tour. If they are not involved, they may not see any benefits and could oppose the ecotourism project if it does not include them.

Ecotourism has been used interchangeably with another term "nature-based tourism" but is best described as travel to natural areas that conserves the environment and supports the wellbeing of the local people (Ecotourism Society 1993 cited in Norman and others 1996).

Ecotourism is therefore a combination of interests arising out of environmental, economic and social concerns. All aspects of ecotourism involve the realization that a destination needs to incorporate all attributes of environment, community and natural resources for meaningful tourism. The Trans Frontier Conservation Areas (TFCAs), wetlands, culture and heritage wildlife and forestry reserves in the Basin are major attractions which provide opportunities for ecotourism to thrive. In addition to conservation elements of ecotourism, aspects of respect for culture which is also part of cultural tourism are integrated into the whole concept of responsible travel in the Basin.

At local, national and Basin levels, the adoption and implementation of essential ecotourism principles may vary but are often visible in the form of community involvement and capacity building for communities, creation of a conducive environment for local communities to benefit socially and economically from tourism projects and activities, sustainable waste management and management of resource use in protected areas through monitoring of appropriate numbers of wildlife and tourists visiting these places (Garrod and others 2006). In recent years, ecotourism in the Zambezi River Basin has come to assume a strategic importance in the political economy of the region, as seen by the advantages presented in Table 8.5.

According to Massyn (2004), tourism enterprises based on the natural attractions of the region are today regarded as key drivers for job growth, wealth creation and economic empowerment – particularly for small accommodation establishments widely known as "safari lodges". They are scattered around the

Table 8.4 **Advantages of Nature-Based Tourism**

- Provides a lucrative source of foreign exchange that can be used to finance economic growth and development;
- Suggests a form of industrial growth that is well-suited to rural areas. Studies have shown that ecotourism is a better form of land use than most agricultural pursuits, especially in arid and semi-arid areas;
- Offers a form of economic development that can spread revenue to the poorest strata of marginal rural communities;
- Promotes the protection of wildlife while promoting social development; and
- Has capacity to promote respect for other people's cultures on the part of visitors from foreign countries.

SARDC, Chenje (ed). State of the Environment Zambezi Basin 2000

rural areas where they are often the major driver of economic activity. Drumm and More (2005) argue that tourism presents a mix of opportunities and threats, not only to wildlife but also to communities that are close to the protected areas. Activities such as trekking and mountain climbing, walking safaris in wildlife and forestry reserves may drive away game and disturb breeding patterns (cited in Munanura and others 2013).

It is also acknowledged that the contribution of ecotourism to sustainable development is often compromised by high rates of "leakage". In rural settings in southern African characterised by a lack of local economic capacity, a shortage of skills and skewed patterns of asset ownership, external commercial interests typically capture a disproportion of the benefits linked to tourism. This concentration of benefits among international and urban elites does little to support social and economic development in the remote rural areas where ecotourism destinations are located. In this way, the potential for beneficial linkage between the ecotourism industry and its surrounding rural economy is undermined (Massyn 2004).

Environmental Impacts of Tourism

Loss of Vegetative Cover

The Zambezi River Basin has a number of observable spots that have had all or part of their natural vegetative cover de-

Table 8.5 **Impact of Tourism on the Environment**

Bio Physical Impact	Potential Cause
Land degradation and habitat Loss Soil erosion (including island and river bank erosion)	• Hotel construction, airports, additional roads and access points, residential areas and service sites • Roads, boat traffic, bush clearing, deforestation, and increase in upgrading and maintenance costs
Wildlife disturbance	• Workers, visitors, and traffic around key species and prime view points • Movement constrictions by canoes, hotels and fences, resulting in changes in animal behaviour • Increased human and wildlife conflicts
Loss of biodiversity	• Trampling and picking of flora and disturbance of nesting birds, increased fire hazard
Fire hazards and litter(waste) Visual impacts and landscape deterioration Loss of archaeological sites Pollution (including noise) Degradation of water quality and quantity	• Cigarettes, braais, tins, bottles, plastic bags • Inappropriate structures • Road infrastructure, purposeful damage, absence of maintenance • Motorised crafts, litter, sewage effluent, dumps • Domestic water use ,effluent discharge and interference with natural water flow regimes for activities such as white water rafting

SARDC Chenje. State of the Environment Zambezi Basin 2000

stroyed as a result of tourism activities, for example around Lake Malawi/Niassa/Nyasa, and at Cape Maclear and Nkhata Bay in Malawi, through an increase in the number of structures. These structures cater for all types of market segments, from high end and medium to budget markets, along parts of the Zambezi River and parts of the Chobe/Kasane area in Botswana. Construction of access roads for use by tourists for trekking or game drives in wildlife and forestry reserves has led to destruction of natural habitats.

Incompatible architectural designs to suit the needs of tourists have been noted in some areas leading to a loss of aesthetic value of such places (UNWTO 2010; Burns and Holden 1995). Some of the causes and potential impacts of tourism are given in Table 8.6 below.

Overuse of some basin areas for tourism activities such as boating, scuba diving, snorkelling in Lake Malawi/Niassa/Nyasa, self-drives for game viewing in almost all national parks within the basin such as Mfuwe, Chobe, Mana Pools and others, including the tendency of safari operators, drivers, and boat operators to take tourists closer to animals for observation and photography, does disturb wildlife. Based on one study of some of East African reserves, such actions disturb the eating and breeding habits of wild animals (Tomas 1993 cited in Burns and Holden 1995).

The loss of natural resources and therefore some of the rare wildlife species due to loss of vegetative cover is a setback to the development of tourism in the Zambezi Basin which deprives the area of the potential economic benefits from tourism (Munanura and others 2013). While the removal of habitats for tourism is inevitable in most cases, the international principle which has been incorporated in the Environmental Management Plans and Laws of all Basin countries is that any tourism development project has to have an Environmental Impact Assessment (EIA).

The SADC Protocols on Environment and Forestry and other agreements require that member states ensure a significant proportion of their land is dedicated to forestry cover. Tourism in the Basin mot often takes place in rural areas where competition for natural resources with communities is high (Sirima and Backman 2013), therefore a sustainable and equitable benefits-sharing strategy for the use of woodlands must be in place. Efforts such as Community Based Natural Resources Management (CBNRM) which has seen local communities manage resources jointly, should also be applied to cases of tourism development. For example, for any vegetative cover removed for tourism development, the developer provides ten times more seedlings for replanting by the communities. Again use of IKS in conservation should be adopted to repopulate areas whose vegetative natural cover that has been taken up by artificial plants.

Agriculture remains the main economic mainstay for rural communities in the Basin (SADC 2012b). Pressure on resources on which both tourism and agriculture depend is likely to continue. For example, reported cases of conflicts over protected areas and farming communities have been recorded in Tanzania, Malawi, Zambia and Zimbabwe (Sirima and Backman 2013b). Some communities near protected areas such as forestry and wildlife reserves have encroached into these areas and are involved in subsistence poaching for their livelihoods (DNPW 2012). In addition to general poverty levels, population pressure has led to widespread catchment degradation. The growth in a number of economic sectors including tourism and other sectors such as mining and construction may, therefore, have compounded the pressure on land resources (Shela 2000).

Air Pollution

The increase in tourist arrivals in the Zambezi River Basin and movements at local and national levels brings with it environmental pollution from combustible fuels in aircrafts, boats and motorised water vessels, and motor vehicles. As a result, the tourism sector is a contributor to Green House Gas (GHG) emissions and at the same time highly vulnerable to the effects of climate change, according to a new report by UNWTO, UNEP and WMO. GHG emissions from air travel has become a growing concern and transport of tourists to reach their destination is estimated to account for between 59 percent and 97 percent of a tourist's ecological footprint, according to mode of transportation (Dolnicar and others 2010 cited in Pomering 2013). The Zambezi Basin has seen an increase in air charter frequencies including regional and long haul flights between 2000 and 2010.

Most Basin states have implemented a carbon tax on vehicles within their borders. Recent efforts by countries to migrate from use of lead to unleaded fuels should be encouraged to ensure harmonization of green travel for tourists visiting the region. Motorised boating has increased on major lakes such as Malawi/Niassa/Nyasa and Kariba, and rivers such as Zambezi, Shire and Chobe, providing for the leisure of tourists but having a negative ecological impact on water bodies, biodiversity and livelihoods.

At national and Basin levels the investors in the airline and air charter business argue that fuel-efficient airplanes and crafts are expensive to source in the region due to unfavourable acquisition incentives on top of huge taxes for running and spare parts (Malawi Tourism Association 2012).

Pollution of Water Bodies

Over the years from 2000- 2010, the number of tourism establishments has increased in the Basin, implying an increase in water usage, an increase in solid and liquid waste, and challenges on sustainable disposal (UNWTO data for 2013 and national figures).

Case studies show that in some African water bodies, an estimated 70 percent of waste waters go directly into water bodies without treatment or purification (Holden and Burns 1995). Such waste causes faecal pollution and damages beach fronts and river bodies. This has a direct risk to both the local communities and tourists. All Basin countries have Water and Land Management Acts and policies that seek to protect water bodies and catchment areas. The Zambezi Watercourse Commission (ZAMCOM) Agreement, the Revised SADC Protocol on Shared Watercourses and various regional and inter-country agreements and protocols seek to champion and encourage efficient and equitable use of water and related resources in the basin and encourage the reduction in pollution of water bodies (SADC/SARDC and others 2012).

Despite national legislation and regional agreements to reduce water pollution, this continues to be a problem at national and basin level. For example, the increase in the number of boats on Lake Kariba has resulted in oil and fuel pollution of water mainly as a result of spillages and leakages from engines and in some instances by deliberate waste oil dumping into the lake (Chenje 2000). Although regulations have been tightened and monitoring increased, there are few prosecutions. As pollution also emanates from other sectors such as the extractive and chemical sectors, the degree to which the tourism sector contributes to overall pollution is likely to increase due to local, national and regional projections of the sector's growth (UNWTO 2013; WTTC 2013). The industry and public authorities could therefore utilise the current general principle and requirements of modern travellers who are said to demand greener and cleaner environments. Efforts to reduce water pollution could build upon this momentum of clean travel that the tourism sector is encouraging.

Tourism and Climate Change

The Basin prides itself in wildlife-based tourism, and is home to some of the largest concentration of the Big Five -- Lion, Elephant, Leopard, Rhinoceros and Buffalo. However, recent research shows that climate change has an impact on species in African wildlife reserves. Climate change impacts on Africa's ecosystems could have a negative effect on tourism, although this is still under review. According to modelling by the International Panel on Climate Change, 25 - 40 percent of mammal species in national parks in sub-Saharan Africa could become endangered (N. Nakicenovic 2000). This would result in undesirable impacts on the local habitat in some of the Basin areas such as the Chobe/Okavango, Mana Pools, and the Lower Shire River valley, including mammals, vegetation and large trees along rivers and in protected areas (GEF 2012). Present and future economic returns and jobs could be in jeopardy due to the subsistence nature of agriculture and economic opportunities in rural communities, although they often have stronger resilience capacities due to indigenous knowledge.

Increased frequencies of drought in the Basin could affect tourism arrivals over time if the current rainfall patterns and cycles are disrupted. For example, in mid-2015, lower than normal water levels along the Zambezi River are impacting on electricity supply and could reduce water-based activities such as river rafting, boating, scuba diving and others, leading to reduced business volumes. Reduced flows in the Zambezi River could also lower the volume of water over the Victoria Falls and the resultant spray, making it less attractive to tourists (SARDC and HBS 2010). Communities that rely on tourists for marketing of their local goods and services can be greatly affected, and servere or extended droughts can have a negative impact on wildlife.

Climate change is a real phenomenon that affects tourism, but tourism activities also contribute to climate change. Recent studies indicate that the impacts of climate change on the tourism sector will steadily intensify, particularly under higher global GHG emission scenarios. Therefore, any efforts that significantly help the travel and tourism industry should be pursued at all levels within the Zambezi Basin. Deliberate policy efforts such as harmonising incentives schemes for acquisition of fuel-efficient aircrafts and other motorised equipment used by the sector will help in combating the effects of climate change associated with the sector (UNEP 2012, study on Climate Change and Tourism).

An Advance Summary of the Report entitled *Climate Change and Tourism: Responding to Global Challenges,* attempts to quantify the links between tourism and climate change. Among the key conclusions of this study are:

- Carbon dioxide emissions from the sector's transport, accommodation and other tourism activities are estimated to account for between four and six percent of total emissions.
- If no mitigation measures are taken, tourism contribution to CO2 emissions could grow by 150 percent in the next 30 years, based on UNWTO tourism market forecasts.
- Impacts of climate change on the tourism sector will steadily intensify, particularly under higher global GHG emission scenarios.
- Changing climate patterns might alter major tourism flows where climate is of paramount importance, such as Northern Europe, the Mediterranean and the Caribbean.
- Coastal, mountain and nature-based destinations in least developed countries and small island developing states might be particularly affected.

Due to emerging topical issues related to climate change mitigation, concepts such as "carbon footprint" in the tourism sector will need to strategically focus on resilience, including adaptation measures in affected destinations within the Zambezi Basin in order to safeguard economic returns and jobs, and mitigation measures of specific forms of tourism in order to achieve substantial emission reductions.

Programmes such as the transfrontier management of wildlife and forestry reserves, shared watercourse commissions such as the Zambezi Watercourse Commission (ZAMCOM) should therefore be embraced. Basin countries are all members of key international policy frameworks such as the United Nations Conventions on Biological Diversity (UNCBD). The Basin's protected areas are a major draw card for tourism and present a good source for carbon credits, integrated management of these resources is essential. Carbon credit earnings from protected areas can be used to encourage more community efforts in conservation and reforestation.

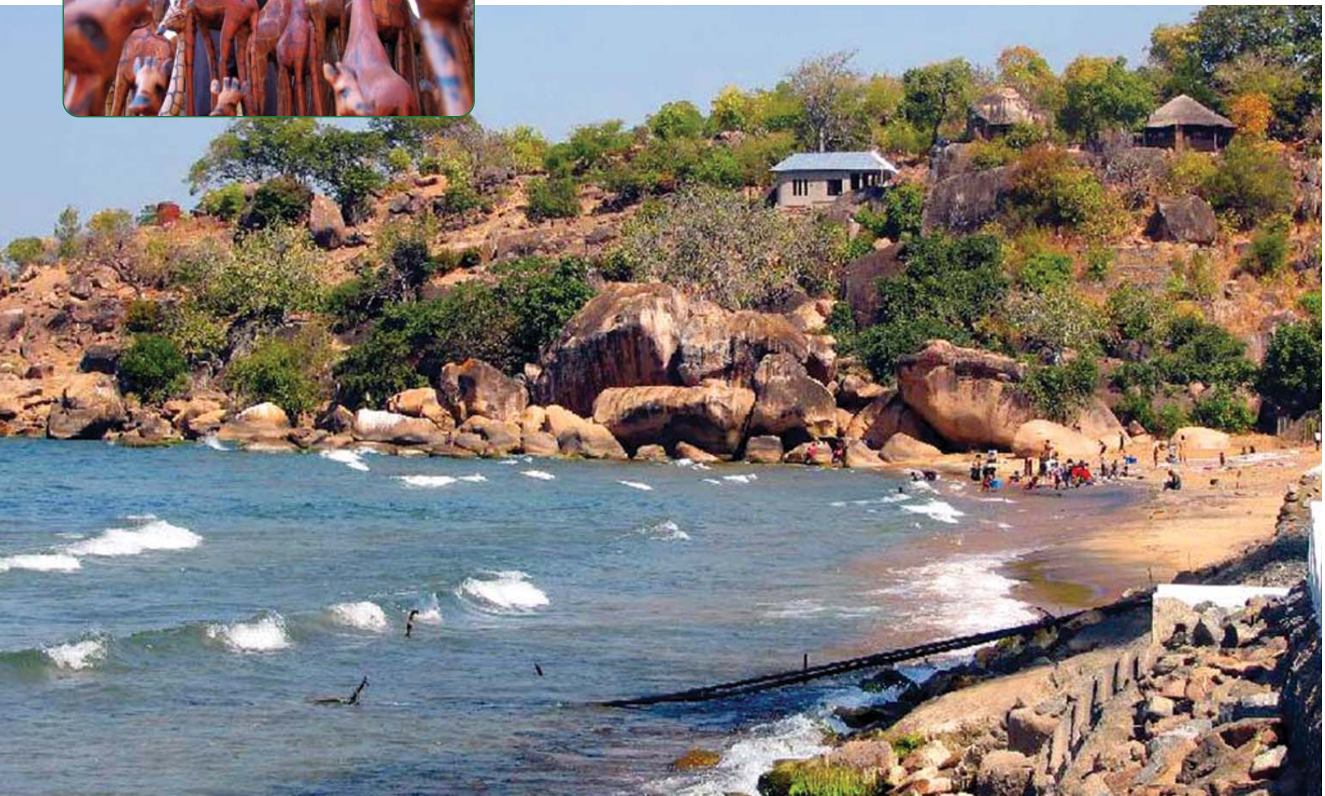
Tourism Opportunities and Challenges

Various national tourism policies show that all riparian states of the Zambezi River Basin have developed strategies for positive growth in terms of the contribution of tourism to national economies.

The establishment of TFCAs, for example, presents a significant opportunity for sustainable growth of the tourism industry in the Basin. Five Basin states have established the Kavango-Zambezi (KAZA) Transfrontier Conservation Area, thus demonstrating that it is possible to combine conservation efforts across national boundaries to provide a unique tourism product. The conservation area established by Angola, Botswana, Namibia, Zambia and Zimbabwe boasts of numerous tourist attractions such as the Victoria Falls, San Rock Paintings, white water rafting and other water sports, and the absorbing wildlife in the Basin. An Integrated Development Plan has been prepared for the enlarged Park and its surroundings.

Related opportunities include the joint marketing of attractions, thus presenting prospective tourists with a wider range of options and experiences. It is predicted that the KAZA TFCA could attract as many as eight million tourists to the region annually in future as well as creating employment for thousands of people (SADC/SARDC and others 2012).

A related challenge is that tourists are sensitive to issues of personal safety and security. Therefore, internal political instability in any of the countries that are party to a TFCA programme can result in the reduction of tourist arrivals to the area (SADC 2012d). This sensitivity may be compounded by the fact that tourists' knowledge of national boundaries in the areas they visit may be limited hence instability in one country can affect tourist flows to other countries nearby. The political environment in the region needs to be monitored and managed to ensure that the Zambezi River Basin and the SADC region has a safe and positive tourism profile.



Population and Tourism

With combined population and tourism growth in the Basin, there other challenges in addition to benefits. Tourism consumption competes for natural resources with other human activities. Population growth and general livelihood patterns also affect and are affected by tourism, especially in cases where growing pressure on available arable land forces communities to encroach into protected areas which are maintained not only for their traditional and ecological values but are a major tourism product. A study of tourism development in the Usanga Plains in Tanzania by Sirima and Backman (2013) found that some communities were displaced to make way for tourism development. They argue that benefits of such displacement have not been shared with the displaced communities, often creating tension and misgivings about tourism development.

Tourism employment is cyclical and often distorts conventional work patterns. It may take people away from other productive and traditional sectors of the economy, particularly agriculture during the growing season (Bryden 1973 cited in Burns and Holden 1995). These take labour and families away from their usual jobs and economic activity which may have negative effects on such families if the earnings from tourism are inadequate.

Despite the positive social impacts, tourism within the region poses some challenges to local communities which are cultural and social in nature (Dyer and others 2003). If not well managed, tourism has the potential to negatively modify local culture, resulting in social tensions and undesirable change in local customs and values (Mbaiwa 2005 cited in Munanura and others 2013; Burns and Holden 1995). According to Garrod and others (2006), "difficulties tend to arise when local residents affectively become an intrinsic part of the attraction, their distinctive manner of dress, languages,

customs or ways of life being something that visitors have come to experience as local residents develop antipathy towards visitors."

Exclusion from Resources

Other negative social changes resulting from tourism include the exclusion of locals from resources. This has been seen in areas near water bodies, where tourism operators fence off the river banks and beach fronts thus preventing the local inhabitants from accessing what has been traditionally their heritage and a source of livelihood. Another social impact is the perception of the use of scarce local and national resources for what is perceived as the enjoyment of wealthy foreigners (Garrod and others 2010; Gunn 1994) leading to the commercialization or overexploitation of that resource.

Another notable occurrence is the loss of "living culture" or theft of works of art created in the Basin which has seen a number of artworks including music and drama being patented in the north Africa and Europe (GoM 2005; Mbaiwa 2005). As a result, tourists may not fully associate these with the Zambezi River Basin.

Benefits from tourism tend to be shared unevenly among communities. A study by Sirima and Backman (2013) showed that the displacement of people for tourism development in Tanzania left the majority of local communities around the park with little or no access to prime livelihood resources. The displacement further shifted the land use patterns and tenure systems and created disparities in benefits.

Planning Tourism Development

While the first tourist arrival is viewed as an opportunity for jobs in the community, the euphoria that comes with this gradually wanes to antagonism if benefits are not forthcoming. This is referred to as the Doxley Irridex or Doxley's Irritation Index (Ryan 1991) which analyses the stages that communities go through due to tourist arrivals. This is especially common in the areas of the Basin where "informal tourism developments" start without proper integrated planning which leads to competition over land and resources between locals and tourists. Where there has been no proper planning and strong implementation, such as the case in some areas along Lake Malawi/Niassa/Nyasa, along the Zambezi River and around Lake Kariba, cases of irritation about the intrusion of tourists is often high.

Behaviour Change

The copying effect where local populations observe the way of dress, drinking and socialization of tourists may have negative effects on the social life of local communities within the Basin. The adoption of tourist behaviour has been viewed as a negative impact in the region especially if such behaviour is socially unacceptable at local and national levels. This was manifested in some legislative requirements for some Basin countries in the 1970s and 1980s that prescribed a code of dress in public areas.

Ill Treatment and Low Wages

There have been reported cases of ill-treatment of women and youth operating in the tourism sector in some destinations. Though national legislation in the Basin outlaws child employment and prescribes a minimum wage for workers, the cases of underage employment and wage structure tend to discriminate against women and the youth in this sector. A deliberate policy shift that recognises the role of women and youth in sustainable tourism through active involvement in community development projects and capacity-building programmes needs to be included as an integral strategy to empower women to benefit from natural resources.

Sustainability

Another challenge that needs the attention of Basin states is that of sustainability. One of the challenges for the sustainable development of the tourism industry is to convince stakeholders that tourism cannot continue to grow unless the negative impacts on nature's life-support systems are considered. As tourism offers opportunities for employment and reducing poverty, the mutual relationship between tourism and healthy ecosystems should not be compromised.

SARDC Chenje (2000) identified a number of challenges that need to be addressed in order to strike a balance between ecology and tourism in future.

These include:

- Efficient planning such as adequate forecasting of tourist pressures and capacities;
- Tourist marketing and awareness oriented towards natural resources; and,
- Improved cooperation between organizations involved in the industry.

Another challenge to sustainability is international and intra-national air access. Despite adoption of the Open Skies Policy, very few countries had implemented this policy to encourage more airlines to ply routes within and across the destinations by 2010, except for Botswana. Delays in opening up air services with a view to protect national airlines have resulted in a huge cost to the tourism sector since this has made travel to and within the region very expensive.

Illicit Flows

A major hindrance to tourism development is that of corruption and illicit flows of financial and natural resources. This remains a key governance issue in the Zambezi Basin. Increasing cases of corruption reported in member states in areas such as illegal wildlife hunting, illegal trade in ivory and animal products, and tourism concessions in protected areas have impacted on tourism activities and the environment.

According to the annual report of the Department of National Parks and Wildlife of Malawi, more than 20 cases of illegal ivory trafficking have been reported over the last two years and courts have handed down sentences to a number of people who connive with traders (GoM 2013). Zimbabwe reported an incident of elephants poisoned by poachers believed to be conniving with illegal traders. The case was prosecuted and oversight increased, but new challenge quickly emerge. According to IUCN 2013, a surge in elephant poaching could threaten the previously secure populations in southern Africa, although the numbers still exceed the carrying capacity of the habitat.

Box 8.6 **THE CASE OF CECIL – HUNTING AS TOURISM IN THE ZAMBEZI BASIN**

Selective hunting of wild animals is an important tourism activity in the Zambezi Basin that generates significant income for the sector. Hunting tourism has been identified as an effective conservation tool with social, economic, and environmental benefits if well-regulated and closely monitored. This attaches an economic value to the wildlife and encourages the cooperation of local people in conservation efforts for economic gain.

