Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin

SADC-WD/ Zambezi River Authority
SIDA/ DANIDA, Norwegian Embassy Lusaka

April 2008

Euroconsult Mott MacDonald

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Preface

In 1987, the then Southern African Development Co-ordination Conference (SADCC), which is now the Southern African Development Community (SADC), adopted the Zambezi River Action Plan (ZACPLAN). The objective of ZACPLAN is to achieve environmentally sound planning and management of water and related sources in the Zambezi River Basin.

The Zambezi Action Plan Project 6, Phase II (ZACPRO 6.2) project was designed upon the vision that the eight riparian states, namely Angola, Botswana, Namibia, Malawi, Mozambique, Tanzania Zambia and Zimbabwe will achieve a higher and sustainable socio-economic development for all, through equitable and sustainable utilization of the shared water resources of the Zambezi River Basin. One of the main focuses of the project is the development of an Integrated Water Resources Management Strategy.

"Equitable and sustainable utilization of water for social and environmental justice, regional integration and economic benefit for present and future generations."
Southern Africa Vision for Water, life and the Environment in the 21st century

The key actors in the Zambezi River Basin are the eight riparian states, the SADC Water Division, the Zambezi River Authority (ZRA) and the ARA-Zambeze. For ZACPRO 6.2 the eight riparian states own the process and it is coordinated on their behalf by the SADC Water Division and implemented through the ZRA. A Project Implementation Unit (PIU) based at the ZRA head office in Lusaka has direct responsibility for shaping and guiding the process.

A Project Steering Committee (PSC) responsible for the monitoring and supervision of the Project was established. It comprises the national contact persons in each riparian country nominated by and representing that country and representatives of SADC WD, ZRA and the cooperating partners who are funding the Project. The co-operating partners are the Nordic countries through their development agencies DANIDA, NORAD and Sida. The management of the Project is coordinated through a Joint Project Management Committee (JPMC) which comprises of ZRA, SADC WD and the PIU. The JPMC is chaired by the Chief Executive of ZRA, Sida sits as observer.

This Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin is the main end product of this project and is complemented by the internet-based Zambezi Water Information System ZAMWIS.

The Consultants like to express their appreciation of the pleasant cooperation with ZRA, the PIU, the country representatives and the national teams. In particular they like to mention Dr. Mike Tumbare, Chief Executive of ZRA, who on many occasions guided and supported the consultancy team with his vast knowledge and experience of the Zambezi Basin and its development. The stakeholder consultation processes surrounding the IWRM Strategy heavily relied on the support of Dr. Zeb Phiri, Dr. Jefter Sakupwanya and Ms. Leonissah Munjoma of the PIU.

Strategy Overview

Overall Objective	***Equitable sustainable utilisation of water for social and environmental justice, regional integration and economic benefit for present and future generations***			
Challenge	Integrated and Coordinated Water Resources Development and Management (1)	Environmental Management and Sustainable Development (2)	Adaptation to Climate Variability and Climate Change (3)	Basin-wide Cooperation and Integration (4)
Strategic Objective	*Develop and manage water resources so as to serve social and economic development in the Basin*	*Mainstream environment in the development and management of water resources in the Basin*	*Adapt water resources management to current and future climate variability and change*	*Operationalize the institutional frameworks in support of basin-wide water resources development and management*
ISSUES	▪ Inadequate water infrastructure for achieving regional energy security (1.1) ▪ Insufficient water infrastructure for agricultural development to achieve regional food security (1.2) ▪ Major dams in the Basin were constructed for a single purpose and their operation is not optimised for multiple uses (1.3) ▪ Inadequate financing of water resources development and management (1.4) ▪ Low access to Water Supply and Sanitation (1.5)	▪ Inadequate protection and sustainable development and use of wetland (2.1) ▪ Deterioration of water quality due to point pollution from mining, industrial and urban centres (2.2) ▪ Proliferation of invasive aquatic weeds (2.3) ▪ Unsustainable and low-productivity fisheries management (2.4) ▪ Tourism development is threatened by degradation of the aquatic environment (2.5) ▪ High-value and unique eco-systems and related ecological and economic functions in the Basin may be threatened and fragmented by accelerated development (2.6)	▪ Extreme variability and uneven distribution of rainfall is likely to be amplified by climate change (3.1) ▪ Lack of integrated flood management in development planning (3.2) ▪ Poor drought management and integration in development planning (3.3) ▪ Inadequate coping mechanisms for climate change (3.4)	▪ Absence of a river basin organisation for the whole Zambezi Basin (Zambezi River Basin Organisation not yet established and operational) (4.1) ▪ Weak capacity of national water management institutions to perform river basin management tasks (4.2) ▪ Inadequate water resources knowledge base for Basin-wide development and management (4.3) ▪ Inadequate effective stakeholder participation in water resources planning, development and management (4.4)
STRATEGIES	▪ Address the high demand for new water infrastructure to meet regional energy security (1.1) ▪ Address the demand for water in agricultural development and regional food security (1.2) ▪ Improve operation of existing and new major dams in the Basin to take into account and optimise multiple functions of water (1.3) ▪ Increase funding for water resources development and management (1.4) ▪ Improve access to sustainable Water Supply and Sanitation (1.5)	▪ Adequately manage the ecological and economic functions of wetlands and sustain their viability (2.1) ▪ Control water pollution from point sources – especially from urban centres and mining areas (2.2) ▪ Control invasive aquatic weeds and prevent new outbreaks (2.3) ▪ Promote sustainable fishery management as a contribution to regional food security (2.4) ▪ Ensure water resource development and management does not harm tourism potential (2.5) ▪ Prepare and implement strategic environmental plans and procedures including the development of area networks (2.6)	▪ Improve the knowledge base on climate variability and climate change and their impacts on water resources (3.1) ▪ Improve flood management and mitigation mechanisms at national and regional scale (3.2) ▪ Improve regional and national drought management (3.3) ▪ Develop regional capacity to adapt to climate change and make use of the development opportunities associated with global climate change mitigation (3.4)	▪ Operationalise the institutional frameworks in support of basin-wide water resources development and management and discuss issues of inter-basin transfer (4.1) ▪ Strengthen organisational, financial and human resource capacities of water management institutions at regional, national and local levels (4.2) ▪ Improve and expand Basin-wide water resources data collection, processing and information transfer systems (4.3) ▪ Promote broad-based stakeholder participation in water resources development and management (4.4)

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MAIN ACTIONS	(1.1) ▪ Joint development of feasible package of major hydropower sites, taking into account multiple functions in coordination with SAPP ▪ Identify and promote options for small scale hydropower development	(2.1) ▪ Improve the wetland related regulation and management between riparian countries ▪ Assess and maintain environmental flows appropriate to each river section ▪ Develop management plans for all the major wetlands in the Basin taking into account the different wetland functions ▪ Develop and implement special initiatives for environmental management around hotspots	(3.1) ▪ Carry out comprehensive assessment of the vulnerability of basin water resources to climate variability and climate change	(4.1) ▪ Encourage signing and ratification of the ZAMCOM Agreement and establish and operationalise ZAMCOM – through promotion of targeted measures to raise awareness of benefits of basin-wide management of water resources, ▪ Establish Interim ZAMCOM Secretariat ▪ Develop public information function of Interim Secretariat and later ZAMCOM Secretariat ▪ Strengthen coordination with ongoing programmes in the Basin (SADC/ COMESA/SAPP/NEPAD/Waternet/ IUCN/WWF/HYCOS/World Bank), including management commissions of sub-basins (Joint Water Commission, ZRA)
	(1.2) ▪ Support the development of agriculture through basic facilities such as reliable input supply and better road networks ▪ Expand irrigated agriculture ▪ Promote and support the restoration and sustainability of flood plain agriculture ▪ Enhance the productivity of rain-fed agriculture through improved water management options	(2.2) ▪ Set up integrated water quality monitoring system ▪ Harmonize legislation and enforcement systems ▪ Promote clean technology	(3.2) ▪ Integrate flood management in development planning ▪ Develop and implement effective land use planning ▪ Strengthen and encourage collaboration of existing early warning institutions ▪ Dovetail the operation of major water infrastructure to optimize flood storage ▪ Formulate comprehensive flood preparedness and flood response mechanisms, making use of regional good practice	(4.2) ▪ Develop and implement performance based training programmes on water resources management based on institutional development assessments ▪ Implement well-designed plan to harmonise water resources management policies, legislation and strategies of the basin states

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MAIN ACTIONS contd.	(1.3) ▪ Develop appropriate river simulation models to identify the influence of dam operations on the downstream flow regime, including unregulated tributaries ▪ Optimize multi-purpose management of existing reservoirs	(2.3) ▪ Harmonize the legislation on the control of aquatic weeds ▪ Set up national focal points on aquatic weed control ▪ Initiate regional capacity building ▪ Initiate joint monitoring and survey of aquatic weeds ▪ Adjust reservoir operations (incl. provision for weed control)	(3.3) ▪ Support development of drought management plans, including local irrigation development, improved food stock logistics, crop adaptation and drought insurance ▪ Mainstream drought forecasting in water resources planning and management	(4.3) ▪ Formulate and implement a data and information sharing protocol for further operationalization of ZAMWIS ▪ Harmonize data measurement and storage methods in basin ▪ Improve basin-wide data (water quality and quantity measurements, sediment content, groundwater) collection systems ▪ Priority improvement of data and knowledge base on groundwater resources ▪ Further development of ZAMWIS (increasing accessibility and interactivity and developing models and DSS tools) ▪ Strengthen basin-wide research on water resources through joint programmes, collaboration of research institutions, and enhanced information exchange
	(1.4) ▪ Improve overall investment climate to make water development infrastructure financing more attractive ▪ Develop mechanisms for local infrastructure co-financing ▪ Raise awareness of the vital role of the water sector in economic development and poverty alleviation	(2.4) ▪ Collaborate with NEPAD programme towards improving fisheries productivity. ▪ Integrate fisheries development with water resources development – new reservoir operating rules, fishery production, provision for fish migration	(3.4) ▪ Integrate strategies to deal with climate variability and climate change in national socio-economic development planning ▪ Exploit development opportunities under global climate change protocols for afforestation and reforestation at national level ▪ Setup a regional centre of excellence to document and support activities for effective adaptation to climate variability and climate change	(4.4) ▪ Strengthen stakeholder participation through policy and legislation review and revision throughout the basin states ▪ Formulate and implement a public information programme to raise awareness among a broad range of stakeholders ▪ Strengthen and sustain the Annual Basin Forum meetings as part of awareness and information sharing among basin stakeholders

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MAIN ACTIONS contd.	(1.5) ▪ Expand coverage of water supply and sanitation services in rural and urban areas	(2.5) ▪ Systematically integrate tourism development in water resources planning, development and management ▪ Develop catchment management plans incorporating areas of tourism value such as game management areas and wetlands. ▪ Operation of water infrastructure to support and enhance tourism management		
		(2.6) ▪ Prepare a comprehensive and spatially explicit map of ecosystems services ▪ Delineate high priority conservation areas such as headwaters, recharge zones and flood plains and implement land use plans for these areas ▪ Start international cooperation on linking areas with high significance for biodiversity – coming to Protected Area Networks ▪ Develop and implement guidelines for the use of proper EIAs and SEAs in development planning		

Table of contents

List of annexes

List of Tables

List of Figures

List of abbreviations

amsl	Above mean sea level
AR-CDM	Afforestation/Reforestation-Clean Development Mechanism
BIPP	Bankable Investment Project Profiles
BOOT	Build-Own-Operate-Transfer
BPC	Botswana Power Corporation
BRIC	Brazil, Russia, India, China
CAADP	Comprehensive Africa Agriculture Development Programme
CDM	Clean Development Mechanism
CMU	Coordination and Monitoring Unit
COMESA	Common Market for Eastern and Southern Africa
DANIDA	Danish International Development Agency
DRC	Democratic Republic of Congo
EdM	Electridade de Moçambique
EIA	Environmental Impact Assessment
ENE	Empresa Nacional de Electricidade (Angola)
ESCOM	Electricity Supply Corporation of Malawi
EU	European Union
EU ETS	European Union Emissions Trading Scheme
EUR	Euro (USD 1.57 on 4 April 2008)
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIS	Geographical Information System
GWP	Global Water Partnership
HCB	Hydroelectrica de Cahora Bassa
HYCOS	Hydrological Cycle Observing System
IHE	Institute for Water Education, Delft, The Netherlands
IPCC	International Panel on Climate Change
IUCN	The World Conservation Union
IWRM	Integrated Water Resources Management
JPMC	Joint Project Management Committee
MDG	Millennium Development Goal
MoU	Memorandum of Understanding
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NMIP	National Medium Term Investment Programmes
NORAD	Norwegian Agency for Development
NSC	National Steering Committee
PES	Payment for Environmental Services
PES	Payment for Environmental Services
PIU	Project Implementation Unit
PPP	Public Private Partnerships

PRSP	Poverty Reduction Strategy Paper
PSC	Project Steering Committee
RETOSA	Regional Tourism Organisation of Southern Africa
RSA	Republic of South Africa
SADC	Southern Africa Development Community
SADCC	Southern African Development Coordination Conference
SADC-WD	Southern Africa Development Community – Water Division
SAPP	Southern African Power Pool
SARCOF	Southern African Regional Climate Outlook Forum
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
SIDA	Swedish International Development Agency
TANESCO	Tanzanian Electricity Supply Company
TNC	The Nature Conservancy
UK ETS	United Kingdom Emissions Trading Scheme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
USD	United States Dollar
WARFSA	Water Research Fund for Southern Africa
WUA	Water Users Association
WWF	World Wide Fund for Nature
ZACPLAN	Zambezi River Action Plan
ZACPRO 6	ZACPLAN Project 6 (Phase 1 and 2)
ZACPRO 6.2	ZACPLAN Project 6 Phase 2
ZAMCOM	Zambezi Watercourse Commission
ZAMWIS	Zambezi Water Information System www.zamwis.com
ZESA	Zimbabwe Electricity Supply Authority
ZESCO	Zambia Electricity Supply Company
ZINWA	Zimbabwe National Water Authority
ZRA	Zambezi River Authority

Executive Summary

This Strategy for the Zambezi Basin was preceded by a …

This Strategy presents the main Integrated Water Resources Management (IWRM) challenges for the Zambezi Basin and proposed possible strategies and actions to address these, both in terms of water management and institutional development.

… Rapid Assessment of the Zambezi Basin, an Issues Paper …

The formulation of this Strategy was preceded by a Rapid Assessment, presenting an up-to-date status of the Basin and an objective assessment, identification and quantification of the water resources issues, opportunities and challenges for shared water resources management in the Basin up to 2025. These challenges have been summarized in an Issues Paper that was the subject of discussion in national consultations in the riparian countries.

… and a Strategy Options Paper.

A Strategy Options Paper was prepared as a key resource for a consultative meeting of experts in the Southern African Development Community (SADC) region, aimed at providing an independent critical assessment of the proposed options for dealing with identified IWRM issues.

Water resources are used only for 20%, mainly for hydropower; …

The Rapid Assessment has shown that the surface water resources in the Basin are very unevenly distributed over the 13 sub-basins. Evaporation by the two main hydropower reservoirs Kariba and Cahora Bassa is the largest single water use (16%), followed by irrigated agriculture (1.4%). Total water use is less than 20% of average run off. This could increase to 40% in 2025 with further development of hydropower, irrigation and industrial and domestic use.

… further development is feasible, provided quality is safeguarded.

Because of uneven distribution and a high and growing variability, increased water use may still lead to temporary water shortages in certain areas. Water quality is at risk because of discharges from urban, mining and manufacturing centres.

Water resources planning has to take all functions into account …

Floods and droughts are part of the hydrological features of Southern Africa and occur almost cyclically. Floods are attenuated partly by the two large reservoirs, which also increase low flow. When planning changes in the use of surface water resources, provisions should be made for the maintenance of sufficient flow for all river functions.

… including inland and coastal fisheries, …

River regulation has caused significant changes to fisheries and biodiversity and includes the rise of the tilapia and kapenta fisheries in the main reservoirs, and economic damage to both the freshwater and marine shrimp fisheries in the Zambezi Delta. Basin countries are now defining environmental flow requirements for the ecosystems in the Basin.

… and should pay attention to watershed degradation.

Although large parts of the Basin are sparsely populated, the watershed suffers from deforestation and soil degradation because of a high level of dependency on fuel wood and charcoal for cooking, heating, brick and tobacco curing. Overgrazing by livestock and wild animals is reported in certain areas.

Immediate concerns are power and food security, floods and droughts.

The main challenges are to quickly increase power production to sustain economic development in the urban centres, manufacturing and mining, to meet the growing demand for food in a global situation of food grain shortages and sharply rising prices through support to irrigated and rainfed agriculture, to mitigate floods and droughts, and to change from a single to multi-functional use of reservoirs.

The Strategy is constructed around four challenges, …

The overall objective of this strategy is the "Equitable and sustainable utilisation of water for social and environmental justice, regional integration and economic benefit for present and future generations". The strategy has been constructed around four "Challenges":

1. Integrated and coordinated water resources development
2. Environmental management and sustainable development
3. Adaptation to climate variability and climate change
4. Basin-wide cooperation and integration.

… each with a number of strategies and main actions.

For each challenge Strategic Objectives have been defined, and for each objective a number of Strategies and Main Actions have been identified and worked out in detail. The Challenges, Strategic Objectives, Issues, Strategies and Main Actions are summarized in the Strategy Overview table. The Implementation Plan schedules the actions and assigns responsibilities for implementation to organisations.

The new ZAMCOM will play a pivotal role in strategy implementation …

A prominent role for strategy implementation has been assigned to the Zambezi Watercourse Commission (ZAMCOM). As the signing and ratification process of the ZAMCOM agreement is taking time, it was decided to try and establish an Interim Secretariat to keep up the momentum. The Implementation Plan proposes an agenda for this secretariat and for ZAMCOM.

… and will manage and further develop ZAMWIS.

One of the tasks of the commission would be to manage and promote the use and further development of the Zambezi Water Information System (ZAMWIS), which was developed in parallel with this Strategy. ZAMWIS is a digital IWRM database and repository accessible through the Internet.

Summary, Challenges, Issues, Strategies, Main Actions & Implementation Plan

This Strategy document starts with a summary of the existing situation, followed by a detailed description of the Challenges, Issues, Strategies and Main Actions for each of the four Strategic Objectives. The Implementation Plan presents proposals for the short (0-2 years), medium (3-5 years) and long term (6-15 years) and includes suggestions for financing. The Annexes contain 36 thematic maps of the Basin, schematic overviews of the hydropower potential and summaries of the country and regional consultations carried out as part of the formulation of this Strategy.

1 Introduction

1.1 Overview

This document presents an Integrated Water Resources Management (IWRM) Strategy and Implementation Plan for the Zambezi Basin. This IWRM Strategy and Implementation Plan Report presents the main challenges for the management of the water resources of the Zambezi Basin and the recommended strategies and actions to address them, both in terms of water management and institutional development. It builds on the Rapid Assessment (Euroconsult Mott MacDonald, December 2007) that provides an overview of present and expected future water availability, utilization and water quality issues. The IWRM Strategy is complemented by an implementation plan that prioritizes the main activities.

The preparation of a strategy is the occasion to develop a compendium of the initiatives that are required to address the major water resources management challenges, but it also provides the opportunity to discuss a number of critical choices. There are several important choices that have a large bearing on the development of water resources in the Zambezi Basin: the pace of hydropower development, the scope of agricultural development and the development trajectory of the Zambezi Watercourse Commission. These choices – or different development scenario's - are discussed in this report as well.

The IWRM Strategy Report consists of a brief overview of the Zambezi water resources (Chapter 2), a summary of the main challenges and issues (Chapter 3), recommended strategies and actions to address these challenges (Chapter 4), an implementation plan (Chapter 5) and identified follow-up steps (Chapter 6). In Annex 1 maps are provided, covering a wide range of themes, Annex 2 presents schematic overviews of the Basin and Annex 3 contains summaries of the country consultations.

1.2 Vision and Background

The formulation of the IWRM Strategy for the Zambezi Basin has been prepared within the framework of the Zambezi River Action Plan (ZACPLAN) Project 6 Phase 2. ZACPLAN is an initiative of the Southern African Development Community (SADC) aimed at achieving environmentally sound planning and management of water and related resources in the Zambezi Basin. The ZACPLAN Project 6 (ZACPRO 6) titled "Development of an Integrated Water Management Plan for the Zambezi River Basin" has been implemented over two phases. Phase 1, implemented over the period 1995 to 1999, was concerned with the development of a knowledge base of water and related information to provide a sound basis for the planning and development of water resources of the Zambezi River Basin. The next phase, ZACPRO 6 Phase 2, was designed to build upon the results of the previous phase and its objective was to establish an enabling institutional environment and management tools for integrated water resources management of the Zambezi River Basin. Key among these tools was the IWRM Strategy, a vital management tool for effective management of the shared water resources of

the basin. The formulation of the IWRM Strategy has been carried out over the period September 2006 to April 2008.

In the SADC region, most of the water resources are in shared watercourses cutting across more than one country. The Zambezi is the single largest shared water course covering eight countries in SADC[1]. Hence management of the shared watercourse has both national and regional dimensions. Water being an important contributor to socio-economic and environmental development, it is widely recognized that cooperative management of the basin's water resources will contribute to the SADC goal for "the attainment of an integrated regional economy on the basis of balance, equity and mutual benefit for all Member States". The SADC Regional Water Policy (2004) and Strategy (2005) provide the context and intent for water resources management over the region and is anchored on the principles of regional cooperation and economic integration, environmental integrity, and cooperative management of shared watercourses within the region, including the Zambezi, and integrated water resources management (IWRM).

The IWRM Strategy for the Zambezi Basin is also prepared within the context of the "Southern Africa Vision for Water, Life and the Environment in the 21st Century", which was developed in 2000 in collaboration with the Global Water Partnership and adopted by SADC as a contribution to the formulation of the Africa Water Vision. The Southern Africa IWRM vision of "Equitable and sustainable utilisation of water for social, environmental justice, and economic benefits for present and future generations" is supported by and made much more explicit by sub-visions, namely:

- Social and economic development;
- Equitable access to water of an acceptable quantity and quality;
- Proper sanitation for all and safe waste management;
- Food security for all;
- Energy security;
- Sustainable environment;
- Security from disasters; and
- Integrated water resources development and management.

The SADC Protocol on Shared Watercourse Systems, whose main objective is to "foster closer cooperation for judicious, sustainable and coordinated management, protection and utilisation of shared watercourses and advance the SADC agenda of regional integration and poverty alleviation", first adopted in 1995 and then revised in 2001, is the legal instrument for the implementation of the Regional Water Policy. Under the Protocol bilateral and multilateral agreements may be established for cooperative management of shared watercourses. Based on the Protocol an agreement was negotiated between the riparian countries of the Zambezi River Basin on the establishment of the Zambezi Watercourse Commission (ZAMCOM). The ZAMCOM Agreement was signed in 2004 by seven out of the eight Basin countries. It is currently undergoing the ratification process by the Basin States. An Interim Secretariat is envisaged till this process is finalised.

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".

[1] Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, Zimbabwe

This is a practical expression of the intents of the SADC states as stated in the Protocol and the SADC agenda of regional integration and poverty alleviation.

This Zambezi IWRM Strategy is prepared in the above mentioned context. Figure 1.1 shows the conceptual framework of the Zambezi IWRM Strategy in the development context in SADC. The need for a Water Management Strategy is foreseen under the ZAMCOM Agreement since the strategy is the basis of the Strategic Plan for ZAMCOM. It is expected that the formulation of the Zambezi IWRM Strategy will significantly contribute to the development of the Strategic Plan for ZAMCOM. IWRM is the guiding principle, balancing the different social, economic and environmental functions of water resource development and management, as well as the cooperative management of the shared water resources to achieve mutual benefits for the Basin States in particular and the SADC region as a whole.

1.3 Methodology

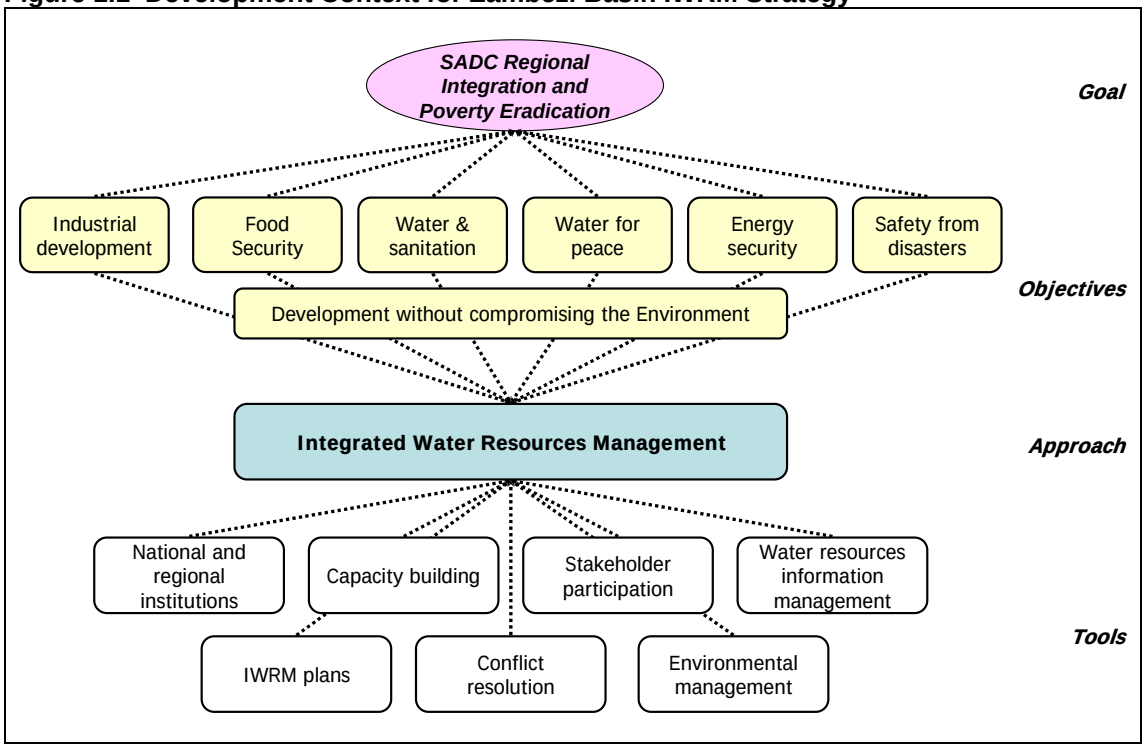
1.3.1 Key Stages

The formulation of the integrated water resources management strategy for the Zambezi Basin involved three key stages as follows:

1. Rapid Assessment of water resources in the basin. Building on earlier Sector Studies under the ZACPLAN Project 6 Phase 1 as well a large range of topical studies undertaken in the last ten years, the Rapid Assessment determined an up-to-date status on water resources in the Basin, and also provided an objective assessment, identification and quantification of the water resources issues, opportunities and challenges for shared water resources management in the Zambezi Basin up to 2025. The issues were summarized in an Issues Paper (Euroconsult Mott MacDonald, 2007)
2. Stakeholder consultation and participation in the formulation of water resources management issues as well as input in the formulation of Strategy Options based on the identified issues and challenges.
3. Formulation of the IWRM Strategy based on the Strategy Options already identified with participation of broad range of stakeholder at national and regional levels

Parallel to the work on the Rapid Assessment and the IWRM Strategy, data has been assembled into the Zambezi Water Information System (ZAMWIS) that was developed as an independent component of the Strategy formulation process. ZAMWIS is a Geographical Information System (GIS) enabled database and also contains a repository of digitally available reports, which are catalogued by country and sub-sector. Through ZAMWIS, these reports will become available to a larger public. A ZAMWIS Manual has been produced (Euroconsult Mott MacDonald April 2008).

