ZAMBEZI RIVER BASIN

ATLAS OF THE CHANGING ENVIRONMENT

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Cover Design by Paul Wade and Tonely Ngwenya

Cover Artwork by Tapfuma Gutsa. Made from Tonga baskets, the front cover depicts the Zambezi river spirit, Nyaminyami, and the back cover image is Mulonga, the river. Related artwork inside is Husha, all from Tapfuma Gutsa's exhibition titled Mulonga, Deep Waters and Starry Skies

Cartography, design and print by GRID-Arendal, Norway

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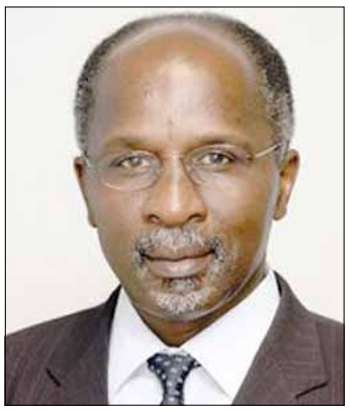


The Zambezi is Africa's fourth largest river basin after the Congo, Nile and Niger, and spreads over eight Member States of SADC: Angola, Botswana, Malawi, Mozambique, Namibia, United Republic of Tanzania, Zambia and Zimbabwe. The basin represents the best of what we have in the SADC region in terms of natural capital. Within the basin's large expanse, there exist many natural resources ranging from water, land and soils, forests and wildlife, and the minerals that are plentiful under the soil. These define our economic activities including, agriculture, forestry, mining, manufacturing and tourism. As these resources are under threat from environmental and climate change we need to find strategies to sustain and protect these resources to meet the needs of current and future generations, as well as replenishing the needs of the natural environment.

Access to knowledge is a valuable strategic resource that helps to define and support meaningful strategies to address the threats from environmental changes. As stated by world leaders in their declaration 20 years ago at the Earth Summit in Brazil (Agenda 21), the acquisition and provision of timely, effective information on the state of our natural resources is an important factor to the attainment of sustainable natural resources management.

We therefore welcome the production of the Zambezi River Basin Atlas of the Changing Environment, the first of its kind in the Zambezi River Basin and in southern Africa. The Atlas captures environmental changes graphically and pictorially, providing striking and undisputable evidence that can be used as a basis for intervention at local, national and regional levels.

Publication of this Atlas is based on the principle that information is key to transformation and that informed action is rooted in the use of sound knowledge. By indicating changes in the basin in an accessible format, this publication provides a basis and a stimulus for taking action at all levels.

The Atlas is anchored in the SADC policy frameworks endorsed by the eight riparian states of the Zambezi River Basin. These include the Revised SADC Protocol on Shared Watercourses which fosters close cooperation for judicious, sustainable and coordinated management, protection and utilisation of shared watercourses, and advances the SADC agenda of regional integration and poverty reduction. The SADC Regional Water Policy highlights various opportunities for water management to achieve the SADC goals and objectives; and the SADC Regional Water Strategy promotes the adoption of a basin-wide approach for planning, development and management of water resources.

Since the basin is the most shared within the SADC region, the Zambezi River Basin Atlas of the Changing Environment provides a foundation for assessing trend analysis of water resources and environmental issues at a basin level. By providing such analysis the Atlas fulfils two of the objectives of the SADC Regional Water Strategy under data and information acquisition and management which compel the region to:

- Provide sustainable water resources data and information systems at national, transboundary and basin levels to meet the needs for effective planning and management of water resources; and
- Improve access to data and information for all stakeholders.

I am delighted that the Zambezi Watercourse Commission (ZAMCOM) established under the Revised SADC Protocol on Shared Watercourses, has come into force as this can unlock many opportunities for implementation of development projects including adaptation strategies to climate change. The prime objective of the ZAMCOM Agreement 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." The Atlas will therefore provide foundation information for the achievement of this objective. It also provides a basis for implementation of the Zambezi Basin Integrated Water Strategy formulated in 2008 as part of the ZAMCOM agreement.

This Atlas comes at a time when issues of water resources and climate change are very critical, requiring sustainable solutions. While our region is characterised by variability of water resources, both in time and space, this is exacerbated by threats posed by the global climate change that renders our available water resources to be stressed as a result of overall changes in the timing and extent of precipitation. Climate change is causing more intense and frequent extreme events such as droughts and floods, thus necessitating coordinated management of our shared watercourses.

The Zambezi River Basin Atlas of the Changing Environment is expected to raise awareness among stakeholders and to aide policy makers in making informed decisions as it provides convincing visual and scientific evidence of environmental change on which to build.

I believe that this well-illustrated Atlas will heighten interest among policy and decision makers and the public in taking positive steps towards sustainable resource utilisation in the Zambezi River Basin.

It is also my hope that the contents of this Atlas will provoke ongoing discussions on climate change and variability, and provoke the need to take serious actions in development of resilient strategies.

I applaud the SADC Directorate of Infrastructure and Services through the Water Division and its arm, the Zambezi Watercourse Commission Interim Secretariat, working with our longstanding partners, the Southern African Research and Documentation Centre (SARDC) I Musokotwane Environment Resource Centre for Southern Africa (IMERCSA), the United Nations Environment Programme (UNEP), and UNEP/GRID-Arendal. I want to thank the Government of Norway for their consistent support and for their contribution to sustainable development in southern Africa through funding this important initiative.

This process and the publication reflect 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 Tomáz Augusto Salomão
Executive Secretary, SADC
August 2012

still gentle mythical
the zambezi river
taps offers a cool breeze
a narrative in verse and air
the breeze will pick you up
in rhythm and rhyme

a seductive sensibility
woven into the fabric
deconstruction construction
skillful resplendent ethereal
ripples of water lap your ankles
skim the water with your fingers

a natural flow with the river
the current gets stronger
power of the cascade
let it wash over you
stand and refresh
in all its might and splendor

Poem by Paul Wade, May 2012

Depiction of Nyaminyami, the Zambezi river spirit, by Tapfuma Gutsa from his exhibition *Mulonga*, Deep Waters and Starry Skies

Preface

The Zambezi River Basin Atlas of the Changing Environment profiles an outstanding and globally important river basin. The massive Zambezi River Basin is a vital resource that holds potential for cooperation of the eight riparian nations in areas of environmental governance, cultural and heritage preservation, and economic development.

Aiming to be of value in guiding decision- and policy-making, the Atlas is expected to be an indispensable tool for benchmarking environmentally sustainable development and protection of ecosystem services in the basin. The eight countries sharing the basin – Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe – will benefit from the Atlas through the profiling of the basin's potential, as well as facilitation of increased cross-border cooperation.

The chosen concept and format of an environmental assessment, which uses visual science in defining policy direction should have a positive impact on safeguarding the magnificent landscapes and important ecosystems of the basin. Being the most shared and largest river basin in the Southern African Development Community (SADC), wise management of the Zambezi naturally could provide leadership and an example of success that authorities in other regions of shared river basins could want to replicate.

With five major transfrontier conservation areas, the Zambezi River Basin is important in fostering regional cooperation. Such cooperation is significant for the SADC region given the strong economic, cultural and political ties, which are aided by regional policies such as the one-stop border post, uni-visa system for tourists and the SADC protocol on the movement of people and goods.

The Zambezi River Basin Atlas of the Changing Environment underscores the importance of the environment dimension in sustainable development by emphasizing the ills of deforestation, land degradation and loss of biodiversity, among others, while also showcasing the benefits of sustainable conservation. For example, the Atlas acknowledges the importance of wildlife corridors as provided by trans-frontier conservation areas in allowing the free movement of wildlife as they search for pasture and water. The Atlas also acknowledges the important role the Zambezi River Basin plays in the integration of the SADC region by being the backbone of hydro-power generation.

By visually presenting an in-depth assessment of the scale of change in the state of the environment in the basin, the Zambezi River Basin Atlas of the Changing Environment not only supports policy-making, but also opens up new opportunities for collaborative research.

The preparation of the Atlas demonstrates the value of partnerships, with GRID-Arendal and SARDC IMERCSA bringing in their capacity to communicate complex science in a user-friendly way, and with SADC and the Zambezi Watercourse Commission providing the necessary political legitimacy to the process. GRID-Arendal values partnerships in as far as they are mutually beneficial and help leverage each other's potential. Partners such as SARDC have enabled GRID-Arendal's products to have a global outreach. It is therefore GRID-Arendal's wish that such partnerships are not only strengthened but also allowed to be more visible.

Dr. Peter Prokosch
Managing Director, GRID-Arendal
August 2012

Executive Summary

The Zambezi River Basin Atlas of the Changing Environment is a basin collaborative initiative with the objective of providing scientific evidence about changes that are taking place in the natural resources and the environment. The Atlas, with climate change as its running theme, is for use by policy makers and other stakeholders, and the general public, to generate action towards climate resilience through adaptation and mitigation of the impacts of climate change.

The Atlas discusses the impacts that these changes are having on the basin's people and resources, thus contributing to the documentation and study of the relationship between human populations and the environment.

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 are a number of natural resources ranging from water, land and soils, and minerals, to 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.

The Zambezi River Basin Atlas of the Changing Environment contains five chapters. The chapters make use of satellite images, maps, tables, graphs, photographs and illustrative text to present the key issues in the Basin.

Chapter 1 presents the biophysical and socioeconomic features of the Zambezi River Basin and sub-basins, and some examples of the rich cultures, stretching across eight countries – Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe.

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. Environmental change due to both natural and human activities is continuous, and in some cases very dramatic.

Chapter 2 presents the socio-economic and environmental changes taking place in the Zambezi River Basin. The causes of these changes are not entirely the result of human activities in the Basin, but are also as a result of activities that have occurred elsewhere in the world, such as large-scale emissions of greenhouse gases leading to climate change. Other causes include increased population pressure on the land and its resources, with associated processes of urbanisation, increased mining and industrial activities, increased deforestation and wildfires.

The resultant environmental effects of the local and global changes are presented in this chapter, including temperature rise, and rise in sea level, leading to increased frequency and severity of floods, droughts and cyclones. The associated socio-economic and environmental impacts are presented, including the impact on human health, agriculture, water resources and biodiversity.

Chapter 3 presents six transboundary issues of importance to the Zambezi River Basin: ecosystems and protected areas, water resources, movement of people, movement of pollutants, fire outbreaks, and navigation. The key components that constitute the environment such as plants, animals, weather systems and people do not remain solely within their national boundaries, and thus environmental issues of mutual concern arising from a shared natural area, resource, system, or migratory species become transboundary.

Neighbouring countries often face similar problems related to the causes of environmental change in a shared natural area and to the impacts on people and livelihoods. The Zambezi River Basin has for the past years witnessed a drastic change in its natural environment, mainly as a result of climate change, urbanisation and increased demand for agricultural land. These three major forces have caused alarming rates of water pollution in transboundary water resources, high loss of biodiversity and the drying up of valuable wetland ecosystems. All of this impacts on the wellbeing of people, wildlife and their environment.

Chapter 4 tracks Goal 7 on Environmental Sustainability, of the eight Millennium Development Goals (MDGs), with profiles of the eight riparian states of the Zambezi River Basin. The objective of the Millennium Declaration of 2000 was to promote a comprehensive approach and a coordinated strategy, tackling many problems simultaneously across a broad front, through the MDGs and related targets and indicators.

Water resources form the basis of almost every aspect of life in the Zambezi River Basin, including the sustenance of human livelihoods and biodiversity. The resources drive the socio-economic, political and cultural development of the basin's population. Apart from sustaining a rich diversity, water resources are critical for meeting the basic needs for domestic and industrial requirements, sanitation and waste management, which are among the targets for Goal 7.

The need to effectively coordinate and manage water resources has become a top priority in the Zambezi Basin to promote sustainable utilisation of such critical resources. Challenges of integrated and coordinated water resources development, environmental management and sustainable development, climate change adaptation, and the strategies required to address these challenges underline the need for stronger regional cooperation and closer integration in the field of water management.

Chapter 5 presents the policies and strategies that have been put in place to promote integrated resource management among the Basin states. A number of initiatives and activities have since been adopted to allow harmonisation, transparency and accountability in the water resource

sector. However, there is no single focal point to manage the resource. The need to formalise the cooperative framework and further strengthen basin-wide cooperation remains a challenge.

Among the policies and strategies for coordination and management is the Zambezi Watercourse Commission (ZAMCOM), an agreement signed by most of the Zambezi Basin states in 2004. To date, seven of the eight Basin states have signed the agreement with the exception of Zambia, and six have ratified the agreement. The remaining states have shown commitment to speed up signing and/or ratification. Through the ZAMCOM Agreement, the riparian states of the Zambezi River Basin envisage working together to develop and manage the shared water resources of the vast basin. The agreement is designed to help the riparian states to unlock the potential of the Basin in contributing to the socio-economic development of the Basin states and the region as a whole.

The Zambezi River Basin states have established the Interim Secretariat for the Zambezi Watercourse Commission (IZS) hosted by the Government of Botswana in Gaborone. The initial responsibility of the Secretariat is to coordinate and inform the riparian states of the expected steps needing their support towards the realisation of the ZAMCOM agreement and its vital governance organs. The establishment of the IZS means that the riparian states of the Zambezi Basin have a forum through which they can deliberate and plan the efficient management and development of the river basin resources for the benefit of present and future generations.

This Atlas supports initiatives of the African Ministerial Conference on the Environment (AMCEN) through the Africa Atlas of Our Changing Environment and the Africa Water Atlas, both UNEP-led initiatives, as stated in Decision 8 of the 12th Session of AMCEN.

The project is implemented by the Southern African Research and Documentation Centre (SARDC) through its environment institute, the I. Musokotwane Environment Resource Centre for Southern Africa (IMERCSA), in consultation with the Southern African Development Community (SADC) Water Division, the Interim Secretariat of the Zambezi Watercourse Commission (ZAMCOM), and Zambezi River Basin stakeholders. SARDC IMERCSA is the regional collaborating centre for southern Africa for UNEP under the Africa Environment Information Network (AEIN). Technical and financial support was provided by GRID-Arendal.

Acknowledgements

The Southern African Research and Documentation Centre's environment institute, the I Musokotwane Environment Resource Centre for Southern Africa, is pleased to present the *Zambezi River Basin: Atlas of the Changing Environment*. The work of many hands, both individuals and institutions, has made this Atlas unique and useful. It is the first such atlas of a single ecosystem in southern Africa, documenting the shared resources and potential for sustainable development as well as environmental impact, and we are rightly proud of the result.

SARDC would like to thank the partners in this initiative who are, first and foremost our long-term partners in the Southern African Development Community (SADC), the SADC Executive Secretary for his support and the SADC Water Division for partnership, the Interim Secretariat of the Zambezi Watercourse Commission (ZAMCOM) for having that fine mix of professional skills and people skills, the United Nations Environment Programme (UNEP) and especially the Managing Director and staff at GRID-Arendal who provided financial support as well as designing and printing of this fine publication. SARDC IMERCSA is pleased to present this Atlas as an output of its role as the UNEP Collaborating Centre for Southern Africa for environmental reporting, early warning and assessment.

The preparation of this Atlas benefited from a network of National Collaborating Centres (NCCs) in the Zambezi River Basin, including the Ministry of Energy, Water and Environment, Angola; Kalahari Conservation Society, Botswana; Coordination Unit for the Rehabilitation of the Environment (CURE), Malawi; ARA Zambeze, Mozambique; Integrated Rural Development and Nature Conservation (IRDNC), Namibia; Ministry of Water and Irrigation, Department of Water Resources, Tanzania; Zambia Environmental Management Agency (ZEMA); and the Environment Management Agency (EMA), Zimbabwe.

We want to thank the National Environment Management Authority (NEMA) of Uganda for use of their atlas (2009), Uganda: Atlas of Our Changing Environment, as reference for composition and presentation. And we also warmly thank our partners at NEMA for the staff exchange during this process, under the Norwegian FK programme.

The preparation of the Atlas started in 2010 with the formation of a consultative group from representatives of the eight Zambezi basin states. Through online consultation with this group and other Zambezi River Basin stakeholders including SADC, and in collaboration with UNEP/GRID-Arendal, SARDC IMERCSA prepared a zero draft of the Zambezi River Basin Atlas of the Changing Environment. A regional review workshop was then convened to identify data gaps and cross check the presented data for other available sources and updates, check on accuracy of facts, identify other significant changes not included in the draft, identify hotspots in the basin, and indicate other planned initiatives not captured in the draft, as well as to obtain wider regional ownership of the process and content of the Atlas. SARDC IMERCSA then finalized the manuscript by incorporating comments and updating, review and edit.

Design and printing was done by GRID-Arendal in consultation with SARDC, and GRID-Arendal also designed and hosts the internet version of the Atlas which is available at www.grida.no with links to the Virtual Library for Southern Africa at www.sardc.net (Knowledge for Development) as well as links to www.sadc.int, www.unep.org and www.zambezicommission.org.

The partners would like to thank well-known Zimbabwean artist, Tapfuma Gutsa, to use images of his artwork on the cover and opening pages of this Atlas. This gives the Atlas the timeless perspective of Nyaminyami, the spirit of the Zambezi river, whose presence is shown on the front cover; while the back cover image depicts Mulonga, the river itself; and Husha marks the inside Contents pages. These are part of Gutsa's 2012 exhibition entitled, Mulonga, Deep Waters and Starry Skies.

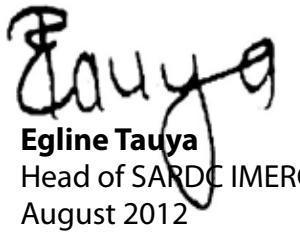
The Atlas was produced with financial support from GRID-Arendal and technical backstopping from UNEP as well as from Planet Action who provided GIS software through Environmental Systems Research Institute (ESRI). We want to thank GRID-Arendal for their patience and creativity in the design process and for printing the final product. To Clever Mafuta, the Africa Coordinator at GRID-Arendal, we acknowledge your spirit of partnership and shared vision as well as your personal commitment to this initiative. Thanks yet again to the pillar of shared water resources in southern Africa, Phera Ramoeli, Senior Programme Officer SADC Water Division, and to Michael Mutale, Executive Secretary of the Interim ZAMCOM Secretariat, both of whom gave us enormous encouragement and an institutional framework of firm support. You know already that your IZS Communications Specialist, Leonissah Munjoma, is second to none.

Here we must make another very personal acknowledgement, to Achim Steiner, Executive Director of UNEP, with very special thanks for starting out with us on this journey long ago and staying the course!

Phyllis Johnson, the SARDC Executive Director, we thank you for your engagement, thorough technical review and knowledgeable editorial eye that made this Atlas a cut above the rest. The SARDC Programmes Director, Munetsi Madakufamba, who set the tone for the review workshop with this thoughtful opening remarks, and for his support, we thank you. The IMERCSA staff who worked tirelessly to make this product a success, we greatly appreciate your determination and commitment. A detailed list of the Editorial and Production team is found at the back of the Atlas.

There are many organisations and individuals who have contributed directly and indirectly to this process. While efforts have been made to acknowledge their input, it may be that not everyone has been credited by name. Please accept this acknowledgement of your role in this important publication.

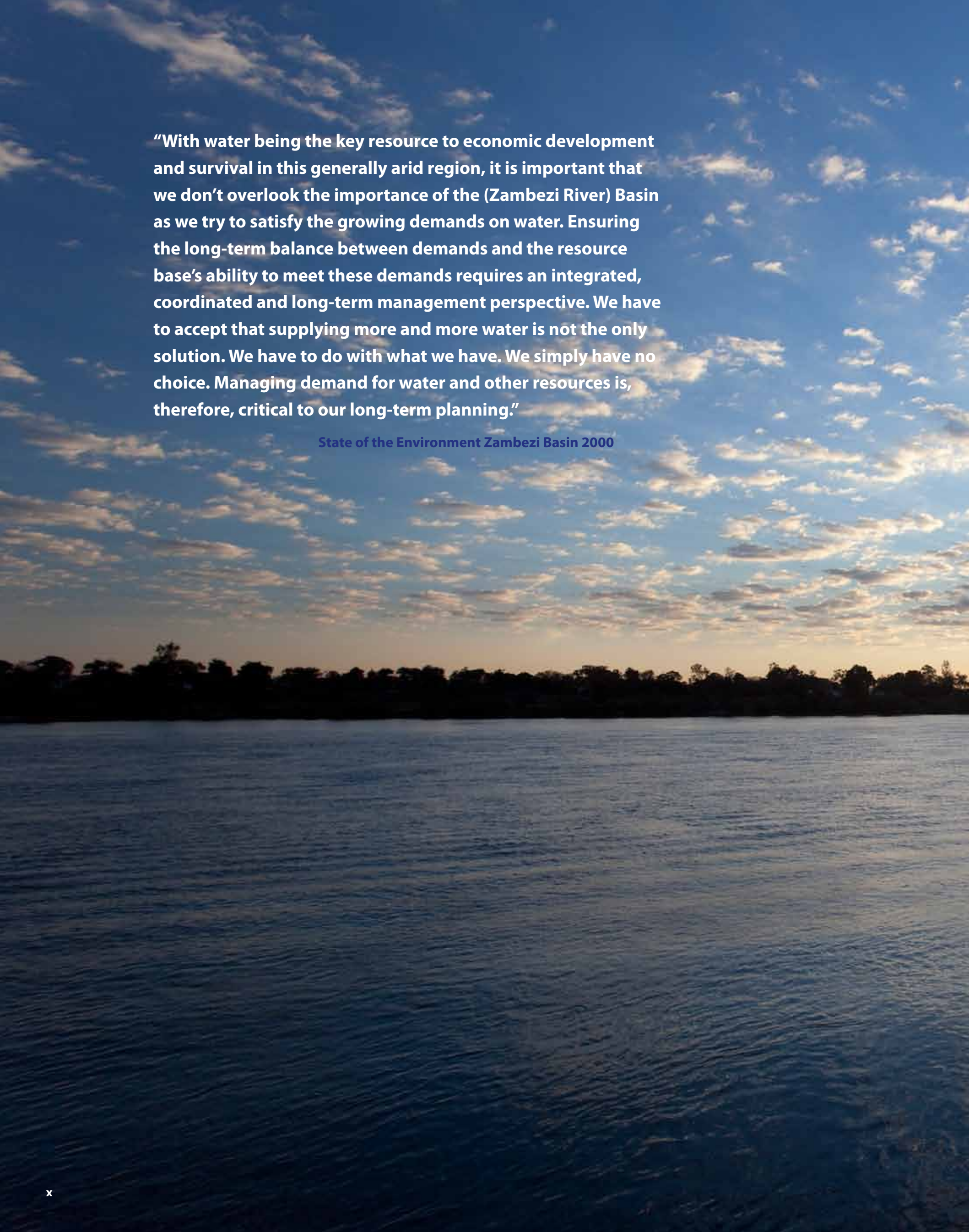
We dedicate this work to you, the users.



Egline Tauya
Head of SARDC IMERCSA
August 2012

Acronyms

AEIN	Africa Environment Information Network
ADBG	African Development Bank Group
AIDS	Acquired Immune Deficiency Syndrome
AMCEN	African Ministerial Conference on the Environment
AU	African Union
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species
DDT	Dichlorodiphenyltrichloroethane
DEWA	Division of Early Warning and Assessment (UNEP)
FAO	Food and Agricultural Organisation (UN)
FAOSTAT	Food and Agricultural Organisation Statistics
GRID	Global Resource Information Database
GWP	Global Water Partnership
HBS	Heinrich Boll Stiftung
HIV	Human Immunodeficiency Virus
IIED	International Institute for Environment and Development
IMERCSA	I Musokotwane Environment Resource Centre for Southern Africa
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
MDGs	Millennium Development Goals
MGDS	Malawi Growth and Development Strategy
MICOA	Ministry for Co-ordination of Environmental Affairs
MICS	Multiple Indicator Cluster Survey
NCCs	National Collaborating Centres
PROBEC	Programme on Basic Energy Communities in Southern Africa
RBOs	River Basin Organizations
RSAP	Regional Strategic Action Plan
SADC	Southern African Development Community
SADC–WD	Southern African Development Community--Water Division
SAEO	Southern Africa Environment Outlook
SARDC	Southern African Research and Documentation Centre
SWI	Shared Watercourse Institutions
TFCA	Trans Frontier Conservation Area
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNESA	United Nations Economics and Social Affairs
UNICEF	United Nations Children's Fund
USGS	United States Geological Survey
WHO	World Health Organisation
WWF	World Wildlife Fund
ZACPRO 6.2	Zambezi Action Plan Project 6.2
ZAMCOM	Zambezi Watercourse Commission
ZAMWIS	Zambezi Water Information System
ZRA	Zambezi River Authority
ZRB	Zambezi River Basin



"With water being the key resource to economic development and survival in this generally arid region, it is important that we don't overlook the importance of the (Zambezi River) Basin as we try to satisfy the growing demands on water. Ensuring the long-term balance between demands and the resource base's ability to meet these demands requires an integrated, coordinated and long-term management perspective. We have to accept that supplying more and more water is not the only solution. We have to do with what we have. We simply have no choice. Managing demand for water and other resources is, therefore, critical to our long-term planning."

State of the Environment Zambezi Basin 2000

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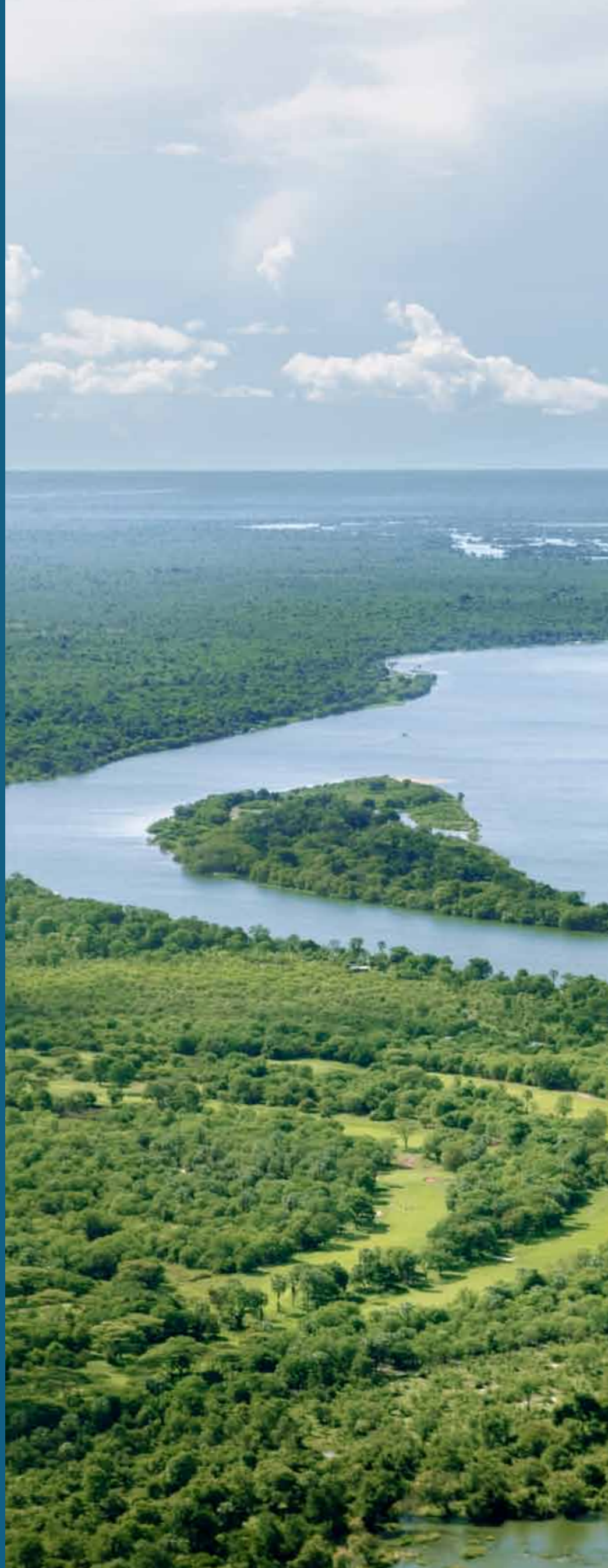
1

THE ZAMBEZI RIVER BASIN

The Zambezi River Basin drains parts of eight countries and is the most shared river system in southern Africa. The river basin is shared by Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. The Zambezi River and its dense network of tributaries discharge an average of 2 600 cubic metres per second (m^3/s) of water, a rate in the same range as the Nile (2 830 m^3/s) and the Rhine (2 200 m^3/s) (Beck and Bernauer 2010). The basin has abundant water, fertile land and soils for agriculture and diverse habitats that are home to large populations of wildlife. This natural capital defines the basin's economic activities which include agriculture, forestry, manufacturing, mining, conservation and tourism. The basin is also a centre for scientific monitoring and research.



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Overview of the Zambezi

The Zambezi River flows over a distance of almost 3 000 kilometres, 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 in the Indian Ocean, 200 kilometres north of the Mozambican port of Beira (Chenje 2000).

The Zambezi River has tributaries along both banks, and these drain portions of eastern and southeastern Angola and northern Zambia onto a low-gradient area that forms the Barotse floodplain. From the Ngonye Falls, the river steepens, collecting water from more tributaries, including the Cuando-Chobe River that drains southern Angola and Namibia's Caprivi Strip. Three hundred kilometres downstream, the river drops a dramatic 100 metres forming the Victoria Falls and marking the beginning of the river's middle section (Moore and others 2007).

Figure 1.1
There are 63 transboundary river basins in Africa, covering 64 per cent of the continent's land area (UNEP 2010). The Zambezi basin is the fourth largest in Africa after the Congo, Nile and Niger River Basins (Mukosa and Mwiinga 2008).

As it traverses its more than 3 000-km journey from the Kalene Hills, Zambia to the Indian Ocean, the Zambezi River takes various shapes, with some sections wide while others are narrow. The river also makes twists and turns, flowing through deep gorges and flat floodplains.

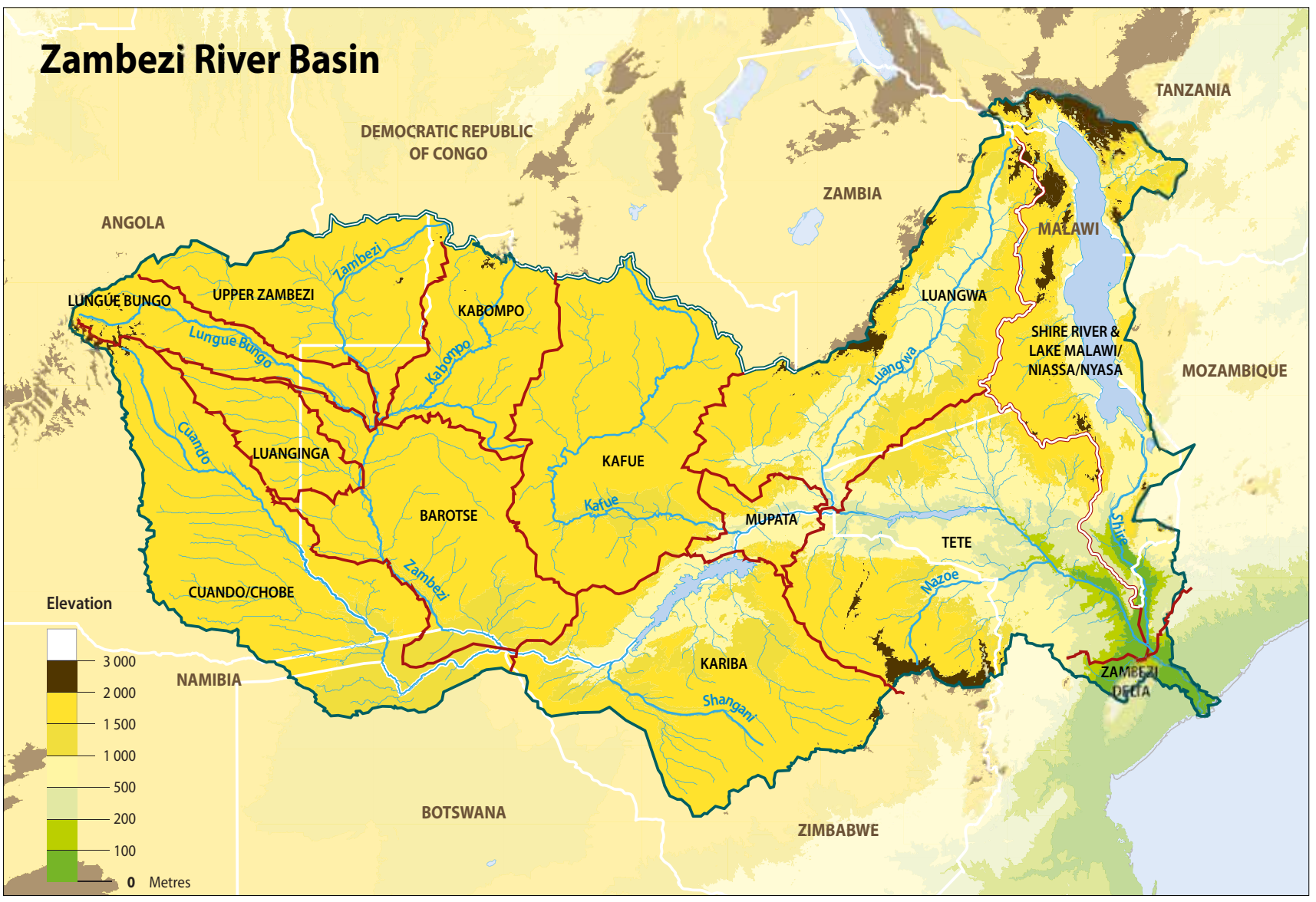
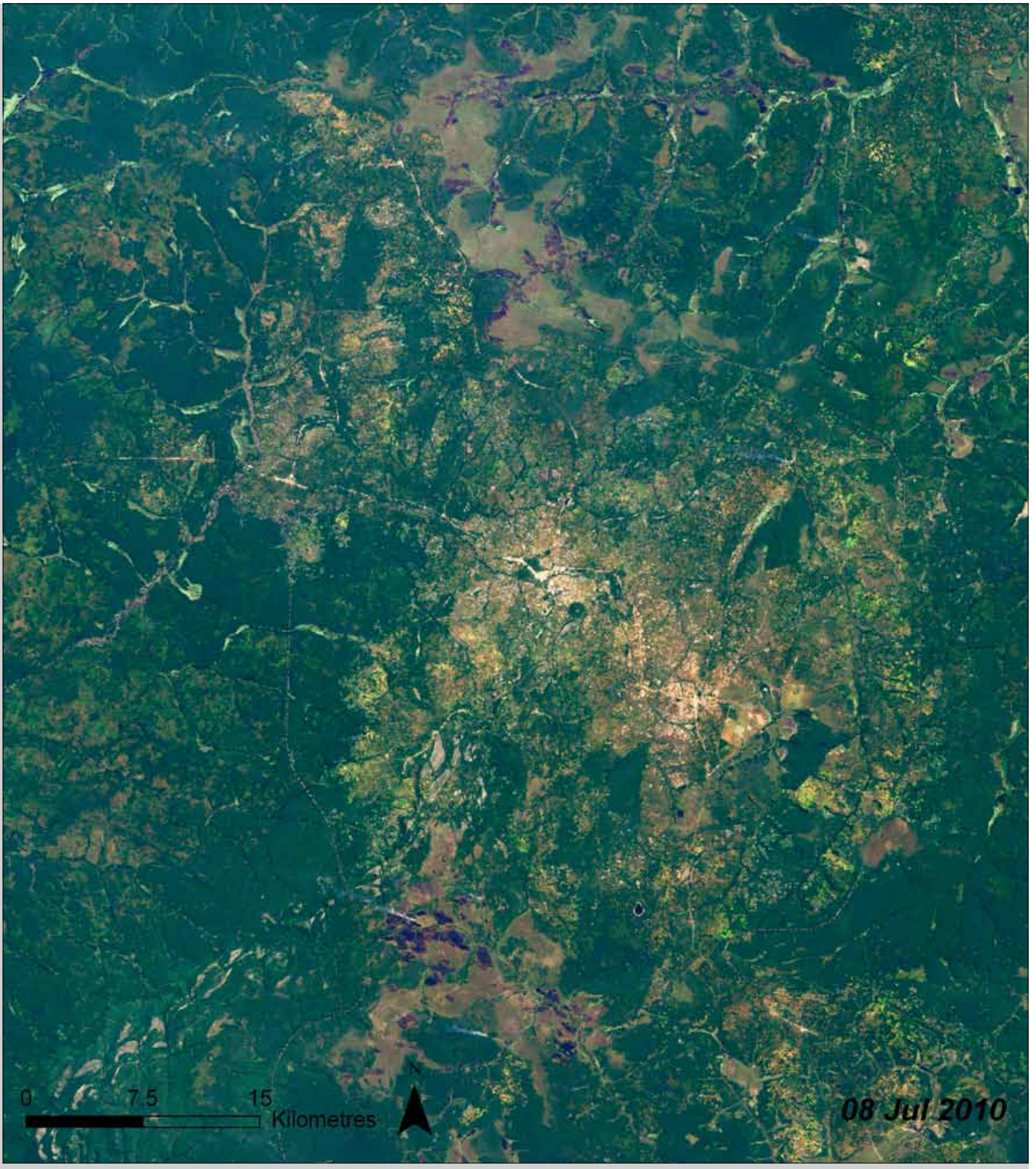


Figure 1.2
The Zambezi River Basin is located between 8–20° S latitude and 16.5–36° E longitude in southern Africa (Chenje 2000). It drains an area of almost 1.4 million square kilometres, stretching across 8 of the 15 member states of the Southern African Development Community (SADC).

The Zambezi River has its source in a marshy bog near the Kalene Hills in Zambia. The Zambezi starts as a small river flowing along a granite dome. Located in Mwinilunga Province, the area around the Kalene Hills is largely used for farming and conservation. Good land use practices



have seen the area unchanged over the last decades with a predominant Miombo woodland vegetation type. The Miombo woodlands cover much of central and southern Africa, and are home to about 8 500 plant species, including 300 trees.

Below Victoria Falls, the gradient steepens sharply, the flow accelerates, rapids rise, and the river makes a series of sharp turns for several kilometres (Moore and others 2007). The river then widens forming the border between Zambia and Zimbabwe. As it enters Lake Kariba the river expands dramatically (UNEP 2010).

Approximately 200 kilometres downstream of the Kariba Dam, the Zambezi River enters Mozambique and flows into Lake Cahora Bassa. Below this, the gradient levels out again as the river crosses the coastal plain and is joined by Shire River. Below the confluence with the Shire River, the Zambezi crosses another area of floodplains before reaching the Zambezi delta and emptying into the Indian Ocean in Mozambique (UNEP 2010).

The Victoria Falls marks the beginning of the middle section of the Zambezi River. The Falls are about 1 700 m wide, with a height ranging from 80–108 m. In mid-April when peak flood waters occur, about 625 million litres of water flow over the edge every minute.

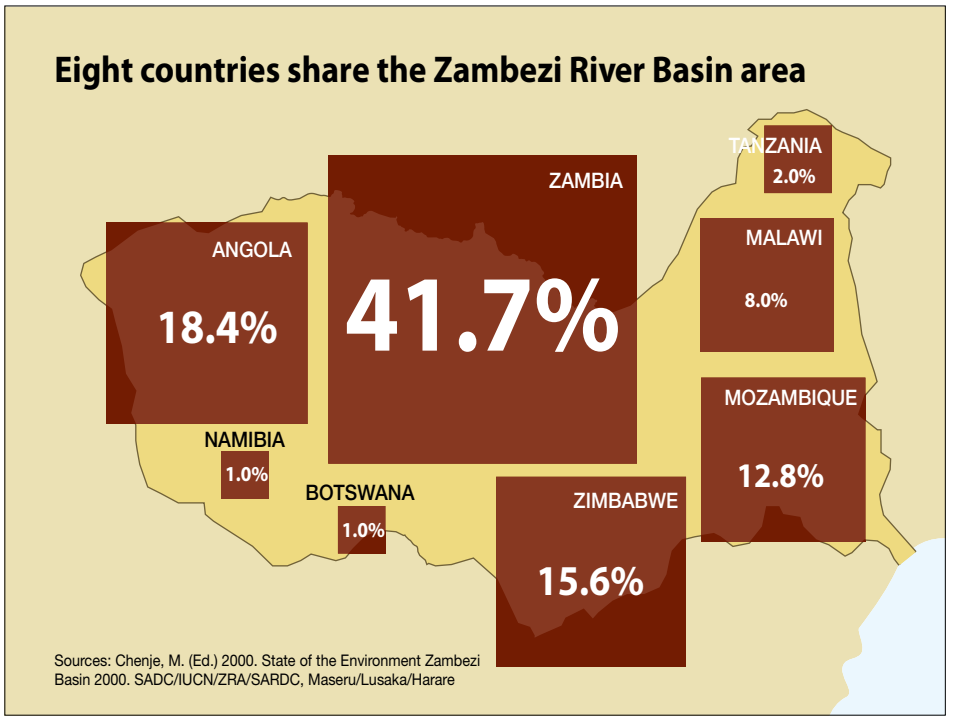


Figure 1.3
The Zambezi River Basin has 13 sub-basins, most of which are transboundary. The largest portion of the basin lies in Zambia, with smaller segments in Angola, Zimbabwe, Mozambique and Malawi in that order. Tanzania, Botswana and Namibia have less than three per cent of the basin each.

The Zambezi River at the Victoria Falls.

Population

The population of the Zambezi River Basin was almost 31.7 million in 1998. This represented about one-third of the total population of 100 million in the eight basin countries at the time. Ten years later, in 2008, the basin population reached 40 million, with 7.5 million living in the urban centres (SADC and ZRA 2007).

The total population of the eight countries of the Zambezi basin is expected to reach 168 million by 2025. The basin population is projected at 47 million, about 30 per cent of the total, with urbanization steadily increasing. The basin's population is expected to increase modestly, at the same rate as the national populations, as no substantial immigration into the Zambezi basin is anticipated. Population growth in the region has been moderate because the AIDS pandemic has had some impact on 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.

Table 1.1. Area and Population of 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*	2025 population (000) UN medium projection	% of National Population in Basin
Angola	1 246 700	256 500	20.5	18.47	13 399 000	25 940 000	487 200	950 080	36.63
Botswana	581 730	19 100	3.3	1.38	1 651 000	2 270 000	12 000	16 500	.073
Malawi	118 484	110 700	93.4	7.97	10 475 000	18 695 000	9 821 400	18 071 955	96.67
Mozambique	799 390	163 800	20.5	11.8	17 240 000	26 730 000	3 991 870	6 187 455	23.15
Namibia	824 290	17 100	2.1	1.23	1 900 000	2 460 000	60 890	82 438	3.35
Tanzania	945 087	27 300	2.9	1.97	31 900 000	56 090 000	1 271 920	2 200 420	3.92
Zambia	752 614	577 900	76.8	41.63	9 886 000	18 285 000	7 046 250	11 979 610	65.52
Zimbabwe	390 759	215 800	55.2	15.55	11 696 000	17 395 000	9 050 000	11 674 065	67.11
Total	5 659 054	1 388 200	24.5	100	98 147 000	167 865 000	31 741 530	51 161 960	

Sources: Spatial data from Hirji *et al.* 2002, Deconsult 1998, SADC and SARDC 2008.

The livelihood of riverine communities is largely dependent on fishing.

Fishing village, Cahora Bassa.

Women are mostly responsible for cooking, tilling gardens, fetching firewood and water, and keeping small livestock such as goats. Women also have obligations, which fall within their domestic domain such as food preparation and childcare.

Gender

Women and men play gender-specific role in all socio-economic activities including, agriculture, mining, fishing, hunting and gathering, forestry, tourism, recreation, crafts, transport, water resources development and environmental management. Men are generally responsible for attending political and social meetings as well as being responsible for hunting, fishing and animal husbandry. They also make decisions about what crops to grow, what land preparation procedures to use, when to harvest and how much produce to sell.

In Zambia, 90 per cent of agricultural land falls under traditional authority, which is based on patriarchal principles of allocation. This is despite the existence of a clause in the 2002 Land Policy of Zambia, which aimed to allocate 30 per cent of land to women. There is no strategy to change customary law so that women can have both use and ownership rights to land. In 2002, the government of Zimbabwe also committed to allocating 20 per cent of land to women through resettlement, but implementation of this provision is weak (SARDC WIDSAA 2008).

Women are active and knowledgeable managers and caretakers of the environment. In many rural areas, women carry out natural resources conservation work, such as soil conservation and planting.

In the urban areas, women take primary responsibility for the maintenance of clean living conditions for their families. While women constitute the majority of the agricultural workers in the region, and are mainly responsible for food production, their land rights are limited in all countries in the basin.

Technology is used mainly for crops grown by men, and for the large part, men are the ones who receive Master Farmer training. They are also usually responsible for overseeing the family water and sanitation systems. Due to factors such as urbanization, gender roles have begun to change with women taking over decision-making positions that were previously dominated by men. In order for the basin and the rest of southern Africa to achieve its poverty reduction and eradication objectives, its policies and strategies should address the gender gaps that exist across southern African society (SADC and SARDC 2008).

Firewood is the most common energy source in the Zambezi basin's rural areas.

Land Cover and Land Use

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 *et al.* 2002).

Almost 75 per cent of the land area in the basin is forest and bush. Cropped land with mostly rain-fed agriculture covers 13 per cent of the land area, and grassland covers about 8 per cent of the land area.

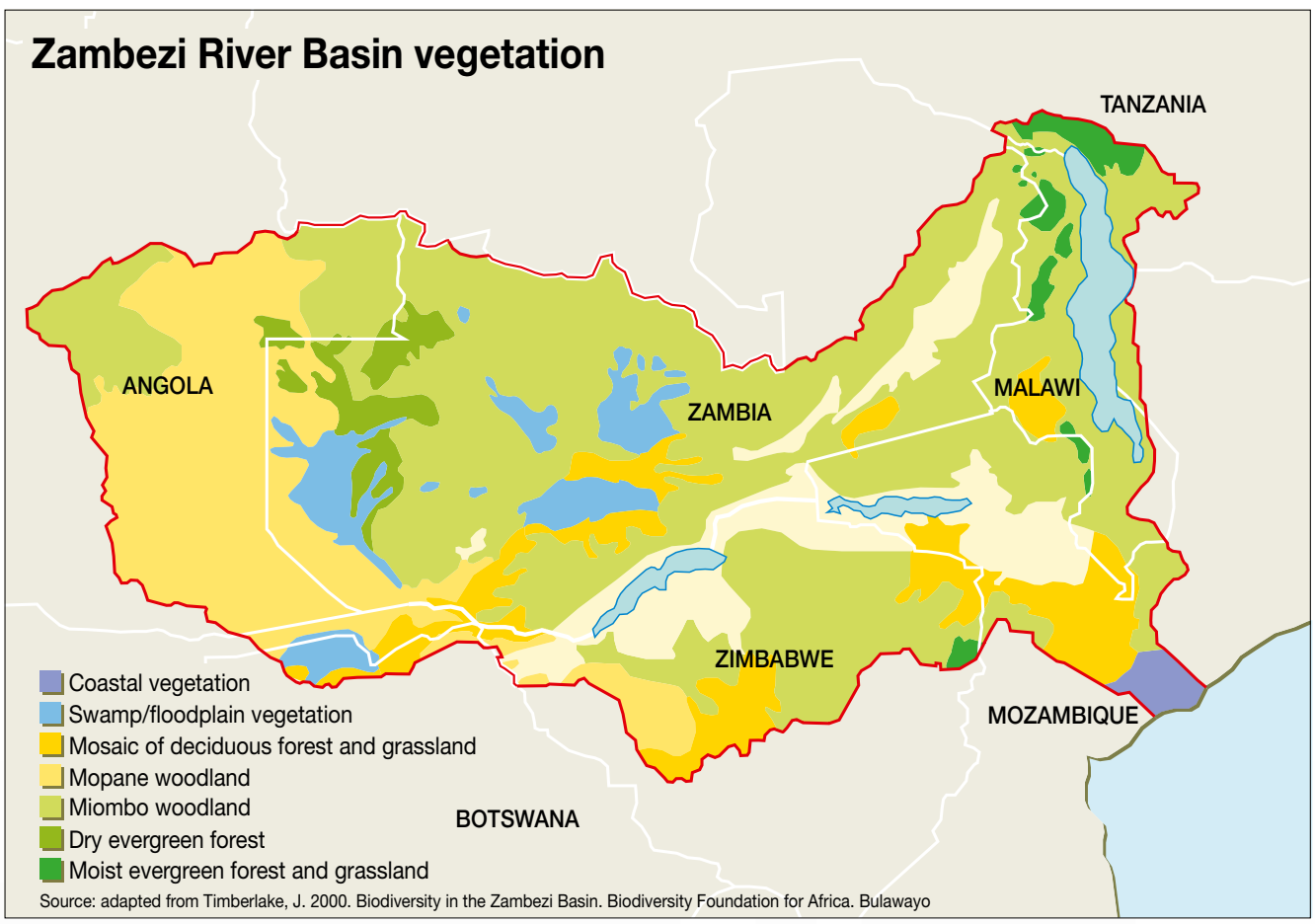


Figure 1.4

Biodiversity

The Zambezi River Basin is rich in biodiversity and includes four distinct biomes; the Zambezian, Congolian, Montane, and Coastal (Chenje 2000).

Zambezian Biome

The Zambezian biome covers 95 per cent of the basin, and comprises woodland, grassland, swamp and lakes (Timberlake 2000). The climate has distinct seasons with marked dry and wet seasons. This biome is sometimes subdivided into moister areas characterized by broad-leaved miombo (*Brachystegia*) woodland, and drier areas with mopane (*Colophospermum mopane*) and/or Acacia or wattle woodland. The Zambezi basin is home to more than 6 000 species of flowering plants, 650 species of birds and 200 species of animals (Timberlake 2000). In addition, 165 species of freshwater fish are recorded in the basin and more than 500 endemic species (mostly cichlids) in Lake Malawi/Nyasa/Niassa (SARDC IMERCSA 2003).

Montane Biome

The Montane biome lies between 1 800 and 2 000 metres above sea level. It is cooler, wetter, often shrouded in mist, and has a much more temperate climate. Species found in this biome include grassland herbs and introduced species such as pine and wattle trees (Chenje 2000).

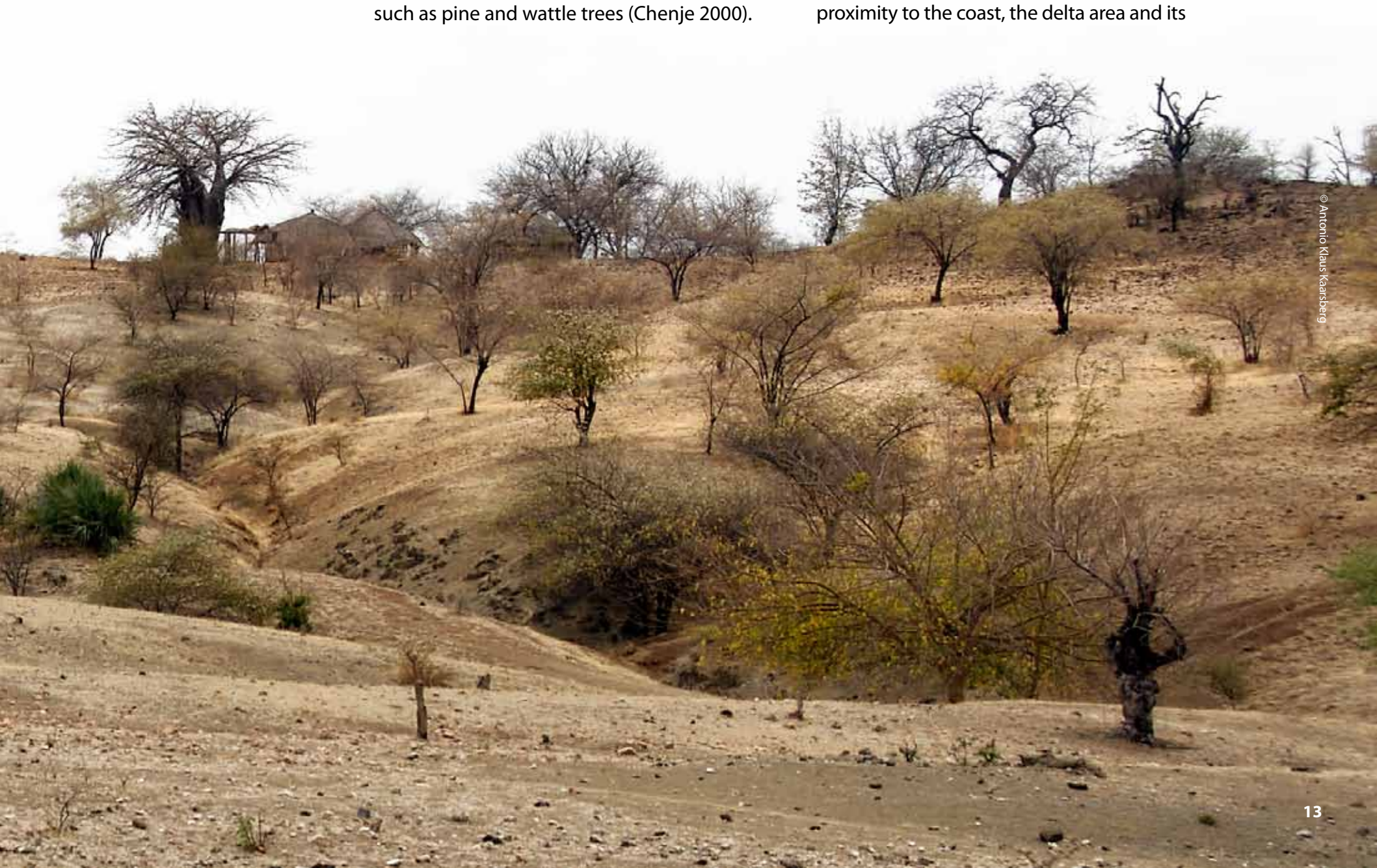
The Yellow Billed Stork is one of the many birds found in the Zambezi basin.

The Congolian Biome

The Congolian Biome is within the head waters of the Zambezi in northwestern Zambia and northeastern Angola. The biome has a moister and warmer climate than the rest of the plateau portion of the basin. The vegetation and wildlife species are a mix of those found in the forested Congo Basin and in the less tropical, more wooded Zambezi basin (Chenje 2000).

Coastal Biome

The coastal biome is the small part of the basin in Mozambique where climate is modified by proximity to the coast, the delta area and its



Lake Cahora Bassa has a storage capacity of about 63 000 million cu m upon completion of the dam. The lake started filling in December 1974. The inundation flooded a large area, and had caused a significant change to the surronding habitat. This almost resulted in the disappearance

immediate surroundings. There is no marked dry season, temperatures do not fluctuate greatly, and habitats include dry forests and grasslands. Most species found here are widespread along the East African Coast from Somalia to northern Kwazulu–Natal in South Africa.

Threats to Biodiversity

There are numerous threats to the basin's biodiversity, including land clearance for agriculture and expansion of human settlement, dam construction, fires, and invasion by alien species. Examples include the invasion of pines and wattle trees into the montane grasslands of Mt. Mulanje, the introduction of the Nile tilapia fish (*Oreochromis niloticus*) to the waters of the Middle Zambezi, and Kariba weed (*Salvinia molesta*) into the Chobe system and Lake Kariba (Timberlake 2000). Probably the greatest impact on biodiversity in the basin was due to dam construction. The Kariba, Cahora Bassa, Itezhi-Tezhi and Kafue dams (constructed from 1950 to 1970) changed hydrology, modified flooding cycles, and affected habitat and species composition.

Cahora Bassa is the second largest artificial lake in the Zambezi basin, after Kariba.

of the Cape buffalo (*Syncerus cater*). Despite altering the Basin's flood regime, and causing loss of wildlife, the lake strengthened access to clean energy, with an installed capacity of 2 075 Mw of hydropower.

In Botswana, Namibia and Zimbabwe, the elephant population exceeds the countries' carrying capacity, creating problems of overpopulation and destruction of habitats. For example, Botswana has 106 000 elephants in an environment with an estimated carrying capacity of 50 000. Large elephant populations negatively affect the recovery of the rhinoceros herd by preventing the animals from using grazing areas and gaining access to water points.