An Africa-wide study by the UNWTO (2015) compiled figures from governments and tour operators throughout Africa to assess the state of the wildlife tourism industry. This found that the wildlife tourism industry contributes 80 percent of international travel sales to the continent, and a large portion of the $34.2 billion African tourism industry.

However, "big game hunting" of wildlife has potential impacts as it can lead to a loss of key species upon which tourism depends, as illustrated by the killing of Cecil the Lion at Hwange National Park in Zimbabwe in 2015. Cecil was a popular figure in the park whose activities had been monitored for several years with the help of a tracking collar. However, he was enticed out of the park and onto private land using raw meat, and targeted by an American wildlife hunter using a bow and arrow, initially wounding him.

The death of the iconic lion, whose cubs still prowl the Hwange National Park, has led to local prosecutions as well as tighter regulatory and monitoring mechanisms, as all hunters must now be accompanied on their hunt by a game ranger, not only a licensed safari operator. Although Cecil was well-known locally and is missed in the park, his story and image have gone global. His legacy is more likely to result in an increase rather than a reduction in tourism revenue, as tourists are attracted to the image of the distinguished animal with the black mane.

Cecil the lion, Hwange National Park

Uncontrolled hunting can lead to the extinction of rare animals or species, as they become a target because of their different characteristics. Hunting tourism must therefore to be practised following the regulations attached to it and with due diligence for the environmental and tourism impacts.

Table 8.6 below presents some of the opportunities and challenges encountered by the riparian states of the Zambezi River Basin in their endeavour to develop the potential of the tourism sector.

Institutional Responses

The riparian states of the Zambezi River Basin belong to the major international organizations that monitor, manage and advocate for sustainable

Table 8.6 **Selected Challenges and opportunities for Tourism Growth by Country**

Country	Challenges	Opportunities
Angola	Safety and price concerns undermine growth of leisure tourism. Investment in travel and tourism largely dependent on government investment with bureaucratic delays that discourage private investment.	A healthy growing economy that has improved travel and tourism. Opening up of airspaces with new aircraft acquired by the national airline which offers direct flights within Africa and has expanded growth into European airspace. Programme to upgrade travel and tourism infrastructure being pursued.
Botswana	Lack of investment in infrastructure such as the road network is reducing access to some parts of the country. Lack of qualified staff for high-end hotels results in most training being done outside Botswana.	Botswana has adopted the open skies policy and signed eight Bilateral Air Services Agreements. Acquisition of new aircraft by Air Botswana to service more regional routes. A growing European market coupled with regional market arrivals which is showing greater positive growth.
Namibia	Declining numbers from some major source markets such as Switzerland, UK and France. Lack of specialist skills and expertise in the travel and tourism industry. Appreciation of local currency against major currencies which may discourage mid- to budget travellers	Emergence of a number of luxury tour operators over the last 10 years. More travel retailers showcasing their products at major tourism expos allowing more small-scale operators market access and linkages. Focus on more domestic tourism to compensate for declining international arrivals from its major source markets.
Malawi	Malawi lacks investment in long-term infrastructure for its major attractions including the lake. Failure to attract large numbers of tourists despite its product diversity. Limited international connections and lack of implementation of the open skies policy. High costs of travel packages compared to competition.	Governments drive to concession management of certain protected areas. Recognition by Government of tourism as a key economic priority area in the economic Recovery Plan. More international Tour Operators packaging Malawi. Recent government decision to privatise national airline and partner with another airline.
Mozambique	Underdevelopment of basic infrastructure in some areas. Instability and corruption are barriers.	Increased government marketing efforts have positive impact. Reconstruction and private investment buoying travel and tourism. Positive developments for luxury tourism through public/private investment and grading of accommodation units.
Zimbabwe	Economic instability has hampered economic growth and investment. Lack of redevelopment and face-lifting of accommodation facilities.	Government's bilateral agreements with some neighbours such as Zambia for free movement of tour operators between the two countries. Refocus of marketing efforts targeting the China and elsewhere in Asia from the traditional northern focus. Variety of attractions and world-renowned heritage sites.

RETOSA 2012; UNWTO Travel Barometer 2010; Euromonitor country reports 2013 tourism, such as RETOSA, UNWTO and UNESCO, among others. These helped with policy and technical assistance in areas of product development, standards, statistics, monitoring and others. They advise and influence rather than regulate international tourism. RETOSA, located in Johannesburg, was created to coordinate and develop the regional tourism potential and promote regional products while providing a one-stop-shop for both member states and tourists (Tumbare 2004). The coordination by RETOSA has yielded a number of positive achievements by collectively marketing the region through events and website. In addition, regional guidelines for classification of hospitality infrastructure have been developed while the UNIVISA has been developed with a timeline for implementation, and piloting in some Zambezi Basin states. In addition, the SADC Regional Infrastructure Development Master Plan (RIDMP) has identified priorities for strengthening of infrastructure within TFCAs, which are the prime tourism sites in the region and the Zambezi Basin (SADC 2014).

Policy Options in the Zambezi Basin

Since the riparian states are part of the SADC region, all the countries in the Basin have benefitted from the regional policies and strategies adopted over the years.

Protocol on the Development of Tourism 1998

SADC approved the Protocol on the Development of Tourism in SADC in 1998, which was ratified and later amended in 2009. The Protocol sets out SADC's objective to build upon the region's potential as a tourist destination. SADC intends to ensure even distribution of tourism development throughout the region and to create a favourable environment for tourism development.

One of the objectives of the protocol is to use tourism as a vehicle to achieve sustainable socio-economic development through the full realization of its potential for the region. It also seeks to optimise resource usage and increase competitive advantage in the region over other destinations through collective efforts and c-operation in an environmentally sustainable manner. It also includes an institutional framework for implementing the Protocol, specifying committees, units, duties, and procedures relevant to improving tourism in the region (SADC 1998).

Regional Infrastructure Development Master Plan -- Tourism Sector Plan 2012

When SADC developed the Regional Infrastructure Development Master Plan which was approved in 2012, it took into consideration tourism issues. The Tourism Sector Plan presents an approach for development of transfrontier conservation areas as key drivers of tourism in the SADC region. The Sector Plan analyses the current situation in SADC regarding conservation, tourism trends, and tourism policies, offering projections for the future and an assessment of gaps between the current situation and infrastructure goals for 2027.

It then sets out a strategic framework for improvements to tourism infrastructure, as well as an implementation strategy that prioritises projects, resource requirements, and methods of implementation. These infrastructure improvements intend to capitalise on growth in this sector as it shifts toward experiential holidays, which the SADC region has abundant potential to provide (SADC 2012d).

Box 8.7 ZIMBABWE LAUNCHES ITS NATIONAL TOURISM POLICY

Zimbabwe launched its new National Tourism Policy in July 2014. The policy is intended to transform the tourism sector into one of the highest earners in terms of revenue generation. This policy is a revision of the one approved in 2012, and makes it clear that tourism is government-led, but private-sector driven. The policy will treat the whole country as tourism development zones and looks at other opportunities such as religious, agro-industry, music, culture, township and mining tourism to lure tourists and grow the sector contribution to total revenue. Another aspect from this new policy is regional marketing of tourist resorts. In addition, the new policy considers each region or province of the country as a tourism hub. The policy provides for the enshrinement of liberation struggle battles and events during the colonial period, and also pre-colonial sites. The policy seeks to rebrand the various ancient structures throughout the country into ancient cities to show the contemporary importance of historical times.

Extract from The Herald, Zimbabwe, titled, "National Tourism Policy the great stride"

Protocol on the Facilitation of Movement of Persons

The SADC Protocol on Facilitation of the Movement of Persons of 2005 is a great step in the Basin as it favours tourism development. It seeks to fulfil the objectives of the SADC Treaty, which require SADC to develop policies aimed at the progressive elimination of obstacles to the free movement of capital and labour, goods and services and of the people of the region among Member States. This liberalization of visa regimes for SADC citizens and the use of one entry port for tourists visiting TFCAs will create a customer-friendly environment (SADC 2005).

National Policies

All riparian states of the Zambezi River Basin have developed strategies for positive growth of the tourism industry. The tourism policy for most of the Basin countries is to promote "low volume high price/return/value" tourism.

In terms of national marketing strategies, this implies that the target is the top end of market or the high-net-worth discerning traveller. The extent to which the policy is implemented varies by country but as international visitors have the potential to provide a higher yield than regional and domestic tourists, it has driven the tourism industry in the Basin towards an international market orientation.

Some riparian states have now started to realign their national tourism policies to reflect current trends and developments with a bearing to the tourism industry. In Zambia, the government adopted a new approach in the forest sector known as Joint Forest Management aimed at increasing the rights of local communities in managing and benefiting from forests and areas around them (ECZ 2008).

CHAPTER LINKAGES

Overview

The Basin is rich in wildlife and other biological resources that provide significant tourism attractions. Developments in wildlife conservation through community-based natural resources management, transboundary conservation areas and protected areas are key to maintaining the Basin's rich culture, flora and fauna.

Water Resources

The biodiversity of wetlands is important to the Basin as it promotes the tourism industry. However the current conversions of some wetlands for development purposes pose a threat to the tourism industry in the Basin.

Land and Agriculture

Land is an important resource in the Basin as it supports both agriculture and tourism activities. It is essential for riparian states to ensure that agricultural activities do not encroach into areas designated for the conservation of wildlife and forests on which the tourism industry and local communities depends

Biodiversity and Forests

An important value of biological diversity in the Basin is that of supporting tourism activities, and these activities are threatened by any damage or loss to biodiversity.

Climate Change and Variability

Climate change can affect tourism, but tourism activities also contribute to climate change. The Basin's protected areas which are a major draw card for tourism present a good source for carbon credits and integrated management.

Energy

Tourism components including airlines, accommodation, tour operators and motor vehicles among others are rely on electricity and fuel energy, without which the industry is unable to function. The current shortage of electricity in the Basin has an impact on the tourism industry and requires resilience measures.

Urbanization and Human Settlements

Human settlements provide infrastructure required by the tourism sector, including transport and telecommunications. However, the rapid rate at which the Basin is urbanising also results in pollution of natural resources and wetland ecosystems known to support tourism activities.

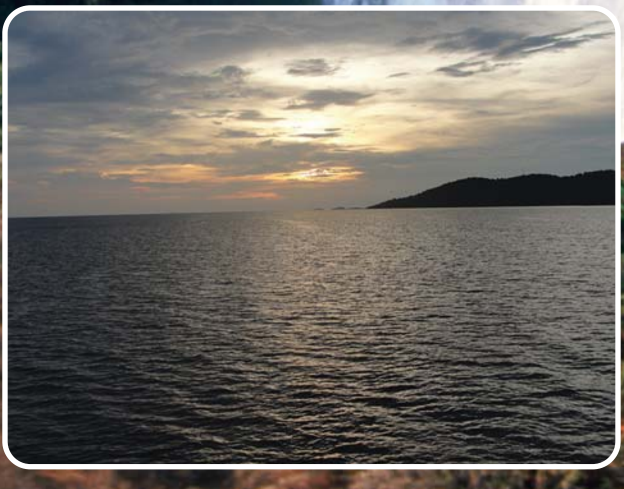
Industrial Development

Tourism as an industry supports economic growth and development in the riparian states of the Zambezi Basin, and is a key factor in development.

Scenarios

Riparian states have over the past decades derived economic benefits from tourism, and the success of the industry in future will be anchored upon proper management of natural resources to ensure sustainability in addition to putting in place structures and guidelines for the development, marketing and regulation of tourism facilities.


CHISEMWA CHAZAMBIA



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INDUSTRIAL DEVELOPMENT 9

Introduction

Industrialization is a critical engine of economic growth and development. It is a process by which a country or region transforms itself from a primary resource based economy into an economy based on the manufacturing of goods and services.

A thriving and vibrant industry is a prerequisite for the provision of goods and services, employment and sustainability. Without strong industries to create jobs and add value to raw materials, underdevelopment will remain a challenge. Acceleration of industrial development and diversification of the economy enables a country or region to attain its development and poverty alleviation goals.

Experience has shown that all developing countries that have successfully made the transition from low income to middle and high income status, such as China and the East Asian "Tigers" economies as well as Latin American countries, have done so by relying on a strong manufacturing sector as the driver of an export-oriented growth economy (SADC 2014). The experience of developed countries of the North and some of the emerging powers of the South also shows that playing a constructive role in the global economy, attaining sustainable development, and increasing living standards cannot be achieved on a weak industrial base (AU 2007).

This chapter analyses industrial development in the Zambezi River Basin and discusses challenges that lead to low levels of industrial growth. These include low capacity utilization, weak infrastructural base (poor road, rail and air networks, power shortages), lack of access to appropriate modern technologies, lack of access to affordable capital for investment in industrial development, as well as the small size of Basin economies to engage in the competition that comes with economies of scale.

Despite these challenges, the Zambezi Basin can build on existing opportunities. These include a rich natural resource base that can become a competitive advantage through value addition and beneficiation, the Basin's demographic dividend of youthful population and high literacy rates in some countries, as well as the problem of infrastructure which is now receiving political attention (Madakufamba 2014).

State of Industrialization in the Zambezi Basin

Industrial development involves the production of an economic good or service within an economy. Raw materials are converted into finished or semi-finished products for domestic use or for export. Many of these industries consume large quantities of water and energy and require factories and machinery. They also produce waste materials that may pose environmental problems or cause pollution.

A thriving and vibrant industry is a pre-requisite for the provision of goods and services, employment and a sustainable economy. Industrial development creates jobs and improves standards of living and can also support and uplift communities by creating employment, boosting economic activity and helping to increase wealth and reduce poverty.

The Zambezi Basin is characterised by low levels of industrial development. The structure of production of the Basin countries is characteristic of a developing region where large portions of Gross Domestic Product (GDP) originate from primary production sectors, mainly agriculture and mining. The contribution of these sectors is relatively high, averaging close to 50 percent of GDP (SADC 2014). Value addition and beneficiation in the primary sectors remain low (SADC 2014). Other activities are still to be fully utilised as a springboard for industrial development in the region such as the information technology sector which is growing rapidly.

Major industrial activities in the Basin concentrate on processing goods using raw materials from agriculture such as textiles and garments from cotton, as well as food and beverages, sugar and various dairy products. Other activities include the manufacturing of chemicals, fertilizers, furniture, hardware products, glassware and other products.

As illustrated in Table 9.1, the contribution of the manufacturing sector to GDP has never peaked 17 percent for any Basin countries, and is lower than 5 percent in some Basin states from 2000 to 2011. The contribution of manufacturing to GDP has remained relatively unchanged over the last decade, despite some small upward and downward movements across countries. This is characteristic of countries that have not yet had a structural transformation into industrialised economies.

In Angola and Botswana, for different reasons, manufacturing measured as a share of value added to total GDP has never been significant, reaching 6.5 percent in 2011 and 4.2 percent in 2000 respectively. In Mozambique and Namibia, the sector's contribution is higher, but still low by international standards.

Table 9.1 **Contribution of Manufacturing to GDP (%)**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Angola				3.90	4.00	3.60	4.94	5.28	4.88	6.20	6.25	6.50
Botswana	4.22	3.85	3.56	3.78	3.54	3.37	3.08	3.42	3.23	3.82	3.62	3.83
Malawi			9.56	10.42	8.66	7.84	9.22	9.80	10.60	10.25	10.03	
Mozambique	10.47	12.07	12.44	14.57	15.54	13.73	14.21	13.76	13.63	12.61	12.33	
Namibia	11.49	11.45	11.76	13.59	12.36	12.28	14.24	15.54	12.73	13.31	12.84	11.96
Tanzania	8.68	8.30	8.22	8.21	8.01	7.87	7.70	7.68	7.72	8.52	8.87	
Zambia	9.53	9.24	9.80	10.32	10.31	10.16	9.90	9.26	8.95	8.89	8.29	7.95
Zimbabwe	12.16	12.42	10.97	13.44	14.41	10.38	27.50	8.04	6.92	15.81	15.93	16.06

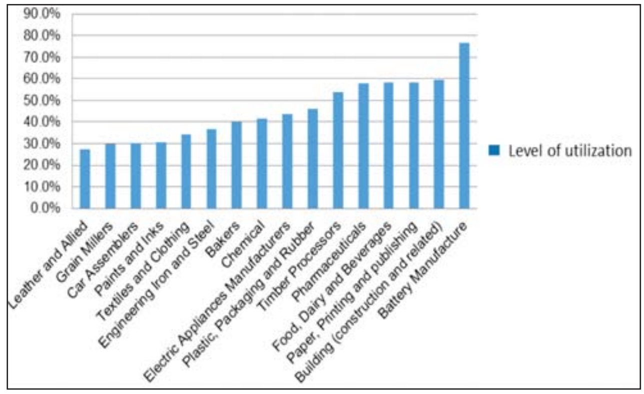
SADC. SADC Statistical Yearbook 2012

Table 9.2 **Manufacturing Performance in Zambezi Basin Countries**

Country	MVA per capita 1990 (US$)	MVA per capita 2010 (US$)	MVA per capita (compound annual growth rate) 1990-2010
Angola	26	66	4.8
Botswana	124	171	1.6
Malawi	21	17	-1.0
Mozambique	15	52	6.2
Namibia	92	348	6.9
Tanzania	19	28	2.2
Zambia	36	44	1.1
Zimbabwe	106	34	-5.5

UNCTAD / UNIDO database cited in SADC Industrial Development Policy Framework 2014

Figure 9.1 **Capacity Utilization in Zimbabwe Manufacturing Sector**



ZIMSTAT. Economic Statistics Indicators, 2014

Table 9.2 illustrates Manufacturing Value Added (MVA) per capita in the Zambezi Basin. Between 1990 and 2010, Malawi and Zimbabwe recorded a decline in MVA per capita while only Mozambique and Namibia registered a growth rate of more than five percent.

Malawi and Zimbabwe experienced a de-industrialization process between, largely as a consequence of the Economic Structural Adjustment Programmes (ESAP). In the case of Zimbabwe, the recent economic crisis also led to shrinking of industrial growth (SADC 2014).

Figure 9.1 shows how, as a consequence of the economic crisis, Zimbabwean firms in most manufacturing sub-sectors operate well below capacity.

Export of Primary Commodities

The industrial sector in the Zambezi Basin is characterised by a lack of diversification. This is reflected in its export composition. Primary commodities represent between 70 percent and 91 percent of total exports, and minerals such as gold and diamonds account for most of this, more than agricultural and food commodities (Table 9.3).

The top three export products are dominated by resource-based, non-value added products. Only in Malawi, Namibia and Zimbabwe do agricultural commodities figure in the top three export products: tobacco, sugar, fisheries. From an employment perspective, however, agricultural commodities are labour-intensive and contribute marginally to total exports and GDP.

While recognizing the need to strengthen a foothold in export markets, commodity exports are unlikely to sustain economic growth (SADC 2014). Therefore, despite being abundantly endowed with natural resources, including many industrial minerals and agricultural resources, the Zambezi River Basin remains poor because these resources are exported mainly in primary form, with little return from such exports.

Table 9.3 **Primary Commodities in the Zambezi Basin Countries**

	Primary commodities (%)	Of which (excluding precious stones and gold/food commodities) (%)			Top three export products (%)
		Agricultural raw materials	Minerals	Fuel	
2011					
Botswana (2011)	88	0	8	0	Diamonds excluding industrial (75%) Nickel mattes (6%) Gold, non-monetary excluding ores (1%)
Malawi (2011)	90	5	9	0	Tobacco, wholly or partly stemmed/stripped (25%) Tobacco, not stemmed/ stripped (14%) Sugars, beet or cane, raw (13%)
Tanzania (2011)	84	3	22	1	Gold, non-monetary excluding ores (36%) Precious metals, ore, concentrates (11%) Manganese ores and concentrates including manganiferous iron ores (10%)
2010					
Mozambique (2010)	91	4	53	18	Aluminium, aluminium alloy, unwrought (52%) Electric current (12%) Natural gas, liquefied (6%)
Zambia (2010)	91	1	83	0	Copper anodes and alloys (64%) Copper plate, 15mm+th (9%) Copper ores and concentrates (3%)
Zimbabwe (2010)	70	6	32	1	Nickel mattes, sintra (14%) Tobacco, wholly or partly stemmed/stripped (13%) Gold, non-monetary excluding ores (9%)
2008					
Namibia (2008)	71	0	31	0	Diamonds excluding industrial (16%) Uranium ores and concentrates (16%) Fish, frozen, fillets (7%)

AU / UNECA. Making the most of Africa's commodities: Industrializing for growth, jobs, and economic transformation, 2013

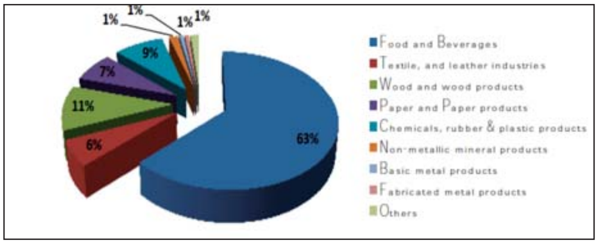
Note. In some countries, the sum of columns 2, 3 and 4 does not equal column 1. This is due to the fact that column 1 includes food commodities (such as cocoa and coffee), precious stones, and gold, which are not represented in columns 2, 3, and 4. Angola trade data older than 2000 is available from COMTRADE.

Value Addition

As mentioned previously, the Zambezi Basin is characterised by very low levels of industrial development, with industrial output heavily concentrated on low-technology products such as food, beverages, textiles, clothing and footwear. In Zambia, for example, growth in the sector is largely driven by agro-processing (food and beverages, 63%) as illustrated in Figure 9.2. Other minor contributions are from secondary processing of metals, including the smelting and refining of copper. Other products include fertilizers, chemicals, explosives and construction materials such as cement, as well as wood products and paper products (Zambia Development Agency 2013).

In 2007, the Zambian government launched Multi-Facility Economic Zones (MFEZs) and Industrial Parks with the objective of attracting major investment in export- and domestic-oriented manufacturing industries through dedicated infrastructure and provision of sector-specific investment incentives. Government also promotes small and medium enterprises in rural and urban areas so as to enhance labour intensive light manufacturing activities (Zambia Development Agency 2013).

Figure 9.2 **Composition of Zambia's Manufacturing Sector**



Zambia Development Agency. Zambia Manufacturing Sector Profile, 2013

Agro-Processing

Agro-processing involves turning primary agricultural products into various commodities on various scales, ranging from women drying or smoking fish to manufacturing leather from reared livestock to the production of beverages using extracts of cultivated crops. The former can be described as a primary processing operation and the latter as a secondary processing operation. In countries such as Zimbabwe the agricultural output serves as both a source of raw materials for industry and a consumer of industrial outputs (Feresu 2010). The agriculture sector has the potential to boost industrial development and economic growth, as Basin countries are mostly agro-based.

While agricultural commodities play an important role in national economies, their full potential to boost industrial development is yet to be discovered. Agricultural and food commodities contribute less in overall commodity exports because they are still being exported in unprocessed form.

Tobacco

Over the past decade, Zimbabwe, Malawi and Tanzania have featured in the top ten world producers of tobacco (FAOSTAT 2014).

Although the quantities of tobacco production are small compared to bigger producers such as Indonesia and Brazil, Basin states strive to be net exporters of tobacco products such as cigarettes. A threat to the cigarette industry in the Basin is the international campaign to ban tobacco, pushed by the World Health Organization (WHO) Framework Convention for Tobacco Control (FCTC). WHO FCTC is an international treaty composed of obligations to address the health and economic impacts of tobacco use, initiated due to pervasive cases in the United States of products containing a high quantity of chemicals. Zimbabwe and Malawi are the only Basin states yet to sign the treaty, due to significant Asian markets for the dried, unprocessed tobacco and products, although it has been argued that signing the treaty will put producer countries at the table of discussions and negotiations.