Figure 1.1 Development Context for Zambezi Basin IWRM Strategy



Source: Adapted from SADC Regional Water Strategy, (SADC Water Division, 2005)

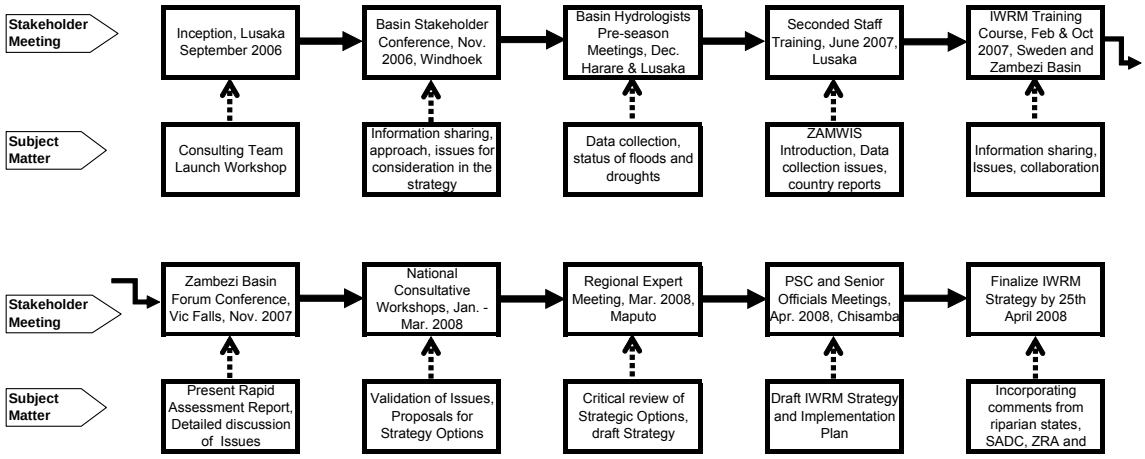
1.3.2 Stakeholder Participation and Consultation

Water resources management touches upon interests and views of different parties or interest groups. The stakeholders in water resources management include regional economic development communities (such as SADC), basin state governments (central, and local), river basin organisations, sub-basin organisations, local and international NGOs, community based organisations, the private sector (suppliers of goods and services - consultants, contractors and suppliers), and academic and research institutions. IWRM recognises the importance of stakeholder participation – stakeholders are the custodians of natural resources, they bring about multi-sectoral skills and experiences that are fundamental to integrated planning and management of water resources, and they confer legitimacy and validation of solutions. To this end a programme of stakeholder participation ran through all stages of the strategy formulation.

1. The consultative and participation programme involved two sets of activities:
2. Participation of national staff from the riparian states in data and information collection and verification, and facilitating national level consultations.
3. Consultative workshops at national and regional levels at key stages in the formulation process, using intermediate outputs as they became available.

The main activities in the consultation process are presented in Figure 1.2. Following the inception phase two persons from mainly the hydrological organizations in each of the riparian states were seconded to the Consultants team to assemble data and information needed for carrying out the Rapid Assessment and for the Zambezi Water Information System (ZAMWIS). The seconded staff verified data and provided feed back as the Consultants analysed the data or input into the ZAMWIS. Subsequently, the seconded teamed up with the Consultants to facilitate national consultative workshops.

Figure 1.2 Consultative Activities during Strategy Formulation



The Issues Paper produced after the Rapid Assessment was the subject of discussion in national consultations in the riparian countries. The objective of the national consultations was to enable the riparian countries to examine, validate and amplify the identified challenges and issues in water resources management in the Zambezi Basin.

A Strategy Options Document was prepared drawing upon the national consultations on the IWRM Issues; it also set out the strategic options for dealing with the already identified issues. The Strategy Options Document was a key resource for a regional consultative meeting of experts in the SADC region aimed at providing independent critical assessment of the proposed options for dealing with already identified IWRM issues. Following the expert meeting a Draft IWRM Strategy for the Zambezi Basin was prepared, which included an implementation plan. This Draft IWRM Strategy was widely circulated and was the subject for discussion in the Senior Officials Meeting before being finalized into the Zambezi IWRM Strategy.

The consultations also took advantage of the annual regional Stakeholder Forum Meetings, held in November each year, to obtain feedback on proposals for strategic options or to exchange information on on-going programmes and projects that could have effect on, or inform the Zambezi IWRM strategy. Besides these regional meetings, further workshops were held with the Sida supported IWRM Training Course held twice a year, in October (in Sweden) and February (in the region) to exchange views on IWRM issues in the participants' respective countries or the basin, and to get the participants propose measures for addressing these issue as special assignments in the course. Consultative meetings were also held with hydrologists from the basin during their annual technical meetings aimed at information sharing and consultations on the prognosis of the hydrology in the forthcoming hydrological season.

These consultative meetings provided valuable feedback on what needed to be taken into account in the IWRM Strategy, and also provided valuable background information on water resources development in the Zambezi Basin and elsewhere. Annex 3 summarizes the main points raised in these meetings.

1.3.3 Strategy Definition

The IWRM Strategy for the Zambezi Basin is defined as a set of measures that the Basin as a whole needs to undertake to achieve a desirable water future. It consists of short, medium and long-term measures in support of integrated water resources management to meet socio-economic development including poverty eradication and environmental integrity. The strategies are derived from an objective assessment, identification and quantification of the water resources issues, opportunities and challenges. The strategies address these issues that impact the sustainable and effective management of water resources in the basin. These are presented in Chapter 4.

2 Summary of Existing Situation

The description of the Zambezi River Basin is summarised in this chapter. For a more detailed description of the present situation of the Zambezi River Basin, reference is made to the Rapid Assessment document.

2.1 Location, Topography and Geology

The Zambezi River Basin is located between 9-20° South and 18-36° East in Southern Africa. The Zambezi River, together with its tributaries, forms the fourth largest river basin in Africa and is the largest river basin in the SADC region. Its total area of 1.37 million km^2 extends through Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. The Zambezi Basin covers almost all of the territory of Malawi and the lion's share of Zambia, covers also around half of Zimbabwe including the most densely populated areas, and significant areas of both Mozambique and Angola. Only minor parts of Tanzania, Botswana and Namibia are situated inside the Basin.

There are significant variations across the Basin in terms of rainfall, temperature, physical characteristics, land use, economic development, and even cultural state of the riparian countries. For purposes of analysis and management the Zambezi Basin has been divided into 13 sub-basins, see Annex 1, Map 1.

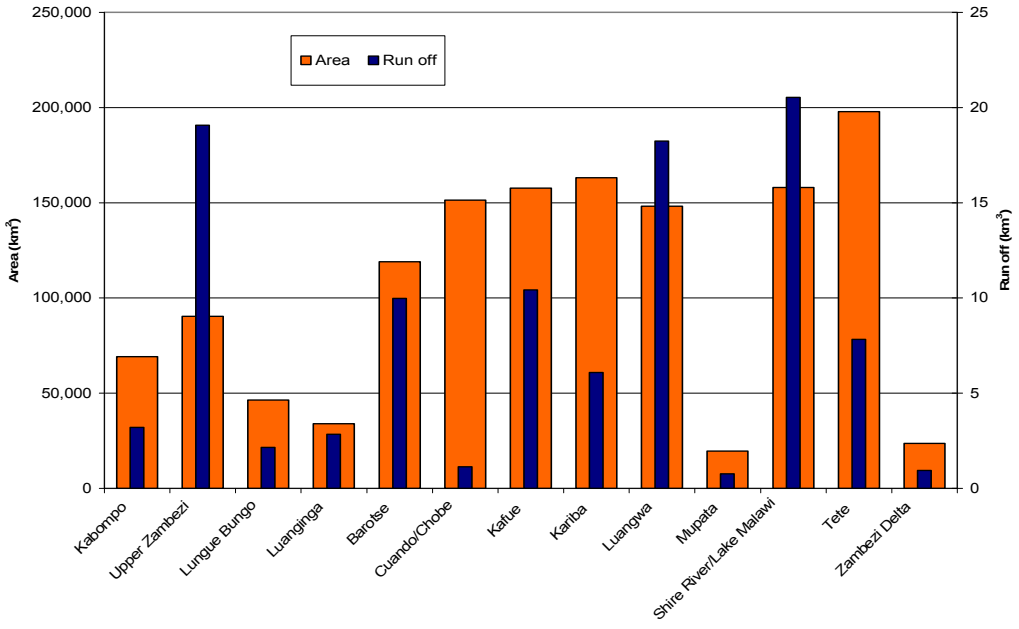
Most of the Zambezi Basin is high plateau land of the ancient Gondwana Continent, with elevations varying between 800 and 1,450m amsl (see Annex 1, Map 2), the most extensive areas being between 1,000 and 1,300m amsl. Only very small portions of the Basin are below 100m or above 1,500m. These elevation differences contribute significantly to the high hydropower potential of the Basin.

2.2 Water Resources

The Basin receives a mean annual rainfall of about 950 mm, most of which is concentrated in the austral summer period (October – April). The north and east of the Basin experience significantly more precipitation than the south and west. The rainfall pattern is such that there are distinct wet and hot summer months and a dry and cooler period in the remainder of the year. Less than 10% of the mean annual rainfall in the Basin flows through the Zambezi River into the Indian Ocean. The remainder evaporates and returns directly to the earth's atmosphere.

The Zambezi carries an average run-off of about 103 km^3 (103 billion m^3) per year. There are significant variations and an uneven distribution in the available water resources from one sub-basin to another and over time. The major contributors to the runoff are the sub-basins in the upper part of the Zambezi, as well as the Kafue, Luangwa and Shire sub-basins; the large Cuando/Chobe Basin in contrasts contributes only very little. Figure 1.1 shows the sub-basin areas and sub-basin run off.

Figure 2.1 Available surface water resources



Sediment loads in the Zambezi are modest, as in most areas in the semi-humid/ moderate central belt of the continent. FAO Aquastat mentions that the pre and post dam sediment yields are as a low 48 and 20 t/km^2/year. This is for the whole basin, yields in the smaller sub catchments will be considerably higher. The Kariba and the Cohara Bassa trap most if not all the sediments arriving from the drainage basin. The rivers downstream from the dams will pick up bed load, but the fine sediment supply will be greatly reduced. One should not make the mistake of equating soil erosion rates with dam sedimentation rates: only a small proportion of the eroded sediments reaches a reservoir dam in large catchments, such as the Zambezi. The construction of the reservoirs and the changed supply of sediment has effected the build up of the delta and the changed the composition of water, especially during low flows, with consequences for aquatic life and weeds.

Groundwater maintains the base flow in the Zambezi River during the dry season and is an important resource for providing water for household use through natural springs, shallow wells and boreholes. National plans for water supply and sanitation indicate that in almost all the countries of the Zambezi River Basin, groundwater is the main source of rural, urban and peri-urban water supply.

Given the relatively high rainfall in summer, it is a safe assumption that a significant part of the precipitation is temporarily stored in shallow aquifers. However, the aggregated impact of more pressure for fuel wood, shifting cultivation and urbanization would lead to reduced recharge of aquifers and an increase in surface runoff. Information about the availability and use of groundwater is limited and fragmented.

There are three major lakes in the Zambezi Basin: Lake Malawi/Nyasa/Niassa, Lake Kariba and Lake Cahora Bassa. The latter two are reservoirs created by the construction of dams on the Zambezi River. There are many other natural and man-made lakes that are smaller in size and are associated with dams constructed for hydropower and water supply for irrigation or domestic use.

2.3 Demographic Features

The Zambezi River Basin is populated by an estimated 30 million people of which approximately 7.5 million live in the urban centres. The population is expected to increase to 47 million by 2025 with urbanization steadily increasing. Population growth is highest in Angola with 2.6% per annum, whereas Botswana has a stagnant population. The incidence of HIV in the adult populations varies between 3.7% in Angola to 24% in Botswana. Growth of the labour force is below the population growth in most Basin countries. In Botswana the labour force is actually shrinking due to the high incidence of HIV. The proportion of rural population varies from around 50% in Zambia to around 85% in Malawi. This population split has a bearing on water demand since domestic water consumption in rural areas is relatively smaller than in the urban areas.

2.4 Socio-economic Profile

The economies in the Zambezi Basin have two faces: a fast growing and high income generating economy centred around the extraction of mineral resources such as diamonds, oil, copper, cobalt, and a rural economy with high levels of poverty and low coverage of basic services. The agricultural sector is important in most Basin countries, except in Angola and Botswana. In most riparian countries, economic growth in the last few years has been high and has exceeded population growth – around 6%, with Angola far exceeding this number (18.6%) and Zimbabwe being the exception at the other side with a contracting economy. Expected economic growth for the coming years is expected to be good, especially in Angola. The basic economic indicators of the riparian countries are presented in Table 2.1.

Table 2.1 Basic economic statistics of riparian countries

Angola	Botswana
Population ▪ 16.4 million (2006) ▪ 2.8% annual population growth ▪ 2.9% annual growth labour force ▪ 3.7% HIV (age 15-49) **Economy** ▪ Strong economic performance ▪ Increase of oil production, around 13% ▪ Increase of agricultural value of 8% ▪ Inflation fell from 19% to 12% in 2006 ▪ Medium term outlook is positive; GDP is expected to grow about 25% on average in the next two years and about 8% average in 2009-2010 driven by the oil sector. ▪ Fiscal deficit is projected to be sustainable in the medium and longer term **Current GDP numbers (2006)** ▪ 45.2 billion USD ▪ 18.6% annual growth ▪ 69.7% industry ▪ 21.4% service ▪ 8.9% agriculture **Expected economic growth 2006-10** ▪ GDP: 15.8% ▪ GDP per capita: 13.9%	**Population** ▪ 1.8 million (2006) ▪ 1.2% annual population growth ▪ -0.3% annual growth labour force ▪ 24.1% HIV (age 15-49) **Economy** ▪ Botswana's economy is dominated by the diamond mining industry ▪ GDP growth over the past years established around 5%. This trend is expected to continue in the medium-term ▪ Major challenge is to diversify economy and look for other engines of growth as the diamond growth begins to taper off **Current GDP numbers (2006)** ▪ 10,6 billion USD ▪ 53.1 % industry (38% accounts to diamond mining industry) ▪ 44.9% services ▪ 2% agriculture **Water and sanitation (2005)** ▪ 42% of population has access to improved sanitation facilities ▪ 95% of population has improved water source **Expected economic growth 2006-10** ▪ GDP: 3.8% ▪ GDP per capita: 3.6%

Malawi	Mozambique
Population (2006) ▪ 13.2 million ▪ 2.2% annual growth rate ▪ 2.0% annual growth labour force ▪ 14.1% HIV (age 15-49) **Economy** ▪ relatively small economy ▪ Agriculture is the mainstay, but vulnerable to weather shocks ▪ Unequal land distribution. Over 40% of smallholders households cultivate less than 0.5 hectares ▪ Export is dominated by tobacco, tea, cotton, coffee and sugar ▪ Improvement of macroeconomic performances **Current GDP numbers (2006)** ▪ 2.2 billion USD ▪ 10.9% annual growth rate ▪ 44.7% services ▪ 19.8% industry ▪ 35.5% agriculture **Expected economic growth 2006-10** ▪ GDP: 5.4% ▪ GDP per capita: 4.0%	**Population (2006)** ▪ 20.1 million ▪ 2.0% annual population growth ▪ 1.6% annual growth labour force ▪ 16.1% HIV (age 15-49) **Economy** ▪ Export commodities: aluminium, cashews, prawns, cotton, sugar, citrus, timber, bulk electricity, natural gas **Current GDP numbers (2006)** ▪ 7.6 billion USD ▪ 8.5% annual growth rate ▪ 49.3% services ▪ 29.0% industry ▪ 21.7% agriculture **Expected economic growth 2006-10** ▪ GDP: 7% ▪ GDP per capita: 5.5%

Namibia	Tanzania
Population ▪ 2.1 million (2006) ▪ 1.3% annual growth rate (2005) ▪ 1.3% annual growth labour force ▪ 19.6% HIV (age 15-49) **Economy** ▪ Middle income country ▪ Among top 10 countries worldwide in share of GDP spent on education ▪ The generally good growth and macroeconomic picture is overshadowed by the lingering levels of poverty; high unemployment; and unequal distribution of wealth and income **Current GDP numbers (2006)** ▪ 6.4 billion USD ▪ 4.6% annual growth ▪ 57.7% services ▪ 31.0% industry ▪ 11.3% agriculture **Expected economic growth 2006-10** ▪ GDP: 4.4% ▪ GDP per capita: 3.2%	**Population** ▪ 39.5 million ▪ 2.6% annual population growth ▪ 2.4% annual growth labour force ▪ 6.5% HIV (age 15-49) **Economy** ▪ Economic performances continue to be strong, despite the drought of 2006 **Current GDP numbers (2006)** ▪ 12.8 billion USD ▪ 5.9% annual growth rate ▪ 37.3% services ▪ 17.4 % industry ▪ 45.3% agriculture

Zambia	Zimbabwe
Population (2006) ▪ 11.9 million ▪ 1.8% annual population growth ▪ 1.7% annual growth labour force ▪ 17.0% HIV (age 15-49)	**Population (2006)** ▪ 13.6 million ▪ 0.6% annual growth rate ▪ 1.5% annual growth labour force ▪ 20.1% HIV (age 15-49)
Economy ▪ Negative impact on economy by macroeconomic instability, resolved with debt cancellation. ▪ Income between 1974 and 1990 fell by 5% ▪ In 2002 Zambia was hit by a copper crisis and a severe drought ▪ Mining constrained by power supply	**Economy** ▪ Decade after independence economic growth was strong, but in the late 1990 the growth began to slow ▪ In 2002 Zimbabwe's economy was severely constrained ▪ Overvalued exchange rate ▪ Unsustainable external debt burden ▪ Inflation in 2006 more than 1,000%
Current GDP numbers (2006) ▪ 10.9 billion USD ▪ 6.0% annual growth rate ▪ 59.2% services ▪ 24.8% industry ▪ 16.1% agriculture	**Current GDP numbers (2006)** ▪ 5.0 billion USD ▪ -4.8% annual growth ▪ 50.7% services ▪ 27.4% industry ▪ 21.9 % agriculture
Expected economic growth 2008-09 ▪ GDP: 6.8%	

Source: World Bank, March 2008

The challenges for most economies is to diversify and improve the productivity and value-addition of the sectors that provide the bulk of the employment, services and agriculture, and hence achieve sustainable development. At the current stage non-oil producing and food grain importing countries are vulnerable to increasing fuel and food grain prices. The food security crisis of the early part of this century is a reminder of this.

2.5 Agriculture, Fisheries and Navigation

Almost 75% of the Basin land area is covered by forests and bush; cropped land (mostly rainfed agriculture) covers 13%, and grassland covers approximately 8% of the land area; the rest is barren or used by infrastructure. The Zambezi Basin includes extensive flood plain areas or wetlands, a number of them are of international importance and are gazetted under the Ramsar Convention.

Agriculture in the Zambezi Basin is largely rain-fed or flood-dependent. An estimated 5.2 million ha is cultivated yearly in the Basin. Zimbabwe, Zambia and Malawi have together 85% of this area. The majority of the population in rural areas across the Basin practice subsistence agriculture along the flood plains, swamps, wetlands and margins of large water bodies.

Fisheries, fauna and flora need water of specific qualities and quantities to survive. The most important fish habitats in the Basin (rivers, lakes, and wetlands), the aquatic ecosystem supporting variety of wildlife and birdlife, as well as scenic beauty depend on sufficient quantities of water for survival. Large water resource developments or excessive abstraction of water from rivers affect their flow regimes, water chemistry, sediment load and temperature regimes, consequently affecting their fauna and flora.

With the construction of the Kafue Gorge Dam in 1971 and its regulating reservoir at Itezhi-Tezhi in 1978, river regulation was instituted. Since 1972, regulation has attenuated the flood peaks and raised base flows; drainage has been retarded, the area of floodplain reduced and unseasonable fluctuations in water level induced. Although the Itzehi-Tezhi was the first reservoir in Africa with a provision for flood releases, the construction of the Kafue dams has led to decline in fish production and fish biodiversity, and a decline in flood plain pasture.

In the Lower Zambezi and Zambezi Delta in Mozambique, river regulation began with the closure of the dam at Kariba in 1958, but was aggravated by the completion of Cahora Bassa in 1975. There is now little seasonal variation in river flow at Tete. The natural flood has been attenuated and the base flow increased; flood peaks are unpredictable and may occur at any time.

Regulation has caused significant change to fisheries and biodiversity and includes the rise of the tilapia and kapenta (Tanganyika sardine) fisheries in the Cahora Bassa and Kariba reservoirs, and economic damage to both the freshwater and marine shrimp fisheries in the Delta. Basin countries are now defining the environmental flow requirements for the ecosystems in the Basin.

"It is important to make a distinction between water use and water demand. Water use is dependent on availability of resource, infrastructure and affordability; water demand on the other hand depends on essential or basic need for the resource. Consequently whereas actual water use in the basin is presently small, the actual demand is much higher. We should not assume there is plenty of water to go around."
Regional Expert Meeting.

The Zambezi River is navigable up to Cahora Bassa (650 km from the delta), and then in shorter stretches elsewhere. There are also some navigable stretches on the tributaries and on the main lakes. Testimony to the relatively low economic growth of the region in the last two decades, there has been little development of new navigation in the Zambezi Basin. There is now considerable interest to improve and further develop the navigability of the Zambezi, including the lakes and impoundments. This concerns both international transport routes (Kazungula and Katima Mulilo-Sesheke), as well as major national routes like in the upper Zambezi River and Caia in Mozambique and on Lake Malawi/Nyasa/Niassa. The National Water Resources Plan of Mozambique has a provision to undertake studies to improve navigability of the Lower Zambezi.

The considered initiatives concern berthing infrastructure, flow level regulation, aquatic weed control and, in selected places, dredging. The resurgence in mining may prompt navigational improvement. Recently an agreement has been concluded between the Governments of Malawi and Mozambique to revitalize navigation on the Lower Shire. Improved navigation, combined with regional road network planning, could be a step forward towards closer cooperation between countries in the Basin. In the Rapid Assessment a number of options to improve navigation on the Zambezi have been identified.

2.6 Water Use in the Basin

At present around 20% of the total Basin runoff is used (see Table 2.2). However, given the high degree of seasonal and spatial variability in available water resources, some areas in the Basin

have much higher water demand relative to the available water resources. Water demand projections for all uses (as listed in Table 2.3) have been made up to the year 2025. For the Basin as a whole, the total projected consumptive water use is less than 40% of available runoff. Given the uneven distribution and temporal and spatial variability, and the possible effect of climate change, a number of areas (or countries) would experience water stress and/or scarcities. In addition, there are a number of water quality issues that demand attention, in particular point pollution around large urban, manufacturing and mining centres, the spread of aquatic weeds and wetland degradation.

Table 2.2 Current consumptive water use and run-off

	Mm^3	%
Available run off	**103,224**	**100**
Rural domestic consumption	24	0.02
Urban domestic consumption	175	0.17
Industrial consumption	25	0.02
Mining	120	0.12
Environmental/ flood releases	1,202	1.16
Irrigated agriculture	1,478	1.43
Livestock	113	0.11
Hydropower (evaporation)	16,989	16.46
Total consumptive water use	***20,126***	***19.49***

Source: Rapid Assessment, 2007

Table 2.3 Future water use (2025)

	Mm^3	%
Available run off	**103,224**	**100**
Water demand		
Rural domestic consumption	43	0.04
Urban domestic consumption	676	0.65
Industrial consumption	85	0.08
Mining	408	0.40
Environmental/ flood releases	6,445	6.24
Irrigated agriculture (2005)	1,477	1.43
Additional under Partial Scenario (50%)	2,217	2.15
Additional under Full Scenario (100%)	4,635	4.49
Livestock	167	0.16
Hydropower	16,989	16.46
Additional under Moderate Scenario	175	0.17
Additional under Medium Scenario	1,365	1.32
Additional under Mega Scenario	7,609	7.37
Total (high development scenario)	***38,534***	***37.32***

Source: Rapid Assessment, 2007

The knowledge base on groundwater resources in the region is poor. The data and information presently available is fragmented, there are different standards and practices of assessing the resource limited and not sufficient to support its planning and management at regional level. However national reports indicate that groundwater potential is significant, and is a major source of supply for some large urban centres, for irrigation and for rural areas especially in the dry season.

2.7 Hydropower

Hydropower production is an important sector in the Zambezi Basin. A number of hydropower plants in the Zambezi River Basin are run-of-river plants with only a small reservoir or intake dam. Other plants have a reservoir with a storage capacity to store water from the rainy through the dry season. Only three reservoirs have a regulating capacity of significance: Kariba, Cahora Bassa and Itezhi-Tezhi.

A total capacity of 4,684 MW (about 10% of the total potential) has been developed in the Zambezi River Basin, of which 75% is on the Zambezi River itself, producing an average of almost 33,000 GWh per year. Although hydropower generation itself does not consume water, the associated evaporation from the hydropower reservoirs has been estimated at approximately 17 km^3 and is by far the largest water use in the Basin. The evaporation is dominated by Kariba, which accounts for more than half of the total evaporation, and Cahora Bassa, which accounts for close to 35%. Development of irrigation and other forms of consumptive water use would theoretically reduce the generation of hydropower downstream.

2.8 Floods and Droughts

Floods and droughts are part of the hydrological features of the Zambezi River Basin and occur almost cyclically. Floods in swamps, wetlands and flat areas along the extensive Barotse Flood Plains, Kafue Flats and Lower Zambezi Delta, occur every rainy season to some extent. Floods due to over bank flows along the upper Luangwa, Caprivi Strip, upstream of Cahora Bassa reservoir and Lower Tete are usually associated with extreme rainfall. In the upper, middle and lower Zambezi, floods inundate extensive areas resulting in loss of life, serious infrastructure damage and property loss.

Floods also have significant positive roles in culture and livelihoods of the people as they bring sediments and nutrients that increase soil fertility, and increase spawning grounds for fish, especially in the Zambezi Delta. Improved reservoir operations for the main two man-made reservoirs in the Basin will have considerable benefits for both ecology and flood mitigation. In the large unregulated parts of the Basin, reduction of the negative impacts of floods can be achieved by flood management. These are non-physical interventions like improved land use planning and flood forecasting/disaster management systems.

In 2007 the Zambia Wildlife Authority designated the Busanga Swamps (200,000 ha), the Luangwa Flood Plains (250,000 ha) and the Zambezi Floodplains (900,000 ha) as wetlands of international importance (Ramsar sites). In addition, Zambia has extended the area of the Kafue Flats Ramsar site, designated in 1991, to 600,500 ha.

The impacts of flow alterations by major dams (Kariba, Cahora Bassa, Itezhi-Tezhi and Kafue Gorge) include flood attenuation, the increase in annual low flows, and changes in water quality. These changes have had both positive and negative impacts for people and wildlife. On the positive side there have been benefits for urban populations (electricity supply) as well as for commercial farmers for whom river regulation ensures a steady supply of water. Negative impacts were in the first place felt by the rural communities who were displaced by the reservoirs. Other impacts for the rural population include reduction of grazing lands and lands for crop production as a result of loss of moisture retention that would have followed floods; increased tick-borne diseases in cattle and increases in pests (rats); reductions in fisheries,

partly caused by loss of fish breeding grounds. Wildlife also suffered, e.g. on the Kafue Flats the population of Kafue Lechwe, an endemic species of antelope, has declined by more than half following river flow regulation by the Itezhi-Tezhi and Kafue Gorge dams. Environmental flow releases have been studied in detail for the Kafue Flats and are now practiced on an experimental basis.

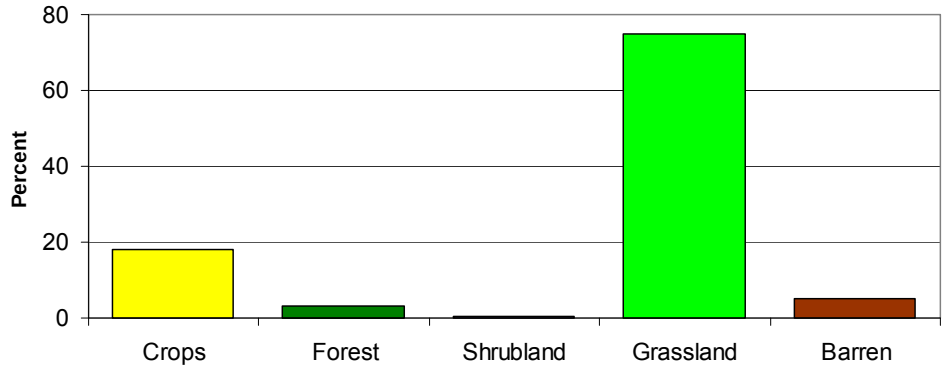
Unlike floods, droughts cover extensive geographic areas and have had a larger impact than floods. It is usually much more difficult to perceive the beginning and end of droughts as this is normally a result of accumulated deficit in soil moisture.