Water Resources

Water resources are essential for the social and economic development of the basin's society, supporting industry, domestic water use, hydropower generation, irrigation, transportation and recreation.

Wetlands

Wetlands cover a large area of the Zambezi River Basin. For example, in Zambia the Kafue Flats, Lukanga swamps, Barotse flood plains, Nyambomba swamps, Cuando, Busanga, Luangwa and Luena flats cover an area greater than 2.6 million hectares (SADC and ZRA 2007). These wetlands are used for fisheries, agriculture, wildlife management, and transportation services.

The variations in flooding in areas such as the Zambezi floodplains, East Caprivi wetlands, Kafue Flats and Muzarabani district create the soils used to support the intensive agriculture that sustains communities living near them.

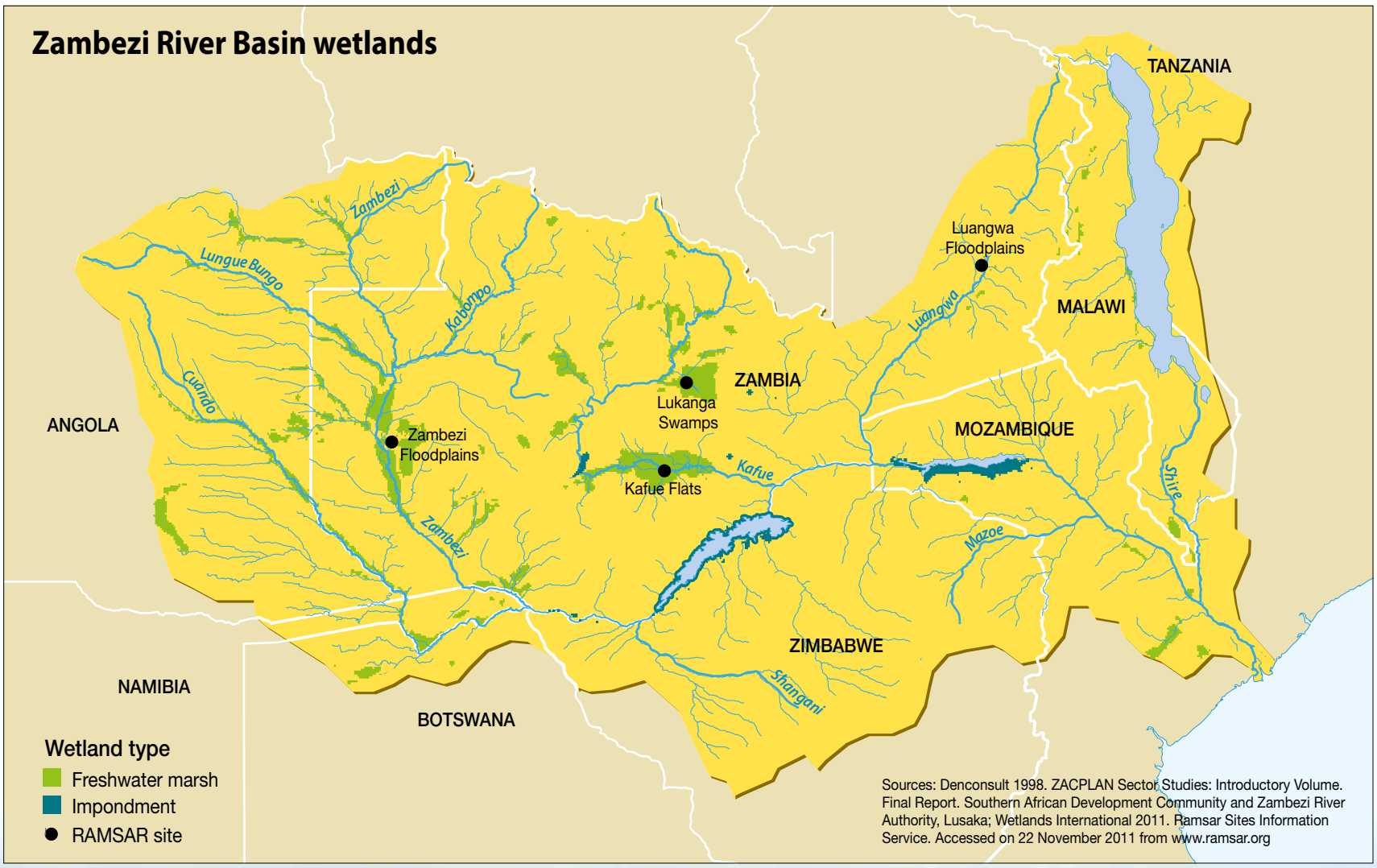


Figure 1.5

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Ramsar Convention

The Ramsar Convention is a global environmental treaty governing the use of wetlands. The treaty was signed in Ramsar, Iran in 1971. The convention's mission is the "conservation and wise use of all wetlands through local and international actions and international cooperation as a contribution towards achieving sustainable development throughout the world". Wetlands are among the world's most threatened ecosystems.

One of the main activities of the convention is the designation of wetlands of international importance as Ramsar sites. The other activities are the promotion of wise use of wetlands in each signatory country and international cooperation to further the wise use of wetlands and their resources. Angola and Zimbabwe are the only countries in the Zambezi basin that are not parties to the Ramsar Convention.

Table 1.2. Major Wetlands and Ramsar Sites

Country	Wetland	Area (ha)	Utilisation	Ramsar listed
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	Lago Niassa e Zona Costeira	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 & Cuvelai drainage	600 000	Farming, fishing domestic water supply, wildlife	23 Aug 1995
	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
Tanzania	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
	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
Zambia	Bangweulu Swamps	1 100 000	Ecotourism	28 Aug 1991
	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 wa Ntipa	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
Zimbabwe	Mid-Zambezi Valley and Mana Pools	36 000	Tourism	Not listed
	Save River System		Agriculture	Not listed
	Gorhwe and Manjinji Pans	4 000	Wildlife	Not listed
	Pans of the Western Districts	15 000 (estimate)	Tourism	Not listed

Source: Wetlands International 2011

The most important wetlands in the basin are Barotse Floodplains in Zambia, the Chobe Swamps in northeastern Namibia, the Linyanti Swamp in Botswana, the Busanga Swamps on the Lunga River, the Lukanga Swamps and the Kafue Flats on the Luangwa River, and the Elephant Marsh near the town of Chiromo in Malawi.

Wetlands are important habitats for fish, animals and birds and provide vegetative cover and suitable breeding and feeding grounds for many species. Wetlands are also used for commercial fisheries, the most notable of which are in Lake Malawi/Nyasa/Niassa, the Zambezi delta/Sofala bank, Cahora Bassa, Itezhi-Tezhi, Kafue and Lake Kariba. Fish contribute a significant part of the daily diet of the people who live near wetlands.

Wetlands also promote tourism activities including photography, bird watching and hunting (SADC and SARDC 2008).

The Barotse Plains in Western Province of Zambia is also known as the Bulozi Plain, Lyondo or the Zambezi Floodplain. It is a designated Ramsar site, and is regarded as of high conservation value.

Wetlands are important habitats for many species, including birds.

© Lisa de Vreede

Lake Malawi is shared with Mozambique, where it is called Lago Niassa; and with Tanzania, where it is called Lake Nyasa.

Lakes

There are three major lakes in the Zambezi basin, Lake Malawi /Nyasa/Niassa), Lake Kariba and Lake Cahora Bassa. Lake Malawi/Nyasa/Niassa is the second deepest lake in Africa after Lake Tanganyika and the third deepest in the world (Chenje 2000). Lake Kariba and Lake Cahora Bassa are artificial lakes created by the construction of dams on the Zambezi River. There are many other smaller natural and artificial lakes associated with dams constructed for hydropower and/or water supply for irrigation or domestic use.

© SARDC

With a capacity of 180 billion cubic metres, Lake Kariba is the largest artificial lake in the Zambezi basin, and the second largest in Africa after Lake Volta.

© SARDC

Climate

The Zambezi River Basin's climate is strongly influenced by prevailing wind systems that include the South-easterlies, the Congo air mass, the North-easterlies and the Inter-Tropical Convergence Zone. The presence of large water bodies, Lake Malawi/Nyasa/Niassa, Lake Kariba and Lake Cahora Bassa, also plays a role in modifying weather conditions.

The temperature across the river basin varies according to elevation and, to a much lesser extent, latitude. Mean monthly temperatures for the coldest month, July, vary from below 13°C for higher elevation areas in the south of the basin to 23°C for low elevation areas in the delta in Mozambique. Figure 1.7 indicates that the coolest area is the south-eastern part of the basin, part of which is in Zambia and the other part is in Zimbabwe. Ground frost occurs locally in some parts of the basin between July and August as daily minimum temperatures in higher elevation areas can be below 0°C.

Mean daily temperatures for the warmest months (October and November) vary from around 23°C in the highest elevation areas, to 31°C for the lower parts of the Zambezi Valley (Chenje 2000). The basin experiences a high daily range of temperatures, with an average range 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 northern Zimbabwe. Due to the high temperatures, the annual total evaporation ranges between 5 to 10 mm per day. As a result, about 65 per cent of all the

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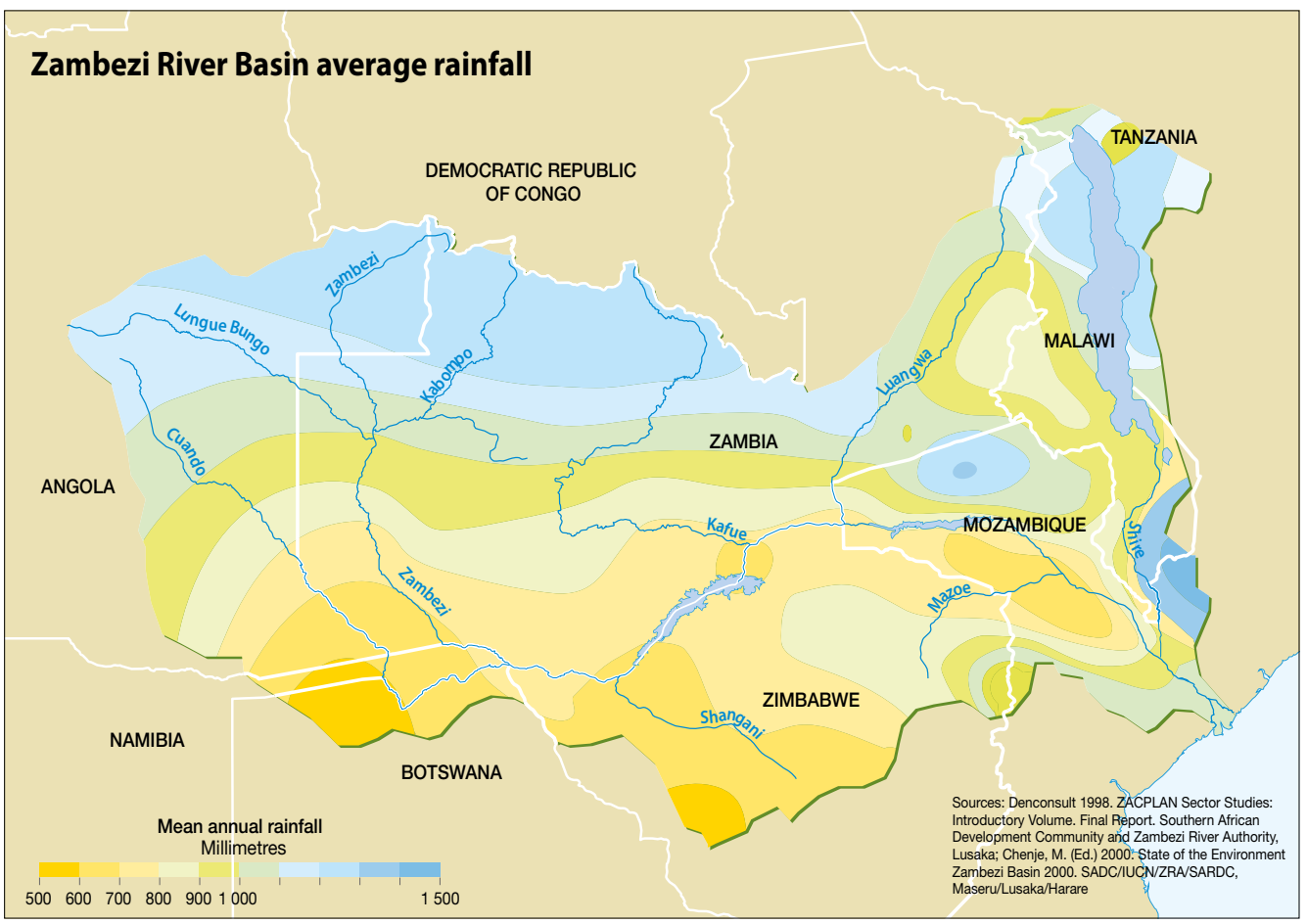

Figure 1.6

rainfall evaporates as soon as it falls, 20 per cent is lost through evapotranspiration and an average of 14 per cent is available as surface runoff (Chenje 2000).

Average annual rainfall across the river basin varies from 500 mm in the extreme south and southwest part of the basin to more than 1 400 mm in the Upper Zambezi and Kabompo sub-basins, in the north-eastern shores of Lake Malawi/Nyasa/Niassa in Tanzania, and in the southern border area between Malawi and Mozambique (Chenje 2000).

Rainfall is greatest in the north, with an extensive area receiving over 1 000 mm, and declines towards the south, where most areas receive less than 700 mm (SADC and ZRA 2007). In general, there is only a single rainy season in the year. Rainy seasons are longer in the north and northeast, and much shorter in the southwest.

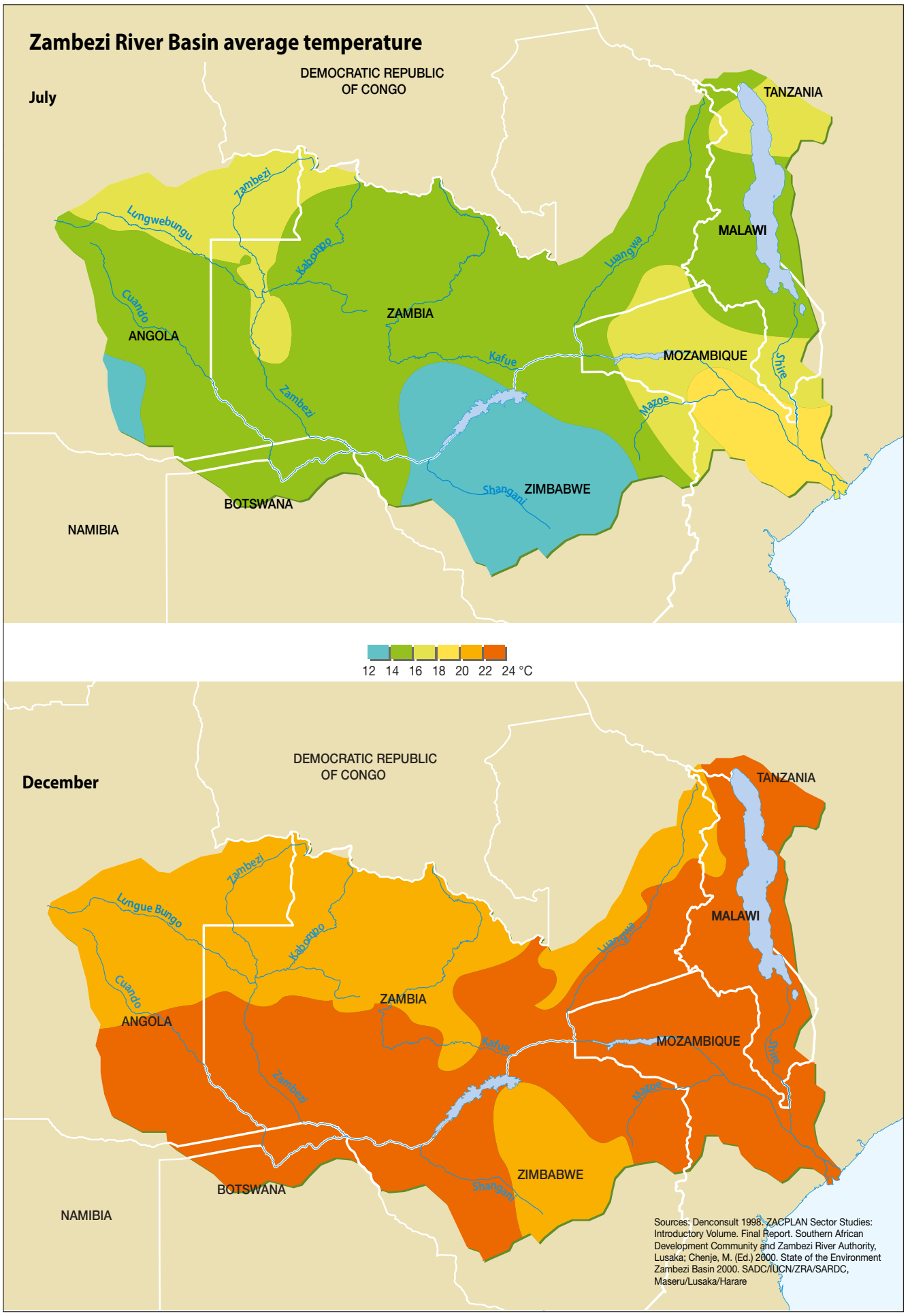

Figure 1.7

Energy

About 74 per cent of the total energy needs of the eight basin states come from biomass (Chenje 2000). Wood fuel energy is used mostly for domestic purposes, including cooking and lighting. There are 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. Renewable electricity sources such as hydropower and non-renewable sources such as thermal power, petroleum and natural gas are available in the basin. New technologies such as wind and solar energy are gaining prominence (SARDC 2009).

The hydropower potential of the Zambezi River Basin is estimated at 20 000 megawatts (MW)

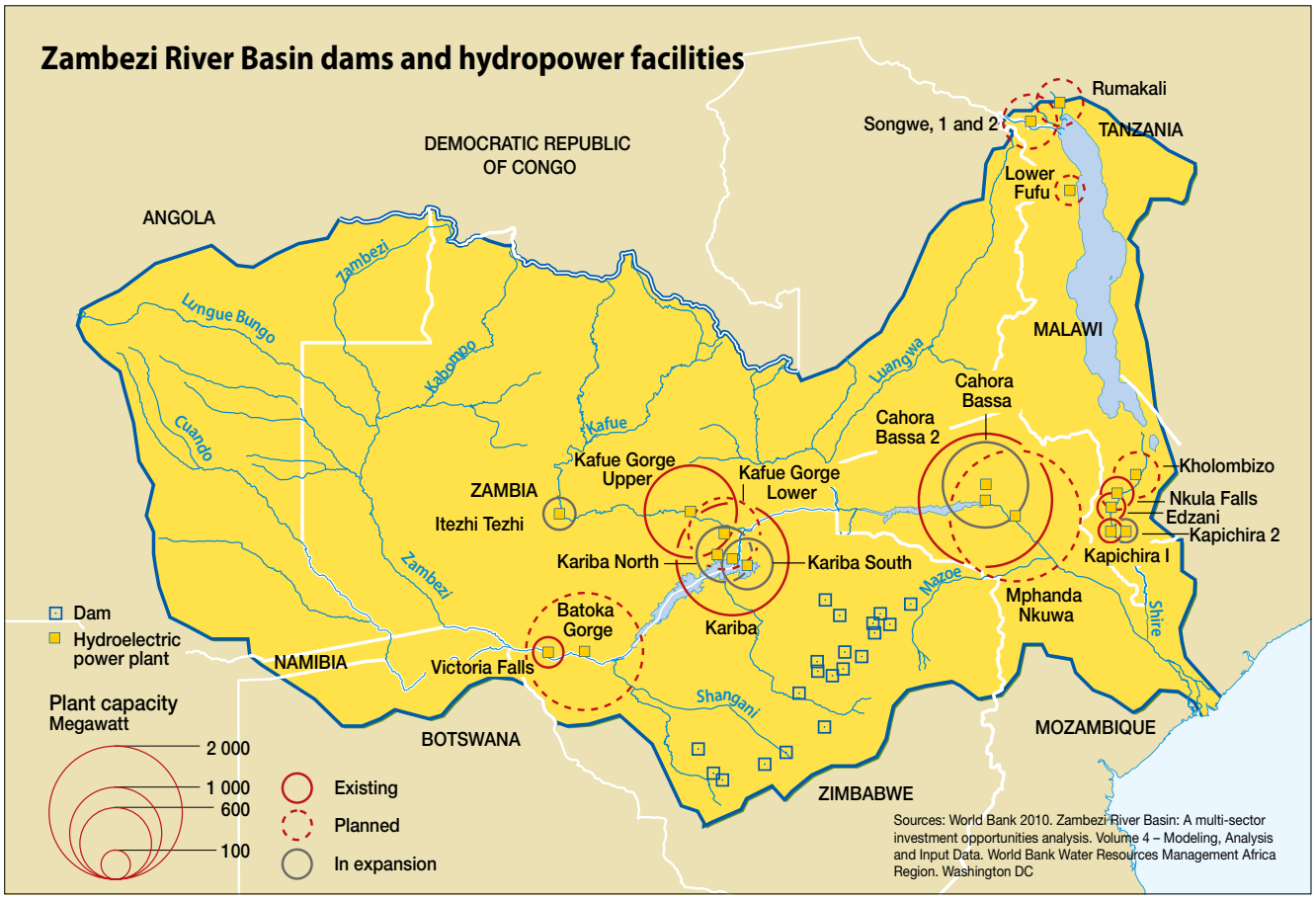

Figure 1.8

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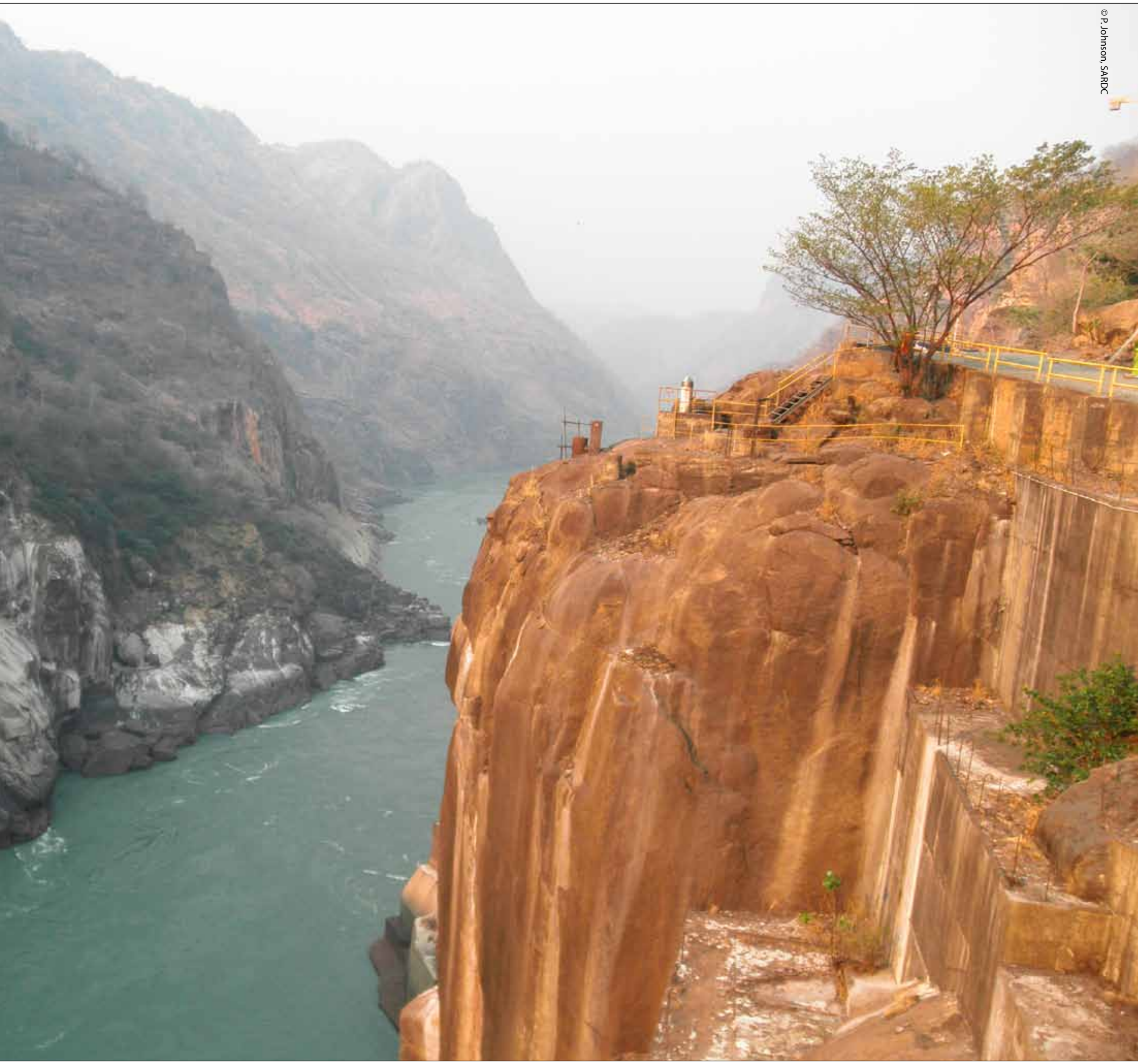
Kapichira hydropower station in Malawi generates 64 MW of electricity, and there are plans to double the output.

of which about 5 000 MW has been developed (Tumbare 2004). More than half of this potential is in Mozambique, about one-quarter in Zambia and one-sixth in Zimbabwe (SADC and ZRA 2007).

The Cahora Bassa, Kariba and Kafue Gorge dams provide the bulk of the basin's hydropower, generating 2 075 MW, 1 470 MW and 990 MW of electricity, respectively (World Bank 2010).

The Kapichira Falls hydro station on the Shire River in Malawi is one of the smallest power stations in the Zambezi River Basin. The plant generates 64 MW (World Bank 2010) but there are plans to double output. Other smaller hydro plants are Nkula Falls and Tedzani in Malawi and Victoria Falls in Zambia, which generate 124 MW, 90 MW and 108 MW, respectively (World Bank 2010).



The largest hydropower plant in the Zambezi basin is at Cahora Bassa, Mozambique. The plant, which generates 2 075 MW of electricity, is the second biggest in Africa after Aswan.

Tourism

The wide variety of landforms and vegetation zones in the Zambezi basin offer many spectacular tourist attractions. The major tourism destinations in the Zambezi basin are national parks and nature reserves, with wildlife and scenery as the primary attractions. The big mammals which draw many tourists to the region include elephants, buffalo, rhinoceros, leopards and lions. Tourism, especially game viewing, sport hunting, and fishing, has become an increasingly important economic sector in many of the riparian states in the Zambezi Basin (Chenje 2000).

The Victoria Falls, on the main section of the Zambezi River between Zambia and Zimbabwe, is the major tourist attraction of the basin, providing water-based tourist activities, game viewing and dramatic scenic views. Bungee jumping off the Victoria Falls Bridge, with its 111-metre drop, is also a major attraction. It is one of the highest commercial jumps in the world. Considered the most spectacular feature along the Zambezi, the Victoria Falls is known locally as *Mosi-oa-Tunya* (or The Smoke that Thunders), and is one of the Seven Natural Wonders of the World.

Water-based activities include canoeing, boating, white-water rafting, scuba diving, and sport fishing. Most of these activities are carried out on the main Zambezi River, Lake Kariba and Lake Malawi/Nyasa/Niassa.

Lions and buffalo are among the Big Five wild animals that are popular with tourists in the Zambezi River Basin.

Bungee jumping off the Victoria Falls bridge is a major attraction for tourists visiting the Zambezi basin.

River rafting down the Zambezi River is seasonal and dependent on rainfall and water levels. Low water level is from mid-July to the end of January, while high water levels are from February to mid-July.

Navigation

Various sections of the Zambezi River are used for navigation. Efforts are being made to improve navigability of the river along the Kazungula and Katima Mulilo-Sesheke transportation routes through Botswana, Namibia and Zambia.

The National Water Resources Plan of Mozambique has a provision to undertake studies to improve navigability of the Lower Zambezi (SADC and ZRA 2007). The initiative requires improved infrastructure, flow level regulation, aquatic weed control and dredging. Improved navigation combined with regional road network planning could be a step towards closer cooperation between countries in the basin.

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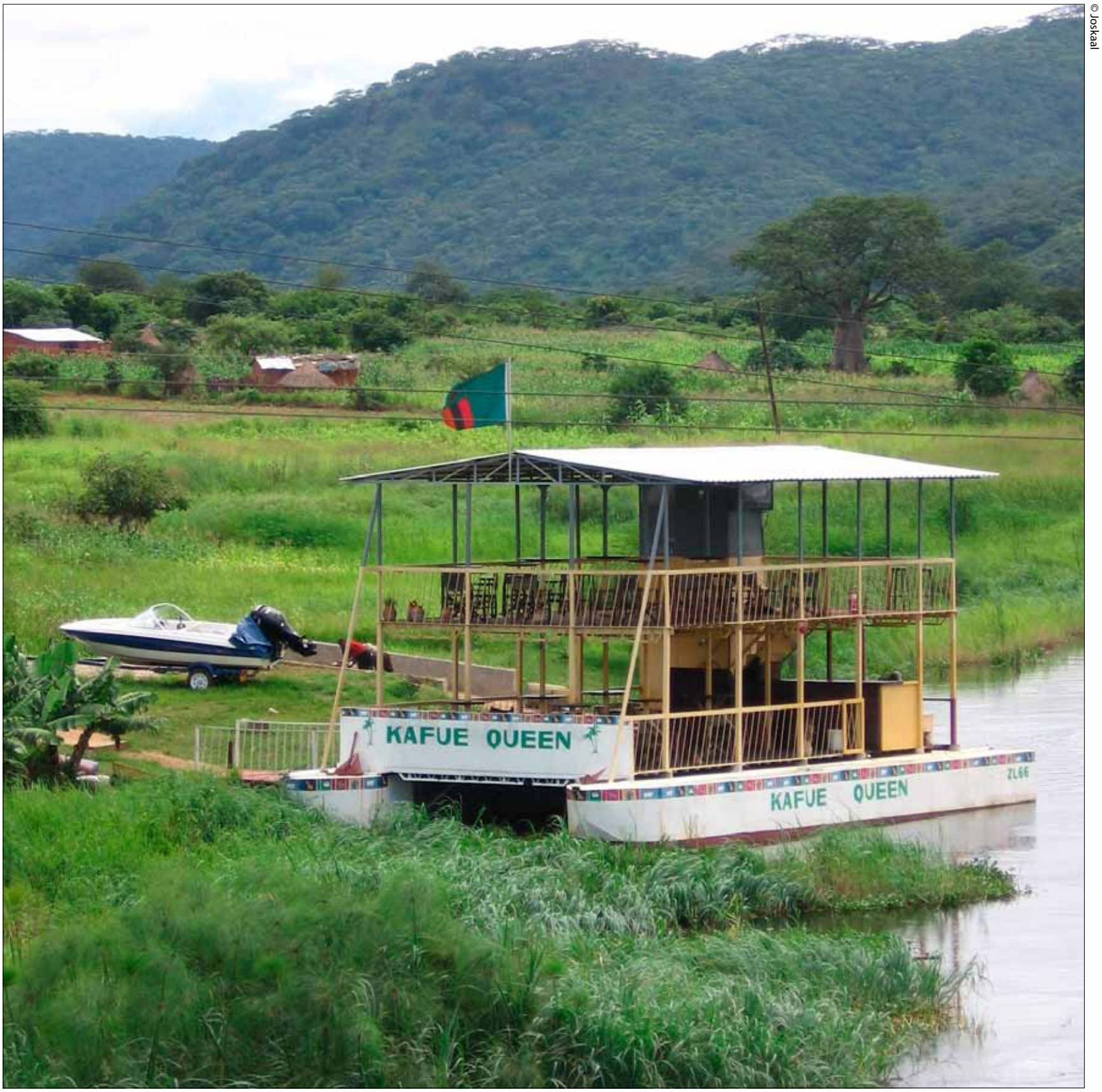

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Canoes and ferries are used to transport people and goods at various navigable sections of the Zambezi basin.

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Main Industries and Agricultural Development

Most countries in the Zambezi basin are urbanizing rapidly, resulting in increased industrial activities and larger waste discharges into the river system. Industries in most of the urban areas dump hazardous waste directly into rivers, and this compromises water quality. For example, about 1 400 tonnes of waste is produced daily in Lusaka with only 10 per cent collected by the municipality (SADC and SARDC 2008). Although it is difficult to assess the amount of pollution originating from industries on the Zambezi tributaries, there is clear evidence that highly urbanized sub-basins such as the Kafue and Manyame are discharging waste into the Zambezi River system (SADC and ZRA 2007).

Effluent discharge is also a matter of concern in the Zambezi Delta. The Sena Sugar industry in Marromeu, Mozambique releases large amounts of biodegradable waste and wastewater into the Zambezi water system (SADC and ZRA 2007). In Harare, the Mukuvisi River which drains into Manyame, is considered the most heavily polluted river system in Zimbabwe. The river flows through both industrial and residential areas of Harare (Chenje 2000).

In the Tanzanian part of the basin, the quality of water is generally good except for the pollution of the Kiwira River by coal mines, and of the Songwe River by a cement-manufacturing company (SADC and ZRA 2007).

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Overgrazing by livestock leads to soil erosion.


© SADC

Gold, copper, tin and coal are some of the minerals found in the Zambezi basin.

Mining

Mining activities are extensive in the Zambezi basin. Sub-basins such as the Luangwa River, Lake Kariba, and the Kafue and Kabompo Rivers have high concentrations of mining operations, contributing to water pollution in the Zambezi River (SADC and ZRA 2007). All the streams that drain mining areas in the Copperbelt region release waste into Kafue River or its tributary, the Kafubu River. These are the main sources of drinking water for most of the towns in the Copperbelt. Mining operations contribute to serious environmental problems such as water pollution caused by acid mine drainage, cyanide spills in gold mining and heavy metal contamination (Chenje 2000).

Agriculture

Agriculture plays an important role in sustaining economic development in most of the basin countries. Zimbabwe, Zambia and Malawi together have 86 per cent of the estimated 5.2 million hectares of the land area cultivated annually in the basin (SADC and ZRA 2007). Use of fertilizers and agrochemicals in the basin contributes to the eutrophication of floodplain water bodies, especially abandoned channels, oxbow meanders, and shallow marshes.

Water quality in the basin is also affected by soil erosion. For example, farming in the Sanyati catchment area of Zimbabwe, generates pollution through leaching of nutrients from the fields (SADC and ZRA 2007).


© ZACPRO 6.2


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Many crops are grown in the Zambezi basin, including wheat, maize, sunflower, sugar cane, soya beans and other vegetables.

© SARDC

People and Cultures

There are some 30 ethnic groups and related cultures in the Zambezi River Basin. The basin's population also includes a number of smaller clans and extended families, as well as foreign settlers and residents. More than one-third of the main groups are found in Zambia, some living along national boundaries sharing cultural traits and languages with groups in a neighbouring country but speaking with different dialects (Chenje 2000). The colonial boundaries demarcating countries were arbitrary and often split people and families across borders.

The cultures in the Zambezi basin include the Lunda, Luchaze and Quioca in Angola; the Tswana in Chobe, Botswana; the Chewa, Tumbuka, Yao, Ngoni, Nyanja and Sena cultures in Malawi; the Sena 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. 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.

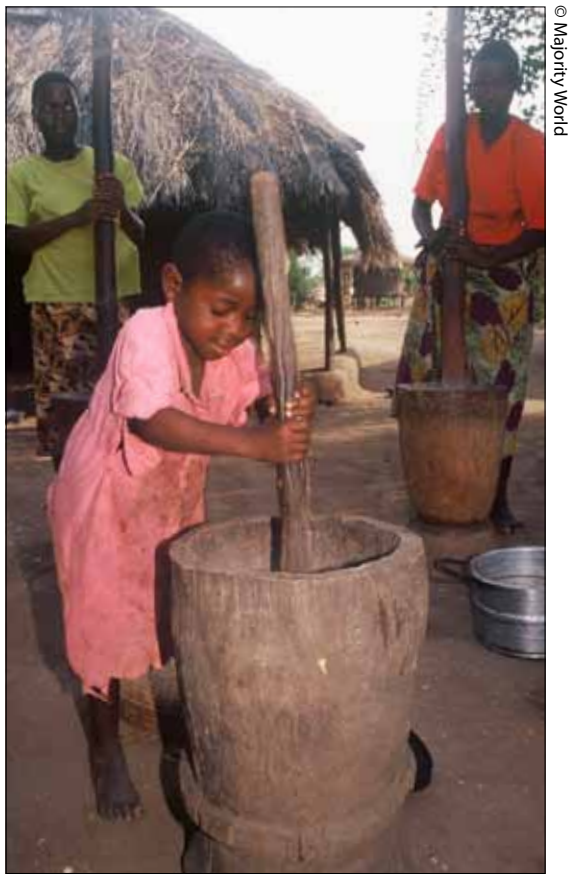
There are traditional conservation activities related to the rural livelihoods of fishing, hunting, beekeeping, basket-making from reeds in wetlands and making clay pots from the soil, as well as cultivation of cassava, peanuts, sorghum and maize (Chenje 2000). The chiteme, a form of shifting cultivation, is one such example of traditional practices.

Many plants are used traditionally as medicine or to improve general health by boosting the immune system and strengthening the body's resistance to illnesses and infections. These plants include moringa, which many medical practitioners accept is an immune booster, and the African potato, a dark, bulbous and fibrous root of the hypoxis plant. Some medicinal plants, such as 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).

Among the Zambezi basin's traditional cultures and indigenous knowledge systems, there are many activities that act as resilience strategies in adapting to changes in water flow or rainfall, and strategies that contribute to the conservation of the basin resources. The following are some stories and snapshots of indigenous conservation and resilience strategies.

© Majority World

Amacimbi (dried caterpillars) are a nutritious source of protein.



© Majority World

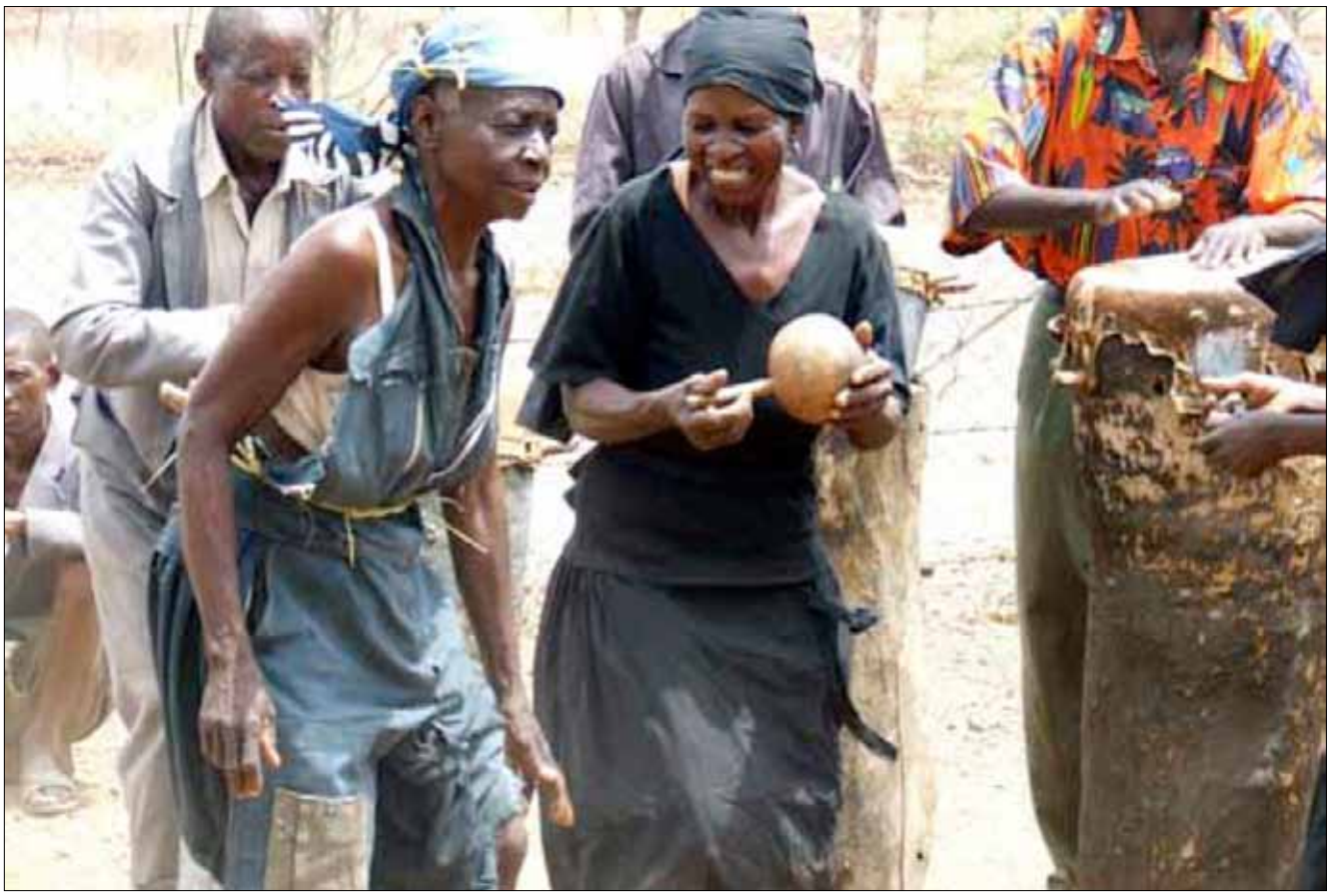
Traditional food processing.

© Majority World

Reeds, grass and tree bark are used to make baskets and mats.

© Antonio Klaus Kaarsberg

The Nyau dance is common in Malawi, Zambia and Mozambique.



Nambya Cultural Festival.

Tonga

The Tonga people reside along both sides of the Zambezi River in Zambia and Zimbabwe and were displaced in large numbers by the filling of the Kariba dam reservoir. They are the native inhabitants of what was the Gwembe valley of the middle Zambezi River. The Tonga had evolved an agricultural strategy that ensured food security throughout the year by using both seasonal rains and the flood patterns of the Zambezi River (Magadza 2006). With the construction of the Kariba dam in the 1950s, they were relocated to semi-arid lands with a high risk of crop failure.

Carvings of wood or stone are a common form of art in the Zambezi basin.

Nyaminyami

In Tonga culture, the Zambezi River god or snake spirit, known as Nyaminyami, is believed to protect the Tonga people and give them sustenance in difficult times. One of the most popular beliefs is that the Nyaminyami is associated with the rapids of the Zambezi (Magadza 2006).

Nambya

In the Hwange area of Zimbabwe and lands stretching to Namibia's Caprivi Strip are the Nambya people. The Nambya were traditional hunters and trackers who tipped their arrows with poison from a traditional bulb called *chenyami*. Their flourishing cotton cultivation, textile industry, and iron foundries were disrupted by the slave trade, but they were active in buying back their people from slavers along the river. As their landholdings diminished during the colonial period, and they were pushed back towards the Zambezi River, they grew bulrush millet, sorghum and maize along the riverbanks (Martin 1997). A Nambya Cultural Festival is still held annually after the harvest to celebrate the richness of Nambya culture through music, song, dance, and traditional food displays (Nambya Development Organisation Trust 2011).

The Lozi tradition of *kuomboka*

Perhaps the most enduring and well-known tradition related to the Zambezi River and its floodplains is the *kuomboka* ceremony practiced annually by the Lozi people in western Zambia. *Kuomboka* is a Luyana word meaning "to get out of water". It is applied today to a traditional ceremony, which attracts more interest than any other in Zambia as an annual celebration of local culture.

© ZACPRO 6.2

Ndebele traditional Dance is one of the many cultural activities in the Zambezi basin.

The floods came early for *Kuomboka*

Kuomboka is a survival strategy in which the paramount chief of the Lozi in western Zambia leads the people in an annual migration out of the rising floodwaters. *Kuomboka* is held when the annual inundation of the Bulozi floodplain of the Upper Zambezi River reaches a height (up to 12 metres above normal) that requires the people to move to a drier area. The paramount chief, the Litunga, leaves the floodplain and journeys by barge to higher ground. This is usually at the end of March or beginning of April, although the date changes each year and is kept secret by the Barotse royal establishment until close to the day.

The route taken today is from the village of Lealui (which was the capital of the Lozi kingdom in the time of paramount chief Lewanika, 1878-1916) to Limulunga, the summer or flood-time capital where the current Litunga spends most of his time. The ceremony is preceded by heavy drumming of the royal Maoma drums, the sound of which echoes around the royal capital the day before *Kuomboka*, announcing the event. Thousands gather to dance, feast and watch the royal barge, the Nalikwanda, rowed by dozens of oarsmen beneath a giant replica elephant.

The *kuomboka* is the cue for local people, who are traditionally cattle herders, to follow the paramount chief in escaping the rising waters.

However, the reality of climate change is catching up with this colourful traditional ritual. In 2008 the flood came too soon and too strong, killing at least 31 people in Zambia's western province. The devastating aftermath left people hungry and homeless.

Source: Oxfam 2007, in SADC and HBS 2010, Responding to Climate Change Impacts: Adaptation and mitigation strategies as practised in the Zambezi River Basin; www.barotseland.com/kuomboka1

© Oxfam

2

THE BASIN'S CHANGING ENVIRONMENT

There are many factors contributing to the environmental changes occurring in the Zambezi River Basin. These drivers of change include population growth and expansion of settlements, especially urban areas; economic activities such as mining, manufacturing and agriculture; and natural environmental dynamics characterized by increasing frequency of floods and drought. The scale of change in the basin is variable ranging from small-scale localized change to widespread regional changes.

Over the years the landscape of the basin has changed, water-based ecosystems have been altered, wildlife numbers have fallen and general biodiversity has changed through the introduction of alien species and loss of some species.

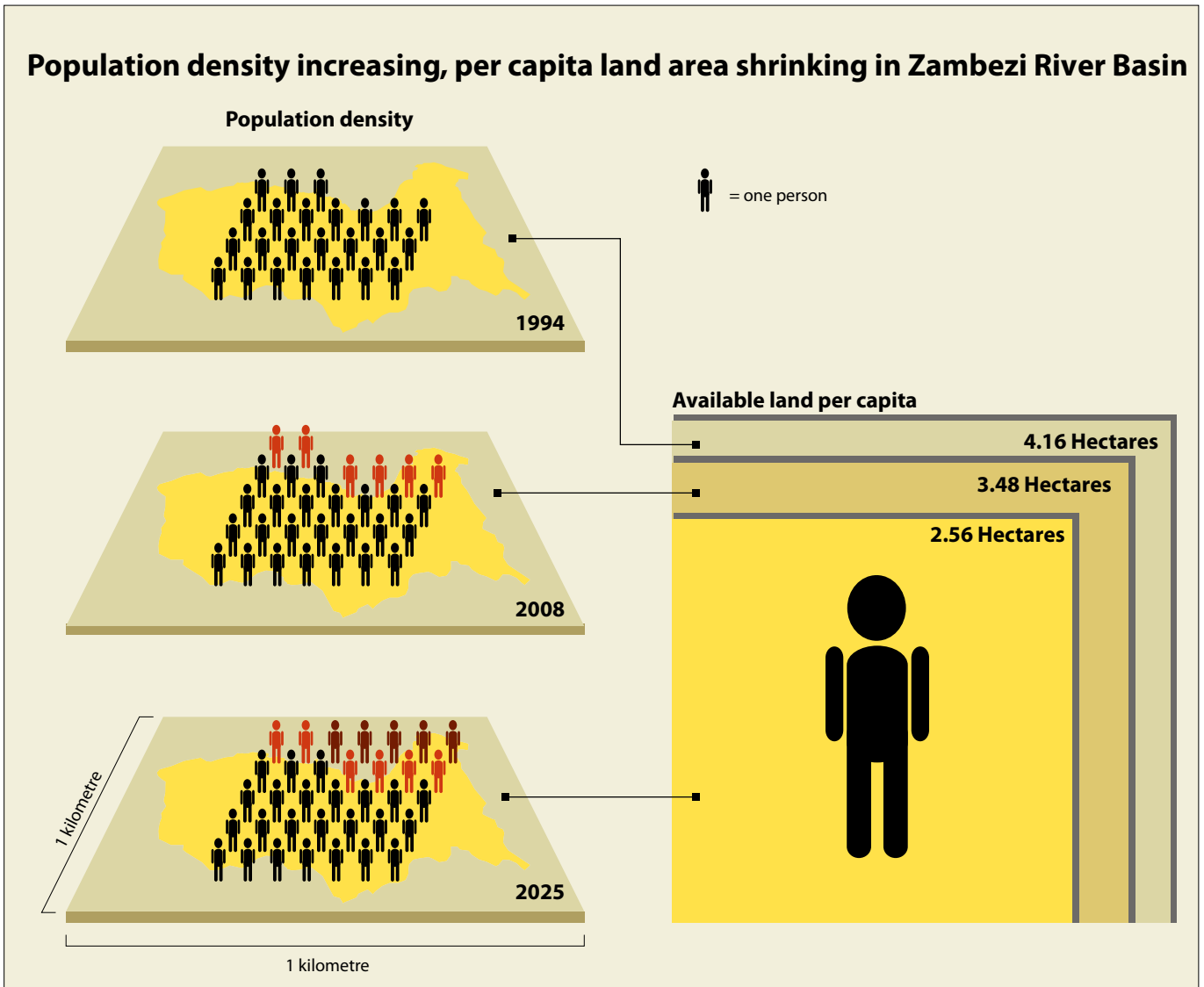
The environmental changes in the basin are continuous and in some cases very dramatic. While most of the causes of the changes are local, there are also external causes such as greenhouse gas emissions and the associated changes in weather patterns and climate.

The Growing Population and Shrinking Resource Base

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 (Chenje 2000; SADC and ZRA 2007; SARDC and HBS 2010). 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 (Chenje 2000; SARDC and HBS 2010). 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 45 people per sq km, Zimbabwe had 31.9, and Zambia had 16.8 (UN Statistics Division 2011). In 1998 Malawi had an average of 105 people per sq km; Tanzania had 36; Zimbabwe had 28.5; and Zambia had 13 (Chenje 2000).

Population growth places pressure on facilities, including rural housing.



Source: SADC and ZRA 2007. Rapid Assessment Report: Integrated Water Resources Management Strategy for the Zambezi River Basin. SADC Water Division. Gaborone

Figure 2.1

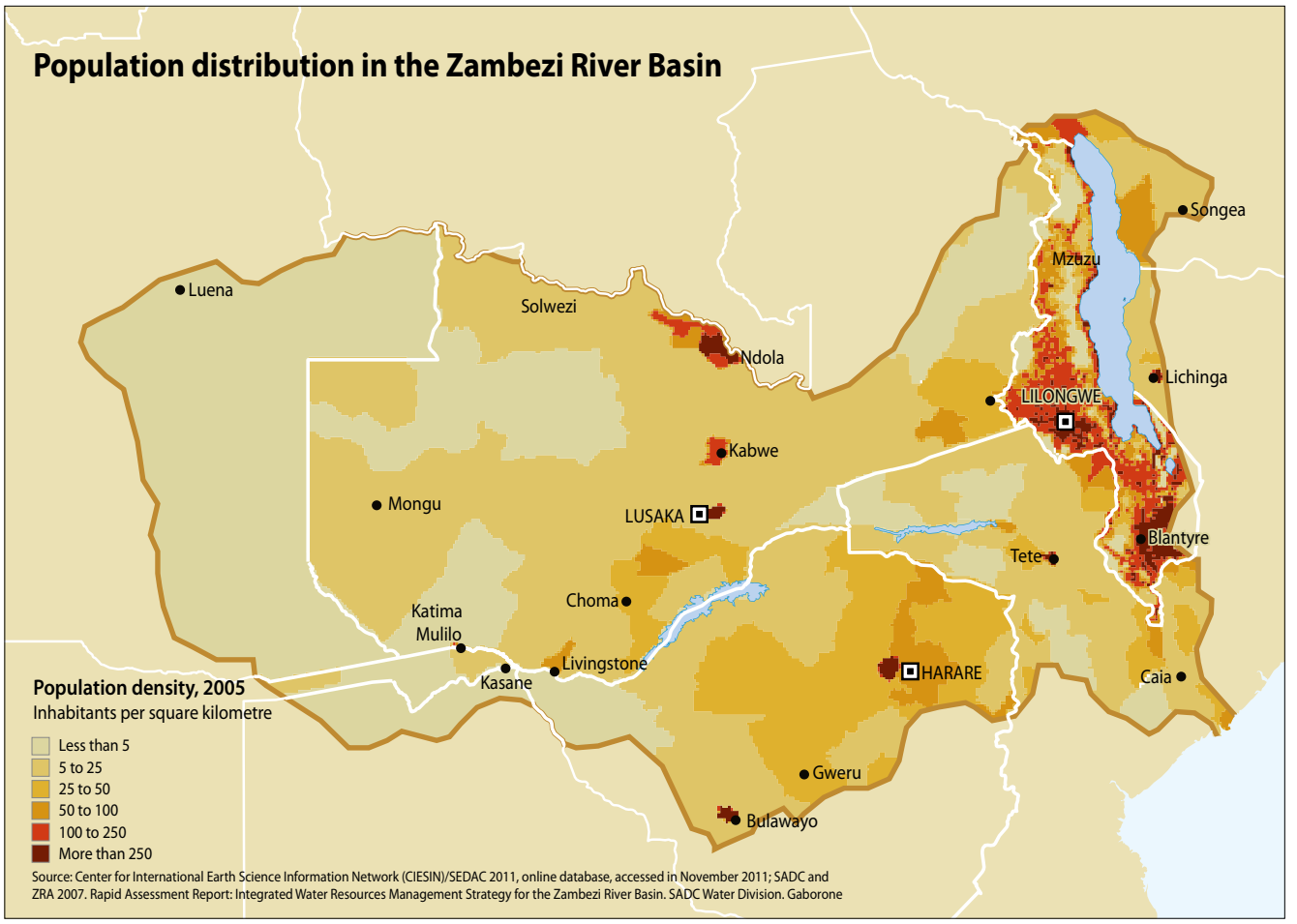


Figure 2.2

© Pritidu

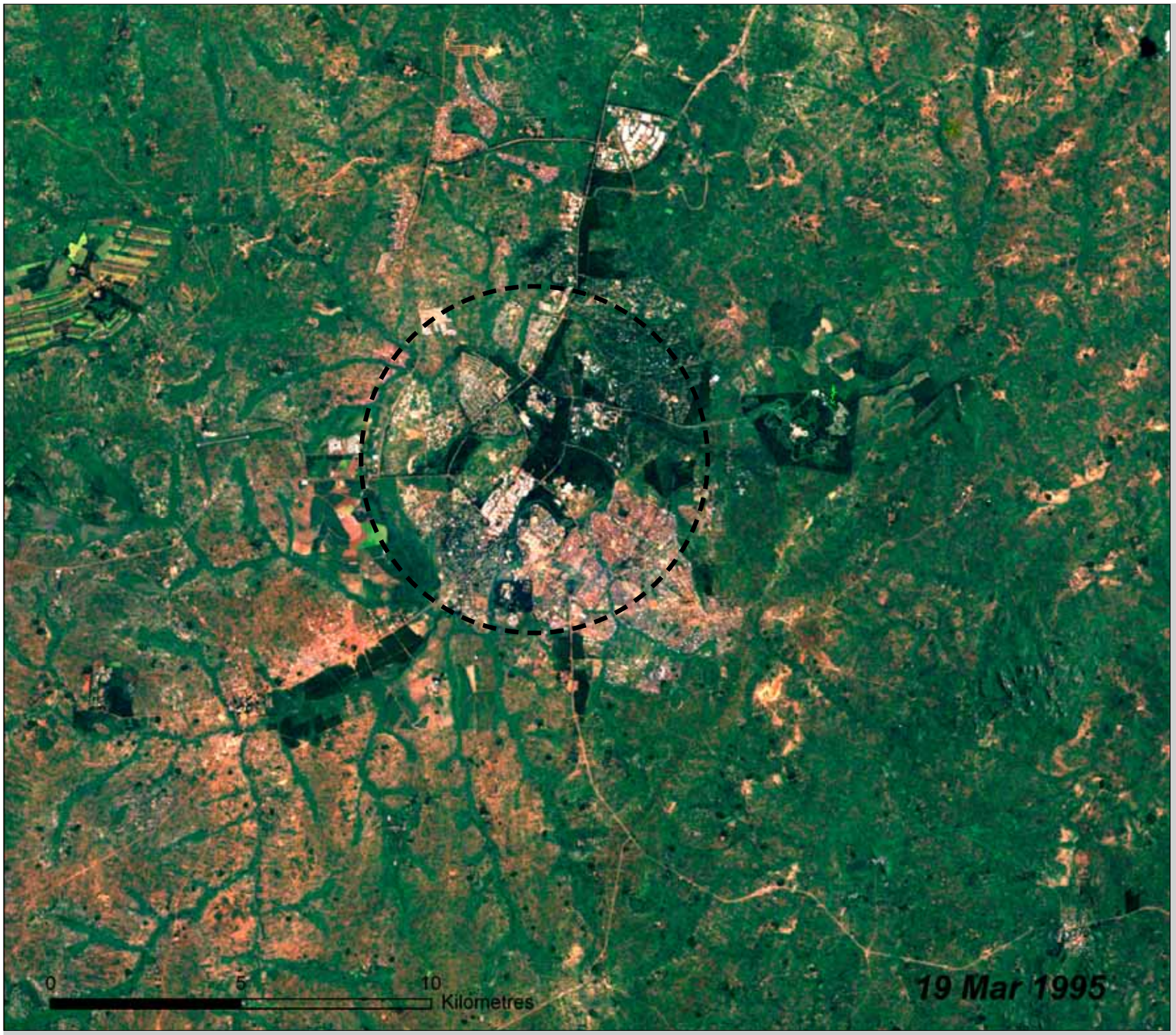
Lusaka is the capital city of Zambia.