Table 9.4 **Production of Tobacco, Raw Unmanufactured (tonnes)**

	2000	2002	2004	2006	2007	2008	2009	2010	2011	2012
Brazil	578 451	670 309	921 281	900 381	908 679	851 058	863 079	787 817	951 933	810 550
Malawi	98 675	89 401	106 187	121 600	118 000	160 238	208 155	172 922	174 928	151 500
Zambia	9 533	13 982	37 311	48 000	61 759	64 066	65 704	59 338	60 329	61 500
Zimbabwe	227 726	178 408	783 12	44 451	79 000	81 952	85 085	109 737	111 570	115 000

FAOSTAT. UN Food and Agriculture Organization, Statistics Division, 2014

Table 9.5 **Export/Import of Cigarettes (tonnes)**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Brazil	782	480	1 614	2 572	2 823	2 743	3 768	5 082	3 622	1 908	284	237
Indonesia	21 942	30 865	26 031	22 600	27 885	35 047	40 009	45 928	55 520	54 287	55 599	56 309
Malawi	0	-393	-440	-267	-349	-532	-892	-689	-1117	-763	-933	-352
Tanzania	218	280	990	564	602	71	130	17	74	377	922	1 491
Zimbabwe	661	523	1 552	-4	3 229	1 690	45	16	228	4 385	-6	5 408

FAOSTAT. UN Food and Agriculture Organization, Statistics Division, 2014

Cotton

Another industrial activity that is yet to meet its full potential is the textile and clothing industry. This industry can benefit from cotton production in the region. Significant price increases for cotton on the world market since 2009 have made cotton production attractive for African smallholders including those in Basin states (Eliassen 2012). The net production value of cotton products such as cotton lint has been highly variable and inconsistent for all Basin states for the past decade, but it remains an important cash crop that would benefit from value addition.

Historically, Tanzania and Zimbabwe have been the top producers of cotton among the Basin states. The clothing and textile industry involves a process from cotton cultivation to ginning cotton into lint which is then spun into yarn. The yarn can be made into fabric and further processed into garments or products for sale. Most Basin states end at the ginning process and export cotton lint. There are few textile manufacturers operational in the Basin.

In Zambia and Zimbabwe, studies have shown that the number of manufactures and employment in the textile and fabric industry decreased significantly from the 1980s to 2000, a trend that continued after 2000 (Eliassen 2012). The import of textile and cloth products from Asia has resulted in a decline of national industry and employment opportunities in the formal sector in both countries (Eliassen 2012). This can be observed in the Basin where many people in urban areas rely on cheaper imports rather than buying from domestic suppliers.

Table 9.6 **Net Production Value for Cotton Lint**

	(constant 2004-2006 1,000 Int. $) (1000 Int. $)												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Angola	6224.18	1556.4	1429.2	1429.2	1429.2	1429.2	1429.2	1429.2	1429.2	1429.2	1429.2	1429.2	1429.2
Botswana	1286.28	1702.18	1100.49	990.44	1046.18	1119.07	948.99	713.17	843.23	643.14	571.68	428.76	428.76
Malawi	13863.28	14149.12	14292.04	14577.88	20937.84	20008.86	22867.26	25725.67	29298.68	27154.88	11290.71	20008.86	92898.26
Mozambique	16079.97	50022.14	57882.76	37873.91	65028.78	54309.75	75747.81	78606.22	88610.65	88610.65	27154.88	51451.34	125770
Namibia	2782.66	1807.79	798.95	726.79	4463.1	47.64	110.84						
Tanzania	59131.89	116408.7	90039.85	71460.2	162929.3	180405.6	62556.26	101149.1	176649.6	125055.4	142920.4	77177.02	141491.2
Zambia	28584.08	31442.49	36730.54	44805.55	54238.29	66958.21	55024.35	64028.34	57596.92	62170.37	48878.78	60026.57	123254.6
Zimbabwe	182266.4	182938.1	104331.9	121482.3	142920.4	107190.3	102902.7	114336.3	165787.7	114336.3	54309.75	128628.4	136346.1

FAOSTAT. UN Food and Agriculture Organization, Statistics Division, 2013

Table 9.7 **Export/Import Value of Beverages**

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	(1000 US$)											
Angola	0	0	-31	0	-6	-3	0	-4	-1	-2	-16	-40
Botswana	-23	-66	-48	-6	-1	-904	-1 788	-2 373	-3 404	-7311	-7 492	-8 174
Malawi	0	0	0	0	-26	-10	0	-10	-389	-123	-383	-355
Mozambique	0	0	0	-487	-63	-35	0	-287	-17	-17	-1 876	-377
Namibia	-3 400	-9 500	-8 000	-13 149	-3 000	-376	-264	-98	-98	-98	-274	-1 325
Tanzania	-122	-40	-10	-75	-59	-53	-1 570	-124	-291	-530	-971	-866
Zambia	-22	-262	-113	-131	-448	-565	-887	-5 024	-8 784	-6579	-17 451	-13 022
Zimbabwe	-1 534	-2	-1 597	-121	-68	-33	-119	-51	-109	-31	-44	-26

FAOSTAT. UN Food and Agriculture Organization, Statistics Division, 2013

Beverages

Consumption of beverages remains an important contributor to the food and agro-processing sector. All Basin states have been net importers of beverages for the past decade. Angola however has managed to significantly increase its export/import value of beverages by manufacturing its own and relying less on imports.

Small and Medium Scale Enterprises

Small and Medium Enterprises (SMEs) play a major role in economic development in the Zambezi Basin. They account for about 75 percent of total employment in the manufacturing sector in southern Africa (Ayyagari and others 2007; Calice, Chando and Sekioua, 2012). This is exemplified in Mozambique where 28,478 of the 28,870 enterprises in the economy are SMEs (Nhancale and others 2009). In the Copperbelt region of Zambia, following the World Bank/IMF structural adjustment programmes, formal employment declined and there has been a resurgence of home-based enterprise, self-employment and other micro-economic activities most of which are in the informal sector (Kazimbaya-Senkwe 2004).

There is no universally accepted definition to what constitutes SMEs. However, the commonly used yardsticks are number of employees and rate of turnover, although it has been argued that rate of turnover is too variable to be used as a consistent indicator. The typically accepted numbers used to describe SMEs

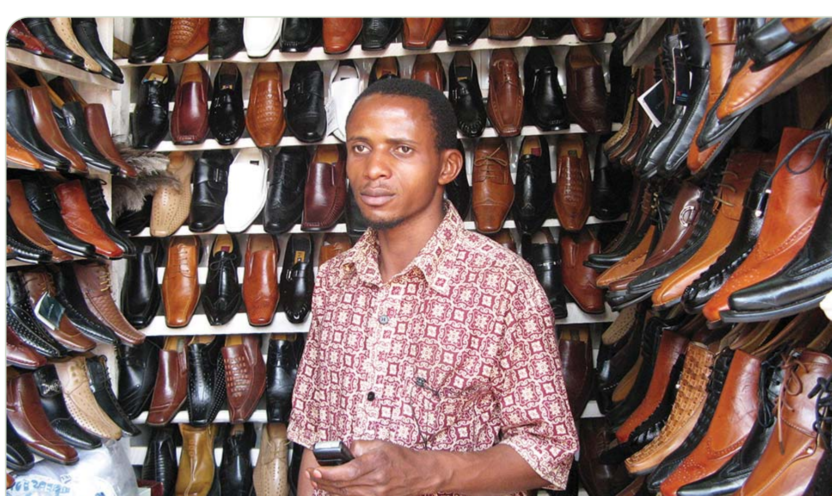
Table 9.8 **SMEs Definitions, Typical Numbers**

Micro firms	1-9 employees
Small firms	10-50 employees
Medium firms	50-250 employees

Fjose, Grünfeld, and Green. SMEs and growth in Sub-Saharan Africa: Identifying SME roles and obstacles to SME growth, 2010

are indicated in Table 9.8, although the exact numbers vary from country to country as well as by economic sector.

SMEs are effective in the utilization of local resources and adding value to those resources using simple and affordable technology (GoT 2002). A study of various communities in Mozambique has shown that SMEs are very active in the forestry sector by producing an array of forest products including products such as honey, commercial timber products, charcoal and furniture (Nhancale and others 2009). Estimates from that study suggest that SMEs comprise 95.8 percent of the formally registered enterprises in the forestry sector.



Some of the major barriers to SME development evolve around infrastructure and sustainable financing. In the scope of industrialization, there is need to include SMEs in development policies as they have the potential to increase manufacturing output and spur local economic growth. Another challenge that is still being addressed is the role of sustainability and social responsibility from SME enterprises. Although studies have been done for some activities such as charcoal and fuelwood, it is important to study and understand the impact that some of these activities have on the environment and society so as to ensure sustainable growth.

Challenges for Industrial Development in the Zambezi Basin

The SADC Industrial Development Policy Framework (2014) as well as the AU Action Plan for the Accelerated Industrial Development of Africa (2007) identify several challenges leading to low levels of industrial growth in the SADC region and Africa respectively. These challenges are also reflected in the Zambezi Basin. They include weak infrastructure base, lack of access to modern technologies, and lack of capital.

Infrastructure

An efficient and cost-effective infrastructure remains a prerequisite for industrial development in the Zambezi Basin. However, industrial development has been hampered by inadequate infrastructure, including road, rail and air transport services.

Improved Information and Communication Technologies (ICTs) are also essential. A diagnostic study to determine the prevailing infrastructure gaps in the SADC region undertaken in 2011/12 revealed serious gaps in infrastructure provision, including insufficient energy supply to serve increased production and to extend access, highly priced, unpredictable transport and logistics services, especially for landlocked states; lack of low-cost access to ICTs; and inadequate meteorological services for effective and efficient planning and management of water resources, energy production, transport services and other climate-sensitive sectors (SADC 2014).

Services

In addition to lack of sound infrastructure, the Zambezi Basin has a shortage of services including financing, communications, and energy. As reported in Chapter 6 on Energy, the Basin has encountered an energy deficit since 2007. As industrial activity is energy intensive, the shortage of energy is seriously hampering manufacturing processes.

Impacts of Structural Adjustment Programmes

Another challenge relating to industrial development in the Zambezi Basin was the introduction of economic reforms in the 1990s by the Bretton Woods institutions, called economic structural adjustment programmes. These were aimed at promoting production and resource mobilization through commodity exports, public sector reform, market liberalization and institutional reform. They also sought to limit the role of government in the economy, promote private sector operations and remove restrictions in the economy and ensure market determined prices. However, the structural adjustment had negative impacts on the economies of Basin states. Many industries in the Basin restructured their operations resulting in workers getting laid off or reduced working hours, leading to increased unemployment.

The structural adjustment programme not only affected industrial performance but impacted on social services delivery. In the health sector for example, there were increased cuts in health spending. Many people were no longer able to afford health care due to reduced income. Other resultant challenges included increased malnutrition in children, increased incidence of infectious diseases, and higher infant and maternal mortality rates.

Environmental Impacts of Industrial Development in the Basin

The processes employed in the various industrial activities such as growing and curing tobacco, ginning cotton or tanning leather involve the use of toxic chemicals and at times produce toxic by-products. These chemicals tend to be persistent organic pollutants or ozone depleting substances that have long-term negative effects on the environment. Leather tanneries use chemical recipes during the de-hairing process that often result in toxic effluents being released into the natural environment.

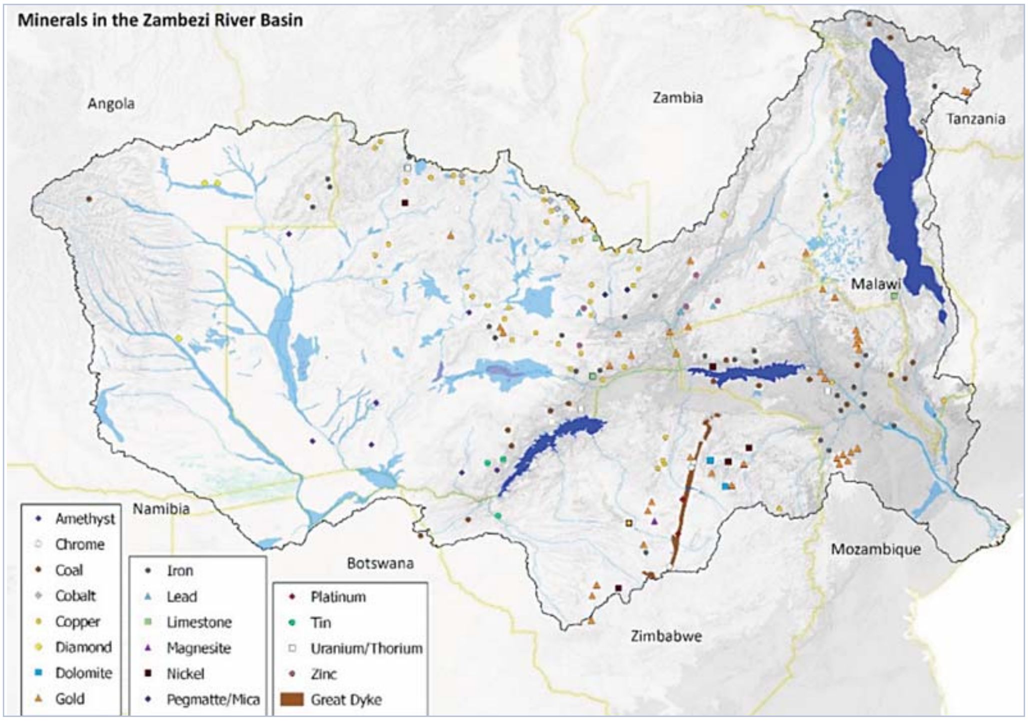
The commodity boom in countries such as South Africa over the years has seen in an influx of South African manufactured products in Basin State markets. This has resulted in an increase in plastic waste especially in urban and peri-urban areas where household-generated waste has been increasing. In the city of Harare, the waste management system is still based on old methods and technologies, waste is not separated at the source and old vehicles that do not compact waste are used for collection (Feresu 2010). In some settlement areas in Kabwe District in Zambia, most of the waste is disposed of indiscriminately in pits, open areas and by burning (Kabwe Municipal Council 2010). A study done by the Government of Malawi showed that majority of household waste in major cities such as Lilongwe, Blantyre and Mzuzu is disposed of in pits near households (Government of Malawi 2010).

Many city councils are struggling to cope with waste management mainly because of outdated infrastructure and changes in behavioural patterns of the consumers. The rapid build-up of household waste often results in storm drains being blocked exacerbating flooding in settlement areas and the prevalence of stagnant water. Flooding in some areas such as Chowa has been attributed to refuse that had choked the drains and eventually the main canal (Kabwe Municipal Council 2010). The widespread disposal of generated waste in open pits has been a cause of concern for soil and groundwater pollution. Leachate produced from waste has been known to percolate into the soil especially in unlined dumpsites (Feresu 2010).

Opportunities for Accelerating Industrial Growth in the Basin

The Zambezi Basin is endowed with abundant natural resources which form the basis for resource-based industries, particularly mining and food-processing industries. Important natural resources include among many fisheries, forestry, wildlife, farming lands and minerals. These can be turned into a competitive advantage through value addition and beneficiation.

Map 9.1 **Minerals in the Zambezi Basin**



SARDC IMERCSA 2014. Data from SADC and ZRA. Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin, 2007

The discovery of mineral resources and proximity to major transport and trade routes largely influenced urbanization and development geographical patterns in the Zambezi Basin. Today, the major industrial settlements include Blantyre and Lilongwe in Malawi; Tete in Mozambique; Chililabombwe, Chingola, Chipata, Kabwe, Kafue, Kitwe, Livingstone, Lusaka, Luanshya, Mazabuka, Mufulira, Ndola and Solwezi in Zambia; and Chegutu, Gweru, Harare, Hwange, Kadoma, Kwekwe, Marondera and Norton in Zimbabwe. Map 9.1 shows major mineral deposits in the Zambezi Basin.

Zimbabwe's Great Dyke, which stretches almost 530km across the southern Zimbabwe Craton is extremely rich in platinum and chromium deposits (Chenje 2000 and NASA EO 2004). The dark patches indicate burn scars from fires as a result of mining activities.

NASA-EO 2004

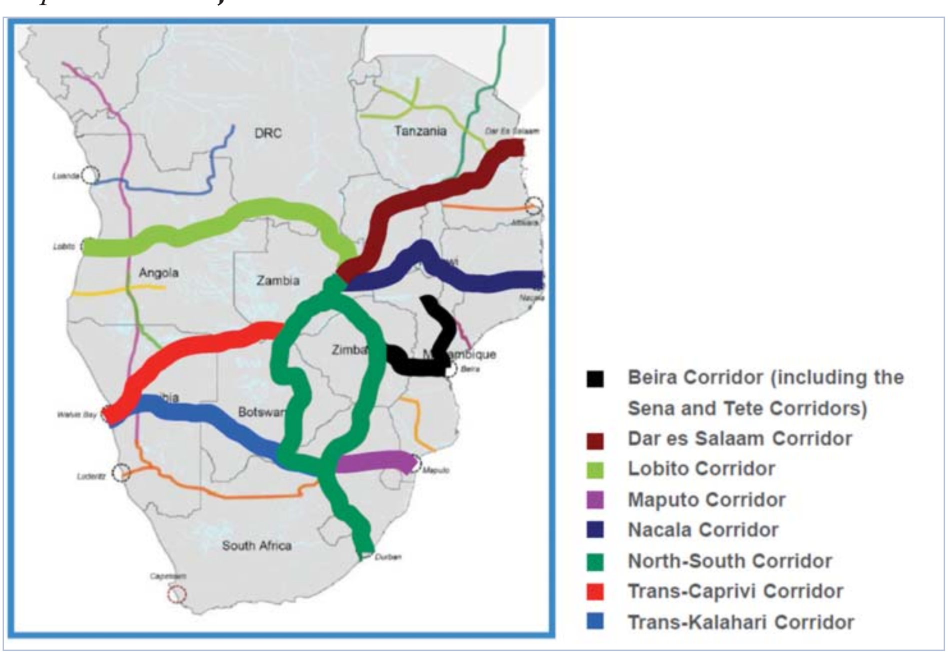
Infrastructure Enhancement Efforts

There are renewed efforts in the Zambezi Basin and southern Africa to upgrade transport and infrastructure services, as a way of enhancing industrialization. This is in realization that an efficient, integrated, and cost-effective infrastructure is a prerequisite for the Basin's industrial development.

According to the SADC Industrial Development Policy Framework, the structural transformation of the SADC industrial sector has all along been hampered by inadequate infrastructure and high-cost services. The region and the Basin is not coping with current infrastructure requirements, including those related to expansion of industrial capacity such as energy, transport and logistics services, and ICTs.

An approach to boost industrial development in the Basin is to concentrate development along economic corridors. This approach can promote broader economic development by lowering barriers and increasing flows of goods, services and people between increasingly urbanized centres. Recent corridor development initiatives look at regional transport routes not only as a means of transporting goods and services or as a gateway for land-ocked countries, but also as a tool for stimulating social and economic development in the areas surrounding the route (NEPAD 2013).

Map 9.2 **Major Economic Corridors in Southern Africa**



JICA. Data Collection Survey for Economic and Industrial Development along Economic Corridors in Southern Africa, 2013

Economic corridors accomplish this by creating complementary infrastructure such as feeder roads, promoting investment in industry and social facilities in conjunction with critical nodal transport infrastructure. In doing so, they develop rural and border areas, increase the earnings of low-income groups, and create employment. Political boundaries thus cease to be economic boundaries and spatial-economic regional planning takes the lead (NEPAD 2013). See Map 9.2.

Of relevance to the Zambezi Basin are the Beira Corridor (including the Sena and Tete Corridors), Nacala Corridor, the North-South Corridor as well as the Lobito Corridor. The Zambezi Valley Development Corridor is not yet operational and presents an opportunity to unlock industrial development in the Basin. Examples of envisaged largescale industries along Economic Corridors are shown in Table 9.9 below.

Table 9.9 **Examples of Largescale Basic Materials Industries Envisioned in Southern Africa**

Example	Description
Copper fabrication and the iron/steel industries in Zambia (Nacala and North-South Corridors)	Zambia has enhanced its status as an important base for manufacturing and supply of copper rod in through the development of Multi-Facility Economic Zones and individual plants along the corridors in and around Lusaka and the Copperbelt, while at the same time facilitating industrial development in the region.
Aluminium production in Mozambique (Maputo Corridor)	Development of the Mozal and Mozal II Aluminium Smelters in Mozambique. Mozal, located in the Beluluane Industrial Park, is a joint venture between BHP Billiton, Mitsubishi Corp., IDC of South Africa and the Government of Mozambique. Its SMEs linkage programme has helped local enterprises to supply goods and services such as signage, air conditioners, cleaning chemicals, pumps, mosquito nets, landscaping, and protective clothing.
Liquefied Natural Gas (LNG) production in Mozambique (Beira and Nacala Corridors)	Natural gas discoveries offshore in Mozambique (including the Rovuma Offshore Area) are large and competitive, with potential for more to be discovered. The country is well-situated relative to other potential LNG developments in the world.
Heavy chemical industries in Mozambique (Nacala Corridor)	The Nacala Special Economic Zone, established in 2008 in the Nacala-Velha and port districts, has transformed into a largescale petrochemical industry base, exhibiting synergy with other heavy industries including an oil refinery as well as steel and cement factories. Other downstream industries such as fertilizers and plastics have developed and have produced important inputs for the agricultural sector and agro-processing firms in Mozambique and landlocked countries along the corridor.
Heavy chemical industries in Tanzania (Dar es Salaam Corridor)	A new port has been constructed at Bagamoyo, about 60 km north of Dar es Salaam, to respond to the increasing international trade of the country, and a large-scale industrial park has been developed in the port area where a heavy chemical industrial complex as well as other industries have located.

AU / UNECA. Making the most of Africa's commodities: Industrializing for growth, jobs, and economic transformation, 2013

Beira Corridor

The Beira and Zambezi development corridor initiatives aim to develop an economic region linking Malawi, Mozambique, Zambia and Zimbabwe, anchored to the port of Beira.

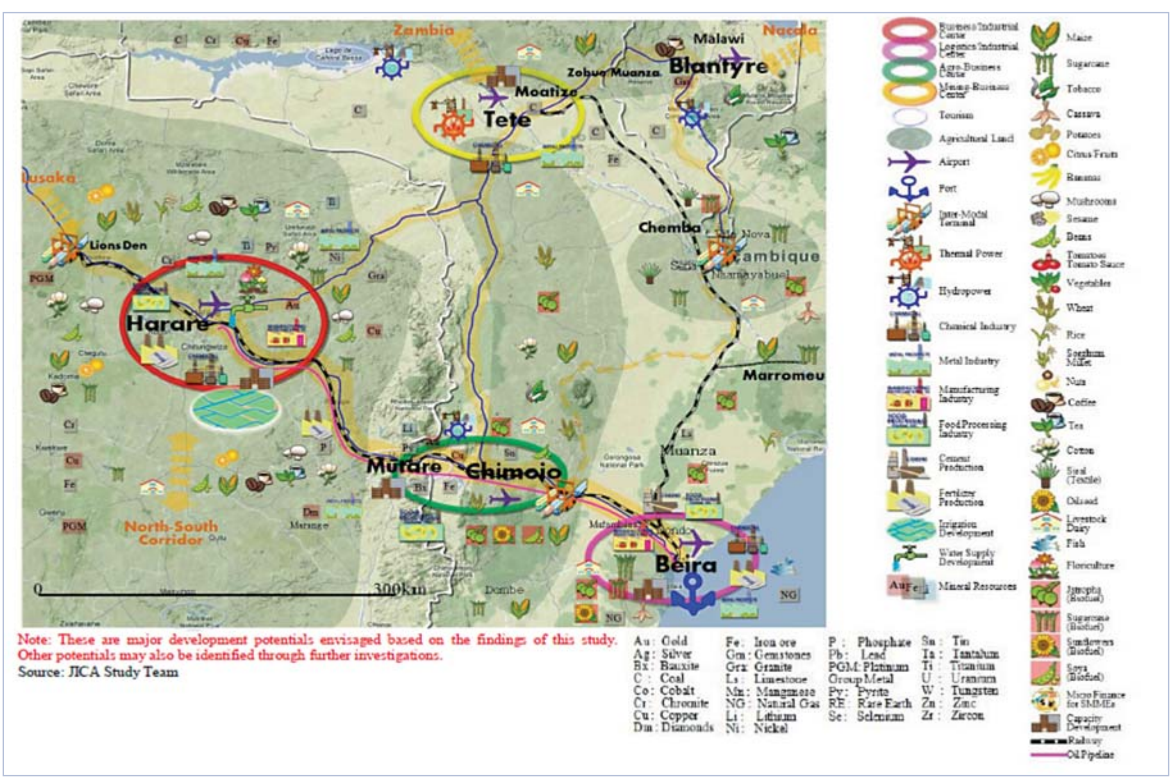
Key objectives are to re-establish and upgrade the infrastructure linkages inland and infrastructure development projects include upgrading of:

- the Beira port, electricity supply, gas and liquid fuel pipelines;
- the proposed Harare-Beira toll road;
- the Harare-Beira railway line upgrade; and,
- the airports.