The most notorious droughts in recent history hit the region during the periods 1991-1992 and 1994-1995. These droughts affected water supplies (both in rural as well as urban areas – evidenced by severe water rationing in urban centres) and reduced crop production. The situation is likely to get worse as population increases put more pressure on the environment and increases vulnerability. In addition, climate change is expected to increase the incidence of droughts in the region.

2.9 Watershed Condition

The condition of the watersheds in the sub-basins has decreased over time and is critical in many places. Of special importance is the vegetative cover close to the major rivers in the Basin. The area within 5 km of the major rivers in the Zambezi Basin is mostly covered by grassland, very little by forests and shrubland (World Resources Institute, 1998), see Figure 2.2.

Figure 2.2 Land cover within 5 km of major rivers



Source: World Resources Institute 1998

Although large parts of the Basin are sparsely populated, the origin of the decrease in forest cover is largely anthropogenic: collection of firewood and wood for charcoal production in excess of natural re-growth, overpopulation by domestic livestock, and in some cases overpopulation of wild animals in national parks. Overgrazing and compaction of soils occur when stocking rates exceed the carrying capacity. This leads to a reduction in vegetation cover and soil erosion (see Annex 1, Map 35). Deforestation is caused by cultivation, bushfires, timber extraction and the development of settlements and infrastructure, are other causes of watershed degradation.

More than two-thirds of the people in southern Africa cultivate land on shifting and semi-permanent basis. Forests and woodlands are being cleared in order to grow crops. In Malawi, 24 percent of the total forested area has been converted to arable land (Lele and Stone 1989). Of the estimated 0.9 million ha deforested in Zambia in 1990, shifting and semi-permanent cultivation were responsible for 95 percent and the remaining 5 percent was attributed to charcoal production (Chidumayo 1997).

In Zimbabwe the main decreases in woody vegetation between 1963 and 1973 were in areas of moderate to high population densities, particularly in communal areas where extension of croplands and wood harvesting had resulted in annual cover losses of 3-10 percent.

Most rural people in southern Africa use fuel wood for cooking and heating, and this often results in cutting trees if no underbrush or deadwood is available. This contributes to deforestation, with annual rates ranging from 0.03 to 2.2 percent. Other uses of wood fuel include the curing of bricks, especially in rural areas. In Zimbabwe, the wood used for brick-making is said to equal that used for cooking in some rural areas. (Bradley and Dewees 1993). Coastal vegetation such as mangroves, has been similarly, affected by vegetation cutting for timber and fuelwood.

For the management of watersheds of international river basins, the SADC Protocol on Shared Watercourses forms an ideal foundation for facilitating watershed management initiatives. Basin States should integrate their approaches and actions regarding watershed management. Upstream states have to recognize that they have an obligation not to cause unreasonable effects on both the quality and quantity of water which flows to downstream Basin States.

At the national level an integrated approach requires that government policies across all relevant sectors must reflect the linkages between natural resources which are all components of a watershed. Thus an agricultural policy to improve agricultural production should take the effects on water resources, vegetation and wildlife into account.

3 Challenges and Issues

This Chapter presents challenges and issues in the management of water of water resources in the Zambezi Basin. These are the issues that are to be addressed in the Strategy. These challenges and issues were derived from the Rapid Assessment and were summarized in an Issues Paper, which was subsequently discussed in National Stakeholder Consultations. The feedback from these gatherings – held in seven out of the eight riparian countries - led to changes in prioritization, formulation and grouping.

There are many challenges and issues with respect to management of water resources in the Zambezi Basin. They include extreme variability and uneven distribution, the way resources are presently managed, the predominance of internationally shared watercourses (even for small sub-basins), the importance of the aquatic environment (wetlands) and the extremely valuable eco-systems of the Zambezi Basin, but also the widespread poverty and low satisfaction of basic human needs (water, sanitation, food, energy). On the other hand, there are tremendous opportunities for higher utilisation of available water resources to better satisfy the socio-economic needs of the basin population – provided this is done with an context where the integrity of the water resources and the related eco-systems is safeguarded. The key water management issues in the Basin have been grouped into four categories:

1. Integrated and Coordinated Water Resources Development and Management
2. Environmental Management and Sustainable Development
3. Adaptation to Climate Variability and Climate Change
4. Basin-wide Cooperation and Integration

These categories reflect the structure of the SADC Regional Water Policy as well as the sub-visions in the Southern Africa Water Vision (see Section 1.2). Consequently, the proposed Zambezi IWRM Strategy is grounded into the SADC water development framework.

3.1 Integrated and Coordinated Water Resources Development

> "Access to water from the Zambezi is crucial for the semi-arid states like Botswana and Namibia since internal water sources are virtually exhausted and will not cope with future water demands for socio-economic development."
> *Botswana National Stakeholder Consultation*

The Zambezi Basin is rich in resources, but low in population. The Basin has considerable potential for development in agriculture, tourism, hydropower and mining. As the global economies develop, this creates considerable opportunities for the Zambezi Basin. Water resources development and management will be a key factor in the socio-economic development and management of the SADC region as a whole and the Zambezi Basin in particular. Increased food security, energy for industrial and domestic use, improved access to water supply and sanitation, protection against extremes of floods and droughts, and sustainability of the eco-systems will invariably require the development and effective management of the water resources of the Zambezi Basin. The various ambitions of riparian countries with respect to water resources development will need to be

effectively coordinated. While water resources in the Zambezi Basin are considerable, they are not limitless. Wasteful development in particular – with high evaporation and little return to water utilization – needs to be avoided.

Recent widespread power outages and load shedding throughout the region underline the issue of improving energy security. Current hydropower facilities account for a consumptive use of about 15% of available Zambezi run-off. This is mainly due to the evaporation from the two largest reservoirs Kariba and Cahora Bassa. These two dams represent a generating capacity of 4,684 MW. According to estimates the unused hydropower potential in the Zambezi Basin is 13,000 MW (see Table 3.1). Several of these infrastructure projects have been studied at reconnaissance and feasibility level. The evaporation of the different reservoirs varies considerably. The plans for hydropower development need to be synchronized at Basin and SADC level, keeping in mind the annual fluctuation in water availability, the likely impact of climate change and the water requirements for other uses or purposes.

Ensuring food security is a major challenge in an area characterised by high variability in available water resources. The current estimated water use for irrigated agriculture and livestock does not exceed 2% of the mean annual stream flow in the Zambezi River. There are, however, ambitious plans in most of the riparian countries to expand the area under irrigation. As the majority of the rural population in the Basin relies on subsistence rain-fed agricultural systems, water management issues in these systems will need to be addressed as well.

There is much to gain with the integrated and coordinated multi-purpose operation of the hydraulic infrastructure so as to maximize the benefits in terms of flood mitigation, navigation, fisheries, environmental flow releases for flood plain agriculture and wetland and wild life maintenance, while safeguarding power delivery.

"Funding is vital for water resources development and management. Strategies for establishing water resources development funds along the lines that have been established in the road sector should be explored and included in the IWRM Strategy"
Mozambique National Stakeholder Consultation

The water sector as a whole, particularly water resources development and management, receives very little funding from the national budgets of the Basin States, even in countries that are regarded as arid or semi-arid. At Basin level there is poor funding of projects of a transboundary nature. The lack of a basin-wide organization with responsibility for managing the Basin including planning, resource mobilization, and project implementation has continued to negatively impact cooperative development of water resources in the Basin.

As the economies of the region develop, there is also a need for essential infrastructure that allows the sharing of benefits. These are the basis of regional development and they include the coordinated planning of power supply and the linking of national road networks with navigation possibilities.

Access to safe drinking water supply and adequate sanitation is still low in most of the basin states, though some countries, notably Botswana, have made considerable progress over the last five years. A UNICEF mid-term assessment of coverage in 2002 shows that most of the Zambezi basin states have only 50-75% coverage with safe water supply, and less than 50% of the population have proper sanitation . Much higher coverages are reported in urban areas than in the rural areas. There are therefore a large number of people in urban and rural areas still to

be served. If the current development trends continue, the majority of Basin states will not meet the MDG water and sanitation targets by 2015. Since safe water supply and sanitation contribute significantly to all the relevant millennium development goals (MDGs) (including Eradicating Extreme Poverty and Hunger; Achieving Universal Primary Education, reduction of child and maternal mortality, and Ensuring Environmental Sustainability), improving access to safe water supply and sanitation in all the riparian states is of paramount importance.

In summary, the following five issues are identified:

1. Inadequate water infrastructure for achieving regional energy security (1.1)
2. Insufficient water infrastructure for agricultural development to achieve regional food security (1.2)
3. Major dams in the Basin were constructed for a single purpose and their operation is not optimised for multiple uses (1.3)
4. Inadequate financing of water resources development and management (1.4)
5. Low access to Water Supply and Sanitation (1.5)

3.2 Environmental Management and Sustainable Development

The Zambezi Basin is an area of outstanding environmental value – as is clear from the extensive wetlands, lakes and numerous national parks. What is more, economic growth in the Basin will depend to a large extent on ecosystems services provided. This justifies sound ecosystem protection and management and balanced use of natural resources, not just to provide benefits for nature but also to provide the basis for sustainable growth.

Accelerated development, as is expected in response to the large demand for energy and agricultural production (see section 3.1), runs the risk of altering the land and waterscape significantly and coming at the cost of these ecosystem services – by changing land use and hydrology but also by fragmenting ecological valuable areas. The challenge is to safeguard these high value eco-systems and environmental functions, whereas at the same time allowing the development of water resources in support of poverty alleviation and economic development.

"Water is key to socio-economic development, but if we look around us the available water resources aren't used in a sustainable way. It's just not happening!"
Regional Expert Meeting

Wetlands are potentially among the most productive ecosystems in the river Basin, providing a wide range of goods and services of local, national and international importance. However, wetlands are also among the most environmentally sensitive areas and are often widely degraded. There is a need to strengthen wetland protection and management with appropriate legislation on local resource access rights, effective community resource management programmes and regional cooperation and research on holistic wetland resource management in pursuit of optimising multiple uses. A key aspect of wetland management will be the maintenance of adequate environmental flows below dams. Another important challenge is to safeguard the integrity of the larger Zambezi eco-system by creating a network of interlinked Zambezi protected areas.

The management of mining waste is an operational and long-term environmental imperative as is the improvement of urban waste water facilities – particularly as the countries in the Zambezi Basin want to progress to higher standards of living. With consumptive use increasing and the

Basin population growing, the pressure on water quality will continue to increase. The establishment of agreed common water quality standards, a unified system of water quality monitoring, an action plan against pollution hotspots in the Basin that addresses problems in their national context, are examples of issues that will become increasingly important in the near future and would benefit from regional cooperation.

The invasion of aquatic weed species has become a problem in a number of sub-basins. As the Zambezi Basin is an integrated water system, the control of aquatic weeds would benefit from a coordinated combat, supported by the riparian countries, both at the level of joint action and at the level of developing effective control mechanisms.

Fisheries are an important contributor to food security in the Zambezi Basin. The construction of dams and reservoirs has led to changed flow regimes, affecting the downstream fish spawning areas and, subsequently, the sustainability of fisheries. The vitality of fisheries in the basin will depend on securing a flow regime that offers potential for growth of the sector and supportive measures to enhance the contribution of the fisheries sector to contributing to local food security.

With the Victoria Falls as its flagship, the Zambezi Basin is highly attractive for water-related tourism. The Basin's water resources as well as its management are instrumental in the sustainability of the landscape, nature reserves and wildlife. The potential to attract even wider groups of tourists from around the globe will rely on the ability to protect the Basin's ecosystems.

The above is summarized in these six issues:

1. Inadequate protection and sustainable development and use of wetland (2.1)
2. Deterioration of water quality due to point pollution from mining, industrial and urban centres (2.2)
3. Proliferation of invasive aquatic weeds (2.3)
4. Unsustainable and low-productivity fisheries management (2.4)
5. Tourism development is threatened by degradation of the aquatic environment (2.5)
6. High-value and unique eco-systems and related ecological and economic functions in the Basin may be threatened and fragmented by accelerated development (2.6)

3.3 Adaptation to Climate Variability and Climate Change

Climate variability has been a fact of life in the Zambezi Basin and drought and floods are natural and recurrent phenomena. Historically land use in many parts of the basins was based and dependent on regular floods. The modification of the river system has altered this and the adaptability to floods has been negatively effected by changing land uses in the flood plains.

Extreme floods are probably the most pressing transboundary water management issue for the population living in the Zambezi River Basin. Flood management at the national level is usually a shared responsibility between the water departments and a national disaster management apex body that has the power and mandate to mobilize the necessary resources to address flood problems. The large number of institutions involved even at national level already presents challenges of coordination, and the challenges are amplified at regional level. Although flooding is often perceived as a disaster, a degree of flooding (especially from moderate floods) may well be essential for the sustainability of an ecosystem. There is need for improved understanding of

the flooding processes and a requirement for coordination, reporting, and disaster management plans.

Droughts are common phenomena in the region and predominantly affect the south-western parts of the Basin. There are a number of challenges in dealing with droughts, including: poor data networks of climatic and hydrological variables (including water supply); poor information sharing and exchange among Basin States; lack of integrated physical and socio-economic indicators that would facilitate a comprehensive understanding of the magnitude, spatial extent and impacts of droughts, lack of sound drought management plan, and bureaucratic obstacles to efficient implementation.

> "Climate Change is not necessarily negative. Opportunities might be arising, but our ability to address climate change issues within the basin is limited."
> *Regional Expert Meeting*

There is now compelling evidence that an irreversible shift towards a new climatic state, driven by global warming, is underway. The impact of climate change will depend not only on the change in climate, but also on how water resources are managed. The adoption of flexible policies and management approaches which can cope with increasing climatic variability will reduce vulnerability to climate change. One practical implication is that water resource development proposals should consider the effects of climate change on the ability of the proposed schemes to deliver their objectives. Other important areas of climate change adaptation are:

- Better understanding of groundwater and groundwater recharge in the Zambezi Basin
- Selection and adaptation of crops and varieties that are better adjusted to generally higher temperatures and lower rainfall
- Revisiting the logistics of food supply, including storage and regional transport networks, so as to respond to local shortages or emergencies
- Revisiting the operational rules of the main reservoirs in the Basin and more in general drought and structural and non-structural flood management procedures – to take into account possible larger fluctuations in surface runoff

The international focus on climate change mitigation and adaptation brings with it opportunities to finance sustainable development in the Basin, including the prevention of land degradation and afforestation/reforestation measures.

This is summarized in the following four issues:

1. Extreme variability and uneven distribution of rainfall is likely to be amplified by climate change (3.1)
2. Lack of integrated flood management in development planning (3.2)
3. Poor drought management and integration in development planning (3.3)
4. Inadequate coping mechanisms for climate change (3.4)

3.4 Basin-wide Cooperation and Integration

At present there is no single organisation with responsibility for water resources management of the Zambezi Basin as a whole. The steps taken so far to establish the Zambezi Watercourse Commission will go a long way to address this problem, once the agreement has been ratified and comes into force.

The following broad steps in the institutional cooperation mechanisms can be foreseen:

- Coordination and consultation on major hydraulic works
- Joint investment planning of consumptive water use
- Coordinated operational management
- Harmonization of water use licensing in the full basin context
- Promoting the development of basic infrastructure that allows the sharing of benefits, in particular regional electricity grids, road networks and improved navigation.

With such important issues on the horizon, the responsibility of ZAMCOM to address them is obvious. The development of the ZAMCOM (Interim) Secretariat will be of paramount importance to address issues such as these. There are many gains to be made and a short and medium term agenda is proposed in Table 5.2 and Table 5.3.

Institutional capacity of the water management institutions, both at national level as well as at the regional level, is the Achilles heel of the sector. Water management institutions lack adequate financial resources not only for capital investment but even for normal operations. However, great leaps forward have been made in the last 10 years due to dedicated regional leadership, effective regional water research programmes and capacity building networks. The deficiency of the existing institutional capacity is still apparent when looking at the issue of hydro-meteorological monitoring, multi-sectoral planning and environmental management, including the use of Strategic Environmental Assessments (SEAs) and Environmental Impact Assessments (EIAs) of envisaged infrastructural projects. Addressing these aspects in the basin context is one strategy that could be explored to enhance institutional capacity.

A sound basis for tackling the Zambezi Basin water resources development and management issues lies in good knowledge of the resources, its people and services. In general, data availability to support an acceptable level of planning in the Zambezi Basin is inadequate. In particular it is worth pointing out the paucity of data on groundwater – extent, types, distribution, and quality. There is also inadequate knowledge on water demands, their locations, or valuations. An illustration of this is the poor state of knowledge on environmental flow requirements, or even baseline water quality in a number of streams in the region.

> "Resuscitate the way we monitor our flows in ways that work and are reliable. Keep it simple!"
> *Regional Expert Meeting*

The collection, processing and storage of hydrometric data is done by Basin States primarily through various Government ministries and departments, many of whom are centralised. Data collection networks are declining, rather than increasing, in almost all Basin States. Lack of real time data (in the case of floods) or long term records (in the case of droughts) severely hampers flood management and drought mitigation measures. Information sharing and exchange has been improving lately, but it is being hampered by lack of protocols for data sharing (what data can be shared, cost of data, levels of access); and lack of common standards for data processing and storage. ZAMWIS, which has been developed in parallel with the IWRM Strategy formulation, presents an excellent starting point to address this problem. Its success depends on the vital role of Basin States in contributing and updating data and information to ZAMWIS. A related issue is that ZAMWIS requires an institutional base where its functions can be sustained.

Water resources management touches upon interests and views of various parties or interest groups. Stakeholder participation in water resources management in the Zambezi Basin is not

yet well established. There are a number of issues, including national and regional legislation doesn't support institutions for facilitating stakeholder participation, inadequate knowledge sharing at all levels and between local, national and regional (basin) levels; lack of effective representation of stakeholders at decision levels and weak capacities of stakeholders, particularly at local levels, to understand and implement principles of IWRM.

Thus, the following five issues are presented:

1. Absence of a river basin organisation for the whole Zambezi Basin (Zambezi River Basin Organisation not yet established and operational) (4.1)
2. Weak capacity of national water management institutions to perform river basin management tasks (4.2)
3. Inadequate water resources knowledge base for Basin-wide planning, development and management (4.3)
4. Inadequate effective stakeholder participation in water resources development and management (4.4)

3.5 Options Analysis

The Strategy is essentially the set of options determined to be the best measures for addressing the issues affecting water resources development and management in the Zambezi basin. Thus strategy formulation provides the occasion and opportunity to analyse strategic options for the Zambezi Basin. Options analysis was a logical step following identification of issues. For a number of issues (as discussed in the previous section) there is hardly any choice or discussion of optimum option; there is only one way to address the issue, and the question is not so much whether but when and in which sequence to implement the solution. The strategic option therefore is reduced simply to project design, determining scope of development, the timing, and the associated costs.

Options analysis was a key component of the consultative workshops conducted in the riparian states with National Steering Committees, and also the Basin Forum Meeting and the Regional Expert Meeting. While the options analyses were primarily subjective (group discussions), the results present synthesis of collective knowledge, experience and expertise; hence greater weightage was given to the outputs of these consultative meetings.

There are some issues/challenges with a number of options that present mutually exclusive choices as to what should be done or not, following the IWRM Strategy. There are three main areas of discussion that have a very large bearing on the development of the Zambezi Basin and regional cooperation:

- The extent of hydropower development: follow a low, medium or high ambition scenario?
- The extent of irrigation development; following medium ambition or high ambition scenario?
- The nature of ZAMCOM: a water management organization or a regional development organization?

3.5.1 Hydropower Development Options

The hydropower potential of the Zambezi Basin is presented in Table 3.1. The main new sites are depicted in Annex 1, Map 36 and Annex 2. The table is a long list of possible systems, whose feasibility in terms of water/energy productivity, social, environmental and financial viability varies widely.

Table 3.1 Hydropower potential of the Zambezi Basin

Sub-basin	Power plant/ reservoir	River	Capacity	Mean annual generation		FSL ****	Surface area ****	Annual evaporation	
			(MW)	(GWh)	(%)	(m)	(km^2)	(Mm^3)	(%)
2	Cahora Bassa II	Zambezi	1,200	6,800	12.6				0.0
	Mepanda Uncua	Zambezi	2,000	10,524	19.5	205	80	174	0.9
	Boroma	Zambezi	444	3,240	6.0	142	30	65	0.3
	Luapata	Zambezi	654	4,960	9.2	125	335	730	3.7
	Ancuaze- Sinjal I	Zambezi	330	2,230	4.1	98			0.0
	Ancuaze- Sinjal II	Zambezi	600	4,460	8.2				0.0
	Chemba	Zambezi	1,040	8,740	16.2	98	1,400	3,052	15.5
	5.8	Revubue	36	155	0.3	600	80	174	0.9
	5.9	Revubue	110	310	0.6	520	8	17	0.1
	5.13	Revubue	85	380	0.7	260	100	218	1.1
	7.6	Luia	267	600	1.1	300	100	218	1.1
	7.11	Capoche	60	250	0.5	440	220	480	2.4
3	Kapichira II	Shire	64		0.0				0.0
	Lower Fufu	S. Rukuru/ N. Rumphi	90	570	1.1	820	0.3	1	0.0
	Songwe	Songwe	150	930	1.7				0.0
	Masigira	N. Ruhuru	118	630	1.2	938			0.0
	Rumakali	Ruhuru	222	1,320	2.4		1.8	3	0.0
		Rumakali			0.0	2,055	13	14	0.1
4	Mpata Gorge	Zambezi	640		0.0		1,190	2,380	12.1
5	Lusiwasi Ext.	Lusiwasi	40	49	0.1		7.5	12	0.1
6	Victoria Falls Ect.	Zambezi	390		0.0				0.0
	Victoria Falls (Zim)	Zambezi	300		0.0				0.0
	Kariba North** Ext.	Zambezi	300		0.0				0.0
	Kariba South*** Ext.	Zambezi	300		0.0				0.0
	Katombora	Zambezi			0.0	940	7,733	10,826	55.1
	Batoka Gorge	Zambezi	1,600	4,700	8.7	770	37.3	56	0.3
	Devil's Gorge	Zambezi	1,240 *		0.0	595	762	1,219	6.2
7	Lower Kafue	Kafue	600	3,000	5.5	582	0.3	1	0.0
	Itezhi- Tehzi	Kafue	80		0.0				0.0
12	1	Lumbage	1	11	0.0				0.0
	2	Zambezi	4	32	0.1				0.0
	3	Zambezi	2	19	0.0				0.0
	4	Luvua	1	10	0.0				0.0
	5	Luizavo	11	100	0.2				0.0
	6	Ludevu	3	26	0.0				0.0
	7	Lumache	1	5	0.0				0.0
	8	Lufuige	2	16	0.0				0.0
	9	Macondo	3	25	0.0				0.0
Total			***12,988***	***54,092***	***100***		***12,098***	***19,640***	***100***

Source: Rapid Assessment, 2007

* Personal Communication by ZRA

** Kariba North Bank is in the process of up rating its capacity to 720 MW

*** Kariba South Bank has already up rated its capacity to 750 MW

**** Surface area calculated on Full Supply Level (FSL)

The construction of the Katombora barrage upstream of the Victoria Falls, for example, would regulate the falls, which is a World Heritage site. This is one example of a project in the long list that under current circumstances may not be highly feasible on account of its environmental impacts. Other projects in the long list score a lot better.

The foreseeable future will involve increased development of hydropower in the region to cope with the increased demand for energy in the Basin countries and the Southern African region as a whole. However, the full development indicated in Table 3.1 is unlikely to be realised over the next decades, as more detailed technical, economic and environmental feasibility of the schemes is established. Consequently the projected demand (up to 2025) on water resources development for hydropower does not correspond to the envisaged full hydropower potential of the Basin.

The Southern African Power Pool (SAPP) power expansion plan (Alternative Case Expansion) over the period up to 2025 envisages development of almost all power plants in the Kariba Sub-basin (No. 6), those in the Shire River/Lake Malawi/Nyasa/Niassa Sub-basin (No. 3), Kafue Sub-basin (No. 7) and the two major power sites (Cahora Bassa II and Mepanda Uncua) in Tete Sub-basin (No. 2). This set of power plants was selected to permit an integrated generation and transmission expansion plan offering full benefits of power pooling through the region – capacity balance, energy balance, system reliability and economies in investment costs and operation and maintenance. Adopting this development package as the total expansion of the hydropower system, the total power development is estimated at approximately 53% (6,616 MW) of the total hydropower potential, and only about 1% (249 Mm^3) of the annual evaporation.

In addition to the above combination of power plants there is also significant potential for small hydropower production, especially in the upper catchments of the Basin and in the Shire River/ Lake Malawi/Nyasa/Niassa sub-basins. The SAPP power expansion plan envisages development of 24 MW of small hydro per year over the period 2006 – 2025.

3.5.2 Irrigation Development Options

The Rapid Assessment presented an overview of the combined irrigation development plans of the riparian countries, which is in line with the high development scenario of a recent World Bank review (2006).

Agriculture in the Zambezi Basin is largely rain-fed, and about 5.2 million hectares are cultivated annually. The area under irrigation is only about 3% of the total cultivated area. There exists significant potential for irrigation and a number of states have ambitious plans for expanding irrigation. The maximum projected new irrigated area developed by 2025 would be 467,385 ha, almost threefold increase from 171,621 ha at present.

On the basis of this maximum projected irrigation development two scenarios are used to assess future irrigation water requirements. The first scenario is the full development scenario, based on these projections. The second scenario is a 50% achievement of the maximum projection of newly developed area. A number of reasons may trigger the second scenario:

1. The limited capacity to develop new irrigation system in the Basin at the level of professionals, technicians and equipment suppliers
2. Constraints in transport infrastructure, making a steep expansion in farm production non-feasible

3. Increased scarcity of feasible sites, making it more difficult to develop new irrigation systems at acceptable cost

A modest (50%) expansion of irrigated agriculture seems more likely than the maximum expansion envisaged under the riparian states' development plans. This level of expansion would be used for assessing future water demand for irrigation. It is also important to synchronize plans in the different countries. Prima facie there are ample water resources in the Basin, but in different locations the area-specific water availability also in years of drought needs to be assessed as well as the impact on existing water uses, as a standard procedure for the development particularly of the more ambitious new irrigation developments.

3.5.3 ZAMCOM Development

Zambezi Watercourse Commission (ZAMCOM) is designed to be a water management organization for the Zambezi Basin as a whole. 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. The Commission, according to Agreement, is expected to perform the following functions:

- Collect, evaluate and disseminate all data and information on the Zambezi Watercourse as may be necessary for the implementation of this Agreement
- Promote, support, coordinate and harmonise the management and development of the water resources of the Zambezi Watercourse;
- 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 matters
- Advise Member States on measures necessary for the avoidance of disputes and assist in the resolution of conflicts among Member States with regard to the planning, management, utilization, development, protection and conservation of the Zambezi Watercourse
- Foster greater awareness among the inhabitants of the Zambezi Watercourse of the equitable and reasonable utilization and the efficient management and sustainable development of the resources of the Zambezi Watercourse;
- Cooperate with the institutions of SADC as well as other international and national organisations where necessary
- Promote and assist in the harmonization of national water policies and legislative measures
- Carry out such other functions and responsibilities as the Member States may assign from time to time
- Promote the application and development of the agreement according to its objective and the principles.

To guide the development and management of water resources in the basin, the Commission, through its executive arm, the Secretariat, is required to develop a "Strategic Plan" defined in the Agreement as "master development plan comprising a general planning tool and process for the identification, categorisation and prioritisation of projects and programmes for the efficient management and sustainable development of the Zambezi Watercourse". Clearly, ZAMCOM will be responsible for all water management issues. However, it is certainly not a regional development organization; that is the responsibility of SADC.

At present progress on ZAMCOM has been less than what was expected or hoped for. Ratification of the Agreement is still slow three years after signing of the agreement. This being the case it is proposed to be realistic and cautious with respect to short and medium term cooperation on the Zambezi.