Urbanization

Zambezi River Basin countries share similar settlement patterns characterized by both low and high densities. While the basin is largely rural, urbanization rates are high. In Botswana and Angola, urban population constitute more than 60 per cent (SADC and SARDC 2008), and is projected to exceed 80 per cent by 2050 (UN-HABITAT 2010). At just more than 25 per cent (UN-HABITAT 2010), Malawi is the least urbanized country in the basin, and yet the most densely populated. The majority of Malawi's urban residents live in the major towns of Blantyre, Lilongwe, Mzuzu and Zomba (Chenje 2000).

Mining is the key driver of Zambia's urbanization. As a result, 85 per cent of the country's urban residents are concentrated

Located on the Zambezi River, Tete is the provincial capital of Mozambique's Tete Province. A prominent feature of the city is the one-kilometre suspension bridge

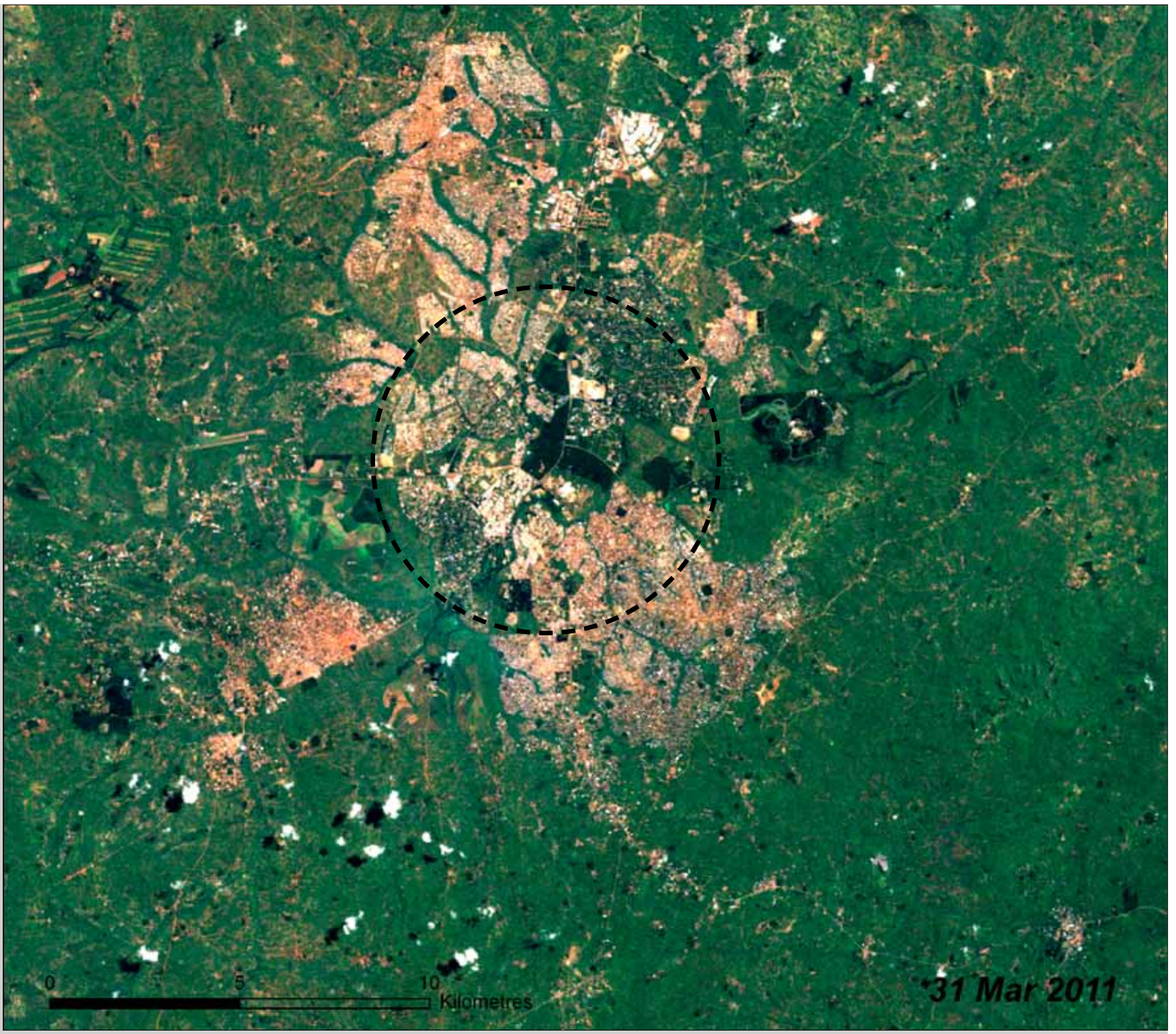


Lilongwe is the capital city of Malawi. The city started as a small village along Lilongwe River. In 1977 the city's population was estimated at about 99 000, and this grew to 781 500 in 2012. Expansion of the city has resulted in the deforestation of large surrounding areas due to the

that crosses the Zambezi River. The city has grown rapidly in recent times, with the population growing from about 56 000 in 1986 to almost 156 000 in 2008.

in the two provinces of the Copperbelt and Lusaka. Copper is the country's major export mineral. About 46 per cent of Zimbabwe's population lived in urban areas as at 2010 (UNE-HABITAT 2010), and this ratio is projected to increase to about 65 per cent by 2050. The country's largest city, Harare, is located in the basin, while the second city, Bulawayo, is on the basin's margins. There are plans to draw water for the city of Bulawayo from the Zambezi River

Urbanization comes with a variety of environmental challenges including air, land and water pollution; changes to the microclimate resulting from activities such as quarrying, illegal developments such as slums; and environmental degradation, including soil erosion, deforestation and over-extraction of groundwater (SADC and SARDC 2008; UN-HABITAT 2007).



high demand for firewood and land for farming by the growing population. Lilongwe was founded as an agricultural market centre for the fertile Central Region Plateau of Malawi. The city replaced Zomba as the national capital in 1975.

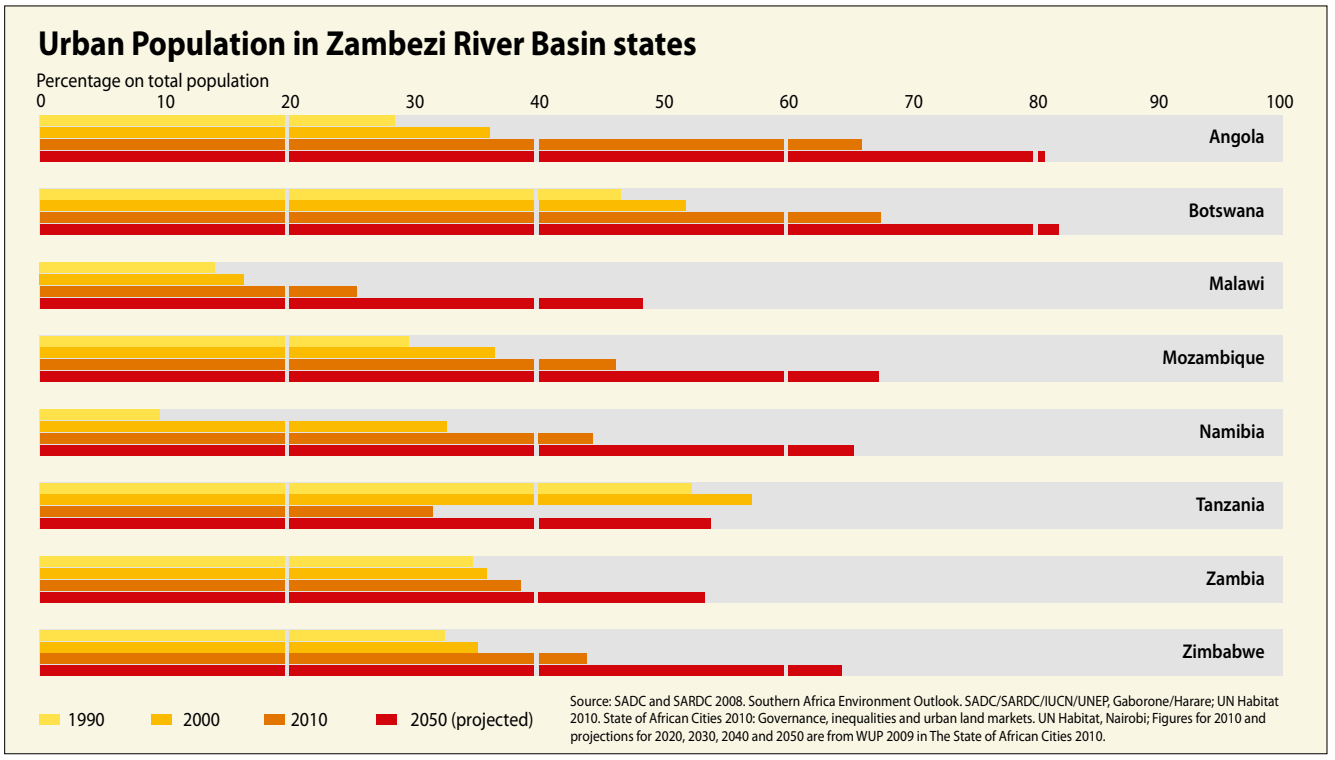


Figure 2.3

© Cordelia Persen, UN-Habitat

There is an increasing demand for goods and services in the basin's urban areas. Some of such goods and services are supplied by informal traders.

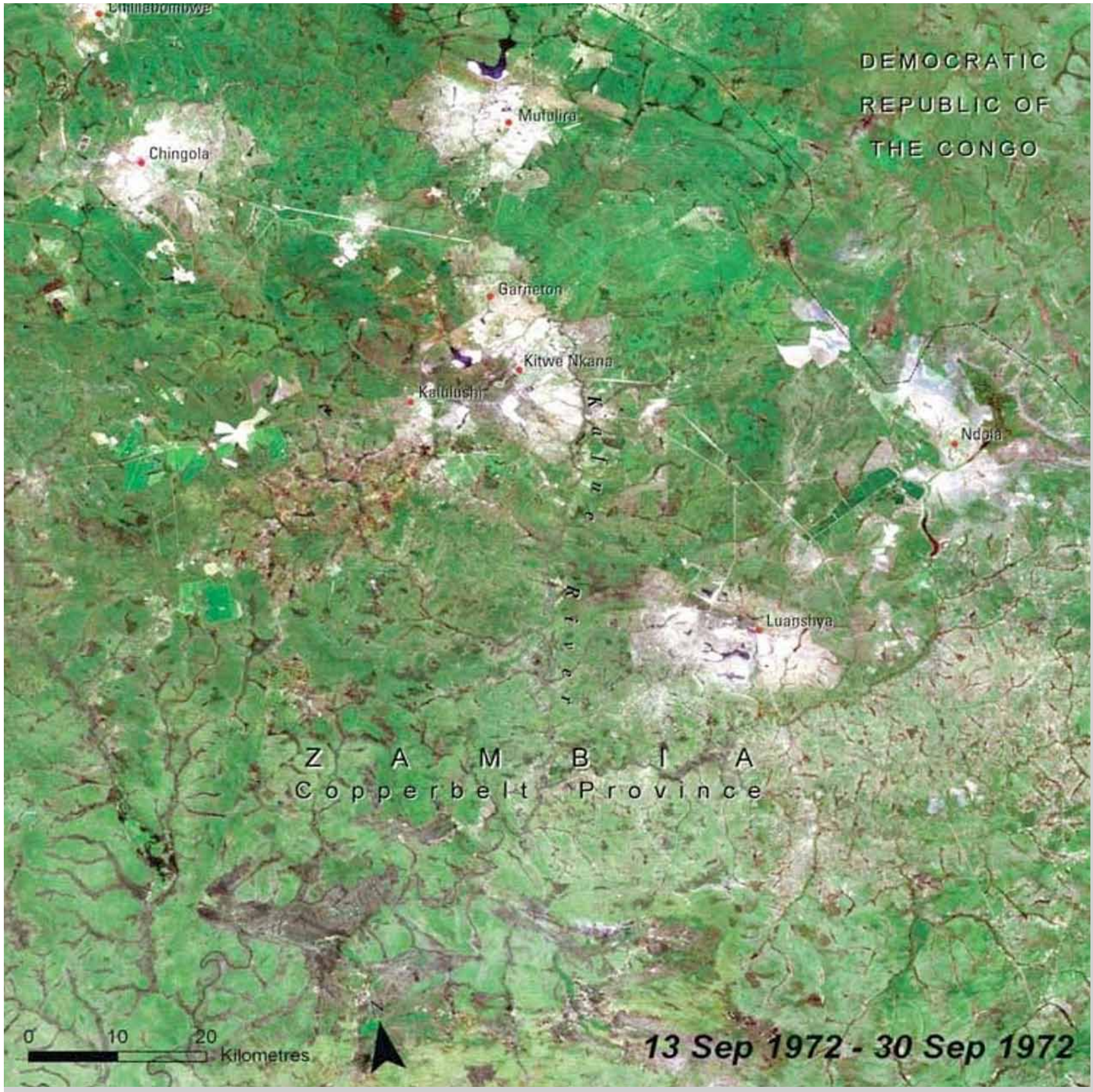
Harare's Central Business District and some of its neighbourhoods (2011)

Pollution

Air, land and water pollution have been major effects of urbanization in the basin, with emissions of greenhouse gases such as carbon dioxide, nitrous oxide, and methane on the rise even though they remain proportionately small on the world scale. Thermal power stations at Chichiri and Lilongwe in Malawi, the Copperbelt gas turbines in Zambia, and coal power stations in Hwange, Munyati and Harare, Zimbabwe are the basin's major emitters of greenhouse gases (SARDC and HBS 2010; SADC and SARDC 2008). Greenhouse gas emissions, much of which come from outside the Zambezi basin, are blamed for the rise in temperatures, altered weather patterns such as shifting seasons, and increased incidence of droughts and floods. Floods and temperature increases are also associated with the rising incidence of pests and diseases such as malaria (SARDC and HBS 2010).

Carbon dioxide, nitrous oxide, sulphur dioxide, suspended particulate matter, carbon monoxide and lead, are the most common and harmful air pollutants in the Zambezi basin. The use of leaded fuel in most vehicles throughout the basin, coupled with the ageing fleet, is worsening the levels of pollution (Chenje, 2000; UN-Habitat 2007). There has been slow progress in phasing out leaded petrol in the basin. Only Botswana, Namibia and Zambia have stopped using leaded petrol.

Greenhouse gases are emitted into the atmosphere by some of the industries in the basin.

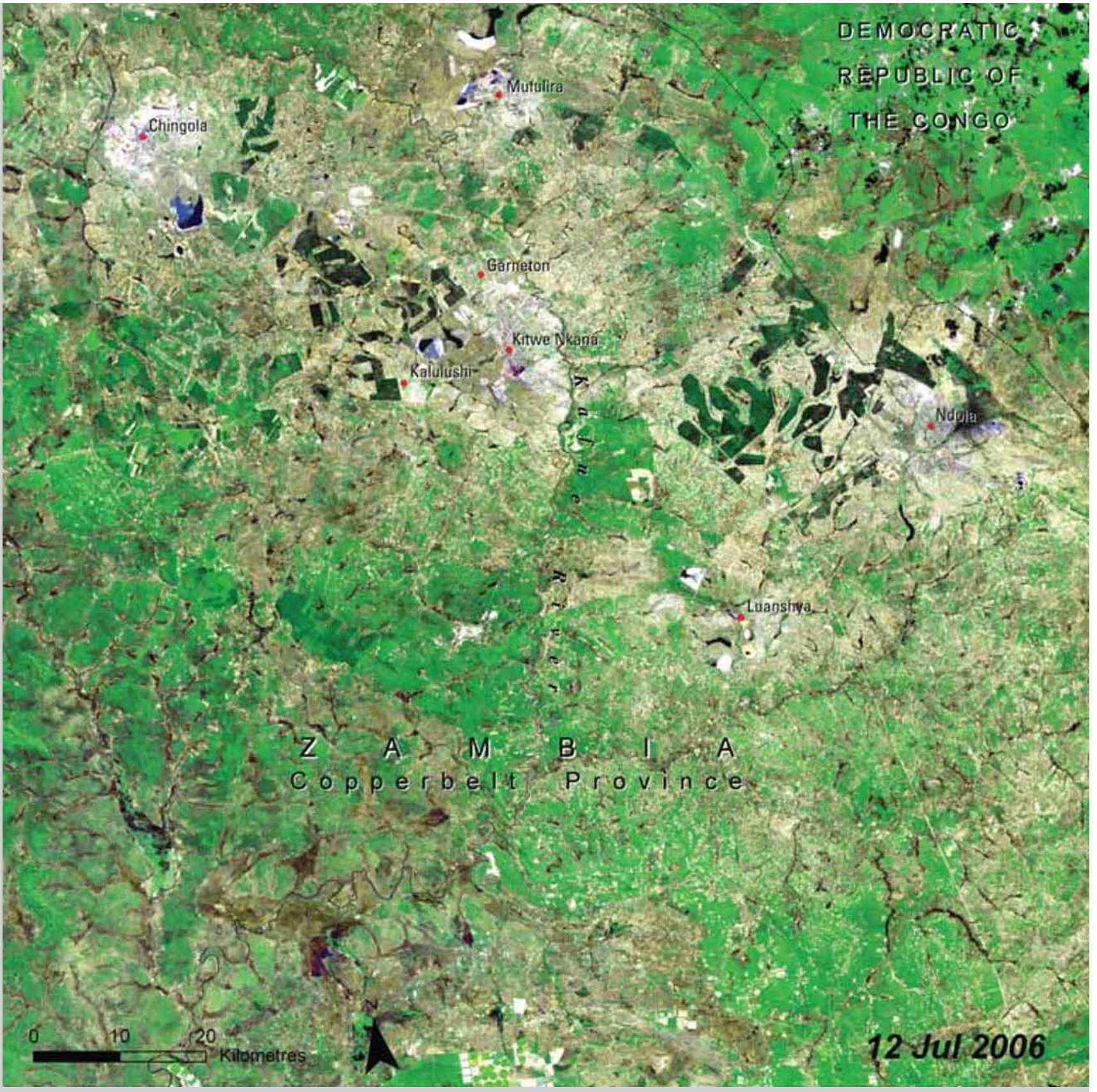


The mining industry has been Zambia's economic and social backbone since the 1930s. The industry is dominated by copper mining, which started large-scale production in Luanshya in 1931 followed by Nkana in 1932, Mufulira in 1933 and then Nchange in 1939. Copper production surpassed 400 000 tonnes per year in the 1950s, before reaching a peak of 700 000 tonnes per year in the period between 1969 and 1976.

Mining

Mining and mineral extraction are some of the key activities in the basin's urban areas. 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. Large-scale mining in Zambia's Copperbelt province began in the 1930s, attracting workers and turning the savannah woodland into a heavily populated area. Until the 1960s, the mining industry used wood from surrounding lands to produce energy for the copper mines. This resulted in the clearing of much of the surrounding woodland.

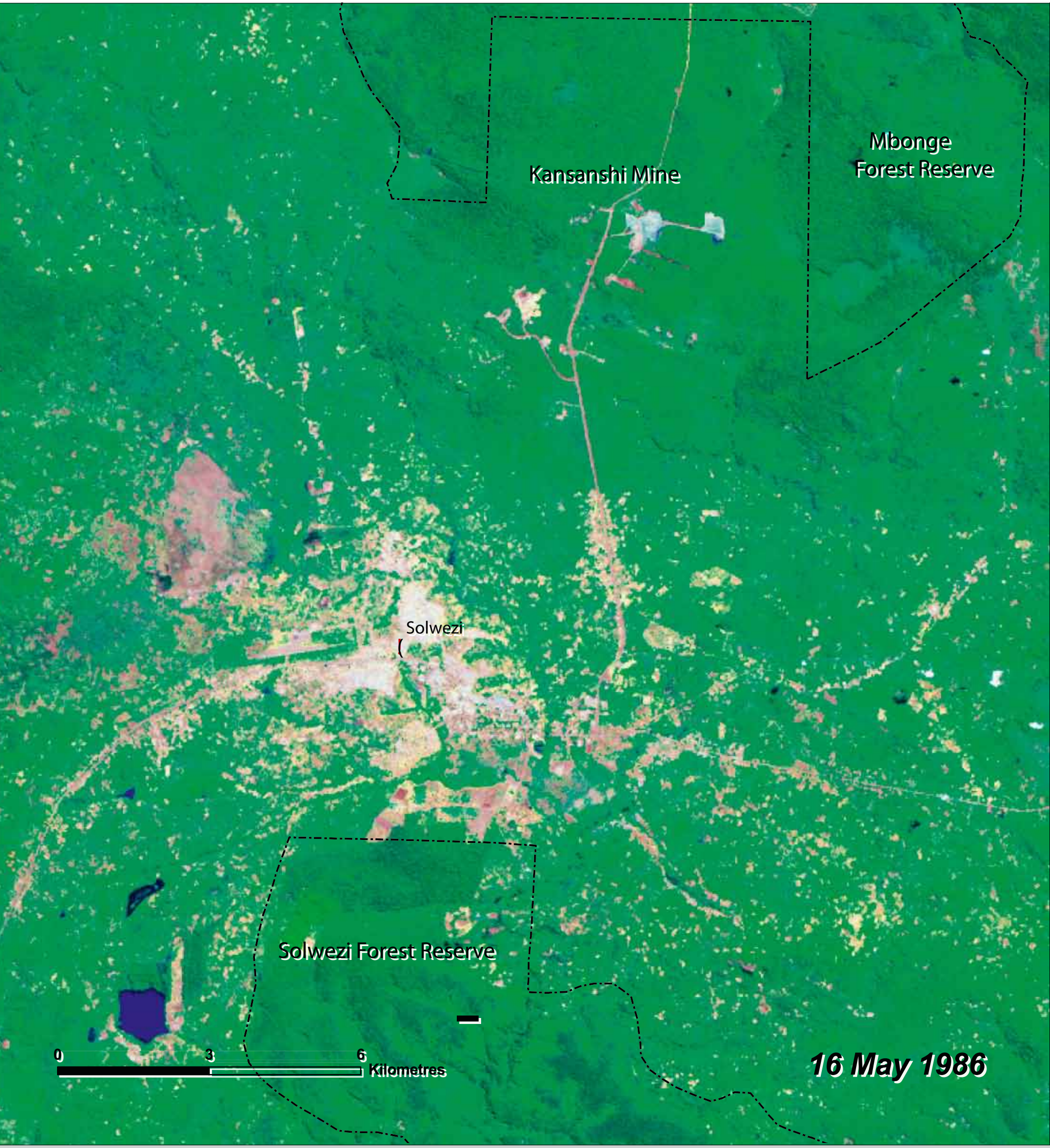
There is also significant small-scale mining in rural areas. This includes panning for gold, a poverty-driven activity that is estimated to support the livelihoods of about 2 million people in the riparian states of the Zambezi basin (Drescler 2001). Panning operations tend to cause massive damage to river systems. The



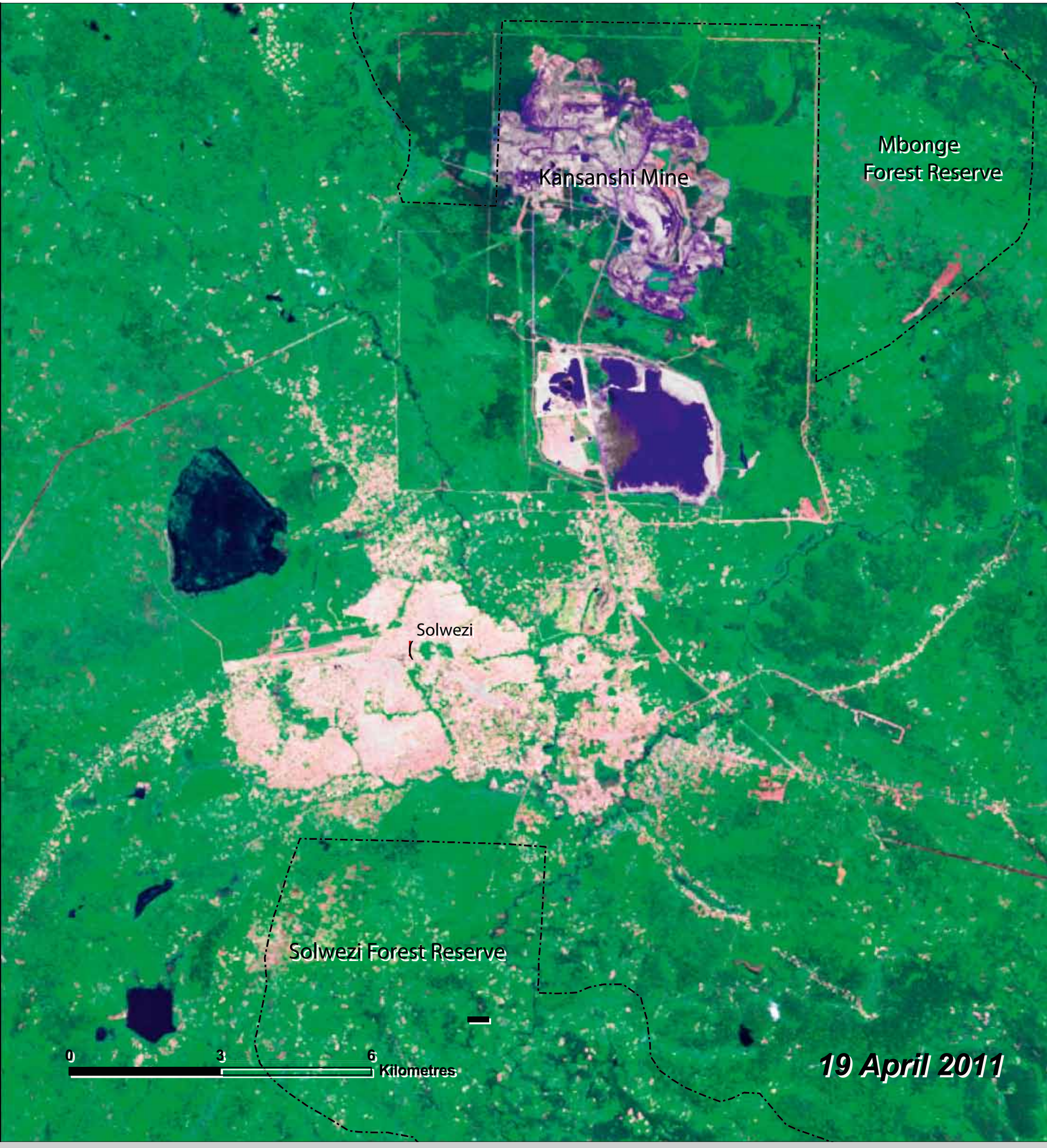
Thereafter copper production progressively declined reaching a low of 307 000 tonnes per year in the 1980s due to depressed world prices. Copper production declined at the turn of the millennium due to firming world prices and favourable investor policies. With increasing copper production levels, Zambia witnessed severe but localized land degradation and deforestation.

hydrological system is affected by physical and chemical damage caused by digging in river channels, banks and their flood plains, as well as contamination of river water with mercury and cyanide, which are used in processing gold (Shoko and Love 2005; Billaud *et al.* 2004). Environmental impacts of isolated small-scale gold panning activities may not be significant, but an accumulation of numerous panning operations can create problems for both aquatic and terrestrial ecosystems (Zwane *et al.* 2006).

A woman and her family panning for gold in Mozambique.



With a population estimated at about 150 000, the number of people living in Solwezi has more than tripled since 2000. The revival of copper mining at the nearby Kanshanshi and Lumwana mines caused a paid population influx, resulting in the rapid but haphazard expansion of the



town. As a result of the mining activities, areas around Solwezi have seen significant land use changes in recent years. Much of the forested areas has been cleared for firewood, while some areas have been opened up for peri-urban farming.

Environmental Dynamics

Over the years, the Zambezi River Basin has slightly become warmer, while the frequency of floods and droughts has increased. These environmental changes are partly blamed for land degradation, habitat changes and drying or inundation of important ecosystems such as wetlands.

Temperature

The Fourth Assessment Report of the IPCC states that global greenhouse gas emissions due to human activities grew by 70 per cent between 1970 and 2004 (IPCC 2009). The emission of greenhouse gases in one region may result in a temperature rise, with associated effects, in another region. Thus the high rate of greenhouse gas emissions across the world is partly the cause of the temperature rise of at least 0.5°C in southern Africa over the past century. Partly as a result of this temperature increase, the 1990s were the warmest and driest years in the Zambezi basin in recent times (SARDC and HBS 2010).

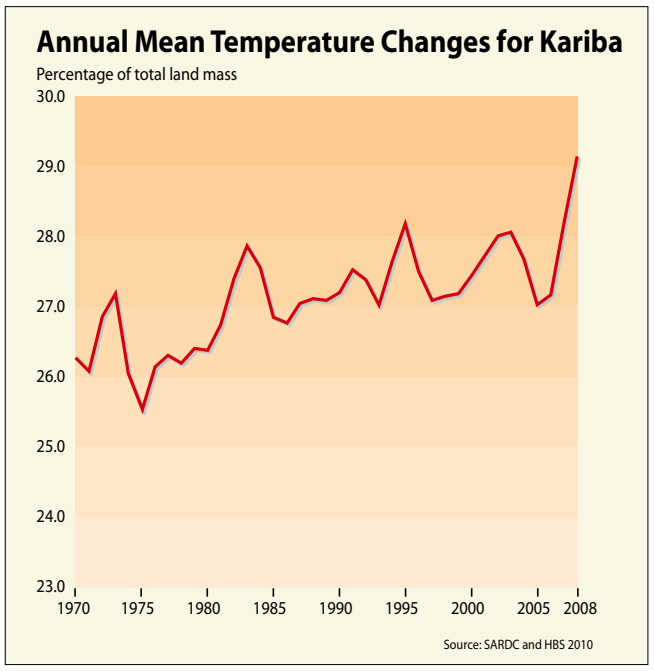


Figure 2.4

Floods

Over the last two decades, the Zambezi River Basin has experienced extreme floods and droughts (SARDC and HBS 2010). Most of the flooding in the basin is associated with active cyclones that develop in the Indian Ocean. The IPCC predicted that tropical cyclones will become more intense, with higher peak wind speeds and heavier precipitation associated with increases in tropical sea surface temperature (IPCC 2009). Major floods were recorded in parts of the Zambezi basin during the rainfall seasons of 1999-2000, 2005-06 and 2007 (SARDC and HBS 2010).

While flooding in some areas, such as the Barotse plains, is a regular event providing vital water for irrigation and replenishing soil fertility, the frequency, timing, intensity and duration of floods are changing in the basin (SARDC and HBS 2010). The extent of flooding has intensfied due to poorly maintained embankments and structural measures, while in urban areas poor land use planning and inadequate drainage worsen flooding. In addition to destruction of homes and infrastructure, and loss of crops and livestock, flooding also inundates land, decreases soil fertility and destroys fodder resources, limiting agricutural production.

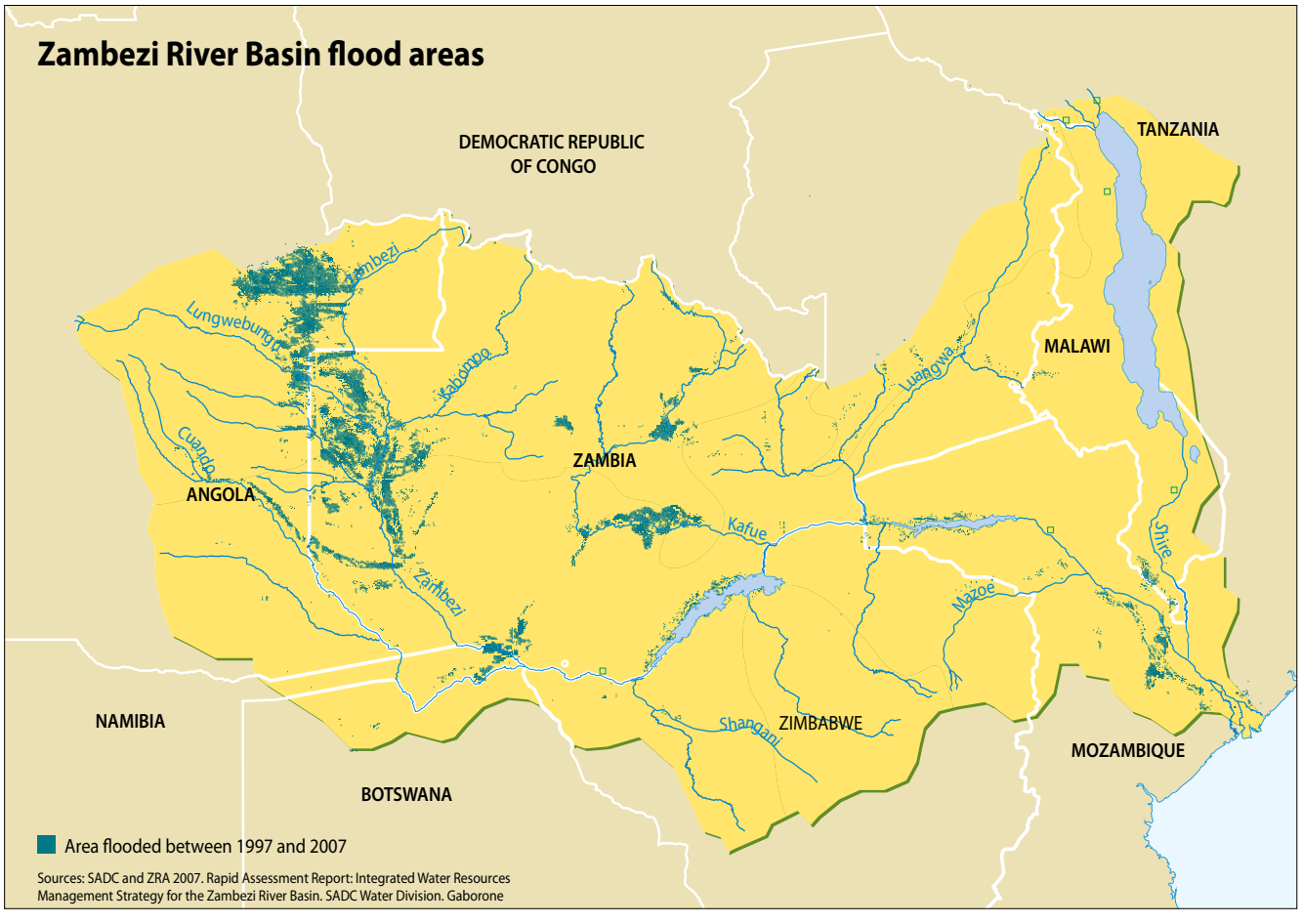


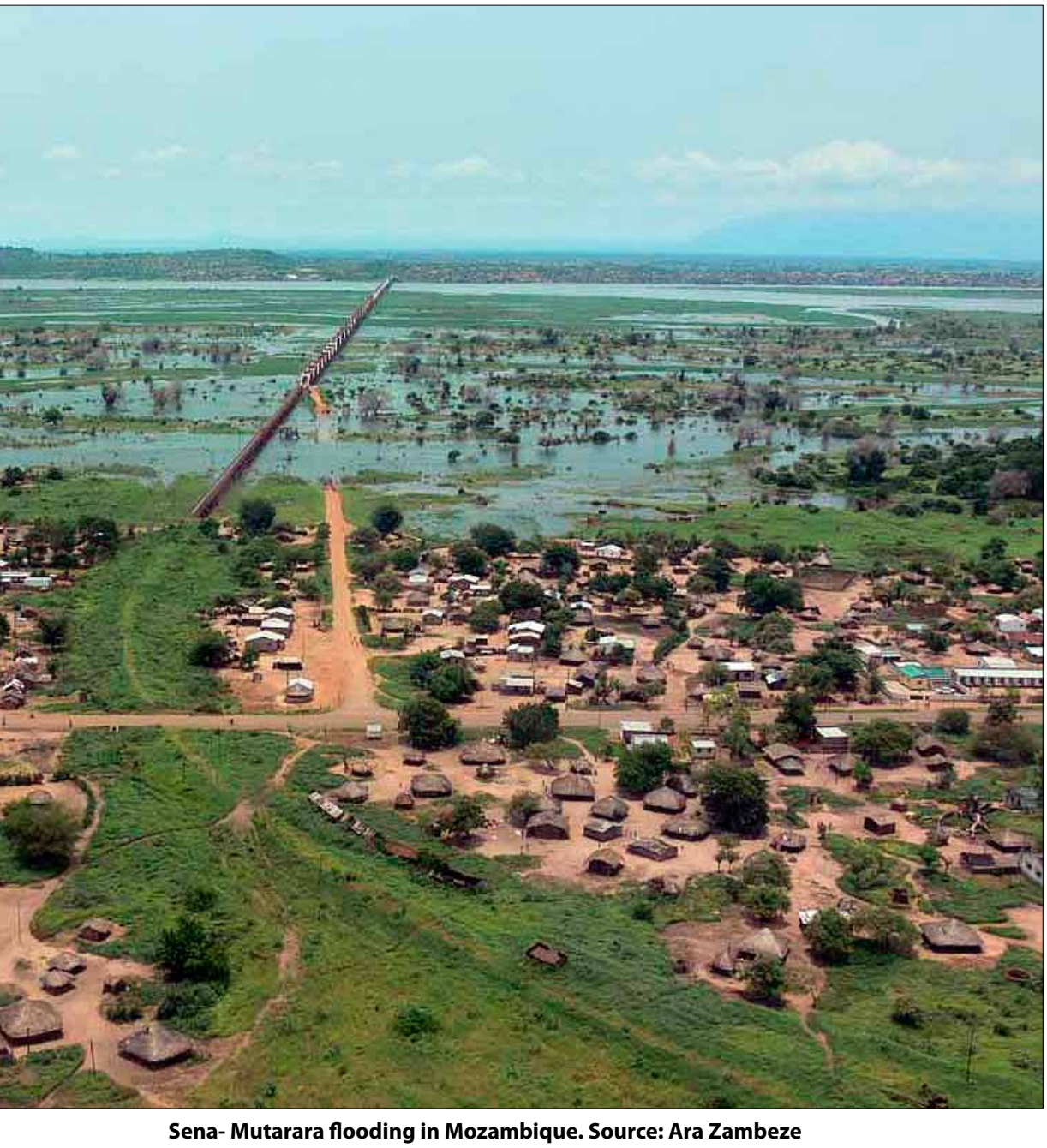
Figure 2.5

© Ara Zambeze

Table 2.1. Rainfall Trends in the Zambezi River Basin

2008-2009	The basin experienced flooding, displacing thousands of people in Angola, Botswana, Malawi, Namibia and Zambia.
2007	Cyclone Favio-induced floods affected Mozambique and parts of Zimbabwe.
2005-2006	Parts of Mozambique, Southern Africa and Zimbabwe received very heavy rains resulting in flooding that caused considerable infrastructural damage, destroying schools, crops, telecommunications and roads.
2001-2003	Southern Africa experienced abnormally high rainfall and disastrous floods causing damage to infrastructure and loss of lives and property, followed by a severe drought particularly from Zimbabwe northwards.
1999-2000	Cyclone Eline hit the region and widespread floods devastated large parts of central Mozambique and eastern Zimbabwe.
1994-1995	Many countries in the SADC were hit by a severe drought, surpassing the impact of the 1991-1992 drought.
1991-1992	The worst drought in living memory was experienced in the 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 subtropical 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 in 1967.

Source: SARDC and HBS 2010.



Sena- Mutarara flooding in Mozambique. Source: Ara Zambeze

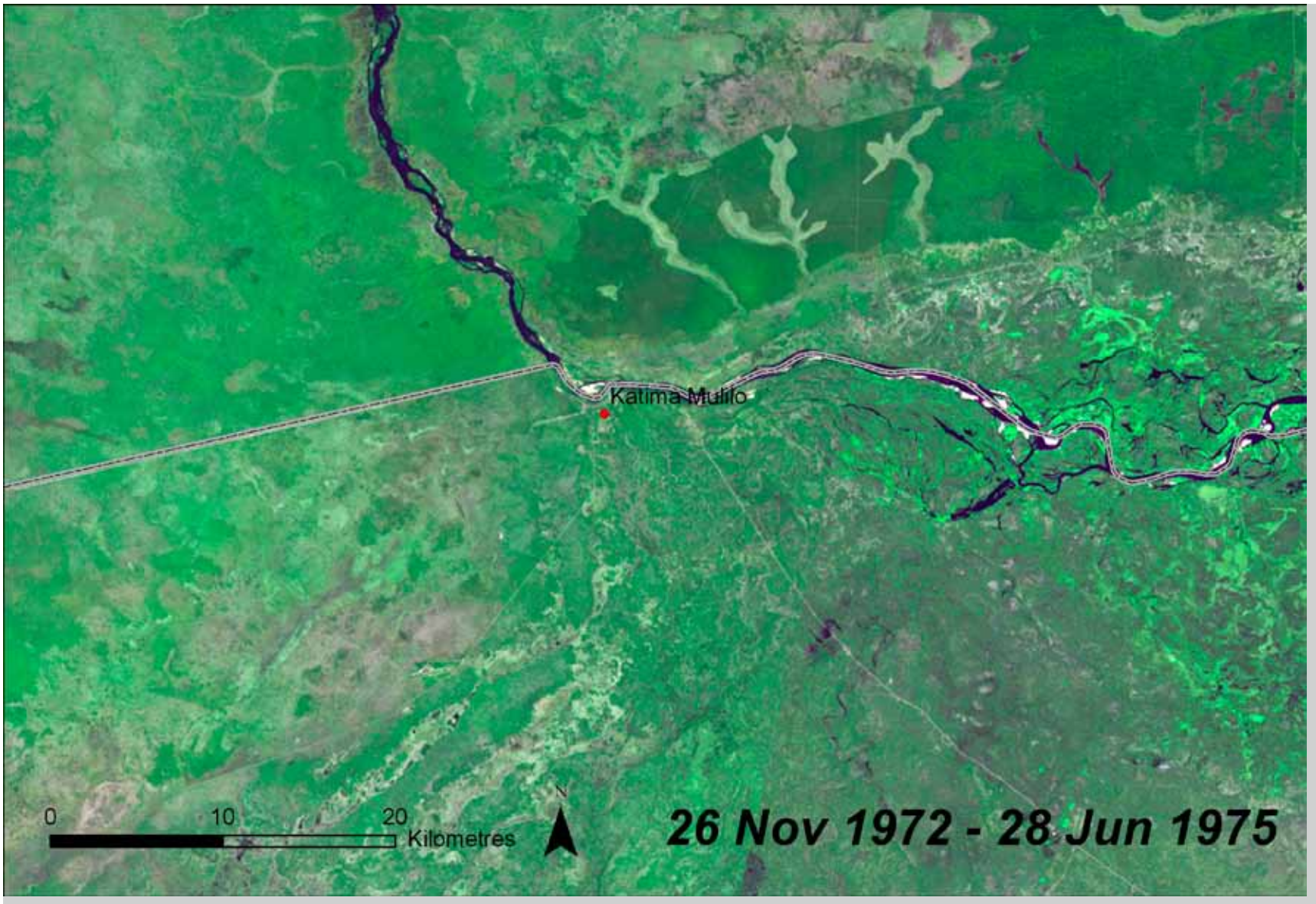
Destroyed homes following flooding in the Zambezi basin.

Flooding of police camp at Luangwa River, Great East Road Bridge Zambia 2007.

Droughts

Recurrent and prolonged droughts in the Zambezi basin are a threat to food security. Extensive droughts affected the basin in 1981-82, 1986-87, 1991-92, 1994-95 and 2001-03 (SARDC 2009b). Besides the direct impact on agriculture, previous droughts have caused water levels in dams and rivers to fall. For example, the water level of the Kariba Dam dropped by 11.6 metres from 1981 to 1992 due to a series of droughts (SARDC and HBS 2010). This had a major impact on the dam's capacity to generate hydro power. In Malawi, many rivers that rise from Mt. Mulanje, and historically had reliable water flow year round, have begun to dry up (IIED 2008).

A maize crop wilting due to drought.



Land degradation is a major threat to Namibia's land resources. Uncontrolled grazing, poor methods of crop production and fire are some of the causes of land degradation in Namibia's Katima Mulilo region. The Katima Mulilo area is one of the fire hotspots of southern Africa. Katima

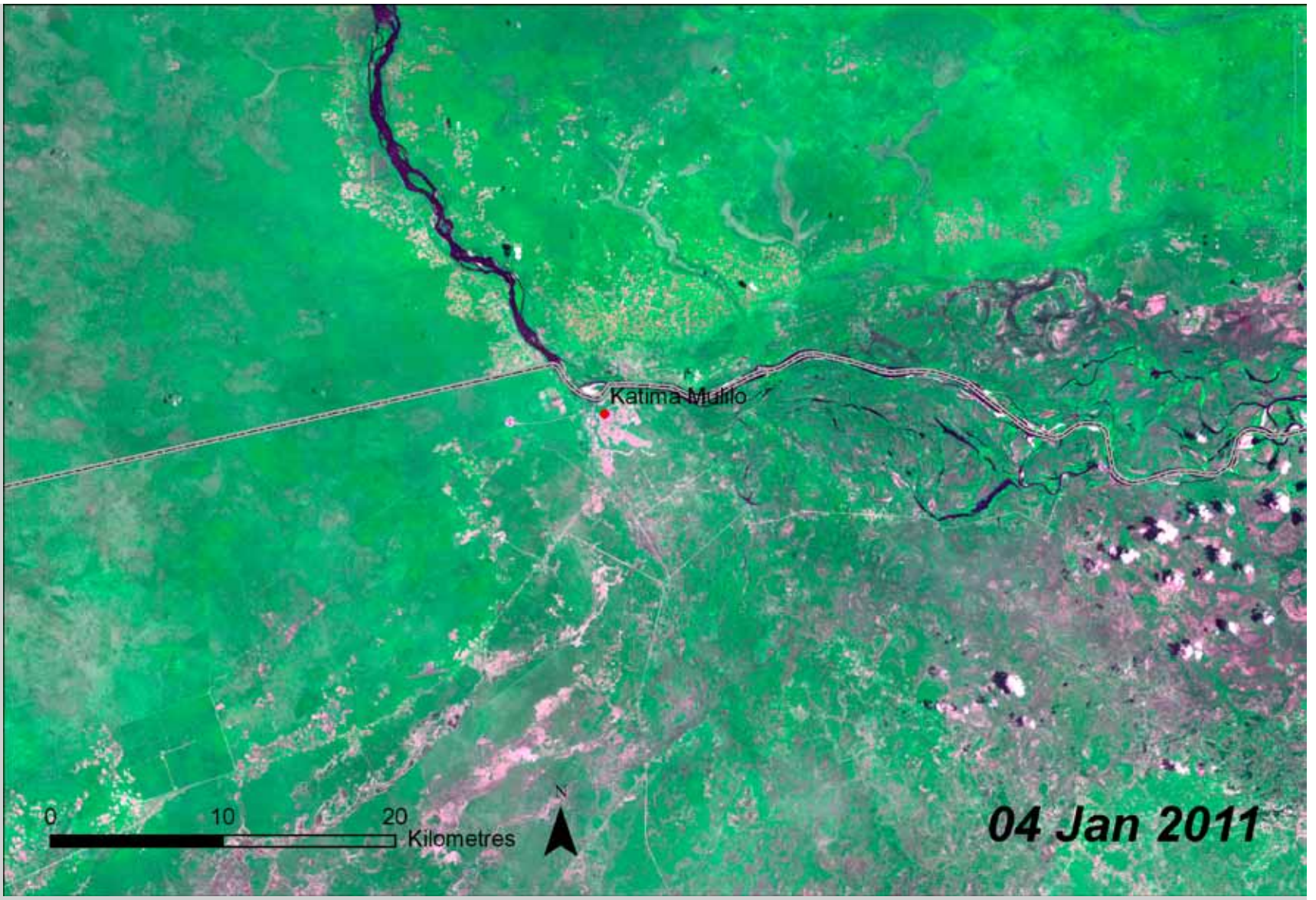
Land degradation

Soil erosion is the most widespread form of land degradation in the basin accounting for about 15 per cent of all degraded land in the Zambezi River Basin (SADC and ZRA 2007). Other forms of land degradation include loss of vegetation cover, soil crusting and compaction, declining soil fertility and siltation of dams. The main causes of land degradation are over-grazing, poor agricultural methods, deforestation, forest fires, panning for minerals, floods and droughts.

Land degraded by gold panning.

Land degradation on slopes in Malawi.

Soil erosion following drought.



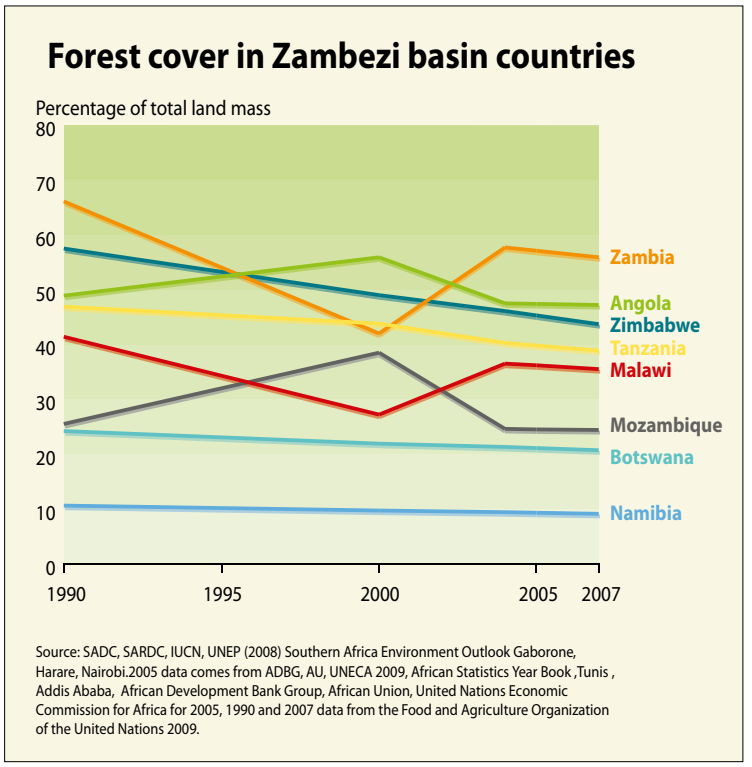
Mulilo is the administrative centre of Namibia's Caprivi strip. The centre is strategically located along major transport routes linking the towns of Livingstone in Zambia, Victoria Falls in Zimbabwe, and Kasane in Botswana.

Deforestation

Zambezi River Basin countries have been losing forests over the decades, and this loss continues unabated. Rates of forest loss per year in the last 20 years have been significant with Tanzania, Zimbabwe and Mozambique recording the highest losses of 403 350 hectares, 327 000 hectares and 217 800 hectares, respectively, while Malawi and Namibia recorded the smallest losses at 32 950 hectares and 73 600 hectares, respectively (FAO 2011). The main causes of forest loss include land clearance for agriculture and settlements due to growing population, and wild bush fires. In Botswana's Chobe enclave, forest loss has also been caused by increased commercial logging by private companies and destruction by elephants.

Deforestation in Mt Mulanje Forest Reserve in 1989 (left) and 2010 (right). Mulanje Mountain is a Global Biosphere Reserve designated under UNESCO's Man and Biosphere Programme. Biodiversity of Mt. Mulanje is under threat from deforestation and encroachment, poaching, bush/

Wood for charcoal production.