Projects already being implemented include the Sena railway line commissioned in 2004. Development of the Shire and Zambezi rivers into navigable waterways is a strategic project aimed at increasing transport options for access to the sea for landlocked Malawi.

The implementation of a number of natural resources-based projects include reopening of Moatize coking coal mine and development of a thermal power station, agricultural development in Dondo and Chimoio, as well as tourism in the Eastern Highlands of Zimbabwe and the Zambezi Valley. See Map 9.3.

Map 9.3 **Major Development Potential along the Beira Corridor**



JICA. Data Collection Survey for Economic and Industrial Development along Economic Corridors in Southern Africa, 2013

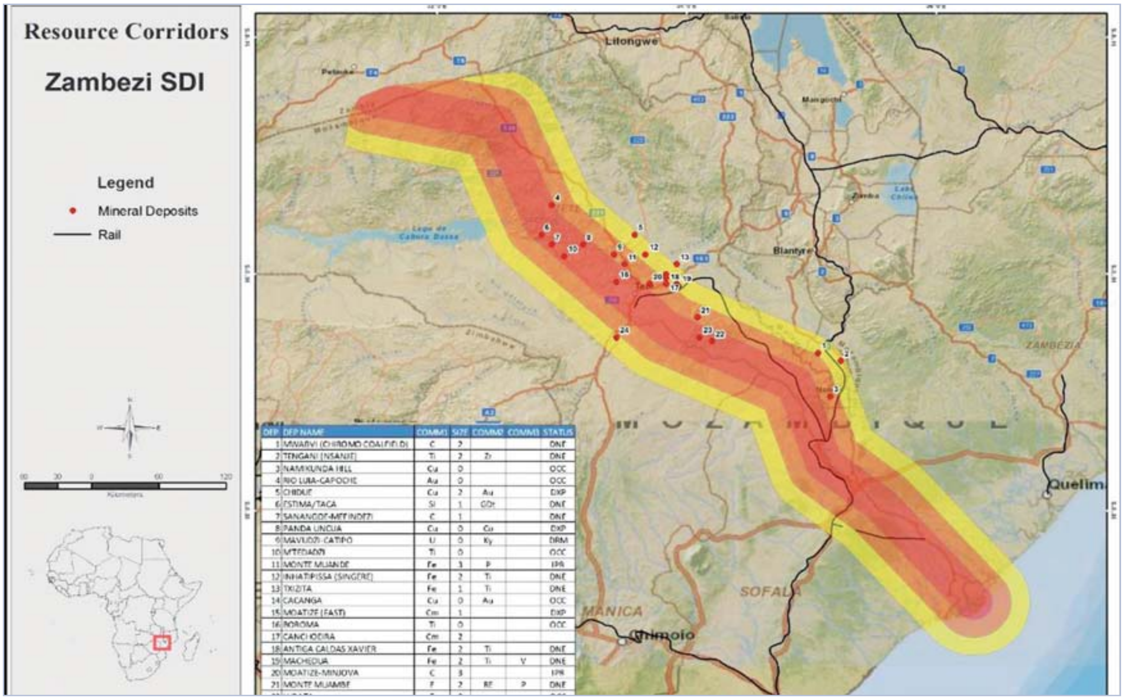
Zambezi Valley Development Corridor

The Zambezi Valley Development Corridor cuts across the central provinces of Mozambique and southern part of Malawi. The central provinces which form part of the Zambezi Valley Development Corridor are the water and mineral rich province of Tete, the southeastern part of the Manica Province, the southern part of the Zambezia Province and the Sofala Province. The Tete Province and the southern part of Malawi are endowed with one of the biggest unexploited coal resources in the world. See Map 9.4.

Coal is a major mineral resource found along the Zambezi Valley Development Corridor. In addition, the central provinces of Mozambique have vast and unexplored resources such as iron ore, magnetite, bauxite, nepheline syenite, heavy minerals and fluorspar. Coal will be used as the anchor sector in the Zambezi Valley Development Corridor.

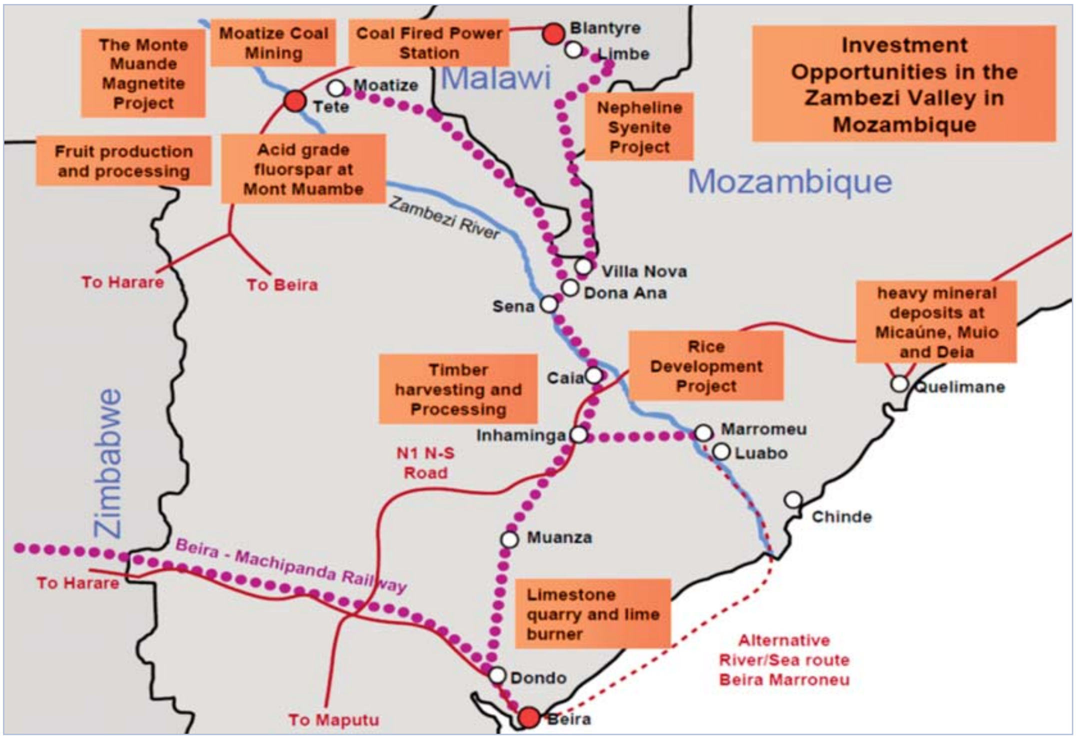
Two crucial elements of the development corridors are road and railway links. The success of the Zambezi Valley Development Corridor depends on the railway connection from Moatize to Beira (the Sena Line). The global mining company Vale was involved in the construction of a rail link from their mine at Moatize to a new terminal at Nacala, a distance of 915 km, routed through Malawi (Nkaya), at an estimated cost of US$ 4.4 billion. The rail line is designed, built and operated to handle 22 million tons per annum of coal exports from Vale with the Nacala terminal designed to handle 30 million tons per annum of coal. See Map 9.5.

Map 9.4 **The Zambezi Valley Development Corridor**



Mtegha and others. Resources Corridors: Experiences, Economics and Engagement; A Typology of Sub-Saharan African Corridors, 2012

Map 9.5 **Investment Opportunities along the Zambezi Valley Development Corridor**



NEPAD. Regional Integration and Trade Department, 2013

Table 9.10 **An Analysis of the Zambezi Valley Development Corridor**

Context	Discussion
	Zambezi Valley Development Corridor
Natural Resources	• Coking Coal • Thermal Coal
Infrastructure	• Weak with limited rail Infrastructure • Currently being upgraded
Private Sector	• Active Involvement • Multinational mining companies are driving project development– Rio Tinto and Vale with a host of Junior Australian and Indian exploration companies.
Business Case/ Anchor Projects	• Quality of Resources drives business case. • High quality coking coal and thermal coal deposits. • Undeveloped resources or iron ore, nepheline, syenite and heavy minerals.
Policy and Regulatory Environment	• Incentivised FDI for natural resource projects • Government and Vale have agreed through the state institution that oversees ports and railway development to upgrade the Sena line via concession. • Experience gained in MDC with regard to PPP • Transport ministry integrate national transport system to use SDI methodology to transform transport into development corridors.
Policy Support	• Currently corridor modality in Mozambique supports government's political and economic agenda.
Corridor Authority	• Not yet established, however the SDI Programme is based in the Ministry of Transport. • Donor collaboration, DFID, World Bank and DTI (South Africa) are supporting the SDI programme. Financial contribution of $2.15 million over 3yr period from July 2010.
Stakeholder Participation	• Programme not fully implemented
Linkages	• No focus on the creation of local SMME products and services largely from South Africa. • However experience from Mozal aluminium is intended to be carried into policy on mining.
Cross Border Arrangements	• Appear to be limited with most activity taking place in Mozambique-can be attributed to fact that the corridor is largely within Mozambique.
Skills and Technical Capacity	• The SDI unit is yet to be fully staffed.

NEPAD, Regional Integration and Trade Department, 2013

Dar es Salaam Corridor

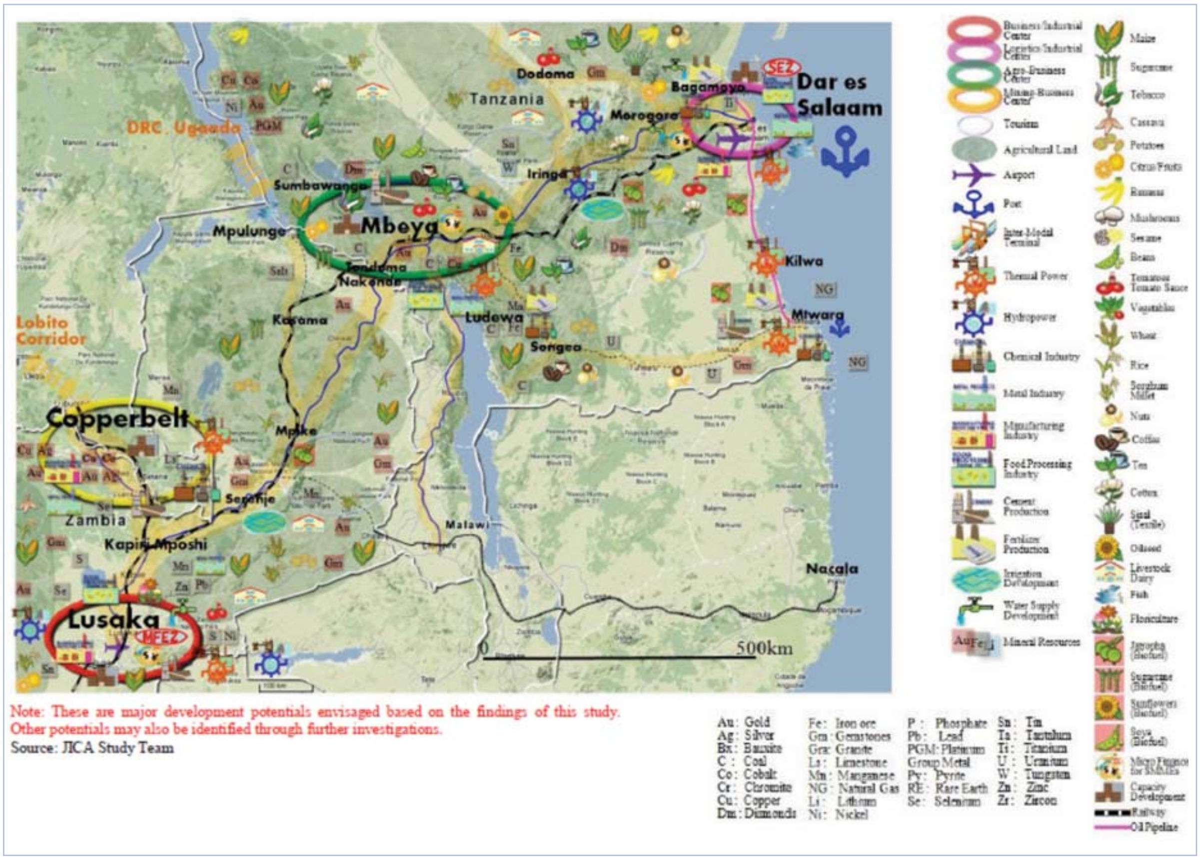
The Dar es Salaam Corridor consists of various primary industrial development strategies that aim at boosting economic development. Investments within the agricultural sector along the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) and extension of the SAGCOT in Zambia are intended to develop a robust agro-industry which will result in the development and promotion of agribusiness-centred industrial clusters. These clusters will include SMEs and Micro Manufacturing Enterprises (MMEs) engaged in agri-business activities located in key cities along the corridor in Tanzania and Zambia (JICA 2013).

The Dar es Salaam Corridor will see the development of iron and coal mining and other industries downstream in the Ludewa area of Iringa Province in Tanzania. The Bagamoyo Special Economic Zone (SEZ) in Tanzania will be developed along with the construction of a new port, leading to development of heavy chemical and other industries. In order to promote these developments, regional integration initiatives including regional trade and transport facilitation measures will also be implemented (JICA 2013).

The Zambezi Basin has experienced relative peace and stability over the years. The current political stability enables Basin states to attract investment in key sectors such as industrial development, energy and infrastructure. Angola and Mozambique have experienced rapid economic growth and infrastructural development since the end of conflict, showing that stability is a prerequisite to economic and industrial development.

This is most evident by the rehabilitation of the Benguela Railway in the Moxico province of Angola that borders Zambia and DRC. The railway is part of the Lobito-Lusaka Corridor which will connect the Zambezi Basin to other regions through three pillars of intermodal transport (land, air and sea). The major industries are: the Port of Lobito, the Benguela Railway, the International Airport of Catumbela and the Lobito Oil Refinery (Port and Corridor 2012).

Map 9.6 **Major Development Potential along the Dar es Salaam Corridor**



JICA. Data Collection Survey for Economic and Industrial Development along Economic Corridors in Southern Africa, 2013

Policy Options for Sustained Industrial Growth

Several regional development policy and planning initiatives have been approved in recent years to provide a framework for the promotion of infrastructure and industrial development in southern Africa, including the Zambezi River Basin. These include, at continental level, the

- New Partnership for Africa's Development (NEPAD);
- Africa Action Plan (2010–2015), prepared by the African Union;
- Programme for Infrastructure Development in Africa (PIDA), a long-term plan for the next three decades, prepared by the African Union with the NEPAD Planning and Coordination Agency (NPCA) and the African Development Bank (AfDB);
- Africa Agro-business and Agro-industry Development Initiatives (3ADI); and
- Accelerated Industrial Development of Africa (AIDA).

Regional Policy Initiatives

Initiatives on industrial and infrastructure development at the level of regional economic integration include the SADC Industrial Development Policy Framework, and the SADC Regional Infrastructure Development Master Plan (SADC RIDMP) approved by Heads of State and Government at their Summit in Maputo in August 2012.

There have been transformative developments by SADC in this period, especially in 2014/15, when the focus of regional development was reviewed and adjusted, and a new policy was approved by SADC Heads of State and Government meeting at an Extra-Ordinary Summit in Harare in April 2015. This is the SADC Industrialization Strategy and Roadmap which is expected to facilitate economic growth and development, and ensure that SADC member states harness the full potential of their vast and diverse natural resources. The industrialization strategy and roadmap is anchored on three pillars: Industrialization, Competitiveness and Regional Integration.

The message from the "industrialization summit" was clear -- southern Africa has the capacity to become a dominant force in global affairs if the region adds value to its vast natural resources before exporting them. The strategy, whose drafting was spearheaded by a team of regional and national consultants in which the Zambezi Basin states were well represented, aims to provide the framework for major economic and technological transformations at the national and regional levels within the context of deepening regional integration. During the implementation phase, it will be important for the region to focus more on key enablers such as infrastructure development and energy, as well as research and development, to enhance the effectiveness of the strategy.

In addition, at the same extra-ordinary Summit in Harare in April 2015, SADC leaders recalibrated the regional integration targets as part of efforts to align the region's development agenda with new realities and emerging global dynamics. Summit approved the Revised Regional Indicative Strategic Development Plan (RISDP), which has been under review since 2010. The RISDP is a 15-year strategic plan agreed by SADC leaders in 2003 as a blueprint for regional integration and development, and the revised plan is informed by the industrialization strategy and roadmap.

The Revised RISDP identifies four main priorities to be pursued by the region from 2015-2020. Priority A seeks to promote industrial development and market integration through strengthening the productive competitiveness and supply-side capacity of member states as well as improving movement of goods and facilitating financial-market integration and monetary cooperation. Priority B is the provision and improvement of infrastructure support for regional integration and Priority D is the promotion of special clusters of socio-economic programmes of regional dimension. The above priorities are underpinned by Priority C which is the promotion of peace and security.

National Policies

At national level, Zambezi Basin countries have formulated specific policies to strengthen industrial development (See Table 9.11), but the level of implementation and resources allocated differs between countries.

Most of these industrial policies target resource-based industries: leather, agro-processing, clothing and textiles, and wood products. Some countries have designed or are designing mineral beneficiation policies which, if successful, will have a major impact on the industrial landscape of their economies. These countries include Botswana (diamonds), Mozambique (steel), Zambia (copper), and Zimbabwe (platinum). Zimbabwe, or example, has launched the Industrial Development Policy 2012-2016 whose vision is to transform the country from a producer of primary goods into a producer of processed value-added goods for both the domestic and export market (GoZ 2012).

Institutional responses have been regionally and locally motivated by various policies and policy frameworks. At regional level, Basin states have participated in the development and application of several policy frameworks.

A major new institutional development is the coming into force of the Zambezi Watercourse Commission (ZAMCOM) Agreement in 2011 which has since been adopted by all eight countries that share the Zambezi River Basin. ZAMCOM's main objective as a River Basin Organization (RBO) is "to promote the equitable and reasonable utilization of the water resources of the Zambezi watercourse as well as the efficient management and sustainable development thereof."

Table 9.11 **Policies of Zambezi Basin States on Industrial Development**

Country	Key document
Angola	*Plano Nacional de Desenvolvimento* 2013-2017
Botswana	National Export Strategy 2010-2016 Economic Diversification Drive. Medium to Long Term Strategy 2011-2016
Malawi	National Export Strategy 2013-2018
Mozambique	Industrial Policy and Strategy 2007
Namibia	Namibia Industrial Policy 2012
Tanzania	Integrated Industrial Development Strategy 2011-2025
Zambia	Commercial, Trade and Industrial Policy 2008
Zimbabwe	Industrial Development Policy 2012-2016

The ZAMCOM Technical Committee (ZAMTEC) is tasked with instituting a monitoring mechanism for water abstractions and intra-watercourse transfers (ZAMCOM 2011). This will allow ZAMCOM to assess impacts of various industrial activities on watercourses, and recommendations can be made to member states through the ZAMCOM Council. Article 13 of the ZAMCOM Agreement explains equitable and reasonable utilization of the Zambezi Watercourse, while Article 14 outlines member states' responsibilities. Both stipulate the need for use of the watercourse to be based on principles of sustainable development to prevent harmful use. ZAMTEC will provide assistance to ensure that the water resources are being used well, which will influence industrial operations.

Sustainable Development and Environmental Assessment

When the SADC RISDP was first adopted and approved by Summit in August 2003 with the ultimate objective of deepening regional integration, the framework required SADC institutions to align their focus to achieving goals in their respective clusters, including policies that mitigate environmental impacts while improving trade and production in the industrial sector.

Under the Environment and Sustainable Development priority area, certain targets were set in order to meet the ultimate goal "To accelerate economic growth of the poor majority; and to ensure equitable and sustainable use of the environment and natural resources for the benefit of the present and future generations" (SADC 2003).

In line with RISDP targets, Basin states have continued to adopt policies and change institutional structures in order to meet sustainable development targets. Consistent participation in the Rio Conferences of sustainable development (1992, 2002 and 2012) by Zambezi Basin states has influenced national policies on sustainability resulting in various institutional changes.

Since the Rio Summit in 1992, Basin states have been enacting national policies that speak directly to the environment as a whole. Each Basin state has a piece of legislation that requires Environmental Impact Assessments to be undertaken as a prerequisite for various industrial projects. Another common practice among Basin countries is the development of environmental management laws and regulatory agencies that oversee implementation, most of which entered into force within the last decade. See Table 9.12.

It is through such frameworks that countries have been able to monitor ecosystems and report on the environment regularly to inform on changes occurring and provide recommendations or action plans on enhancing environmental integrity, at the national level and collectively at the Basin level.

Another major international initiative adopted by Basin states that seeks to address the environmental impacts caused by industrial activity is the United Nations Framework Convention on Climate Change (UNFCCC) which arose from the UN Conference on Environment and Development held in Rio de Janeiro in 1992. The convention recommends methods for cooperation in reducing the effects of global warming by reducing carbon emissions which by extension seeks to reduce emissions from industry and other sectors.

Basin states are Parties to UNFCCC as Non-Annex 1 Parties. Non-Annex Parties are described by the Convention as groups of developing countries that are recognized as being especially vulnerable to the adverse impacts of climate change, including countries with low-lying coastal areas and those prone to desertification and drought. This criterion speaks directly to all Basin states. Therefore signing onto the Convention and implementing its programmes to cut GHG emissions will influence industrial activities within the Basin.

Table 9.12 **Legislation that Guides Environmental Protection Per Country**

	Environmental Legislation	Implementing Agency
Malawi	Environmental Management Act, 1996	The Act mandated the Establishment and composition of the National Council for the Environment, which advises the Minister on issues affecting the environment and recommends measures that can be used to integrate environmental considerations in planning and development.
Mozambique	Environment Law (Law Nº 97 of July 30). Approved in 1997	Through this law the National Council for Sustainable Development was established. It is charged with overseeing implementation of the law.
Angola	Law on the Environment (Law No 5/98 of June 19, 1998)	Responsibilities are shared among Government agencies whose control or activity has influence on the environment, through the use of natural resources, production and emission of pollutants and impact on socio-economic conditions of communities.
Zimbabwe	Environmental Management Act, 2002	This established the Environmental Management Agency, a statutory body responsible for ensuring the sustainable management of natural resources and protection of the environment, prevention of pollution and environmental degradation, and preparation of environmental management plans.
Tanzania	Environmental Management Act No 20, 2004. (Repeals the National Environmental Management Act No.19 of 1983)	National Environment Management Council continues to undertake enforcement, compliance, review and monitoring of environmental impact assessment.
Botswana	Environmental Impact Assessment Act No. 6 of 2005	Provides for Environmental Impact Assessments to be used to assess the potential effects of planned developmental activities; to determine and to provide mitigation measures if such activities as may have a significant adverse impact on the environment; to put in place a monitoring process and evaluation of the environmental impacts of implemented activities; and to provide for matters incidental to the foregoing.
Namibia	Environmental Management Act, 2007	Responsibility is shared by Minister of Environment and Tourism which coordinates at the national level; the Sustainable Development Advisory Council which advises the Minister and promotes co-ordination and co-operation amongst Government institutions; Environmental Commissioner who is involved in the implementation of environmental assessments; and environmental officers help to enforce the Act.
Zambia	Environmental Management Act, 2011 (This repeals the Environmental Protection and Pollution Control Act of 1990).	The new Act renames the Environment Council of Zambia to become the Zambia Environmental Management Agency, and empowers the Agency to do all that is necessary to ensure the sustainable management of natural resources and protection of the environment, and prevention/control of pollution.

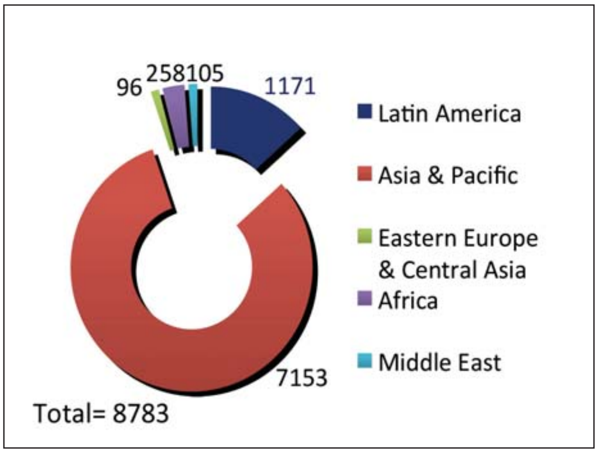
The UNFCCC Conference of the Parties held in Kyoto, Japan in 1997 adopted the Kyoto Protocol which entered into force in February 2005. The Kyoto Protocol reiterates the objectives of the UNFCCC by committing its Parties to set and adhere to international emission reduction targets.