"Harmonization of national water policies is a pre-requisite to basin-wide management and cooperation."
Tanzania National Stakeholder Consultation

It is therefore proposed that the future ZAMCOM focuses primarily on transboundary water management issues and has a supportive and facilitating role in addressing generic water issues in the Basin that are primarily riparian in nature. Similarly, ZAMCOM or its predecessor structures should coordinate and liaise with larger regional development activities and make strong link with water resources development and the development of other infrastructure and facilities. This would allow time for institutional development of ZAMCOM as well as riparian state institutions, facilitate confidence building, build knowledge base for basin-wide water resources management and basin cooperation. This would then set a sound foundation for future river basin management.

This change in emphasis in the role of ZAMCOM is reflected in the proposed Strategy Implementation Plan (see Table 5.3).

4 Main Strategies

This Chapter presents the main strategies for the Zambezi Basin. The strategies and proposed actions respond to the main challenges and their components. Table 4.1 is an overview of all challenges, strategies and proposed actions.

4.1 Integrated and Coordinated Water Resources Development

The Strategic Objective under the Challenge of Integrated and Coordinated Water Resources Development and Management is to *"Develop and manage water resources so as to serve social and economic development in the Basin".* Water resources development and management should serve many purposes – hydropower and irrigation, but also fishery, aquatic weed control, flood plain agriculture, flood control and the sustenance of environmental flows – and benefits and costs should be shared.

This Strategic Objective translates into a number of strategies that are discussed below. These strategies should be read in close conjunction with other strategies, in particular in the field of mainstreaming of environment and adaptation to current and future climate variability. The strategies to achieve integrated and coordinated water resources development are:

1. Address the high demand for new water infrastructure to meet regional energy security (1.1)
2. Address the demand for water in agricultural development and regional food security (1.2)
3. Improve operation of existing and new major dams in the Basin to take into account and optimise multiple functions of water (1.3)
4. Increase funding for water resources development and management (1.4)
5. Improve access to sustainable Water Supply and Sanitation (1.5)

In quantitative terms there are two important demands on water resources development in the Zambezi Basin – water for energy and water for agriculture. These two sectors are already the main water consumers, but it is inevitable that these sectors will put an even larger demand on Zambezi water resources in the future. In the previous Chapter different scenarios were presented by way of options, as to the intensity and pace of hydropower development and irrigation expansion over the next fifteen to twenty years.

Table 4.1 Overview of all strategies and actions proposed

Overall Objective	***Equitable sustainable utilisation of water for social and environmental justice, regional integration and economic benefit for present and future generations***			
Challenge	Integrated and Coordinated Water Resources Development and Management (1)	Environmental Management and Sustainable Development (2)	Adaptation to Climate Variability and Climate Change (3)	Basin-wide Cooperation and Integration (4)
Strategic Objective	*Develop and manage water resources so as to serve social and economic development in the Basin*	*Mainstream environment in the development and management of water resources in the Basin*	*Adapt water resources management to current and future climate variability and change*	*Operationalize the institutional frameworks in support of basin-wide water resources development and management*
ISSUES	▪ Inadequate water infrastructure for achieving regional energy security (1.1) ▪ Insufficient water infrastructure for agricultural development to achieve regional food security (1.2) ▪ Major dams in the Basin were constructed for a single purpose and their operation is not optimised for multiple uses (1.3) ▪ Inadequate financing of water resources development and management (1.4) ▪ Low access to Water Supply and Sanitation (1.5)	▪ Inadequate protection and sustainable development and use of wetland (2.1) ▪ Deterioration of water quality due to point pollution from mining, industrial and urban centres (2.2) ▪ Proliferation of invasive aquatic weeds (2.3) ▪ Unsustainable and low-productivity fisheries management (2.4) ▪ Tourism development is threatened by degradation of the aquatic environment (2.5) ▪ High-value and unique eco-systems and related ecological and economic functions in the Basin may be threatened and fragmented by accelerated development (2.6)	▪ Extreme variability and uneven distribution of rainfall is likely to be amplified by climate change (3.1) ▪ Lack of integrated flood management in development planning (3.2) ▪ Poor drought management and integration in development planning (3.3) ▪ Inadequate coping mechanisms for climate change (3.4)	▪ Absence of a river basin organisation for the whole Zambezi Basin (Zambezi River Basin Organisation not yet established and operational) (4.1) ▪ Weak capacity of national water management institutions to perform river basin management tasks (4.2) ▪ Inadequate water resources knowledge base for Basin-wide development and management (4.3) ▪ Inadequate effective stakeholder participation in water resources planning, development and management (4.4)
STRATEGIES	▪ Address the high demand for new water infrastructure to meet regional energy security (1.1) ▪ Address the demand for water in agricultural development and regional food security (1.2) ▪ Improve operation of existing and new major dams in the Basin to take into account and optimise multiple functions of water (1.3) ▪ Increase funding for water resources development and management (1.4) ▪ Improve access to sustainable Water Supply and Sanitation (1.5)	▪ Adequately manage the ecological and economic functions of wetlands and sustain their viability (2.1) ▪ Control water pollution from point sources – especially from urban centres and mining areas (2.2) ▪ Control invasive aquatic weeds and prevent new outbreaks (2.3) ▪ Promote sustainable fishery management as a contribution to regional food security (2.4) ▪ Ensure water resource development and management does not harm tourism potential (2.5) ▪ Prepare and implement strategic environmental plans and procedures including the development of area networks (2.6)	▪ Improve the knowledge base on climate variability and climate change and their impacts on water resources (3.1) ▪ Improve flood management and mitigation mechanisms at national and regional scale (3.2) ▪ Improve regional and national drought management (3.3) ▪ Develop regional capacity to adapt to climate change and make use of the development opportunities associated with global climate change mitigation (3.4)	▪ Operationalise the institutional frameworks in support of basin-wide water resources development and management and discuss issues of inter-basin transfer (4.1) ▪ Strengthen organisational, financial and human resource capacities of water management institutions at regional, national and local levels (4.2) ▪ Improve and expand Basin-wide water resources data collection, processing and information transfer systems (4.3) ▪ Promote broad-based stakeholder participation in water resources development and management (4.4)

Overall Objective	***Equitable sustainable utilisation of water for social and environmental justice, regional integration and economic benefit for present and future generations***			
Challenge	Integrated and Coordinated Water Resources Development and Management (1)	Environmental Management and Sustainable Development (2)	Adaptation to Climate Variability and Climate Change (3)	Basin-wide Cooperation and Integration (4)
Strategic Objective	*Develop and manage water resources so as to serve social and economic development in the Basin*	*Mainstream environment in the development and management of water resources in the Basin*	*Adapt water resources management to current and future climate variability and change*	*Operationalize the institutional frameworks in support of basin-wide water resources development and management*
MAIN ACTIONS	(1.1) ▪ Joint development of feasible package of major hydropower sites, taking into account multiple functions in coordination with SAPP ▪ Identify and promote options for small scale hydropower development	(2.1) ▪ Improve the wetland related regulation and management between riparian countries ▪ Assess and maintain environmental flows appropriate to each river section ▪ Develop management plans for all the major wetlands in the Basin taking into account the different wetland functions ▪ Develop and implement special initiatives for environmental management around hotspots	(3.1) ▪ Carry out comprehensive assessment of the vulnerability of basin water resources to climate variability and climate change	(4.1) ▪ Encourage signing and ratification of the ZAMCOM Agreement and establish and operationalise ZAMCOM – through promotion of targeted measures to raise awareness of benefits of basin-wide management of water resources, ▪ Establish Interim ZAMCOM Secretariat ▪ Develop public information function of Interim Secretariat and later ZAMCOM Secretariat ▪ Strengthen coordination with ongoing programmes in the Basin (SADC/ COMESA/SAPP/NEPAD/Waternet/ IUCN/WWF/HYCOS/World Bank), including management commissions of sub-basins (Joint Water Commission, ZRA)
	(1.2) ▪ Support the development of agriculture through basic facilities such as reliable input supply and better road networks ▪ Expand irrigated agriculture ▪ Promote and support the restoration and sustainability of flood plain agriculture ▪ Enhance the productivity of rain-fed agriculture through improved water management options	(2.2) ▪ Set up integrated water quality monitoring system ▪ Harmonize legislation and enforcement systems ▪ Promote clean technology	(3.2) ▪ Integrate flood management in development planning ▪ Develop and implement effective land use planning ▪ Strengthen and encourage collaboration of existing early warning institutions ▪ Dovetail the operation of major water infrastructure to optimize flood storage ▪ Formulate comprehensive flood preparedness and flood response mechanisms, making use of regional good practice	(4.2) ▪ Develop and implement performance based training programmes on water resources management based on institutional development assessments ▪ Implement well-designed plan to harmonise water resources management policies, legislation and strategies of the basin states

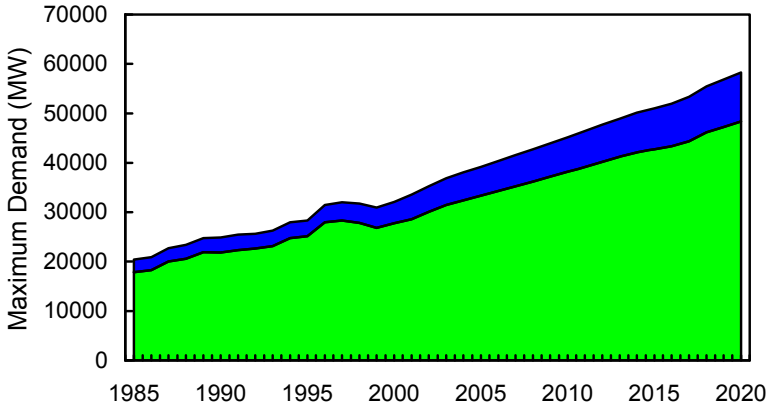
Overall Objective	***Equitable sustainable utilisation of water for social and environmental justice, regional integration and economic benefit for present and future generations***			
Challenge	Integrated and Coordinated Water Resources Development and Management (1)	Environmental Management and Sustainable Development (2)	Adaptation to Climate Variability and Climate Change (3)	Basin-wide Cooperation and Integration (4)
Strategic Objective	*Develop and manage water resources so as to serve social and economic development in the Basin*	*Mainstream environment in the development and management of water resources in the Basin*	*Adapt water resources management to current and future climate variability and change*	*Operationalize the institutional frameworks in support of basin-wide water resources development and management*
MAIN ACTIONS contd.	(1.3) ▪ Develop appropriate river simulation models to identify the influence of dam operations on the downstream flow regime, including unregulated tributaries ▪ Optimize multi-purpose management of existing reservoirs	(2.3) ▪ Harmonize the legislation on the control of aquatic weeds ▪ Set up national focal points on aquatic weed control ▪ Initiate regional capacity building ▪ Initiate joint monitoring and survey of aquatic weeds ▪ Adjust reservoir operations (incl. provision for weed control)	(3.3) ▪ Support development of drought management plans, including local irrigation development, improved food stock logistics, crop adaptation and drought insurance ▪ Mainstream drought forecasting in water resources planning and management	(4.3) ▪ Formulate and implement a data and information sharing protocol for further operationalization of ZAMWIS ▪ Harmonize data measurement and storage methods in basin ▪ Improve basin-wide data (water quality and quantity measurements, sediment content, groundwater) collection systems ▪ Priority improvement of data and knowledge base on groundwater resources ▪ Further development of ZAMWIS (increasing accessibility and interactivity and developing models and DSS tools) ▪ Strengthen basin-wide research on water resources through joint programmes, collaboration of research institutions, and enhanced information exchange
	(1.4) ▪ Improve overall investment climate to make water development infrastructure financing more attractive ▪ Develop mechanisms for local infrastructure co-financing ▪ Raise awareness of the vital role of the water sector in economic development and poverty alleviation	(2.4) ▪ Collaborate with NEPAD programme towards improving fisheries productivity. ▪ Integrate fisheries development with water resources development – new reservoir operating rules, fishery production, provision for fish migration	(3.4) ▪ Integrate strategies to deal with climate variability and climate change in national socio-economic development planning ▪ Exploit development opportunities under global climate change protocols for afforestation and reforestation at national level ▪ Setup a regional centre of excellence to document and support activities for effective adaptation to climate variability and climate change	(4.4) ▪ Strengthen stakeholder participation through policy and legislation review and revision throughout the basin states ▪ Formulate and implement a public information programme to raise awareness among a broad range of stakeholders ▪ Strengthen and sustain the Annual Basin Forum meetings as part of awareness and information sharing among basin stakeholders

Overall Objective	***Equitable sustainable utilisation of water for social and environmental justice, regional integration and economic benefit for present and future generations***			
Challenge	Integrated and Coordinated Water Resources Development and Management (1)	Environmental Management and Sustainable Development (2)	Adaptation to Climate Variability and Climate Change (3)	Basin-wide Cooperation and Integration (4)
Strategic Objective	*Develop and manage water resources so as to serve social and economic development in the Basin*	*Mainstream environment in the development and management of water resources in the Basin*	*Adapt water resources management to current and future climate variability and change*	*Operationalize the institutional frameworks in support of basin-wide water resources development and management*
MAIN ACTIONS contd.	(1.5) ▪ Expand coverage of water supply and sanitation services in rural and urban areas	(2.5) ▪ Systematically integrate tourism development in water resources planning, development and management ▪ Develop catchment management plans incorporating areas of tourism value such as game management areas and wetlands. ▪ Operation of water infrastructure to support and enhance tourism management		
		(2.6) ▪ Prepare a comprehensive and spatially explicit map of ecosystems services ▪ Delineate high priority conservation areas such as headwaters, recharge zones and flood plains and implement land use plans for these areas ▪ Start international cooperation on linking areas with high significance for biodiversity ▪ Develop and implement guidelines for the use of proper EIAs and SEAs in development planning		

4.1.1 Address Demand for Water Infrastructure

Power shortages have become acute in the Basin and early 2008 even resulted in the temporary suspension of power trading between countries. For the entire SADC region power consumption has been increasing at a rate of about 3% per annum, implying an additional requirement of 1,200 MW per year (see Figure 4.1). The increase in demand may even accelerate, as most Basin countries have set themselves ambitious targets for economic growth – in most cases exceeding 5% per year. As much as 92 to 99% of the rural population of the Basin countries and 13-74% of the urban population (World Bank 2007) does not have access to electric connections yet, seriously affecting the quality of life. Biomass burning is still the primary source of energy. Hence effective electricity coverage needs to go up. Important economic sectors, such as mining, depend on reliable power supply. The main power consumer in the SADC region is South Africa and this is expected to remain so in the foreseeable future. The demand for electricity in the fast growing economy of South Africa creates demand for energy export from the Basin. Against all these backgrounds, increased and reliable supply of power is indispensable.

Figure 4.1 Southern Africa power forecasts



Source: Feasibility Study for Mepanda Uncua and Cahora Bassa North

The Zambezi Basin has considerable potential for hydropower development. Several sites have been identified, some at reconnaissance levels, others at pre-feasibility level. The medium development option – described in Chapter 3 – presents a feasible set of multipurpose hydropower projects and corresponds to the project pipeline proposed by SAPP under the Regional Generation and Transmission Expansion Study for the entire SAPP region (Nexant, 2007). In this study a Base Case and an Alternative Case is proposed. Both cases provide a reasonable set of generating unit additions balanced among peaking, mid-range, and base load units. For the entire SADC Region the Base Case adds about 39,300 MW with greater emphasis on conventional coal-fuelled steam plants. The Alternative Case instead adds about 36,600 MW with greater emphasis on hydro projects and the transmissions needed to move the power to areas of demand. A special feature of the Alternative Case is to connect to Congo (DRC) and move power from it to Angola and South Africa.

As far as hydropower development in the Zambezi Basin is concerned, the difference between the Base Case and the Alternative Case is mainly in the timing of construction of Batoka Gorge, as can be seen in Table 4.2. The total additional installed capacity at Batoka Gorge would be in both cases 1,600 MW. The Kariba extensions will only provide peaking power and reserve capacity; they will not increase overall firm energy before the construction of the Batoka Gorge dam. This

dam would create a reservoir with a surface area at maximum retention of 25.6 km^2. The reservoir would be entirely contained in the gorge and would therefore not result in the displacement of a significant number of people.

Table 4.2 Identified hydropower development options in the Zambezi Basin

Country	Utility	Project	Base Case Capacity (MW)	Base Case Operating Year	Alternative Case Capacity (MW)	Alternative Case Operating Year
Malawi	ESCOM	Tedzani 1 & 2 - Refurbishment	40	2008	40	2008
	ESCOM	Kaphichira II	64	2010	64	2010
	ESCOM	Songwe	340	2014-2016	340	2016
	ESCOM	Fufu			100	2012-2021
	ESCOM	Kholombizo			240	2018-2022
	ESCOM	Mpatamanga			260	2020-2022
Zambia	ZESCO	Kariba North - Refurbishment	120	2008	120	2008
	ZESCO	Itezhi-Tezhi	120	2009	120	2009
	ZESCO	Kariba North - Extension	360	2010	360	2010
	ZESCO	Kafue Gorge Lower	750	2014	750	2014-2016
	ZESCO	Batoka Gorge North	800	2015	800	2019-2024
Zimbabwe	ZESA	Kariba South - Extension	300	2012	300	2012
	ZESA	Batoka Gorge South	800	2015	800	2019-2024
Mozambique	EdM	Mepanda Uncua	1,300	2020	1,300	2015-2020
	EdM	HCB North Bank			850	2017-2018
		Total	***4,994***		***6,444***	

Source: Regional Generation and Transmission Expansion Study (Nexant, 2007)

The time to prepare and develop a hydropower project is considerable. At the same time new projects should be prepared in an integrated manner to accommodate and optimize the different functions in water resource management. According to SAPP the most promising projects in terms of cost-output and in terms of possible negative side effect in the Zambezi Basin are in Mozambique, Zambia and Zimbabwe. In Zambia the refurbishment and extension projects of Kariba North and Itezhi-Tezhi would have a short gestation time. The 750 MW Lower Kafue Gorge scheme and the 1,600 MW Batoka George Project (together with Zimbabwe) can make a substantial contribution to power supply.

In Mozambique, expansion of power generation has been studied recently, considering Mepanda Uncua, Cahora Bassa North and Boroma. An ultimate development comprising Mepanda Uncua with 2,400 MW, plus Cahora Bassa North 600 MW, plus Boroma 160 MW (implemented in stages) was found to be economically attractive. It was concluded that the development of Mepanda Uncua was a logical first step in the development. The project could supply both Mozambique and South Africa. The Cahora Bassa North project would be constructed at the site of the existing Cahora Bassa hydropower station. The focus of the development will be a substantial powerhouse complex with an installed capacity of 850 MW with its network of hydraulic power and access tunnels. Estimated investment cost is EUR 403 million plus EUR 418 million for transmission. The

expected average power output would be 2,835 GWh/year. This project was relatively costly because of the high transmission costs, but it is becoming feasible again with the recent sharp increase of fossil fuel prices.

The Mepanda Uncua project site is located some 61 km downstream of the Cahora Bassa dam. The project comprises a development dominated by a 110 m high dam impounding a reservoir with a surface area of some 100 km^2. It would have an installed capacity of 1,300 MW and would require an investment of EUR 950 million plus EUR 866 million for transmission. The expected average power output would be 9,070 GWh/year. This project seems highly attractive economically.

The discussion on major hydropower infrastructure should not distract from the potential of small scale hydropower development in the Basin, particularly in areas that are remote from transmission lines. Recently, there have been technology breakthroughs and cost reductions and with the popularization of these energy options in Asia more improvements could be expected. Small hydropower units can harnesses energy from flowing or falling water from rivers, rivulets, storage dams or canal drops, even as low as one metre. Small run-of-river hydropower units can act as an important non-polluting renewable source of energy at a cost that is considerably less than wind or solar energy. Start-up costs depend on the size and design of the system but for very small systems investment costs start from USD 300. Small hydropower units can be integrated with the local power grid if excess energy is produced. Site selection is obviously important and there may be low-power delivery during dry periods.

The following main actions are proposed:

1. The accelerated and joint preparation of a feasible package of major hydropower sites, taking into account the multiple functions of the infrastructure and the feasibility in terms of costs, overall evaporation, land inundated, resettlements, and down stream functions affected. This should be done with the ongoing work of SAPP – but with additional impetus from the Basin Countries
2. The identification and promotion of small scale hydropower

4.1.2 Support Agricultural Development

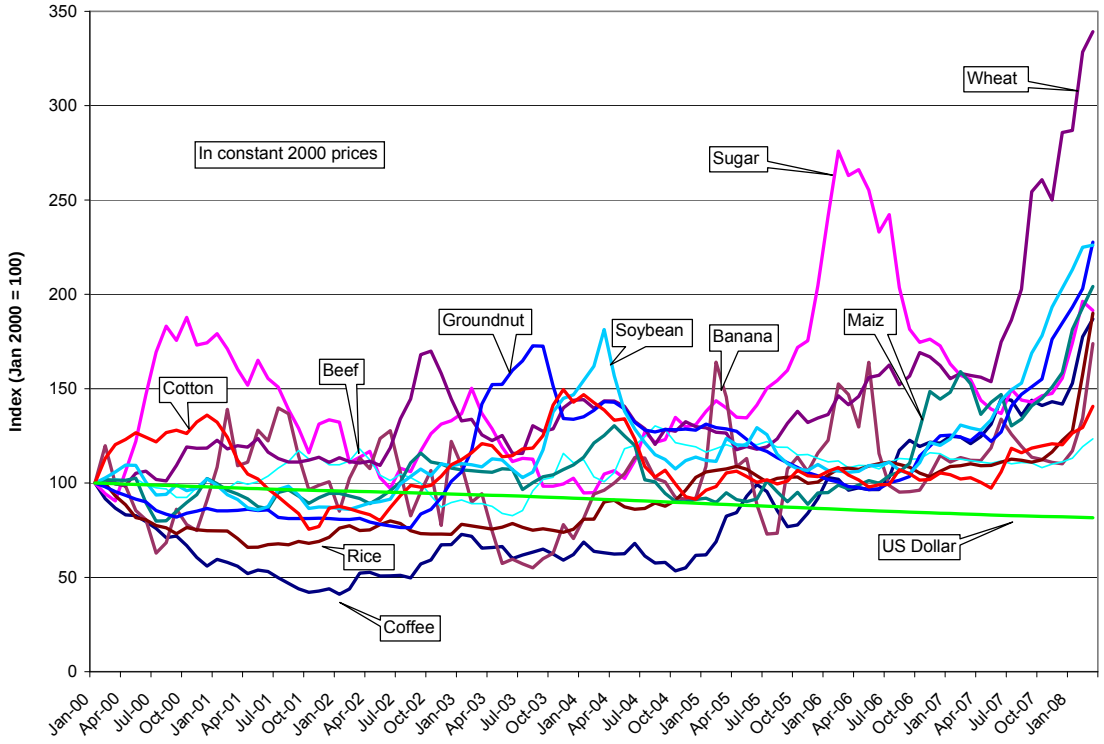
Throughout the Zambezi Basin agricultural development is seen to hold the key to poverty alleviation and economic growth. This is reflected in the national development policies of the riparian countries. To achieve the Millennium Development Goals on halving the population in poverty, the Comprehensive Africa Agriculture Development Programme (CAADP) of NEPAD sets a goal of improving agricultural productivity at an average growth rate of 6% per year. Already now agriculture growth is a significant component of Gross Domestic Product (GDP) growth in Zimbabwe (50%), in Tanzania (40%) and in Mozambique (20%).

> "The water demand in the rural areas is much higher than the actual use."
> *Malawi National Stakeholder Consultation*

Agricultural commodity prices have reached levels not seen for decades. Figure 4.2 shows the mounting trend for all important crops in the Basin. The high prices seem structural rather than incidental, because they are caused by the demand for bio-fuels (replacement of staple crops with bio-diesels and the conversion of staple crops such as maize to a source of ethanol) and food & feed demand from fast growing economies in Asia. The high world market prices may taper off as globally unutilized agricultural land comes (back) into production, but the expectation is that

agricultural prices will stabilize at a high plateau. Lower food reserves and higher prices raise the issues of regional food security for the Zambezi Basin. In the short to medium term they may spell the end of cheap food imports. With the exception of Malawi and Zambia, all Basin countries are net food importers (see Table 4.3). The changes in the global commodity economy show the large vulnerability to food deficits.

Figure 4.2 Volatility of prices of selected agricultural commodities 2000-07



Source: Based on World Bank Commodity Prices and inflation data

Table 4.3 Net cereal import requirements and estimated import bill 2007/08

	Maize (10^3t)	Wheat (10^3t)	Rice (10^3t)	Net import requirements (10^3t)	Total import bill (M USD)*
Angola	102	425	230	757	363
Botswana	155	96	36	287	114
Malawi	-510	60	1	-449	-123
Mozambique	-105	410	340	645	346
Namibia	67	60	0	127	51
Zambia	-244	30	19	-195	-49
Zimbabwe	508	125	22	655	229

Source: FAO (January 2008, Tanzania not included) * At November 2007 import parity prices.

Increased agricultural production in the Basin is urgently needed for economic survival and poverty reduction. To realise this, several African governments[2] have committed to allocating at least 10 percent of their national budgets to agriculture. This was agreed at the African Union meeting in

[2] Including Angola, Botswana, Malawi, Mozambique and Namibia.

Maputo, 2003. The consensus is that agricultural growth can be triggered by a number of investments, in particular:

- Poor infrastructure reduces farmers' access to markets and agricultural inputs, such as fertilisers. Developing transport networks between cities and rural areas will help farmers to benefit from new technologies and agricultural inputs, as well as raising incomes if they can sell their crops at markets. Better infrastructure will also speed up the delivery of food aid in crisis situations
- Intensified agricultural research should be leading not to a massive green revolution but rather to a series of smaller 'rainbow evolutions'. These are localised technological developments that respond to the varied and different contexts in the Basin
- Fertilizer prices in sub-Saharan Africa were USD 232 to USD 487 per tonne for urea and phosphates; whereas prices in Asia were between USD 68 to USD 201 over the same period. The use of fertilisers in sub-Saharan Africa is low, combined with the generally poor soils (see also Annex 1, Map 3), which results in the world's lowest crop yields
- Extending the area under sustainable land management and reliable water control systems, in particular by increasing access to perennial irrigation and safeguarding the reliability of flood based production systems.

Irrigation is directly related to water resources development and management in the Zambezi Basin. By increasing irrigation and safeguarding the productivity of flood-based systems, water resources development may be expected to make a significant contribution to agricultural productivity and regional food security. The promotion of irrigation will reduce the regional exposure to climate variability (see also Section 4.3). Perennial irrigation development is likely to be based on the use of tributaries, both through run-of-river systems or small reservoirs, and on the use of groundwater.

All Basin countries have projected new irrigation developments by 2025. If all these plans would materialize, the new irrigated area developed would be 467,385 ha (see Table 4.4). In addition to the present 171,621 ha, this would bring the total to 639,001 ha. This corresponds to the upper scenario in the study on Sustainable Water Resources Development for Irrigated Agriculture in the Zambezi Basin (World Bank 2006). A number of reasons may cause a lower but still impressive achievement, and hence a target of 50% is more realistic and still commendable:

- The limited institutional capacity to develop new irrigation system in the Basin at the level of professionals, technicians and equipment suppliers
- Constraints in transport infrastructure, making a steep expansion in farm production non-feasible
- Increased scarcity of feasible sites, making it more difficult to develop irrigation systems at acceptable cost

The second main strategy will be to safeguard the productivity of flood based agriculture. The Zambezi Basin includes extensive flood plain areas, such as the Caprivi, Barotse, Luangwa, Liuwa, Kafue Flats and Zambezi Delta, which provide a livelihood to some of its poorest people.

In a context of low population density, flood plain agriculture is highly productive when measured in output per capita, though less in output per land unit. In large parts of the Zambezi Basin, however, land is not necessarily the limiting factor. Flood recession resource systems have several other benefits – such as recharging shallow aquifers; sediment deposits contributing to soil fertility; regenerating rangeland in outwash areas, sustaining fisheries and maintaining wetland functions.