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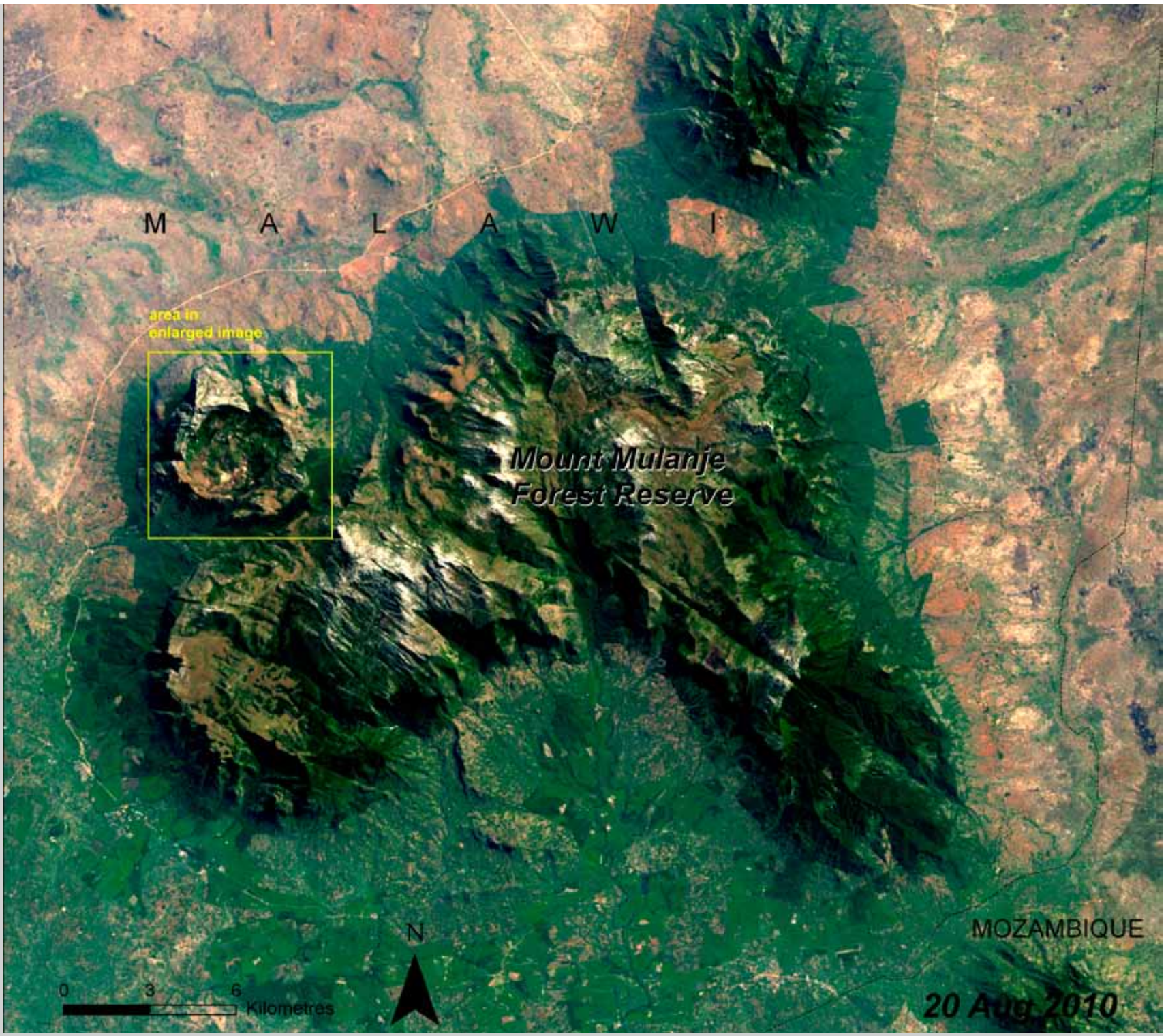
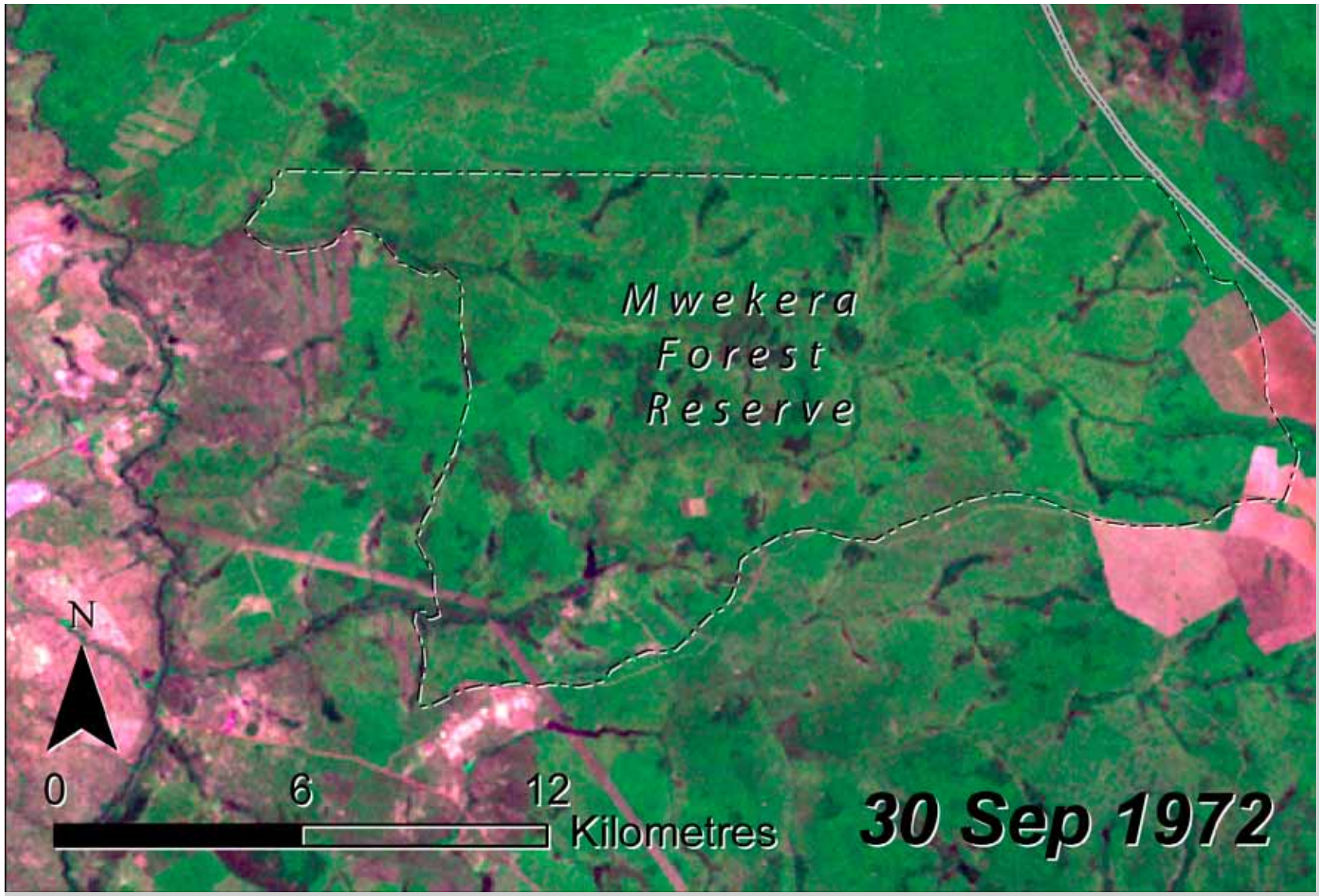
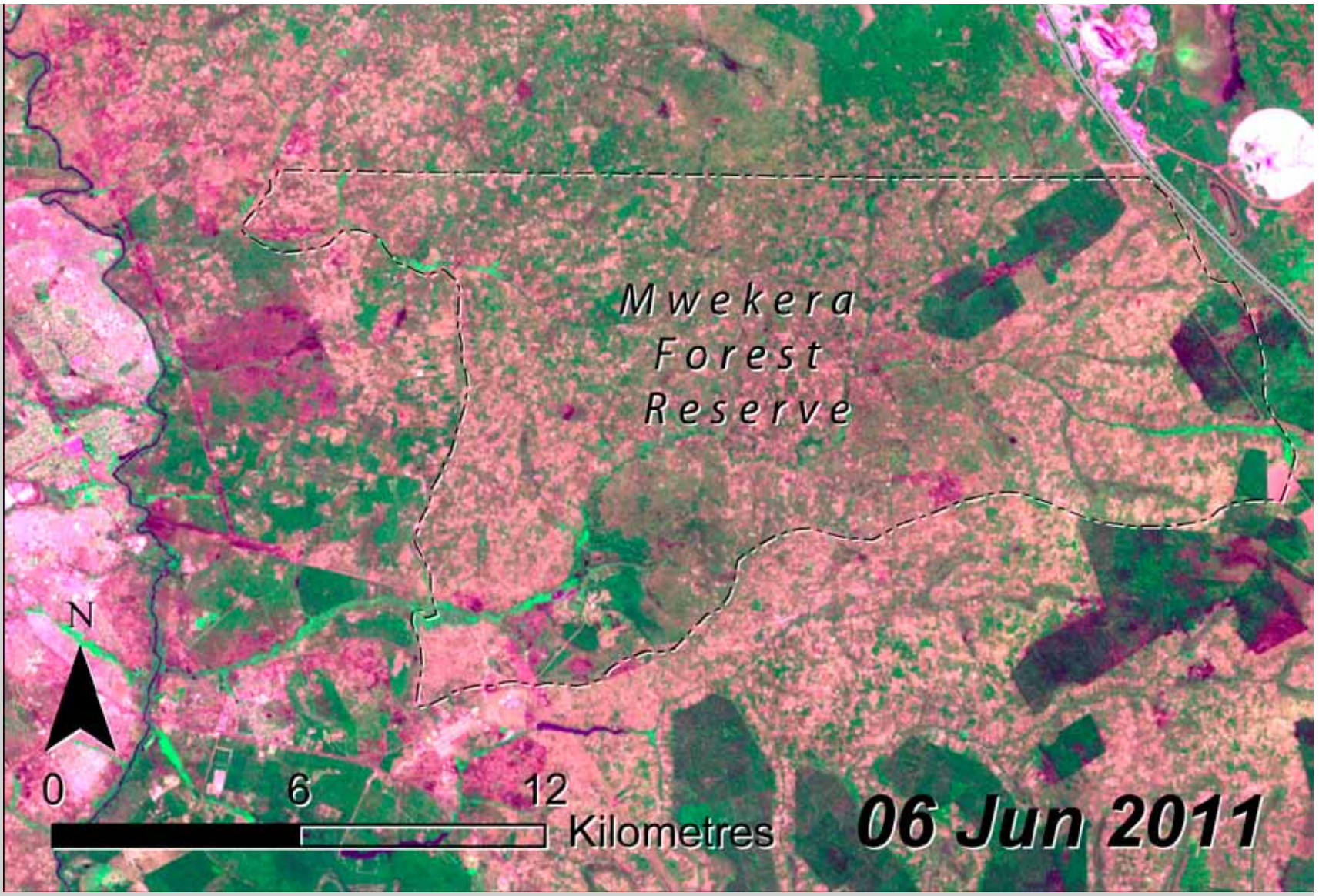


forest fires and invasive alien species. One of the rare and endemic species under threat is Mulanje Cedar (*Widdringtonia* whiteii). Mulanje cedar is a popular timber source because of its durability as it is resistant to termite and fungal attack (Mulanje Mountain Conservation Trust 2008).



Mwekera National forest was gazetted a forest reserve in 1946. The forest covered about 18 000 hectares at the time of gazetting. The forest is the catchment area of Mwekera stream, which flows into the Kafue River, which in turn flows into the Zambezi River. Uniquely, the forest reserve has



legal human settlements. Due to human activity, the size of the forest reserve has been declining rapidly since 1997. While "no take" management is often blamed for preventing local people from benefiting from forest resources, allowing access has to be approached with some controls.

CIFOR

There is a growing incidence of forest fires in the basin's savannah woodlands.

Forest Fires

The incidence of forest fires is increasing throughout the Zambezi basin. Although the use of fire for land management has a long history in the basin, widespread poverty and other socio-economic challenges such as migration to urban areas and diseases such as HIV and AIDS, result in shortage of labour in rural areas. This has led to increasing reliance on fire to clear agricultural land (SAFnet 2009). The high frequency of fires results in changes in the density of vegetation cover and forest species as well as structural composition of forests. Such changes affect hydrological processes, cause land degradation and contribute to carbon dioxide emissions.

A large swath of burnt forest.

Forest fires are common in the Zambezi Basin, especially during the period July to November.

© Candice Bate, WWF

Buffaloes grazing in the lush grass on the banks of the Savute River.

Freshwater Resources

Access to safe drinking water is a major concern in the Zambezi basin and one of the key Millennium Development Goals for all eight basin countries.

The water flow in the Zambezi river is estimated at 3 600 cu m per second. This represents about 87 mm/year of equivalent rainfall and less than 10 per cent of the average rainfall in the basin (Shela 2000). The average annual rainfall in the basin is about 950 mm/year (Mitchell 2004), but is unevenly distributed across the basin. The southern and western parts of the basin receive less rainfall than the northern and eastern parts. The more densely populated areas are located in the medium to low rainfall areas (Shela 2000).

Water consumption in the Zambezi basin is estimated at 15–20 per cent of total runoff (SADC and SARDC 2008). The consumptive uses include water supplies for drinking and sanitation in the basin's cities and towns, including Blantyre, Bulawayo, Harare, Kitwe, Lilongwe, Lusaka, Ndola and Tete. Irrigation consumes about 1.5 cu km per year. About 200 000 hectares of the estimated potential 7 million hectares have been developed for irrigation in the basin (Shela 2000).

Non-consumptive uses of the water resources of the Zambezi basin include hydro power generation at Kariba, Cahora Bassa, Victoria Falls and Kafue Gorge, and other dam sites. Other non-consumptive uses include fisheries, tourism, sport and navigation.

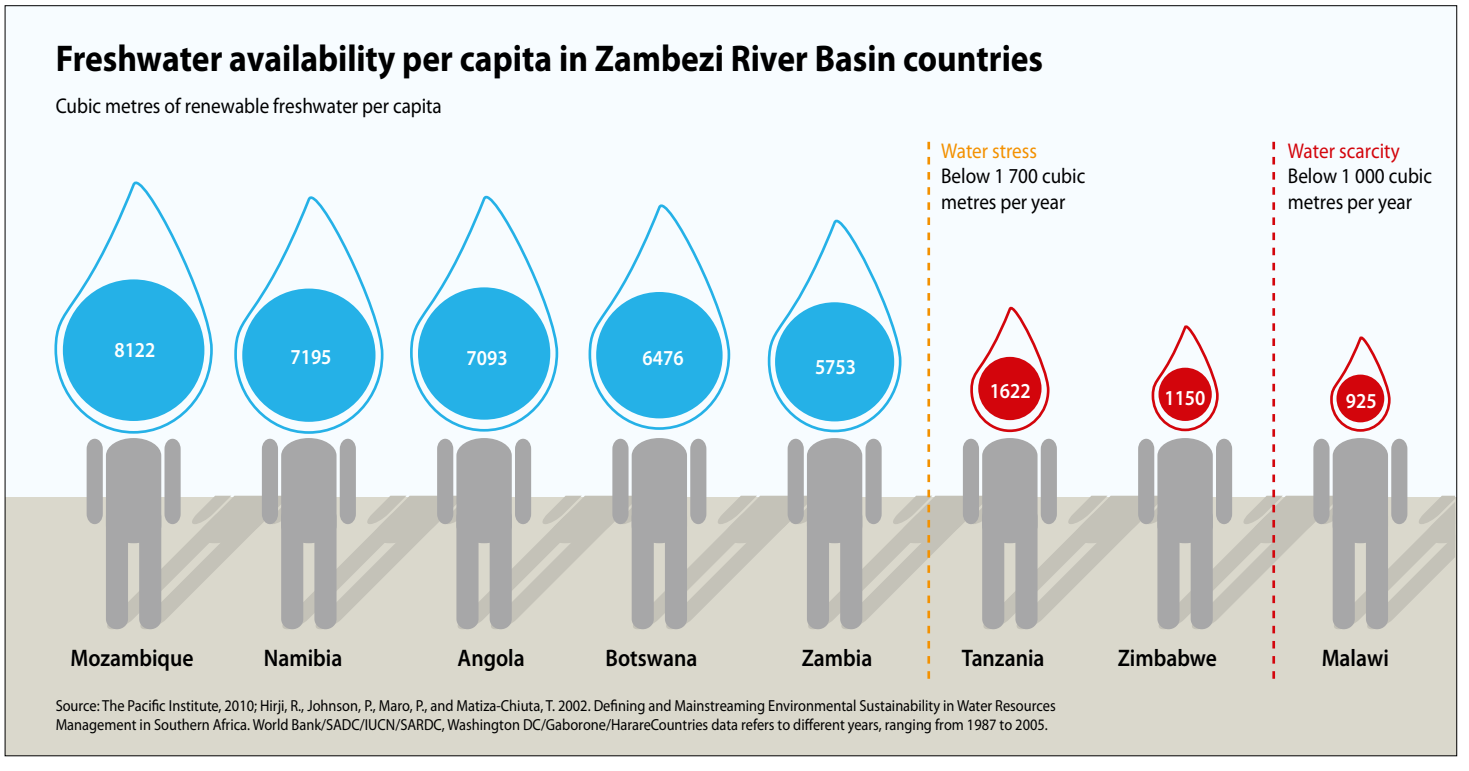


Figure 2.7
Per capita water availability is dwindling in all the basin countries, and the situation is particularly dire for Malawi, Tanzania and Zimbabwe.

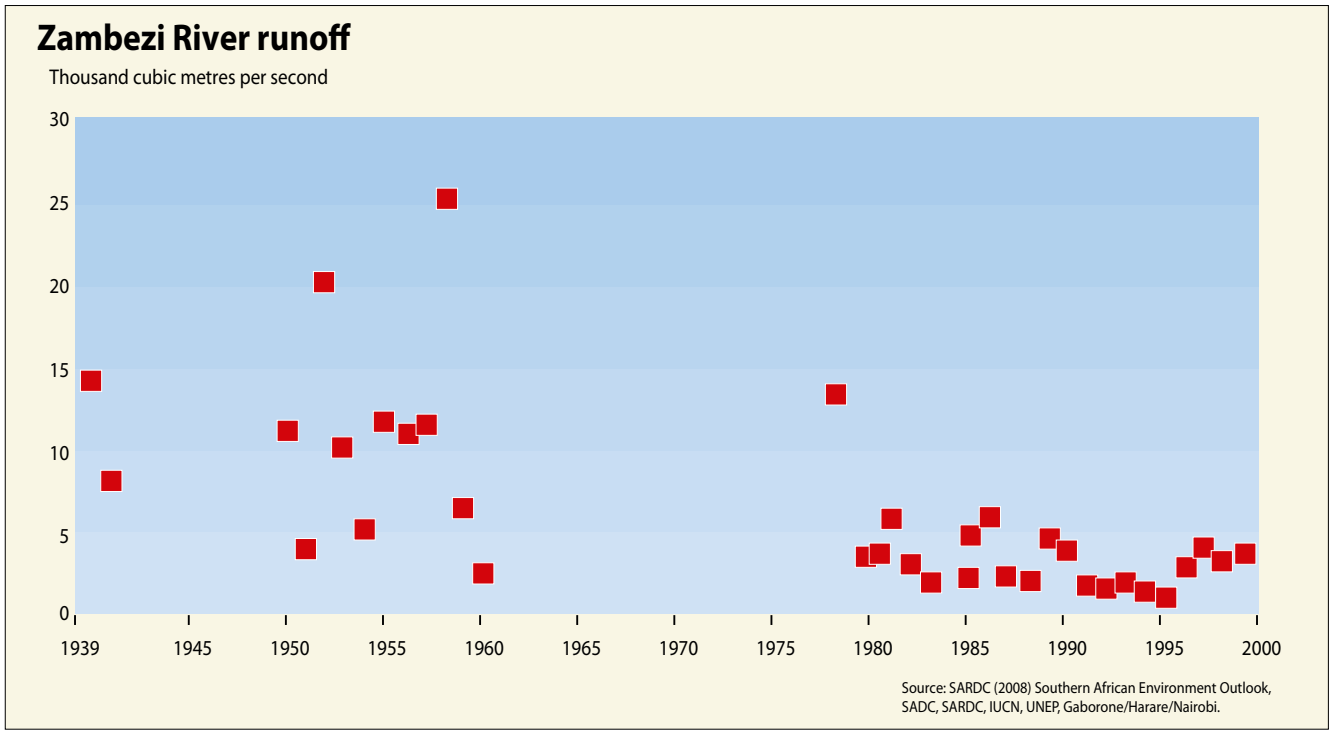


Figure 2.8
Flow Reduction in the Zambezi River Basin due to dam construction.

Reduced Runoff

A major impact of the construction of the Kariba and Cahora Bassa dams from 1950–1970 was the reduction in the Zambezi River runoff. Before the dam construction, the Zambezi River was torrential with high flows during the wet season from November to March and relatively low flows in the dry season from April to October. On average, the river discharged 60 to 80 per cent of its mean annual flow during wet season. Since the dams were built, the wet season runoffs have been reduced by about 40 per cent, whereas the dry season runoffs have increased by about 60 per cent (SADC and SARDC 2008).

Changing River Flows

The generally arid southwestern part of the basin has produced some river flow regimes that are not consistent with the seasonality of the rainy and dry seasons. For example, the Savute River is uncharacteristically dry for long periods before flowing again, while the Lake Liambezi almost disappeared between 1985 and 2000 before in began filling up again.

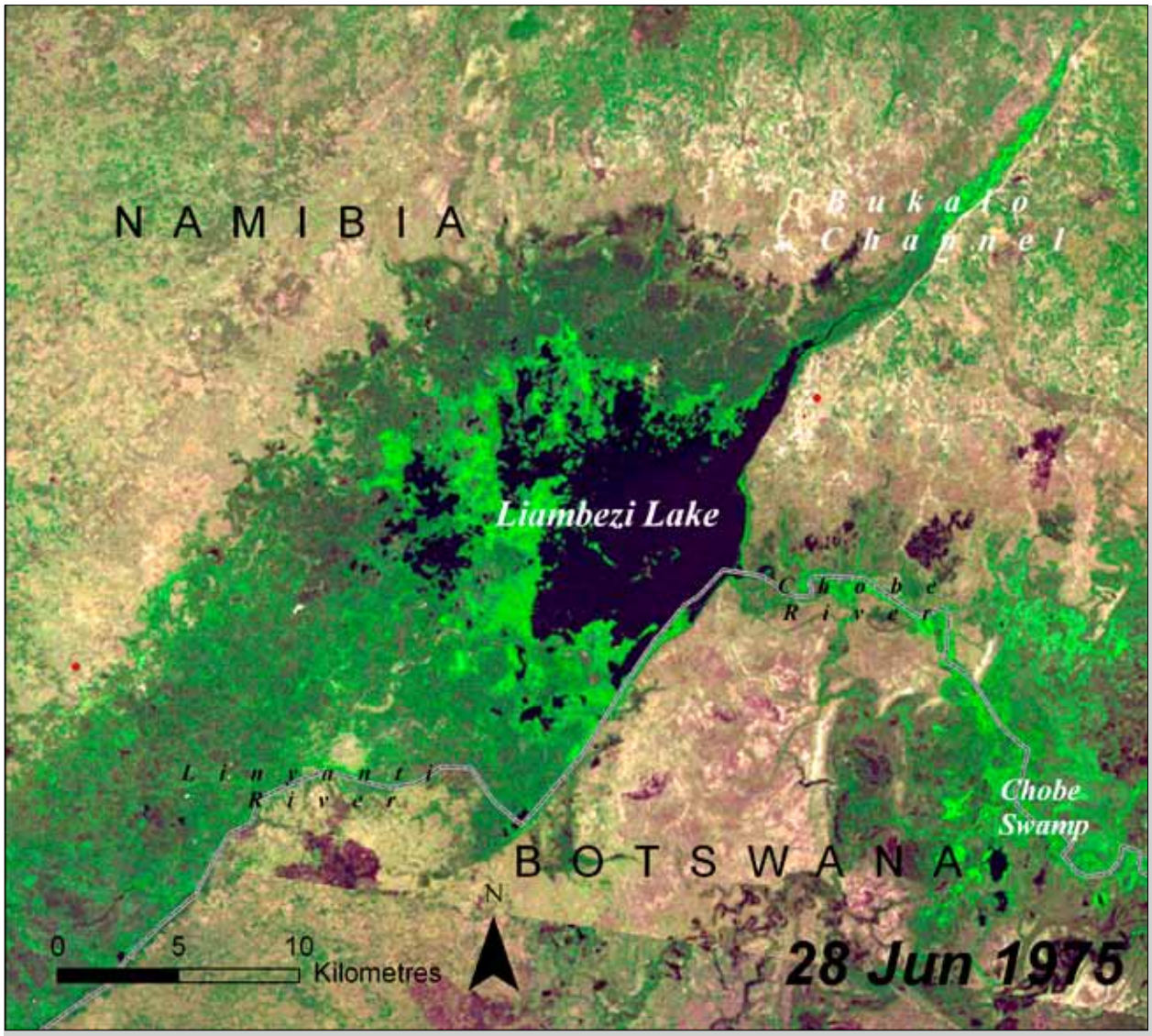
Savute River in Botswana flowing again

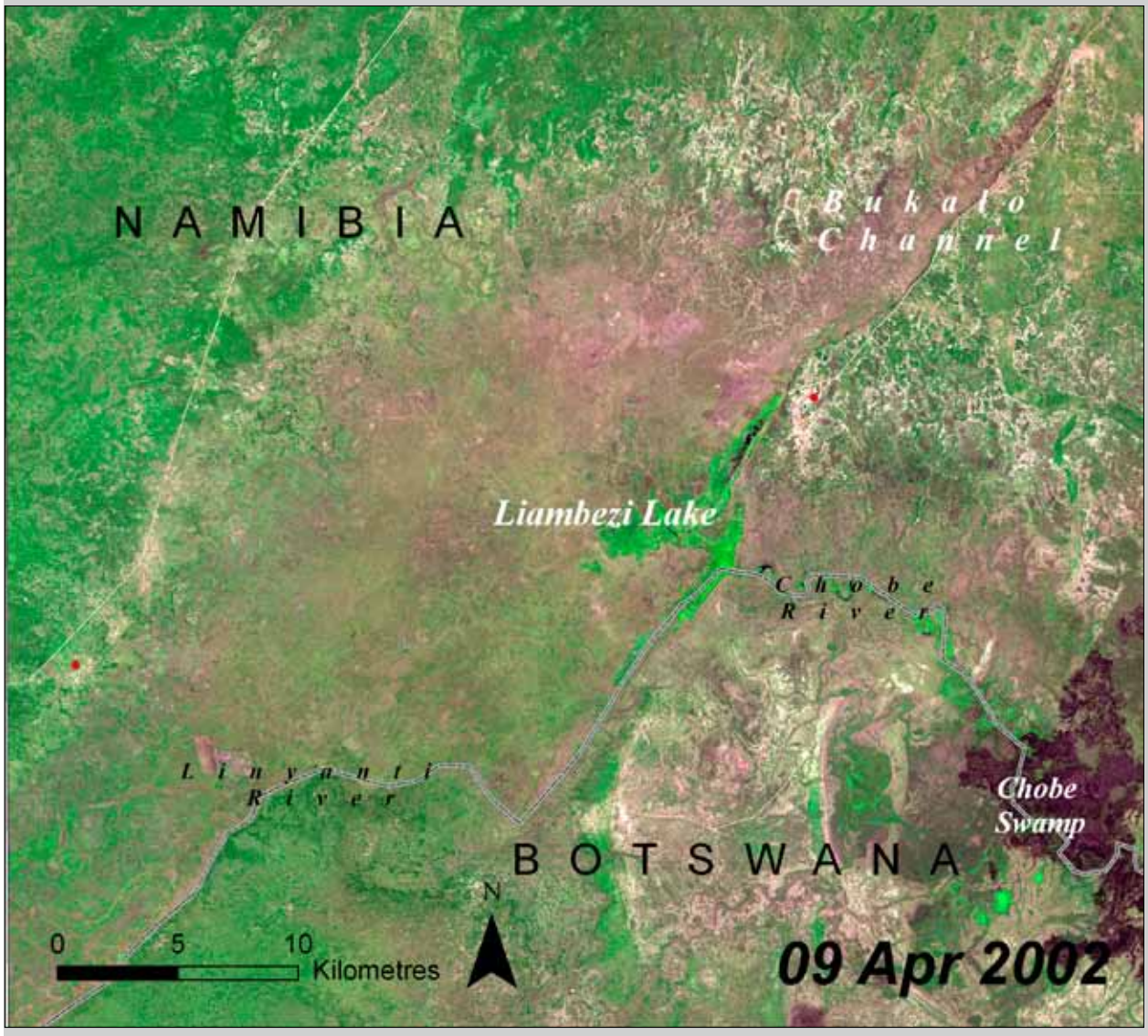
After 28 years of aridity, the Savute Channel is flowing again, bringing an explosive growth of vegetation and drawing wildlife. The channel flowed from the 1850s to the 1880s, then stopped flowing and remained dry until it began flowing again in 1958. It stopped flowing in 1965, started again in 1967 then stopped in 1982, remaining dry for 28 years, until 2010 when water filled the channel again (Pfotenhauer 2011). This irregular flow of water explains the numerous dead trees that line the channel, as they have germinated and grown when the channel was dry and been drowned when it flowed again.

The exceedingly high rainfall in the Angolan Highlands in the 2009-10 rainy season, along with the good floods of the year before, caused phenomenal flooding of the Okavango Delta in the winter of 2010, the highest ever recorded. Small tributaries of the Okavango River flow into the Selinda Spillway, now also flowing after many dry years. The spillway connects with the Kwando/Linyanti river system which, further north and east, flows into the Chobe River and eventually meets the Zambezi.

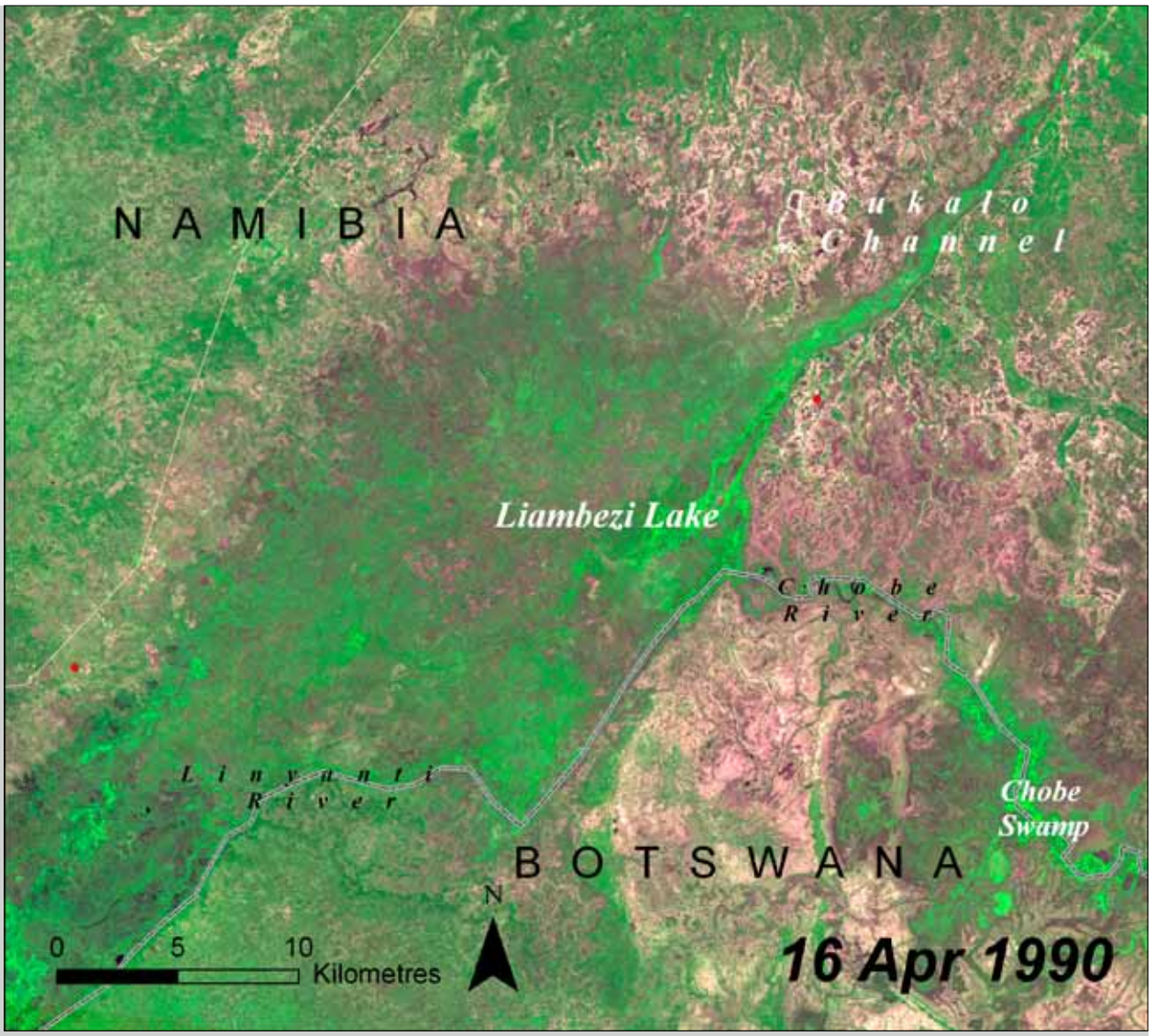
Elephants drinking from the Savute River.

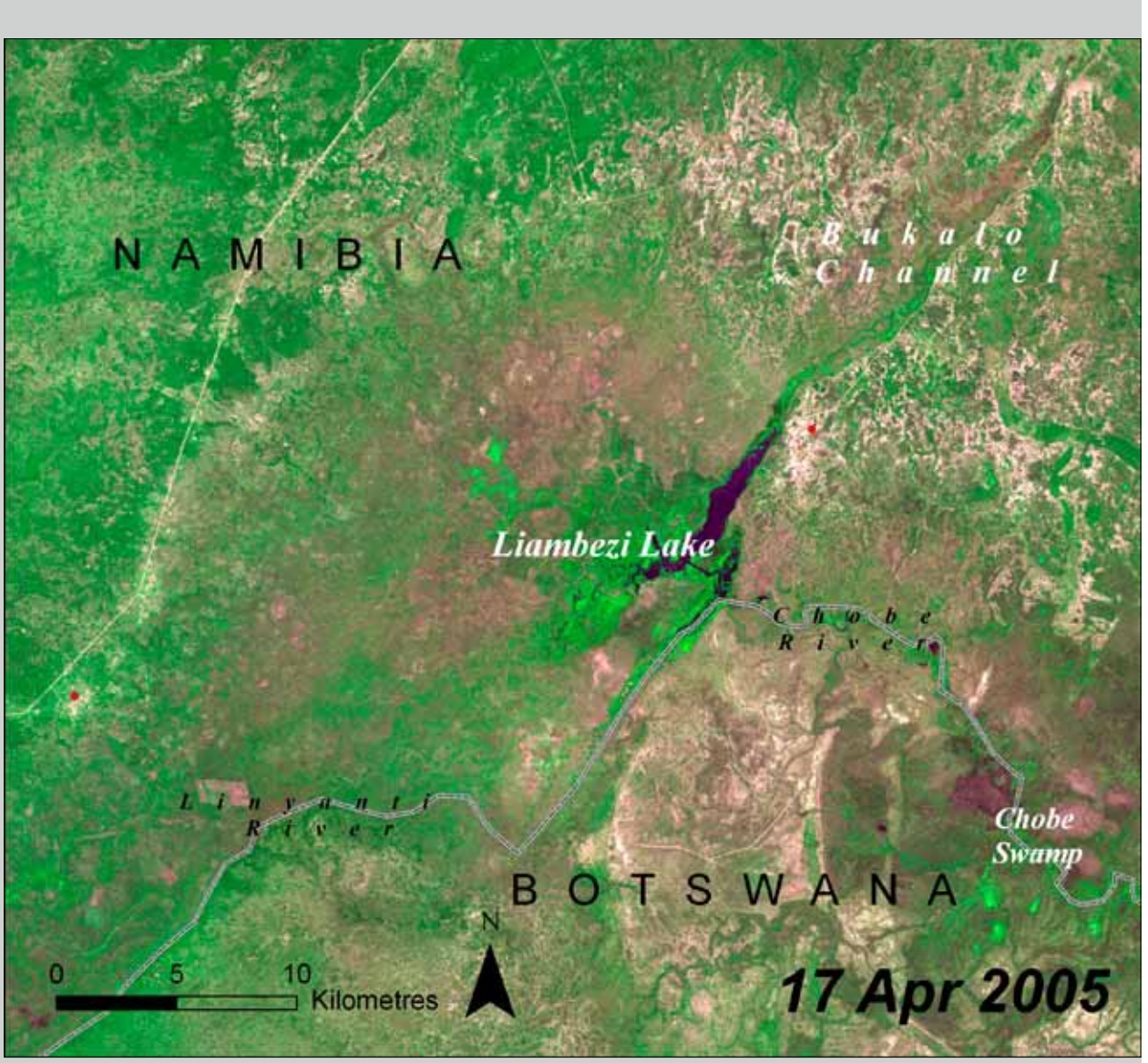
© Antonio Klaus Kaarsberg





Lake Liambezi in 1975 (top left), 1990 (top right), 2002 (bottom left) and 2005 (bottom right). Lake Liambezi is a shallow depression located in Namibia on a fault line near the confluence of the Chobe and Zambezi Rivers. The lake is less than six metres deep, semi-endorheic and





characterized by cyclic episodes of filling and drying. For example, the lake dried up in 1985, and remained dry until June 2001, when a small section near the Chobe River was partially inundated (Palmer 2001).

Table 2.2. Freshwater resources in the Zambezi River Basin countries

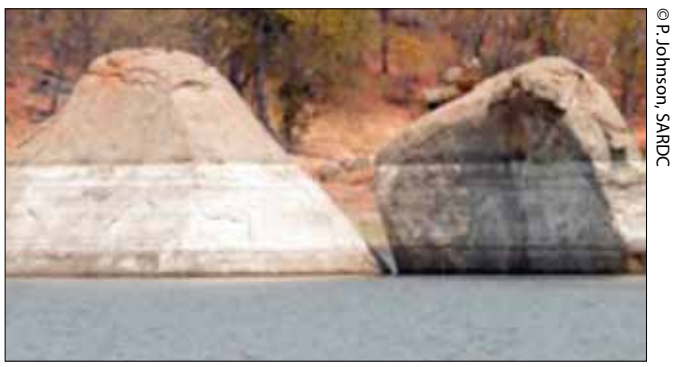
Country	Total annual renewable freshwater available (km^3/yr)	1995 population (000)	1995 availability per capita (m^3)	2000 population (000)[a]	2000 water availability per capita (m^3)~	2025 population (000) UN medium projection	2025 water availability per capita (m^3)
Angola	184	11 558	15 920	13 399	13 732	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	10 475	1 785	18 695	1 000
Mozambique	216	15 400	14 026	17 240	12 529	26 730	8 080
Namibia	45.5	1 590	28 616	1 900	28 947	2 460	18 496
Tanzania	89	28 400	3 134	31 900	2 790	56 090	1 587
Zambia	116	9 100	12 747	9 886	11 733	18 285	6 345
Zimbabwe	20	11 526	1 735	11 696	1 710	17 395	1 580

Source: SADC and SARDC 2008.

Improved access to safe drinking water is one of the Millennium Development Goals.

Reduction in Lake Levels

The IPCC (2009) records point to increasing temperature in southern Africa, and predict small changes in temperature and water balance that could alter water levels, as well as mixing regimes and productivity. Higher temperatures would increase evaporative losses, especially if rainfall also declined. Declines in mean annual rainfall of 10-20 per cent for extended periods would have a significant impact on lake levels even if temperatures were unchanged.



There are seasonal fluctuations in the levels of water in lakes, leaving an indelible mark on rocky shorelines.

© R.J. Boroto

The delivery of safe drinking water in most of the basin's urban areas is hindered by old and inadequate infrastructure.

Wetlands

Some wetlands in the Zambezi River Basin are receding due to reduced flows caused by droughts and water extraction. Other wetlands are increasingly being infested by aquatic weeds while still others are exposed to persistent organic pollutants such as DDT, the pesticide dichlorodiphenyltrichloroethane. Some wetlands have also been inundated with water as a result of dam construction. Additional threats to wetlands include overexploitation of resources, uncontrolled fires, pollution and deforestation. These threats alter wetlands, causing habitat change and species loss (Chenje 2000).

The Lower Shire River in Malawi, the Zambezi Delta in Mozambique, the Kwando/Linyanti/Chobe system draining down the Caprivi in Namibia, and the Kafue flood plains in Zambia are the most environmentally sensitive wetlands in the basin (Bethune 1999).

The Kafue Flats

The Kafue Flats in southern Zambia are an extensive floodplain system that lies in the middle Kafue River. The floodplain covers an area of approximately 6 500 sq km, and is sandwiched between two large dams, which are 270 km apart (Mumba and Thompson 2005). The dams have altered the hydrological regime of the system, with backwater from the Kafue Gorge Dam downstream and releases from the Itezhi-Tezhi Dam upstream creating a permanently flooded area in the floodplain. The hydrological and vegetation changes have affected the habitat for important wildlife communities including the endemic lechwe antelope, (*Kobus lechwe kafuensis*). The other dramatic change in vegetation is the colonization of parts of the floodplain by the invasive alien plant, *Mimosa pigra* (Mumba and Thompson 2005).

The Kafue River and its floodplains are heavily utilized and highly industrialized, and subjected to pollution from mining, industry, agriculture and municipalities. A joint study by the University of Zambia and the Swedish Lulea University of Technology shows high levels of heavy metals, particularly copper, in the Kafue River near the Copperbelt area. The floodplain also suffers from heavy grazing and overfishing (SADC and SARDC 2008).

The Zambezi Delta

Water regulation from Cahora Bassa dam has substantially reduced the Zambezi Delta wetland productivity and even offshore shrimp catches in Mozambique (Chenje 2000). Saltwater intrusion has become a problem in the delta as a result of reduced freshwater flows and the lack of regular substantial seasonal floods. Irregular floods in the delta are associated with cyclonic rainfall along the Mozambique coast.

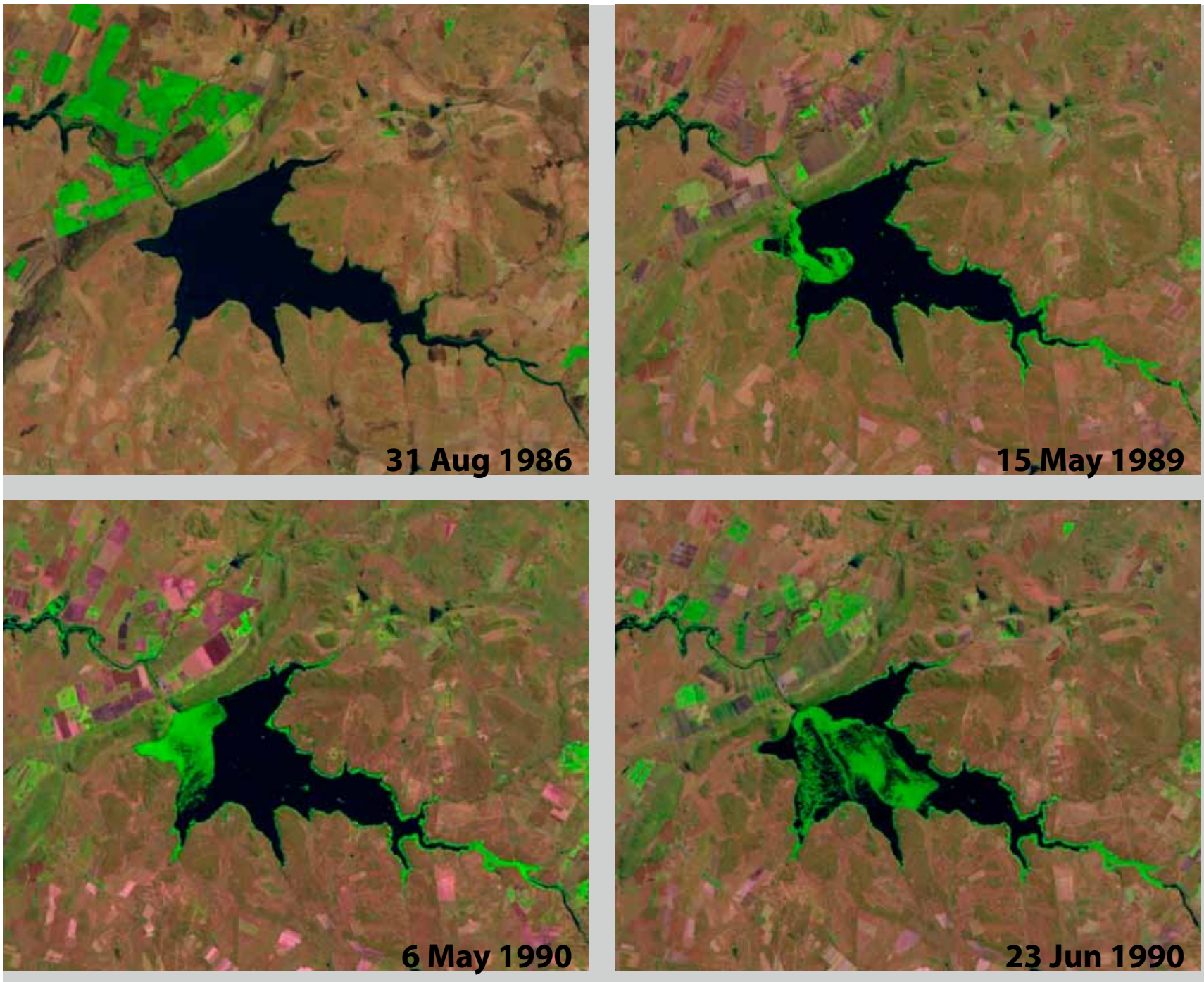
Invasive Alien Species

Aquatic weeds, mostly free-floating species such as Water Hyacinth (*Eichhornia crassipes*), Water Lettuce (*Pistia stratiotes*), Red Water Fern (*Azolla filiculoides*), and Kariba Weed (*Salvinia molesta*), are dominant in the Zambezi basin (Hirji *et al.* 2002).

Although water hyacinth growth is a problem throughout the basin, areas that are particularly problematic are the Kafue Flats, Lower Shire, Lake Kariba, and Lake Chivero. In Lake Kariba water hyacinth and hippo grass (*Vossia cuspidate*) are found in the estuaries and along the shoreline.

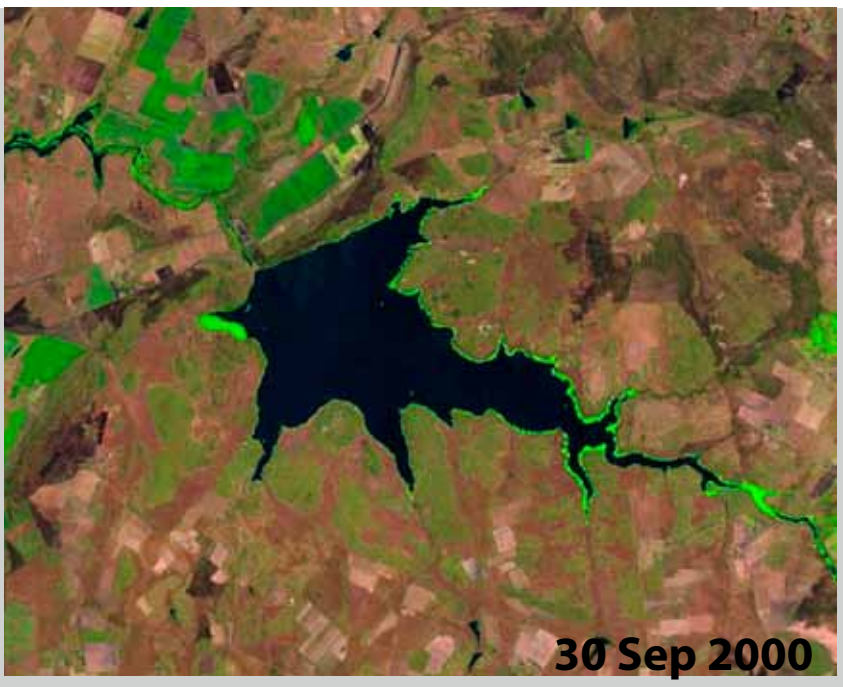
Lake Chivero

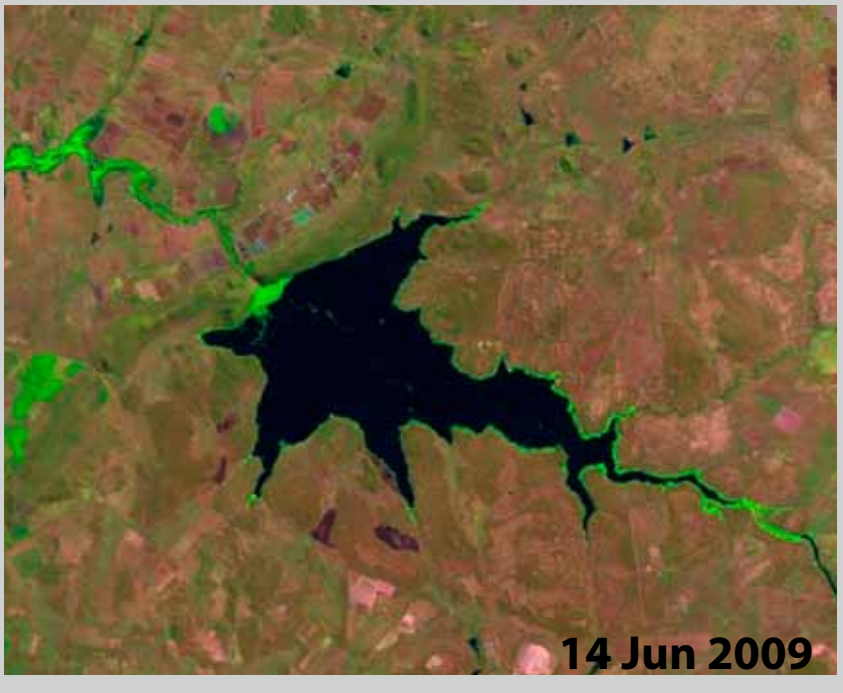
Lake Chivero was created in 1952 with the damming of the Manyame River, 37 kilometres southwest of Harare (Shekede *et al.* 2008). Water hyacinth appeared in the lake for the first time in 1953. Its proliferation was aided by the nutrient enrichment of the lake from nearby farms and from municipal and industrial waste from Harare. By 1956, the first serious water hyacinth outbreak had been successfully controlled using chemical herbicides (UNEP 2008). The weed reappeared, and by 1976 occupied 42 per cent of the lake, before declining to 36 per cent in 1989 and later to 22 per cent in 2000. Chemical spraying and mechanical weed control methods used during the 1960s and 1970s also lowered levels of nutrient enrichment are believed to have contributed to the decline (Chikwenhere and Phiri 1999). The introduction of biological control in 1990 using the water-hyacinth weevils, *Neochetina eichhorniae* and *N. bruchi*, reduced most of the water hyacinth in the lake in the late 1990s (Chikwenhere and Phiri 1999). By 2005, the invasive plants had returned, covering as much as 40 per cent of the lake (UNEP 2008). Another widespread weed in the lake is the spaghetti weed (*Hydrocotyle ranunculoides*).

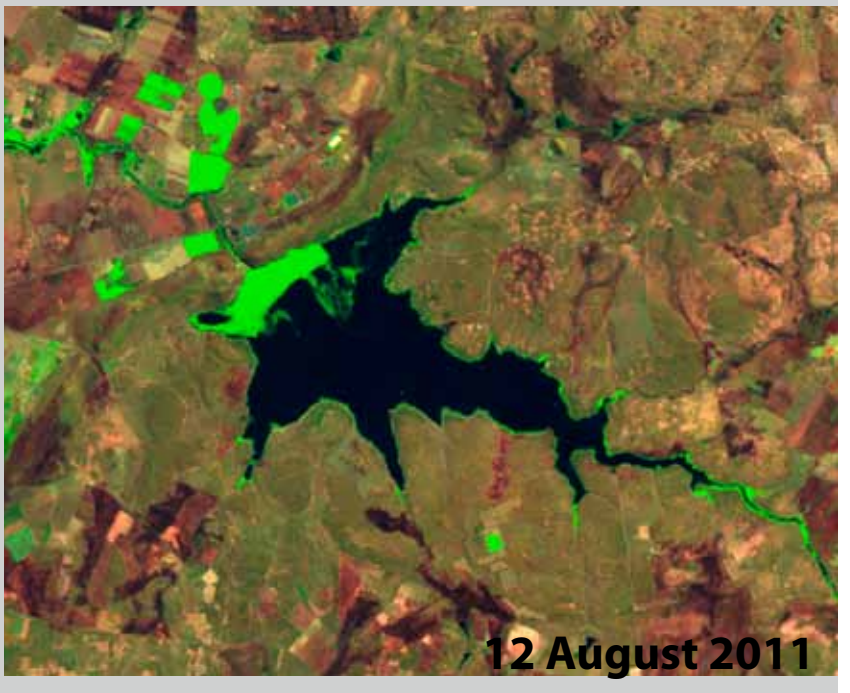


Created in 1952 to supply water to Harare, Lake Chivero became hypertrophic 15 years later. Nutrient removal and wastewater treatment reduced the trophic state in the 1970s. Urban growth in the 1980s resulted in increased discharge of partially treated wastewater into the lake.

Water Hyacinth in Ithezhi Tezhi dam. Source: Environmental Council of Zambia.







The proliferation of the water hyacinth is strongly correlated with the measures to reduce the nutrient loads in the lake. However, the control measures which also included biological and mechanical control, yielded partial success.

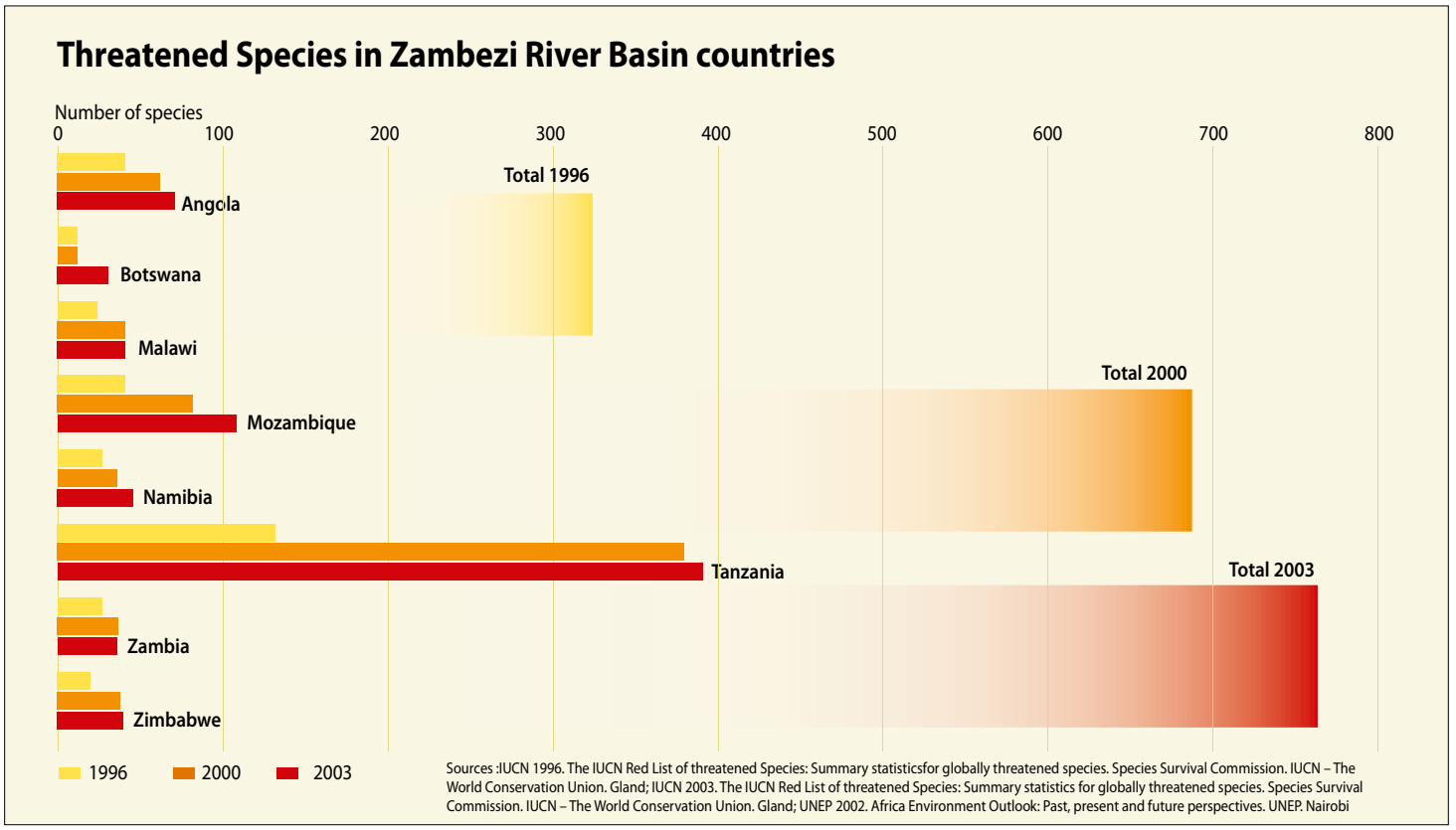


Figure 2.9

Wildlife

The Zambezi basin is rich in wildlife, fish, plants, and insects. These are found in terrestrial, freshwater and marine ecosystems. Many species are endemic to the Zambezi River Basin, including Lake Malawi's cichlids and the Mt. Mulanje cedar (SADC and SARDC 2008).

Despite the abundance of wildlife resources in the basin, there are pressures that threaten the existence of this resource. Species that have become extinct in the basin in recent times include the blue wildebeest in Malawi, the Tsetsebe in Mozambique, and the Kob in Tanzania (SADC and SARDC 2008).

Others face a high risk of extinction, and the number of threatened species across the basin continues to rise. The White (Grass) rhinocerous, Black (Browse) rhinoceros, and the Black Wildebeest are critically close to disappearing altogether, even though decisive conservation action is allowing some populations to revive (SADC and SARDC 2008). The Wattled Crane is endangered in the basin partly due to controlled flooding in the Kafue Flats which has reduced its nesting sites. The population of the lechwe (Kobus lechwe kafuenis) has also fallen in the Kafue due to alteration of their marshy habitat (SADC and SARDC 2008).