The Parties to the convention agreed that developed countries will have a legally binding commitment to reduce their collective emissions of greenhouse gases by at least five percent of 1990 levels over the period 2008-2012 (SADC and SARDC 2008). The Protocol created a Carbon Market in order to meet these targets. There are three mechanisms that drive the Carbon Market, which are:

1. Emissions trading;
2. Joint implementation; and,
3. The Clean Development Mechanism (CDM).

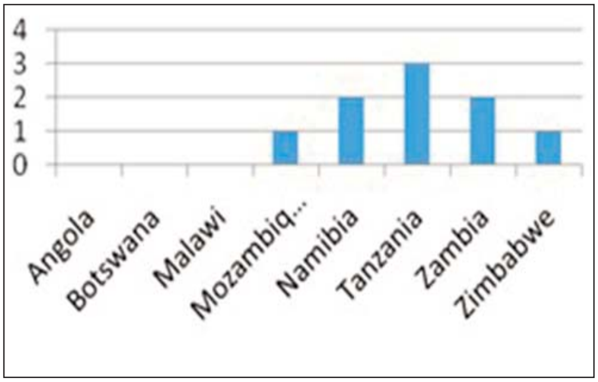
In the Emissions Trading instrument, countries that have emissions exceeding their targets will be allowed to buy emissions from another country with emissions below its target while the Joint Implementation mechanism allows carbon emissions units to be traded among industrialised countries by supporting specific projects that reduce carbon emissions. CDM is a project initiatives that allows emission-reduction projects in developing countries to earn Certified Emission Reduction (CER) credits, which can be traded and sold, and used by industrialized countries to meet their emission reduction targets (UNFCC). A recent review report has shown that promoting clean technologies that lower pollution, and facilitating technology transfer, have been the main rationales in CDM project applications (ISS and PACJA 2012).

Figure 9.3 **Total Number of CDM Projects (Registered and Requested)**



UNEP-Risø. CDM Pipeline Spreadsheet, 2013

Figure 9.4 **Total Number of Registered CDM Projects in Zambezi Basin States**



UNEP-Risø. CDM Pipeline Spreadsheet, 2013

The CDM has been branded as having the potential to significantly reduce GHG emissions while making industries cleaner. While there have been widespread concerns across the continent about some of its workings, most notably the concern over incentives that discourage countries from adopting policies and practices to reduce carbon emissions bur rather develop individual projects in order to stay eligible for CDM funding. Africa remains on the periphery with just 2.94 percent of CDM projects in Africa.

At the regional level Basin states have adopted and observed various legislative protocols and strategies that aim to guide industrial activities and encourage effective environmental practices. The SADC Industrial Development Policy Framework is based on the premise of the SADC bloc realizing the importance of industry in economic development. The framework sets out areas of regional cooperation to build an industrial base which contributes to sustainable growth. The framework also recognizes the need for "green" interventions in industrial processes and sees climate change impacts as an opportunity to build an industry set on low energy intensity, low-carbon emissions and clean technologies.

An emerging policy that will address industrial impacts on the environment will be the SADC Regional Green Growth Strategy and Action Plan for Sustainable Development which seeks to improve regional efforts in sustainability taking into account priority recommendations identified at the Rio 20+ Conference. Following a SADC

Progress Report on Sustainable Development in preparation for the Rio Conference, several gaps and shortcomings were identified. Such a strategy will push the region's industrial process towards cleaner technologies and practices that will mitigate environmental impacts from industry. Environmental policies and laws that aim to curb environmental impacts from industrial activities are also embedded in legislature that regulates certain major industries in the Basin.

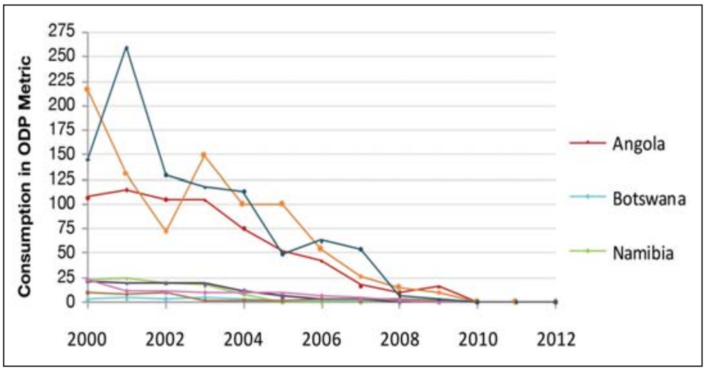
Reversing Negative Environmental Challenges of Industrialization

Several measures have been taken at the regional, national to individual levels to reduce environmental impact from industrial processes. Many Basin states are signatories or parties tovarious Multilateral Environmental Agreements (MEA) that aim to address issues arising from industrial activities. The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in 1987 and revised in 1990. By1992 it had been ratified by all Basin state countries.

The aim of the Protocol is to reduce the production and consumption of Ozone Depleting Substances (ODS), particularly chlorofluorocarbons (CFCs) from industrial processes, consequently reducing their abundance in the atmosphere (SADC and SARDC 2008). Malawi provides an example of domestication of the Montreal Protocol as government is developing strategies to address the issue of ODS. By 2010 Malawi had phased out the use of methyl bromide in tobacco industries (a major contributor to the national economy) and banned the importation of refrigerators and air conditioners that use different types of ODS (GoM 2010).

In Zimbabwe, the Ozone office was created and it has established a register of all licensed ODS traders and trained customs officials to monitor and regulate ODS at the borders (Feresu 2010). Latest available data for CFC consumption per country shows that all Basin states managed to greatly decrease CFC consumption by 2010 due to Basin states domesticating the Protocol in national policies. However, in some cases the phasing out of CFCs is in part due to their replacement by the use of other less harmful ODS such as Hydrochlorofluorocarbons (HCFC) (Feresu 2010).

Figure 9.5 **Trends of CFCs Consumption in the Zambezi River Basin**



UNEP Ozone Secretariat

Zambezi Basin states are also parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, and the Stockholm Convention on Persistent Organic Pollutants both of which are intended to protect human health and the environment. The Basel Convention entered into force in 1992 after widespread global concerns about the unethical dumping of toxic wastes in less developed countries. The Convention seeks to provide guidelines for the movement and regulation of toxic substances.

The Stockholm Convention which entered into force in 2004 addresses the use of Persistent Organic Pollutants (POPs), substances that remain intact in the environment for long periods such as DDT (Dichlorodiphenyltrichloroethane). Such conventions provide necessary platforms that guide nations when developing their industrial policies.

Table 9.13 **Multilateral Environmental Agreements Ratified by Basin States**

	Montreal Protocol	Kyoto Protocol	Basel Convention	Stockholm Convention
Angola	•	•	•	•
Botswana	•	•	•	•
Malawi	•	•	•	•
Mozambique	•	•	•	•
Namibia	•	•	•	•
Tanzania	•	•	•	•
Zambia	•	•	•	•
Zimbabwe	•	•	•	•

Secretariat of the Basel Convention 2011; Secretariat of the Stockholm Convention 2008; UNEP-Ozone 2014; UNFCCC 2014

Technological developments within industry have helped to reduce the negative environmental impacts and steer industry towards set targets as outlined in various policies. Recycling and waste management have been common responses to industrial pollution amongst Basin States. In Zambia and Zimbabwe, several large industries, individually or in clusters, have been responsible for the construction of waste sites and recycling centres in order to curb their environmental impact. In Zambia, the ECZ regulates waste generated by mining companies with a total of 69 decommissioned, 45 active and five inactive waste-disposal sites being licensed in 2006 (ECZ 2008). The Zimbabwe Environmental Management Act 2002 stipulates necessary requirements for waste disposal sites to be used, thus influencing technological responses to waste management. Private businesses have also contributed to recycling efforts in Zimbabwe and there are plans to create a recycling centre in Harare that will recycle PET and export the flake plastic to China. Polyethylene terephthalate (PET) is safe plastic used for beverage containers.

In pursuing sustainable development, various measures can be taken during the industrial process to reduce waste and to mitigate the impacts from the hazardous waste. Hazardous waste manufacturing processes has been increasing due to the very fast proliferation of small-to-medium industries in and around big cities, such as Harare

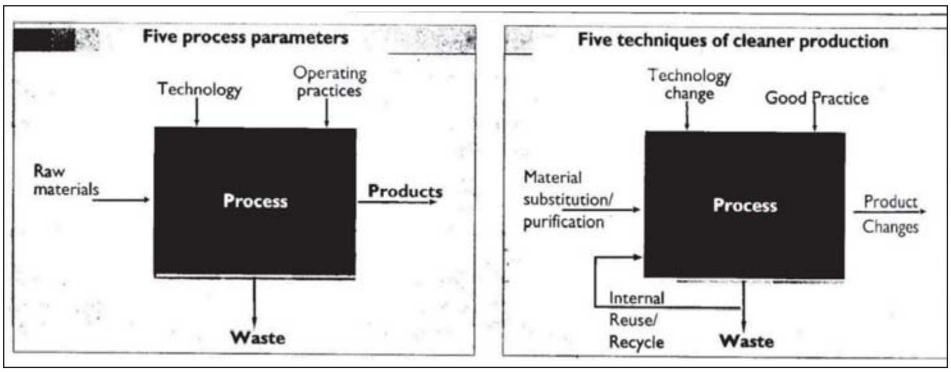
Box 9.1 **BEVERAGE COMPANIES BUILD RECYCLING PLANT IN ZIMBABWE**

Petrecozim is a beverage initiative that is premised on sustainable, extended producer responsibility. The company was created by several corporations to provide a solution to the environmental challenges focusing on post-consumer PET disposal by providing a national springboard for the sustainable collection and recycling of PET bottles. It plans to build a 6,000 sq m recycling site that would produce PET flakes/chips. Flakes are intermediate materials which are used as raw materials in fibre manufacturing, geo textiles, new bottle manufacturing and other downstream or end-use markets.

The Financial Gazette, Harare, 28 February 2013 and Bulawayo. Through the Environmental Management (Hazardous Waste Management) Regulations, 2007, Statutory Instrument producers of waste are required to prepare a waste management plan specifying quantities and components of the waste. The regulation also divides hazardous waste into four different categories denoting level of safeness which determine the fee to be paid for disposal or discharge (Feresu 2010).

Some companies in Zimbabwe have opted for resource recovery practices as part of a Waste Recovery, Recycling and Utilization strategy which often involves processing of waste using various types

Figure 9.6 **Strategies for Cleaner Production**



UNEP Ozone Secretariat

Figure 9.7 **Examples of Implementing Cleaner Production in Industrial Processes**

Improve Housekeeping	Process Modification	Product Redesign
➔ *Reduce raw material and product loss due to leaks, spills, drag-out, and off-specification solutions.* ➔ *Improve monitoring of operations and maintenance of all facets of the production process.* ➔ *Schedule production to reduce equipment cleaning, e.g., formulate light before dark paints so that vats do not have to be cleaned out between batches.* ➔ *Improve management of inventory of raw materials and products.*	➔ ***Filtration and washing:** Use counter-current washing, and recycle used solvent.* ➔ ***Parts cleaning:** Use mechanical cleaning devises; improve draining before and after cleaning; use plastic bead blasting.* ➔ ***Surface coating:** Use electrostatic spray-coating system; use powder coating systems; use airless air-assisted spray guns.*	➔ ***Consumer Goods Redesign:** A traditional flashlight, running on dry cell batteries that are usually disposed of with domestic waste, is redesigned to run on a manually powered dynamo, eliminating the dry cells altogether*
Technology Change	**Input Material Substitution**	**On-Site Recycling**
➔ ***Leather Tanning:** Use a machine that de-hairs and de-fleshes hides at the same time.*	➔ ***Printing:** Substitute water-based ink for solvent-based ink.* ➔ ***Textiles:** Reduce phosphorus in wastewater by reducing use of phosphate-containing chemicals; use ultraviolet light instead of biocides in cooling tower.* ➔ ***Electronic components:** Replace water-based film developing system with a dry system.*	➔ ***Printing:** Use a vapour recovery system to recover organic solvents.* ➔ ***Textiles:** Use ultra filtration system to recover dye-stuffs from waste-water.* ➔ ***Metal rules:** Recover nickel-plating solution using an ion-exchange unit.*

UNEP. Changing production patterns: Learning from the experience of National Cleaner Production Centre, 2002

Box 9.2 REGIONAL EFFORTS TO ADDRESS AIR POLLUTION

Developing an Air Pollution Regulatory Framework in Southern Africa
The Harare resolution on the Prevention and Control of Regional Air Pollution in Southern Africa and its Likely Transboundary Effects (1998).

Acknowledging the growing concern over air pollution and its potential effects, Zambezi River Basin states with other SADC member states attended and developed the Harare Resolution (1998). Recognizing the impacts of poor air quality on human health and the various ecosystems within the region, the conference resolved to develop a Protocol on Regional Air Quality and Atmospheric Emissions taking into consideration, amongst many others, the importance of encouraging the use and development of improved technologies as well as enhancing regional co-operation.

Maputo Declaration on the Prevention and Control of Regional Air Pollution in Southern Africa and its likely Transboundary Effects (2003)

This policy dialogue was attended by Botswana, Malawi, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe in Maputo. The meeting recognized the potential of increased air pollution from various economic activities including those from the industrial sector such as thermal power stations, smelters, cement factories, chemical industry; and their impacts on the Southern African environment including biodiversity and climate change. Taking into consideration previous resolutions from the Harare Decleration (1998), the participating nations recommended to SADC states to develop and implement initiatives that regularly monitor, assess and report on emissions through a regional network.

Lusaka Agreement (2008) - SADC Regional Policy Framework on Air Pollution

Attended by 14 SADC Members, this Policy Dialogue took into consideration the significant and increasing impacts of air pollutants that cause damage locally such as Particle Matter 2.5 (PM25), Sulphur Dioxide (SO2) and persistent organic pollutants (POPs) and their strong correlation to industrial activities as well as other economic activities. With regard to industry the participants agreed to:

- Regional co-operation through policy harmonization of national frameworks for air quality;
- Promote the use of best available technology for new industrial plants in order to meet harmonized standards including retrofitting of old industrial plants; and
- Enact regulations that require industry to undertake environmental impact assessments.

of equipment and facilities. This approach not only saves money for the company but also reduces the amount of waste in the environment while decreasing the amount of new raw materials needed for other industrial processes.

Upcoming technological responses in the Basin are based around concepts of Cleaner Production and Green Technologies. Cleaner Production seeks to reduce waste production by using raw materials and energy sustainably in order to minimise and prevent waste during processing as opposed to an end-of the pipe approach were waste is dealt after production. This is has been introduced through National Cleaner Production Centres to various SMEs in the region with some reported success in Namibia and Zimbabwe.

Cleaner production techniques involve paying attention to housekeeping issues such as updated inventories, regular monitoring; retrofitting or installing equipment; replacing raw materials with less hazardous ones or recycled material.

UNEP. Changing production patterns: Learning from the experience of National Cleaner Production Centre, 2002

Air pollution that arises from various economic activities of industrial development has affected air quality throughout the region resulting in regional responses that seek to address this transboundary issue. The SADC Air Pollution Framework developed through UNEP and the Air Pollution Information Network-Africa (APINA) was guided and initiated by a long-term process that started with the Harare Declaration (1998).

Another influential measure with potential as an institutional response that can curb environmental impacts is self-regulation by private entities and industries who take it upon themselves to do so. Several industries within the Basin have adopted best practices in order to meet International Organization for Standardization requirements and gain ISO accreditation. ISO 9000 and ISO 14001 require industries to produce quality goods in ways that consider the environment. In Zimbabwe 30 companies had received ISO 14001 accreditation by 2010 (Feresu 2010). The ISO 14001 set of standards requires companies to implement environmental management systems that continually monitor and assess environmental impacts.

Conclusion

The challenge of industrial development in the Zambezi Basin is two-fold. On the one hand, the Basin economies need to strengthen their manufacturing sector and diversify their economies beyond the natural resource sector. They also need tomake the most of their commodities by maximising upstream and downstream linkages; channelling increasing revenues from the mineral sector into long-term investment in infrastructure; health and education; and transforming the infrastructural configuration of the region into a well-developed, integrated and comprehensive infrastructural system. On the other hand, the Zambezi Basin needs to pursue its industrialization agenda in a sustainable manner. The implementation of national, regional and international policy and legal frameworks to which countries have signed up to is critical in this respect. It is critical for industrial policies and strategies at national and regional levels to promote improved environmental management and adoption of technological changes at the firm level, as part and parcel of the overall industrial development strategy.

CHAPTER LINKAGES

Overview
The industrial sector promotes economic growth as well as improving livelihoods of people in the Basin. The major industrial activities in the Basin are agriculture, tourism, mining and manufacturing.

Water Resources
Water resources support most of the industrial activities. Industrial development is also responsible for water pollution through the discharge of a variety of highly toxic chemicals, particularly the mining industry and the use of agro-chemicals.

Land and Agriculture
Agriculture is the largest productive sector in the Zambezi Basin, and most people in the Basin depend on agriculture, which also provides raw materials for Agro-processing industries.

Biodiversity and Forests
Industrial development depends on the biological resources which are used as raw material for manufactured goods. Industrialization is also responsible for land degradation leading to loss of biodiversity.

Climate Change and Variability
Air pollution that arises from economic activities of industrial development has affected air quality. Gaseous emissions from industry pollute the air and the effluents pollute water resources

Energy
Energy plays an important role in industrial development in the Zambezi Basin. Mining and other industrial activities use heavy machinery which demand abundant electricity supply.

Urbanization and Human Settlements
Industrialization has largely influenced urbanization. Many industrial settlements have grown into major cities in the Basin.

Tourism
Tourism is one of the most important industries in the Basin providing employment to women and youth, and relies on industry to provide goods that can support tourism.

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ZAMBEZI RIVER BASIN SCENARIOS

CONVENTIONAL WORLD / Business as Usual OR SUSTAINABILITY WORLD / Policy Reform

10

Introduction

The challenges and opportunities presented by the environmental changes in the Zambezi River Basin have long-term implications, which require forward-looking policy solutions. Informed strategic decisions in the sectors and themes assessed in this report requires anticipation of what lies ahead and a grasp of ongoing, emerging and latent developments in these sectors -- water resources, land and agriculture, biodiversity and forests, climate change and variability, energy, urbanization and settlements, tourism, and industrial development.

A desirable future is one in which sustainable management and cooperative development of the Zambezi Basin's resources accelerate regional integration, improve land productivity and agricultural yields, increase hydropower generation, and enhance economic opportunities. As the future unfolds, many challenges and opportunities could be encountered. The challenges and opportunities with both certain and uncertain trends, have long-term implications, and hence require forward looking policy solutions.

Moving into the future, the main drivers of environmental change remain the same, that is, climate change and human activities. There is need to examine these changes beyond the usual legislative cycles through development of various scenarios, as a means of viewing the current and emerging trends in the environmental issues presented in previous chapters. Scenarios are a range of future possibilities, good and bad, expected and surprising, but always plausible.

The Zambezi River Basin scenarios analysis was conducted to track the efficacy of environmental policies and actions on the achievement of selected sustainable development goals in a

Box 10.1 WHAT ARE SCENARIOS?

Scenarios, by definition, are "plausible descriptions of how the future may unfold for the environment, organizations, our issues, nations and even our world, based on 'if-then' propositions." Environmental scenario planning helps to identify unique interventions, simulate and rehearse policy decisions that could have profound implications moving forward.

Scenarios planning highlights inter-linkages among environmental issues that may not be obvious. It is a structured and systematic approach to exploring what we do not know, instead of what we already know, thereby increasing the possibility of achieving impact from environmental management actions. Scenarios planning is the process of creating narratives about the future based on factors likely to affect a particular set of challenges and opportunities. Scenario analysis helps us to address discontinuity and uncertainties of future environmental and socio-economic developments. This is meant to facilitate the design and adjustment of robust "policies that can withstand the test of time" (Alcamo and others 2011).

Some examples of scenario analysis deployed in recent decades include the long-term emission scenarios of the Intergovernmental Panel on Climate Change (IPCC 2007 and 2013) that are in use, with their downscaled variants in the analysis of climate change, its impacts and mitigation and adaptation options, to support international negotiations on setting long-term targets. Within southern Africa, the Millennium Ecosystems Assessment (2005) conducted both global and regional scenario analysis with a special focus on the Zambezi River Basin, among other major river and lake basins of the world.

The United Nations Environment Programme (UNEP) has used scenario analysis to present future trends and policy options at different scales -- ecosystems, national, sub-regional, regional and global. The most recent *Africa Environment Outlook* and the *Global Environment Outlook* reports (UNEP 2011 and 2013) both employed scenario analysis to present alternative environmental futures to long-term environmental assessments.

shared transboundary resource. The long-range assessment in this chapter is intended to facilitate actions and decision for achieving the respective targets and goals under each themes of the current report at all levels. Based on the analysis contained in the previous chapters, this Scenarios chapter looks back to find the direction that the basin has been taking and projects the direction in which it is moving. The chapter explores, compares and contrasts two different scenarios regarding the future development of the Zambezi River Basin.

Drivers of Change

The Zambezi Basin environment is poised to change under both certain and uncertain trends with the likelihood of specific changes in water resources, land and agriculture, biodiversity and forests, climate change and variability, energy, urbanization and settlements, tourism, and industrial development -- as dictated by key drivers including population, transboundary governance of basin resources and institutions, economic transformation, social and cultural trends, technology and climate change. These factors will determine the trends and magnitude of demand on environmental goods and services occasioning attendant changes in the basin's natural resource base and sustainable development outcomes.

Population

According to the *Zambezi River Basin Atlas of the Changing Environment,* the demography of the basin will remain the main driver of environmental change. Population of the basin in 1998 was 31.7 million rising to an estimated 40 million in 2008, with some 7.5 million people living in urban centres. The Atlas notes that the basin population was estimated to be 47 million in 2012. The total population of the eight countries of the Zambezi Basin is projected to reach 168 million by 2025, of which approximately 51 million will be in the basin (SADC/SARDC and others 2012). See Table 10.1.

Some recent scenario assessments including International Futures (PRB 2013) projects population as presented in Figure 10.1.

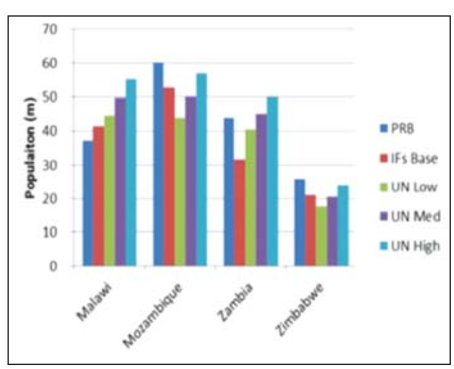
Although the projected population growth is modest, averaging 2.09 per annum, the Zambezi Basin can expect significant increases by 2040 due to its youthful population. For example, Malawi's youthful population of which almost half (46 percent) is under the age of 15 will contribute significantly to the country's population growth. The con-

Table 10.1 **Population in the Zambezi River Basin**

Country	Total National Population 2000	Projected National Population	Population National in the Basin 1998	Projected Population in Basin 2025
Angola	13 399 000	25 940 000	487 200	950 080
Botswana	1 651 000	2 270 000	1 000	16 500
Malawi	10 475 000	18 695 000	9 821 400	18 071 955
Mozambique	17 240 000	26 730 000	399 870	6 187 455
Namibia	1 900 000	2 460 000	60 890	82 438
Tanzania	31 900 000	56 090 000	1 271 920	2 200 420
Zambia	9 886 000	18 285 000	7 046 250	11 979 610
Zimbabwe	11 696 000	17 395 000	9 050 000	11 674 065
Total	98 147 000	167 865 000	31 741 530	51 161 960

Spatial data from SADC/SARDC (Hiriji and others, eds). Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa 2002; SADC and SARDC. Southern Africa Environment Outlook,2008

Figure 10.1 **Projected Population for Zambezi Basin Countries Based on International Futures and UN Scenarios**



Hughes 2010; UNDESA 2011; PRB 2013

tainment of the AIDS pandemic and declining HIV prevalence rates as well as improving medical care will also contribute to longer life expectancies and the growth in populations. Zimbabwe's HIV prevalence rate declined from 29 percent in 1997 to 16 percent in 2007 (Halperin and others 2011).Although the Zambezi Basin will remain largely rural, urbanization rates will increase (Chapter 7 Table 7.1 and Figure 7.1).