Table 4.4 Maximum projected new irrigation development by 2025

Country	Assumption	New irrigation development by 2025 (ha)
Angola	Development of sugar estates in southern region	20,000
Botswana	Diversion of 400 Mm^3	40,000
Malawi	Development of 74,000 ha up to 2012 – continuing next at 50% of the pace 90% of national cultivated land in the Basin	163,400
Mozambique	New development at 2000 ha/year up to 2012 – accelerating with 50% subsequently and rehabilitation of 5,000 ha	49,000
Namibia	Development of Caprivi Farm	15,000
Tanzania	Limited expansion within the Basin	15,000
Zambia	Development of 70,000 ha up to 2011– continuing next at 50% of the pace 70% of national cultivated land in the Basin	117,600
Zimbabwe	Expansion of irrigated area with 3% annually of basis (84,000 ha)	45,360
Total newly developed irrigated area		***467,385***

Source: Rapid Assessment (Euroconsult Mott MacDonald, 2007)

To promote the productivity of flood plain agriculture two important actions are required. The first is to support the productivity through the various measures described earlier – in particular the promotion of irrigation from groundwater in flood plain areas has a lot of potential, following the examples of similar projects in other African flood plains. The second main action is to reconsider the management of the main current and future reservoir systems, so as to include the release of 'managed floods' and 'e-flows' (see Section 4.1.3). Analysis on the Lower Zambezi for instance indicates that an immediate improvement in the Lower Zambezi flow regime could be made with no impact on hydropower production from the Cahora Bassa reservoir. A two-week release in February of 4,500 m^3/s could be achieved in almost all years. With the present operational rules such a release occurs only in 7% of the years. This outflow would be achieved with 97% power reliability and no reduction in hydropower generation.

The third element – in addition to the specific requirements of flood plain agriculture - to address food security is in increasing the overall productivity of rain-fed and flood-based agriculture. More than 90% of the area in the Zambezi Basin is flood and rain-dependent, higher than the global average. World-wide it has been estimated that food production from rain-fed areas will take care of 75% of the global increase in global food production required to avert hunger. In the Zambezi Basin this is even higher. The most important key to food security hence in the basin is with improving the productivity of rain-fed and flood-based agriculture.

Better seed material is expected to make an important contribution. There has been little renewal or treatment. Loss of crop due to pests is high. A special challenge is the expected increase in temperature over the Basin, which may suppress maize yields, unless genetic renewal takes place. The other key to achieving higher yields in rain-fed areas is better management of soil moisture. Soil moisture is often the most unreliable and often scarce resource in agricultural production in rain-fed farming, so the challenge is to enhance the availability and productivity of water for bio-mass production. There are several ways to enhance soil moisture availability, best used complementarily:

Basic tillage methods – ploughing and planking – are effective in preserving soil moisture. This is essential in rain-dependent agriculture, as there may be a time lag between the arrival of the rain and the sowing of the crops. In conservation tillage a number of practices are promoted that further enhance moisture conservation, in particular deep ripping and sub-soiling (breaking the plough pan). These conservation tillage techniques can result in yield that are 60% higher, as they increase water infiltration and reduce splash and sheet erosion.

There are a number of measures that enhance soil moisture over larger areas, in particular closing drains and gullies in an area. By closing deep gullies soil moisture can improve over large areas. Trials in Zambia and Tanzania indicate the potential to more than double yields of staple crops with limited fertilizer application along permanently ripped planting lines. Conservation agriculture systems maximized rainfall infiltration and reduced the need for animal traction by half.

A final contribution would come from small supplementary irrigation from groundwater to tidy over drought spells and peaked periods of moisture stress in rain-dependent farming system,

The following main actions are proposed:

1. Support the development of agriculture through basic facilities such as road network and agricultural input supply. Though these are not directly in the realm of water management organizations, they have a major impact on the vitalization of agriculture in the Basin.
2. Support the development and promotion of irrigation. This has two elements. First is the promotion of groundwater based irrigation in areas where this is hydrologically and economically feasible. Current services in the groundwater sector are limited and opportunities are not utilized as in many areas even the most basic technology (that has driven agricultural development elsewhere) is not available. The second element is the development of a number of feasible irrigation projects. This can be built on the work done by the FAO Investment Centre on behalf of the New Partnership for Africa's Development (NEPAD) and on other plans. The FAO Investment Centre has prepared National Medium Term Investment Programmes (NMIP) for most of the Basin countries, as part of its support to NEPAD and the CAADP. Based on an assumed long term average unit investment for irrigation of USD 3,000 per ha (not considering storage costs), and a fairly low gross value added of USD 400 per ha per year, the economic viability of irrigation schemes would be about 10%. As part of these studies, a number of Bankable Investment Project Profiles (BIPPs) have been prepared, some of them in the irrigation sector. For Zimbabwe there are the Smallholder Irrigation Development and the Rehabilitation of Smallholder Irrigation Schemes. For Zambia there is the Nega–Nega Smallholder Irrigation Scheme Development Project in the Kafue flats area, for Mozambique there are the Small-scale Irrigation Project II and the Small Dams Rehabilitation and Construction projects. In Malawi the Integrated Water Management and Rural Agricultural Credit project was identified.
3. Ensure the restoration and sustainability of flood plain agriculture by investigating measures for managed flood releases, including their proper introduction. This will require investigation into changed operational rules into e-flows (see next section) as well as their proper introduction, so that the benefits of managed floods can be optimally used.
4. Support initiatives to increase the productivity of rain-fed agriculture through a range of measures, such as better fertilizer availability (without draining public finance through subsidies), promote seed improvement programmes, promotion of animal and mechanical traction (which is essential for conserving soil moisture), revitalized agricultural extension, among others to promote conservation tillage, undertake in-field water conservation and gully-plugging programmes and improved marketing of staple crops. The spectre of

HIV/AIDS means that the focus should be on high productivity and not high labour intensity approaches.

4.1.3 Improve Operation of Major Dams

The multi-purpose operation of existing and future reservoirs is essential to water resource development on the Zambezi Watercourse and its tributaries. Only three existing reservoirs in the Zambezi River Basin have a regulating capacity of significance: Kariba, Cahora Bassa and Itezhi-Tezhi. All others show a regulating ratio (live storage as per cent of average annual inflow) close to zero.

Although only part of the river system is regulated, dam operations in the Basin have a profound effect on downstream water flows. Up to now, operational decisions at the dams have been largely based on hydropower needs. There is much to be gained from integrated and coordinated management of the dams in the Basin, whereby water uses and downstream flow regimes are optimized to include other purposes such as flood mitigation, flood plain agriculture, fisheries, wetland management, wildlife habitats, navigation and even aquatic weed control. The planning and construction of new dams in the Zambezi River will increase the need to develop comprehensive operational rules. It will also increase the scope for conjunctive and integrated water management.

For this purpose, the Zambezi Basin management authorities in a joint effort with the dam operators will need to strive towards developing a Decision Support System (DSS) that incorporates simulation and optimization models. Such models will show to what extent managed floods are feasible and their impact on overall hydropower production. Important work has already been undertaken on the Cahora Bassa (International Crane Foundation), Itezhi-Tezhi (WWF) and Kariba (WWF/IHE/TNC). This work can be elaborated and used as the point of departure to come to new operational rules.

There are two main actions required:

1. Development of a river simulation model. What are the effects of river flows with varying magnitude and duration on downstream locations and livelihoods depending on these parts of the Zambezi River Basin? Which environmental flows are required to serve a multitude of purposes, including flood plain fisheries and agriculture or the sustainability of wetlands? What is the balance between the different functions? Existing data and research will need to be complemented to gain a better insight in these interactions. While some relations can be quantified, other interactions can be clarified and qualified through the involvement of local stakeholders. Setting objectives for water management should be followed by the development of different flow scenario's to address these different objectives.
2. Optimize the multi-purpose management of the existing and planned reservoirs – in particular Batoka and Mepanda Uncua - by using the simulation model. Of special interest will be the release of environmental flow releases from Kariba[3], the managed flooding downstream of the main reservoirs, the added impact of the newly planned reservoirs, the conjunctive management of the main infrastructures and the overall impact of climate change. In addition it is also important to look at the water balance and flow regime for the Basin as a whole and determine the timing and sequence of the development of new water infrastructure as well as

[3] Preliminary analysis suggest that this can be combined with hydropower functions

conjunctive management strategies from the perspective not of the individual reservoir and its immediate downstream effect but for the water course and its tributaries as a whole.

The concept of environmental flows as well as the multi purpose dam operations will need to be supported by wide spread capacity building across the Basin, from riverbank communities to regional energy policy decision-makers.

4.1.4 Increase Funding for Water Resources Development

An important set of measures involve the creation of more infrastructure for water resource management for power, irrigation, flood control, water supply and wastewater treatment (see sub-sections 4.1.1 and 4.1.2). The development of new water infrastructure will generate substantial long-term benefits and revenue streams, but also require formidable investments.

To give an indication of the magnitude of the investments required, Table 4.5 summarizes the estimated cost for hydropower development (for all systems[4]) for the eight riparian countries for the next 20 years, using two scenarios developed by the SAPP. The estimated costs range between USD 3.4 and 5.2 billion.

Table 4.5 Financing Requirements for Hydropower Investments

Country	Utility	Base Case				Alternative Case			
		Generation		Trans.	Total	Generation		Trans.	Total
		M USD	MW	M USD	M USD	M USD	MW	M USD	M USD
Angola	ENE	2,697	2,368	0	2,697	2,209	1,768	94	2,303
Botswana	BPC	6,600	3,630	24	6,624	1,200	1,200	24	1,224
Malawi	ESCOM	510	480	47	557	1,439	1,080	47	1,486
Mozambique	EdM	2,030	1,334	89	2,119	5,365	4,153	1,076	6,441
Namibia	NamPower	640	774	74	714	1,340	760	74	1,414
Tanzania	TANESCO	2,815	1,480	82	2,896	1,187	930	82	1,269
Zambia	ZESCO	2,184	2,150	82	2,266	2,394	2,370	613	3,007
Zimbabwe	ZESA	3,376	3,450	26	3,402	3,715	3,800	1,487	5,202

Source: Regional Generation and Transmission Expansion Study (Nexant, 2007)

It is unlikely that large multipurpose dams will be totally financed by the private sector, especially if the development conditions on the dams also include management of public goods such as sustaining environmental flows or providing flood storage. There are several ways of financing power projects and in each case the public-private partnership will have to be re-crafted. The line between private and public financing is thin: private projects can have public shareholders and public projects can be financed with loans from private financers. Public-private partnership can come in many shapes: service contracts; management contracts, lease operations, Build-Own-Operate-Transfer (BOOT) contracts, concessions or joint ventures.

The role of the riparian governments will be to 'direct, support, facilitate and monitor' such large infrastructure developments. Responsibilities start with early preparation of shared projects, i.e. taking the lead in developing broadly supported project concepts and commissioning sound

[4] Including those outside the Zambezi Basin

engineering studies as well as environmental and social impact assessments. Riparian governments will have to arrange clearance, provide risk sharing guarantees and do the initial structuring of project financing options.

Power projects in the Zambezi Basin have been able to attract private capital – including from the region and from new capital sources, such as the BRIC (Brazil, Russia, India, China) countries. Attracting private capital under favourable terms is helped when effective mechanisms for joint investment by shareholder countries in the Basin are in place and political risk is mitigated. Such preconditions translate in lower financing costs. Financial risk and financing costs are further reduced, if overall governance in the region is up to the mark. The business environment is reflected in three independent indicators (Table 4.6), showing that there are substantial differences in the Basin and that there is scope for improvement.

Table 4.6 Ranking of Basin countries on business environment indices

Country	Ease of doing business	Ibrahim index of African governance	Corruption perception
Angola	167	42	147
Botswana	51	3	38
Malawi	118	12	118
Mozambique	134	23	111
Namibia	43	7	57
Tanzania	130	14	94
Zambia	116	19	123
Zimbabwe	152	31	150

Sources: www.doingbusIness.org www.moibrahimfoundation.org www.transparency.org

There are several elements that will contribute to sustainable investment in power generation:

- Strong sponsorship from national governments, including regional cooperation in developing project packages
- Reduce the institutional risk on the part of the countries by continuing to build capacity to lead or participate in negotiations, as is being initiated by the Common Market for Eastern and Southern Africa (COMESA), SADC and international development banks
- Support the development of well-structured packages of sufficient commercial quality – mitigating and allocating risk
- Harmonization of national regulations in the power sector, especially in energy regulations, technical codes and specifications, regional trading mechanisms and transmission tariffs and regulations, building on the SADC Protocol on Energy
- Rationalize tariff structures and operating practices of national power utilities so as to come to the provision of reliable services at sustainable financing
- Continue to work on transmission integration in the context of SAPP.

To make the financing of water infrastructure attractive, there will also be a need to streamline power tariffs in the region. In some countries power tariffs effectively treat earlier investments as sunk cost, creating an unfair competition between existing and future power projects. In such instances power prices would need to be increased to make it more attractive for investment by future private and public investors keen to exploit untapped hydro electric potential.

The rationalization of tariffs is also important to ensure the adequate operation and maintenance of infrastructure. So far this has been problematic in parts of the Basin, due to unfavourable power supply arrangements and sometimes too low consumer tariffs. There is no reason to this should be a bottleneck in a world of high prices for energy and agricultural products.

In addition to the direct revenues from selling water or energy, infrastructure operators should be allowed – when reasonable – to charge for other new services that come with the infrastructure. When water infrastructure is operated for multiple functions, then there are values attached with all these issues. These values can be capitalized through a variety of ways – user charges, concession, increased property values. Examples are real estate on water fronts, tree plantation or farming system based on increased atmospheric moisture. In charging for different functions a number of principles may be used as a guideline:

- The sustainable management of vital infrastructure is the first priority
- Functions that preceded the development of infrastructure should not be charged
- In balancing charges between function social consideration are important and a balance is to be made between charging high value and low value functions without jeopardizing the latter.

The following main actions are proposed:

1. Improve overall investment climate to make water development infrastructure financing more attractive
2. Develop mechanisms for local infrastructure co-financing
3. Raise awareness of the vital role of the water sector in economic development and poverty alleviation and create the capacity to put together financial packages

4.1.5 Improve Access to Water Supply & Sanitation

Access to safe water supply and sanitation is for most people in the Basin the most ‘pressing’ water issue and is mentioned also as such in the Poverty Reduction Strategy Papers (PRSP) of the riparian countries which have prepared such documents. Coverage is low in the riparian states – and this translates in women spending considerable time on collecting water over large distances in part of the year. Stimulated by the MDG goals, there is a drive in almost every basin country to do better and to do so quickly and there is accelerated investment in rural and urban water supply and sanitation.

An important issue in improving access to water supply and sanitation is effective coverage. Non functionality of drinking water systems is high. In Tanzania for instance close to 40% of the rural drinking water systems are not functioning. There is a range of reasons for this, but technical problems (systems not functioning properly from the start), lack of maintenance (as it is difficult to get spare parts and specialized skills to distant areas), resource problems (dried resources) and management problems all play their part.

The main action proposed under this strategy is to expand the effective coverage of water supply and sanitation services in rural and urban areas. This is very much the responsibility of national and local players – but it needs to be mentioned in the Basin Strategy because of the magnitude of the problem. Consequently, there will be both cooperative and collaborative actions at national and regional levels to improve access to safe water supply and proper sanitation. There are several things that can be done practically:

- Strengthen capacity by local government, NGOs or private sector to service the water supply systems. In peri-urban areas in Mozambique small entrepreneurs are providing this support.
- Improve technical skills and construction discipline in the development of new systems
- Promote improved techniques for locally funded safe drinking water supply – such as rope pumps, manually drilled wells or low cost filter techniques – so as to serve the niche of areas with shallow groundwater adequately
- Take measures where required to protect vital groundwater sources from pollution and contamination. An example was the protection of the clay layer close to Tete Town in Mozambique. By keeping this clay layer intact pollution from effluents and polluted surface water was reduced to an extent.

4.2 Environmental Management and Sustainable Development

All countries in the Basin have ambitious and optimistic economic growth scenarios to ensure better living and reduced poverty. In a global context the Basin countries will derive the larger part of their growth from natural resources use – mining, fishery, agriculture, forestry and in nature tourism. This places environmental management and natural resources governance in the core of development in the Zambezi Basin. The strategic objective of this challenge is therefore to *"Mainstream environment in the development and management of water resources in the Basin".*

There are six strategies that are particularly important for sustainable development in the Zambezi Basin:

1. Adequately manage the ecological and economic functions of wetlands and sustain their viability (2.1)
2. Control water pollution from point sources – especially from urban centres and mining areas (2.2)
3. Control invasive aquatic weeds and prevent new outbreaks (2.3)
4. Promote sustainable fishery management as a contribution to regional food security (2.4)
5. Ensure water resource development and management does not harm tourism potential (2.5)
6. Prepare and implement strategic environmental plans and procedures including the development of protected area networks and valuable eco-systems (2.6)

4.2.1 Manage Wetland Functions

The Zambezi Basin contains several very large wetlands that are of regional, if not international scale and importance and include three Ramsar sites (see Section 2.8). The area covered by the wetlands is in excess of 50,000 km^2. The wetlands perform a large range of functions – retaining water, improving water quality, spawning ground, animal habitat, grazing area. Several of these functions translate into monetary values and local economic opportunities, in particular fishery and tourism. However, wetlands are also among the most environmentally sensitive areas of the Basin and are often widely degraded.

Wetland management suffers from an institutional vacuum. In most riparian countries there is as yet no regulatory framework to ensure the rights of local people to their traditionally-held natural resources. As a result, common property management of water and floodplain pasture, wildlife and fisheries regimes are often undermined (see also Rapid Assessment, sub-section 5.4.4). There is a need to strengthen wetland management with appropriate legislation on local resource access rights, effective community resource management programmes, close linkage to national policies on agriculture and fisheries among others and regional cooperation and research on holistic

wetland resource management in pursuit of optimising multiple uses (see Table 4.7 for an overview of sectoral policy links).

"Wetland functions need to be better understood if we are to manage wetlands in a sustainable manner. Consider the hydrological function of the Barotse Flood Plain in flood management of the middle and lower Zambezi. The value of the Barotse Flood Plain is therefore very significant."
Zambia National Stakeholder Consultation

Although having similar goals and aims, macroeconomic and sector policies are not integrated between the different countries. There is little formal co-ordination in wetlands management. Some attempts are being made to address cross-border issues and overcome the lack of cooperation in wetlands management in the southern African region, but this needs to be strengthened.

Basin countries are signatory to a number of international conventions and agreements which touch on wetlands issues, and as such are bound in common by their provisions. These include most importantly the Convention on Wetlands of International Importance (Ramsar), the Convention on Biological Diversity, the Convention on International Plant Protection, the Convention on the Conservation of Migratory Species of Wild Animals, the Convention on International Trade in Endangered Species as well as the African Convention on Conservation of Nature and Natural Resources. Although these conventions provide a common starting point, translation of the provisions of these agreements into coordinated on-the-ground measures for the sustainable utilisation and management of wetlands areas and species is the real challenge.

Practical wetland management initiatives need to complement these conventions and agreements and combine local development with sustainable resource management. Examples are:

- Using improved and appropriate technology to reduce pressure on resources (reducing fuel wood consumption in wood burning stoves)
- Reduce human-wildlife conflicts (for instance in Lower Shire in Malawi and Mozambique) by establishing buffer zones to reduce wild life damage to crops and develop initiatives which provide benefits for wetland communities (for instance eco-tourism) – following good examples in the region
- Fishery management including seasonal closures, use of appropriate mesh sizes and processing technology
- Explore under-exploited resources which have potential to yield new and sustainable sources of income – from clay to medicinal/ industrial plants
- Establishment of local management committees (Barotse Flood Plains in Zambia) and improving the security of land tenure in the Delta (Mozambique)

The actions required at Basin level are:

1. Improve the wetland related regulation and management between riparian countries
2. Assess and maintain environmental flows appropriate to each river section.
3. Develop management plans for all the major wetlands in the Basin taking into account the different wetland functions
4. Develop and implement special initiatives for environmental management around hotspots

Table 4.7 Sectoral policy links to sustainable wetlands utilisation and management

Sectoral policy or strategy	Possible conservation incentives	Possible conservation disincentives	Gaps in consideration of wetlands issues
Environment	▪ Broad environmental protection ▪ Protection against water contamination and pollution ▪ Environmental impact assessment requirements		▪ Wetlands protection ▪ Maintenance of wetlands goods and ecosystem functions
Wildlife	▪ Habitat and wild species conservation ▪ Establishment of protected areas ▪ Promotion of sustainable utilisation ▪ Development of community-based conservation		▪ Role of wetlands habitats and wild species ▪ Wetlands biodiversity ▪ Wetlands protected areas ▪ Wetlands resource utilisation ▪ Community-based wetlands management
Forestry	▪ Watershed catchment and biodiversity conservation ▪ Establishment of protected areas ▪ Promotion of sustainable utilisation ▪ Development of community-based conservation		▪ Role of forests in upstream catchment and watercourse protection
Water	▪ Regulation of water use ▪ Guidelines for water-based developments	▪ Increased extraction and use of water ▪ Water-based developments	▪ Wetlands ecosystem functions ▪ Role of wetlands in maintenance of water supply and quality
Land	▪ Definition of land tenure and ownership ▪ Provisions for land management	▪ Sometimes insecure and ill-defined land rights ▪ Lack of effective land use guidelines and regulations ▪ Lack of incorporation of environmental concerns into land policy	▪ Wetlands tenure and access
Agriculture	▪ Land and environmental conservation and restoration ▪ Promotion of sustainable agricultural practices	▪ Expansion and intensification of agriculture ▪ Agro-chemical pollution ▪ Irrigation water extraction	▪ Threat of agricultural conversion ▪ Role of wetlands in irrigated agriculture
Fisheries	▪ Regulations on fishing areas, gear and methods	▪ Expansion of fisheries	▪ Threat of unsustainable fisheries ▪ Wetlands role in fisheries support and diversity
Urban and industrial	▪ Guidelines for planning and developments ▪ Standards for pollution and effluents	▪ Promotion of urban and industrial development	▪ Threat of wetlands pollution and contamination ▪ Role of wetlands in maintenance of water supply and quality
Tourism	▪ Explicit encouragement of conservation and wise use of natural assets ▪ Promotion of conservation by private sector	▪ Promotion of tourism development in sensitive areas	▪ Role of wetlands in attracting tourism Controlling expansion of tourism industry
Regional agreements	▪ Provisions of international conventions and agreements	▪ Poor on-the-ground implementation ▪ Poor regional co-ordination	▪ Lack of binding measures for action

4.2.2 Control Water Pollution

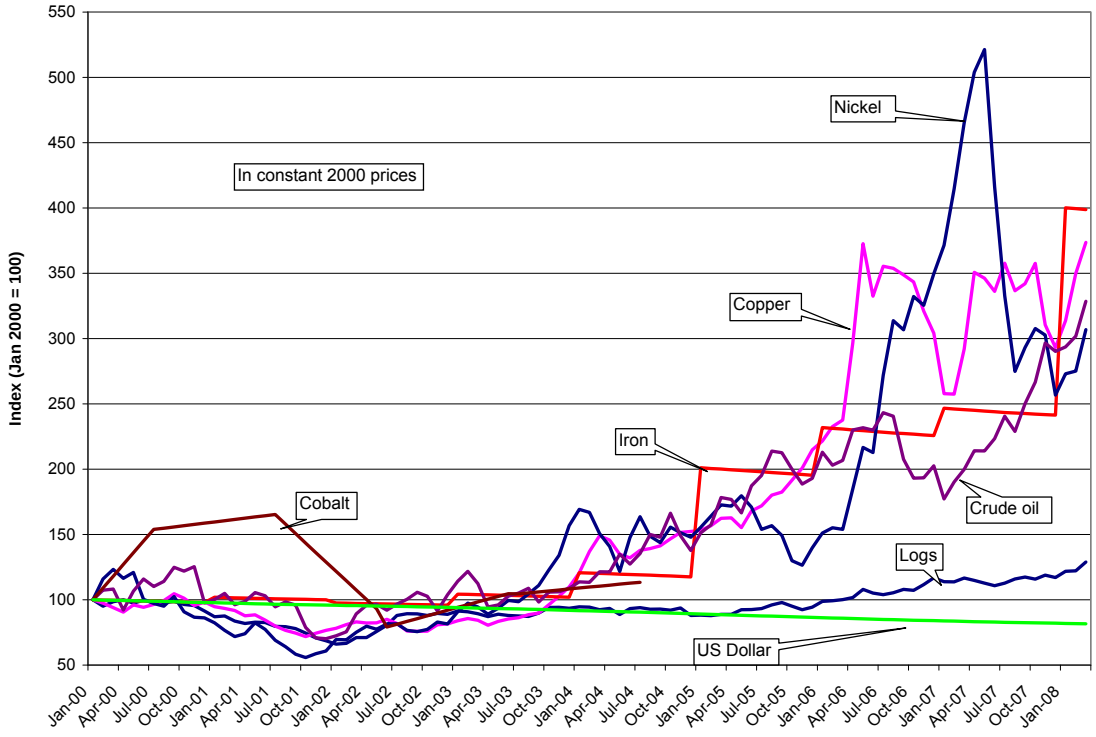
The Rapid Assessment summarized the knowledge available with respect to the water quality status in the Zambezi Watercourse. Non-point pollution is not an issue, but point pollution in

particular near mining and industrial sites and urban centres is at times an issue. Various tributaries were found to have increased total amount of suspended solids, such as Kafue, Luangwa, Deka and Gwai Rivers. Uncontrolled effluent releases have led to fish-kills and drinking water hazards. Mining and industry may also contribute to local water quality deterioration through heightened atmospheric SO_2 concentrations (for instance in the Nkana and Mufulira mining areas in Zambia) causing acid rain. The high mineral prices (see Figure 4.3) make it plausible that mining will increase in the region, making it important to maintain vigilance.

The following main actions are required to control water pollution in the Zambezi River Basin:

1. Set up an integrated monitoring system in the Basin, harmonized between the different riparian countries. The water quality data should be communicated in real time and be publicly accessible. The monitoring stations should be placed close to potential sources of pollution, so as to be able to track unusual events and take corrective action quickly
2. Harmonize legislation and enforcement systems between the countries, in particular with respect to emissions and effluents from potentially major contributors
3. Promote and help introduce clean technologies, including treatment of tail water and recycling, through a system of environmental audits for mines and industries and main urban centres

Figure 4.3 Development of mineral prices 2000-07



Source: Based on World Bank Commodity Prices and inflation data

4.2.3 Control Aquatic Weeds

Aquatic weed infestation is a problem of regional scale in the Zambezi Basin. Over the years invasion of aquatic weeds has occurred in several sub-basins, such as Kafue, Lake Kariba, Lake Chivero, Kwando-Linyanti and the Lower Shire. The cost of aquatic weed infestation is considerable, economically, socially and environmentally. Aquatic weeds can interrupt navigation, as happened on the Lower Shire, and hamper the operations of hydropower facilities as happened

"Intensify research in the area of aquatic weeds. Cross reference with pollution control." *Regional Expert Meeting*

on Kafue Gorge and Lake Kariba. They can reduce the tourist potential of lake fronts. Aquatic weeds can cause a decline of fish stock, as they reduce the oxygen levels of water bodies. One nightmare scenario is a large-scale spread of aquatic weeds on Lake Malawi/Nyasa/Niassa, akin to what occurred in Lake Victoria. Lake Malawi/Nyasa/Niassa is home to 800-1,000 endemic fish species that might seriously suffer from such an event. Aquatic weed infestation can have seriously effect on rural livelihoods: in the Shire sub-basin the cover of weed made lagoons and marshes dry out faster, exacerbating low water levels during droughts. This reduced fish stock and deprived local people of a major source of livelihood. The weed mats also harboured crocodiles and snakes, making it difficult for women to fetch water and do washing in infested places. The problem of aquatic weeds is not unique to the Zambezi Basin and has occurred throughout the SADC Region.

The most persistent of the aquatic weeds in the Basin at this time are water hyacinth *(Eichhornia crassipes)*, Kariba weed *(Salvinia molesta)* and catclaw mimosa *(Mimosa pigra)*. There are other weeds that are common in the larger Southern African region that have not made their mark in the Zambezi Basin, but could do so in the future. Regional cooperation is required to control the existing infestations and prevent the outbreak of new ones.