South Luangwa National Park, Zambia.

South Luangwa National Park, Zambia.

Elephants drinking water.

The Elephant Population

In Botswana, Namibia and Zimbabwe, the elephant population has grown so much in recent years that it now exceeds the carrying capacity of its habitat in these countries, creating problems of overpopulation and habitat destruction (SADC and SARDC 2008). For example, the elephant population in Namibia grew from 7 769 in 2002 to 12 531 in 2006. Tanzania has greater carrying capacity but also has a larger population of elephants. The elephant population in Tanzania increased from 92 453 in 2002 to 141 000 in 2006 (IUCN, African Elephant Database 2002 in SADC and SARDC 2008).

Human Health in a Changing Environment

The health of millions of people in the Zambezi basin is under threat due to an increase in the occurrence and spread of water-borne, vector-borne and respiratory diseases resulting from climate change related events (Boko and others 2007 in SARDC and HBS 2010). As a result of rising temperatures, it is predicted that the malaria-carrying female Anopheles mosquito will spread to parts of the region where it has not been found before by 2100 and there will be longer seasons of transmission in other areas (IPCC 2007 in SARDC and HBS 2010). New malaria areas include the southern highlands of Tanzania. In the Caprivi Strip in Namibia, malaria cases rose from 380 500 in 1993 to 444 000 in 2003 while in Zambia cases rose from just below 2 million in 1990 to 4.5 million in 2006 (SARDC and HBS 2010).

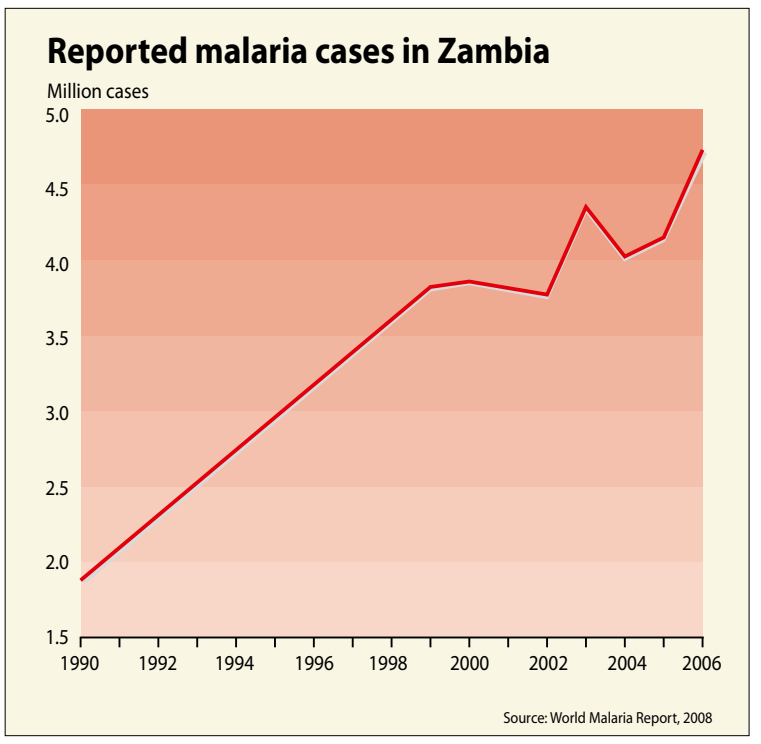


Figure 2.10

3

THE ZAMBEZI: A SHARED RESOURCE

Neighbouring countries often face similar challenges related to environmental change in a shared natural area and the impacts on people and livelihoods. The Zambezi River Basin has witnessed a drastic change in its natural environment in recent years mainly as a result of demographic dynamics, urbanization and increasing demand for agricultural land. These drivers have brought about changes to ecosystems, water resources and the way different cultures interact.

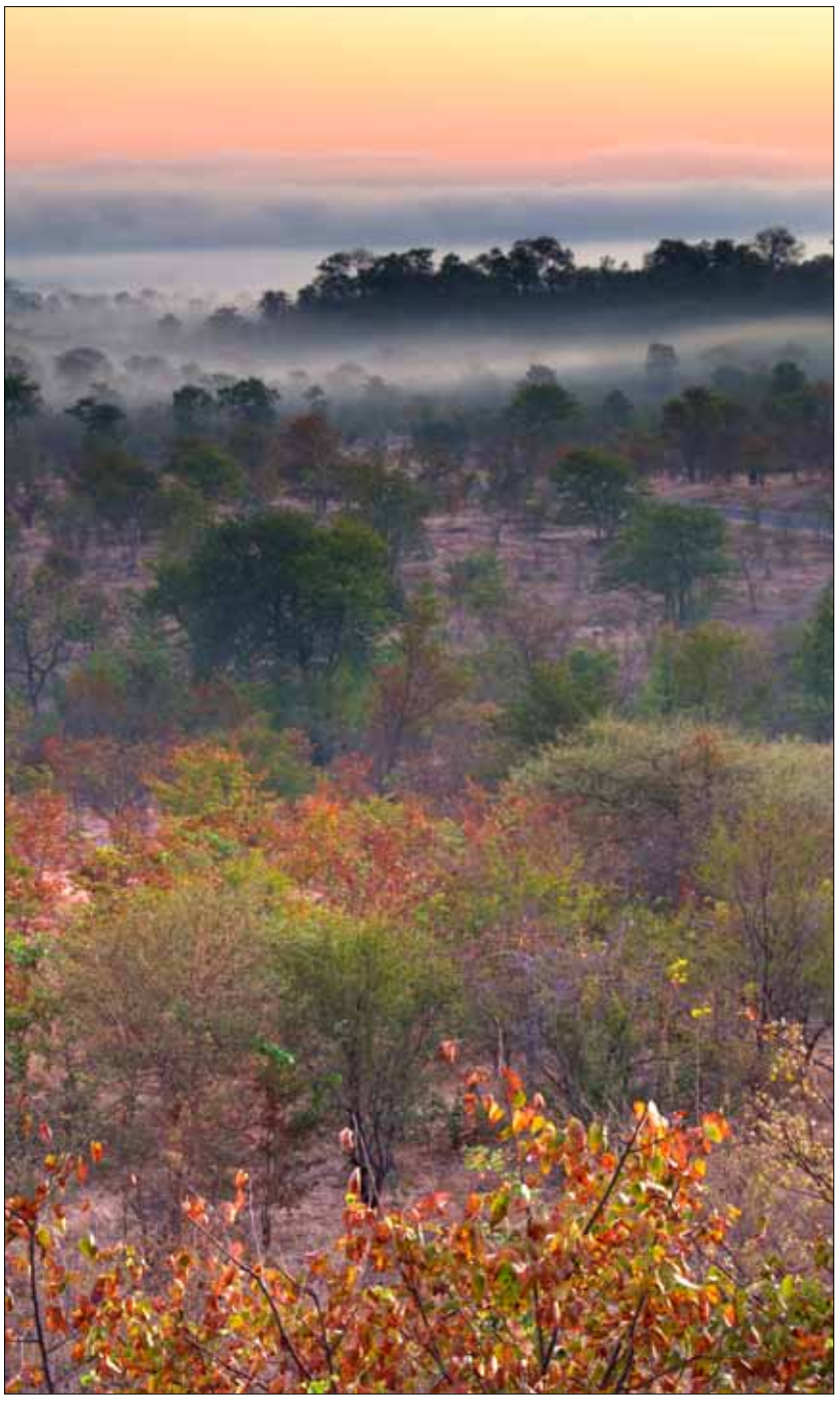
Ecosystems

The Zambezi teak forests, shared by five of the Zambezi basin countries, and the Miombo woodlands are examples of transboundary ecosystems in the basin (SADC and SARDC 2008).

Teak forests are found in the western parts of Zimbabwe and Zambia, extending into northern Botswana, northeastern Namibia and parts of southeastern Angola. The dominant tree species is the Zambezi redwood (*Baikeaea plurijuga*) and is usually found in association with Bloodwood teak (*Pterocarpus angolensis*). Msasa (*Brachystegia spiciformis*) is the other dominant species.

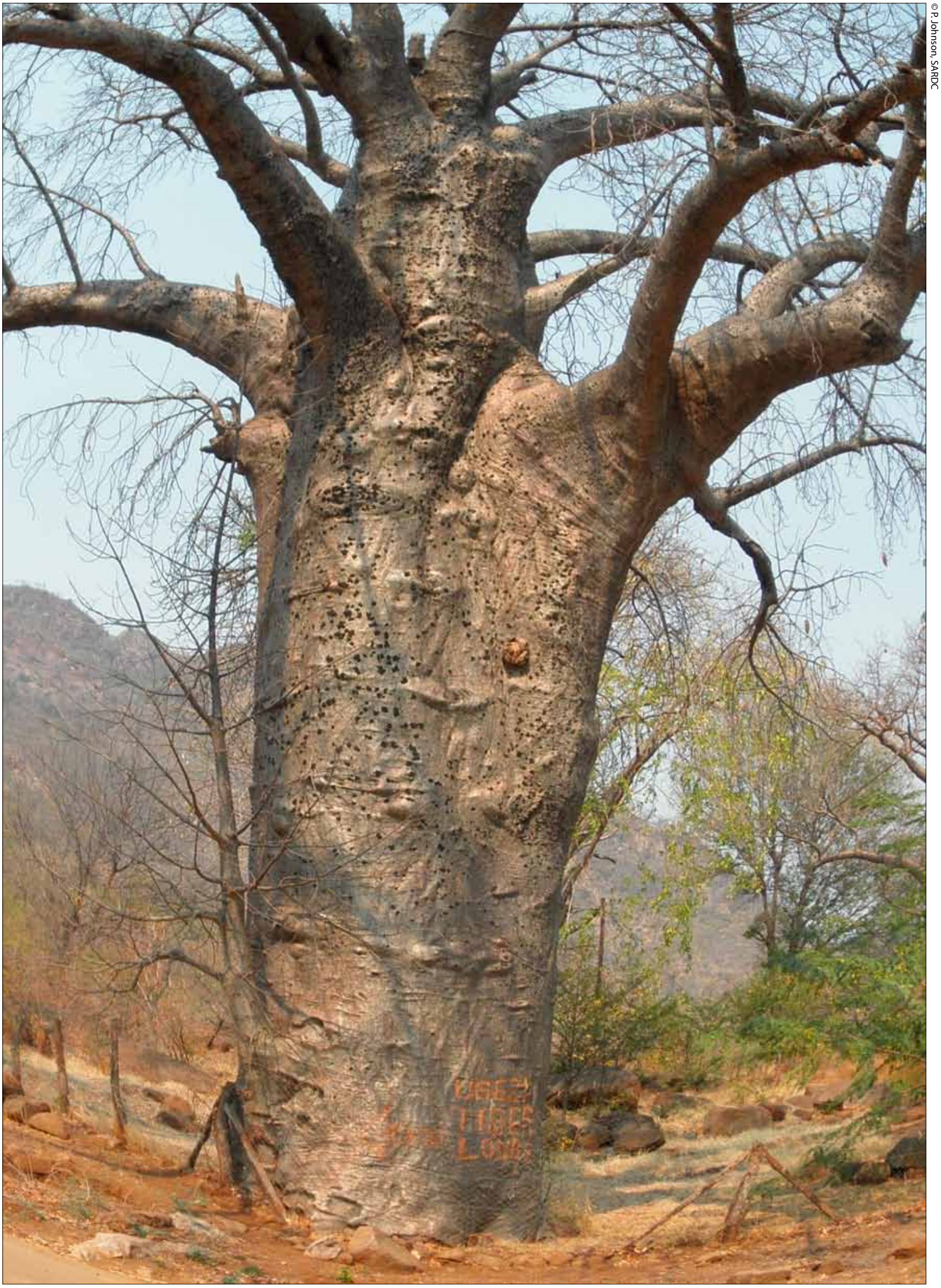
Wet Miombo woodlands form the most extensive woody vegetation type, and cover much of Zambia, and parts of Angola, Malawi and Tanzania (Kwesha 2008). Common tree species include the Munondo (*Juibernardia* species), Msasa and Pod Mahogany (*Alfzelia quanzensis*). As most of the Miombo woodlands have been converted into intensive agricultural areas, it is now difficult to find pristine woodlands.

Waterhole landscape in Zambezi National Park in Zambia.



Miombo woodlands are dominated by *Brachystegia* species.

The only rainforest in the Zambezi River Basin is found at Victoria Falls where it is watered with the spray from the Falls.



© P. Johnson, SARDC

Although mostly comprised of miombo woodlands with trees of the Brachystegia genus, baobab trees (*Adansonia digitata*) are ubiquitous in the Zambezi River Basin, inter-spaced with grasslands. The baobab bark is eaten by elephants, and people eat the tree's fruit and leaves.

Transboundary Conservation

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 still at the conceptual phase. Among those with MOUs in the Zambezi River Basin are Kavango-Zambezi TFCA, covering Angola, Botswana, Namibia, Zambia and Zimbabwe and the Malawi-Zambia TFCA. Those still at conceptual phase 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.

Vultures sitting on the bank of the Chobe River, Chobe National Park, Botswana. The Chobe National Park is part of the Kavango Zambezi Trans Frontier Conservation Area.

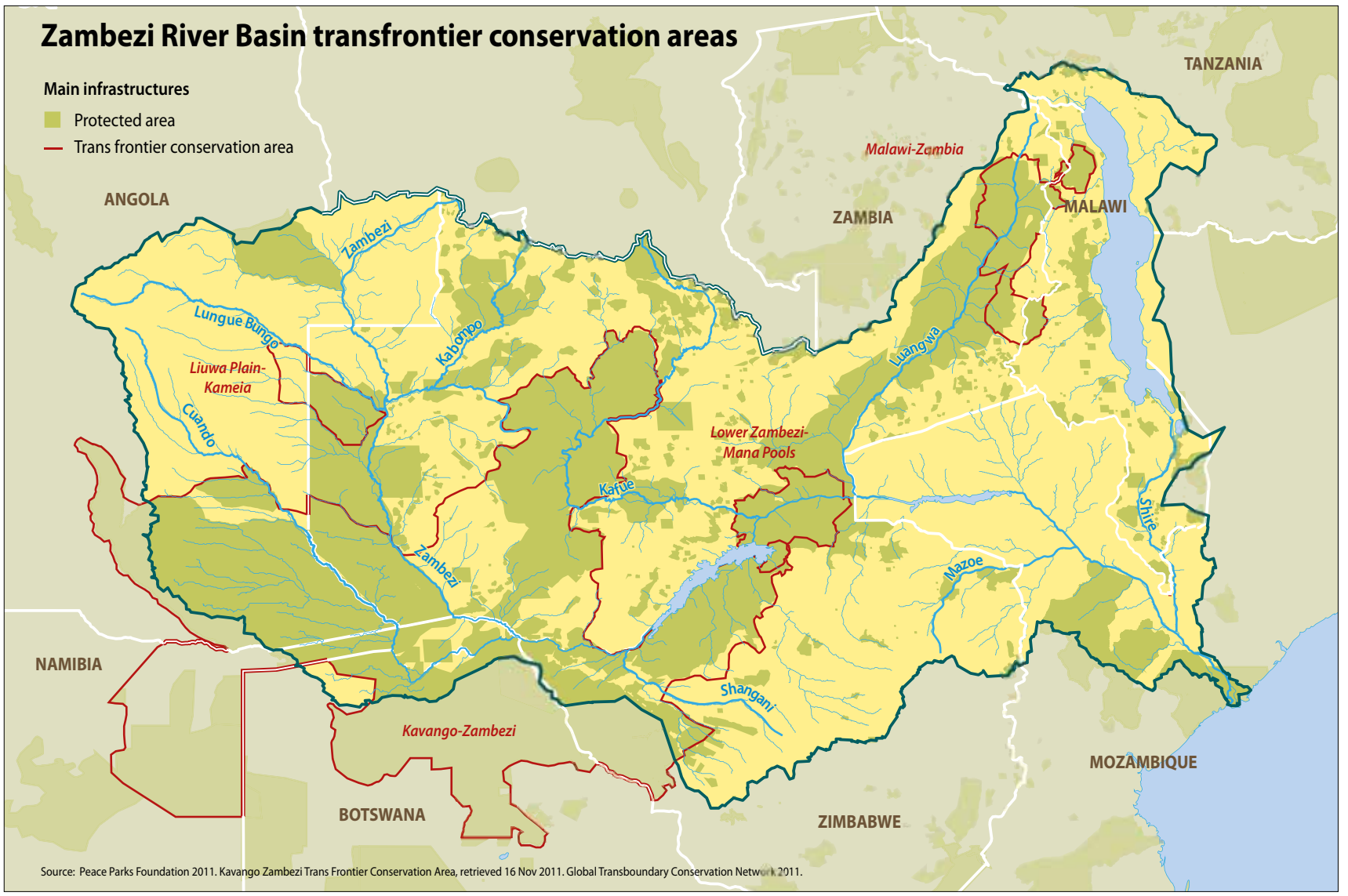


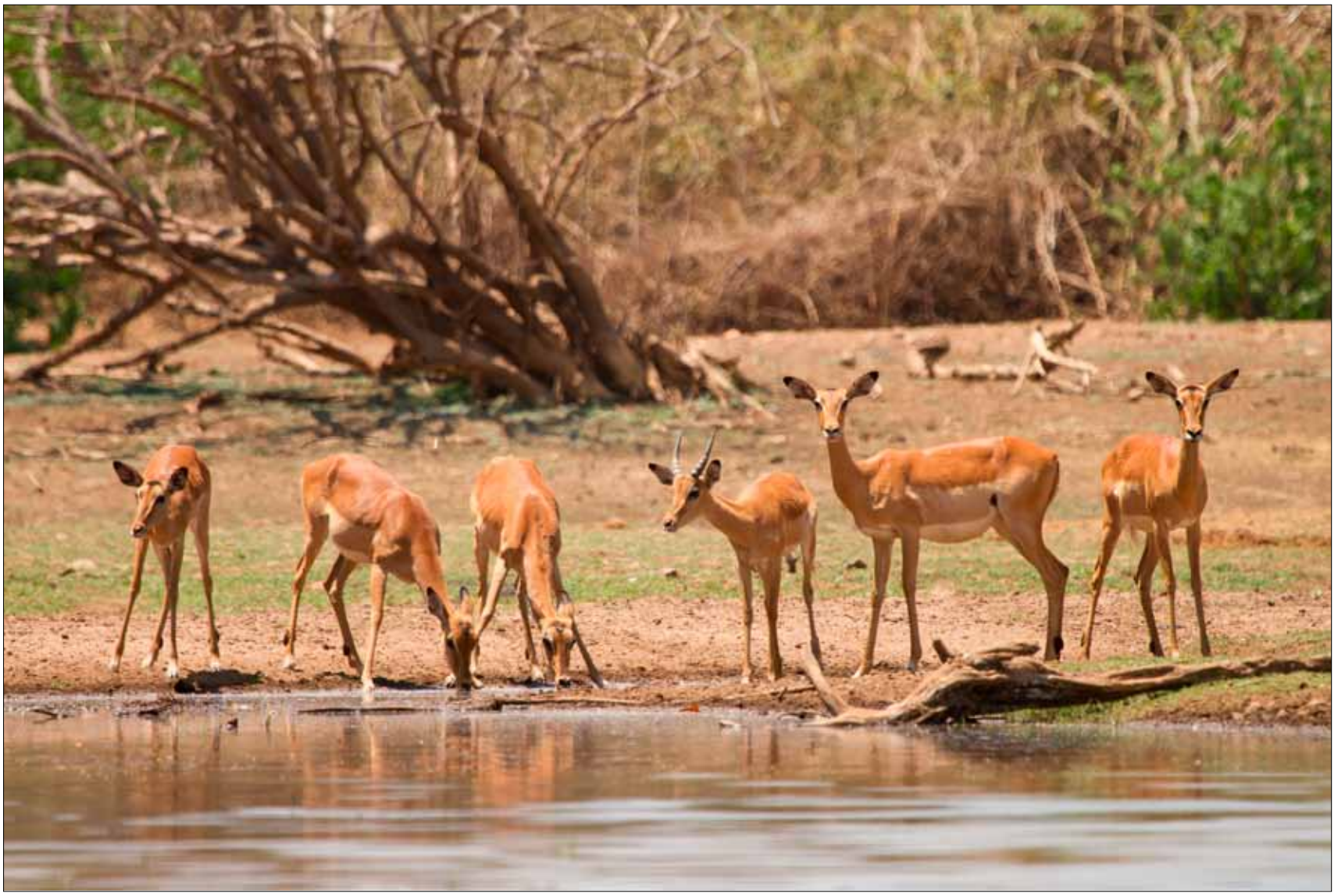
Figure 3.1

© Stefanie Van Der Vinden/Dreamstime.com

Jackal, Zambia

© Seventigers/Dreamstime.com

Crocodile, Zimbabwe



© Smellme/Dreamstime.com

Impala gazelle, Zambia

© Steve Allen/Dreamstime.com

Black-winged stilt, Chobe River, Botswana

© Manuela Klopsch/Dreamstime.com

Cichlid fish, Malawi

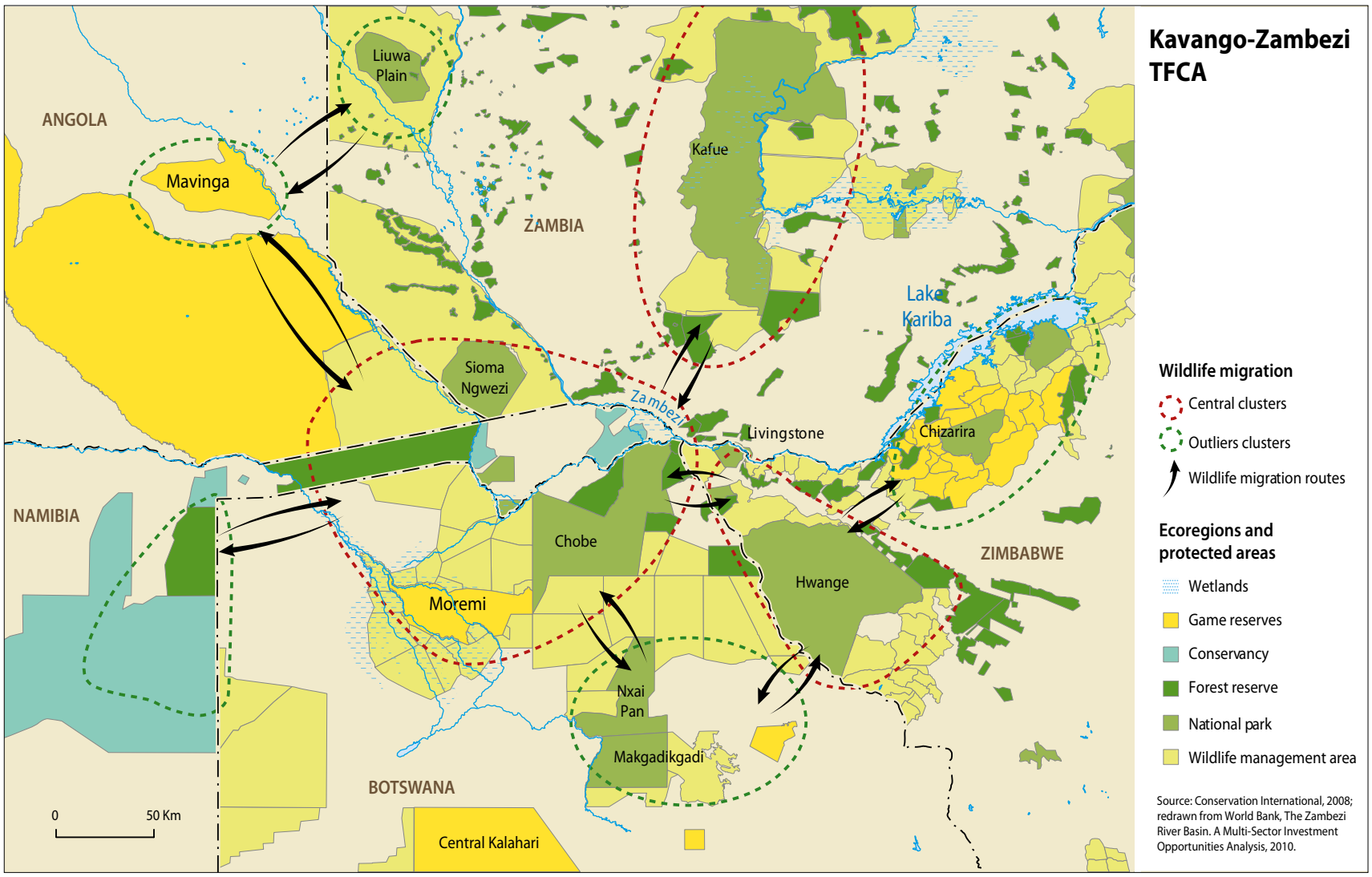


Figure 3.2
The Kavango–Zambezi Trans Frontier Conservation Area covers 36 protected areas, and merges fragmented wildlife habitats. The arrows on the map show some of the wildlife migration routes.

Kavango- Zambezi Trans Frontier Conservation Area (KAZA)

In December 2006, the governments of Angola, Botswana, Namibia, Zambia and Zimbabwe signed an MOU establishing the KAZA TFCA. The TFCA covers an area of 287 000 square kilometres and stretches from the Khaudum National Park in Namibia in the west to Lake Kariba in Zimbabwe in the east (SARDC 2010). Thirty-six protected areas including national parks, game reserves, community conservancies and game management areas are included in the TFCA. One of the main objectives of the TFCA is to merge fragmented wildlife habitats into an interconnected mosaic of protected areas and transboundary wildlife corridors, which will facilitate and enhance the free movement of animals across international boundaries. The area also boasts of numerous attractions such as the Victoria Falls on the Zambezi River between Zambia and Zimbabwe, the San rock paintings in Botswana, and a large wildlife population (SARDC 2010). The area includes at least 3 000 species of plants, 100 of which are endemic to the sub-region, as well as more than 600 bird species. The Caprivi Strip in Namibia provides migration routes for wildlife from Botswana into Angola and Zambia

ZIMOZA Trans Frontier Conservation Area

The tourism authorities of Zimbabwe, Mozambique and Zambia reached an agreement in 2009 to establish the ZIMOZA cross-border conservation area. The joint venture by the tourism authorities covers the management of the cultural heritage of local communities, hunting and fishing, and wildlife conservation (ZELA 2009). The conservation area covers much of the area where the borders of the three countries meet and includes Lake Cahora Bassa in Mozambique.

The Selous-Niassa Trans Frontier Conservation Area

Tanzania and Mozambique are planning a TFCA that would protect an extensive migration

© P. Johnson, APG

Trans Frontier conservation opens up wildlife migration routes.

© Stefanie Van Der Vinden/Dreamstime.com

© Selous Niassa Corridor

Fishing is a key livelihood for the many residents of the planned Selous-Niassa TCFA.

corridor for elephants in southern Tanzania and northern Mozambique. The Selous-Niassa Miombo woodland ecosystem covers 150 000 square kilometres and extends across southern Tanzania and into neighbouring Mozambique (Selous-Niassa Corridor Organisation 2010). The Selous-Niassa Transfrontier Conservation Areas covers the 47 000 square kilometre Selous Game Reserve in Tanzania, and the 42 400 square kilometre Niassa Game Reserve in Mozambique. The main species found in the TFCA are the elephant, buffalo, eland, sable antelope, hippopotamus, Lichtenstein hartebeest, common waterbuck, bushbuck, common duiker, southern reedbuck, wildebeest, zebra, impala, klipspringer, warthog and the bush pig. Leopards are common in the entire corridor. Lions are mainly concentrated in the northern part. Spotted hyena, jackal, civet cat and other carnivore species are also common. Packs of wild dogs are observed in all parts of the corridor.

Malawi/Zambia Trans Frontier Conservation Area

The Malawi/Zambia Trans Frontier Conservation Area includes the Nyika conservation area, which is centred around a high undulating montane grassland plateau above the bushveld and wetlands of the Vwaza Marsh. The TCFA also incorporates the Kasungu/Lukusuzi, an area of importance for biodiversity conservation in the Central Zambezi Miombo Woodland eco-region. The Malawi/Zambia TFCA is famous for wild flowers and orchids, especially during summer.

Lower Zambezi-Mana Pools Trans Frontier Conservation Area

The planned Lower Zambezi-Mana Pools TFCA between Zambia and Zimbabwe 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 would combine to create a massive wildlife sanctuary on both sides of the Zambezi River. Mana Pools in Zimbabwe is a World Heritage Site with over 350 bird species and many aquatic wildlife species. These pools are remnant oxbow lakes carved out by the Zambezi River thousands of years ago as it changed its course. Hippopotamus, crocodiles and a wide variety of aquatic birds are found in the pools. Long Pool, the largest of the four pools, has a large population of hippopotamuses and crocodiles and is a favourite watering spot for large herds of elephants that come out of the thickly vegetated areas in the south to drink and bath.

Liuwa Plain-Mussuma Trans Frontier Conservation Area

The Liuwa Plain-Mussuma Trans Frontier Conservation area between Angola and Zambia protects the third largest migratory population of blue wildebeest in Africa. Every year massive herds of blue wildebeest migrate from Zambia to Angola and back, traversing the plains in the thousands and mingling with zebras on migration.

Inter-Basin Water Transfers

Several riparian countries have identified potential projects transferring water to or from the Zambezi basin to meet various demands. Botswana, for example, is planning to use water from the Zambezi basin for domestic and industrial use within and outside the basin. This project, called the 'Zambezi Water Transfer Scheme', is in the conceptual phase (SADC and ZRA 2007). The Bulawayo–Matebeleland–Zambezi Water Supply Project in Zimbabwe is at its feasibility stage. Although Bulawayo is outside the basin, further water supply to a larger area of Matebeleland may become inter-basin transfer with the Limpopo Basin.

Energy Resources

The estimated hydropower potential of the Zambezi River is in the order of 20 000 MW of which only 4 684 MW has been developed (Hirji *et al.* 2002). About 40 possible new hydropower plants with a total installation capacity of more than 13 000 MW have been identified in the basin. About 85 per cent of this capacity is on the Zambezi River itself while the remainder is on its tributaries. Close to half the mapped potential is in Mozambique, about 25 per cent in Zambia and about 20 per cent in Zimbabwe. A little more than five per cent of the potential is divided between Angola, Malawi and Tanzania (SARDC 2008).

Cahora Bassa, Kariba and Kafue hydropower stations, and Hwange coal power station are some of the electrical power suppliers in the Zambezi basin. These power stations feed into the Southern African Power Pool (SAPP), which was inaugurated in 1995 (O'Leary *et al.* 1998) to create a more efficient regional market for electricity. The power pool was created as a common power grid because of the distribution of power sources in southern Africa, with a large reserve of low-cost hydroelectricity in the northern part, especially the Inga Reservoir in the Democratic Republic of Congo and the Cahora-Bassa Reservoir in Mozambique. Other factors that led to the establishment of the power pool are the large reserves of thermal power in South Africa and the hydropower from the Kariba Dam on the border between Zambia and Zimbabwe which, being in the middle of the regional system, plays the "buffer" role.

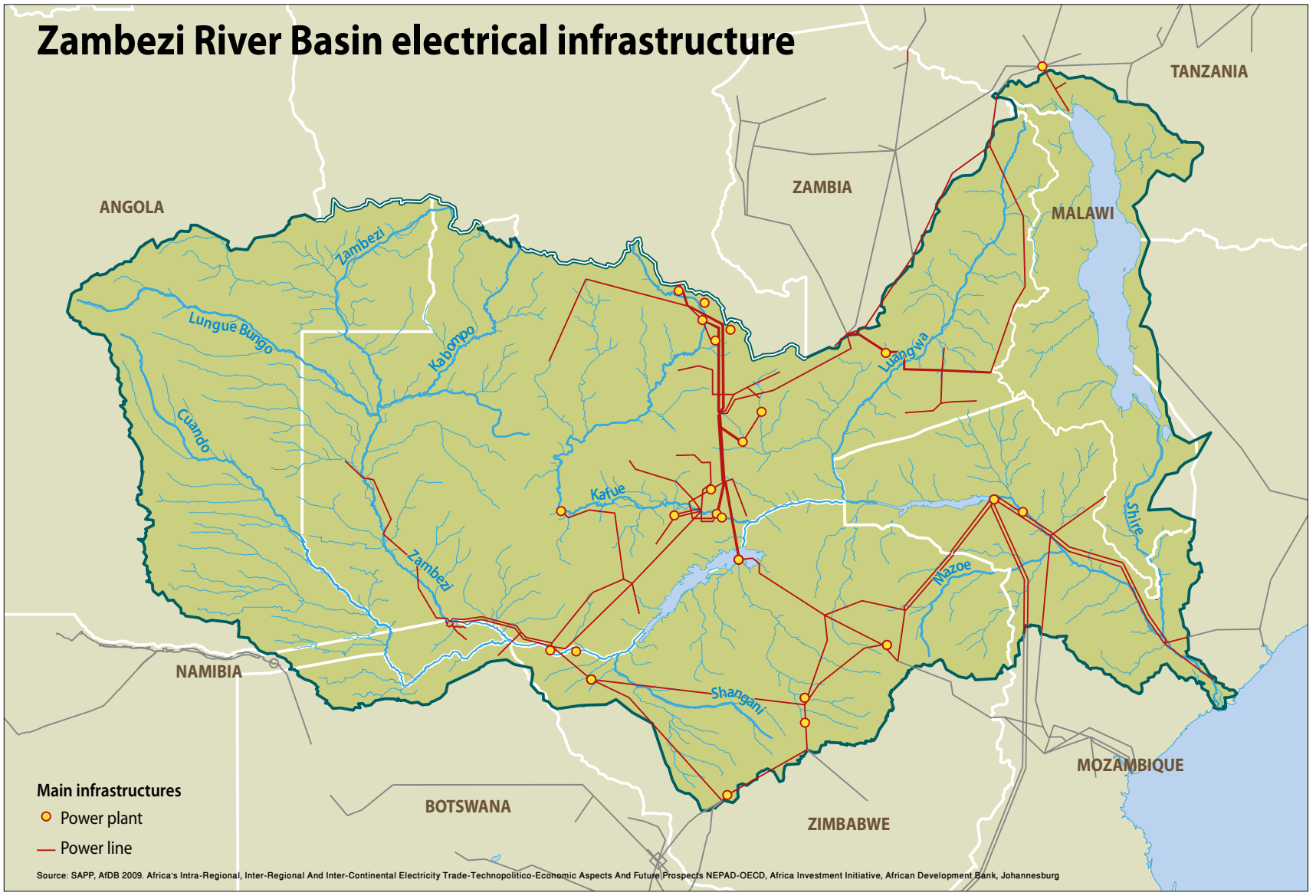


Figure 3.3

Movement of People, Goods and Services

Various arrangements have been put in place to improve the movement of people in the basin and in the southern African region as a whole. In 2005, the leaders of the Southern African Development Community (SADC) Member States adopted the Protocol on the Facilitation of Movement of Persons in the SADC aimed at developing policies that allow movement of people across borders in the SADC region. The new protocol has already been signed by half of the 15 member states and is still subject to ratification by two-thirds of the member states before it enters into force. It is intended to facilitate visa-free entry, residence and establishment by individuals or families in territories of member states (Madakufamba 2005).

In order to facilitate the easy movement of people, goods and services between the countries, one-stop border post arrangements are being established. This type of border crossing was piloted at the Chirundu border post between Zambia and Zimbabwe in 2009 (SARDC 2009a). Infrastructure such as bridges are being developed and expanded. This includes the construction of Kazungula Bridge between Botswana, Zambia and Zimbabwe and the Katima Mulilo Bridge across the Zambezi between Namibia and Zambia which opened in 2005 (SADC and ZRA 2007).

Chirundu Bridge over the Zambezi River between Zambia and Zimbabwe.

Trucks waiting to cross the Chirundu bridge between Zambia and Zimbabwe.

Navigation in the Zambezi Basin

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 (Denconsult 1998). There are major crossings on the Kabompo River, Kafue River and Chobe River in Namibia and Botswana, and on the Shire River in Mozambique and Malawi. Tanzania, Malawi and Mozambique, which share Lake Malawi/Niassa/Nyasa, all use the lake for navigation (Denconsult 1998). The section of the Zambezi running 570 kilometres from Mphanda Nkuwa, Mozambique to the Indian Ocean is the longest navigable portion of the river. Coal was transported in barges along the river in the 1940s and molasses in the 1970s. Construction materials for the Cahora Bassa Dam were also transported in barges up to Mphanda Nkuwa in the 1970s. New projects in the region may require transportation of materials by river and lake navigation. These include coal mining in Tete, the rehabilitation of Sena Sugar Estates in Mozambique, and the construction of the Mphanda Nkuwa River Dam (SADC 2000).

On Lake Kariba, a ferry provides the main transport system linking Binga and Kariba in Zimbabwe. On the Zambian side another ferry operates between Siavonga and Chepepo, and Siavonga and Shenga. In Zambia, a number of other ferries operate on the Zambezi River at Chavuma, Ngoma, and Sandaula/Malumbu in Mongu, Katima Mulilo/Shesheke, and the Kalongola/Senanga. In Lukanga, water crossings exist between Chilwa Island and Chitanda. Other crossings are at Caia and Songo in Mozambique

Ferries are one of the main means of transport on navigable sections of the Zambezi basin.

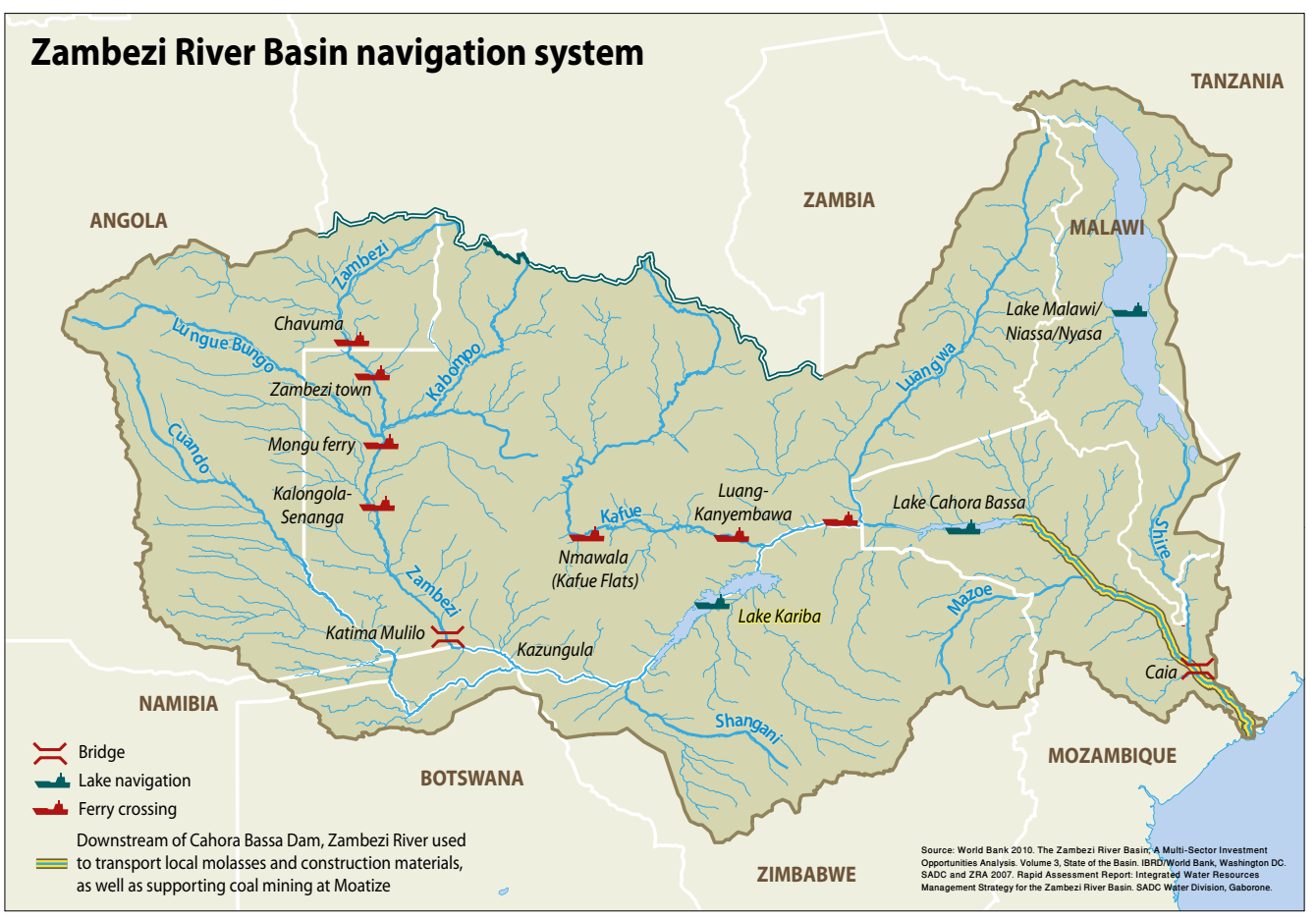


Figure 3.4

4

TRACKING PROGRESS TOWARDS ENVIRONMENTAL SUSTAINABILITY

UN Millennium Development Goals

The objective of the Millennium Declaration of 2000 is to promote a comprehensive approach and a coordinated strategy, tackling many problems simultaneously across a broad front. The declaration calls for halving poverty by the year 2015, through reducing by half the number of people who lived on less than one dollar a day in 1990. This involves finding solutions to hunger, malnutrition and diseases, promoting gender equality and empowerment of women, guaranteeing a basic education for everyone, and supporting the Agenda 21 principles of sustainable development. Direct support from the richer countries, in the form of aid, trade, debt relief and investment is to be provided to assist the initiatives of developing countries.

The solutions form the eight Millennium Development Goals (MDGs).

- Goal 1 Eradicate extreme poverty and hunger
- Goal 2 Achieve universal primary education
- Goal 3 Promote gender equality and empower woman
- Goal 4 Reduce child mortality
- Goal 5 Improve maternal health
- Goal 6 Combat HIV and AIDS, malaria and other diseases
- Goal 7 Ensure environmental sustainability
- Goal 8 Develop a global partnership for development.

MDG 7 Environmental Sustainability

This chapter tracks Goal 7 on Environmental Sustainability (Table 4.1), with profiles of the eight countries of the Zambezi River Basin.

Overview

All Zambezi Basin states show progress on some aspects of all of the four Targets for environmental sustainability, although some of the indicators are not prioritized or well-populated. Existing information is often dated and incomplete, and may be obtained from secondary sources, although some data exists for all Basin states for most indicators. The data is generally accessible at national level rather than for specific areas, such as those within the Zambezi River Basin. Therefore of necessity the data that follows is national rather than specific to that portion of the country within the Basin.

Target 7A – Reverse the loss of environmental resources

The most immediate challenge for the Zambezi basin states out of the five indicators for Target 7A is deforestation, and this is likely to continue to be a challenge until economically viable alternatives to fuelwood are in general use. That is, until the economies improve and acceptable alternatives are easily accessible and affordable. There is a growing body of evidence that the rate and extent of deforestation contribute to climate change in the Basin (SARDC and HBS 2010). The major causes of deforestation in the Basin are agricultural expansion, fuelwood collection, harvesting of non-timber forest products, commercial harvesting of natural/ indigenous timber species and forest fires. These are some of the issues that must be addressed in order to stem the destruction of forests and meet the MDG Target 7A of reducing the loss of environmental resources. Figure 4.1 shows the reduction in forest reserves by country in hectares over a 20-year period from 1990.

With regard to the other indicators, the extent of carbon emissions is not well documented and is not considered a significant factor in the Zambezi Basin. The consumption of ozone depleting substances has not been well studied in the Basin. Some data on the proportion of freshwater fish stock has been assembled by FAO for Lake Malawi/Nyasa/Niassa and Lake Kariba, although not yet for Cahora Bassa, and there is no general agreement on the definition of "safe biological limits" for those water bodies. Proportion of total water resources is based on estimates drawn from modelling and is dated, but significant work on this subject has been applied in the publication by Hirji *et al.* (2002) entitled Defining and Mainstreaming

The Millennium Development Goals

Table 4.1. MDG 7 Ensure Environmental Sustainability

Targets	Indicators
Target 7A Integrate the principles of sustainable development into the country policies and programmes and reverse the loss of environmental resources	7.1 Proportion of land area covered by forest 7.2 Carbon emissions total, per capita and per $1 GDP (ppp) 7.3 Consumption of ozone depletion substances 7.4 Proportion of fish stock within safe biological limits 7.5 Proportion of total water resources
Target 7B Reduce biodiversity loss, achieving by 2010 a significant reduction in the area of loss	7.6 Proportion of terrestrial and marine areas protected 7.7 Proportion of species threatened with extinction
Target 7C Halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation	7.8 Proportion of population using an improved water source 7.9 Proportion of population using an improved sanitation facility
Target 7D By 2020 to have achieved a significant improvement in the lives of at least 100 million slum dwellers	7.10 Proportion of urban population living in slums

Source: UNEP 2008.

Environmental Sustainability in Water Resources Management in Southern Africa, with some surprising results, as shown in Chapter 2.

Target 7B – Reverse biodiversity loss by 2010
The extent of protected areas is well documented for most Basin states, although marine parks have not been included here as they fall outside the Zambezi River Basin. The proportion of species threatened with extinction has been documented and publicized for many years through the The IUCN Red List of Threatened Species although some data for Zambezi basin states is based on informed estimates as the vast wilderness areas have not been studied in some countries.

All Zambezi basin states are party to the international Convention on Biological Diversity (CBD) and all except Angola have ratified the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Target 7C – Access to safe drinking water and improved sanitation by 2015
Improving acess to safe water and sanitation is the top priority for all Basin states, and all can show significant progress in the proportion of the population using an improved water source and santiation. This is the target most likely to be met by the Basin States, and some have already exceeded the target.

Target 7D – Improve the lives of slum dwellers by 2020
Some Basin states have made significant progress in improving the lives and reducing the population of urban slums, but this remains a work in progress as urban areas continue to grow. Six of the Basin states have significant urban areas within the Zambezi basin. The total population of the 15 member states of the Southern African Development Community (SADC) was 267 million in 2009 (Table 4.2), with about 39 per cent living in urban areas. Due to the steady increase in the urban population relative to rural over the past decade, and with no indication of any disruption to this trend, it is expected that the urban population of the SADC region has now reached over 40 percent. The SADC population at mid-year in 2010 was 275.8 million, including the eight Zambezi River Basin states.

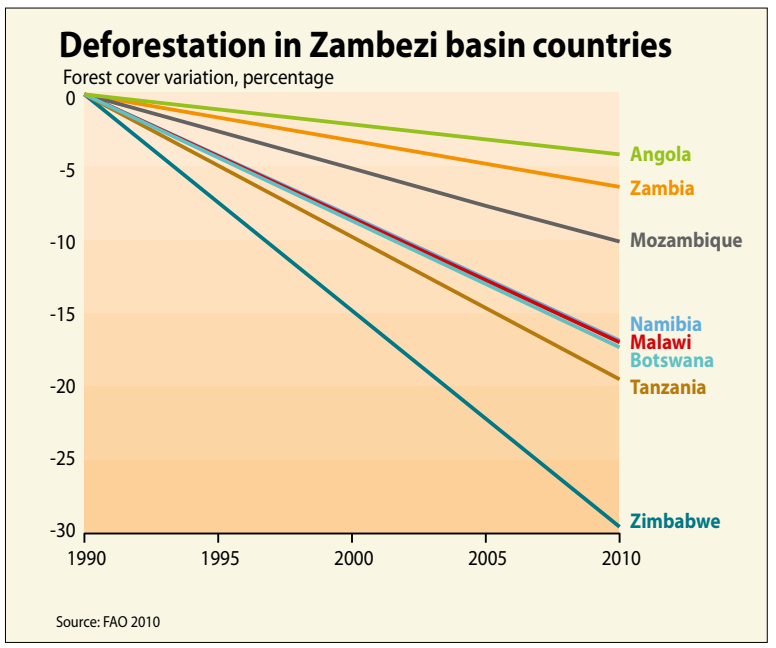


Figure 4.1

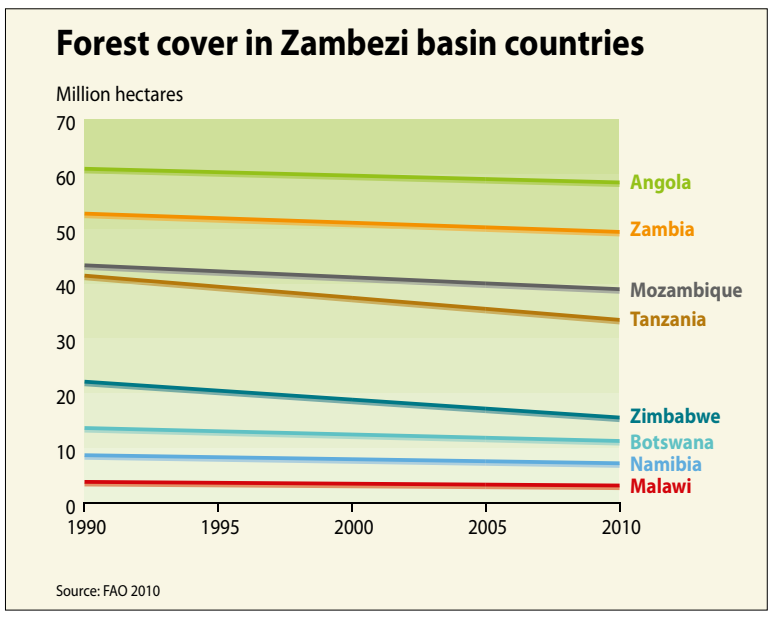


Figure 4.2

Country Profiles

The total population of the eight riparian states of the Zambezi River was 126.5 million in 2010, with an estimated 38.2 million people living in the Zambezi Basin, about 30 per cent of the total (Table 4.2). The national populations of Basin states range from the United Republic of Tanzania with 42 million people to the Republic of Botswana with 1.8 million (Table 4.2).

Table 4.2. Total National Population of Basin States 2006-2010, and Portion in Basin 2010

Country	2006 millions	2007 millions	2008 millions	2009 millions	2010 millions	% in Basin	Population in Basin 2010*	% of Basin Population
Angola	15.9	16.3	16.8	17.3	17.8	3.66	651 480	1.70
Botswana	1.7	1.8	1.8	1.8	1.8	.73	13 140	0.03
Malawi	12.8	12.9	13.1	13.5	13.9	96.67	13 050 000	34.17
Mozambique	19.9	20.6	21.2	21.8	22.4	23.15	5 185 600	13.58
Namibia	2.0	2.0	2.1	2.1	2.1	3.35	70 350	0.16
Tanzania	37.5	38.3	39.5	40.7	42.0	3.92	1 646 400	4.31
Zambia	11.8	12.2	12.5	12.9	13.0	65.52	8 517 600	22.33
Zimbabwe	12.0	12.0	12.1	12.2	13.5	67.11	9 059 850	23.72
Total	**113.6**	**116.1**	**119.1**	**122.3**	**126.5**		**38 194 020**	**100**

* Estimate based on ratios shown in Chapter 1 Table 1.1
Source: Population figures from Chapter 1 of this Atlas

Angola

Total Area of Country	1 246 700 sq km
Portion of Country within Zambezi Basin	256 500 sq km (20.5%)
National Population in 2010	17.8 million
Portion of National Population within Zambezi Basin	651 480 (03.66%)
Important Environmental Issues	• Biodiversity loss • Access to potable water

Although the Zambezi River rises in Zambia, part of its upper course is in northeastern Angola, which is the seventh largest country in Africa by area and has an Atlantic coastline of 1 650 km. The country has distinct and alternating rainy and dry seasons, and is semi-arid in the South and along the coast to the capital, Luanda.

Oil is at the core of the Angolan economy and the sector contributes more than 90 per cent of national exports (AfDB 2010). Other mineral resources include diamonds and iron ore. A civil war initially supported by apartheid South Africa caused widespread loss of life and damage to infrastructure in the 25 years following independence from Portugal in 1975. The economy was shattered and large parts of the country were inaccessible. Human development suffered and environmental assessment could not resume until after the internal peace agreement in 2002. The figures below should be read in this context, as some show notable progress in the past decade.

Threats to Angola's land productivity include landmines, as well as drought and soil erosion, which contribute to water pollution and siltation of rivers and dams. Pressure is increasing on peri-urban land, in the context of rural-urban migration and the low incomes received from urban employment.

Progress towards environmental sustainability

Reverse the loss of environmental resources

Angola is the most densely forested country in the Basin (FAO 2010, see Fig. 4.3), including tropical rainforests in the north. While some Basin states had deforestation rates as high as 2.2 per cent, Angola shows a rate of between 0.1 and 0.2 per cent, although this is estimated as many of the forested areas were inaccessible for a long period. There has been no forestry inventory in Angola since independence in 1975, but the Ministry of Agriculture estimates the minimum reserve at 17.45 million cubic metres of trees, allowing 20 years of rotational annual cuts.

The use of forestry plantations has been increasing steadily in Angola, which has the largest forest plantation area in the Basin, together with Zimbabwe (SADC and SARDC

2008). Those two countries are the main exporters of forestry products in the Basin. The area under forest and woodland in Angola has declined at a rate of two per cent between 1990 and 2010 (FAO 2010) as shown in Figure 4.3.

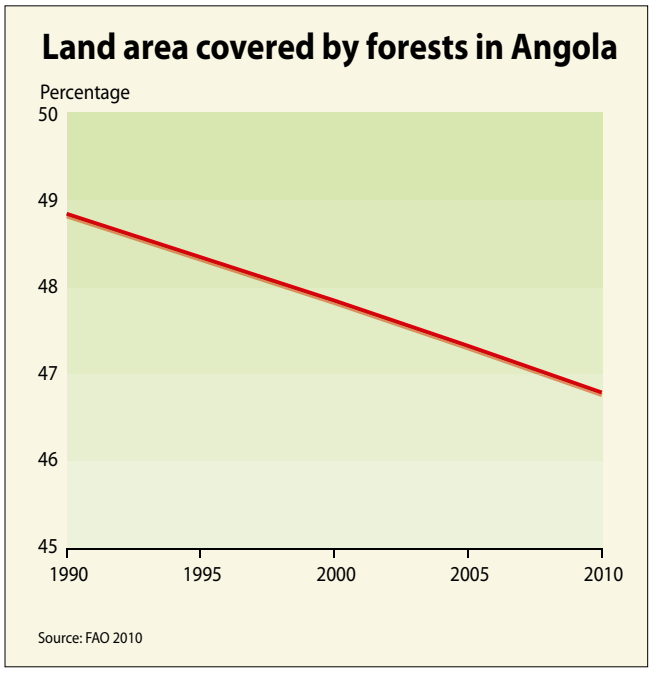


Figure 4.3

Much of the fuelwood cut in Angola is converted to charcoal for use in urban households. Rural industries also use substantial amounts of fuelwood to burn bricks, smoke fish, brew beer or dry salt. These are some of the issues to be addressed, including alternative methods. Indigenous knowledge systems should be incorporated into sustainable harvesting.

Carbon emissions have not been a significant part of environmental monitoring in Angola as the potential is minimal when compared to industrialized countries, and estimated figures are still low, although increasing rapidly due to expansion in the exploitation and use of petroleum resources. Figure 4.4 shows annual carbon emissions per capita.