In Botswana and Angola, the urban population already constitutes more than 60 percent of the total national population (SADC and SARDC 2008). Mining, value addition and other emerging industrialization activities will remain the key drivers of Zambia's urbanization. According to UN-Habitat (2010), more than 80 percent of the Zambia's urban residents are concentrated in the two provinces of the Copperbelt and Lusaka.

Economy and Infrastructure

The demand for environmental goods and services will be driven by interlinked demographic and economic trends across countries. Assessing the future risks and opportunities for sustainable basin management thus requires a consistent set of assumptions about the economic and social development of the region.

Most countries in the basin are urbanizing rapidly, putting pressure on finite resources. The high demand for energy, water, food and other ecosystem goods and services will invariably put pressure on the sub-basins and specific natural resources. Land for farming by the growing population, water for hydroelectric power generation and biodiversity resources will be most affected going forward, unless deliberate efforts are made at multiple scales to address the pressure. Mining, for instance, is already escalating as an economic activity in the Basin with far-reaching land-use changes as a result of mining activities, notably in Zambia where copper mining has been revived. Urbanization will continue to mirror the economic activities.

The new opportunities for mining at Kanshanshi and Lumwana mines in Solwezi in north-western Zambia has led to a population influx, resulting in the rapid but haphazard expansion of the town (SARDC 2013). This has resulted in conversion of surrounding forests into peri-urban farmlands. The trend is expected to continue under current trajectories. Effects of population pressure, climate change and economic activities in sub-basins will be equally marked. Sub-basins such as Luangwa River, Lake Kariba, and Kafue and Kabompo rivers are receiving more population due to expansion of mining operations. Environmental effects such as water pollution will necessitate strategic measures to curb the impacts.

Industrial activities are expected to increase as well due to investments in both primary and secondary production and service industries. With this scenario, new jobs will be created, population distribution patterns and movement will certainly change and waste generation is likely to be a concern to both rural and urban environments.

The Zambezi Basin is at the centre of major infrastructure projects in support of SADC regional integration efforts. The SADC Infrastructure Master Plan has been concluded and Member States are instituting efforts to implement the flagship projects under both national and regional arrangements. The SADC Infrastructure Vision 2027 is anchored on six pillars consisting of energy, transport, Information Communication Technology (ICTs), meteorology, trans-boundary water resources and tourism (Trans Frontier Conservation Areas), which constitute the SADC Regional Infrastructure Development Programme.

The Master Plan will dictate the basin's environmental changes going forward in many ways. Other projects include the Kazungula bridge which will significantly enhance the movement of traffic and people across the Zambezi Basin; the Batoka Gorge and Mphanda Nkuwa hydropower projects which will result in the inundation of large areas; airport and hotel projects in the Victoria Falls and Livingstone areas; expansive TFCAs such as the KAZA, ZIMOZA and Four Corners project, which will re-open wildlife migration corridors while also allowing the free movement of tourists across borders.

Technology

Technological developments are already apparent and will highly likely propel other changes in demography, social spheres, production and consumption as well as governance in ways that will occasion significant changes in the environment many in positive and negative ways. Demand for natural resources for industrial processes and human needs will impact on the integrity of Basin ecosystems and they may offer opportunities for more efficient use of natural resources, cleaner production techniques and improved environmental management. Additional risks may prevail as a result of these technological developments. The technological changes include and increase in penetration and use of mobile phones, advances in ICTs, and generation, dissemination and use of new production and conservation technologies in land use, water management, tourism and other sectors. Some technologies may pose health risks to the human population.

Technology will improve environmental management through more effective monitoring and assessment techniques, such as remote sensing, the transformation of ICT, biomaterial engineering, rapid advances in biotechnology and genetic modification, and more efficient and faster transportation. Mobile telephone and mobile banking will continue to transform the basin, especially the rural areas where benefits will include improved extension services for agriculture, access to modern banking and finance, access to health services and many others.

Responses to challenges such as climate change and other environmental degradation processes may be better addressed through such technological changes. The pace of technological change, will however depend on improvements in human resource capacity, science and technology and investments from both local and external sources. Countries with favourable investments (proportion of national GDP allocated to research and development) will arguably realize better technological change outcomes on environmental conditions.

Environment

Changing environmental conditions in the basin will present both opportunities and challenges for the integration and cooperation in basin management. Climate change adaptation and mitigation measures in the form of carbon credits and the adoption of clean bio-fuels will significantly affect the Basin. The SADC region in general and the Zambezi River Basin in particular, are expected to experience higher land and ocean surface temperatures, which could affect rainfall, winds, and the timing and intensity of weather events. Although the Basin's contribution to global warming remains insignificant, this may change over the next decades unless appropriate measures are taken. Greenhouse gas emissions from the Basin countries, mainly from the planned thermal power stations, are projected to rise as economies modernize with a possible threefold increase in the next 50 years (SARDC/SARDC and others 2012). See Figure 10.2.

Towards 2040 and beyond, climate change will likely pose a number of risks to Zambezi River Basin goals for regional economic development with incidences of increased frequency and severity of floods, cyclones, and droughts. These are likely to damage infrastructure, expose the population to health risks, damage agricultural farmlands and livestock, disrupt livelihoods, and cause loss of life and other economic losses -- unless effective resilience strategies are implemented.

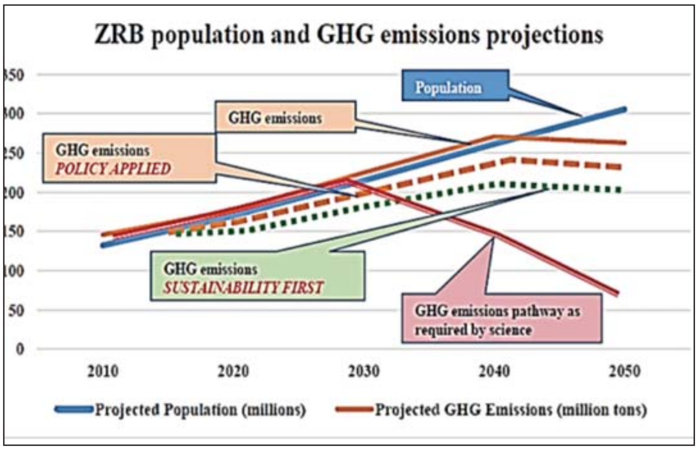
Already, there are significant efforts to blend petroleum fuels with ethanol in Zimbabwe and Malawi, and the Basin has the climatic conditions and land resources that can be used to grow such fuels. will have a great bearing on industrialization, environmental pollution control and other basin ecosystem transformations. There are indications that the water flows and other ecosystems services of the basin will be affected by environmental change (IPCC 2013). Even more dramatic impacts will be witnessed in hydropower generation (International Rivers 2014).

Governance

The Zambezi Basin is at the centre of regional integration in SADC. There are many institutional and governance issues that will guide the future of the Basin. The Zambezi Watercourse Commission (ZAMCOM), Zambezi River Authority (ZRA) and SADC are important institutions that are setting the path for the future development of the basin. There are many regional protocols that seek to bring convergence to national policy and legislative instruments.

The socioeconomic and political landscape in the basin will continue to

Figure 10.2 **Population and GHG Emissions Profiles for Zambezi River Basin into 2050**



International Futures approach

witness transboundary issues that demand governance interventions at all levels. Policies and institutional processes as well as decisions taken now and in the future will dictate the success of initiatives such as protected areas, co-management agreement with local communities, and effectiveness of state and non-state agencies that serve to promote environmental management.

The role of civil society will broaden and become instrumental in environmental management through education, capacity building, practice, lobbying and support for effective environmental governance. This will change due to a momentum already started in the growing level and sources of funding for civil society stakeholders and their increasing access to technology. With improvement in local, national and regional political custodianship, changes are expected in the extent and type of citizen engagement with environmental management while the improving regional geopolitical stability and integration of markets will open space for more regional trade, cooperation and transboundary ecosystems management. This will increase as level of trust in governments, businesses and regional entities such SADC, ZRA and ZAMCOM.

The Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin of 2008 has set the pace for extensive changes through cooperation between riparian countries. It emphasizes broadening basin management through participation of stakeholders including women's groups, youth groups, small farmers, business associations and local authorities, as well as national and regional level decision-makers. Other governance issues to shape the future of the Basin include transboundary harmonization of policies and regulations on resources such as water, minerals, water and land.

Scenario Analysis Approach

The Zambezi Environment Outlook scenarios were aimed at developing a basin-wide information and decision basis at multiple levels addressing transboundary futures under the themes and selected sectors. The scenarios were largely qualitative and took the form of narrative storylines. Basin level storylines were developed during a stakeholder scoping workshop. The scenarios were based on the context of the Basin and recent development in especially transboundary investments and institutional processes such as the establishment of the Zambezi Watercourse Commission (ZAMCOM). Regional and local drivers were chosen, emerging issues discussed and backcasting methodology used in which stakeholders and experts selected desirable end points and identified sets of short-term and medium term actions aimed at achieving these desired futures under each scenario.

The workshop and subsequent narrative development and reviews stimulated a critical evaluation of the key uncertainties and main developments in the Zambezi Basin from 2015 to 2040. The storyline presented in this chapter is therefore a combination of high-level regional developments and local ecosystems specifics. Similar methodologies were adopted by the Southern Africa Millennium Ecosystems Assessment (SAfMA) (MA 2005). The shared insights that emerged are presented on this chapter to aid decision-makers at multiple scales. Selected quantitative scenarios have also been adapted to complement thematic assessments from existing published scenarios. The final narrative however took the form of highly integrative but largely qualitative process.

The Scenarios

Scenario Conventional World/ Business as Usual

The Conventional World Scenario (CWS) depicts plausible future environmental developments along a trajectory representing a continuation of current trends without major policy shifts. In the context of transboundary management of the natural resources in ZRB, CWS explores the potential trends towards achieving environmental and sustainable development targets associated with a world that continues to develop in a Business As Usual (BAU) pattern. No explicit policies to address main environmental and human development outcomes and impacts are in place.

The scenario features a continuation of less harmonized and ineffective set of policy and practice within sub-basins and across boundaries. The scenario projects a continuing increase in extractive industries which require access to environmental goods and services and are largely driven by the same entrepreneurial and market dynamics which have been witnessed over the past few decades. As is already happening, this scenario is characterized by continued national and localized approach to basin resource extraction and management with isolated cases for joint and transboundary efforts but with limited, if any, consideration for transboundary outcomes of environmental actions for regional development.

Scenario Sustainability World/ Policy Reform

The Sustainable World Scenario (SWS) depicts a future where deliberate attempts are made to manage the environment in ways that meet nationally, regionally and internationally agreed development goals with clear targets for basin sustainability. Some of these goals relate to regional and international protocols, targets and specific milestones relating to water resources, land and agriculture, biodiversity and forests, climate change and variability, energy, urbanization and settlements, tourism, and industrial development and other sustainable development outcomes.

The scenario explores the transformative actions required to bring about a more environmentally sustainable future. SWS is based on the assumption that Zambezi Basin environmental management will proceed in a manner that limits degradation and associated negative social, economic and ecological transboundary outcomes. The main objective of the scenario is to reveal the choices of policies and programmes that would ensure the attainment of both the desired environmental and related human development outcomes in each country and between the basin countries.

With the strong momentum already started by the drivers playing out in current trends (CWS), the force to deflect such trends to meet transboundary environmental targets is expected to remain a daunting challenge. This is largely due to population dynamics, social changes, cultural inertia as well as technological and economic growth as well as competition for scarce resources between and among countries and sectors. This is the desirable route to Zambezi futures but achieving it would require considerable policy realignment, investments as well as with mind-set and behavioural change of individuals, communities, institutions and nations. The ZAMCOM strategic plan lays out future actions that typify this world and investments in the action plan is a sure way to track this trend. The scenario reveals "what it would take to overcome barriers to meeting transboundary sustainability goals" (UNEP 2012). Figure 10.3 illustrates the scenario framework adopted.

Elaborating the Scenarios

The scenario-building process adopted an integrated approach underpinned by the DPSIR-framework for qualitative and quantitative elaboration of the storylines. For the two broad scenario groups, a back-casting approach was used to link future images of selected environmental themes with actions and decisions taken along the way towards specific targets. Figure 10.4 illustrates the overall approach used to elaborate the scenarios. Underpinning the elaboration was differential shifts under each scenario of social values and regional efforts towards sustainable transboundary management of the Zambezi River Basin resources.

Figure 10.3 **The Scenario Framework**

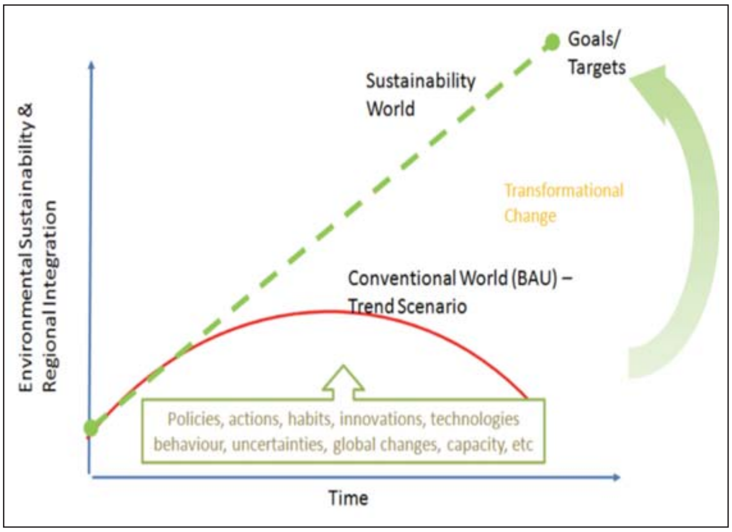
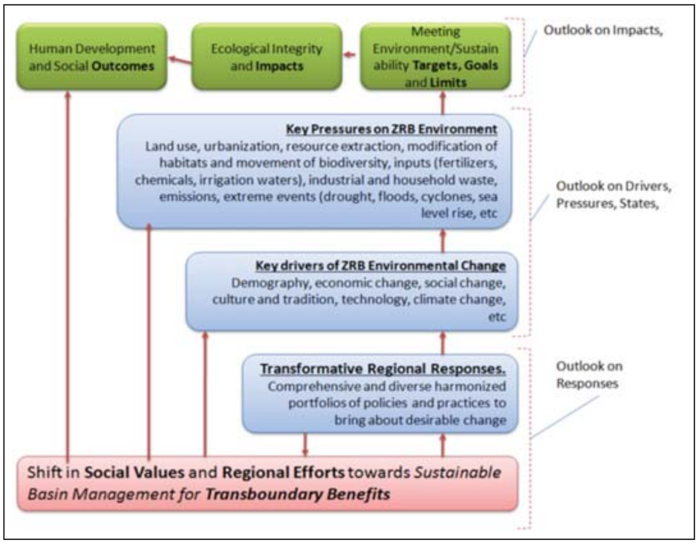


Figure 10.4 **The Scenario Elaboration Framework**



Adopted from UNEP. Global Environment Outlook 5, 2011; Africa Environment Outlook 3, 2013

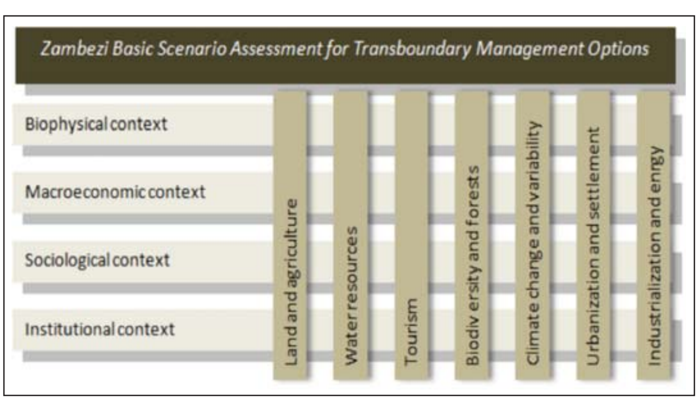
The assessment extrapolated the connections in current trajectories to future (2040) human development outcomes, ecological integrity and impacts and linkages to achievement of sustainable natural resource management targets at basin and sub-basin scales. The storylines embedded transformative regional and local actions (responses) constituting a comprehensive and diverse portfolios of policies and practices that would harness opportunities for sustainable basin management. The key drivers, namely demography, economic change, social change, culture and tradition, technology and climate change were interwoven in the storyline to capture their separate and collective effect on key indicators and environmental outcomes along the pathways.

The Zambezi Environment Outlook scenario analysis was intended to seek alternatives for shifting the prevailing CWS pathway into the desirable SWS. To ensure thematic comprehensiveness and basin-wide coverage, the assessment adopted the integrated approach illustrated in Figure 10.5.

The scenario assessment thus involved:

- Selection of themes consistent with transboundary basin management as a focus of the report and in line with the findings from the thematic chapters;
- Use of relevant models or results from existing scenario analyses in order to provide qualitative and quantitative trends and storylines for each of the thematic areas: land and agriculture, water resources, tourism, biodiversity and forests, climate change and variability, urbanization and settlement, industrialization and energy;
- Identification of medium- and long-term targets/goals including local, national, sub-regional, regional and global as well as environmental limits consistent with the scenario time line of 2040;
- Analysis of possible synergies and trade-offs between the goals and targets in different biophysical, macroeconomic, sociological and institutional domains by linking the different models/scenario findings with the goals and transboundary basin management targets in order to construct the narrative; and
- Identification and analysis of transformative policies and practices necessary to realize long-term goals – shift the trends towards sustainable pathways.

Figure 10.5 **Basin-Wide and Thematic Comprehensive Coverage in Zambezi Environment Outlook Scenario Assessment**



World Bank. Zambezi River Basin Multi-sector Investment Opportunities Analysis, 2010

In doing the above, the Zambezi Environment Outlook scenario process sought to understand the state of the Zambezi River Basin and the future the Basin may face by identifying the tensions and inconsistencies that suggest ecological, political or economic risks in the near and middle term in selected themes. This was also meant to learn about the dynamics of Basin systems. The CWS in particular clarified the goals/priorities and investigated the leverage that may have been there in shaping the Basin's future.

Exploring Selected Issues in the Zambezi Basin

Climate Change and Variability

The Zambezi Basin countries, like other countries in southern African, are working towards addressing climate change impacts on the environment and socio-economic activities through largely adaptation in relation to vulnerability, exposure and the effects of climate change and variability. All in all, the target is to address and minimize consequences of global warming at the basin and country level. Globally, concerns of reduction of global warming dominate with the UNFCCC goal of limiting the average global temperature increases to 2°C above the pre-1990 levels. The achievement of these targets will heavily depend on the actions and policy decisions to be made towards 2050. Under different scenarios, the 2040 picture and pathways from now going forward will differ as illustrated below.

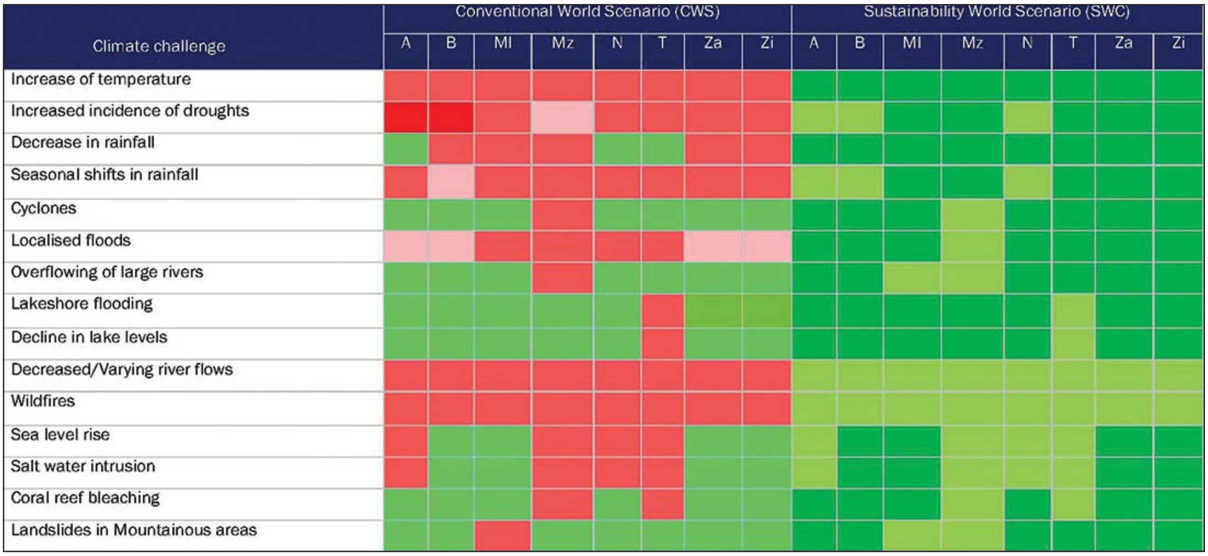
Conventional World

Current trajectories and predictions of Zambezi Basin climate show a rise in average temperature by 2oC, more frequent extreme events causing at least four drought and/or flood occurrences in every 10 years, and much longer mid-season droughts. As much as the rest of the world, the riparian countries of the Zambezi Basin are not likely to meet their targets for reducing greenhouse gas emissions. The basin is further burdened by a surge in the levels of short-lived climate pollutants resulting mainly from widespread bush fires. The basin would be overwhelmed by the changing climate in its coping mechanisms for flood control and drought management.

The Zambezi River Basin is expected to continue experiencing "drier and more prolonged drought periods". Rainfall is expected to decrease by between 10 and 15 percent over the basin (IPCC 2013). A significant reduction in the amount of water flowing through the river system will likely affect all eight riparian countries. As from 2015, the implications would be profound and effect on hydropower operations may intensify due to reduced reservoir inflows, increased extreme flooding events occasioning uncontrolled releases, and risks to dam safety, reduced power production and increased sediment load to reservoirs. There will likely be a significant impact on financial and social fabric due to extreme events, dam failures and ecological damage. Changes in ecosystems result in new diseases for human beings, crops and even wild flora and fauna. Diseases such as malaria may likely spread towards higher ground such as Harare where it was previously not present (SADC and SARDC 2008).

The cost of adaptation to climate change is expected to escalate for individual countries and sectors. Under the two scenarios, the effect of climate risk challenges will differ in the riparian countries as depicted in the qualitative illustration in Figure 10.6.

Figure 10.6 **Future Qualitative Reflections of Climate Challenge Risks in Basin Countries under Conventional and Sustainability World Scenarios**



Key: A – Angola; B – Botswana; Ml – Malawi; Mz – Mozambique; N – Namibia; T – Tanzania; Za – Zambia; Zi – Zimbabwe

Risk of climate change challenge:

In different countries, policies will be responsible for the climate change risk outcomes that will play out in the two scenarios. The risks will be as a compound result of differences in climate change adaptation and mitigation plans, level of coordination of national and basin-wide actions, and effectiveness of regional and global institutional processes that are aimed at sustaining adaptation and mitigation strategies.

Sustainability World

Under the sustainability world scenario, there is increased resilience of communities, sectors and ecosystems in each of the sub-basins. Globally countries are cooperating under the UNFCCC agreements. Regionally the SADC climate change action plan has over the years informed country, sub-basin and Basin actions for both mitigation and adaptation. Cost of adaptation has remained manageable as efforts began early before 2020.

The measures taken over the years have significantly reduced climate change impacts on human security issues such as water stress, land use and food security, natural disasters and environmental migration. Countries operate with manageable levels of conflict over Basin resources, low levels of economic damage and risk to coastal cities and critical infrastructure, and limited environmentally induced human migration. Prevailing early warning systems have made it possible to manage effects of crop damage associated with recurrence of droughts, more and more people. Subsistence farmers and communities living in vulnerable sub-basins and ecosystems have built adaptive capacities over the years.