The consensus is not to reuse the aquatic weeds (for fodder or as a source of fibre for local industry), because the risk and consequences of re-infestation are too serious. Also chemical control is not recommended because of the side effects and costs. Instead biological and mechanical control are preferred – as well as reservoir operations, since rising and falling water levels and flushing can be effective in controlling weeds

There are examples where aquatic weeds have effectively been controlled in parts of the Basin. In Lake Kariba the reduction of water hyacinth by a combination of measures and events – including the increase in lake levels and fluctuations, the use of biological measures. Several countries of the Basin have initiated programmes and started to create institutional structures to control the spread of aquatic weeds. The Botswana government for examples has initiated an Aquatic Weeds Act. The Water Affairs Department is implementing the monitoring, research, control, removal and management of aquatic weeds infestations. In Malawi the government has been implementing a number of projects, including the sensitization of local riparian communities, distributing biological agents along the river. A National Steering Committee on Aquatic Weeds has been established with members representing key stakeholders and communities.

Regional cooperation is called for in the shape of joint programmes and harmonized actions. The following activities are required to be undertaken to combat aquatic weed infestation at regional level:

1. Legislation on the control of aquatic weeds in all riparian countries should be strengthened and harmonized on issues such as bans on the introduction of alien species. This legislation needs to be supported by credible implementation arrangements at regional (i.c. Basin), national and local level
2. Establishment of national focal points on aquatic weed control
3. Exchange of experience and the initiating of regional capacity building programmes, beyond national levels and also at the level of national academic institutes in the region
4. Joint monitoring and survey of aquatic weeds proliferation, especially in hot spot areas. The most important target in monitoring should be the water hyacinth. As water hyacinth is

characterized by substantial variations in the response of the plant to external variables, mid-term prediction is difficult and monitoring should be performed with the high frequency. Where required, special regional or bilateral aquatic weed control programmes need to be launched on basin or sub-basin level

5. Reservoir operations of existing and new storage facilities should include provisions for weed control

Within the SADC region there is already considerable experience and the activities above should be undertaken in the context of SADC, following the activities already initiated.

4.2.4 Promote Sustainable Fisheries Management

Fish is the major source of protein for large parts of the population of the Zambezi Basin. Percentages vary – but in Angola, Malawi, Mozambique and Zambia more than 20% of the population lives on a diet of primarily maize and fish (Table 4.9). Fisheries are an important contributor to food security in the Basin.

Fisheries provide income opportunities to an estimated two million people, especially in the flood plains (NEPAD, 2007). In the Barotse Flood Plains, Eastern Caprivi, Lower Shire and the Zambezi Delta respectively 54%, 75%, 53% and 72% of the households for instance are involved in fishing (NEPAD, 2007). In these areas fishing brings in a net value of between USD 60 and USD 325 per household per year.

Table 4.8 Fish consumption and trends in fish supply

	Fish as percentage of animal protein intake (%)	Trend (1990-2005) in per capita fish supply (%)
Angola	25	- 27
Botswana	2	- 60
Malawi	30	- 42
Mozambique	31	+ 54
Namibia	15	+ 30
Tanzania	16	- 55
Zambia	22	- 20
Zimbabwe	4	- 50

Source: NEPAD (2007)

Fisheries in the Zambezi comes in all shapes – artisenal and medium-scale, inland, lake-based, riverain and coastal. Aquaculture is on the increase, for instance in the Kafue Flats. In the flood plains fish catches are related to the length of the flood season, underlining the importance of floods for fisheries. The reservoirs and lakes of the Zambezi Basin are another important source and have multiplied fish catches. In Lake Kariba kapenta was introduced, now forming the basis of a substantial fish industry. Throughout the Basin migrant workers are involved in fishery, often fishing from fish camps. Total first sales are estimated at USD 200 million. The economic value of fish production is multiplied in the market chain.

There is concern that the per capita fish supplies in the last fifteen years decreased considerably in most riparian countries. There are a number of threats:

- Over-fishing in certain densely populated stretches, such as the Lower Shire River, associated with the use of fine-meshed nets
- Reduction of fish stock due to aquatic weed infestation
- Introduction of alien species, in particular *Oreochromis niloticus*, that is present in the Kafue River and Lake Kariba and in the lower Zambezi River aggressively competes with other tilapias and tends to hybridise with other *Oreochromis* species.

Fish production rates vary considerably between the main water bodies. The production from Cahora Bassa in particular is significantly below that of Lake Kariba, suggesting that there is potential for development. Post harvest losses are high and in general, market and cold storage facilities are inadequate. There is considerable scope to safeguard fishery resources, improve productivity and increase the value of production. These activities at regional level would be supported from the NEPAD Fisheries Programme. There is also a need to integrate the fisheries development with other major water resource developments in the Basin, in particular the development of water storage infrastructure.

The following actions are proposed:

1. In cooperation with the NEPAD programme in this area, working towards improving fisheries productivity in the Zambezi Basin. This will include:
   - Introducing and disseminating improved technology, such as cage fishery and local aquaculture
   - Developing the service sector in support of fishery development
   - Improving landing facilities, access roads and cold storage facilities
   - Explore high value markets
2. Integrate fishery development with water resource development, in particular around the reservoirs. This will consist of a number of activities:
   - Developing reservoir operating rules so as to release e-flows in support of flood plain fisheries (see also sub-section 4.1.3)
   - Investigating the scope for improved fishery production from Cahora Bassa
   - Including fish migration facilities in all new water resource development – in particular fish ladders – to accommodate the migration of species such as the African Mottled Eel (Anguilla bengalensis)
   - Make fishery development an integral part of reservoir development, including good practise such as the removal of trees from potential fishing grounds before impoundment, provision of training and fishing equipment and extension advice and fish stock monitoring. These activities can also be targeted at the small reservoirs that may be developed for local irrigation systems.

4.2.5 Safeguard Tourism Development

Water-related tourism is an important economic sector in the Basin. It generates income and foreign currency and also serves to bring international contacts on a person-to-person basis. Incomes from tourism in the countries of the Basin vary (Table 4.10), but for several countries it is of the same order of magnitude as the returns of a large hydropower plant or the combined annual value of wetland functions in the Basin.

The Victoria Falls on the border between Zimbabwe and Zambia is the tourism icon of the Basin. The site is listed as World Heritage and is surrounded by game parks, hotels and lodges and sustained by a range of leisure activities: cruises and canoeing, helicopter and light aircraft flights,

bungee jumps and elephant rides. Whereas Victoria Falls catches the eye, the Basin has a large number of tourist nature destinations, most of them only weakly developed. All these parks depend on the Zambezi in one way or another.

Table 4.9 Tourism revenue

Country	Tourism Receipts* (M USD)		
	2000	2003	2004
Angola	18		82
Botswana	234	457 (356)	549
Malawi	27	33	
Mozambique	Na	98	
Namibia	288	330	403
Tanzania	739	450	595
Zambia	91	149	161
Zimbabwe	Na	61 (44)	194

**Tourism receipts: Expenditure by foreign (non-resident) travellers on the national territory for less than a year for whatever reason (leisure, work, health, study...).*

Sources: www.worldata.org; www.world-tourism.org; World Travel & Tourism Council, TSA Research 2006; www.britannica.com

The potential for tourism in Angola is big because of the network of important freshwater wetlands and the country's richness in wildlife. A substantial area in the west of the Zambezi headwaters is protected in the Kameia National Park (14,450 km^2). In Zambia, the national parks of West Lunga, Liuwa Plain, Kafue and Sloma Ngwezi are all found in the Basin. The National Parks of Namili and Mudumu together with Caprivi Game Park are the main draw cards in Namibia. The mainstay of Botswana's tourism industry in the Basin is Chobe National Park (10,570 km^2).

Lake Kariba is the second most important tourist area in Zimbabwe's share of the Basin after the Victoria Falls. Since the dam increased the water-availability in this arid area, it has attracted large herds of wildlife, making it an important tourist destination. The Zambezi River itself and all of the protected areas are other major attractions in the Zimbabwean part of the Basin.

Malawi and Tanzania belong to the Lake Malawi/Nyasa/Niassa-Shire River system. While there are no specific tourist areas developed in the Tanzanian part of the Basin, there are many in Malawi, including Lake Malawi National Park. The offshore islands and parts of the mainland are protected since the 1930s preserving the actual waters of the lake and the marine life, up to 100 metres from the shore. The Lake Malawi National Park was declared a World Heritage Site in 1984.

Tourism in rural areas is often the highest value land-use. Where benefits are shared with the local population, a strong win-win situation can emerge. With improved connections and intensified promotion it could attract even more visitors and generate larger income. The strategy is to ensure that water resource management supports the tourism potential of the region. The main actions are for regional water management organizations to systematically liaise with organizations that promote the cooperation and integration of the tourism sector in the region, such as the Regional Tourism Organisation of Southern Africa (RETOSA). RETOSA is actively engaged in the promotion of community based tourism in order to contribute towards the conservation of ecological values and poverty alleviation. Development of tourism ought to include an integrated

water resources management approach. This requires cooperation from all concerned with the tourism industry as wells as the national governments (both natural resources and tourism ministries) in a number of fields:

1. Systematically integrate tourism development in water resources development planning and management
2. Develop catchment management plans incorporating areas of tourism value such as game management areas and wetlands
3. Operation of water infrastructure to support and enhance tourism

For the different eco-regions in the Basin, the water-related tourism potential should be identified and this should be conserved through sound water management. As both tourism and wildlife in the Basin depend to a large extent on the natural flow regime of the river, it is important to manage present and future flow regulation in a sustainable way to enhance the tourism assets in the Basin.

4.2.6 Implement Strategic Environmental Plans and Procedures

The Zambezi Basin has high ecological values that have also intrinsic value and support important economic functions. The Basin States are also bound by international conventions such as Ramsar to maintain these values (see sub-section 4.4.1).

The Zambezi is a by-word for unsurpassed natural landscapes – that are important locally, regionally and globally. Some of the most important areas in the Zambezi basin are the Zambezi Floodplains in Barotseland, the Chobe-Linyanti Swamps in north-eastern Namibia and Botswana, the Busanga Swamps on the Lunga River (a tributary of the Kafue River), the Lukanga Swamps and the Kafue Floodplain on the Kafue River, the Lower Zambezi Mana Pools and the Zambezi Delta (see Annex 1 for map). Smaller areas are located on the lower reaches of the Luangwa River, as well as the Elephant Marsh near the town of Chiromo on the lower Shire River in Malawi and Mozambique. These areas, including the dambos that dominate the landscape of much of Zambia and Zimbabwe are an important aquatic ecosystem.

Their importance derives from ecological /biodiversity, socio-economic value, and physical and/or hydrological significance. They provide a wide range of goods and services. For local people, they provide a variety of benefits: drinking water and water for livestock; land for flood recession agriculture; pasture for dry season grazing; fish and bushmeat, and other foods in times of famine; plant material for house construction, mats and baskets, and clay for pottery and bricks. Several support wildlife, fisheries, irrigated agriculture, livestock production, and tourism of national importance, and there is growing recognition of their international importance for biodiversity conservation. These areas also play a crucial role in maintaining water quality and regulating river flows. These wetlands absorb and attenuate flows from upstream catchment areas, releasing this “trapped” water slowly over a period of several months and maintaining flows during the dry winter months.

The strategy to safeguard these important areas is to mainstream an eco-systems approach in the development of the Basin and also work on the development of a network of linked protected areas. In all planning activities it is important to identify the main areas of high ecological interest and their link with water management. This link works in two directions – ecological areas providing important functions (see above). On the other hand ecologically important area are also affected by water resources development and water management, again in many directions.

The following actions are foreseen to prepare an environmental management plan and create the basis for a network of protected areas in the Zambezi Basin.

1. Prepare a comprehensive and spatially explicit map of ecosystems services
2. Delineate high priority conservation areas such as headwaters, recharge zones and flood plains and implement land use plans for these areas
3. Start international cooperation on linking areas with high significance for biodiversity by providing corridors and fish passages/ladders
4. Develop and implement guidelines for the use of proper EIAs and SEAs in development planning

"Factor in the quality of EIAs and SEAs as the bottom line for infrastructural development. It are important tools."
Regional Expert Meeting

The first is to prepare for the entire basin a comprehensive map of ecosystems (headwaters, recharge zones, streams, riverbanks and wetlands) and important ecosystem functions. The overview should preferably become available in interactive and dynamic form, allowing it to be updated regularly and integrated with other data bases as developed for the Zambezi Basin (see section 4.4). This map will bring together important work that has been done over the years by international NGOs and national organizations – from system inventories (often as a function of project studies) and case studies. Much of this material now exists as grey material and some predates the digital age.

The second activity is the delineation of high-priority areas of conservation significance that need to be taken into consideration in development and management of the basin's resources. These areas may contribute significantly to societal needs. A suite of strategies to protect and maintain high priority areas that provide ecosystem services to cities, towns and villages. These strategies might include environmental flow prescriptions, headwaters protection, land-use zoning, agricultural best management practices, pollution reduction, fisheries management, and improved management of existing protected areas for conservation of aquatic resources. An assessment of how conservation strategies might mutually support or be in conflict with development plans for future uses of the water resources of the basin should be undertaken to identify areas of conflicts and intervention.

The third activity is to establish on the basis of this overview protected area networks (including green corridors). This should link the places that possess significant (exceptional or irreplaceable) hydrological, ecological or biodiversity values. These areas should be as far as possible aquatically or terrestrially be connected, so as to maintain the larger Zambezi eco-system. This will require cooperation between organizations in the different riparian states, including privately managed park areas. This should take into account current protection and management activities – both their strengths and their weaknesses.

More in general, in all activities environmental impact assessment (for assessing individual projects) and strategic environmental assessment (for area development) should be used and procedures and practices between riparian countries should be harmonized.

4.3 Adaptation to Climate Variability and Climate Change

Climate variability has always been an established fact for the Zambezi Basin. In Mozambique for instance a drought year is best described as a year without major floods. The Zambezi River has a low runoff efficiency (i.e. volume of runoff per unit of area) and the Basin has a high dryness index

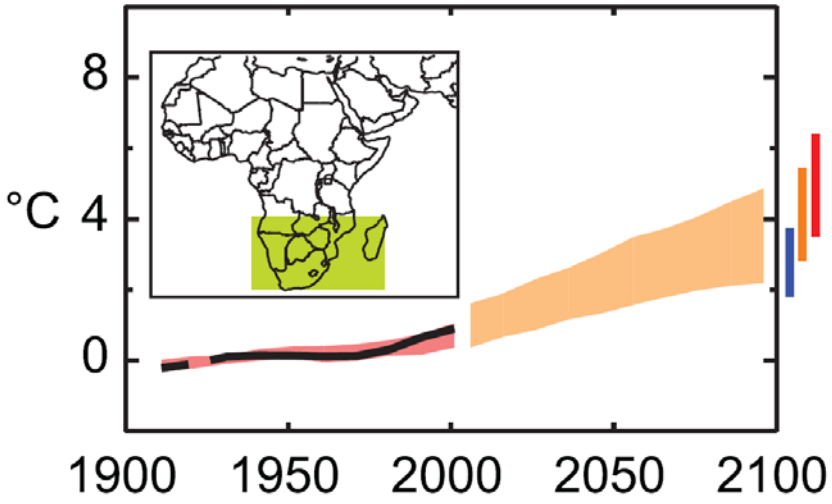
(i.e. dryness of the vegetation based on remote sensing), indicating a high sensitivity to climate variability (see also Rapid Assessment). Global warming is expected to increase this variability and raise temperatures in general.

The Basin as a whole receives a mean annual rainfall of about 950 mm. Most of this is concentrated in a single season. There is considerable variability across the Basin; some parts of the Basin are arid or semi-arid while others receive large amounts of rainfall. The high spatial variability is exacerbated by the fact that areas of high water demand are not located in the same areas of high rainfall.

Climate change is expected to materialize through changes in extreme events such as droughts and floods, affecting agricultural crop and livestock production as well as wildlife population. Rising temperature furthermore is expected to affect the fish production from the major lakes and reservoirs, to cause higher evaporation from these main water bodies and reduce the productivity of main agricultural crops (see also Rapid Assessment, Chapter 5). The ecosystems of the wetlands will be affected because run-off patterns will change. Precise assessments of climate change in Africa are not yet complete and are often limited to mean temperature and precipitation, with relatively little known on changes in extremes.

For Southern Africa the Intergovernmental Panel on Climate Change (IPCC) distinguishes four zones with a more or less uniform rainfall pattern. Area averaged rainfall series for north-east South Africa, Zimbabwe, western Mozambique and southern Malawi and Zambia show that multi-decadal rainfall oscillations have occurred during the 20th Century. The models generally show a drying trend for much of the 21st Century, although decade-to-decade rainfall fluctuations will continue. The simulated annual cycles in a warmer climate show that rainfall may set in one month later and the rainy season will effectively be shortened. This delayed seasonal rainfall onset is predicted in the northern parts of southern Africa as well.

Figure 4.4 Temperature anomalies in Southern Africa



Note: Temperature anomalies with respect to 1901 to 1950 for Southern Africa for 1906 to 2005 (black line) and as simulated (red envelope) by IPCC climate models and as projected for 2001 to 2100 (orange envelope). The bars at the end of the orange envelope represent the range of projected changes for 2091 to 2100 for the low (blue), medium (orange) and high CO_2 emission scenario (red).

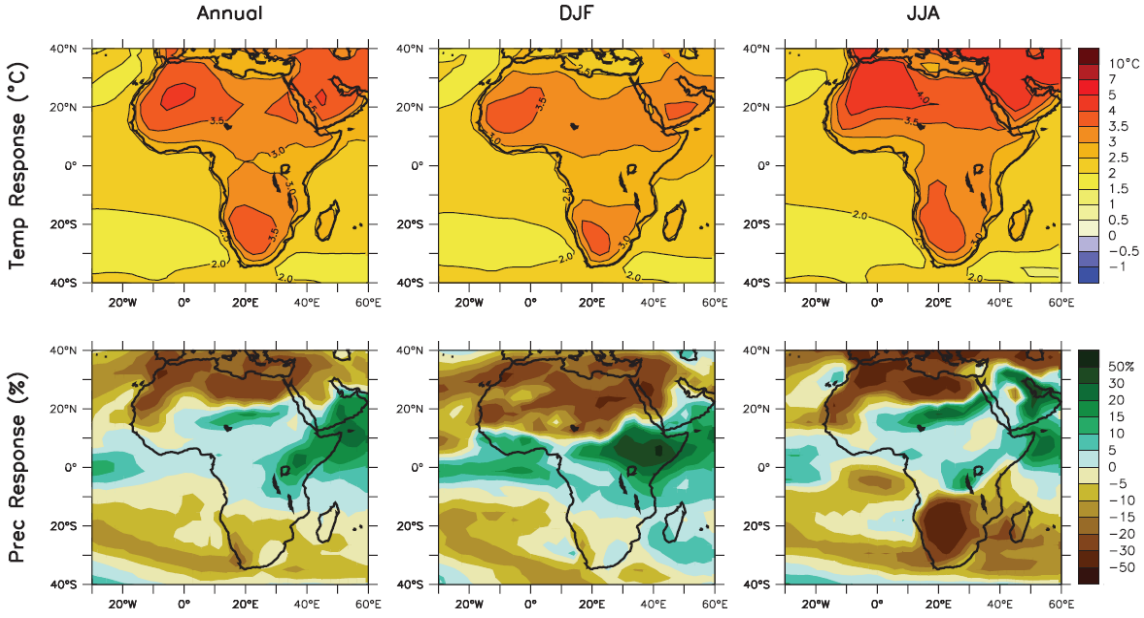
Source: IPCC (2007)

Extremely low rainfall is predicted to become more common over central South Africa and Lesotho, increasing by about 50% around 2100. While some inconsistencies are evident, most models simulate an increase of the extreme dry events over the Kalahari by up to 30%. This is likely to prompt an eastward expansion of the desert. According to the IPCC models (see Figure 4.4 and Figure 4.5), the frequency of extremely dry austral winters and springs increases to roughly 20%, while the frequency of extremely wet austral summers doubles in southern Africa.

The strategic objective under this challenge is to *"Operationalize the institutional frameworks in support of basin-wide water resources development and management"*. This requires four strategies:

1. Operationalise the institutional frameworks in support of basin-wide water resources development and management and discuss issues of inter-basin transfer (4.1)
2. Strengthen organisational, financial and human resource capacities of water management institutions at regional, national and local levels (4.2)
3. Improve and expand Basin-wide water resources data collection, processing and information transfer systems (4.3)
4. Promote broad-based stakeholder participation in water resources development and management (4.4)

Figure 4.5 Temperature and precipitation changes over Africa



Top row: Annual mean, December-January-February and June-July-August temperature change between 1980 to 1999 and 2080 to 2099. Bottom row: same as top row, but for fractional change in precipitation. Source: IPCC (2007)

4.3.1 Improve Knowledge Base

The knowledge base on climate variability and climate change in the SADC region, and especially the effect on water resources is still very weak. It is therefore proposed to carry out a comprehensive assessment of the vulnerability of basin water resources to climate variability and climate change. This will become the basis for improved flood and drought management, and for 'climate-proofing' of the Basin.

4.3.2 Improve Flood Management

Floods are a recurrent feature of several parts of the Zambezi Basin – causing often extensive damage in terms of human casualty, livestock losses and economic losses. As an example the economic damage from the Mozambique floods of 2000 was estimated at USD 3 billion, equivalent to 20% of GDP.

Climate change predictions create a further imperative for strengthening flood management in the Zambezi Basin, requiring close cooperation between riparian countries. To improve flood management, several things are required to happen.

First, it is important that flood management is integrated in development programmes. By including flood risk in programmes covering land use planning, settlement development, infrastructure planning, building codes and related policies, vulnerability towards extreme weather events can be reduced. This should start from the preparation of flood hazard maps – that should document areas highly exposed and local flood buffering mechanisms. Wetlands in particular can reduce flood risk, by acting as a sponge, and should be carefully protected. Further study is required to enhance knowledge on wetland vegetation, which plays an important part in the retention and delay of peak flows.

A second area of improvement is for early warning systems to be improved. Though further improvement is required for instance by adding flow measuring stations having direct satellite communication (SADC/HYCOS system) over the whole catchment; use of sensing rainfall base stations; and more control flow gaugings and calibrations, progress has already been made with medium-term forecasting. Cooperation has been facilitated by the Southern African Regional Climate Outlook Forum (SARCOF), which comes under the umbrella of SADC. The main area for improvement is real-time forecasting. This needs to be considerably strengthened. In the event of a flood emergency response personnel are put in the difficult position of predicting where the flood will occur, issuing adequate and timely warnings, and developing evacuation plans with limited information to draw on.

The third important area is that of effective flood preparedness and response systems throughout the Basin. There were important positive lessons from the Mozambique Floods of 2000, for instance, and the handling of these. These lessons should be adopted throughout the Basin. Given the enormous extend of the flood in Mozambique, human casualty and overall damage was limited, because of a number of factors:

- There is a clear command structure. In times of disaster a high-level committee of ministers chaired by the Prime Minister becomes the overall decision-making body. This is supported by a technical committee comprising experts from the Ministries of Public Works and Housing, Transport and Communications, Health, Agriculture, Environment, Defence, and Foreign Affairs. The committee is meeting daily as long as the disaster lasts
- Under collaboration between the National Institute of Meteorology and the National Disaster Management Institute essential hydrological and climate information is integrated making it possible to predict floods and to manage an effective response
- There was a contingency plan for response to emergencies. The stock of vital emergency equipment was kept up-to-date. The logistics and management capacity were in place to handle donations in kind such as food, non-food items and funds
- Disaster preparedness was effectively decentralized. The Regional Water Administrations issue flood warnings when necessary, to district governments and local authorities and also to the media (radio, television, and newspapers). District governments and local authorities,

in collaboration with the Red Cross and other NGOs, are responsible for the dissemination of information, and in particular warnings, at the local level, and for the evacuation of people before the floodwaters rise. Educational staff were engaged as local flood wardens

- Communication lines were clear and direct with senior persons at ministerial, governorate, district and municipal level identified who would act as the emergency contact person – including access to email and mobile phones.

Other flood response measures that have worked well are the systematic engagement of military personnel and material, the requisitioning of boats, the use of safe shelters and public health measures and the timely evacuation of livestock. These elements show that an effective and integrated regional disaster management plan is essential to mitigate the effects of such disasters.

A fourth important area in flood management is the systematic review of dam operational procedures. Originally the dams were primarily operated for hydropower generation. Recently the Cahora Bassa Reservoir operation has been adjusted so as to enhance its flood storage function, but more fine-tuning is required as well as conjunctive management with the other main reservoirs on the Zambezi, as also described under sub-section 4.1.3. Even then in the present circumstances floods are unavoidable as large parts of the Basin are not regulated.

"Land use is an important factor in water resources management, it affects water pollution, runoff, sediment yield in reservoirs, flood and drought vulnerability and it should be captured as a strategic issue"
Zimbabwe National Stakeholder Consultation

A final area of improvement and not least in importance are structural measures to mitigate the impact of floods - investigations for flood retention areas and embankments and levees to protect populated areas.

The strategy is to improve flood management in different aspects at regional scale. The crucial importance of regional cooperation in this field was acknowledged with the approval, in 2005, of the SADC regional water policy. New agreements on the exchange of data on floods and droughts and the coordination of responses across national borders have also been signed. A regional project is installing 50 new gauging stations in the region's main river basins. A flood risk analysis has been carried out in part of the basins, to identify vulnerable areas and people. Some new initiatives have started in promoting community-based disaster risk management programme, involving raising awareness of risk and building capacity to reduce vulnerability and to respond to disasters.

The main actions required under this strategy are:

1. Integrate flood management in development planning, including systematic incorporation of flood risk assessment, land use planning, and inter-sectoral collaboration – also recognizing the beneficial effects of floods
2. Develop and implement effective land use planning
3. Strengthen and encourage collaboration of existing early warning institutions (e.g. DMS, Early Warning Unit and HYCOS) to enable them get prepared for disasters and co-ordinate efforts when disasters occur. Of special attention is the development of real time flood forecasting
4. Dovetail the operation of major water infrastructure to optimize flood storage (see also section 4.1.3)
5. Formulate comprehensive flood preparedness and flood response mechanisms, making use of regional good practice. Particularly for highly vulnerable areas, joint disaster management

plans should be prepared, including risk assessments, prediction and monitoring, preventive planning and measures and mitigation and strengthening of institutional capacities for disaster management at regional and national level, including emergency capacities

4.3.3 Improve Regional and National Drought Management

Droughts are recurrent phenomena in the Zambezi Basin. The memory of the famine of 2002 is recent – causing wide-spread mortality, while an estimated 15% of the population was in need of food aid. Improving regional and national drought coping mechanisms will need to be included as a strategy.

Water management approaches and policies which can cope with current climatic variability and periodic droughts will also reduce vulnerability to long-term climate change. Specific drought coping measures will:

- Introduce improved agricultural practices such as higher yielding or fast maturing crops, agro-forestry or small livestock
- Better understanding of groundwater and groundwater recharge in the Zambezi Basin and promotion of sustainable groundwater development. Groundwater is the largest storage in the Basin – resilient to temporarily weather fluctuations - but understanding of it is still fragmented
- Promotion of water harvesting and catchment improvements, as particular measures to capture sporadic rainfall and conserve soil moisture so as to better cope with extended dry periods.
- Crop adaptation, looking at crops and varieties better adjusted to higher temperatures and aridity
- Revisiting the logistics of food supply, including storage and regional transport networks, the maintenance and storage of emergency supplies, so as to respond to local shortages. As floods and especially droughts will become more frequent and more pronounced, strategic food reserves need to be in place to prevent food shortages and famines
- Revisiting the operational rules of the main reservoirs in the Basin in general, and in particular make provision for drought – to take into account possible larger fluctuations not only upward, but also downward in surface run-off.

The two main actions under this strategy are:

1. Support development of drought management plans, including local irrigation development, improved food stock logistics, crop adaptation and drought insurance
2. Mainstream drought forecasting in water resources planning and management – incorporating the hydrological and climatological information sets used in the flood forecasting activities (see sub-section 4.3.2). This needs to be complemented by regional assessment of groundwater availability (see also sub-section 4.4.2)

4.3.4 Exploit Opportunities under Climate Change Protocols

Forests play an important role in regulating the earth's temperature and weather patterns by storing large quantities of carbon and water. Deforestation, caused by a number of human activities (land cultivation, animal grazing, mining, urbanization, harvesting fuel wood), and global warming (caused by excessive CO_2 emissions) combine to degrade catchments and adversely affect the availability of water resources.

The Zambezi Basin can also be seen as a huge carbon sink and this can be exploited under carbon markets to finance climate change mitigation measures in the Basin under various Climate Change Funds.