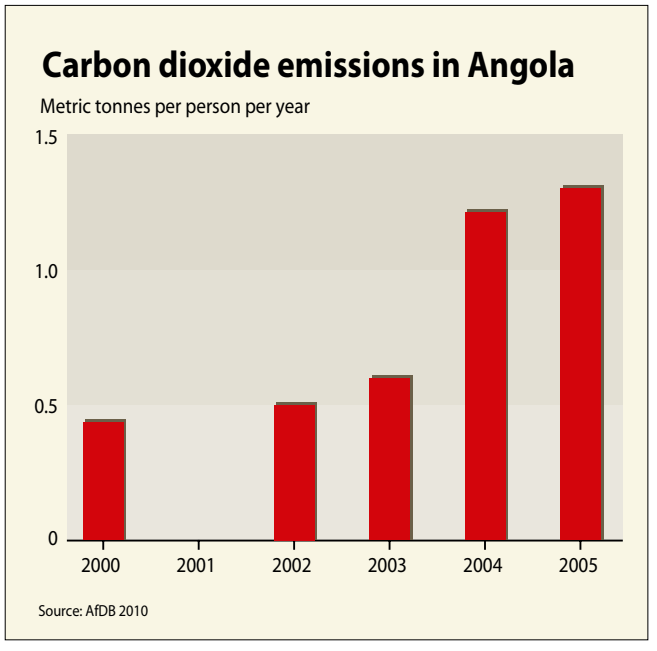


Figure 4.4

Reverse biodiversity loss by 2010

Another indicator of environmental sustainability is the proportion of terrestrial and marine areas protected. The extent of the protected land area in Angola has remained the same since 1990, but there is little data available on the protection of Angola's marine resources. The Southern Africa Environment Outlook shows that Angola's protected areas total 81 812 sq km, an extensive area when compared to many other countries, but just seven percent of total surface area, as shown in Figure 4.5.

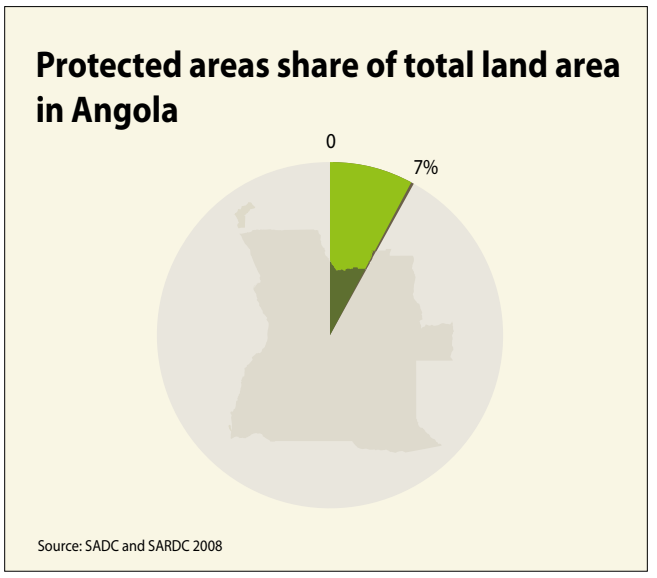


Figure 4.5

Figure 4.6 shows the percentage changes in biodiversity of some species, illustrating the reduction in diversity of mammals and molluscs, while others are steady or increasing (eg, birds).

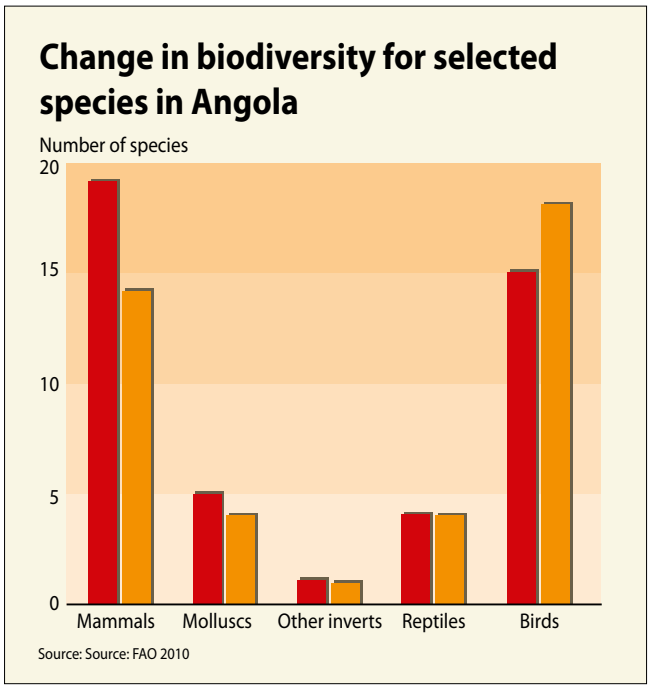


Figure 4.6

© SARDC

Black rhino is critically endangered in Angola, while chimpanzee, mountain zebra, fin whale, wild dog and giant African water shrew are endangered. The African elephant, cheetah, humpback whale and lion are vulnerable.

© William Davies/iStockphoto.com

Cheetah

© SARDC

Elephants

© Cliff Parnell/iStockphoto.com

Wild dog

© SARDC

Mountain zebras

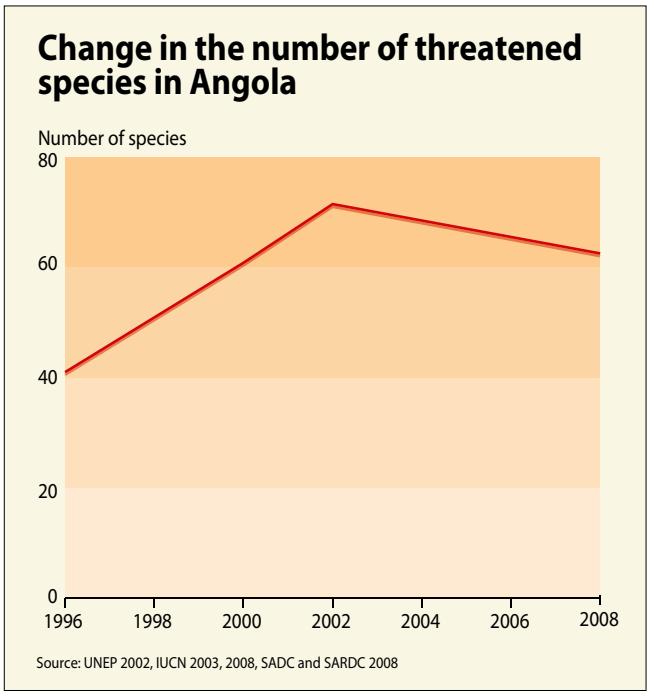


Figure 4.7

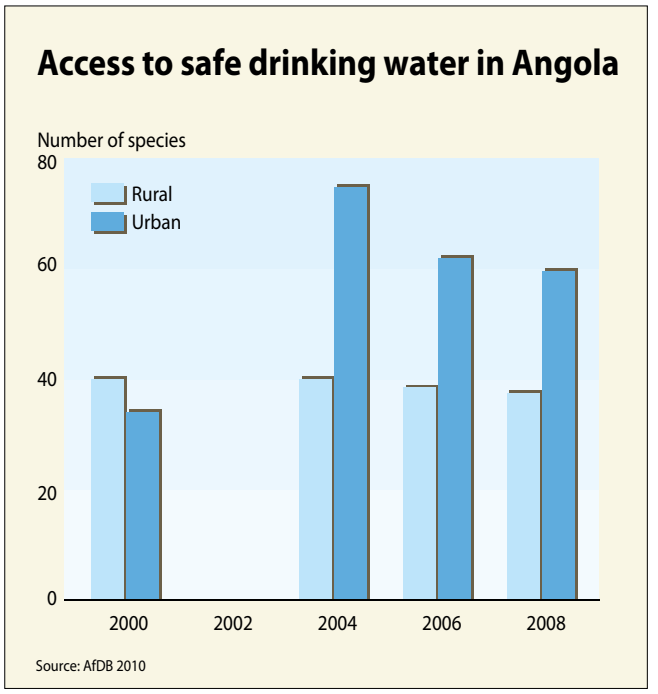


Figure 4.8

Figure 4.7 shows the change in numbers of threatened species, indicating that this spiked at 71 in 2003 following the end of the war when some areas became more accessible and counts resumed. The 2008 figure shows a reduction in the number of threatened species to 63.

Elephants have been reduced from more than 12,000 individuals in Angola in 1981 to 820 in 2006 (SADC and SARDC 2008), largely due to ivory smuggling during the war years. Angola is yet to ratify CITES, an international treaty that restricts the trade in endangered species.

Coastal drainage sites such as the Kunene and Kwanza rivers on the west coast of Angola contain species that occur only in that area. However development activities are not always compatible with conservation of this diversity and it is poorly represented in development process due to a lack of awareness and easily available information.

Access to safe drinking water and improved sanitation by 2015

Large numbers of people were displaced during the war and moved to urban areas, living in overcrowded slums, where the infrastructure did not exist or could not cope with their influx. The sharp increase in access to safe drinking water by 2004 (Figure 4.8) reflects the emergency assistance and humanitarian resources that flowed in following the peace agreement, but in some cases was not sustainable.

Angola has witnessed improved access to sanitation in the same period. With the increasing oil revenue and more stability, safe drinking water and sanitation should become more accessible in both urban and rural areas.

Improve the lives of slum dwellers by 2020

Following the peace agreement in 2002, rather than resettling back home where landmines were an ongoing threat, many people from the rural areas joined family members in the cities, thus expanding the already overcrowded slums. This trend is slowly being reversed through the development of amenities in rural areas as well as dedicated programmes to lift landmines and to help families to resettle in their home areas.

Low income district of Luanda, Angola.

Botswana

Total Area of Country	581 730 sq km
Portion of Country within Zambezi Basin	19 100 sq km (3.3 %)
National Population in 2010	1.8 million
Portion of National Population within Zambezi Basin	13 140 (0.73%)
Important Environmental Issues	• Overgrazing and desertification • Water scarcity and urbanization • High wildlife densities in Maun, Kasane and Chobe areas

Botswana is a semi-arid landlocked country situated on the central plateau of southern Africa, and encompasses most of the Kgalagadi Desert. The country receives little rainfall, experiences frequent droughts, and imports most food and other products. About 95 per cent of all surface water resources in Botswana is concentrated in the northwest corner of the country around the Okavango Delta, while the majority of the population lives in the southeast (UNEP 2008). Cattle ranching was the mainstay of Botswana's economy until after independence from Britain in 1966, and since the discovery of diamonds in the 1970s, mining has become the largest economic sector, with a large portion of the national budget still drawn from customs revenue through the Southern African Customs Union (SACU).

Progress towards environmental sustainability

Reverse the loss of environmental resources

Overgrazing by a booming cattle population threatens vegetation and wildlife as pastoral farming (mainly cattle) dominates the agriculture sector. Rangeland is being degraded due to the tendency of farmers to keep cattle in excess of sustainable stocking levels, low off-take rates, and the incidence of bushfires that reduce available forage.

Water supply is a major challenge as 68 per cent of the country is covered by the Kgalagadi Desert, and droughts often exacerbate the water supply problem. Desert conditions are encroaching in most parts of Botswana due to naturally arid conditions and frequent droughts as well as overgrazing and the creation of boreholes in semi-arid areas. Where water for livestock is limited, large numbers of cattle concentrate around boreholes, leading to localized overgrazing.

Significant growth in cattle stocks has forced pastoralists to expand westward into the Kgalagadi, leading to vegetation loss and erosion of marginal lands. A gradual increase of

cattle stock has been noted from 2002 to 2008 (Government of Botswana 2009), adding a total of 500 000 cattle to an already large national herd, as shown in Figure 4.9.

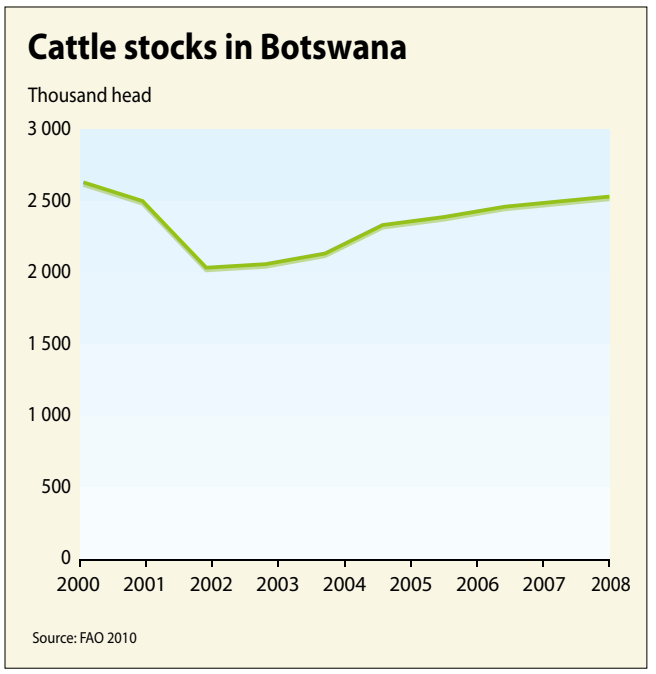


Figure 4.9

Agriculture makes up about 2.3 per cent of Botswana's GDP, and out of this contribution cattle production makes up 70–80 per cent.

Some forest cover is lost to fuelwood that supplies 98 per cent of domestic energy in rural areas and 79 per cent in urban areas (Government of Botswana 2009), but timber operations have been banned since 1992, due to the poor forest resources base (SADC/ SARDC and others 2008). Figure 4.10 shows the reduction in forest cover.

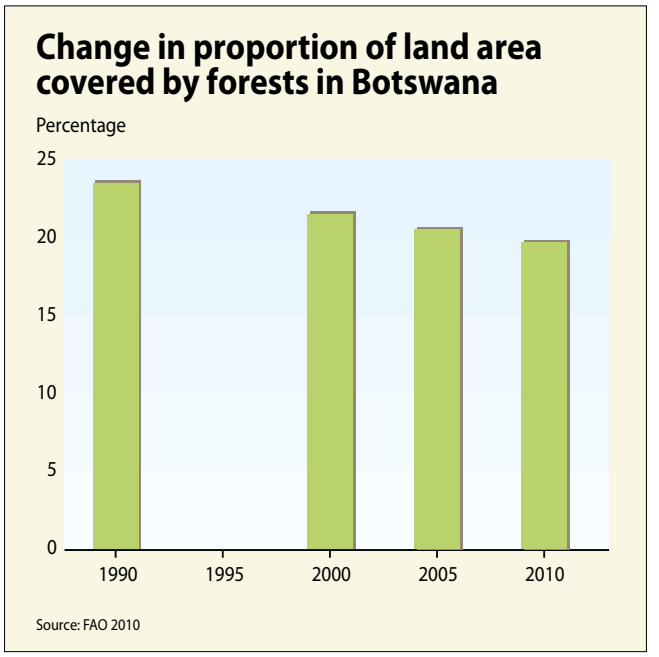


Figure 4.10

Botswana's per capita carbon emissions levels are shown to be the highest in the region, as presented by the African Development Bank, but have not been a significant part of environmental monitoring at local level to date. Figure 4.11 shows carbon emissions levels for Botswana.

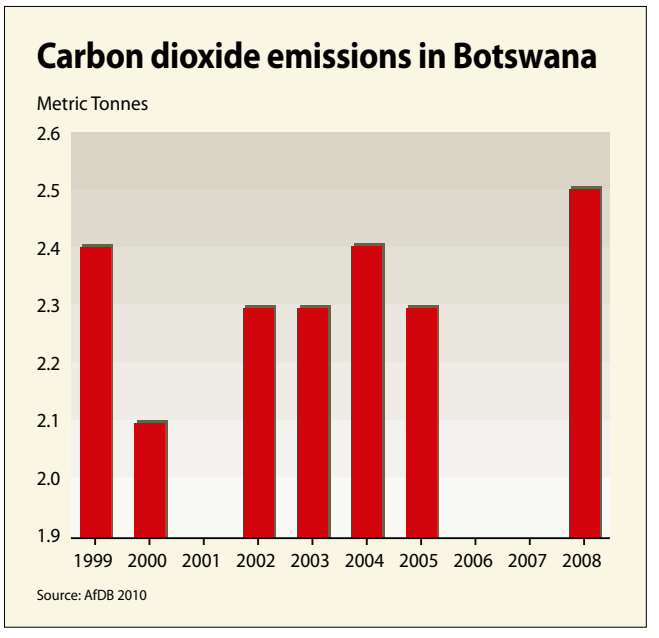


Figure 4.11

Reverse biodiversity loss by 2010
The Government of Botswana has designated a sizeable portion of land area for conservation since before 1990. The protected areas in Botswana total 104,988 sq km, which is 18 per cent of the total surface area of the country, a significant proportion when compared to most other countries in the Basin (Figure 4.12), except for Zambia and Tanzania.

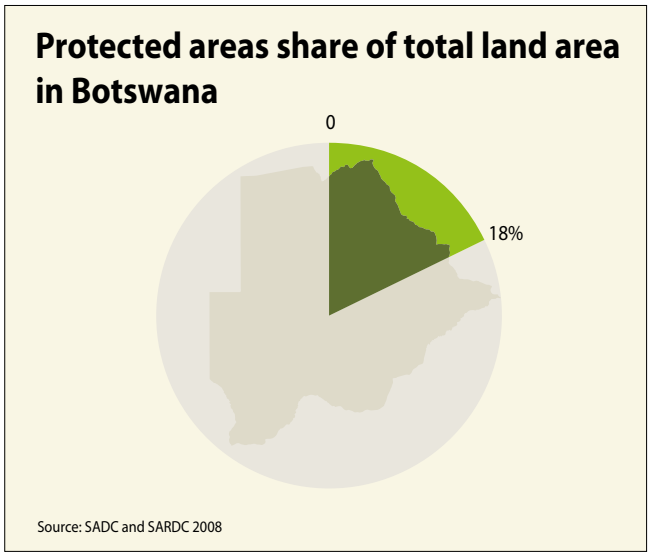


Figure 4.12

Land use conflict between wildlife and agriculture is a problem around Chobe, Maun and Kasane, and elsewhere in Botswana. Elephants exceed 130 000 individuals in Botswana and have surpassed the carrying capacity of their northern territory. This has resulted in the destruction of cropland and the depletion and degradation of resources that are important to rural livelihoods.

A small length of the Chobe River, about 54 km upriver from Kasane to Ngoma Bridge, is included within Chobe National Park, while Chobe Forest Reserve lies adjacent to the flood plain for a further 80 km. The Chobe rapids area and the remainder of the floodplain have little or no protection in Botswana or in neighbouring Namibia. On the Namibian side of the river, and in Botswana outside Chobe National Park, there is fairly heavy human settlement, with large numbers of cattle.

Numerous deliberate fires are destroying floodplain vegetation, including reed beds, and snaring and poaching are widespread, affecting birds as well as mammals. Very large numbers of African elephant (*Loxodonta africana*), concentrating along the river in the dry season, have caused extensive damage to the riparian woodlands. River craft used by tourists and local residents can potentially cause disturbance to breeding birds.

The number of threatened species in Botswana was 12 at the turn of the 21st century and had reached 31 three years later, partly through identification of new threats due to wider research and tracking.

Access to safe drinking water and improved sanitation by 2015
Due to deliberate policy and strategic action, Botswana is in the envious position of having met its water and sanitation targets well before the MDG targets and the timelines for its own Vision 2016. More than 90 per cent of the population in urban and rural areas has access to drinking water and sanitation, as shown in Figures 4.13 and 4.14.

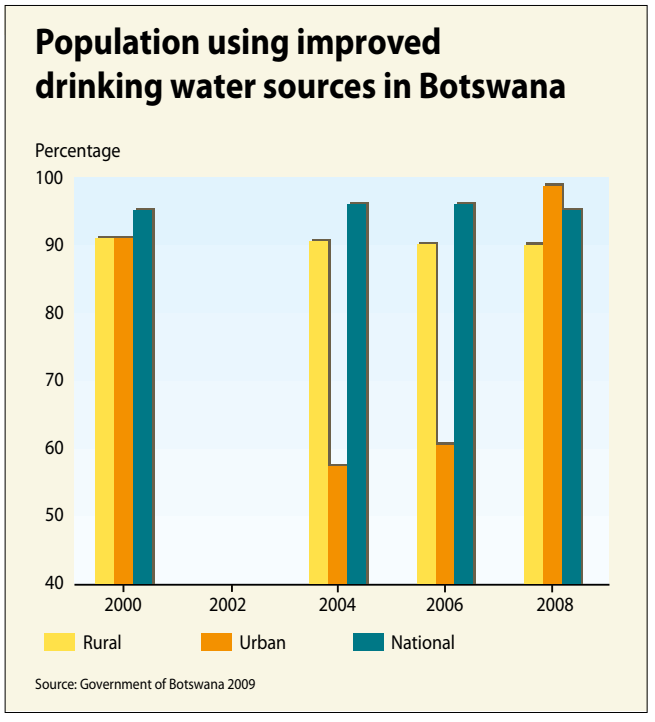


Figure 4.13

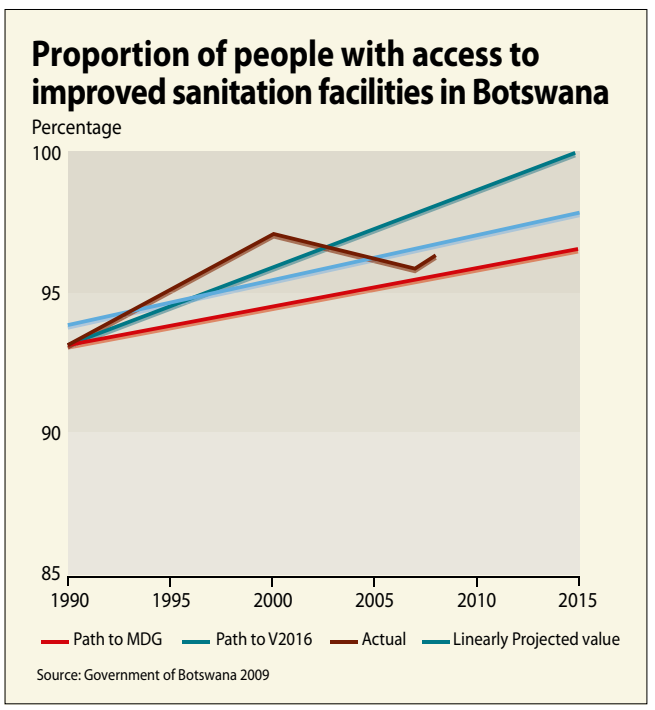


Figure 4.14

Due to the semi-arid nature of the country, Botswana has poor water resources and is subject to frequent, severe droughts, while demand for water is increasing in all sectors. Groundwater accounts for two-thirds of all water consumption, but some underground aquifers are affected by natural salinity and others are threatened by pollution from livestock and human waste (FAO 2005). Water scarcity played a role in the decline of the agricultural sector from almost 40 per cent of GDP contributed in the 1960s to only six per cent in 2004 (FAO 2005). This is also a key factor in driving Botswana's rapid urbanization.

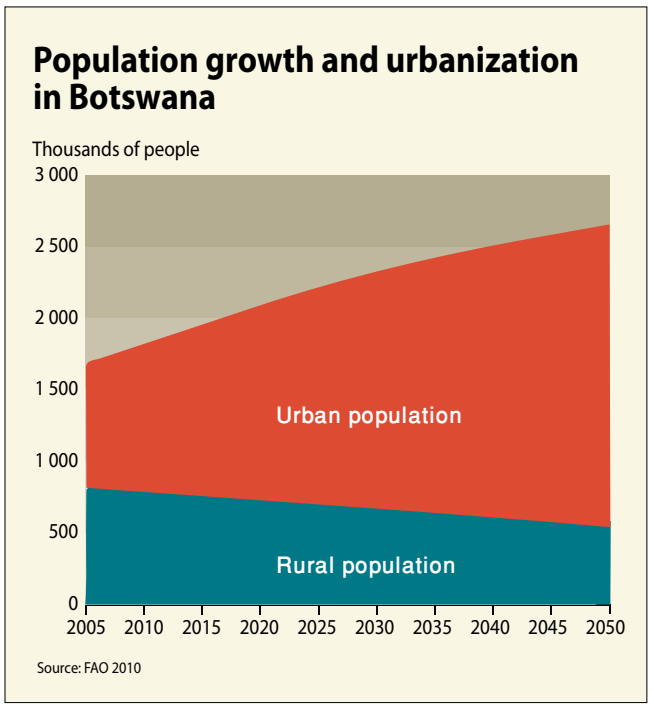


Figure 4.15

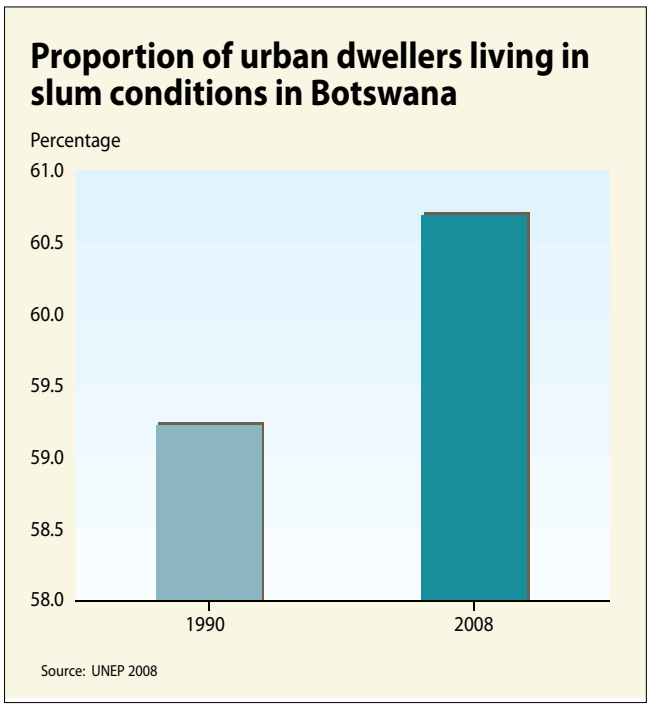


Figure 4.16

Improve the lives of slum dwellers by 2020

The proportion of people living in urban areas is expected to increase from 57 per cent in 2005 to more than 70 per cent in 2030 (Government of Botswana 2009) (Figure 4.15).

The number of people living in slum conditions as a proportion of urban residents is high, according to UNEP (2008), and slowly increasing, as shown in Figure 4.16.

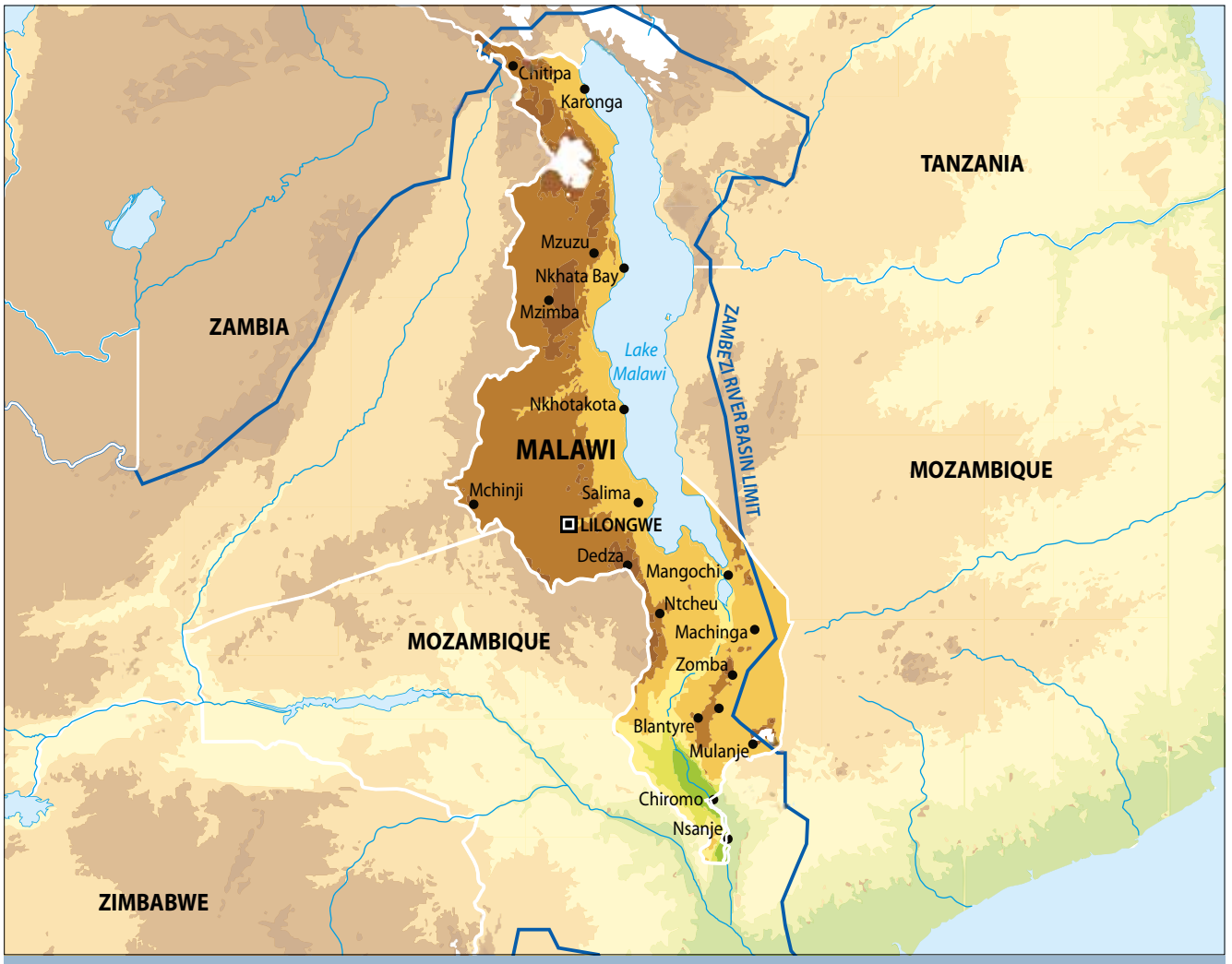
Table 4.3 summarises the country's progress towards MDG targets.

Table 4.3. Summary of Botswana's Progress towards MDG Goal 7

Global Target	Will Target Be Met	Vision 2016 Target	Will Target Be Met	Supportive Environment
Halve by 2015 the proportion of the population without sustainable access to safe drinking water and basic sanitation	Achieved	Reduce by 50 percent the proportion of people without sustainable access to safe drinking water by 2016	Achieved	Strong
Reduce biodiversity loss, achieving by 2010 a significant reduction in the rate of loss	Likely	Reduce conflict between population growth, land usage, and natural resource degradation	Likely	Strong
Integrate the principles of sustainable development into country policies and programmes to reverse the loss of environmental resources	Likely	Promote environmental education and awareness necessary to reduce contamination, achieve sustainable development	Likely	Strong

Source: Government of Botswana 2009

Malawi



Total Area of Country	118 484 sq km
Portion of Country within Zambezi Basin	110 700 (93.4%)
National Population in 2010	13.9 million
Portion of National Population within Zambezi Basin	13 050 000 (96.67%)
Important Environmental Issues	• Land scarcity and soil erosion • Deforestation for fuelwood • Water pollution • Aquatic biodiversity

Malawi is the most densely populated country in the Zambezi Basin. Its diverse physical features support a variety of flora and fauna. Lake Malawi extends over almost two-thirds of the eastern border area and with other water bodies covers one-fifth of the country's total area. This extensive water body has a strong influence on the climate which varies from semi-arid to humid (SARDC/Chenje 2000).

Progress towards environmental sustainability

Reverse the loss of environmental resources

Arable land is Malawi`s most valuable natural resource as agriculture is essential to local livelihoods and the national economy. The cultivated area has more than doubled since 1961 to accommodate a rapid growth in population, resulting in a growing land shortage (FAO 2007). In 2002, an estimated 16 per cent of cultivation was taking place on marginal or unsuitable land (UNEP 2008). This caused soil erosion, sapping soil fertility and causing siltation of lakes and rivers, including the Shire River, which is the major outlet of Lake Malawi.

Malawi is on track towards attaining half of the environmental sustainability indicators, although the land area covered by forest has declined from 32.9 percent in 1990 to 27.3 percent in 2010 (Figure 4.17). This decline can be attributed to fuelwood collection, subsistence and commercial agriculture (UNEP 2008). Tobacco farming, which accounts for almost 80 percent of export earnings, is one of the major causes of deforestation. Government is committed to reverse this trend by intensifying reforestation, afforestation, promotion of natural regeneration, and forest protection and management programmes.

Deforestation, driven significantly by fuelwood harvesting and curing of tobacco, is also contributing to the rapid degradation of Malawi's intensively used lands. Malawi is the second largest tobacco producer in Africa after

© SARDC

There is a big demand for firewood in Malawi.

Zimbabwe (FAO 2005). Harvesting wood to fuel the tobacco-curing process accounts for roughly one-quarter of household wood consumption. Overall, it is estimated that demand for wood exceeds supply by 30 per cent (UNEP 2008). The rising price of alternative energy sources, such as oil, has increased reliance on fuelwood in recent years to over 90 per cent of energy use (FAO 2005).

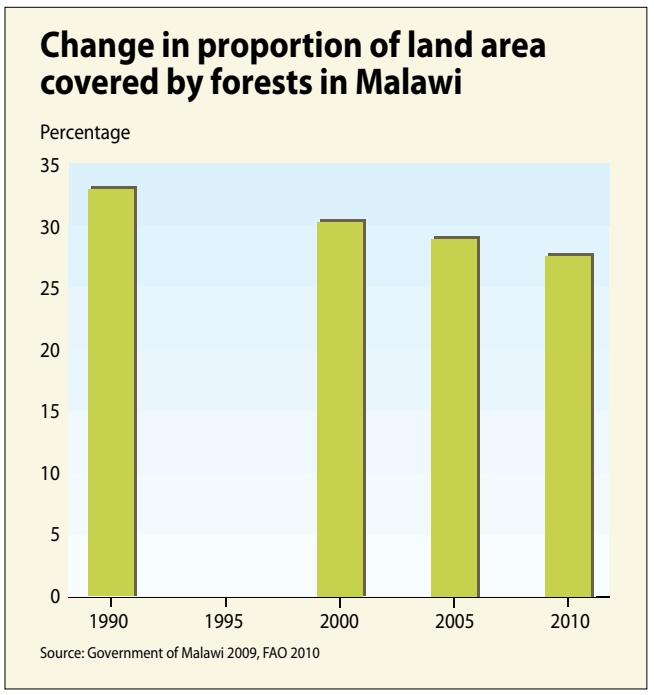


Figure 4.17

Malawi is a water-stressed nation since only 1 374 cu m of water is available per person annually even though annual internal surface water production in 2007 was 16.14 cu km (FAOSTAT 2007). Three-quarters of Malawi's rivers are significantly polluted by human waste while soil erosion and pollution from agriculture pose a significant threat to freshwater resources (UNEP 2008).

The extent of carbon emissions is not well documented in Malawi and is not considered a significant factor in environmental sustainability.

Reverse biodiversity loss by 2010

The extent of protected land area in Malawi has remained at 10 585 sq km since 1990, amounting to nine per cent of the total surface area in a densely populated country, as shown in Figure 4.18.

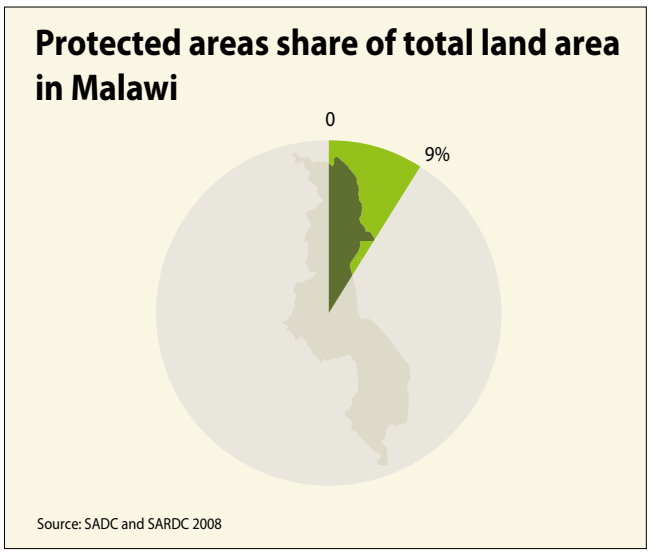


Figure 4.18

Figure 4.19 shows the ratio of area protected to maintain biological diversity.

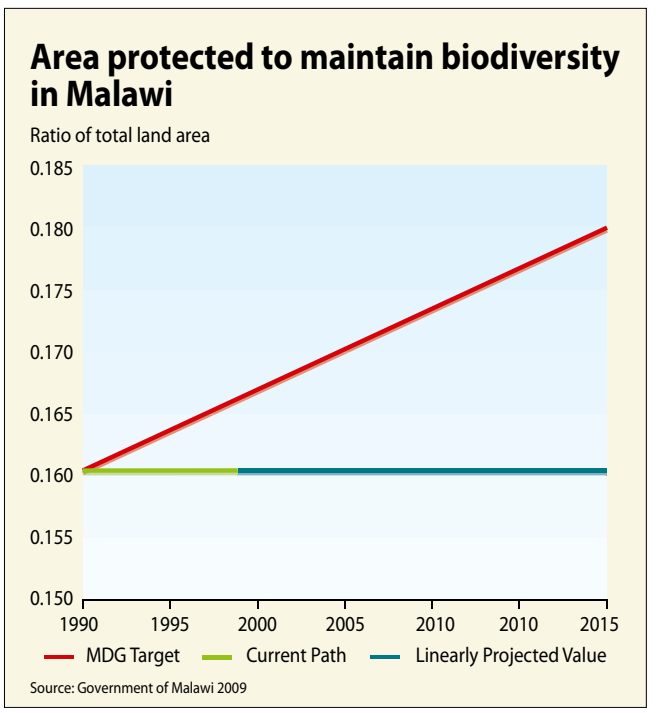


Figure 4.19

Malawi's aquatic resources of over 1 000 fish species, which make up almost 15 per cent of global freshwater fish biodiversity, are under threat from water pollution and overfishing. Lake Malawi contains more unique fish species than any other lake in the world, and more than 90 per cent are endemic (CBD 2007), mainly from the family Cichlidae. The Shire River basin also has high species richness.

There are 117 species in Lake Malawi assessed as vulnerable due to highly restricted distribution, in some cases these species may be restricted to a section of rocky shore of less than a few hundred metres in length. Such species are assessed as vulnerable due to risks that may eliminate entire populations given their highly restricted ranges (IUCN 2011).

Malawi is also rich in biodiversity of birdlife, and the major wildlife groups of mammals, reptiles and amphibians are represented, but the number of threatened species recorded almost doubled between 1996 and 2003, to 41 (IUCN 2006).

Access to safe drinking water and improved sanitation by 2015
According to the Malawi Development Goals Report 2009, the country has already surpassed the MDGs targets for access to clean water and improved sanitation, and is well on its way to achieving 100 per cent for the latter (Figures 4.20 and 4.21).

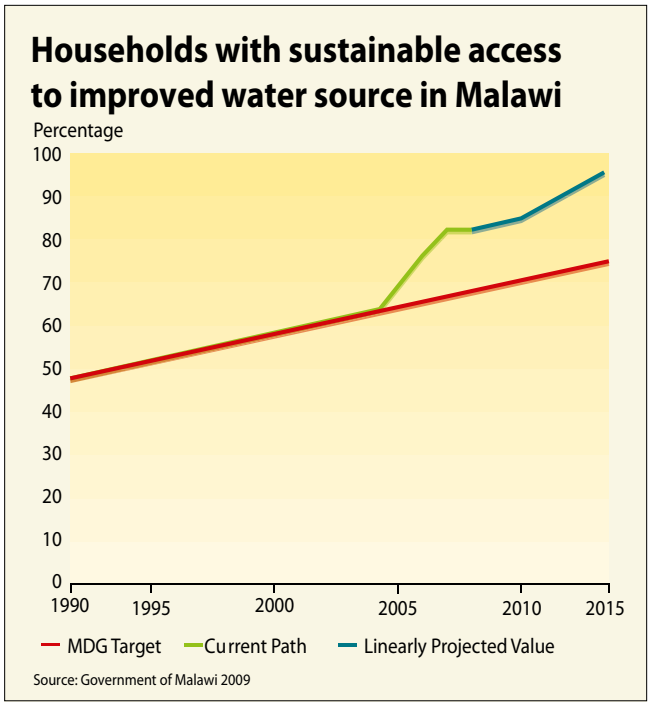


Figure 4.20

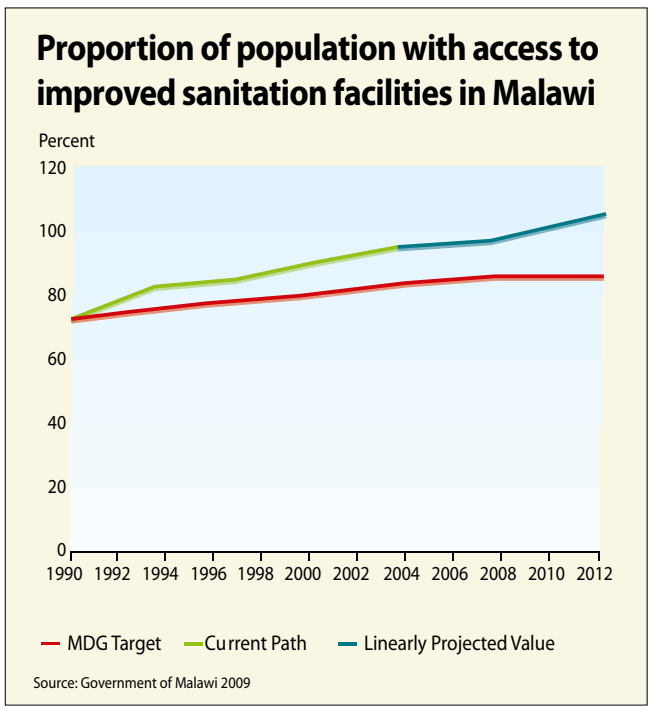


Figure 4.21

Improve the lives of slum dwellers by 2020
The slum population as a proportion of total urban population in Malawi has been reduced by almost 30 per cent since 1990, from 94.6 per cent to 66.4 per cent, and is projected to reach 64.57 per cent by 2015, according to UN-Habitat (2010) as shown in Figure 4.22.

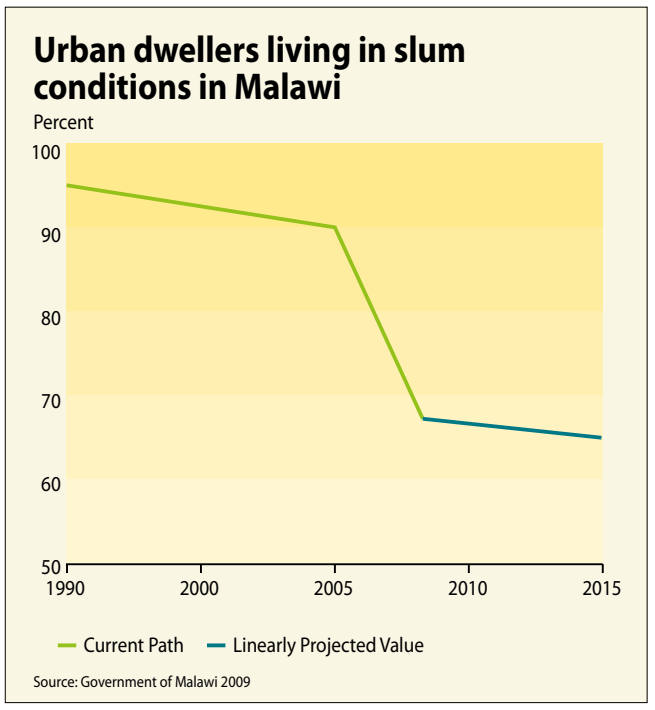


Figure 4.22

Malawi remains committed to achieving what it calls the Malawi Development Goals (MDGs) by 2015 through implementation of a national development plan called the Malawi Growth and Development Strategy (MGDS). The first Strategy covered the period 2006 to 2011, and a successor MGDS was being designed to replace it (Government of Malawi 2009).

Agriculture is the mainstay of Malawi's economy, although the population is under constant threat of crop failure due to droughts. Malawi's government supports agriculture as a way of reducing poverty.

Mozambique

Total Area of Country	799 390 sq km
Portion of Country within Zambezi Basin	163 800 (20.5%)
National Population in 2010	22.4 million
Portion of National Population within Zambezi Basin	5 185 600 (23.15%)

Important Environmental Issues

- Water access and extreme weather events
- Land use
- Protecting wildlife and forests

Mozambique borders the Indian Ocean to the east and its climate is generally tropical, although precipitation varies widely from north to south and from the coast to the inland areas. Drought in the southern regions and prolonged civil war that ended in 1992 led to significant migration to coastal and urban areas, which continue to grow by more than four per cent per year (Government of Mozambique 2010).

Progress towards environmental sustainability

Reverse the loss of environmental resources

Extreme weather events such as droughts, floods and cyclones frequently strike Mozambique, exacerbating water and sanitation problems, destroying crops, threatening food security and human health, and damaging the environment. In 2000 the worst floods in over 50 years due to Cyclone Eline destroyed 140 000 hectares of crops and affected millions people (SARDC and HBS 2010). Mozambique's geographical location has resulted in the occurrence of floods and environmentally related diseases such as malaria and cholera which pose a threat to human health. However, the prevalence and death rates associated with

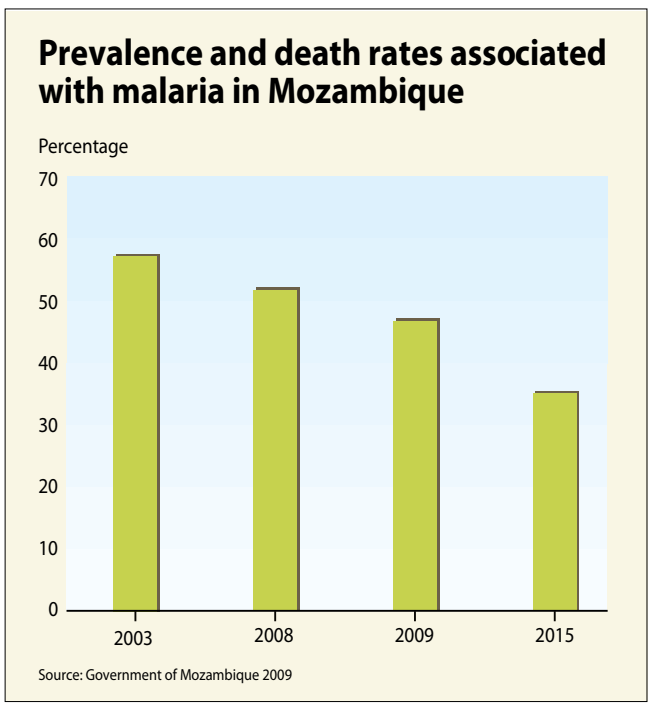


Figure 4.23

Malaria have been reduced significantly since 2003 and are expected to drop further by 2015, as shown in Figure 4.23.

Mozambique lost 5.5 per cent of its forests in the 20 years between 1990 and 2010, but has since launched reforestation projects which have fostered denser forest cover in the wet and fertile regions while thin savannah vegetation characterizes the drier interior (Government of Mozambique 2010). Figure 4.24 shows the proportion of land area covered by forests.

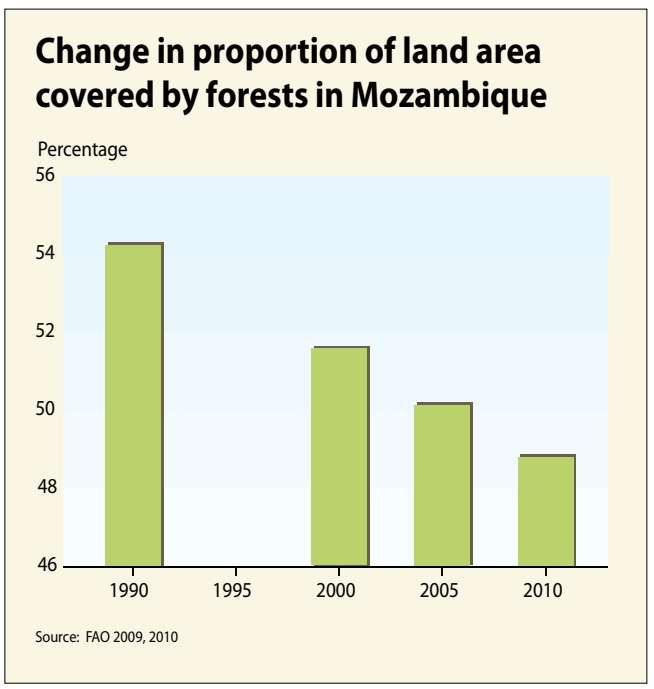


Figure 4.24

The extent of carbon emissions is not well documented in Mozambique and is not considered a significant factor in environmental sustainability. While the consumption of ozone depleting substances has been increasing slowly (Figure 4.25), this too has not been studied in depth and does not appear significant.

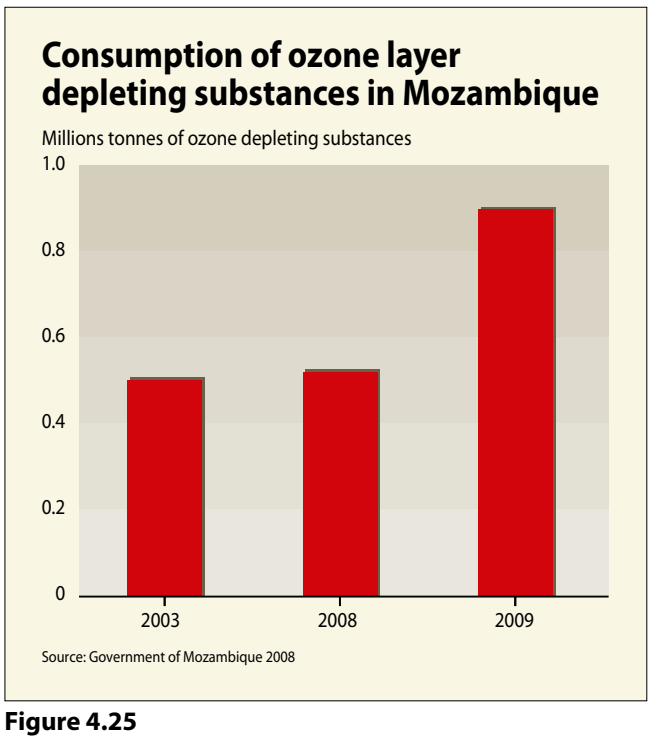


Figure 4.25

Reverse biodiversity loss by 2010

The extent of protected areas has risen slightly from 66 020 at the end of the war in 1992 to 67 300 by 2001, amounting to eight per cent of the total surface area as shown in Figure 4.26.

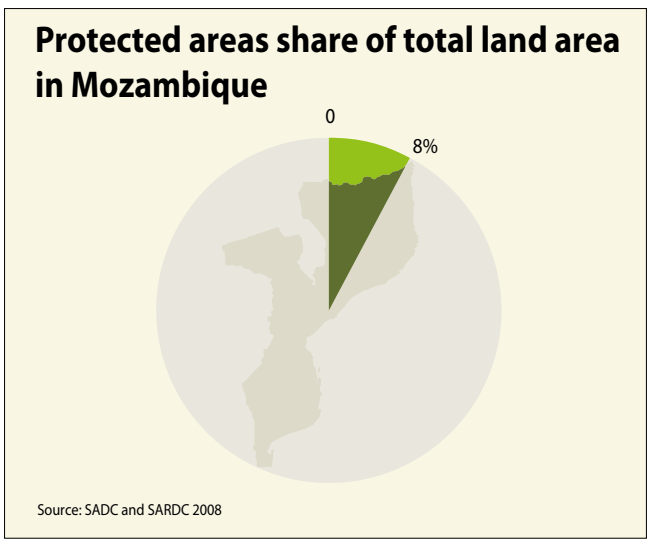


Figure 4.26

Mozambique shares Lake Niassa with Malawi and Tanzania (where it is known respectively as Lake Malawi or Lake Nyasa) and thus is rich in biodiversity of aquatic resources, much of it endemic, with less threat of water pollution and overfishing than the Malawi side of the lake due to low population densities. However, the freshwater fish biodiversity in Mozambique's part of the lake is less well studied.

Coastal drainage sites such as the Zambezi, the Rovuma, the Pungwe and the Buzi systems on the east coast of Mozambique also contain species that occur only in that area. However development activities are not always compatible with conservation of diversity and this is not integrated into development planning due to a lack of awareness and access to information.

Mozambique is also rich in birdlife, mammals, reptiles and amphibians, but the number of threatened species recorded jumped from 41 in 1996 to 108 in 2003 as shown in Figure 4.27, in part due to greater access to areas of study.

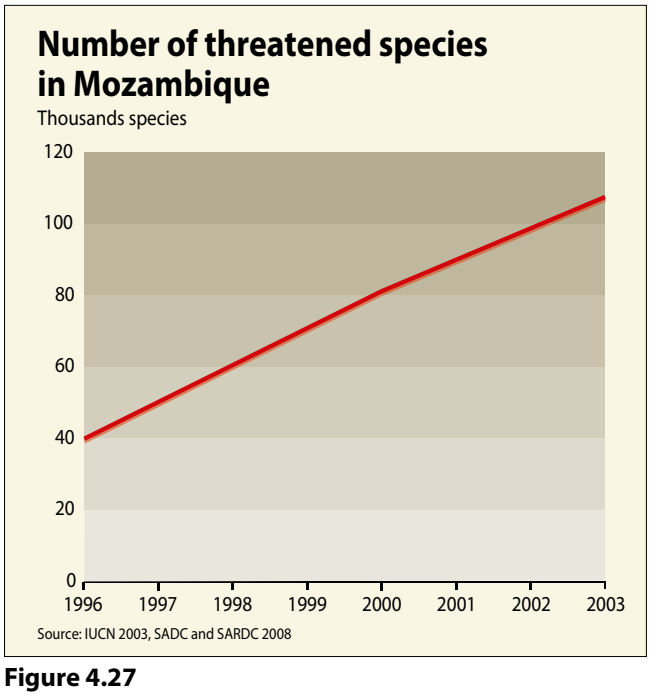
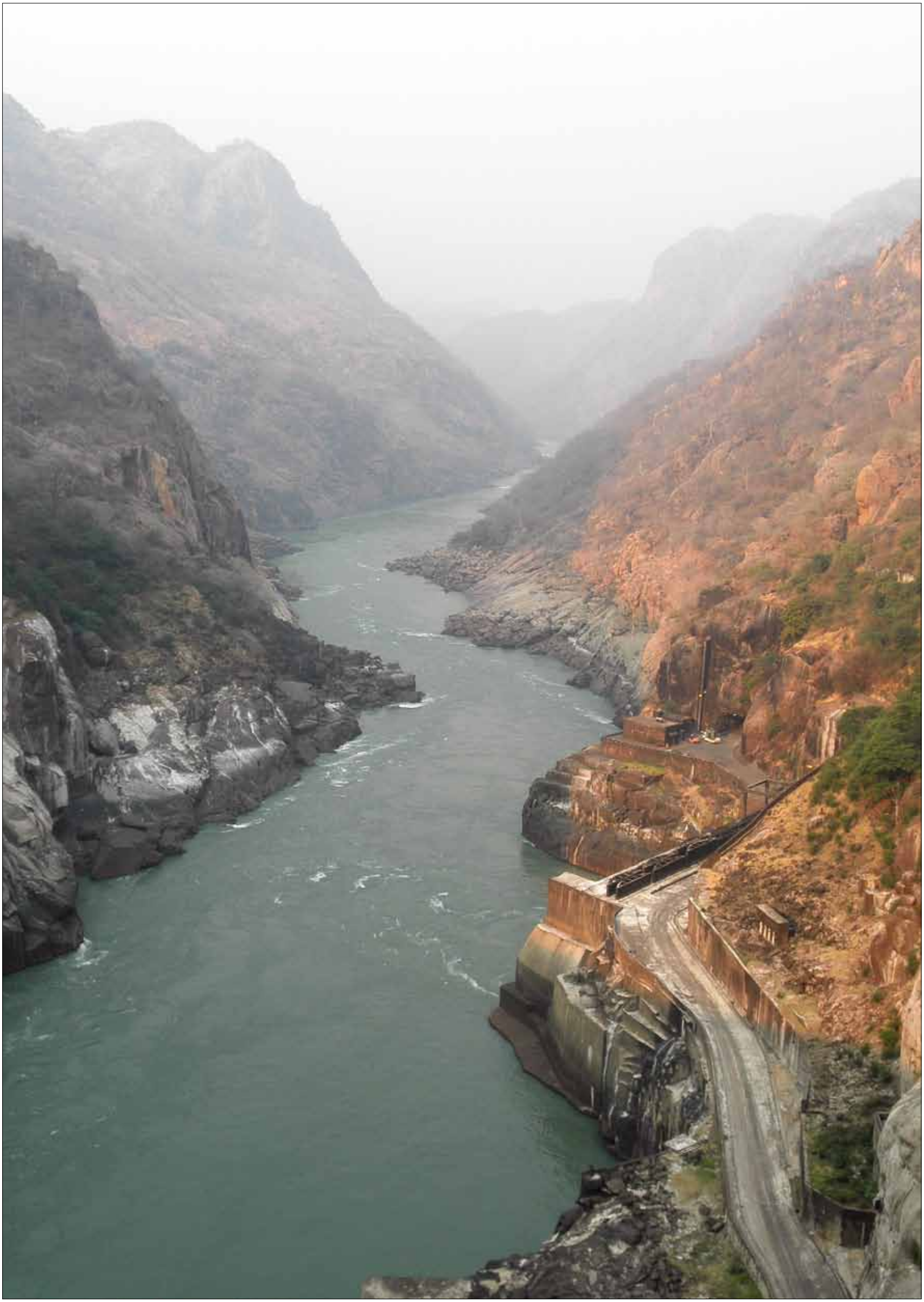


Figure 4.27



© P. Johnson, SARDC

Mozambique is a net exporter of electricity, much of which is generated at Cahora Bassa Dam.