There were significant milestones over the years that led to these positive outcomes:

- Communities, national and regional bodies had been prepared to fully exploit development opportunities under global climate change proto-

cols for afforestation and reforestation at Basin and sub-basin levels;
- Development of regional capacity to adapt to climate change and make use of the development opportunities associated with global climate change mitigation including more Clean Development Mechanisms (CDM) projects launched steadily from 2015 to 2040;
- Drought forecasting in most sectors including water were mainstreamed in planning and management;
- Improvement in flood management and mitigation mechanisms at national, sub-basin and basin regional scale;
- Improvement in regional and national drought management;
- Policy supports the development of drought management plans, including local irrigation development, improved food stock logistics, crop and livestock adaptation and drought insurance;
- SADC and ZAMCOM had set up a regional centre of excellence to document and support activities for effective adaptation to climate variability and climate change;
- Strategies to deal with climate variability and climate change in national socio-economic development planning had been fully mainstreamed in all riparian countries by 2018;
- There had been a build-up of appropriate knowledge base and technologies on climate variability and climate change and their impacts on land, forests, biodiversity, water and other resources and sectors.

Land and Agriculture

The Basin countries are at different stages of implementing the Comprehensive African Agricultural Development Programme (CAADP). A commitment to allocate up to 10 percent of national GDP to agricultural development was agreed under the Maputo Declaration to yield an annual growth rate of six percent in agricultural productivity. Agricultural development essentially targets increase in land under irrigation and agricultural productivity for food security. The various country national investment plans have specific targets for managing land resources in specific sub-basins. The two scenarios would imply differential achievement of key land and agriculture outcomes by 2040.

The SADC targets for agriculture and food security which mirror CAADP goals are propelled by the 2004 Dar es Salaam Declaration on Agriculture and Food Security to boost production and improve access to food in the region. Under the Declaration, the priority areas in the short term (2004-2006) and medium-to-long term (2004-2010) to achieve food security for the region have been identified. The short-term measures include availability and access to key agricultural inputs for farmers, consisting of improved seed varieties, fertilizers, agrochemicals, tillage services and farm implements. In the medium-to-long term, they agreed to meet the African Union target to allocate at least 10 percent of their national budgets to agriculture and rural development. Other targets in the declaration include a regional food reserve facility, improved infrastructure to promote trade and open up the market, as well as construct dams for irrigation purposes.

Conventional World

There will be continued failures in the responses to address the challenges on land and agriculture, making sustainable agricultural intensification and realizing the potential of land resources to contribute to poverty eradication untenable throughout the decades. Interventions will continue to be isolated and less harmonized across the Basin. Even regional and global efforts and land-use related policies will likely fail to stem problems with unsustainable land and water management, market access and integration as well as value addition. Research, technology generation, dissemination and adoption continue to be affected with integral disconnects. The CAADP goal will likely remain unfulfilled under these circumstances.

Agriculture and trade in agricultural commodities will likely continue to play a critical role in the formal and informal economies of Basin countries, especially in sustaining rural livelihoods and in food security. The amount of land under agriculture increases. An increase is also expected in the amount of land under irrigation. Despite these developments, the Basin is likely to continue to be vulnerable to climate change due to its heavy reliance on rain-fed agriculture occasioning inability to meet food demands. Over 70 percent of the Basin's population continues to depend on agriculture for food, income and employment. Agricultural value addition and trade in agricultural products most likely remain low. Contribution of agriculture to the economies of the eight riparian states stagnates, ranging between 5–30 percent of the national GDP. Export earnings from agriculture will also be low and may even decline after 2025 due to the changing climate and reduced competitiveness for global exports.

Population growth is expected to adversely affect agriculture as a consequence of shrinking in per capita land availability, which declines from 4.16 hectares/person to 2.56 hectares/person in 2025 SADC (SADC/SARDC and others 2012). By 2040 the figure drops below two hectares per person. With this decline the basin is expected to witness further encroachment into protected and marginal lands as well as environmentally sensitive areas such as wetlands. The degree of environmental degradation will most likely worsen after 2025, reaching irreversible levels by 2040. The rate of deforestation is expected to surpass 500,000 hectares per annum in Tanzania and Malawi and more people in all sub-basins in the eight countries live on degraded lands.

Arable agricultural land continues to decline as a result of urbanization that expands at unsustainable proportions of over 60 percent of total population. Unsustainable land-use practices such as shifting cultivation, overstocking and veldt fires continue over the years while lack of security of land tenure limit sustainable and productive use of land resources due to challenges with access to

finance for agriculture. Customary or communal tenure will remain predominant in the basin with majority owning small holdings – not adequate to sustain food security and export demands. Land cover changes will still vary between countries, but with a general trend of reduction as forests are replaced by settlements and farmlands. The decline in food production will deepen after 2017 due to the highly variable, erratic rainfall; frequent severe droughts; rising population pressure accompanied by declining farm sizes; falling soil productivity and land degradation. Land equipped for irrigation will not likely increase to levels high enough to fill the gap in production while technologies such as the use of improved seeds and fertilizer remain at levels not high enough to occasion productivity changes. The proportion of land under irrigation is expected to remain below the 2010 level of five percent of all agricultural land for the entire Zambezi Basin (Spalding-Fecher and others 2014).

Sustainability World

Sustainable land management has been achieved and human-related outcomes such as food security, livelihoods and agricultural intensification have been realized. Countries have adhered to CAADP processes with all allocating over 10 percent of their GDP to agricultural development. Despite steady population growth, food production and land availability per capita remain optimal due to careful planning and the Dar es Salaam Declaration were achieved sequentially from 2020 with improved food production, food security due to expanded irrigation and improved markets and infrastructure.

Food security in the basin has not been adversely affected by climate change. Cereal production increased by up to 30 percent over most of the Zambezi River Basin between 2015 and 2040. The targets for land and agricultural productivity were realized largely due to regional (SADC Level) interventions including the main blueprint of the Regional Indicative Strategic Development Plan (RISDP) that entrenched regional integration in development programmes including those targeting land use for poverty eradication. The revisions done to the plan in 2014/15 introduced welcome strategies for land reforms, land use, irrigation expansion and overall agricultural development

Countries also endeavoured to ratify and implement sustainable land use approaches, through appropriate policy instruments, relevant protocols and declarations, such as SADC Protocols on shared watercourses, wildlife management and law enforcement, gender, energy, mining, forestry and fisheries. Sustainable use of natural resources is

Box 10.2 **SEEDS OF CHANGE**

Integrated Basin-Wide Approach To Irrigation Expansion

Under the SADC agricultural and land reform programme of the Regional Indicative Strategic Development Plan (RISDP) irrigation expansion using the Basin's ample land and water resources, the prospect of enhancing profitability of smallholder irrigated agriculture could be achieved through scaling up of irrigated agriculture based on lessons amassed over the years. A tripling of rate at which the riparian countries could expand irrigated areads is possible in SWS. The total area under irrigation in the basin had risen to more than 600,000 ha, and over six percent of the rural population in 2020 had access to improved irrigated land and associated income increases.

In addition, some 12 percent of the rural population were already benefiting through employment (on- and off-farm), lower food prices, increased food availability, and the general rise in rural economic vibrancy catalyzed by irrigation expansion. These efforts were realized through the SADC comprehensive water for agriculture strategy. A basin-wide approach was adopted intentionally by all riparian countries by 2015 to propel efforts to upscale commercial farming, land tenure reforms, agricultural value addition, agricultural intensification and sustainable land use. Farmers continued to be organized in groups in Basin management (catchment and basin councils, for example) further enhancing the role of irrigation in Basin water use planning, and decision making. Lessons from successful attempts on expanding irrigation and reforming land tenure prior to 2015 in Tanzania were modeled for scaling out in entire Zambezi Basin.

at the core of these protocols. Other responses included improvements of the SADC Regional Land Reform Support Facility and adjustments in the Regional Agricultural Policy (RAP) by 2016 to ensure that they adequately created a framework for harmonizing and integrating policy objectives, strategies and programmes of the member states and promoted improved market access.

The regional organization in charge of agricultural research -- the Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) -- had by 2018 become a reference point for integrated agricultural research with several technologies and innovations generated, disseminated and scaled up. Other centres of excellence created to spur transformation in land and agriculture included the SADC Seed Centre that was revamped in 2020 to facilitate the co-ordination and implementation of the regional harmonised seed regulatory system. Others that improved their performance are the SADC Plant Genetic Resource Centre. At the national levels, basin countries reoriented their national land policies and laws to accommodate increasing desire for commercialization. It had become mandatory that basin management projects consolidate efforts to strengthen and transform agriculture through implementation of regional initiatives that promote sustainable production intensification of both livestock and crops.

Water Resources

The sustainable water resource management goals and targets of relevance to the Zambezi River Basin relate to water availability, water quality, water infrastructure and governance. Globally the Johannesburg Plan of Implementation (JPOI) articulates the goal of sustaining water resources, protecting water quality and other aquatic ecosystems and prevention of water pollution. All Basin countries have endorsed the goal of improving access to safe drinking water and improved sanitation with the goal of halving, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation and ensuring full access by 2050. The African Water Vision (AWV) under the AFDB's Africa Water Facility (AWF) also requires strengthening water governance and investments even at Basin and sub-basin levels.

The SADC Regional Infrastructure Development Master Plan (Water Sector Plan) of 2012 sets the following Water Sector Vision 2027 targets. See Tables 10.2 and 10.3.

Table 10.2 **Water Sector Vision 2027 Targets**

SECTOR	CURRENT STATUS	VISION 2027 TARGETS
Surface water storage	14% of ARWR stored (includes Kariba and Cahora Bassa dams)	25% of ARWR stored to meet SADC regional demand. Eventual target is 75% stored, as world benchmark is 70-90% of ARWR stored
Agriculture	3.4 million hectares (7% of potential) irrigated	10 million (20% potential) hectares irrigated. World average is 20%
Hydropower	12 GW (8% of potential) installed	75 GW (50% of potential) installed to meet SAPP targets and exports to other RECs
Water supply	61% of 260 million people served	75% of 350 million people served. Eventual target is100% served
Sanitation	39% of 260 million people served	75% of 350 million people served. Eventual target is 100% served
Abstraction	44 cu km/year abstracted	264 cu km/year abstracted to meet expected increase in water demand

www.sadc.int Regional_Infrastructure_Development_Master_Plan_Water_Sector_Plan.pdf

Table 10.3 **Gap Between Current Situation and Vision 2027 Targets**

SECTOR	CURRENT STATUS	VISION 2027 TARGETS	GAP
Surface water storage	14% of ARWR stored (includes Kariba and Cahora Bassa dams)	25% of ARWR stored to meet SADC regional demand. Eventual target is 75% stored, as world benchmark is 70-90% of ARWR stored	An additional 11% of ARWR to be stored
Agriculture	3.4 million hectares (7% of potential) irrigated	10 million (20% potential) hectares irrigated. World average is 20%	An additional 6.6 million hectares to be irrigated
Hydropower	12 GW (8% of potential) installed	75 GW (50% of potential) installed to meet SAPP targets and exports to other RECs	An additional 63 GW to be installed
Water supply	61% of 260 million people served	75% of 350 million people served. Eventual target is 100% served	An additional 14% of 350 million people to be served
Sanitation	39% of 260 million people served	75% of 350 million people served. Eventual target is 100% served	An additional 36% of 350 million people to be served
Abstraction	44 cu km/year abstracted	264 cu km/year abstracted to meet expected increase in water demand	An increase to 220 cu km/year abstracted

www.sadc.int Regional_Infrastructure_Development_Master_Plan_Water_Sector_Plan.pdf

The Zambezi Basin countries have grand plans to use the Zambezi River all the way to Lake Malawi/Niassa/Nyasa for transportation.

As far as 150 years ago, the Shire-Zambezi was used by explorers and missionaries as an inland transportation waterway from the Mozambican coast on the Indian Ocean to the Malawian District of Nsanje, over a distance of 380 km. Recent use of the waterway for transportation dates back to the early 1970s, where privately operated barges transported sugar cane molasses from Chiromo in Malawi to the port of Chinde in Mozambique. Due to unrest in the region at that time, goods transportation on the waterway was disrupted and Malawi turned to alternative transport modes on corridors such as Durban and Dar es Salaam to continue its external trade.

Sustainable management of fisheries is critical as fisheries play a central role in employment creation, food security and poverty reduction in the Zambezi Basin and SADC region. On a regional level, a protocol on fisheries has been implemented to watch over fisheries management through harmonized policies, legislation and management of fisheries and the aquatic environment (FANRPAN, 2010). The achievements and trends of these targets are captured in the storylines for each scenario below.

Conventional World

The water sector targets of achieving water availability through improved infrastructure and governance is not likely to be achieved. Water pollution will likely be prevalent across the basin despite countries endorsing the goal of improving access to safe drinking water as early as 2015. Water stress is likely to affect more countries. By 2040, under CWS, water stress persists with issues concerning availability and access, competition for different water withdrawals, imbalances in inter-basin water transfers with plans to draw water from the main Zambezi River to distant cities of Bulawayo and Gaborone faltering, water quality and destruction of water ways through aquatic invasive alien species, pollution and degradation of wetlands.

Well-intentioned policies and institutional arrangements such as the Revised SADC Protocol on Shared Watercourses, Regional Strategic Action Plan Phase III, the Zambezi Watercourse Commission (ZAMCOM) Agreement and regional cooperation in water resources management do not bear much fruit in improving basin –

water resources management. Ravages of climate change are expected to worsen the situation especially after 2025 due to breakdown in resilience measures as costs escalate. Urbanization and population growth are expected to continue to putting strain on the water resources. Damming for hydropower generation, industry, mining and commerce, tourism, fisheries, ecosystems, as well as waterway navigation remain ineffective in water management.

Competition between sectors, users of water and sub-basins are expected to intensify exposing the region to failures of weak transboundary management systems. The population growth rate in the Zambezi Basin which was 2.36 percent per year in 2010 (estimated from SADC/SARDC and others 2012) is expected to continue rising, thus exacerbating the water demand with focus on abstraction from transboundary and inter-basin sources.

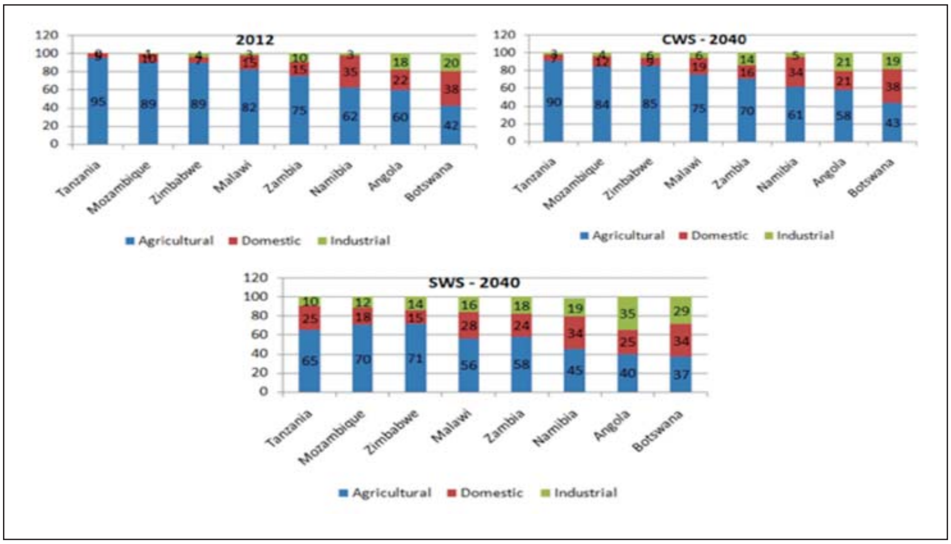
Even with improvement in water infrastructure, access to adequate safe water and sanitation facilities will remain elusive for the majority of riparian states of the Zambezi River Basin. Challenges with water scarcity, water quality deterioration and fragmentation of water resources management policies and practices at national, river basin or regional levels are expected to worsen after 2025. The scenario witnesses, among others, the following water resource features:

- Inadequate financing of water resources development and management;
- Inadequate water infrastructure for achieving regional energy security;
- Insufficient water infrastructure for agricultural development to achieve regional food security;
- Low access to water supply and sanitation; and
- Major dams in the basin were constructed for a single purpose and their operation is not optimized for multiple uses.

These challenges are blamed for the absence of a fully operational river basin organization for the Zambezi Basin until 2014 when the permanent secretariat was operationalized. Until then it was difficult to access and use the integrated water resources knowledge-base collected during the ZACPRO 6.2 project -- the Zambezi Water Information System (ZAMWIS) for basin-wide development and management. Weak capacity for national water management institutions persist, thus lowering their ability to perform river basin management tasks. Water infrastructure for agricultural development, domestic water supply and industrial abstraction remain poor. The major dams in the basin that were initially constructed for the single purpose of hydroelectric power generation have not been remodelled for multiple uses.

Figure 10.7 Proportion of Basin Level Water Resources Abstracted for Domestic, Agricultural and Industrial Use in the Countries, under the Two Scenarios of CWS and SWS.

Figure 10.7 **Proportion of Basin Level Water Resources Abstracted for Domestic, Agricultural and Industrial Use in the Countries, under the Two Scenarios of CWS and SWS**



World Bank. Zambezi River Basin Multi-sector Investment Opportunities Analysis, 2010

Delays in opening the Shire-Zambezi Waterway for navigation to the Indian Ocean increases the costs of transportation of goods. These costs are continuously exacerbated by ever-increasing costs for fuel. As countries do not ratify the Protocol on Fisheries, illegal and unregulated fishing continues, threatening fisheries ecosystems as well as livelihoods.

Sustainability World

Most of the targets have been achieved. By 2040 water resources management in Zambezi Basin had optimized water quality, infrastructure availability and transboundary management. The efforts put in place especially after 2020 recognized that consumptive and non-consumptive uses of water in the ZRB have transboundary implications in the sense that one country's use of the river affects other countries in the Basin. These effects were modest between 2015 and 2020 but had since increased to the extent that river flow patterns changed due to climate change and increases in water demand. As more countries industrialized, the need for efficient water use and management became apparent, occasioning the institution of appropriate mechanisms for Integrated Water Resources Management (IWRM) across the Basin. There had been consistent demand for new water infrastructure to meet regional energy requirements.

Water demand for irrigation had been met to ensure food security. Strategies had been put in place to improve the operation of existing and new major dams in the Basin to take into account and optimize multiple functions of water. There had also been an increase in investments and funding for water resources development and management with a resultant increase in access to sustainable water supply and sanitation in most sub-basins. Stakeholders, especially through participatory approaches had embraced adaptive water resources management leading to more ecological and economic benefits of wetlands and other protected areas to sustain their viability even under climate change extremes.

Water pollution control had become part and parcel of management resource management at community, sub-basin and basin scales. Pollution from especially urban sources had been put on check by 2035 through public education and investment in pollution management infrastructure to serve urban centres, rural areas, mining areas and industrial zones.

Degradation of water bodies through control of invasive aquatic weeds and prevent new outbreaks, and the promotion of sustainable inland fishery management as a contribution to regional food security had been realized in Zambia, Mozambique, Malawi and Tanzania. The integrated water management strategies adopted also ensured that other sectors such as tourism were not harmed.

Strategic environmental plans and procedures including basin-wide issues had become mandatory for water-user associations, local and national governments. Institutional frameworks in support of the basin-wide development of water resources and inter-basin transfer had been operationalized regionally through ZAMCOM and locally through appropriate tools, regulations and policy support. Part of this involved strengthening of organizational, financial and human resource capacities of water management institutions at regional, national and local levels.

As from 2015 basin-wide water resources data were being collected and processed through an integrated information system. This had encouraged broad-based stakeholder participation in water resources development and management and design of a seamless data- and information-sharing protocol for a vibrant ZAMWIS platform.

The re-opening of the Shire-Zambezi Waterway for navigation to the Indian Ocean boosts socio-economic development of the region, including Malawi, Mozambique and Zambia through the reduced cost of transportation. There is also massive infrastructure development, including enlarged Nsanje harbour in Malawi. The increased economic performance of the Zambezi Basin leads to socio-economic development. Regional integration is enhanced as a result of close collaboration between SADC member states in the Zambezi Basin.

Basin countries ratify the Protocol on Fisheries, and establish national programmes aimed at promoting sustainable utilization of fisheries resources. As a result, there is improved regional cooperation with the view of eradicating illegal and unregulated fishing. Fisheries governance and legal frameworks to eliminate illegal fishing are strengthened.

Tourism

Tourism as a sector is poised to make significant contributions to sustainable development and promote transboundary cooperation and economic integration. The main targets being pursued include a 10 percent increase in ecotourism growth in the Zambezi Basin and 15 percent increase in cultural tourism by 2030. The contribution of tourism to national GDPs of the riparian states is also targeted to increase by 10 percent (RETOSA 2012) in 2030. Population growth, technology, consumption patterns remain important drivers of the sector.

The move towards achieving these targets will be dictated largely by the critical uncertainties of culture, governance and globalization. The major developments to track along the scenarios include new infrastructural development, new tourism regulatory frameworks and risk of environmental degradation from tourism activities.

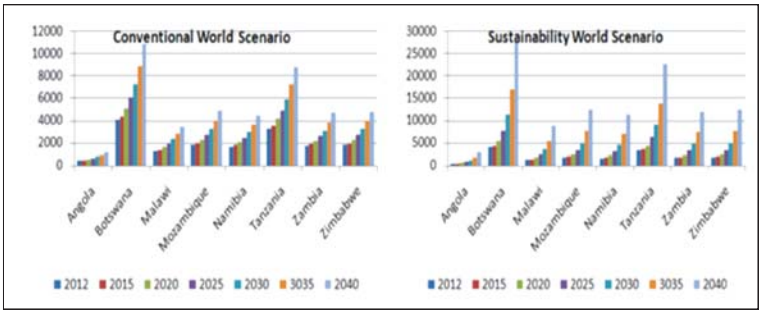
Conventional World

Even in the conventional world scenario, tourism is expected to continue contributing immensely to Zambezi Basin country economies and social development. This is because of the wide variety of landforms, vegetation zones, wildlife, as well as cultural landscapes that will continue to offer spectacular tourism attractions. The attractions are expected to continue in the current major destinations that include national parks, nature reserves, as well as cultural festivals. The cultural events and other attractions are likely to be preserved and maintained even with limited investments in the sector. However, the basin may not realize the full potential and reach the targets for tourism arrivals, employment creation, cultural tourism growth and expansion of ecotourism in especially the traditional destinations. Developments of supportive infrastructure such as hotels, roads and airports are expected to continue but at sub-optimal pace to facilitate robust growth in the sector. Tourism development in this scenario remains constrained by weaknesses in other enabling facilities and technologies that promote movement of people, goods and services.

The positive growth in tourism witnessed around 2013 continues towards 2030, but at a lower rate. Benefits from tourism remained at the pre-2015 levels as captured in the contribution of travel and tourism to the GDP, the total number of people employed in the tourism sector, and the amount of capital investment resulting from tourism and tourism receipts for expenditures are made by tourists visiting the Zambezi Basin. Under CWS, foreign exchange generated from tourism is expected to rise marginally but steadily from US$19.6 billion in 2012 to over US$40 billion by 2030 to stabilize further towards 2030 due to reliance on natural resources that may be overstretched after 2025.

Marginal growth is expected to be noted in sustainable tourism development. The adoption and implementation of essential ecotourism principles, for instance, remain sub-optimal and continue to at local, national, sub-basin and basin levels except for heightened community

Figure 10.8 **Projected Tourist Arrival Trends for ZRB Countries from 2012 - 2040**



Simulated based on data from UNWTO Travel Barometer 2013; RETOSA 2012; WTTC 2013

involvement and capacity building for communities to access tourism jobs that are expected to be created in the sector especially after 2015. Benefits of ecotourism that accrue despite the slow pace of uptake include social and economic gains from tourism projects and activities, sustainable land, forest, biodiversity and waste management.

Sustainability World

By 2030 most of the targets of the tourism sector have been realized. The sector has become robust and making unparalleled contribution to the GDP of Basin states and acting as a major catalyst of regional integration. Ecotourism growth has increased steadily at over 10 percent annually since 2020 while tourism's contribution to national GDPs has been increasing at over 10 percent between 2030 and 2040. With this improvement, the basin is witnessing improved levels of infrastructural development including world class hotels, road, air transport, rail and waterways networks for travel.

These achievements have not jeopardized the ecological integrity and social gains to local communities. Over the years, the following developments took place:

- Development of catchment management plans incorporating areas of tourism value such as game management areas and wetlands;

- Operation of water infrastructure to support and enhance tourism management; and
- Systematic integration of tourism development in water resources planning, development and management with wetlands, waterways, rivers and lakes forming important destinations and being used for tourism transportation and sports.