The Kyoto Protocol in 1997 has engendered a number of funding opportunities for financing activities aimed at mitigating climate change. These activities include afforestation and reforestation projects, small hydropower and alternative energy sources.

Since the signing of the Kyoto Protocol, several carbon markets have emerged, both regulatory and voluntary. Regulatory regimes are the Kyoto (2008-12) Agreement, which includes allowance trading and project based transactions through the Clean Development Mechanism (CDM) and Joint Implementation (JI); the European Union Emissions Trading Scheme (EU ETS) (2005-8), EU-wide pilot scheme and the New South Wales Greenhouse Gas (GHG) Abatement scheme (2003-12) in Australia.

"Climate change is evident though we do not know fully well its impacts in our region. Therefore apply 'precautionary principle' in all major development projects."
Namibia National Stakeholder Consultation

Voluntary regimes are among others the United Kingdom Emissions Trading Scheme (UK ETS), the Chicago Climate Exchange, a voluntary trading scheme in the US Retail market, which generally consists of small project-based emissions reductions not used for compliance or trading. In addition, companies within the European Union (EU) which are covered by the CO_2 trading scheme and its set targets can offset their emissions by investing in climate-friendly projects abroad. In short: to go "carbon neutral", despite a lack of regulation compelling them to do so. A vibrant, but fragmented, market for voluntary emission-reduction credits is meeting this demand. In the absence of the same regulatory rigor as the mandatory cap-and-trade market; however, the standards and efficacy of voluntary projects vary widely.

An overview of projects that quality for carbon credits is given in Table 4.11. Most promising are afforestation and reforestation projects, which are accepted since the Marrakech Accords (2001) as valid activities within the CDM framework. The Afforestation/Reforestation-Clean Development Mechanism (AR-CDM) is the mechanism regulating the generation of stored carbon in forests in developing countries and sale of this carbon (in the form of credits) to countries with a GHG reduction target under the Kyoto Protocol. Rules for generation and sale of these credits are developed by the United Nations Framework Convention on Climate Change (UNFCCC). AR-CDM is an example of Payment for Environmental Services (PES) provided by forests; a lot is expected from these services in terms of financing the future conservation and restoration of forests in the world. As the name AR CDM indicates, the two eligible project activities in the forestry sector are:

- Afforestation: planting trees on land that is barren (does not sustain a forest) for over 50 years
- Reforestation: planting trees on land that is barren since 31 December 1989.

There are many potential investors in AR-CDM projects, public and private, as companies such as airlines are trying to become CO_2 neutral by purchasing carbon credits. The World Bank runs the Carbon Finance Unit. Typical contributions are in the range of 10-20% of investment costs. To develop AR CDM projects in the forestry sector is a lengthy process, but these projects have a great potential in the Zambezi Basin to combat climate change and to resolve the rural energy situation.

Table 4.10 Types of CDM projects

Project types	Small-scale CDM project activity categories
Type I: Renewable energy projects <15 MW	A. Electricity generation by the user
	B. Mechanical energy for the user
	C. Thermal energy for the user
	D. Renewable electricity generation for a grid
Type II: Energy efficiency improvement projects <60 GWh savings	A. Supply side energy efficiency improvements - transmission and distribution
	B. Supply side energy efficiency improvements – generation
	C. Demand-side energy efficiency programmes for specific technologies
	D. Energy efficiency and fuel switching measures for industrial facilities
	E. Energy efficiency and fuel switching measures for buildings
	F. Energy efficiency and fuel switching measures for agricultural facilities and activities
Type III: EB27: 60 ktCO_2 Reduction	A. Agriculture
	B. Switching fossil fuels
	C. Emission reductions by low-greenhouse emission vehicles
	D. Methane recovery
	E. Avoidance of methane production from biomass decay through controlled combustion
	F. Avoidance of methane production from biomass decay through composting
	G. Landfill methane recovery
	H. Methane recovery in wastewater treatment
	I. Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems
	J. Avoidance of fossil fuel combustion for carbon dioxide production to be used as raw material for industrial processes
	K. Avoidance of methane release from charcoal production by shifting from pit method to mechanized charcoaling process
	L. Avoidance of methane production from biomass decay through controlled pyrolysis
	M. Reduction in consumption of electricity by recovering soda from paper manufacturing process
	N. Avoidance of HFC emissions in rigid Poly Urethane Foam (PUF) manufacturing
	O. Hydrogen production using methane extracted from biogas
	P. Recovery and utilization of waste gas in refinery facilities
	Q. Waste gas based energy systems
	R. Methane recovery in agricultural activities at household/small farm level
	S. Introduction of low-emission vehicles to commercial vehicle fleets
	T. Plant oil production and use for transport applications
<8 kt CO_2 absorption	**Small-scale Afforestation/reforestation CDM project activity categories**
	Afforestation and reforestation project activities under the clean development mechanism implemented on grasslands or croplands

A second important category of activities, relevant to the development of the Zambezi Basin, that is eligible for funding – after a process of validation and verification - under the carbon credit system are hydropower projects, both small and large. An example of this is the Zengamina Mini

Hydro Scheme- Zambia. This 700 KW mini hydro scheme is being constructed by the North West Development Trust at Kalene Hills, North-Western province at a site known as the Zambezi Rapids. The purpose of the scheme is to provide cheap, clean and sustainable electric power to the remote Kalene Hill area of North Western Province of Zambia.

The main actions proposed under this strategy are:

1. Integrate strategies to deal with climate variability and climate change in national socio-economic development planning
2. Exploit development opportunities under global climate change protocols for afforestation and reforestation at national level
3. Setup a regional centre of excellence to document and support activities for effective adaptation to climate variability and climate change

4.4 Basin-wide Cooperation and Integration

The challenges discussed in the previous sections and the strategies required to address them underline the need for more regional cooperation and closer integration in the field of water management. It may be clear that integrated water resource development and management is at the heart of economic development and social well-being in the Zambezi Basin.

There are many reasons to move beyond the current informal relations in water management between the riparian countries. A formally established joint Zambezi Watercourse Commission could play a role in:

- Initiating the coordinated development of water infrastructure in the Basin between riparian countries and putting in place multifunctional management rules on the main structures
- Contribute to overall water governance in the Basin, which would contribute to easier conditions on financing of large water infrastructure
- Build strong links between regional infrastructure development (roads, bridges, and water resource development)
- Trigger and encourage joint programmes in wetland management, tourism development and agricultural development
- Support joint action in fishery development and the mitigation of invasive aquatic weeds
- Put in place best practice flood and drought management mechanisms and facilitate regional cooperation
- Stimulate the use of new funding mechanisms for the development of the Basin.
- Enhance stakeholder participation at regional, national and local levels.
- Enhance the participation of women in water management by undertaking the assessment of the implications for women and men of any planned action, including legislation, policies and programmes (gender mainstreaming),

At present there are several activities undertaken to support water management in the Zambezi Basin. These activities, though worthwhile, do not add up, as there is no single focal point. Regional coordination and management on the Zambezi Watercourse need to make steps forward. The strategic objective for this challenge is to: "*Operationalize the institutional frameworks required to address the challenges and opportunities in water resources development, environmental management and climate change adaptation in the Basin.*"

4.4.1 Establish and Operationalize ZAMCOM

The agreement for the Zambezi Watercourse Commission was adopted in July 2004, and now awaits ratification. According to the agreement, ZAMCOM will have three levels of authority:

- The ZAMCOM Council of Ministers of the eight Zambezi States is the highest level where ultimate decision-making takes place
- The ZAMCOM Technical Committee, consisting of Senior Officials, is the second level of authority and responsible for technical advisory support to the Council of Ministers. This is an important intermediate level where the direct interaction with each country's national water department is guaranteed
- The ZAMCOM Secretariat will manage ZAMCOM's daily affairs, in particular its programmes and projects

ZAMCOM, as a river basin organization will be responsible for all water resources management aspects throughout the Zambezi. However as discussed in Section 3.5.3, in the medium to long term future, ZAMCOM activities will concentrate only water issues that are transboundary in nature.

"ZAMCOM is vital for the river basin management of the Zambezi, and all states need to cooperate to ensure the operationalisation of the basin organisation."
Botswana National Stakeholder Consultation

ZAMCOM's likely activities would be to prepare rules for implementing the provisions of the Agreement including a framework for joint water management at key locations in the Basin to ensure flood plain and perennial irrigation, hydropower, flood control and environmental benefits upstream and downstream; to determine environmental flow requirements in the main river system; prepare a Basin development plan and strategy that integrates the development plans and aspirations of the member countries; support the strengthening of national IWRM by growing the knowledge base; develop joint policies on inter-basin and inter-sub basin transfer; developing a shared decision support system and the expertise to use it; upgrade the monitoring network; and promote the sharing of experience.

In late 2007 it was decided that as an intermediate step an Interim Secretariat is to be established. It is proposed that the Interim Secretariat is adequately staffed to serve as the focal point and interface between the riparian countries. The Interim Secretariat would prepare for a full fledged Zambezi Watercourse Commission, but would in the meantime also be an important focal point for a number of important activities currently underway on the main agenda of this Strategy[5] (see Table 4.11).

Systematic riparian cooperation at Basin level in these programmes would build confidence throughout the Basin and help make considerable progress in joint water resources management. The list is not exhaustive but indicates that by improved coordination of these ongoing programmes a substantial programme will take shape addressing several of the important strategies for the Zambezi Basin.

In the period up to the formation of the ZAMCOM it is proposed that considerable effort is invested in further confidence building through the systematic cooperation in the different programmes – with facilitation of the Interim Secretariat. It is proposed to make more work of exchange and

[5] This list may not be exhaustive

cooperation. Also it is proposed that at the highest level the cooperation in the Zambezi Basin has to come 'alive'. A senior personality in the region may be approached to help champion water resources management in the Basin and the eventual creation of the ZAMCOM.

Table 4.11 Developed Strategies

Strategies	Institutions
Infrastructure for hydropower	SAPP
Demand for water for agriculture	NEPAD, World Bank
Operation for multiple functions	WWF/IHE/TNC and Crane Foundation
Coordinate infrastructure development	SAPP, COMESA
Manage functions of wetlands	IUCN
Control of invasive aquatic species	SADC
Sustainable fisheries development	NEPAD
Support tourism potential	RETOSA
Flood management	SADC
Drought coping strategies	SADC
Institutional capacity building	Waternet/ WARFSA/ GWP Southern Africa
Basin wide data collection	SADC-HYCOS

Strengthening Zambezi Basin cooperation should build on the current Joint Water Commissions between Malawi and Mozambique signed in 2005, and Mozambique and Zimbabwe signed in 2001 as well as the Zambezi River Authority. ZRA is a bilateral institution of Zambia and Zimbabwe established in 1987 through parallel legislation in the two countries. In both countries ZRA is institutionally linked to the ministries responsible for energy rather than those responsible for water.

The main activities under this strategy are:

1. Encourage signing and ratification of the ZAMCOM Agreement and establish and operationalise ZAMCOM – through promotion of targeted measures to raise awareness of benefits of basin-wide management of water resources,
2. Establish Interim ZAMCOM Secretariat
3. Develop public information function of Interim Secretariat and later ZAMCOM Secretariat
4. Strengthen coordination with ongoing programmes in the Basin (SADC/ COMESA/SAPP/NEPAD/Waternet/IUCN/ WWF/HYCOS/World Bank), including management commissions of sub-basins (Joint Water Commission, ZRA)

4.4.2 Strengthen Institutional Capacity in Riparian Countries

The performance of the ZAMCOM depends to a large part on the capacity of the constituent parts, i.e. the national water and energy organizations in the riparian countries. Several IWRM capacity building activities as well as research programmes have taken place in the past few years such as Waternet, the Water Research Fund for Southern Africa (WARFSA), various activities in this field by SADC and the Southern Africa Water Partnership of the Global Water Partnership (GWP) and the Transboundary IWRM training programme. These activities are of large importance to regional cooperation along the Zambezi, as they upgrade technical and communication skills, create the regional capacity to create capacity and through research create a kaleidoscope of knowledge on a wide range of relevant topics related to the Zambezi.

To strengthen institutional capacity in the riparian countries it is proposed to build on the strong linkages between the different activities in these field and link them with a capacity building needs assessments and gender analysis within the countries so that strategic choices can be made on the types and scope of training, target groups, in-house and on-the-job training.

In capacity building it is also important to strengthen institutions beyond individual skills. As a starting point it is important that in each of the riparian states special organizations are assigned the responsibility to coordinate transboundary water management issues within the country. A second step is to gradually ensure that national water policies and legislative documents are harmonized and reflect due recognition of transboundary issues and the importance of IWRM, including stakeholder participation and gender issues.

Institutional capacity in water resources development can be strengthened by improving planning and development procedures, including the application of Strategic Environmental Assessments and Environmental Impact Assessments (EIAs). If riparian countries have the capability and procedures available to apply these tools that aim to safeguard the environment, their opportunities for development interventions may well enhance.

Specific activities under this strategy are:

1. Develop and implement performance based training programmes on water resources management based on institutional development assessments
2. Implement well-designed plan to harmonise water resources management policies, legislation and strategies of the basin states

4.4.3 Improve Basin-wide Data Collection and Information Exchange

> "Data collection is a serious problem in the region. More and more non-state actors are coming into the picture and they are not sharing their collected data with government."
> *Regional Expert Meeting*

An important and in several ways fundamental step to intensify cooperation on the Zambezi Watercourse is to come to a shared information base and unrestricted access to data. There is at present still much to do in this field.

Data collection systems in most Basin countries are in a state of deterioration due to non-repair of gauging stations. Hydrological agencies often have insufficient financial and human resources even to maintain regular data collection. Due to constraints in human resources and finances, in some countries there is a backlog of data which is not processed and archived. Another well known problem is the vandalism of hydro-meteorological data collection stations. Groundwater monitoring systems are sparse or absent in most countries in the Basin. It is with a recent SADC project that groundwater is systematically investigated.

Functioning water quality networks are scarce. On the main stem of the Zambezi River, a water quality network has been established and maintained by ZRA. Access to data from organisations is sometimes restricted or relatively costly. Poor data availability is one of the major problems in data management. Another problem is the use of different data management systems/ formats for river flow data and meteorological data, which makes it difficult to exchange and compile basin-wide data and to turn them into information.

A number of actions are required:

- Strengthen data sharing protocols by operationalizing the relevant sections of the ZAMCOM Agreement

> "Mozambique, being on the receiving end of the basin, has insufficient real-time information on what is happening in upstream countries. The strategy should place information exchange on rainfall and run-off as a priority, together with proposed projects that can address this issue."
> *Mozambique National Stakeholder Consultation*

- Harmonize data collection, processing and storage methods– in particular the most vital one, such as stream flow data and groundwater levels
- Improve data collection, with priority on water quality data near hotspots and groundwater data, as well as generally overhaul gauging stations establishing strategic hydrometric stations on the Zambezi Watercourse to capture the relevant hydrological data, especially near main areas of abstractions and transfers
- Develop and establish early warning systems against extreme events (floods, droughts and other disaster situations), as discussed in sub-section 4.3.2 and 4.3.3 including adequate warning procedures

- Further develop ZAMWIS, the joint information system that has been developed alongside the preparation of this Zambezi IWRM Strategy, as a tool for sharing and analysing data by increasing its accessibility and interactivity
- Developing water resources models and decision support tools

4.4.4 Promote Broad Based Stakeholder Participation

Riparian cooperation between countries on the Zambezi has to come alive and be widely understood throughout the Basin. Basin management has to be broad-based rather than being only appreciated by a small group. The benefits for cooperation are obvious and convincing and this message should be communicated widely. Relations should develop across the Basin – among professionals and among other water stakeholders.

Communication cuts across all aspects of the ZAMCOM programme and is critical to building public confidence and ensuring stakeholder involvement. Being a new development, the ZAMCOM or the entire cooperation on the Zambezi is not well known outside of a small inner circle of ministries for water and academics. If this persists, politicians, civil society groups and the public at large will remain sceptical of the regional cooperation.

The first step in the process of change is information and awareness. Communication can create an enabling environment that will allow the ZAMCOM to move forward. A comprehensive public information programme is needed in order to reach groups whose lives may be affected by the cooperation. These include women's groups, youth groups, small farmers, business associations and local authorities, as well as the better-recognized national level decision-makers and opinion-leaders. The wide diversity of language and cultures in the region necessitates a decentralized model of information dissemination and exchange, and all materials need to be tested for gender and cultural sensitivity.

Topics to be addressed are:

- Transboundary harmonization of policies and regulations

- Water availability and allocation
- Water resources degradation
- Institutional and legal constraints
- Capacity-building
- Gender mainstreaming in IWRM
- HIV/AIDS mainstreaming in IWRM
- Disaster Management (drought and floods)
- Environmental requirements (e.g. environmental flows)
- Defining roles and responsibilities among stakeholders.

An effective public information programme that creates public awareness, builds effective public outreach, develops regional, sub-regional, and national public relations programmes, and produces necessary communication materials, is an essential basis for Zambezi Basin Cooperation. This should go beyond one-off events but should permeate in local media and local discussions. Activities should be:

1. Strengthen stakeholder participation through policy and legislation review and revision throughout the basin states
2. Formulate and implement a public information programme to raise awareness among a broad range of stakeholders
3. Strengthen and sustain the Annual Basin Forum meetings as part of awareness and information sharing among basin stakeholders

> "There's a need for workshops on decision support tools for water allocation, as this is one of the most contentious issues in transboundary basin cooperation."
> *Regional Expert Meeting*

To foster relations between stakeholders and to build confidence is an objective that should be reflected in each activity related to the Zambezi Basin. To take this further it may be useful to develop a broad-based Water Partnership for the Zambezi Basin. Such Water Partnership could be part of a global movement and would be platforms of a variety of stakeholders all across the Basin, discussing, promoting and operationalizing IWRM. At present, country water partnerships exists in some countries in the Basin, but not in all. A Basin Water Partnership could build on these and on the Annual Stakeholder Meetings that have been organized successfully in the past few years. The aim is to make Zambezi Cooperation come alive not only in the minds of people, but also in the relations between them.

5 Implementation Plan

5.1 General

This section presents the implementation plan for the Zambezi IWRM Strategy. This plan is meant to take the strategy beyond general directions and describe how the different components of the strategy can be implemented. The implementation plan, as it is described in this document, is meant for discussion and negotiation among member states.

> "Consider taking a regional perspective rather than a Basin perspective in the analysis of projected water use, as there's a strong demand for Inter-Basin Water Transfers in Southern Africa."
> *Regional Expert Meeting*

The implementation plan takes the different activities, described in detail in the previous section and prioritizes them time-wise. It categorizes the actions in initiatives that need to be undertaken in the short-term (0-2 years), medium-term (3-5 years) and long-term (6-15 years). The implementation plan also describes the organizations that should take the lead and that should be actively engaged in these activities, as well a short description of the trigger actions in each field. The plan is presented in Table 5.2.

To build up an agenda for the ZAMCOM and its predecessor organization, Table 5.3 specifically describes the engagement of ZAMCOM and the Interim Secretariat in the different activities. Finally the implementation plan indicates financial sources of support in Section 5.3.

5.2 Prioritization in Time

In prioritizing actions time-wise the main consideration is that it is important to focus on common actions and coordinated investment, as well as on building confidence and synchronizing systems and policies, as they affect water management in the Basin. The history of transboundary organizations is that an exclusive focus on harmonizing rules and joint data collection in the early stage of cooperation risks that momentum is lost, as discussion on more substantive issues is delayed. The sustainability of Basin cooperation may suffer as a consequence. In view of the concerns on energy and food security in the Basin and the urgent requirement to consider multi-functional operation of the reservoirs and e-flow releases, an exclusive focus on institutional matters and data-sharing would not be well-placed. Hence, in sequencing activities, a balance of strengthening the basic framework for cooperation as well as working on substantive issues in water resource development and management in the Zambezi has been chosen.

A second consideration in the prioritization in time is the expected institutional development in transboundary water resource management in the Zambezi Basin. The ZAMCOM Agreement has been signed by all but one riparian country. The establishment of an Interim Secretariat was agreed in late 2007. It is expected to materialize in the second part of 2008.

Given this scenario it seems that in the short-term an Interim Secretariat will be active, while ZAMCOM may become operational in the medium-term. In scheduling the activities those that require the existence of ZAMCOM have been scheduled accordingly. Issues that may be expected

to be a source of controversy, such as discussion on inter-basin and intra-basin transfers are also postponed to either medium and long-term, as it is important to start with an agenda of agreement. Moreover, sensitive topics such as inter-basin transfer can only be discussed in the presence of a fully functional ZAMCOM.

5.3 Implementation Arrangements

The selection of key and support organizations is determined by the fact that in spite of substantive support under the ZACPRO project the institutional progress on Basin cooperation to date is modest. There are promising developments since the second half of 2007, however. The most important development is the agreement on the establishment of an Interim Secretariat. This takes the Basin Cooperation beyond the level of project activities.

Another important development is that there are several initiatives on-going in the Basin that are closely related to central aspects of the Strategy. By bundling these initiatives and by coordination through the Interim Secretariat and later ZAMCOM, a critical mass of activities in support of the integrated management and development of the Zambezi Basin could develop, while retaining progress under different initiatives.

In assigning responsibilities the approach chosen is:

- Where appropriate and possible, there should be a leading role of concerned organizations from the riparian countries, facilitated and coordinated by the Interim Secretariat and later ZAMCOM and its Secretariat. The role of the National Committees is expected to be very important in the transitional phase, as they will liaise with different national organizations as is required for the integrated management of the Basin water resources.
- The role of the Interim Secretariat is coordination and facilitation, but also linking the various support activities to a regional political and decision making process. Once the ZAMCOM is in place, this role could be changing to a more initiating role.
- There should be close cooperation with the SADC Water Division, which is already doing substantial work on some of the themes of the IWRM Strategy. Involvement of SADC facilitates information sharing throughout the Southern Africa Region. SADC can also provide coordinated support to different themes of the Strategy as well as in making use of political processes imbedded in SADC.
- To use the various well-organized service providers working on various themes and linking them closer to even interim governance mechanisms in the Basin, such as the Interim Secretariat, the Stakeholders Forum and the Senior Officials Meeting. It is also understood that in several instances such service providers are able to take the lead in the implementations of subcomponent under agreed understanding with riparian and transboundary organisations.
- The Interim Secretariat and ZAMCOM ensure discussion at high political level on the different strategy items, supported by service providers.
- Encourage service providers to expand on their roles, particularly in areas where there are gaps and shortcomings, such as capacity building, data sharing and certain themes.
- Upgrading the Stakeholders Forum from an Annual Event to a Consultative Group or Partnership.

5.4 Financing Arrangements

There are different categories of activities to be funded as part of the implementation of the strategy. In essence there are:

- Activities that are part of the basic administrative functions of the ZAMCOM and its predecessor Interim Secretariat. Such activities are preferably funded from the riparian countries themselves or from special privileges that come with a hosting arrangement.
- Activities that are part of the regulatory and coordination functions of the ZAMCOM or its predecessor Interim Secretariat. Again these activities may be funded from the core funding of a transboundary organization, that is supplied from contributions of riparian countries. In some cases some external funding may be provided or in the long run the core funding for such regulatory and coordination activities may come from a revenue surcharge on the operation of water infrastructure in the Basin.
- Special development activities that are implemented by regional organizations and service providers. These may be to strengthen water management or prepare for investment. Such externally implemented activities are usually funded by external organizations, yet preferably the contribution to ZAMCOM to such activities is covered as well.
- Special development activities, as above, but implemented by ZAMCOM directly. These may require external funding directly to ZAMCOM, including a coverage for overhead costs.

> "Transboundary river basin management is about sharing benefits and….costs as well."
> *Regional Expert Meeting*

In Table 5.1 the activities described in Table 5.2 are broadly categorized into funding categories, at least for the initial period. As ZAMCOM develops and as it may be able to generate intra-basin revenues, funding patterns may change.

Table 5.1 Funding categories

Funding category	Source of funding
Basic operation of Interim Secretariat and future ZAMCOM	▪ Contributions from Riparian Countries, monetary and in-kind (staff secondment) ▪ Special contribution or privileges from hosting country
Regulatory and coordination functions of Interim Secretariat and future ZAMCOM, such as joint data base and communication system	▪ Contribution and cooperation from riparian countries ▪ External funding for establishment costs ▪ For consideration – part of revenue generated from joint infrastructure to cover for running or program development costs of ZAMCOM
Programs on major elements of the Strategy, strengthening management capacity or preparing investment programmes coordinated by ZAMCOM but implemented by others	▪ External funding ▪ Implementation directly by service providers with preferably provision for costs of Secretariat/ Riparian Countries
Program on major elements of the Strategy, strengthening management capacity or preparing investment programmes directly implemented by ZAMCOM	▪ External funding ▪ Directly implemented by Secretariat/ ZAMCOM including provision for operational expenditures

Table 5.2 Implementation plan

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
1	**INTEGRATED AND COORDINATED WATER RESOURCES DEVELOPMENT & MANAGEMENT**						
1.1	***Address high demand for infrastructure to meet energy security***						
1.1.1	Joint development of feasible package of hydropower sites	✔	✔		ZAMCOM/SAPP	Riparian Energy Organizations, Ministries of Water Resources	Update current studies in view of electricity crisis in part of the Basin
1.1.2	Identify and promote options for small scale hydropower	✔	✔	✔	ZAMCOM/SAPP	Riparian Energy Providers, Private Sector Regulators	Develop package of technical and financial options and case inventory
1.2	***Address demand for water in agricultural development and regional food security***						
1.2.1	Support the development of agriculture through basic facilities such as reliable input supply and better road networks		✔	✔	ZAMCOM/National Road Authorities	Ministries of Agriculture, Donor Organizations	Map main current/future agricultural production areas and marketing constraints
1.2.2	Expand irrigated agriculture	✔	✔	✔	ZAMCOM/National Ministries of Irrigation	NEPAD, World Bank	Collate national plans and identify technical and capacity constraints
1.2.3	Promote and support the restoration of flood plain agriculture		✔	✔	ZAMCOM/Dam Operators	WWF/TNC/UNESCO-IHE	Review implementation experience in Kafue Plains and operationalize studies
1.2.4	Enhance the productivity of rain-dependent agriculture	✔	✔	✔	National Ministries of Agriculture	Fertilizer boards, research and extension organizations	Identify current practices and regional/ international good practices
1.3	***Improve operation of existing and new dams for multiple functions of water***						

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
1.3.1	Develop river simulation models for dam operation and unregulated tributaries	✔	✔		ZAMCOM/WWF/ TNC/UNESCO-IHE	Navigation, Fisheries, Weed Control, Flood Storage Agriculture	Define with many stakeholders all multifunctional requirements
1.3.2	Optimize multi-purpose management of existing reservoirs		✔	✔	ZAMCOM/Dam operators	Different stakeholders as above	Plan review first years flow regimes in practice - including communication
1.4	***Increase funding for water resources development & management***						
1.4.1	Improve overall investment climate to attract water development infrastructure financing		✔		ZAMCOM	Ministries of Planning and Finance/ of Water Resources	Identify bottlenecks with possible investment funds
1.4.2	Develop mechanisms for local infrastructure co-financing			✔	ZAMCOM/SAPP	Ministries of Planning and Finance/ of Water Resources	Initiate discussion with local financial institutes
1.4.3	Raise awareness of the vital role of the water sector in economic development and poverty alleviation	✔	✔		ZAMCOM	Ministries of Planning and Finance/ Water Resources	
1.5	***Increase access to sustainable water supply & sanitation***						
1.5.1	Expand coverage of water supply and sanitation services in rural and urban areas		✔		ZAMCOM	Riparian ministries of water and sanitation	
2.	**ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT**						
2.1	***Adequately manage the ecological and economic functions of wetlands in the Basin***						
2.1.1	Improve wetland related regulation and management between countries		✔	✔	ZAMCOM/IUCN	Local government, Ministries of Environment/ Fishery;	Assess current regulation and operational effectiveness