© Candice Bate, WWF

Cahora Bassa Dam at night.

The elephant count showed a population of 14 000 in 2006 and this figure is increasing as more areas are studied, although the range area has been shrinking (SADC and SARDC 2008) before the development of the Mozambique-Tanzania elephant corridor.

Access to safe drinking water and improved sanitation by 2015

The proportion of the population with access to safe drinking water has increased significantly to 56 per cent in 2009, from 37.3 per cent in 1997. The national target for 2015 is 70 per cent. The proportion of the population with access to improved sanitation has increased from 40 per cent in 2003 to 45 per cent in 2009, with a target of 50 per cent for 2015. Thus, Mozambique is likely to meet the 2015 targets for access to water and sanitation (Figure 4.28).

Improve the lives of slum dwellers by 2020

The 15-year conflict from 1977-1992, and drought in some regions, caused significant migration to coastal and urban areas, which have continued to grow by more than four per cent per year although the war ended 20 years ago. Many people from rural areas joined other family members in the cities, thus expanding the overcrowded peri-urban areas. This trend is slowly being reversed through the development of amenities in rural areas as well as programmes to help families to resettle in their home areas.

Although slum areas have increased slightly as a proportion of urban population as shown in Figure 4.29, the pressure on urban amenities is largely due to the general increase in urban population.

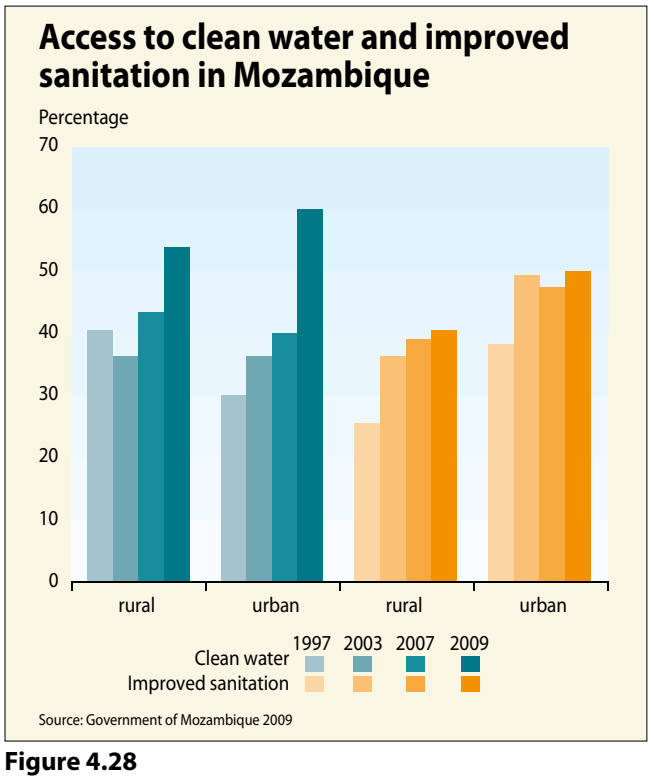


Figure 4.28

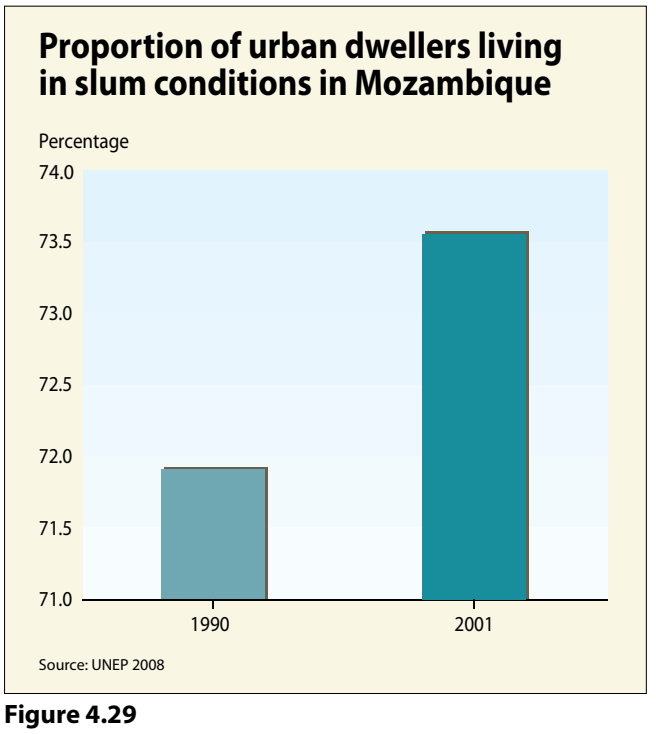
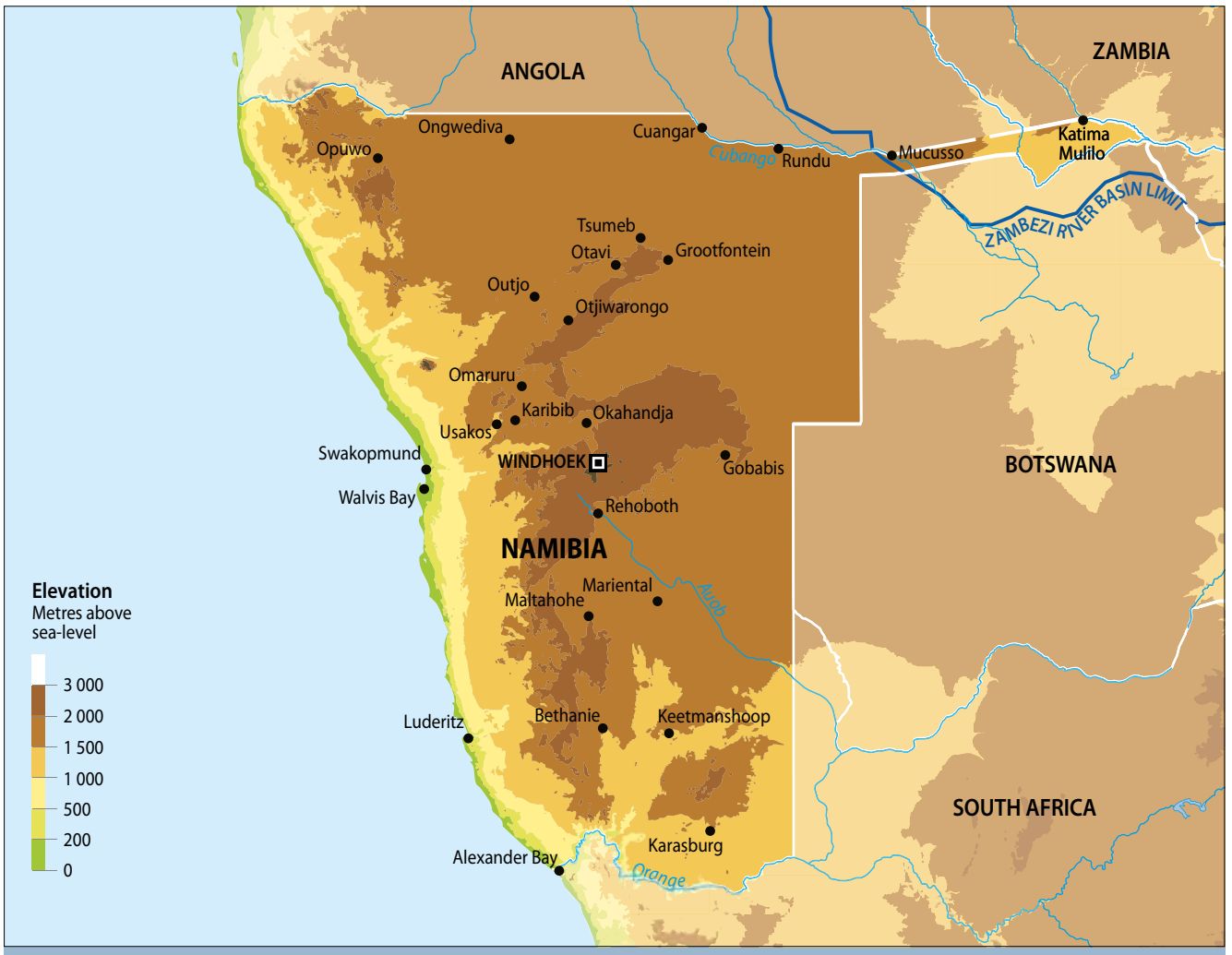


Figure 4.29

Namibia



Total Area of Country	824 290 sq km
Portion of Country within Zambezi Basin	17 100 (2.1%)
National Population in 2010	2.1 million
Portion of National Population within Zambezi Basin	70 350 (3.35%)
Important Environmental Issues	• Land degradation and desertification • Aridity and water scarcity • Biodiversity loss

Namibia is situated at the southern edge of the tropics and is the most arid country in southern Africa receiving an average of only 258 mm of rain per year. Humidity is very low and the average rainfall varies from almost zero in the coastal desert to more than 600 mm per year in the Caprivi Strip. Rainfall is highly variable and droughts are common. With only 2.5 people per square kilometre it is among the least populated countries in the world (FAO 2007, UNEP 2008).

Progress towards environmental sustainability

Reverse the loss of environmental resources

The country's abundant natural resources, particularly fisheries and mining, are the backbone of the national economy. The majority of the population is dependent on the land, especially for extensive cattle, goat and sheep farming. About 3 000 sq km – less than one per cent of all land – is cultivated each year, mainly for maize, sorghum and millet. However, the arid and semi-arid nature of the country coupled with recurrent droughts and flooding, especially in the northern rural areas, makes it difficult for the large part of the population which is dependent on subsistence agriculture.

Water availability is the single greatest factor limiting development in Namibia. Extreme temporal variability and uneven spatial distribution of water resources constrain livelihoods, particularly for the 64 per cent of the population who live in rural areas (Government of Namibia 2008). Perennial surface water resources are limited, located primarily along the northern and southern borders, but all of these sources suffer from significant population pressure and degradation.

Overgrazing is the largest threat to the environment since cattle, which outnumber people in Namibia, have surpassed the carrying capacity of the land. Current evidence of desertification includes declining ground

water levels, soil erosion, reduced soil fertility, increased salt content in soils, and loss of woody vegetation. The increase in cattle stocks is shown in Figure 4.30.

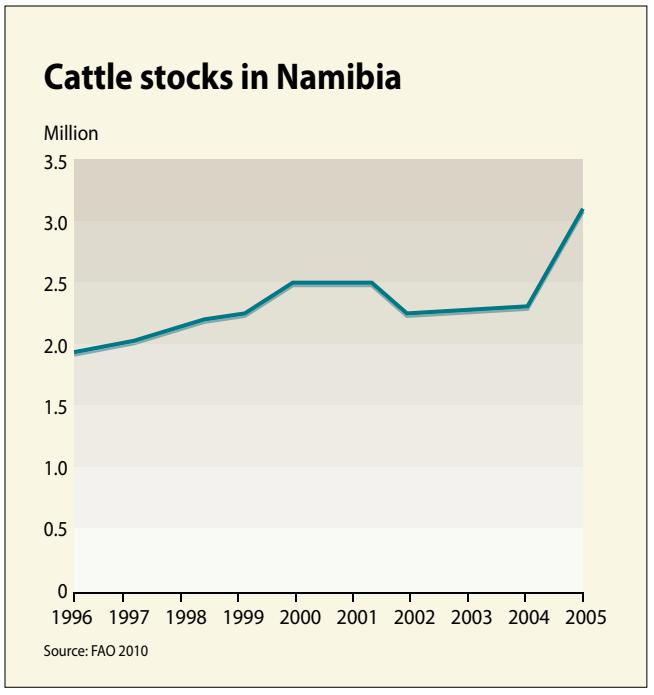


Figure 4.30

Deforestation, soil erosion and desertification also threaten Namibia's lands and forests with an estimated 90 per cent of land at high risk (FAO 2003). If the rate of clearing continues as it has been over the past 53 years in the Caprivi Strip in particular, all land in this region will have been cleared for crops by the year 2082, while all areas with soils rated as having the best potential for cultivation will have been cleared by 2033 (FAO 2009).

While Namibia is not heavily forested, Figure 4.31 shows a 17 per cent drop in the proportion of land area covered by forests since 1990. Just 8.8 per cent of the country was covered by forests in 2010.

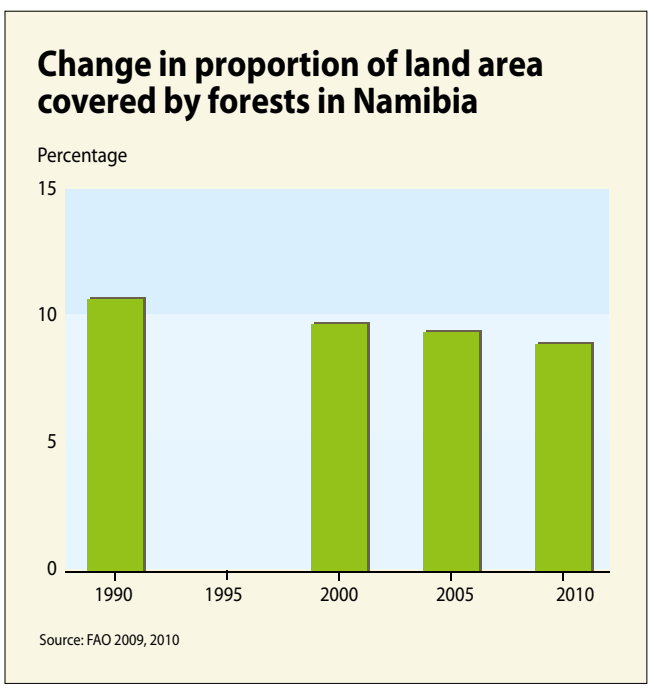


Figure 4.31

Carbon dioxide emissions have increased slightly since 1999 due to urban growth and increased use of fossil fuels, but the increase shown in Figure 4.32 is largely due to improved monitoring.

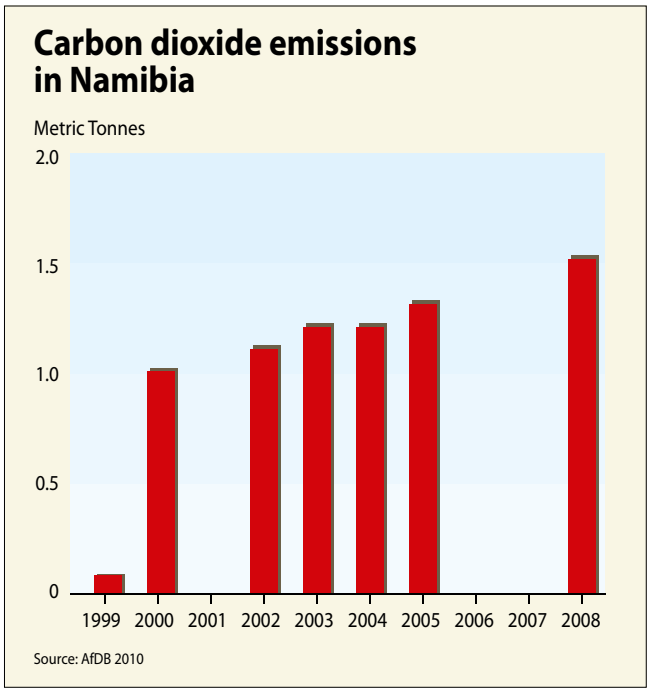


Figure 4.32

Reverse biodiversity loss by 2010

Despite the arid climate, Namibia is home to abundant biodiversity, including unique desert-adapted ecological communities, mega fauna, and productive coastal fisheries. Namibia has one of the largest remaining populations of the highly endangered black rhinoceros, with about three-quarters of the national rhino population found in Etosha National Park. The Government of Namibia has maintained the size of protected areas since independence in 1990 at 112 160 sq km, a respectable 14 per cent of the national surface area, shown in Figure 4.33.

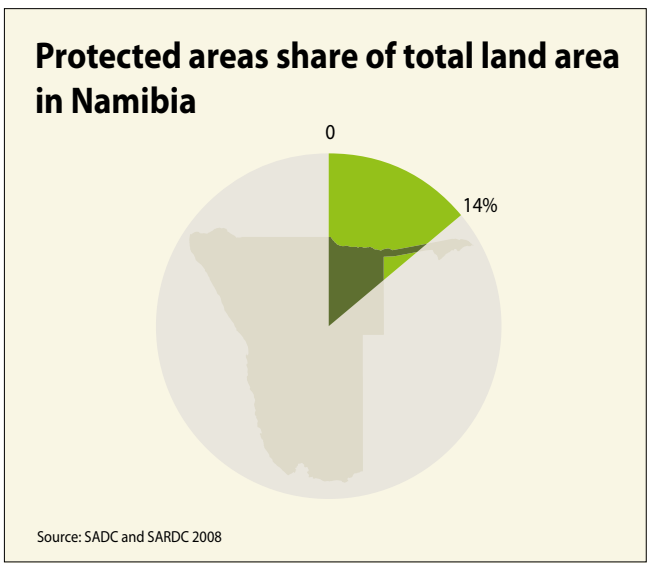


Figure 4.33

Threats to biodiversity include over-grazing, agriculture and mining (WWF 2006). Figure 4.34 shows that there are 58 threatened species in Namibia, an increase of 60 per cent in less than a decade, although some increase in the figure is due to new areas of study that have not been previously researched.

The human population of Namibia is outnumbered by that of cattle. Together with goats and sheep, Namibia's cattle population exceeds the country's carrying capacity.

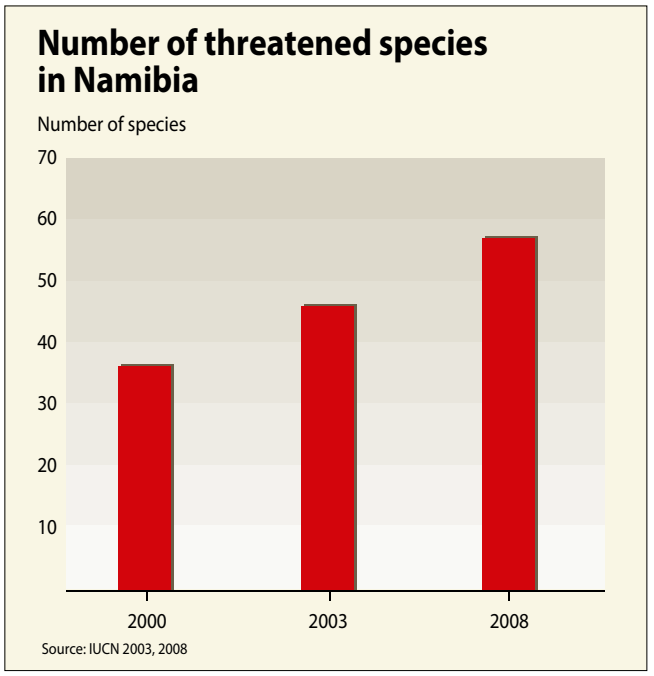


Figure 4.34

The Community Based Natural Resource Management programme has contributed to empowering people to gain access to resources and to build their capacity. Opportunities are available to expand the programme and the support base by working closely with government institutions such as agriculture, inland fisheries, water, rural development, and by synchronizing and harmonizing approaches to make optimal use of both the financial and human resources available. If the programme continues to grow at its present rate, and if the capacity to support and sustain this growth is available, 70 per cent of the communal areas – about 20 million ha – could be within conservancies by 2030, and the programme could be earning as much as N$800 million per year (Government of Namibia 2008).

Access to safe drinking water and improved sanitation by 2015

Access by urban households to safe drinking water is slightly less than 100 per cent, but decreasing. Access of rural households to safe drinking water was 88 per cent in 2008, up from 67 per cent in 2000. The government has improved water supply to rural communities through the provision of new boreholes and the rehabilitation of existing boreholes, as well as the development of pipelines. Namibia recycles water, especially in urban areas. Figures 4.35 and 4.36 show trends in access to water and sanitation.

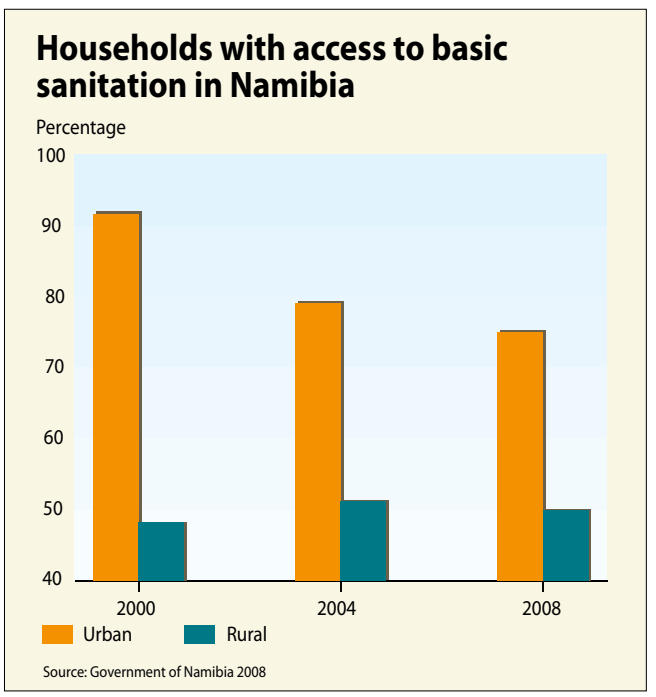


Figure 4.36

While Namibia has improved access to water and sanitation, the country's primary environmental concerns remain water pollution and water scarcity, that is, insufficient water resources for its growing population (Namibia Nature Foundation 2007).

Groundwater accounts for roughly half of all water consumption, but only one per cent of Namibia's meagre rainfall goes towards recharging groundwater, thus over-extraction is a growing concern (Government of Namibia 2008).

Improve the lives of slum dwellers by 2020

One-third of the urban population of Namibia lives in slum conditions, a situation that has remained almost static since 1990, reducing by less than one per cent, as shown in Figure 4.37.

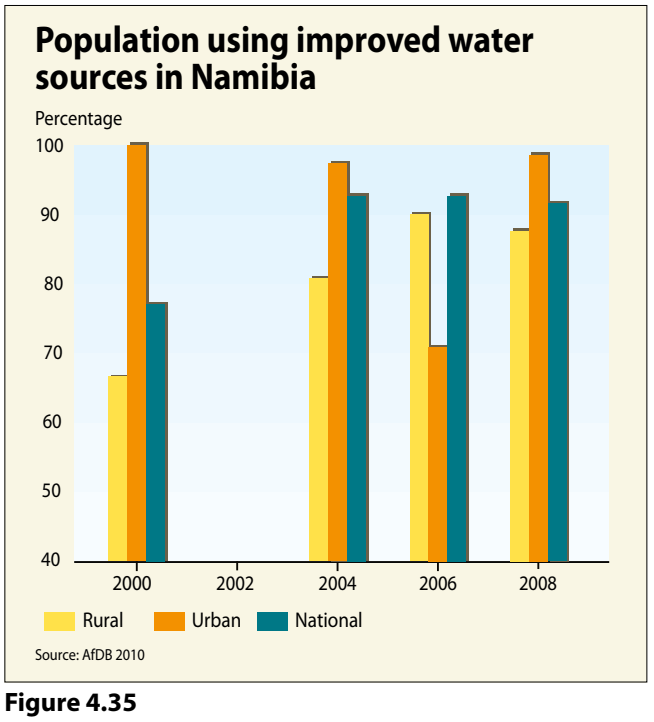


Figure 4.35

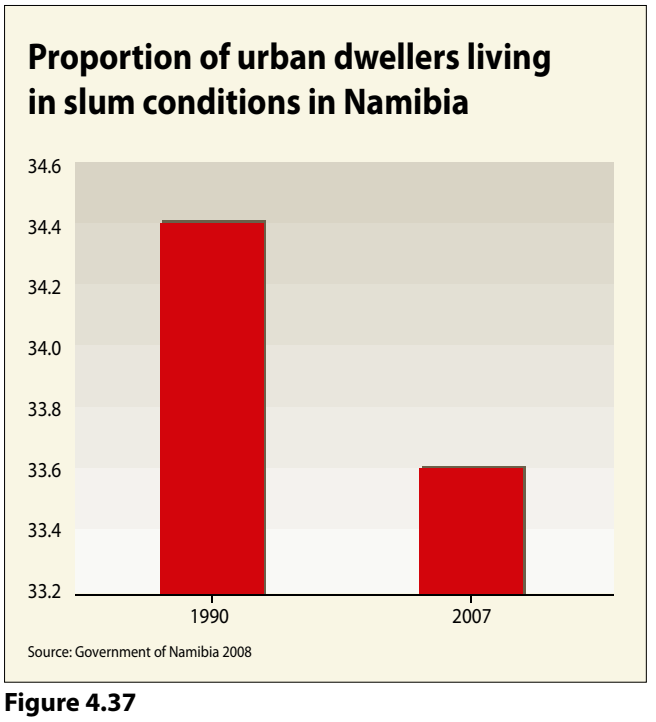


Figure 4.37

Tanzania

Total Area of Country	945 087 sq km
Portion of Country within Zambezi Basin	27 300 (2.9%)
National Population in 2010	42 million
Portion of National Population within Zambezi Basin	1 646 400 (03.92%)
Important Environmental Issues	• Water pollution and aquatic ecosystems • Land degradation and deforestation • Threats to biodiversity and ecosystems

The United Republic of Tanzania, made up of mainland Tanganyika and the islands of Zanzibar, is surrounded by several large bodies of water including 1 300 km of coastline on the Indian Ocean and 2 375 km of shoreline along Africa's three largest lakes: Tanganyika, Victoria, and Nyasa (UNEP 2008). The economy is based on agriculture, which accounts for more than half of GDP, provides 75 per cent of exports, and employs about 75 per cent of the workforce. The major limitation for cultivation is topography and climate. Tourism is another significant contributor to GDP, as is the mining sector.

Progress towards environmental sustainability

Reverse the loss of environmental resources

The three largest lakes in Africa by volume or size – Lake Tanganyika, Lake Nyasa (Malawi/Niassa) and Lake Victoria – cover 5.7 per cent of Tanzania's total surface area (UNEP 2008).

However, pollution from agriculture, industry, mining, and households is threatening the country's water resources and untreated industrial waste causes significant levels of localized pollution. About 80 per cent of the industries, including agro-chemical and chemical industries, breweries and steel manufacturing industries, are located in the coastal area of Dar es Salaam and pollute the Indian Ocean directly or indirectly (UNEP 2008).

The proportion of land area covered by forests has dropped by 19 per cent since 1990 due to deforestation, leaving just over one-third of the land under forests as shown in Figure 4.38. Much of the fuelwood that is cut is converted to charcoal for use in urban households. Rural industries also use substantial amounts of fuelwood. Alternative methods need to be applied and indigenous knowledge systems should be incorporated into sustainable harvesting.

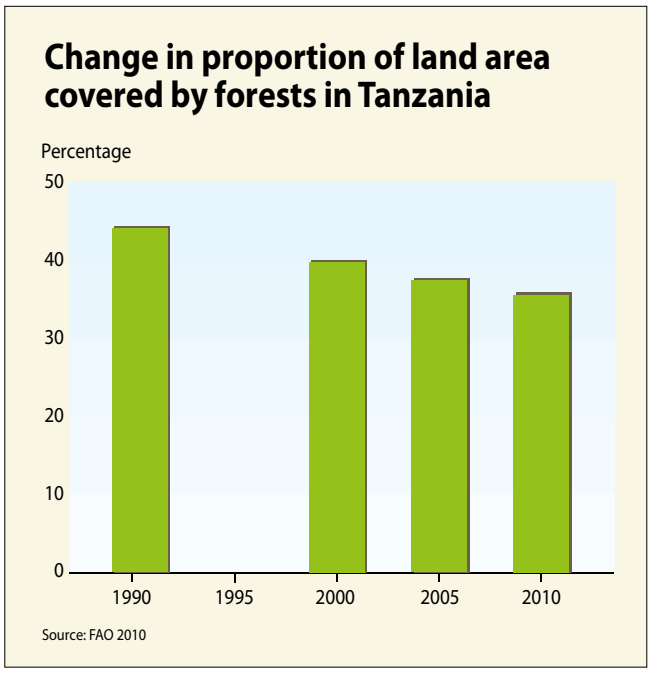


Figure 4.38

The extent of carbon emissions is not well documented and is not a significant factor in environmental sustainability in Tanzania at present. The estimated figures are still low, although increasing due to extensive exploration and developments of gas and oil, and growing use of fossil fuels.

Reverse biodiversity loss by 2010

Tanzania has the second highest proportion of national protected areas among the Basin states, after Zambia, with 28 per cent of the country set aside for national parks, conservation areas, game reserves, and controlled and protected areas (Figure 4.39).

Tanzania has been working hard to meet world limits of 20 per cent protected coastal areas by 2012. Famous marine parks in Tanzania include Mafia Island Marine Park and Mnazi Bay Conservation Area.

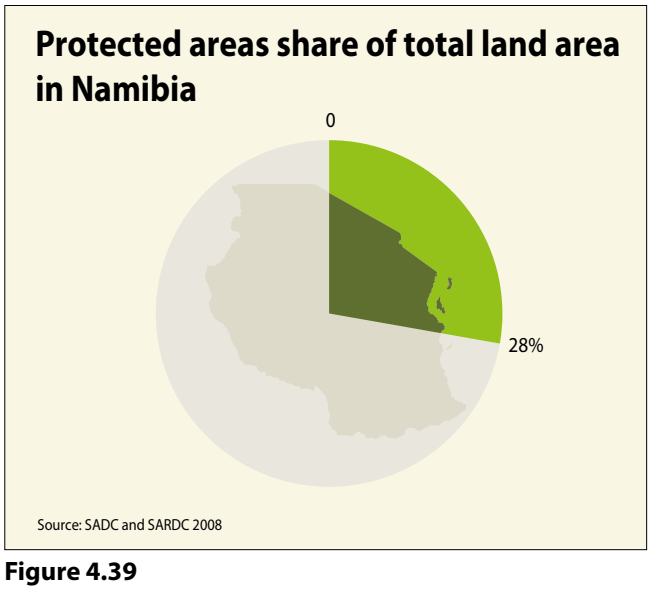


Figure 4.39

Tanzania is a large country with vast biological diversity and high numbers of threatened species, well documented. According to IUCN (2008), Tanzania has 10 008 known species of higher plants including endemic and non-endemic, out of which 235 (2.9 per cent) are threatened. Of the 316 known mammal species 42 are threatened (excluding marine mammals). There are 229 known breeding bird species out of which 33 are threatened (excluding those that migrate to the country in the northern winter); 335 known reptile species out of which 5 are threatened; and 116 amphibian species and 331 known fish species out of which 17 are threatened.

The Tanzanian government has made significant progress in reducing the number of threatened species by 10 per cent between 2003 and 2008, as shown in Figure 4.40.

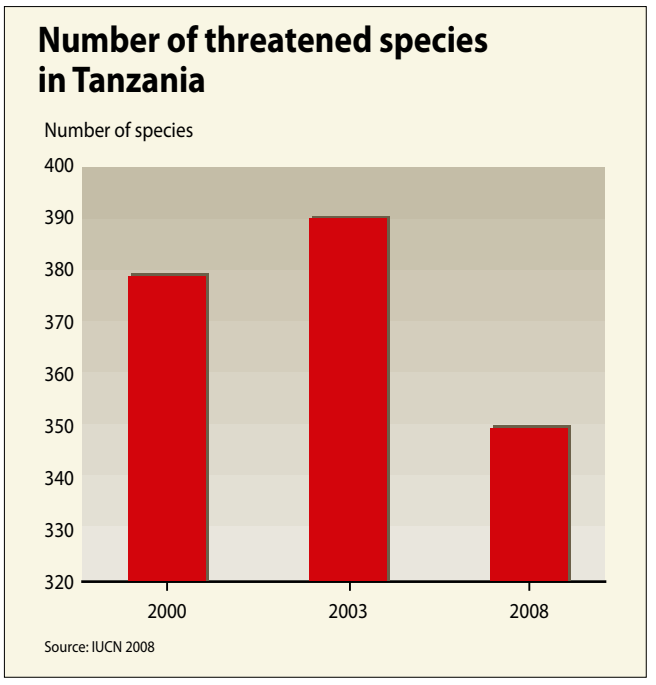


Figure 4.40

The greatest species concentrations of fish and molluscs are within the three African Great Lakes and most are endemic to single lakes. Lake Tanganyika is the richest in biodiversity of molluscs with between 60 and 80 species recorded, depending on the study (IUCN 2011). The main centres of threatened fish species are within Lake Victoria and Lake Nyasa (Malawi/Niassa), due to the combined impacts of invasive species, eutrophication and overfishing. Beyond the Great Lakes, the Rufiji/Ruaha, Pangani, and Malagarasi River basins also have high species richness. The main recorded threats are loss of habitat due to agricultural encroachment into wetland areas and the eutrophication and sedimentation of the riverine habitat (IUCN 2011).

Access to safe drinking water and improved sanitation by 2015

The proportion of people in urban areas who use drinking water from improved sources has increased to 83 per cent in 2008, from 68 per cent in 1990 (Government of Tanzania 2008). While more than 80 per cent of people living in urban areas in Tanzania have access to clean drinking water, the figure drops to just over one-third in the rural areas, thus bringing down the national average to about half of the population with access to safe drinking water (Figure 4.41).

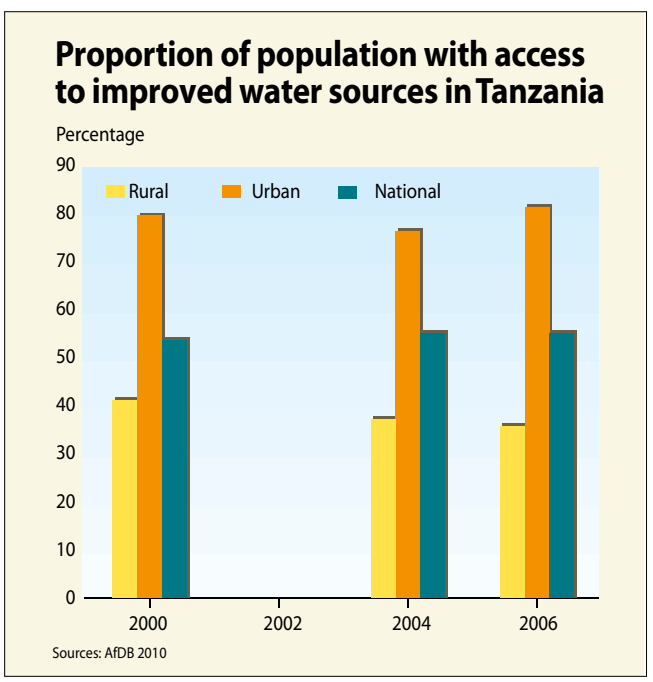


Figure 4.41

The targets for 2015 for improved water supply are 74 per cent for rural areas (from 51 per cent in 1990) and 84 per cent for urban areas (68 percent in 1990). The goal is likely to be met with respect to urban water supply if the challenges of increased population pressure and lack of adequate resources are addressed but less likely in rural areas of mainland Tanzania. Targets with respect to sanitation coverage and urban population living in slums are unlikely to be met, although significant improvement is expected (Government of Tanzania 2008).

Sewerage service coverage in urban centres increased from around four per cent in 1990, to six per cent in 2000 and 17 per cent in 2008. There has been a steady increase of coverage in improved sanitation facilities from 40.2 per cent in 2001, 50 per cent in 2006, to 55 per cent in 2007, as shown in Figure 4.42. Similar progress has been recorded in Zanzibar, with the proportion of population using an improved sanitation facility in urban areas rising from 52 per cent in 1990 to 75 per cent by 2006 and from 26 per cent in 1990 to 51 per cent in rural areas.

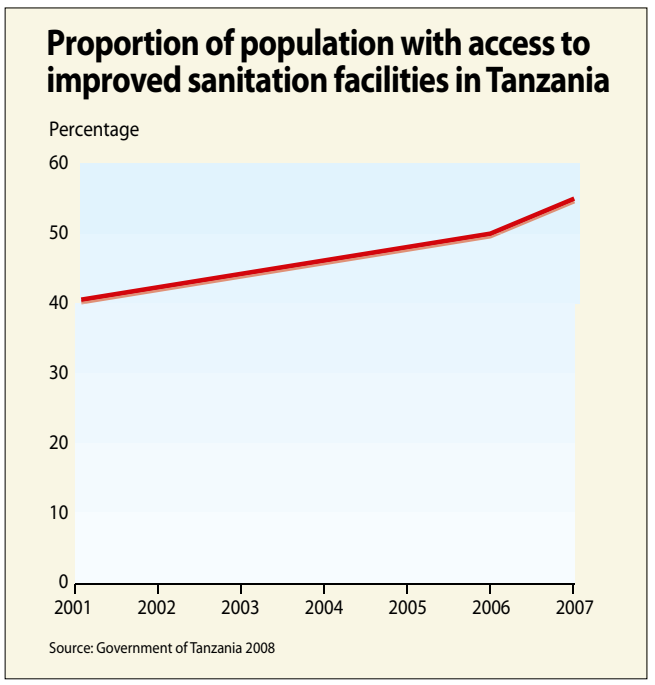


Figure 4.42

Improve the lives of slum dwellers by 2020

The population living in unplanned peri-urban settlements has been decreasing as a proportion of total urban population, as shown in Figure 4.43, while the urban population has also been increasing. Therefore the numbers have been increasing while the proportion has gone down. Both impact on the extent of slum areas.

About 70 per cent of urban residents in most cities in Tanzania live in unplanned settlements, slums or squatter areas. A special programme to upgrade these unplanned urban settlements is being implemented in two phases: First is identification and registration; and second is upgrading infrastructure and utility services. In addition, plot surveying and allocation is being done, with about 55 000 plots surveyed and allocated since 2004 (Government of Tanzania 2000-2008).

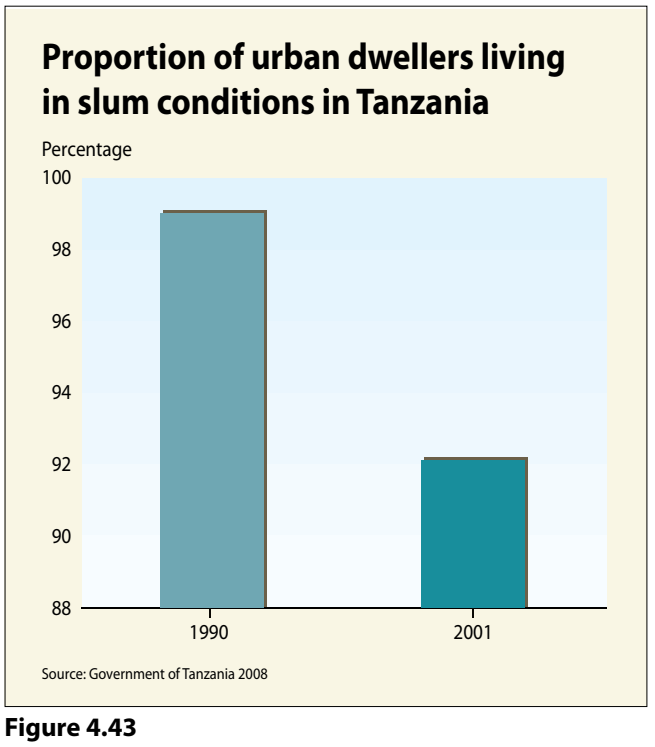


Figure 4.43

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Tanzania's access to safe drinking water improved from 68 per cent in 1990 to 83 per cent in 2008.

Zambia

Total Area of Country	752 614 sq km
Portion of Country within Zambezi Basin	577 900 (76.8%)
National Population in 2010	13 million
Portion of National Population within Zambezi Basin	8 517 600 (65.52%)

Important Environmental Issues

- Copper mining
- Water and air pollution
- Deforestation and wildlife depletion
- Urbanization

Zambia is a landlocked country resting on a high plateau with a subtropical climate characterized by a single rainy season. Savannah is the dominant ecosystem and covers the centre of the country, separating the rain forest in the northwest from the semi-desert region in the southwest. Along Zambia's border with Zimbabwe, the Zambezi River flows over the famous Victoria Falls – *Mosi oa Tunya* in the local Tonga language, "the Smoke that Thunders". The two countries also share the Kariba Dam, built to generate hydroelectric power and also now a major recreation and fisheries area. Northern Zambia joins the southern end of Lake Tanganyika. Zambia is the source of the Zambezi River, which rises as a small spring in the northwest of the country.

Progress towards environmental sustainability

Reverse the loss of environmental resources

Copper mining has played a major role in the national economy since mining began in the late 1920s and the rich reserves of the Copperbelt region have made Zambia a world leader in copper production. However, the absence of effective environmental regulation of the industry has led to widespread air, soil and water pollution, through the use of environmentally damaging mining methods such as open pit and underground digging, as well as pumping and disposal of large volumes of wastewater, and smelting operations that emit sulphur dioxide (UNEP 2008). Zambia's Nchanga mine is the largest opencast mine in Africa and second largest in the world.

The capital city, Lusaka, continues to be the main destination for rural migrants, closely followed by Copperbelt province, together accounting for 69 per cent of the total urbanization (UN-HABITAT 2007). The major urban areas are faced with serious environmental challenges such as soil erosion, loss of soil fertility, and changes to the microclimate resulting from illegal quarrying, illegal development, deforestation, and the overexploitation of forest resources (Government of Zambia 2008).

Between 2000 and 2005, Zambia lost 2.67 million hectares of forest, the second highest total in Africa and the fifth highest in the world (FAO 2005). Expanding agriculture is the principal driver of deforestation, exacerbated by the collection of wood for fuel. Chitemene is a form of shifting cultivation in some parts of Zambia that involves clearing large areas of forest and burning the trees for ash which is then used for fertilising the soil, before moving on to another area and allowing the new growth to resume. With increasing populations and growing pressure on land, this is no longer sustainable but some aspects may be adaptable to woodlands.

The consumption of fuelwood is expected to increase by 35 per cent between 2000 and 2020 (FAO 2003) and had already reached a level of 8.8 million cu m per year by 2009 (Figure 4.44). Much of the fuelwood is converted to charcoal for use in urban households or rural industries.

Eighty per cent of the population continues to use solid fuels, although this is down from 86 per cent in 1990 (Government of Zambia 2008). Alternative methods need to be applied and indigenous knowledge systems adapted and incorporated into sustainable harvesting.

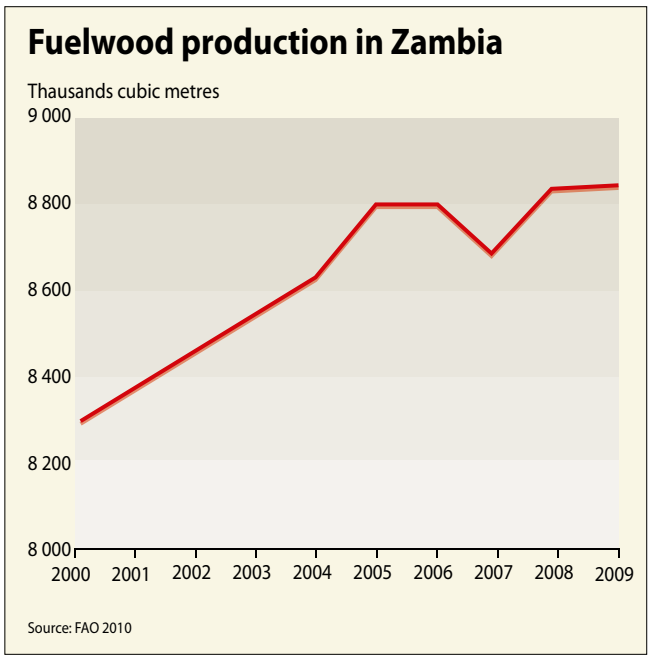


Figure 4.44

The proportion of land area covered by forests has dropped more than six per cent since 1990, leaving two-thirds of the land under forests as shown in Figure 4.45.

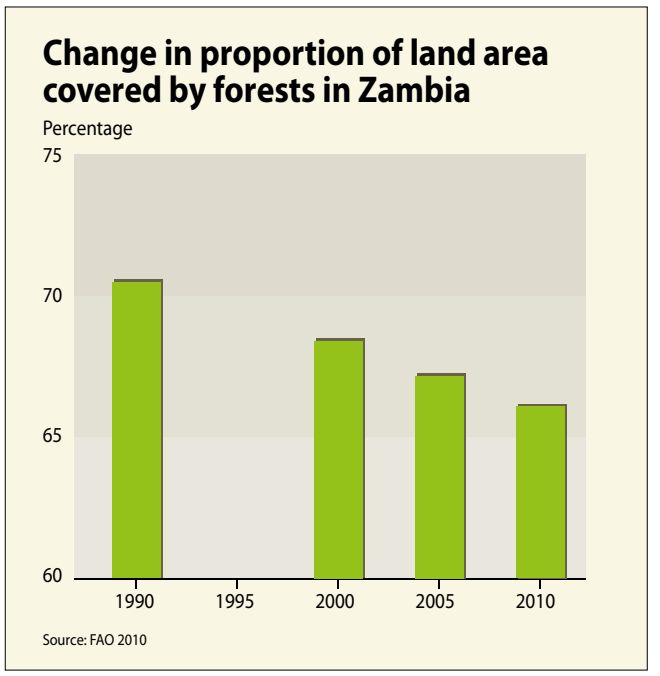


Figure 4.45

The extent of carbon emissions is not a significant factor in environmental sustainability in Zambia at present, and is not well monitored. The estimated figures are still low.

Zambia has the highest proportion of protected areas to total surface area among Basin states, at 236 921 sq km, or 31 per cent, as shown in Figure 4.46.

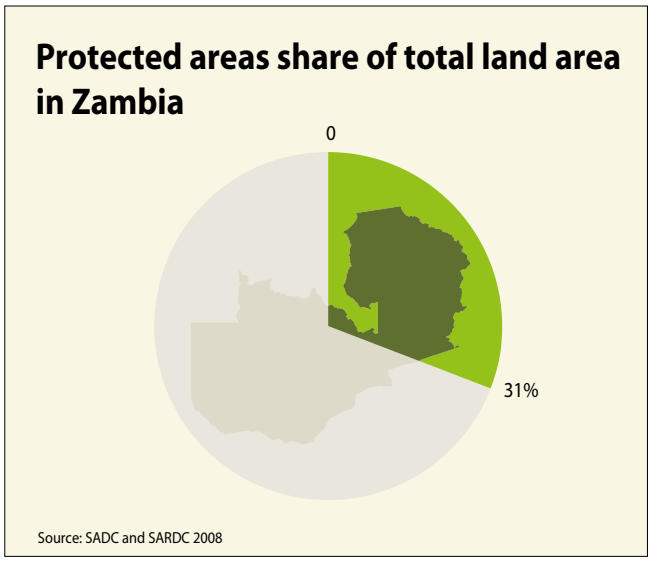


Figure 4.46

The wildlife biodiversity is contained in 19 national parks. The largest parks in Zambia, the South Luangwa and the Kafue National Parks, have seen the stabilization of animal populations, as is the case for North Luangwa and Mosi oa Tunya. In areas not supported by interventions, animal numbers continue to be in serious decline though habitats remain intact.

Of the 8 017 different plant and animal species, 316 are endemic (UN 2007), 174 are rare, and 38 are endangered and vulnerable (IUCN 2006). Zambia's wildlife is threatened by illegal hunting and other exploitation, land-use change, dam development, and other human pressures.

The high level of rural-urban migration is putting pressure on urban amenities such as housing, roads and water delivery.

Access to safe drinking water and improved sanitation by 2015

Although Zambia has serious challenges of water pollution arising from contamination by sewage and toxic industrial chemicals in mining areas, the country continues to sustain the provision of improved water supply to urban areas, although access in rural areas remains below 50 per cent, as shown in Figure 4.47.

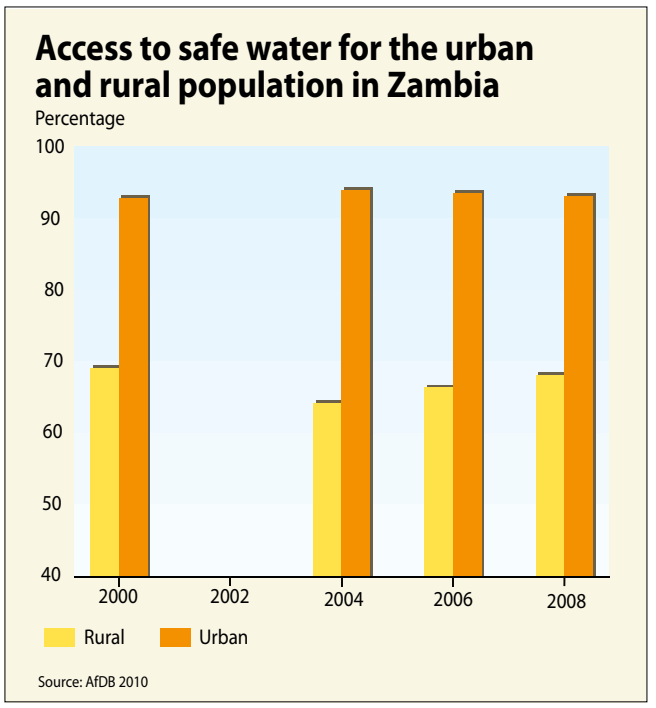


Figure 4.47

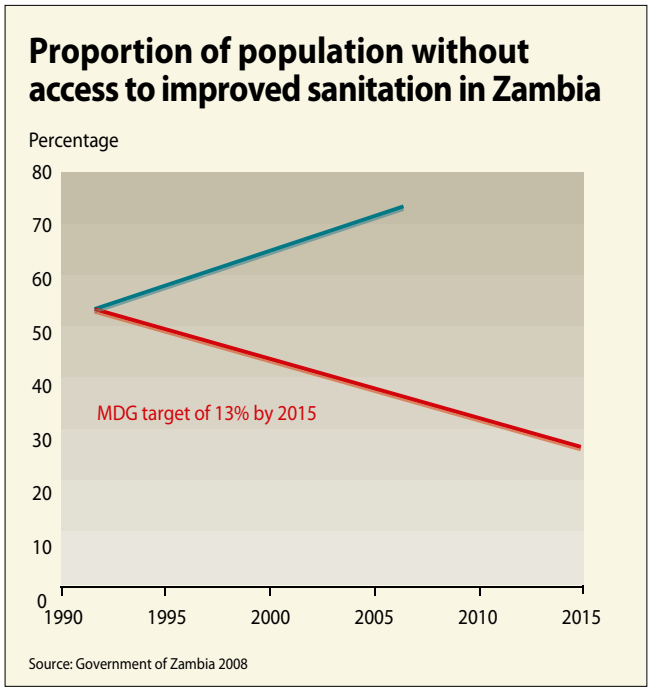


Figure 4.48

The proportion of national population without sustainable access to an improved water source had dropped below 40 per cent by 2008 and is on course to meet the MDG target of 25.5 per cent by 2015. With respect to sanitation, however, the situation is getting worse, and the proportion of the population without access to good sanitation rose by more than 10 per cent from 26 per cent in 1991 to 36.1 per cent in 2006, far from the target of 13 per cent by 2015 (Government of Zambia 2008).

Improve the lives of slum dwellers by 2020

Africa is the fastest urbanizing region in the world and Zambia was the third most highly urbanized country in southern Africa in 1990 after South Africa and Botswana (UN-HABITAT 2010). Zambia has continued to experience high levels of rural to urban migration, as citizens seek to benefit from urban-based employment opportunities and infrastructure, thus putting pressure on urban amenities and expanding unplanned settlements. Almost three-quarters of the urban populations live in unplanned settlements, as shown in Figure 4.49.

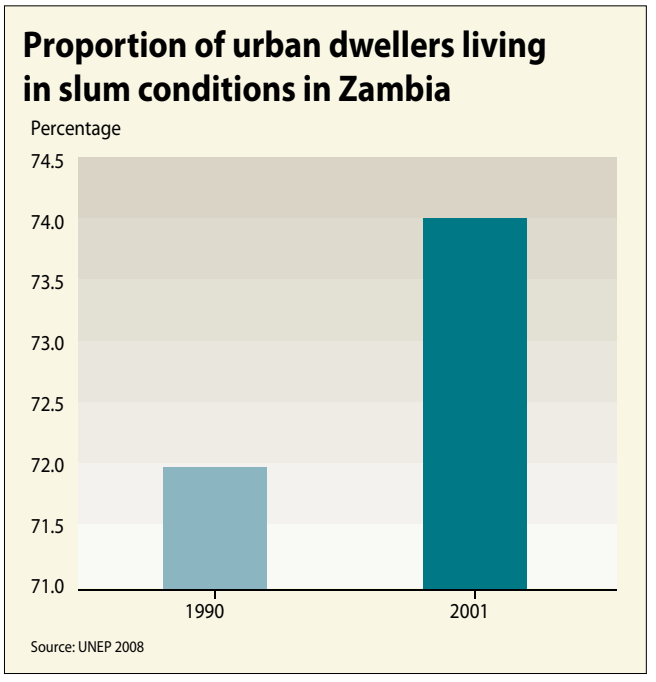
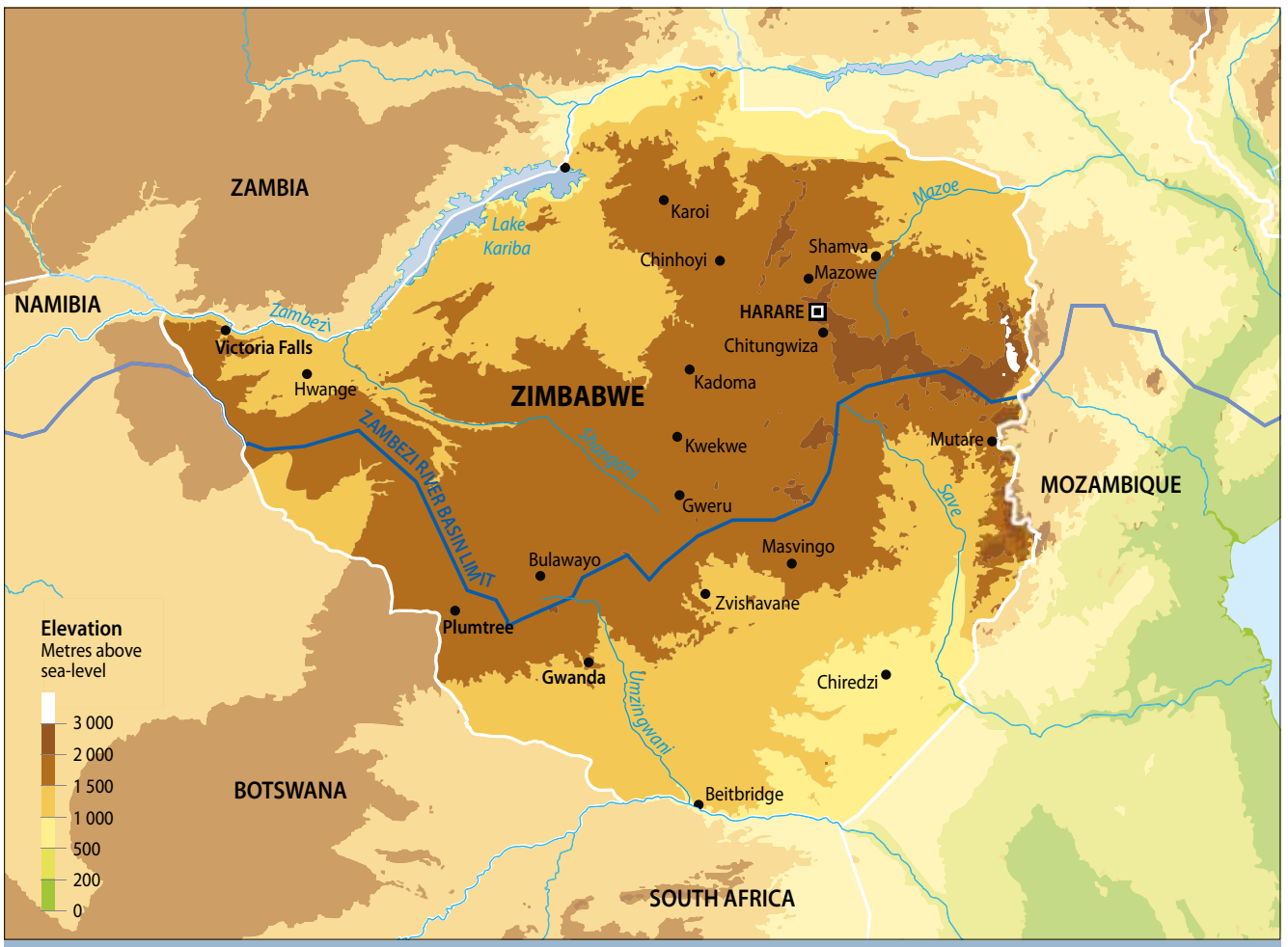


Figure 4.49

The Government of Zambia progress reports for MDGs (2008, 2011) showed that the country has made significant progress towards reaching all goals, except MDG 7 on environmental sustainability, and that the pace of progress must be accelerated.