The role of regional and international organizations became instrumental in the positive changes witnessed in the sector. The vibrant Regional Tourism Organization of Southern Africa (RETOSA) continued to provide advice and influence on promotion and development of the regional and basin-wide tourism as an advocate for intra-regional marketing of the various tourism products and destinations. All the eight basin countries have fully subscribed to the RETOSA charter.

A number of national and regional tourism policies had been improved and contributed to the positive growth in the sector. By 2016 the five member states of the KAZA Transfrontier Conservation Area had completed integration of policies targeting cross-border conservation to promote unique tourism and the products in that area are fully mainstreamed in their Integrated Development Plan for the enlarged Park and its surroundings.

At the national level, countries had addressed their specific challenges through:

- Sustained economic growth supported by improved travel and tourism;
- Opening up airspaces with new aircrafts acquired by the national airlines and direct flights to major tourism source continents/countries;
- Pursuit of integrated travel and tourism infrastructure upgrading;
- Adoption of the Open Skies policy and ratification of appropriate bilateral air services agreements between countries;
- Promotion and targeting of growing markets in Europe, Americas and Asia as well as expansion of regional and local market; and,
- Successful push by RETOSA for the adoption of the universal visa (Univisa) had facilitated ease of access to other destinations within the Zambezi Basin after its approval by SADC member states in 2025.

Biodiversity and Forests

The Convention on Biological Diversity (CBD) has articulated five strategic goals that Zambezi Basin countries are pursuing under the Aichi targets:

Strategic Goal A Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

Strategic Goal B Reduce the direct pressures on biodiversity and promote sustainable use.

Strategic Goal C Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.

Strategic Goal D Enhance the benefits to all from biodiversity and ecosystem services.

Strategic Goal E Enhance implementation through participatory planning, knowledge management and capacity building.

The specific targets under these strategic goals form the basis of biodiversity conservation in the basin as in other regions and countries. The Basin countries have also ratified the goal of increasing forest cover up to at least 10 percent of the total land area and proportion of the area under protection.

Conventional World

Under the CWS, biodiversity and forest resources of the basin continue to be influenced by the pace of population growth and poverty, agricultural expansion, overreliance on wood energy; socio-economic development; and other

emerging issues such as climate change, biofuel production and invasive alien species. The scenario is likely to witness depletion of forests cover and loss of the socio-economic benefits to the basin population and ecosystem.

Attempts by some Zambezi Basin states to conserve biodiversity and forests will not fully succeed over the years. The efforts include the establishment of jatropha and sweet sorghum feedstock through grower schemes and large plantations in Botswana, Malawi and Mozambique. Some of the plantations of jatropha may replace cash and food crops. In Zimbabwe huge plantations of sugarcane for sugar and bio-ethanol production will likely be expanded around 2017.

The below-average performance in conservation of biodiversity will likely result from the inadequate protection, sustainable development and use of wetlands that persisted throughout the years, coupled with the deterioration in water quality caused mainly by increasing pollution from industries and urban centres. After 2020 there is likely to be a proliferation of invasive aquatic weeds that cause havoc in forests, rangelands and wetlands and water bodies in the basin. These developments will probably cause unsustainable and low-productivity fisheries management as well as threats to tourism development due to degradation of the aquatic environment. In the end, the originally high-value and unique eco-systems and related ecological and economic functions in the basin will remain under threat from uncoordinated and fragmented development.

Sustainability World

By 2040 the Zambezi Basin countries had achieved the Aichi target by addressing many of underlying causes of biodiversity loss that prevailed before 2020. This was achieved by sustained public awareness of the values of biodiversity. Mainstreaming of biodiversity conservation in development planning has improved. The rate of loss of natural habitats, including forests had declined by more than half the 2015 levels. By 2020, the threats to fish, mammals, invertebrate stocks and aquatic plants had been reduced drastically through legal frameworks that were applied across the basin while agro-biodiversity conservation formed an integral part of sustainable agricultural intensification. There had been an overall enhancement of equity in the benefits from biodiversity and ecosystem services and an improvement in the participatory involvement of communities and other stakeholders in the planning, knowledge management and capacity-building in biodiversity programmes.

Towards 2020, many measures were implemented to address the challenges of biodiversity and forests loss in the entire basin. A well-coordinated programme for community participation in natural resources management was implemented through education and community level incentives such as rewarding local communities for their indigenous knowledge on natural resources. The Zambezi Basin member states also fully subscribed to the establishment of protected areas and Trans Frontier Conservation Areas (TFCAs).

Effective regional and national policy interventions boosted the slowing down of drivers causing biodiversity and forest loss. In addition, a comprehensive and spatially explicit biodiversity information system was developed to support decision-making and monitoring of Basin level changes in ecosystem services. This had helped in actions undertaken after 2020 such as the delineation of high priority conservation areas such as headwaters, recharge zones and flood planning and implementation land use plans for these areas. There had also been realized effective international cooperation on linking areas with high significance for biodiversity and their inclusion in the basin's Protected Area Networks.

Harmonization had been realized as early as 2016 on the development and use of common guidelines for EIAs and SEAs in development planning. The countries had included in their biodiversity conservation strategies the promotion of effective monitoring, assessment and reporting of biodiversity benefits, and application of appropriate biotechnology and local knowledge. The strong political will from the Zambezi Basin states gave impetus to institutions such as ZAMCOM and local communities to participate in conservation efforts.

Industrialization and Energy

All Zambezi River Basin states, as influenced by the SADC Regional Infrastructure Development Master Plan (RIDMP) incorporated goals and target for industrialization and energy security as articulated in the SADC Infrastructure Vision 2027 focusing on the development of seamless, cost-effective transboundary infrastructure. The SADC Infrastructure Vision 2027 is anchored on six pillars consisting of energy, transport, ICTs, meteorology, transboundary water resources and tourism (Trans Frontier Conservation Areas).

The master plan will be implemented over three five-year intervals – short term (2012-2017), medium term (2017-2022) and long term (2022-2027). SADC has a regional target to gradually increase the uptake of cleaner energy that will result in reduced carbon emission by 2020. In the meeting held in Botswana in 2012, energy experts from the region agreed that the Southern African Power Pool (SAPP) should achieve a renewable energy mix in the regional grid of at least 32 percent by 2020 and 35 percent by 2030 (SARDC 2014).

Regarding industry, one of the specific actions set by SADC in the SADC Industrial Development Framework Policy approved in 2012 is to establish training programmes for light manufacturing (including food industries, leather, metal, garments/textile) that can be offered across the region by 2016. In the same framework, SADC also intends to facilitate development of specialized training in the priority sectors with particular emphasis on mineral processing and pharmaceutical production in institutions of higher learning by 2017.

Conventional World

The industrial development trajectory that is already in motion will likely gain the momentum in place in 2015 and continue through the years with minerals such as gold, copper, coal and diamonds forming the bedrock of industrial production. The agriculture sector will most likely continue to play an important role, although value addition in both manufacturing and agriculture remains low. The two sectors will still be leading in contribution to national GDP. The slow pace of growth in infrastructure may keep industrialization at levels below other regions while the service industry expected is not fully mature.

The increasing demand for goods and services in the Zambezi Basin due to rising population, endowment of the Basin with abundant natural resources which form the basis for resource-based industries, particularly mining and food processing industries will likely drive the otherwise less than impressive performance in manufacturing and agricultural processing.

Industrial settlements had expanded in the traditional industrial cities of Blantyre and Lilongwe in Malawi; Tete in Mozambique; Chililabombwe, Chingola, Chipata, Kabwe, Kafue, Kitwe, Livingstone, Lusaka, Luanshya, Mazabuka, Mufulira, Ndola and Solwezi in Zambia; and Chegutu, Gweru, Harare, Hwange, Kadoma, Kwekwe, Marondela and Norton in Zimbabwe, and they are expected to continue expanding.

The slow pace of infrastructural development (especially roads, railways and power plants) may limit industrial expansion in the Basin despite implementation of the SADC Regional Infrastructure Development Master Plan (SADC RIDMP). The movement of raw materials and industrial products will also remain limited. Some progress may be made in the national policy front. Specific policies that promote industrial development are likely to be formulated but their implementation may not be effective. Artisanal exploration and mining is likely to continue in most parts of the basin.

Although mining and other industries will continue to provide employment and other social benefits to the basin countries, their impact on the environment is likely to result in the degradation of the quality of air, water and land. Land degradation as a result of mining operations in particular will be serious in many parts, especially in Kabwe, Zambia. Siltation of dams and rivers by loosened sand and gravel from mining and washing at mine sites will also continue in many countries while the danger of mercury pollution may persist.

Sustainability World

In 2040, sustainable industrialization has been achieved with green industrial prosperity realized in manufacturing, agricultural processing, service sector and even mining. The latter in particular had expanded and both primary production and value addition has increased the position of the eight member states in regional and global trade in finished products. Socio-economic benefits of industrial growth are visible in equitable contribution to employment and environmental conservation. The SADC-RIDMP had been fully implemented and quality transport networks, water, irrigation and energy systems are in place. Transboundary cooperation led to a basin-wide infrastructural development and industrial prosperity.

The challenges that faced southern African energy sector in general and Zambezi River Basin in particular between 2015 and 2020 were addressed through various actions and energy consumption per capita has generally kept pace with population increases. Electrification levels in riparian countries had steadily increased and the absolute numbers without access were drastically reduced towards 2040. Fewer and fewer cases of power shortages were experienced especially after 2030 as the investment in power supply significantly narrowed the gap between supply and demand over many years. The Zambezi Basin countries benefitted from the increase in electricity supply driven by the Southern Africa Power Pool (SAPP), which included the expansion plan to add more than 6,000 MW of new hydropower after 2015. Reliance by countries on hydropower continued. Strategies for water balance and transboundary management made this possible even with the escalating but periodic water stress during drought. Water demand continued to grow, largely due to major irrigation investments within the basin. Most of the strategies targeted climate change adaptation. The energy sector in particular benefitted from joint development of feasible package of major hydropower sites, taking into account multiple functions in coordination with SAPP and promotion of options for small-scale hydropower development.

Table 10.4 **Hydropower Expansion in Each Future Scenario**

	Year of commissioning	
	Business as usual (CWS)	Optimistic (SWS)
Cahora Bassa North	2022	2017
MphandaNkuwa	2022	2017
Kariba South Extension	2018	2015
Kariba North Extension	2014	2013
Kafue Gorge Lower	2022	2017
Itezhi-tezhi	2014	2014
Boroma	2025	2020
Lupata	2025	2020
Devil's Gorge	2028	2018
Batoka Gorge	2022	2018

Spalding-Fecher and others. Water Supply and Demand Scenarios for the Zambezi River Basin. Climate Change and Upstream Development Impacts on New Hydropower Projects in the Zambezi Project. Report for Climate and Development Knowledge Network, 2014

Table 10.5 **Manifestations of Conventional World and Sustainability World Scenarios – Strategies for Moving Towards Sustainability World**

Theme/Issue/ Sector	Sub-Theme/Sub-Issue/ Priority/Cahallenge	Conventional World Scenario	Sustainable World Scenario	Some Strategies for Addressing Gaps
Land and Agriculture	Land use change	Land under agriculture increases in proportion	Sustainable agricultural intensification and land-use planning	Land reforms and supportive land-tenure regimes
	Agricultural productivity (cereals)	Increased but sub-optimal cereal production. Agriculture contributes up to 30% of national GDP	Agricultural growth rate of 6% per year achieved through national investment of over 10% GPD for agricultural development	Sustainable intensification, application of science and technology and support of generation and upscaling of technology for improved productivity – such as the use of improved and high-yielding varieties and breeds, adoption of mechanization, irrigation and agricultural value addition and improved markets
	Food security	Food insecurity and high levels of malnutrition	Food security and food surplus for export. Countries have managed to cope with climate change	Value addition and agricultural diversification for improved livelihoods and food security
	Land under irrigation	Per capita land availability decline and irrigated land proportion not changed	SADC RISDP promotes irrigation development Over 600 000 ha brought under irrigation	Integrated basin-wide approach to irrigation
Water Resources	Water availability	Water stress persists	Equitable access to water resources	Improved infrastructure for water supply
	Water quality	Water pollution and siltation from agriculture, cities and industries (particularly mining)	Optimal water quality Control of water body degradation	Awareness of water and sanitation, pollution control and adaptive water resources management
	Water withdrawal by sector	Imbalances in water use and water transfers could cause conflicts	Equitable and sustainable balance between consumptive and non-consumptive uses of water in the basin	Water management information system to support decision-making and practice
Tourism	Tourist arrivals	Arrivals to increase due to traditional attractions and destination	Increase in arrivals and tourism receipts	Adoption of group marketing in overseas, regional and local sources
	Employment from tourism sector	Contribution to GDP increases but below potential Employment in the sector unstable	Tourism contribution to GDP increased by over 10%	Mainstreaming tourism and equitable employment regulation in development plans
	Growth of cultural tourism	Cultural festivals and indigenous people's participation not visible and beneficial	Recognition of cultural tourism and rights of indigenous peoples	Culture conservation and protection of rights of indigenous peoples
	Growth of ecotourism	Marginal growth in sustainable tourism	Over 15% growth in ecotourism with benefits to society and ecosystems services/conservation	Systematic integration of tourism development in basin resources planning
Biodiversity and forests	Biodiversity conservation	Loss of biodiversity and disruption of habitats (wetlands, parks, water bodies)	Achievement of all Aichi targets	Awareness campaigns on institution/ratification of necessary protocols
	Protected areas	No change on number and quality of protected areas	Protected Area networks. armonization	Increased implementation effectiveness of protected areas
	Forest cover	Depletion of forest reserves	Effectiveness of regional and national forest policies	Implementation of TFCs Regional policy support for forest conservation
Climate change and variability	Extreme events	Extreme rainfall variability, floods and drought	Effects of extreme events adequately controlled	Improve flood and drought management and mitigation mechanisms
	Cost of adaptation	High costs of adaptation especially for countries that have no action at the beginning	Increased resilience of communities and ecosystems	Regional and local capacity to adapt
	GHG emissions	Escalation of GHG emissions even from sub-basins and also nationally	Globally, achievements Post 2015 Agreement and GHG targets	Regional capacity to adapt and mitigate and make use of the development opportunities, for example CDM
Industrialization and energy	Mining sector development	Remains primary and environmentally polluting	Green industrial prosperity	Improved beneficiation and value addition in manufacturing and agricultural processing
	Infrastructural development	Weaknesses in RIDMP implementation	Energy, water, transport, ICT and other infrastructure in support of industrialization	Fast-tracking of SADC infrastructure vision 2027
	Energy security and development	Hydropower generation, renewable energy introduction faced with challenges. Energy security jeopardized	Sustainable energy production and use. More alternative energy sources in place	SADC RIDMP energy plans to be fully implemented Joint development of feasible package of major hydropower sites, taking into account multiple functions in coordination with SAPP

The development of hydropower in the Zambezi River Basin had taken into account the influence of other water uses and withdrawals from other sectors. Of importance had been the demand for irrigation that influenced power generation potential of plants. The influence of irrigation demand is clear on the absolute growth in water demand from the energy sector. Sufficient water had been available after other priorities have been met. The same demand levels were reached before 2025 (10) years earlier than budgeted in the SADC RIDMP.

Towards Effective Policies and Basin Management

This chapter has presented alternative narratives of the Zambezi River Basin futures under business-as-usual (CWS) and optimistic (SWS) scenarios. Effective policies that would integrate the lessons from this future would need to strategically support a transboundary approach to basin and sub-basin planning, implementation of land, water, biodiversity conservation, industrial development and sustainable resource use policies. Table 10.5 summarizes the features of the two scenarios.

In order to achieve this, the following would be instrumental:

- Fast-tracking the operationalization through encouraging ratification of the ZAMCOM Agreement by the remaining country and promotion of targeted measures to raise awareness of benefits of basin-wide management of water resources;
- Formulation and implementation of public information programmes to raise awareness among a broad range of stakeholders;
- Strengthening and sustaining the annual Basin Forum meetings as part of awareness and information sharing among basin stakeholders;
- Strengthening of coordination with ongoing programmes in the Zambezi Basin by SADC, COMESA, SAPP, NEPAD, Waternet, IUCN, WWF, HYCOS, World Bank and others, including management of sub-basins commissions such as Joint Water Commission, ZRA; and,
- Strengthening stakeholder participation through policy and legislation review and revision throughout the Basin states.

Conclusion

Addressing future developments in the Zambezi Basin becomes apparent if alternative narratives are told in mutually exclusive pathways via the CWS and SWS. The SWS is the optimistic scenario, presenting benchmarks with which to gauge progress and results of transboundary management of Zambezi River Basin resources and their outcomes on regional integration, human development and environmental protection. The dual pathways presented in the chapter reveal lessons on sustainable management and how the interactions of key drivers and pressures will influence trends in land, water, biodiversity, tourism and industrial development. By 2040, the vision is to have a regionally integrated and sustainable Basin ecosystem that supports various human socioeconomic activities but with a sound infrastructure and stable biodiversity. Continuing on the current trajectory is not a good option and major policy interventions are needed to bend the curve towards the outlined sustainability goals and targets.

To realize the respective targets and goals under each of the themes of the current report will require action at all levels and policy support to strengthen the capacity of communities and institutions, infrastructural development as outlined in the six pillars of RIDMP, as well as improved governance and adaptive management of the basin's land, water, biodiversity, forest and other resources in ways that bring about equitable benefits to populations and countries of this shared ecosystem.

CHAPTER LINKAGES

Zambezi Basin Overview
A state of sustainability revolves around proper environmental management and planning centred on such tools as Environmental Impact Assessment and Strategic Environmental Assessment. Population growth is the ultimate driver of socio-economic, political and environmental challenges.

Water Resources
Sustainable development in the Zambezi Basin depends on effective management of water resources and conservation of wetlands. Both resources are critical to environment and development in the Basin.

Land And Agriculture
Per capita access to land and per capita food productivity continue to decline unless countries of the region make use of their comparative advantages, and vigorously pursue the goal of food security by promoting intra-regional trade.

Biodiversity And Forests
The Zambezi Basin is rich in biological resources, which support the economies and raise the standard of living of Basin inhabitants. Destruction of habitats and overexploitation of biodiversity will impoverish the basin, short-circuiting efforts towards sustainability. Increasing awareness and more binding policy measures bring stability in the development of forest, woodland and wildlife sectors.

Climate And Variability
Climate change anomalies such as temperature rise and frequency of droughts and floods continue to haunt. However, global consensus bears fruit in resilience to the impacts of global warming and rise in sea level.

Energy
Both traditional and scientific approaches to energy-use exert pressure on ecosystems, exacerbating land clearance and altering natural functions of ecosystems due to the construction of dams for hydroelectricity generation.

Urbanization And Human Settlements
The urban growth phenomenon remains a key developmental challenge. Urban areas continue to be attractive due to the availability of education, health, sport and social services when compared to rural areas.

Tourism
Over-development of the tourism sector will make it less attractive for tourists who, ultimately, will be forced to visit other sites in the world. Therefore, it is important that tourism, as other sectors, moves towards a state of sustainability.

Industrial Development
The growth of industry could be seen as a positive development as it could wean some of the people from the overdependence on natural resources. However, such growth must take into account the negative aspects of pollution in all its forms and necessary legislative mechanisms must be seen to be effective in mitigating environmental disasters.

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PROFILES

Zambezi Watercourse Commission

ZAMCOM Equitable and reasonable use of water resources

ZAMCOM is a river basin organization made of up the eight riparian states that share the Zambezi River Basin, and works with all stakeholders in the Basin. The objective of ZAMCOM is to "promote the equitable and reasonable utilization of the water resources of the Zambezi Watercourse as well as the efficient development and management thereof". Through the Agreement on the Establishment of the Zambezi Watercourse Commission, ZAMCOM has the responsibility to collect, evaluate and disseminate data and information, and foster greater awareness among the inhabitants of the of the Basin of the efficient management and sustainable development of the resources, among other activities. ZAMCOM activities are rooted in the strategy of Integrated Water Resources Management (IWRM) according to the Dublin Principles that (i) freshwater is finite and vulnerable and is essential to life and the environment; (ii) water development and management should be participatory involving users, planners and policy-makers at all levels; (iii) women play a central role in the provision, management and safeguarding of water; and (iv) water has an economic value for its competing uses. The Zambezi River Basin is the largest and most shared river basin in southern Africa, and the fourth largest in Africa after the Congo, Nile and Niger. The riparian states are Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe.

SADC Vision
A common future, within a regional community that will ensure economic wellbeing, improvement of the standards of living and quality of life, freedom and social justice, peace and security for the peoples of southern Africa.

Southern Africa Vision for Water
An equitable and sustainable utilisation of water for social and environmental justice, regional integration and economic benefit for present and future generations.

Southern African Development Community

SADC A common future within a shared regional community

The Southern African Development Community is a regional economic community comprising 15 Member States (Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe). SADC is committed to regional integration and poverty eradication in southern Africa through economic development and ensuring peace and security. The SADC Common Agenda refers to key principles and values that guide the regional integration agenda. These include, among others, promoting self-sustaining development on the basis of collective self-reliance; achieving complementarity between national and regional strategies; sustainable use of natural resources and effective protection of the environment; using the resources for productive employment; mainstreaming gender in community building; and strengthening and consolidating the longstanding historical, social and cultural affinities and links among the peoples of the region.

The SADC Regional Water Policy was developed in 2005 through a highly consultative and participatory process involving many stakeholders. The policy is implemented through a regional strategy adopted in 2006, and is premised on the SADC Treaty, the Revised SADC Protocol on Shared Watercourses, the SADC Vision for Water, and the Dublin Principles on Integrated Water Resources Management (IWRM). The regional water policy provides a framework for sustainable, integrated and coordinated development, utilization, protection and control of national and transboundary water resources in the SADC region for the promotion of soci-economic development and regional integration, and the improvement of quality of life of all people in the region. It was developed to facilitate the implementation of the Revised Protocol on Shared Watercourses, and to have a focused, coordinated management of regional water resources. The policy recognizes IWRM as the basic approach to achieving these objectives as a "process that promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromised the sustainability of vital ecosystems".

Southern African Research and Documentation Centre

SARDC

Research that informs development

SARDC is an independent regional knowledge resource centre that focuses on policy issues in southern Africa, and has monitored regional developments since 1985. SARDC is made up of topical institutes that focus on relevant regional processes such as water resources, energy, or climate change, and work in partnerships at national and regional levels. SARDC has a strong track record in research, collection, analysis, writing, documenting and disseminating knowledge from a regional perspective in a way that is accessible for different target audiences, including policy and decision-makers in public and private sectors, parliaments, academics, development agencies, media and the public. SARDC was formed at the urging of the Front Line States to add a regional dimension to the collection and dissemination of information. Founding Patron was the late *Mwalimu* Julius K. Nyerere, then Chairman of the Front Line States. SARDC has worked with SADC for 20 years, with an MOU rooted in a clear understanding that accessible knowledge is a key strategic resource for the achievement of regional integration and development. *Southern Africa Today (SADC Today)* is among the publications produced by SARDC for SADC, in the three official languages of English, French and Portuguese.

SARDC
Southern African Research and Documentation Centre

www.sardc.net Knowledge for Development

IMERCSA
I Musokotwane Environment Resource Centre for Southern Africa

I Musokotwane Environment Resource Centre for Southern Africa

IMERCSA

Knowledge for sustainable development

The SARDC institute responsible for environmental reporting and climate change issues, including indicators development, is the I Musokotwane Environment Resource Centre for Southern Africa (SARDC IMERCSA), named for the late IUCN Regional Director, India Musokotwane from Zambia, who inspired IMERCSA and supported its partnerships and its Vision that:

> "…people at all levels of environmental decision-making in southern Africa are motivated and empowered to take positive actions to counter environmental degradation and move towards sustainable development paths through provision of accurate, accessible and meaningful knowledge and information on the environment."

SARDC IMERCSA initiated the first report on the southern African environment in 1994, *State of the Environment in Southern Africa*, in partnership with SADC and IUCN, and has continued to produce thematic and other reports on the southern African environment, with support of the UN Environment Programme (UNEP). Previously known as State of Environment reports, these are now called Environment Outlooks, and these are IMERCSA's most sought after outputs. Two regional Outlooks have been produced, as well as five thematic reports, including *State of the Environment Zambezi Basin 2000*, which was the first assessment of a single ecosystem in southern Africa. SARDC IMERCSA was established in 1992 and is a long-time partner of the SADC Water Division, ZAMCOM and its predecessors dating back to early ZACPRO projects.

SARDC
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