Zimbabwe



Total Area of Country	390 759 sq km
Portion of Country within Zambezi Basin	215 800 (55.2%)
National Population in 2010	13.5 million
Portion of National Population within Zambezi Basin	9 059 850 (67.11%)
Important environmental issues	• Land degradation and deforestation • Water access and drought • Biodiversity threats, including poaching of wildlife such as the black rhinoceros

Zimbabwe is located between the Zambezi and Limpopo rivers, situated primarily on a high plateau that stretches across most of the country and has a subtropical climate tempered by the altitude. Savannah is the dominant ecosystem, with montane forest in the eastern highlands. The economy is based primarily on agriculture, as well as mining and tourism. Together with Zambia, Zimbabwe is home to the Victoria Falls along the course of the Zambezi River. Victoria Falls is protected as a UNESCO world heritage site.

Progress towards environmental sustainability

Reverse the loss of environmental resources

Zimbabwe's major environmental challenges are soil erosion and deforestation, as well as urban air pollution caused by vehicle and industrial emissions, and water pollution from mining, domestic waste and a high use of fertilizers (Government of Zimbabwe 2010). About 40 per cent of land was considered moderately degraded in 2003, with the regions of greatest concern in the north and east where topsoil losses of more than 100 metric tonnes per hectare have been recorded (FAO 2004). The major drivers of land degradation are overgrazing and deforestation.

Zimbabwe has few perennial rivers and no large natural lakes, and as such a network of over 8 000 dams make up the most significant surface water resource, in addition to the large artificial lake created by the Kariba dam. However siltation is reducing dam capacity and poor infrastructure hampers water access.

Despite being a low emitter, there is observed climate variability in Zimbabwe. There has been a noted shift in agricultural seasons, as evidenced by late onset and sometimes late cessation of the rainy season. In the rural areas, highly variable rainfall and drought are challenges to environmental sustainability. Between 1991 and 1997, Zimbabwe experienced three major droughts that necessitated the importation of food (SADC/SARDC and others 2008). Figure 4.50 shows the change in maize production 1999-2007.

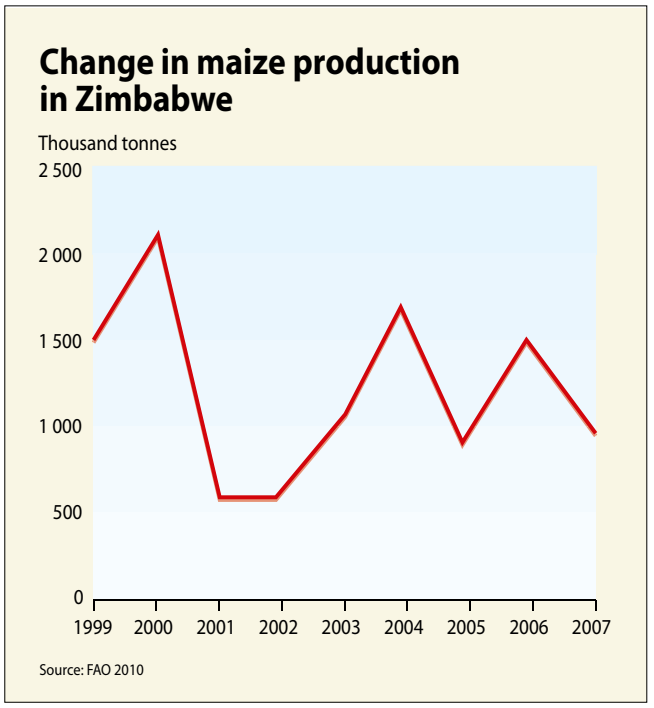


Figure 4.50

Between 2000 and 2008, as economic challenges deepened, a significant proportion of the population was forced to rely more heavily on natural resources for their livelihood, including firewood, bush meat, traditional medicines, and wild fruits and vegetables, and this had an effect on biodiversity. The government has made efforts to ensure environmental protection in resettled areas through the Integrated Conservation Plan for the land reform programme (Government of Zimbabwe 2010).

Between 2000 and 2005, Zimbabwe had the sixth highest rate of deforestation in Africa, averaging 3 130 sq km per year (FAO 2005), with increasing uncontrolled bush and forest fires. Agriculture is responsible for an estimated 700 sq km (roughly one quarter) of this annual loss, while heavy dependence on wood for fuel and commercial logging account for the rest (Figure 4.51).

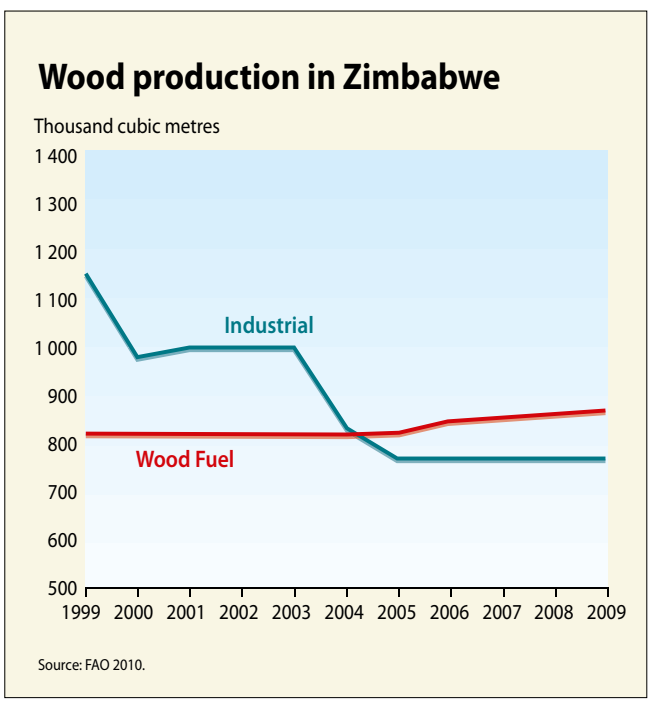


Figure 4.51

The forest plantation programme in Zimbabwe is strongly linked to industrial utilisation and farming.

An initial impact of land reform was deforestation as forests were cleared to accommodate larger numbers of farmers, but the impact is yet to be quantified. Figure 4.52 shows that the proportion of land area covered by forests dropped by eight per cent per decade in the period from 1990 to 2010, according to FAO estimates.

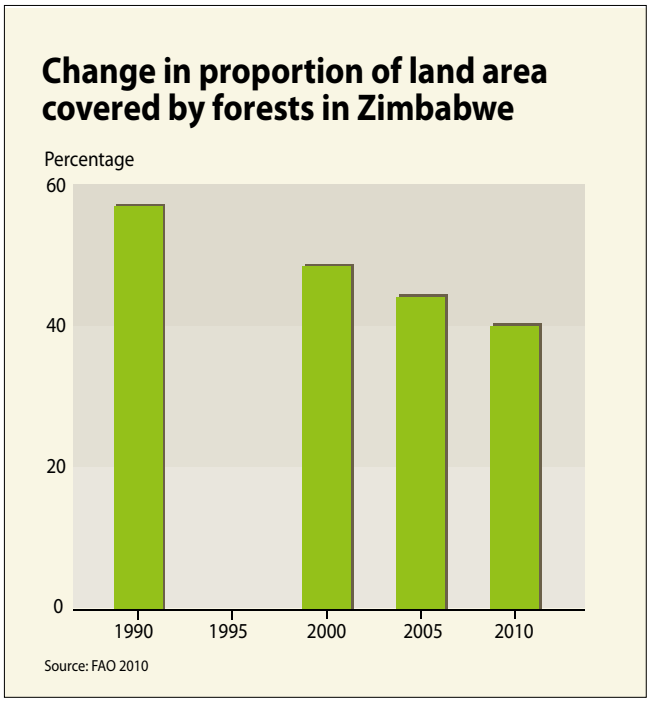


Figure 4.52

Zimbabwe has done well in phasing out ozone depleting substances, reaching the target five years ahead of the 2015 deadline set by the Montreal Protocol (Government of Zimbabwe 2010). The extent of carbon emissions is not a significant factor in environmental sustainability in Zimbabwe at present. The estimated figures are low, and continue to go down (Figure 4.53).

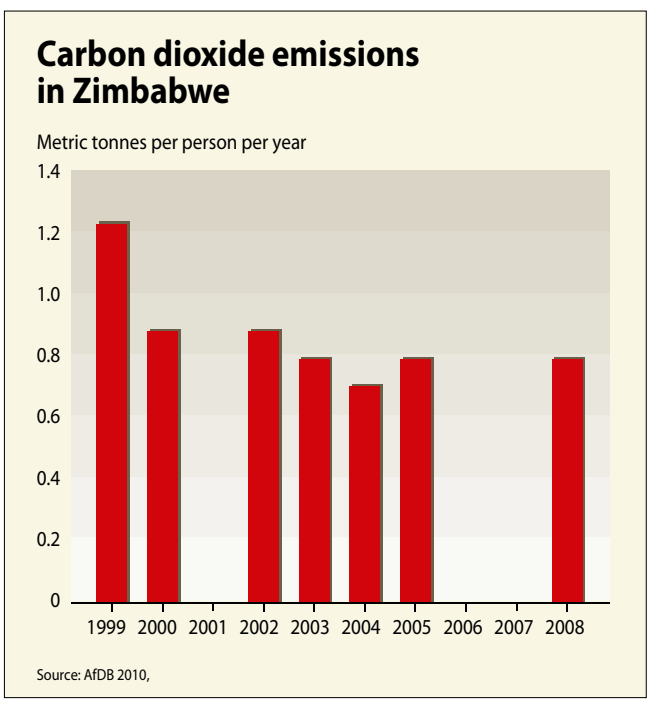


Figure 4.53

Reverse biodiversity loss by 2010
The Government of Zimbabwe has maintained the size of protected areas since 1990 at 46 504 sq km, which is 12 per cent of the national surface area, as shown in Figure 4.54.

Zimbabwe is home to charismatic mega fauna such as the elephant, leopard, black rhinoceros, and giraffe. During the 1980s, Zimbabwe lost over 1 500 rhinos due to heavy poaching, but enhanced conservation measures have increased the population to an estimated current figure of 800, making Zimbabwe an important stronghold for this critically endangered species (SADC and SARDC 2008).

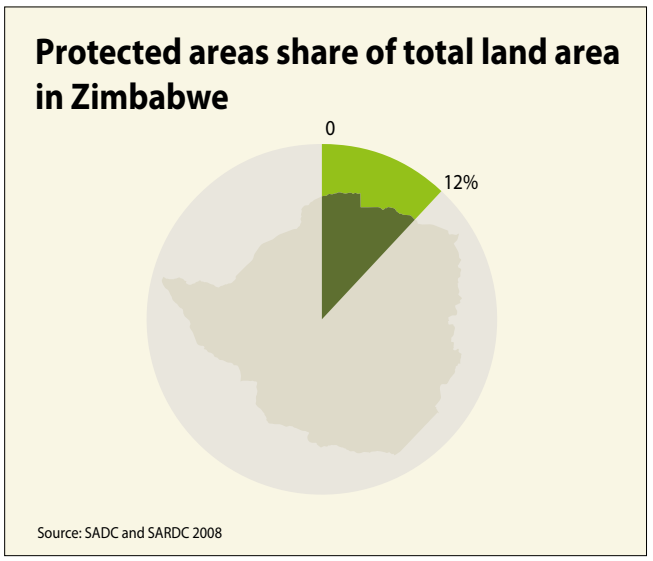


Figure 4.54

Through the intensified conservation programmes, including the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE), the number of threatened species was reduced from 38 in 2000 to 32 in 2004 (Figure 4.55). CAMPFIRE is a community-based natural resource management programme in which Rural District Councils, on behalf of communities on communal land, are granted the authority to market wildlife in their district to safari operators who then sell hunting and photographic safaris to mostly foreign sport hunters and eco-tourists.

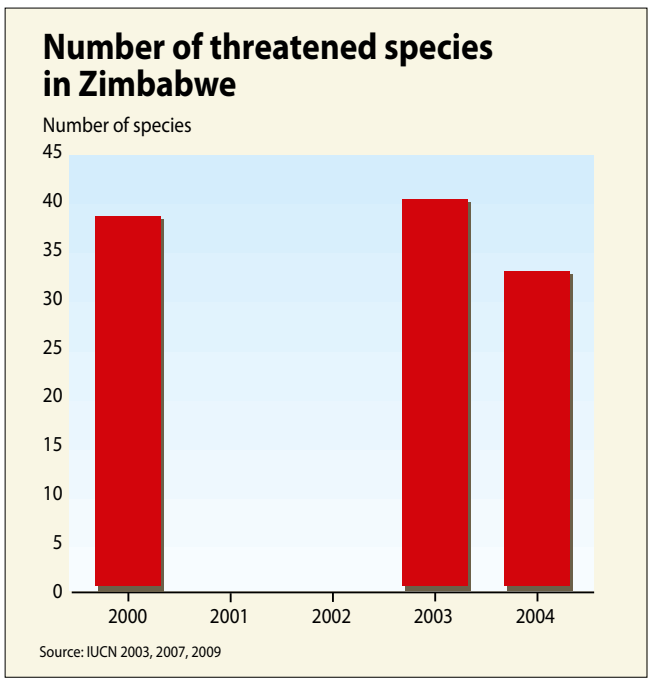


Figure 4.55

The black rhino is one of Zimbabwe's critically endangered species.

Access to safe drinking water and improved sanitation by 2015

Zimbabwe's total annual renewable freshwater resources amount to 20 cubic km per year, and although the country experiences quality and dry season problems at present, continued pressure on the resource will lead to water stress by 2025 (Hirji *et al.* 2002). Poor infrastructure hampers access to water in most urban areas, and in the capital, Harare, and the second main city, Bulawayo, residents have gone without piped water for as long as two weeks during recent years (UNEP 2008). Figure 4.56 shows access to safe water in rural and urban areas.

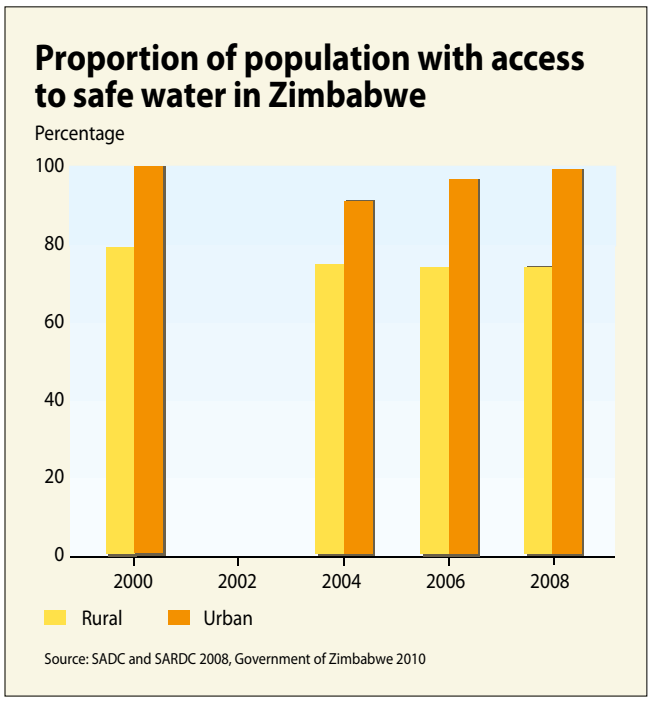


Figure 4.56

Reports from urban settlements give a consistent picture of effluent and raw sewage outflows entering rivers and dams, which are the country's major sources of water supply. Some sewers are blocked, water treatment plants lack chemicals, and many distribution systems need repair.

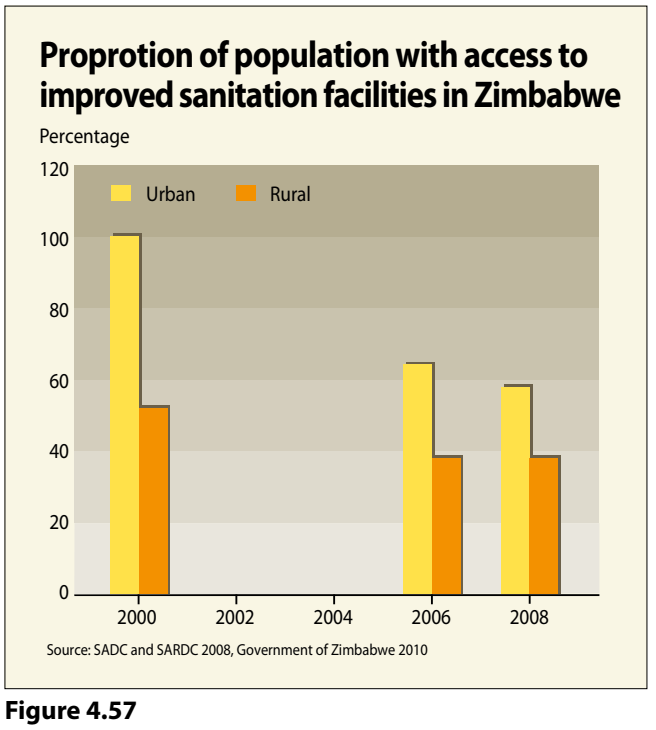


Figure 4.57

Progress in achieving water and sanitation targets is off track (Figure 4.57). Urban water and sanitation systems are in urgent need of renewal, and have faced serious problems that led to localized outbreaks of cholera and typhoid. The country has to raise safe water coverage in rural areas from 61 per cent to 85 per cent and to raise access to improved sanitation from 30.5 per cent to 71 per cent (Government of Zimbabwe 2010).

Zimbabwe needs a water and sanitation sector-wide assessment and full asset inventory followed by an investment plan and an updated and comprehensive water, sanitation and hygiene policy that covers water resources in both urban and rural areas (Government of Zimbabwe 2010).

Improve the lives of slum dwellersby 2020

Zimbabwe has the lowest proportional slum population among the Zambezi Basin states at just 3.4 per cent, down from 4 per cent in 1990, as shown in Figure 4.58.

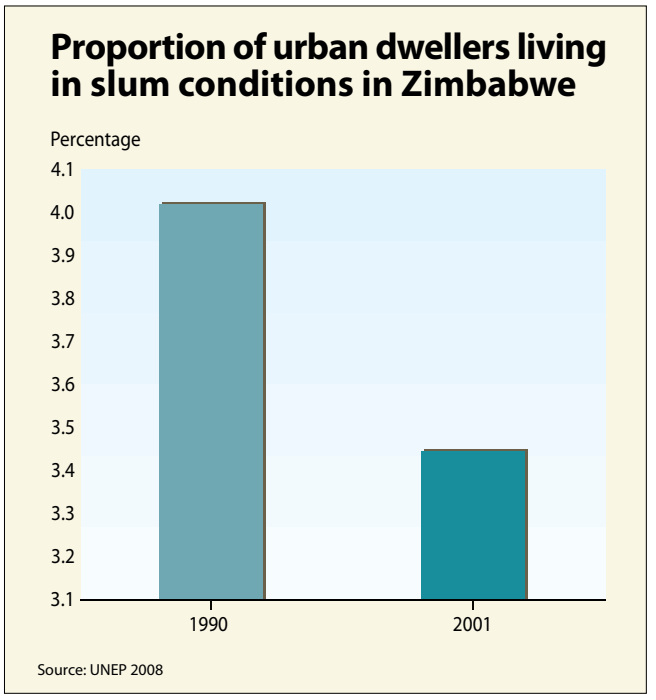


Figure 4.58

The portion of national population living in urban areas was 36.4 per cent in 2006, about four million people, with a projected urban annual growth rate of 2.8 per cent to 2015.

5

INSTITUTIONAL ARRANGEMENTS AND PLANNED DEVELOPMENTS

Water resources form the basis of almost every aspect of life in the Zambezi River Basin. The resources drive the socio-economic, political and cultural development of the basin's population, as well as maintaining their natural environment. Apart from sustaining a rich diversity, water resources are critical for meeting the basic needs of water supply for domestic and industrial requirements, sanitation and waste management in the basin. The need to effectively coordinate and manage water resources has therefore become a top priority in the basin to promote sustainable utilisation.

The challenges of integrated and coordinated water resources development, environmental management and sustainable development, climate change adaptation, infrastructure development, and the strategies required to address these challenges underline the need for stronger regional cooperation and closer integration in the field of water management (SADC Water Division 2008). Water resources are connected in nature and that natural connection provides a metaphor that well illustrates the need for connected and coordinated management. This connectedness is reflected in the theme of SADC's third strategic plan for the integrated development and management of water resources "Watering Life, Together, Forever".

Institutional Arrangements and Policy

A number of initiatives and activities have since been put in place to facilitate harmonisation, transparency and accountability in the water resource sector. However there is no single focal point to manage the resource. The need to formalise the cooperative framework and further strengthen basin-wide cooperation remains a challenge (SADC Water Division 2008). The policies and strategies mentioned here have been put in place to promote integrated resource management among the riparian states.

SADC Regional Water Policy

The Southern African Development Community (SADC) Regional Water Policy was developed in 2005 through a highly consultative and participatory process involving many stakeholders. The Policy, implemented through a regional strategy adopted in 2006, is 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.

This regional water policy is aimed at providing a framework for sustainable, integrated and coordinated development, utilisation, protection and control of national and transboundary water resources in the SADC region for the promotion of socio-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 (SADC and SARDC 2008).

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

- establishment of institutions at national and regional levels;
- capacity building;
- stakeholder participation;
- water resources information management;
- implementation of IWRM plans;
- conflict resolution; and,
- environmental management.

IWRM is defined as "a process that promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

Revised SADC Protocol on Shared Watercourses
The Protocol entered into force in 2003 and its main objective is to foster close and coordinated cooperation in the management, protection and utilisation of shared watercourses and to advance the SADC agenda of regional integration and poverty reduction. The Protocol is the first sector-specific legal instrument to be developed by SADC and creates an overarching framework for management of the 15 shared river basins in the SADC region.

Principles of the Revised SADC Protocol on Shared Watercourses

The main points of the Protocol on Shared Watercourses are:

- Ensuring that utilisation 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.

Source: SADC 2000

The Protocol is operationalised through the Regional Strategic Action Plan (RSAP) for Integrated Water Resources Management and Development in the SADC Region. The RSAP seeks to ensure that water resources management and development adequately contribute to poverty eradication, regional integration and socio-economic development in a sustainable manner.

The Protocol calls for the establishment of shared watercourse agreements and Shared Watercourse Institutions (SWI) to facilitate and coordinate the joint management of shared watercourses. Since the Protocol came into force, SWI have been established on all shared watercourses in the region.

SADC Regional Strategic Action Plans (RSAP I, II, III)

To facilitate the implementation of the Revised Protocol on Shared Watercourses, strategic action plans extending over periods of five years have been developed by the SADC Water Division since 1998. The main focus of the first Regional Strategic Action Plan (RSAP I) 1999-2004, was to create an enabling environment for the joint management of regional water resources (SADC 2011a). Recommendations from the review of RSAP I helped to revise and formulate RSAP II 2004-2010. The review concluded that RSAP I "was the most advanced and comprehensive multi-country freshwater programme in the world." Among the main recommendations was the need to change from a project focus to a programme approach as well as the need to advance from the creation of an enabling environment to water infrastructure development.

Highlights from the review of RSAP II in 2009 included completion of integrated water resources planning studies at basin level; development of basin strategies and databases; and establishment and strengthening of River Basin Organizations (RBOs). The review 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 a number of emerging issues, such as climate change adaptation, ecosystem approach and the human rights based approach to water (SADC 2011a:11). This formed the focus of RSAP III which runs from 2011-2015. RSAP III , which is anchored in the SADC Vision and the Southern African Vision on Water, Life and Environment, seeks to "strengthen the enabling environment for regional water resources governance, management and development through the application of IWRM at the regional, river basin, Member State and community levels" (SADC 2011b).

Conceptual Framework of RSAP III

Implementation of the RSAP III is premised on a conceptual framework with three strategic pillars as shown in Figure 5.1. These are Water Governance, Infrastructure Development and Water Management.

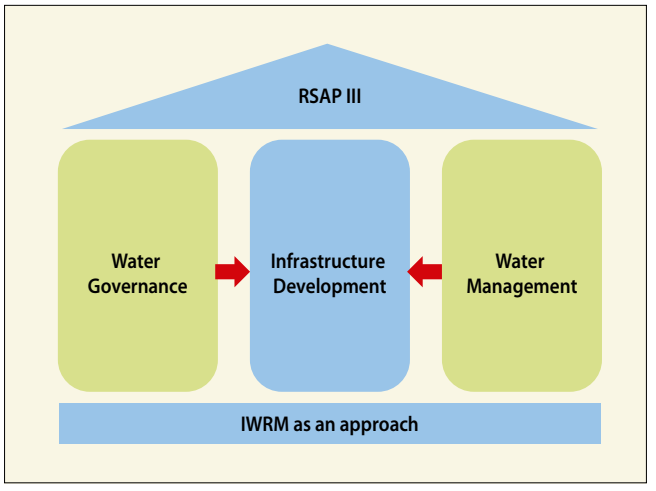


Figure 5.1

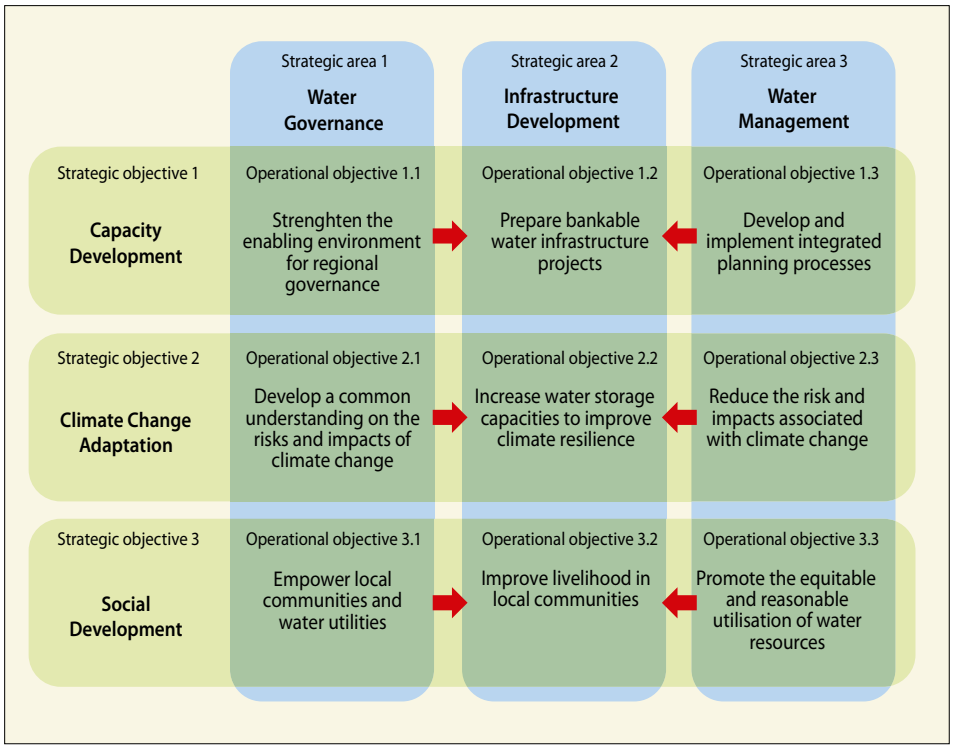


Figure 5.2: RSAP III Strategic Framework.

Three objectives on capacity development, climate change adaptation and social development are realised within each of the strategic areas as illustrated in Figure 5.2 (SADC 2011a).

RSAP III Programmes

RSAP III has 15 programmes, including Infrastructure and Project Preparation, Water Supply and Sanitation, Communication and Awareness, Research and Education, Groundwater Management, and Environmental Water Management. The formation of the Zambezi Watercourse Commission (ZAMCOM) falls within the programme on River Basin Organisations, which seeks to strengthen the organisational and institutional mechanisms for river basin management. The priority intervention areas include: Development and strengthening of River Basin Organizations, 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 2011a).

Climate Change Adaptation: A Strategy for the Water Sector

A Climate Change Adaptation Strategy was developed in 2011 as part of fulfilling the RSAP III programme on Climate Change and Adaptation. The main goal of the strategy is to improve climate resilience in Southern Africa through integrated and adapted water resources management at regional, river basin and local levels (SADC 2011b). Its objective as envisaged in the strategy document, is to promote further the application of integrated water resources management as a priority tool to reduce climate vulnerability and to ensure that water management systems are well adapted to cope with increased climate variability.

Adaptation to climate change refers to the capacity of natural and human systems to reduce vulnerability against actual or expected climatic stimuli and their effects on society, the economy and the environment (UNFCCC 2006).

The Strategy which presents measures to be taken over the next 20 years, recommends that work on adaptation should start immediately to benefit the sectors under present climatic conditions (SADC 2011b).

The strategic framework to climate change adaptation is transboundary in nature requiring adjustment of societies and economies at different levels, from local, 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 droughts (SADC 2011b).

Indigenous knowledge Local communities have been dealing with climate variability for generations and have learned to adapt their lives and livelihoods to the water cycle. New adaptation measures for the water sector must build on such knowledge.

IWRM Strategy for the Zambezi River Basin

The IWRM Strategy for the Zambezi River Basin was formulated within the framework of the Zambezi River Action Plan (ZACPLAN) Project 6 Phase 2 (SADC and ZRA 2007). ZACPLAN was an initiative of SADC aimed at

achieving environmentally sound planning and management of water and related resources in the Zambezi Basin. ZACPRO 6.2 has succeeded in establishing an enabling environment and water resources management strategy for the Zambezi Basin (SADC Water Division 2008).

The strategy is seen as a vital tool for cooperative and sustainable management of the water resources of this important basin. Parallel to the strategy was the development of the internet-based Zambezi Water Information System (ZAMWIS).

The need for balancing efficiency, equity and environmental sustainability has resonance in southern Africa given that water has a key role in unlocking potential for economic development. Further, the majority of the population still needs to gain access to safe water and sanitation, and most people cannot afford to pay for the full cost of water. Competition for water among sectors

IWRM seeks to achieve a balance between economic efficiency, social equity and environmental sustainability.

should not overlook the need to protect the environment for the benefit of future generations.

Zambezi Watercourse Commission (ZAMCOM)

Negotiations for the Zambezi Watercourse Commission (ZAMCOM) agreement began in 1999. Most of the Zambezi Basin states signed the agreement in July 2004. To date seven of the eight Basin states have signed the agreement with the exception of Zambia, and six have ratified the agreement. The remaining states have shown commitment to speed up either signing or ratification.

Through the ZAMCOM Agreement, the Zambezi River Basin states envisage working together to develop and manage the shared water resources of the vast basin. The agreement is designed to help the riparian states to unlock the potential of the Basin in contributing to the socio-economic development of the Basin states and the region as a whole.

The Zambezi River Basin states have established an Interim Secretariat for the Zambezi Watercourse Commission. The initial responsibility of the Secretariat is to coordinate the riparian states and inform them of the expected steps needing their support towards

IWRM is based on the Rio/Dublin Principles

1 Freshwater 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 the 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.
- 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 to people.

Source: SADC and SARDC 2008

ZAMCOM Agreement

The objective of ZAMCOM is to promote the equitable and reasonable utilization of the water resources of the Zambezi basin as well as the efficient development and management thereof.

This is a practical expression of the intents of the SADC states to "foster closer cooperation for judicious, sustainable and coordinated management, protection and utilization of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation" as stated in the Revised Protocol on Shared Watercourses.

The formulation of the integrated water resources management (IWRM) strategy for the Zambezi Basin provides the basin states with a vital management tool for effective management of the shared water resources of the basin. The Rapid Assessment of Water Resources is an important first step in the formulation of the IWRM strategy.

Source: ZAMCOM 2011

Agreement on the Establishment of the Zambezi Watercourse Commission

Article 5: Objectives and Functions of the Commission

The objective of the commission 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. To what end the Commission shall have the following functions:

(a) collect, evaluate and disseminate all data and information on the Zambezi Watercourse as may be necessary for the implantation to this Agreement.

(b) promote, support, coordinate and harmonise the management and development of water recourses of the Zambezi Watercourse

(c) advise Member States on the planning, management, utilization, development, protection and conservation of the Zambezi Watercourse as well as on the role and position of the Public with regard to such activities and the possible impact thereof on social and cultural heritage

(d) advise Member States on measures necessary for the avoidance of disputes and assist in the resolution of conflict among Member States with regard to planning, management, utilization, development, protection and conservation of the Zambezi Watercourse

(e) foster greater awareness among the in habitants of the Zambezi Watercourse of the equitable and reasonable utilization and the efficient management and sustainable development of the resources of the Zambezi Watercourse

(f) co-operate with the institutions of SADC as well as other international and national organizations where necessary.

(g) promote and assist in the harmonization of national water policies and legislative measures

(h) carry out such other function and responsibilities as the Member States may assign from time to time and;

(i) promote the application and development of this Agreement according to its objective and the principles referred to under Article 12.

Article 12: Principles

1. In the implementation of this Agreement, the Member States commit themselves to the following principles:

(a) principle of sustainable development;

(b) principle of sustainable utilization;

(c) principle of prevention to harm

(d) principle of precaution

(e) principle of inter-generational equity

(f) principle of assessment of trans-frontier impacts

(g) principle of co-operation; and

(h) principle of equitable and reasonable utilization.

2. These principles shall be interpreted according to the provisions of Article 3 of the SAC Protocol, and developed in accordance with the latest scientific concepts and with the best international practices.

Article 13: Equitable and Reasonable Utilization

1. The Zambezi Watercourse shall manage and utilized in an equitable and reasonable manner

2. The rules of application of ERU shall be developed by the Technical Committee as provided for under Article 10(1) (c).

3. In the application of ERU the Technical Committee shall take into account all the relevant factors, and circumstances including the following:

(a) geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character

(b) the social, economic, and environmental needs of the Member States;

(c) the population dependent on the Zambezi Watercourse in each Member State;

(d) the effects of the use or uses of the Zambezi Watercourse in one Member State on other Member States;

(e) existing and potential uses of the waters of the Zambezi Watercourse;

(f) conservation, protection, development and economy of the of the water resources of the Zambezi Watercourse and the costs of measures taken to that effect, and;

(g) the availability of alternatives of comparable value, to a planned or existing use of the waters of the Zambezi Watercourse

4. The weight to be given to each factor is to be determined by its importance in comparison with that of the other relevant factors. In determining what is an equitable and reasonable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.

5. In the application of ERU, Member States shall take into account the provisions of Article 14(4).

the realisation of the ZAMCOM agreement and its vital governance organs.

The establishment of the Interim ZAMCOM Secretariat means that the riparian states of the Zambezi River Basin have a forum through which they will deliberate and plan ways of ensuring the efficient management and development of the river basin resources for the benefit of the people.

The ZAMCOM Agreement is based on solid principles and inclusivity hence a great step forward in the Zambezi River Basin (ZAMCOM 2011).

Planned Developments in the Zambezi Basin

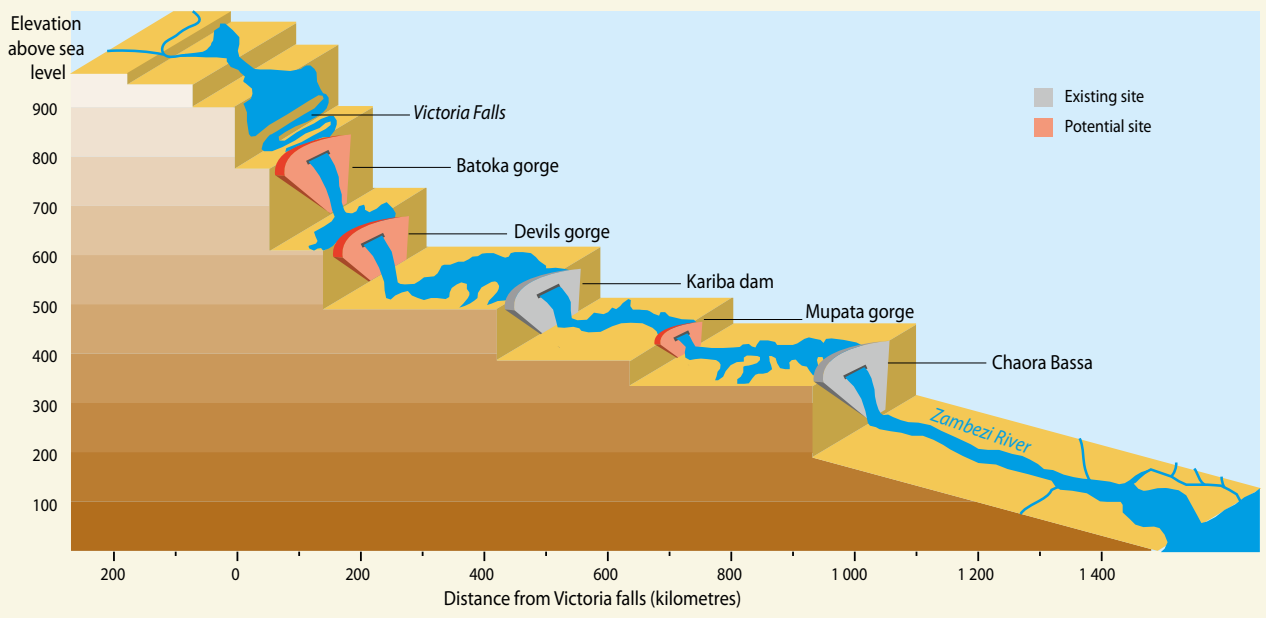
Proposed Dams and Hydropower Projects
Water has many critical roles in the realization of socio-economic development in southern Africa. One such role is to provide hydropower to help the region to meet its ever-growing demand for energy. SADC Member States, through the Southern African Power Pool (SAPP), have thus planned to commission a number of hydropower projects in the Zambezi River Basin. The Basin is considered to have enormous capacity to produce sufficient power for the region if fully harnessed.

SAPP estimates that the Zambezi River has the potential to produce more than 20 000 Megawatts (MW) of electricity (Tauya 2006). However, only 23 per cent of this potential is being harnessed, largely from two main sites: the Kariba Dam between Zambia and Zimbabwe, and the Cahora Bassa Dam in Mozambique (SARDC 2009c). To fully exploit its potential, various projects have been identified for commissioning in the Zambezi Basin.

Batoka Gorge Hydropower Station

The Batoka gorge is located about 50 km downstream of Victoria Falls between Zambia and Zimbabwe. When operational, it has the capacity to produce up to 1 600 MW. National power utilities from the two countries are ready to begin work on the project. However, limited funding, environmental concerns and technical challenges have stalled the process. Zambia and Zimbabwe have also identified other sites on the Zambezi River from which they could jointly tap electricity. These sites include the Devils Gorge (1 200 MW), Mutapa Gorge (1 085 MW) and Victoria Falls South (390 MW) (Tumbare, 2005).

Existing and potential hydropower projects on the Zambezi River



Source: SADC and ZRA 2007. Rapid Assessment Report: Integrated Water Resources Management Strategy for the Zambezi River Basin. SADC Water Division, Gaborone

Figure 5.3

Table 5.1. Rehabilitation and Planned Energy Projects in the Zambezi Basin

	Projected Generation Capacity, MW					
	2011	2012	2013	2014	2015	Total
Angola	150	150	150	150	150	150
Botswana	120	120	120	120	120	120
Malawi	-	-	-	-	-	-
Mozambique	-	-	-	-	-	-
Namibia	23	23	23	23	23	23
Tanzania	60	60	60	60	60	60
Zambia	-	-	-	-	-	-
Zimbabwe	290	290	290	290	290	290

Source: Musaba 2012

Table 5.2. Future Hydropower Projects in the Zambezi River Basin

Project	Status	Utility	River	Country	Type	Base case		Alternative case	
						Capacity (MW)	Operating year	Capacity (MW)	Operating year
Tedzani 1& 2	refurbishment	ESCOM	Shire	Malawi	Pondage	40	2008	40	2008
Kariba North	refurbishment	ZESCO	Zambezi	Zambia	Reservoir	120	2008-09	120	2008
Kafue Gorge Upper	refurbishment	ZESCO	Kafue	Zambia	Pondage	150	2009	150	2009
Kapichira II	extension	ESCOM	Shire	Malawi	Pondage	64	2010	64	2010
Kariba North	extension	ZESCO	Zambezi	Zambia	Reservoir	360	2010	360	2012
HCB North Bank	extension	HCB	Zambezi	Mozambique	Reservoir	n/a	n/a	850	2012
Itezhi Tezhi	extension	ZESCO	Kafue	Zambia	Reservoir	120	2013	120	2013
Kariba South	extension	ZESA	Zambezi	Zimbabwe	Reservoir	300	2014	300	2014
Songwe I, II & III	new project	ESCOM	Songwe	Malawi, Tanzania	Reservoirs	340	2014-16	340	2024
Batoka Gorge South	new project	ZESA	Zambezi	Zimbabwe	Pondage	800	2017	800	2023-24
Batoka Gorge North	new project	ZESCO	Zambezi	Zambia	Pondage	800	2017	800	2023-24
Kafue Gorge Lower	new project	ZESCO	Zambezi	Zambia	Pondage	750	2017	750	2017-22
Mphanda Nkuwa	new project	EdM	Zambezi	Mozambique	Pondage	1 300	2020	2 000	2024
Lower Fufu	new project	ESCOM	S. Ruhuru	Malawi	Run-of-River	n/a	n/a	100	2024
Kholombidzo	new project	ESCOM	Shire	Malawi	Pondage	n/a	n/a	240	2025
Rumakali	new project	TANESCO	Rumakali	Tanzania	Reservoir	222	2022	256	n/a

Source: World Bank 2010

Itezhi-Tezhi Power Project

The proposed project would be in the Itezhi Tezhi District in the Southern Province of Zambia. A surface power plant will be built adjacent to the existing Itezhi Tezhi Dam. It will utilize the existing reservoir. In order to evacuate the power generated, a 300km 220/330kV T-line will be installed from Itezhi Tezhi through a substation at Mumbwa, onto a substation at Lusaka West. Once completed, the power station would generate about 120 MW of electricity (SARDC 2009b).

Kafue Gorge Dam Lower Project

The new Kafue Gorge Lower hydroelectric station, south of the Zambian capital Lusaka, is expected to have a capacity of 660 MW, becoming the second-largest generating facility in Zambia. It would be located in the Kafue Gorge, about 65 km upstream from the confluence of the Kafue River with the Zambezi River.

Kariba North and South Bank Extension

Zambia and Zimbabwe plan to extend the existing plants at the Kariba Dam. Extension of the Kariba North Bank power station, located more than 130 km south of Lusaka is expected to produce about 720 MW when fully operational.

Mphanda Nkuwa Hydropower Dam

The Mphanda Nkuwa power plant has capacity to add about 1 500 MW of new electricity on the regional power grid. The proposed dam is 70 km downstream of the Cahora Bassa Dam in Mozambique.

Proposed Dams for Irrigation or Domestic Use

With regard to the construction of dams for irrigation or domestic consumption, one of the projects identified for commissioning over the next few years is the Matabeleland-Zambezi Water Supply project in Zimbabwe.

The Matabeleland-Zambezi Water Project (MZWP) is an ambitious proposal for the arid Matebeleland North province of Zimbabwe. The project seeks to address the perennial water shortages affecting Zimbabwe's second city Bulawayo, by bringing water from the Zambezi River to the city. The proposed project consists of three phases:

- Phase One: Gwayi-Shangani Dam
- Phase Two: Gwayi-Shangani Dam to Bulawayo Pipeline
- Phase Three: Gwayi-Shangani Dam to Zambezi River Pipeline

Another initiative is the Zambezi Integrated Agro-Commercial Development Project which is in two phases. The first phase involves extracting water from the Zambezi into a 20 000 hectares greenfield farming area about 50 000 kilometres from Kazungula. The second phase supports the Pandamatenga Agricultural Infrastructure Development Project in Botswana which involves taking water from the Zambezi River to Pandamatenga area to irrigate the farms. The specific objective of the project whose timeframe is 2008 to 2012 is to develop appropriate water control drainage system and access road network in Pandamatenga (AfDB 2008).

Transport Routes

The SADC region plans to develop transport networks and corridors to allow easy movement of goods and services across borders. Some of the major projects proposed for countries in the Basin include the construction of roads, railways and airports. The biggest and most comprehensive development is the North-South Corridor between the ports of Dar es Salaam in Tanzania and Durban in South Africa, which runs through the Zambezi Basin in Tanzania, Zambia and Zimbabwe.

North South Development Corridor

This is the busiest and most extensive regional transit link in eastern and southern Africa, linking the largest number of countries. It connects eight countries and interlinks to other corridors including the Trans-Kalahari, Beira, Lobito, Dar es Salaam and Nacala corridors. This corridor is critical because South Africa is the largest African trading partner for most of the countries in the region and the port of Durban handles a significant portion of transit traffic for the landlocked states, as does the Tanzanian port of Dar es Salaam in the north. Key infrastructure involves the ports, the roads and the railway lines.

Tazara Development Corridor

The Tazara Corridor (also called the Dar es Salaam Corridor) is part of the North South Corridor, a strategic artery linking southern Africa with east and central Africa. There is increasing traffic on this route from South Africa, Zimbabwe and Zambia in the south, and from the Nacala Corridor in Malawi and Mozambique. The traffic is largely sugar, cement, fuel and machinery. The Tazara Corridor provides the shortest distance by rail from Zambia's Copperbelt mines to a port, and is owned by the United Republic of Tanzania and Zambia. The corridor traverses some of the most fertile land in southern Tanzania and northern Zambia, and has potential for agriculture, tourism, mining, forestry and fishing.

Mtwara Development Corridor

The Mtwara Development Corridor falls within the territories of Malawi, Mozambique, Tanzania and Zambia, and runs between the Indian Ocean port of Mtwara in the east and Mbamba Bay Lake Malawi. Transport projects include expansion and upgrading of Mtwara port, and the ports of Mbamba Bay and Manda on the lake. Other projects include upgrading Mtwara Airport, and the road and rail infrastructure. Other important projects are the Mchuchuma Thermal Power Station, the Mtwara-Mbamba Bay petroleum pipeline and Songo Songo gas.

Walvis Bay Corridor

The Walvis Bay Corridor serves the central and southern parts of SADC, via the Trans-Kalahari Corridor linking Botswana, Namibia and South Africa, and via the Trans-Caprivi Corridor connecting Namibia and Zambia to Zimbabwe and the DRC. It also links Angola and Namibia via the Trans-Cunene Corridor. The northeastern arm, the Trans-Caprivi Corridor through the Zambezi River Basin was completed in 2004 with the opening of a new bridge at Katima Mulilo and provides an alternative import-export route for Zambia's Coppperbelt and for agricultural and agro-processing industries.

Okavango Upper Zambezi International Tourism (Ouzit) SDI

The Ouzit was initially conceived and presented as a wildlife sanctuary to be located within the context of the Okavango and Zambezi wetland systems. The project centred on a core development area comprising 260 000 sq km incorporating game parks in Angola, Botswana, Namibia and Zimbabwe. Infrastructure development projects within the SDI comprise of the networking of the inland park regions, the fast-tracking of improvements to the air traffic and transport infrastructure in participating countries, and establishment and management of a logistics platform linked to the improved regional air transport system. The Ouzit SDI connects to the Namib Development Corridor in southern Angola.

Conclusions and Recommendations

Key Findings

- The population in the Zambezi River Basin is increasing, and is expected to reach 51 million by 2025.

- Some 7.5 million people live in urban centres in the Zambezi basin. There has been rapid expansion of Lilongwe and Harare between 1990 and 2011.

- There are some 30 ethnic groups and related cultures in the Zambezi River Basin. The cultures in the Zambezi basin include the Lunda, Luchaze and Quioca in Angola; the Tswana in Chobe, Botswana; the Chewa, Tumbuka, Yao, Ngoni, Nyanja and Sena cultures in Malawi; the Sena 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.

- Land available per capita is projected to shrink from 4.16 ha/person in 1998 to 2.72 ha/person by 2025.

- The Basin is endowed with numerous natural resources including lakes, wetlands, forests and wildlife, as well as land and minerals.

- The Basin is highly prone to overexploitation and unsustainable development.

- Climate change coupled with human pressure on resources is resulting in significant change of the Zambezi basin's environment.

- The location, extent and significance of adverse impacts occurring through changes in land use are closely related to human population pressure on the land.

- Seventy-five per cent of the land area in the Basin is forest and bush while13 per cent of the land area is cropland, mostly rain fed. Zimbabwe, Zambia and Malawi have together 86 per cent of the estimated 5.2 million ha of the cultivated area in the basin.

- Use of fertilizers and agro-chemicals in the basin is contributing to the eutrophication of water bodies.

- There has been significant loss of forests in the last 20 years, with Tanzania, Zimbabwe and Mozambique recording the highest loss of 403 350 ha, 327 000 ha and 217 800 ha respectively. Malawi and Namibia recorded the least loss of 32 950 ha and 73 600 ha respectively.

- Biodiversity of Mulanje Mountain, particularly the rare and endemic Mulanje cedar (*Widdringtonia whiteii*), is under threat from deforestation and encroachment, poaching, forest fires and invasive alien species. Mulanje Mountain is a Global Biosphere Reserve under UNESCO's Man and Biosphere Programme.

- The world famous Victoria Falls on the Zambezi River between Zambia and Zimbabwe is an important economic asset to the two countries through tourism, but is under some threat from upsteam dams and other developments that pollute the river. Victoria Falls is a UNESCO World Heritage Site.

- Five countries in the basin have reserved more than 10 per cent of their total land area for the conservation of wildlife, with Zambia and Tanzania having 31 per cent and 28 per cent of their total land area set aside as protected areas, respectively.

- About 74 per cent of the total energy needs of the eight Basin states come from biomass.

- Forty hydropower schemes with a total potential of close to 13 500 MW have been identified, with more than half of these in Mozambique. The estimated hydropower potential of the Zambezi River is 20 000 MW of which only 4 684 MW has been developed.

- The increase in carbon dioxide per capita is concurrent with a rise in temperatures, which has in turn altered weather patterns as evidenced by shifting seasons within the basin, droughts and floods, and increased incidence of pests and diseases such as malaria.

- Regular fire outbreaks, which peak from August to November, are a major emitter of carbon dioxide. In Botswana, about 20 to 30 per cent of the country was burnt between 1996 and 1997. In the Namibian Caprivi and Kavango regions, about 25 to 30 per cent of the area burns every year.

- Climate change has impacted on the Basin's water resources, such as in Lake Liambezi in Namibia, which has experienced shrinking over the years. A major positive development is the flowing again of Savuti river, which had been dry for long periods of time.

- Deforestation is the most significant factor in climate change in the Zambezi basin.

- A number of Trans Frontier Conservation Areas can be found in the Basin:
  - Kavango- Zambezi TFCA, covering Angola, Botswana, Namibia, Zambia and Zimbabwe;
  - ZIMOZA, covering areas in Zimbabwe, Mozambique and Zambia;
  - Niassa-Selous TFCA, covering parts of Mozambique and Tanzania;
  - Lower Zambezi-Mana Pools, between Zambia and Zimbabwe; and,
  - Liuwa Plain-Kameia TFCA, which includes areas in Angola and Zambia.

- Eleven of the 13 Zambezi river sub-basins are transboundary in nature.

- Transboundary lakes include Lake Malawi/ Niassa/Nyasa and Lake Kariba.

- Invasion of alien species is a major threat in Lake Kariba between Zambia and Zimbabwe.

- Planned inter-basin water transfers include Bulawayo Matabeleland Water Supply Pipeline.

- Groundwater is the major source of water for most of the population.

- More than half of the population does not have access to safe water and im proved sanitation.

- The Basin is prone to drought, floods and water-related diseases such as cholera and malaria.

- Mining activities cause serious environmental problems. In the Zambian Copperbelt there are 21 waste rock dumps with approximately 77 million tonnes generated from underground shaft mining covering an area of 388 ha.

- The Protocol on the Facilitation of Movement of Persons adopted by SADC in 2005 aims to develop policies that facilitate the movement of people and goods across borders in the SADC region.

- The Kazungula bridge between Botswana and Zambia, Katima Mulilo bridge between Namibia and Botswana, as well as launch of a One Stop Border Post at Chirundu between Zambia and Zimbabwe are major developments in facilitating the movement of people and goods.

Recommendations

- Rapid population and urban growth in the Zambezi River Basin must be aligned with improvement in service delivery, particularly in larger basin cities which have experienced notable expansion in the last two decades.

- Tree-planting programmes need to be strengthened in all basin states, moreso in areas where notable loss of forest cover has been observed.

- Sustainable fire management practices should be strengthened particular during the dry season due to the threats posed by wildfires.

- Decision-makers need to enhance efforts in reversing the loss of biodiversity.

- Basin countries should increase percentage of land area reserved for wildlife, as loss of biodiversity is increasingly.

- Angola and Zimbabwe are encouraged to become parties to the Ramsar Convention on Wetlands to enhance wetland conservation efforts in the basin.

- Angola is also encouraged to become party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora to ensure that international trade in specimens of wild animals and plants do not threaten their survival in that country and the neighbouring countries.

- As invasive species are a significant driver to biodiversity loss in major water bodies basin states are encouraged to adopt sound land and water management practices to reduce spread of alien species.

- Basin states should deepen their efforts in moving towards sustainable development through green economies and green growth as adaptation and mitigation strategies to address the impacts of climate change, as well as an opportunity to create jobs and livelihoods.

- Basin states need to recognise the importance of indigenous knowledge systems in sustainable development and when considering new climate change adaptation strategies.

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The SARDC institutee 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 for Southern Africa, India Musokotwane from Zambia, who inspired IMERCSA and its Vision that:

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Formerly called State of the Environment (SOE) reports, the Environment Outlooks 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, soon to be revised and updated, as well as a series of Zambezi Basin factsheets and other publications.

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-The World Conservation Union, and has continued to produce thematic and other reports on the southern African environment.

The most recent environmental reports produced by IMERCSA are the Southern Africa Environment Outlook launched in 2009, and Responding to Climate Change Impacts: Adaptation and Mitigation Strategies as Practiced in the Zambezi River Basin, published 2010. These reports highlight the state of environment, impact of climate change in southern Africa on people and the environment, and future prospects and scenarios.

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