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
2.1.2	Assess and maintain environmental flow appropriate to each main river section	✔	✔		ZAMCOM/WWF/ TNC/ IUCN	Dam Operators, Ministries of Water Resources; academia	Synthesize current knowledge from various studies
2.1.3	Develop management plans for all major wetlands in the Basin taking into account multiple functions	✔	✔		ZAMCOM/IUCN	Local government, Ministries of Environment/ Fishery;	Identify and agree on list of main wetlands in the Basin
2.1.4	Develop and implement special initiatives for environmental management around hotspots		✔	✔	ZAMCOM/IUCN	Local government, Ministries of Environment/ Fishery;	Identify and agree major hot spots/ areas under threat
2.2	***Control water pollution from point sources - especially urban centres and mines***						
2.2.1	Set up integrated water quality monitoring systems with real time communication		✔		ZAMCOM/ SADC	National Ministries of Water Resources	Prepare overview of ongoing activities; identify priorities and communication
2.2.2	Harmonize legislation and enforcement systems on water quality		✔		SADC/ZAMCOM	National Committees; National Organizations	Inventory of ongoing legislation and operational effectiveness, including labs
2.2.3	Promote clean technology through system of environmental audits		✔	✔	Industry/ Mining Associations	Ministries of Planning and Finance/ Industries	Review financing/ enforcement mechanism to support clean technology
2.3	***Control invasive aquatic weeds and prevent new outbreaks***						
2.3.1	Harmonize legislation on control of aquatic weeds		✔		SADC	Ministries of Fisheries/ Environment/ Water Resources	Inventory of ongoing legislations and operational effectiveness
2.3.2	Set up national focal points on aquatic weed control	✔	✔		SADC	Ministries of Fisheries/ Environment/ Water Resources	Describe minimum requirements for Focal Point

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
2.3.3	Exchange experience and initiate regional capacity building		✔		SADC	National Focal Points	Describe based on ongoing work and literature good practices in weed control
2.3.4	Initiate joint monitoring and survey of aquatic weeds proliferation		✔	✔	ZAMCOM/ Focal Points	Ministries of Fisheries/ Environment/ Water Resources	Agree on parameters, frequency and means of communication
2.3.5	Adjust reservoir operations including provision for weed control		✔	✔	ZAMCOM/Dam Operators	Other stakeholders in dam operations as described above	Describe based on ongoing work and literature good practices in weed control
2.4	***Promote sustainable fisheries management as contribution to regional food security***						
2.4.1	Collaborate with NEPAD programme towards improved fisheries productivity	✔	✔		ZAMCOM/NEPAD	Reservoir Operators; Private Sector; Ministries of Fisheries	Develop long-list of improved fishery/ marketing practices of relevance for the Basin
2.4.2	Integrate fisheries development with main water resources development		✔	✔	ZAMCOM/NEPAD	Reservoir Operators; Ministries of Fisheries	Screen current reservoir operations (levels, landings, vegetation, fish migration)
2.5	***Ensure water resources development & management does not harm tourism potential***						
2.5.1	Systematically integrate tourism development in water resources planning, development & management		✔	✔	ZAMCOM/RETOSA	Ministries of Water Resources	Identify and describe (incl potential) water-related tourism highpoints
2.5.2	Develop catchment management plans incorporating areas of tourism value such as game management areas and wetlands.		✔		ZAMCOM	Ministries of Water Resources / Natural Resources / Land	

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
2.5.3	Operation of water infrastructure to support and enhance tourism management		✔		ZAMCOM	Ministries of Water Resources; Reservoir Operators	Describe flow and water level requirement for most important tourist activities
2.6	***High and unique ecological values in the Basin may be threatened and fragmented by accelerated development***						
2.6.1	Prepare a comprehensive and spatially explicit map of ecosystems services		✔		ZAMCOM/WWF/. TNC/UNESCO-IHE	Ministries of Environment/Natural Resources	
2.6.2	Delineate high priority conservation areas such as headwaters, recharge zones and flood plains and implement land use plans for these areas		✔		ZAMCOM/WWF/ TNC/UNESCO-IHE	Ministries of Environment/Natural Resources	
2.6.3	Start international cooperation on linking areas with high significance for biodiversity	✔			ZAMCOM/WWF/ TNC/UNESCO-IHE	Ministries of Environment/Natural Resources	
3.	**ADAPTATION TO CLIMATE VARIABILITY AND CLIMATE CHANGE**						
3.1	***Improve the knowledge base on climate variability and climate change and their impacts on water resources***						
3.1.1	Carry out comprehensive assessment of the vulnerability of basin water resources to climate variability and climate change	✔			ZAMCOM	Ministries of Water Resources/ Environment/ Meteorological Services	
3.2	***Improve flood management and mitigation mechanisms at national and regional scale***						

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
3.2.1	Integrate flood management in development planning		✔		ZAMCOM	Ministries of Water Resources/ Environment/ Planning/Finance	
3.2.2	Development and implementation of effective land use planning		✔		ZAMCOM	Ministries of Land / Natural Resources	
3.2.3	Strengthen and encourage collaboration of existing early warning institutions	✔			ZAMCOM	Ministries of Water Resources/ Environment/ Meteorological Services	
3.2.4	Dovetail the operation of major water infrastructure to optimize flood storage	✔			ZAMCOM/Dam operators	Ministries of Water / Disaster Management Units	
3.2.5	Formulate comprehensive flood preparedness and flood response mechanisms, making use of regional good practice	✔			ZAMCOM	Ministries of Water Resources/ Environment/ Meteorological Services / Disaster Management Units	
3.3	***Improve regional and national drought management***						
3.2.2	Support development of drought management plans		✔	✔	Ministries of Planning; local governments. Logistical bureaus	SADC	Share successful experiences from the Basin
3.2.1	Mainstream drought forecasting in water resources planning and management		✔	✔	SADC	Meteorological Services; Disaster Forecasting Services	Assess experience with recent droughts and make priority list of requirements
3.4	***Use regional/global development opportunities presented by climate change***						
3.4.1	Integrate strategies to deal with climate variability and climate change in national socio-economic development planning	✔			ZAMCOM/Miombo Network, Waternet	Ministries of Planning and Finance; Water Resources	Develop briefings based on existing studies; systematically share

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
3.4.2	Exploit development opportunities under climate change financing mechanisms for a.o WRITE IN FULL. afforestation	✔	✔		SADC/Interim Secretariat	Ministries of Planning and Finance; Water Resources; Forestry	Identify service provider that could serve as focal point on carbon credit financing
3.4.3	Setup a regional centre of excellence to document and support activities for effective adaptation to climate variability and climate change		✔	✔	Ministries of Planning and Finance; Water Resources; Forestry	SADC/ZAMCOM/ service providers	Develop a suite of project packages including financing arrangements
4.	**BASIN WIDE COOPERATION AND INTEGRATION**						
4.1	***Establishment and operationalization of ZAMCOM***						
4.1.1	Encourage signing and ratification of the ZAMCOM Agreement	✔			SADC	Ministries of Water Resources; Prime Ministers Office	Identify regional champion and other mechanism to promote cause of ZAMCOM
4.1.2	Establish Interim Secretariat	✔			Project Steering Committee; SADC/ ZRA	National Committees	Agree on work plan of Secretariat and trajectory towards ZAMCOM
4.1.3	Develop public information function of Interim Secretariat and later ZAMCOM Secretariat		✔		ZAMCOM	ZRA and other sub-basin organizations	Developing MoUs on mutually supporting each others activities
4.1.4	Strengthen coordination with ongoing programmes in the Basin	✔			Interim Secretariat	All major service providers (see also list)	Develop MoUs on linking the various programmes to the ZAMCOM process
4.2	***Strengthen organisational, financial and human resource capacities of water management institutions at regional, national and local levels***						

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
4.2.1	Develop and implement performance based training programmes on water resources management based on institutional development assessments	✔	✔		ZAMCOM	Universities / Research Institutes / SADC-WD / WARFSA, CapNet	Training needs assessment
4.2.2	Implement well-designed plan to harmonise water resources management policies, legislation and strategies of the basin states	✔	✔		ZAMCOM	SADC-WD / Ministries of Water Resources / Legal Affairs	
4.3	***Improve and expand Basin-wide water resources data collection, processing and information transfer systems***						
4.3.1	Formulate and implement a data and information sharing protocol for further operationalization of ZAMWIS	✔			ZAMCOM	SADC-WD / Ministries of Water Resources / Meteorological Services	
4.3.2	Harmonize data measurement and storage methods in basin		✔		ZAMCOM	SADC-WD / Ministries of Water Resources / Meteorological Services	
4.3.3	Improve basin-wide data (water quality and quantity measurements, sediment content, groundwater) collection systems	✔	✔	✔	ZAMCOM	SADC-WD / Ministries of Water Resources / Meteorological Services	
4.3.4	Priority improvement of data and knowledge base on groundwater resources	✔			ZAMCOM	SADC-WD / Ministries of Water Resources / Geological Services / Research Institutions	
4.3.5	Further development of ZAMWIS (increasing accessibility and interactivity and developing models and DSS tools)	✔			ZAMCOM	SADC-WD / Ministries of Water Resources / Meteorological Services	

	Challenge / Strategy / Main action	Short Term (0-2 yrs)	Medium Term (3-5 yrs)	Long Term (6-15 yrs)	Lead institution	Main partner institutions	First action
4.3.6	Strengthen basin-wide research on water resources through joint programmes, collaboration of research institutions, and enhanced information exchange.		✔		ZAMCOM	SADC-WD / Ministries of Water Resources / Research Institutions	
4.4	***Promote broad based stakeholders participation in water management***						
4.4.1	Strengthen stakeholder participation through policy and legislation review and revision throughout the basin states.	✔			Interim Secretariat	National Committees	Identify most important messages and national organizations to work with
4.4.2	Formulate and implement a public information programme to raise awareness among a broad range of stakeholders.		✔	✔	ZAMCOM	National Committees	Develop contacts with important associations of target groups and media
4.4.3	Strengthen and sustain the Annual Basin Forum meetings as part of awareness and information sharing among basin stakeholders	✔			ZAMCOM	SADC-WD / Ministries of Water Resources / River Basin Organisations	Formalize an MoU between key stakeholders

Table 5.3 Engagement of ZAMCOM

	Challenge / Strategy / Main action	Role of ZAMCOM/ Interim Secretariat
1	**INTEGRATED AND COORDINATED WATER RESOURCE DEVELOPMENT & MANAGEMENT**	
1.1	***Address high demand for infrastructure to meet energy security***	
	Joint development of feasible package of hydropower sites	Coordinate with SAPP, ZRA and other organizations
	Identify and promote options for small scale hydropower	Develop special program with SAPP
1.2	***Address demand for water in agricultural development and regional food security***	
	Support basic services and development of road network	Initiate number of meeting with main organizations
	Support the promotion of irrigation development	Initiate meeting on groundwater usage for irrigation/ coordinate with NEPAD/ World Bank and irrigation department to identify support measures
	Increase productivity of rain-dependent agriculture	Initiate cooperation and experience sharing and ensure real programmes are developed on moisture management and sustainable fertilizer supply
	Ensure sustainability of flood plain agriculture by managed flood releases	Actively coordinate between dam operators and downstream riparians and promote experience sharing
1.3	***Improve operation of existing and new dams for multiple functions of water***	
	Improve understanding of downstream socio-economic and environmental impact of flow regimes	Cooperate with major service providers, facilitate their work and ensure political embedding
	Identify influence of dam operations on flow regimes ao by simulation models	Cooperate with major service providers, facilitate their work and ensure political embedding
	Optimize management of existing reservoirs	Introduce discussion and proposal at high political level
1.4	***Increase funding for water resources development & management***	
	Improve overall regional water governance	Identify bottlenecks and initiate discussion at political level
	Develop mechanisms for local infrastructure co-financing	Identify service provider and local financial partners to develop templates
	Increase riparian capacity in financial engineering and negotation skills	Identify service provider to engage in capacity building
1.5	***Increase access to sustainable water supply & sanitation***	
	Collaborate in investment plans on road networks, power interconnections and	Link with COMESA and SADC and organize forum meetings

	Challenge / Strategy / Main action	Role of ZAMCOM/ Interim Secretariat
	navigation improvement	
2.	**ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT**	
2.1	***Adequately manage the ecological and economic functions of wetlands in the Basin***	
	Improve wetland related regulation and management between countries	Link with IUCN
	Assess and maintain environmental flow appropriate to each main river section	Engage with service providers and main operators
	Develop management plans for all major wetlands in the Basin taking into account multiple functions	Engage riparian governments to undertake. In case of trans-boundary wetlands create cooperation between countries
	Develop and implement special initiatives for environmental management around hotspots	Link with IUCN and other service providers
2.2	***Control water pollution from point sources - especially urban centres and mines***	
	Set up integrated water quality monitoring systems with real time communication	Identify with riparian governments main requirements and issues
	Harmonize legislation and enforcement systems on water quality	Support work of SADC and engage national committees
	Promote clean technology through system of environmental audits	Actively promote riparian government to engage this and come to unified system
2.3	***Control invasive aquatic weeds and prevent new outbreaks***	
	Harmonize legislation on control of aquatic weeds	Support work of SADC
	Set up national focal points on aquatic weed control	With SADC and national governments
	Exchange experience and initiate regional capacity building	Identify service provider or consortium of national institutes
	Joint monitoring and survey of aquatic weeds proliferation	With SADC work on better data collection, integrate with other data collection efforts
	Adjust reservoir operations including provision for weed control	Make part of overall discussion on reservoir operations
2.4	***Promote sustainable fisheries management as contribution to regional food security***	
	Cooperate with NEPAD towards improved fisheries productivity	Link with NEPAD and initiate meeting with operators and Fishery Depts
	Integrate fisheries development with main water resources development	Make part of overall discussion on reservoir operations

	Challenge / Strategy / Main action	Role of ZAMCOM/ Interim Secretariat
2.5	***Ensure water resources development & management does not harm tourism potential***	
	Systematically integrate tourism development in water resources development and planning	Develop special program with RETOSA
	Operation of water infrastructure to support and enhance tourism management	Make part of overall discussion on reservoir operations
2.6	***High and unique ecological values in the Basin may be threatened and fragmented by accelerated development***	
	Prepare a comprehensive and spatially explicit map of ecosystems services	Coordinate with WWF/TNC/UNESCO-IHE and Ministries of Environment/Natural Resources
	Delineate high priority conservation areas such as headwaters, recharge zones and flood plains and implement land use plans for these areas	Coordinate with WWF/TNC/UNESCO-IHE and Ministries of Environment/Natural Resources
	Start international cooperation on linking areas with high significance for biodiversity	Coordinate with WWF/TNC/UNESCO-IHE and Ministries of Environment/Natural Resources
3.	**ADAPTATION TO CLIMATE VARIABILITY AND CLIMATE CHANGE**	
3.1	***Improve the knowledge base on climate variability and climate change and their impacts on water resources***	
	Carry out comprehensive assessment of the vulnerability of basin water resources to	Coordinate with Ministries of Water Resources/ Environment/ Meteorological Services
3.2	***Improve flood management and mitigation mechanisms at national and regional scale***	
	Integrate flood management in development planning	Central repository of flood management plans, initiate capacity building
	Develop and implement effective land use planning	Coordinate with Ministries of Land / Natural Resources
	Strengthen and encourage collaboration of existing early warning institutions	Encourage formulation of requirements
	Dovetail the operation of major water infrastructure to optimize flood storage	Make part of overall discussion on reservoir operations
	Formulate comprehensive flood preparedness and flood response mechanisms, making use of regional good practice	Encourage identification and sharing of local good practices
3.3	***Improve regional and national drought management***	

	Challenge / Strategy / Main action	Role of ZAMCOM/ Interim Secretariat
	Support development of drought management plans	Encourage identification and sharing of local good practices
	Mainstream drought forecasting in water resources planning and management	Link to SADC work and link to work on flood forecasting
3.4	***Use regional/global development opportunities presented by climate change***	
	Integrate strategies to deal with climate variability and climate change in national socio-economic development planning	Coordinate with Miombo Network, Waternet and Ministries of Planning and Finance; Water Resources
	Exploit development opportunities under climate change financing mechanisms for a.o. afforestation	Initiate a regional programme to support riparian countries in this field
	Setup a regional centre of excellence to document and support activities for effective adaptation to climate variability and climate change	
4.	**BASIN WIDE COOPERATION AND INTEGRATION**	
4.1	**Establishment and operationalization of ZAMCOM**	
	Encourage signing and ratification of the ZAMCOM Agreement	Link with SADC to avoid stalemates
	Establish Interim Secretariat	Ensure agreed agenda and make links with other initiatives
	Strengthen coordination with ongoing programmes in the Basin	Prepare MoUs - including link to Basin Governance structures
	Strengthen coordination with management commission for sub-basins	Prepare MoUs - to define mutually supporting roles
4.1	***Establishment and operationalization of ZAMCOM***	
	Develop regional programmes on reservoir operation, water financing, flood management, irrigation	Identify gaps and start new initiatives
	Ensure restoration and sustainability of flood plain agriculture	Ensure imbedding with all players, including local governments
	Assess feasibility of basin water transfers (inside and outside of the Basin)	Initiate technical, environmental and social studies
4.2	***Strengthen organisational, financial and human resource capacities of water management institutions at regional, national and local levels***	
	Develop and implement performance based training programmes on water resources management based on institutional development assessments	Involve Universities / Research Institutes / SADC-WD / WARFSA, CapNet
	Implement well-designed plan to harmonise water resources management policies, legislation and strategies of the basin states	Involve SADC-WD / Ministries of Water Resources / Legal Affairs

	Challenge / Strategy / Main action	Role of ZAMCOM/ Interim Secretariat
4.3	***Improve and expand Basin-wide water resources data collection, processing and information transfer systems***	
	Formulate and implement a data and information sharing protocol for further operationalization of ZAMWIS	Coordinate with SADC-WD / Ministries of Water Resources / Meteorological Services
	Harmonize data measurement and storage methods in basin	Coordinate with SADC-WD / Ministries of Water Resources / Meteorological Services
	Improve basin-wide data (water quality and quantity measurements, sediment content, groundwater) collection systems	Coordinate with SADC-WD / Ministries of Water Resources / Meteorological Services
	Priority improvement of data and knowledge base on groundwater resources	Coordinate with SADC-WD / Ministries of Water Resources / Geological Services / Research Institutions
	Further development of ZAMWIS (increasing accessibility and interactivity and developing models and DSS tools)	Coordinate with SADC-WD / Ministries of Water Resources / Geological Services / Research Institutions
	Strengthen basin-wide research on water resources through joint programmes, collaboration of research institutions, and enhanced information exchange.	Engage with Waternet, Rambol, GWP, others on developing fundable proposals
4.4	***Promote broad based stakeholders participation in water management***	
	Strengthen stakeholder participation through policy and legislation review and revision throughout the basin states.	Involve SADC-WD / Ministries of Water Resources / Research Institutions
	Formulate and implement a public information programme to raise awareness among a broad range of stakeholders.	Develop strong network also outside the Water Sector
	Strengthen and sustain the Annual Basin Forum meetings as part of awareness and information sharing among basin stakeholders	Improve visibility of Basin Cooperation

6 Follow up Steps

6.1 Key Actions

The short term actions are described in Table 5.2. For all activities in support of the implementation of the Zambezi IWRM Strategy the start up actions are described as well. The short term actions relate both to the establishment and functioning of the Basin organization as well as the coordination of different activities for the development and management of the Zambezi Basin Water Resources.

With respect to the first category of key short term actions (establishment and functioning of the Basin Organizations), the following is required:

- Establish an agreed agenda for the Interim Secretariat, endorsed and supported by the Basin States
- Support ratification of ZAMCOM by initiating special initiatives, such as the engagement
- Closely liaise with the different ongoing programmes by various organizations and service providers, formalized in preparing Memorandums of Understanding (MoUs)
- Strengthen data sharing as a continued input to the Zambezi Water Information System ZAMWIS, removing bottlenecks in timely supply and financial contribution
- Strengthen communication function in cooperation with the National Committees to make Basin Cooperation come alive on a number of practical items.

With respect to the development and management of water resources in the Basin, it is proposed to make this also central, making use of the various ongoing initiatives. For the short term the following actions are proposed:

- Update studies on hydropower development projects in view of the urgent need for energy security
- Promote small scale hydropower potential by listing technical and financial opportunities
- Support irrigation development from groundwater and surface water by comparing plans and identifying constraints
- Promote increase of productivity from rain-fed agriculture in cooperation with organizations working on improved moisture management and fertilizer boards
- Prepare multifunctional operation of reservoirs (for hydropower, managed flood releases, fishery, aquatic weed control and flood storage)
- Determine environmental flow requirements for different reaches of the Zambezi and its tributaries – in close consultation with local players and representatives of the Basin States
- Develop management plans for most important wetlands
- Establish national focal points for aquatic weed control based on a definition of minimum requirements
- Develop fishery potential with NEPAD by long-listing technical, management and commercial development opportunities
- Strengthen flood early and real-time warning systems by reviewing performance in recent floods
- Develop flood preparedness and response plans by sharing and exchanging good practice in the Basin

- Create awareness and broad understanding on climate variability and change by disseminating results from ongoing studies and making work of regional organizations working on these themes accessible
- Use funding opportunities for afforestation under Climate Change funds by identifying a regional service provider that could serve different national programmes.

6.2 Coordination and Monitoring

It is proposed that within the Interim Secretariat a position is created for a Coordination & Monitoring Unit. This Unit is expected to track the activities and progress made on different components of the Zambezi IWRM Strategy, making use of the implementation plan. The Unit will keep close contact with the ongoing activities, including those by SADC, SAPP, NEPAD, WWF/TNC/TCF, IUCN, Miombo Network, Waternet, WARFSA, SIDA-RAMBOL and RETOSA.

Monitoring and coordinating these activities will help link the otherwise isolated activities to other ongoing development and integrate them with political and decision making processes in the Basin. It is also expected that systematic monitoring and coordination will increase the demand orientation of the various initiatives.

It is proposed that MoUs are developed with all the different key initiatives, which simply describes the terms of cooperation, i.e. the timely sharing of information, the link to National Committees and Regional Steering Committee, the presentation in the Annual Stakeholder Forum and possible future Water Partnership and the appointment of a liaison person and point of communication within the various initiatives.

The Coordination and Monitoring Unit (CMU) will report six-monthly on the activities that take place against the sub-sections of the IWRM Strategy for perusal by the Steering Committee.

"The security of data is an important issue in data and information exchange and sharing. How do we ensure security of data?" *Zambia National Stakeholder Consultation*

It is proposed that the CMU develops a website in which the various agenda activities on the agenda of the IWRM Strategy can be followed, by national organizations and regional initiatives and key documents can be downloaded. The key is to keep the website up to date. By making the depth and breadth of work ongoing on different themes available, it will also be possible for the various initiatives, national and regional, to interlink. The key documents can then also be uploaded from and retrieved to the ZAMWIS repository.

It is also proposed that progress on the different agenda items and initiatives is a main topic in the Stakeholder Forums. With this the Stakeholder Forum should develop beyond information sharing and general feedback events and assumes the character of working sessions.

6.3 Zambezi Basin Multi-Sector Investment Opportunity Analysis

Increasingly the Wold Bank is identifying water resources development as a key requirement for growth. In 2007 it has therefore established the Africa Water Resources Unit. The Unit looks both at water resources development and management as a means to stimulate growth and to reduce

poverty. Water resources development is seen as one of the elements of the "infrastructure platform".

In April 2008 the World Bank has started the Zambezi Basin Multi-Sector Investment Opportunity Analysis, which will have a duration of one year. This analysis is being carried out by a consortium of consultants to identify growth focused investment options and to make an initial assessment of the economic, hydrological, social and environmental implications of these options in the Basin. The analysis will assess the benefits of cooperative and joint investments for the riparian countries individually and for the region as a whole, and will assess the inter-relations between existing and proposed World Bank country operations from a Basin perspective.

The analysis will build on this IWRM Strategy in developing and recommending realistic scenarios for management and development of water and related resources. The outputs will include proposals for tangible projects and programmes for cooperative water management, joint investments and multi-purpose management of water-related infrastructure.

The analysis will assess and compare scenarios by using economic indicators, satisfaction of electricity needs, of food security needs, generation of employment, satisfaction of environmental flows, impacts of wetlands, on floods, etc. Inputs for the analysis will be requested from all parties. Comments on the draft document from the Committee of Senior Officials and SADC is regarded as very important. The output of the analysis will be reviewed by international experts. The results of the analysis may lead to a World Bank Strategy document for engagement in Zambezi, which would need agreement from the riparian countries and would be dependent upon invitation.

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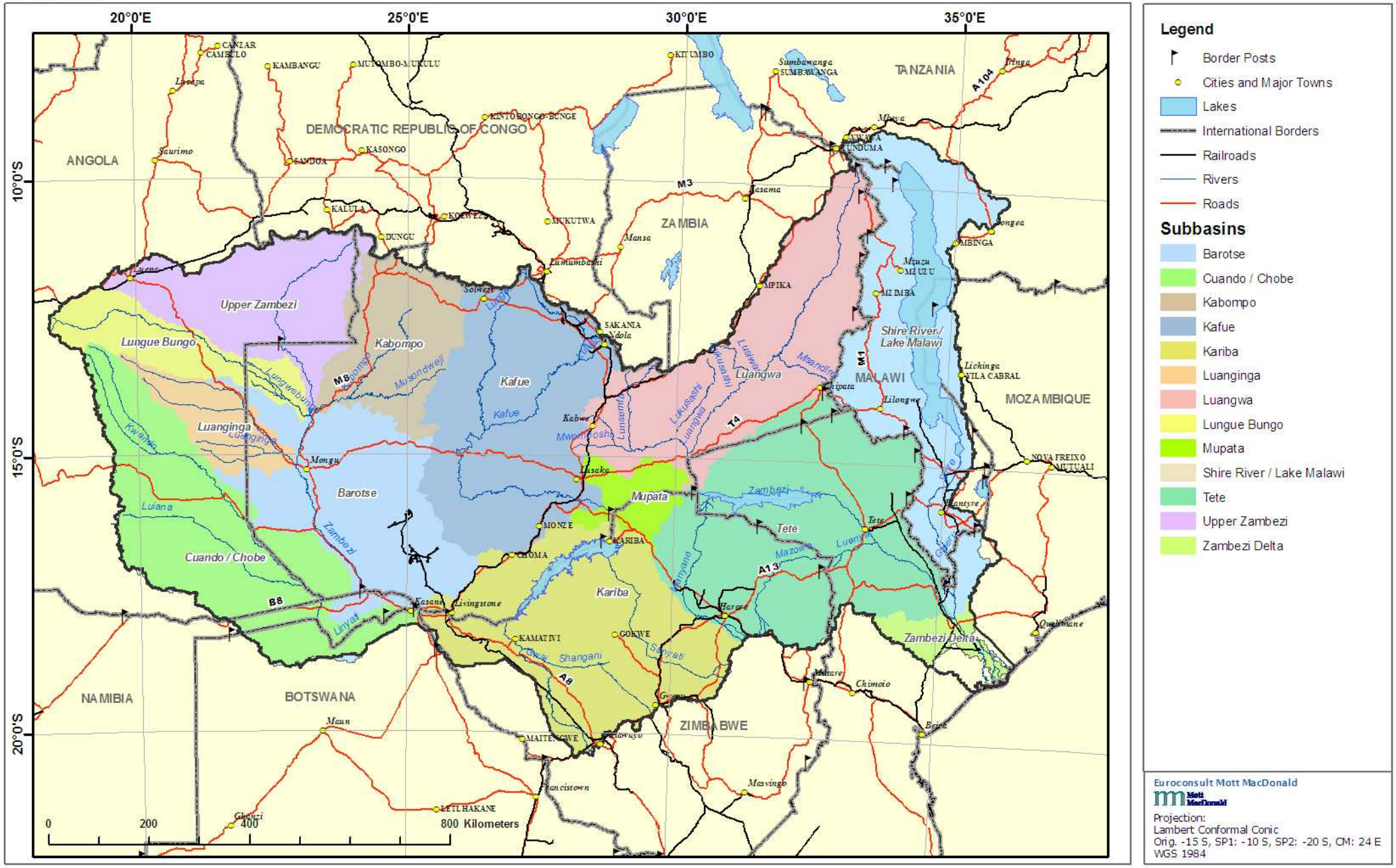
Annex 1 Thematic Maps



Legend

- Border Posts
- Cities and Major Towns
- Lakes
- International Borders
- Railroads
- Rivers
- Roads

Subbasins

- Barotse
- Cuando / Chobe
- Kabompo
- Kafue
- Kariba
- Luanginga
- Luangwa
- Lungue Bungo
- Mupata
- Shire River / Lake Malawi
- Tete
- Upper Zambezi
- Zambezi Delta

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
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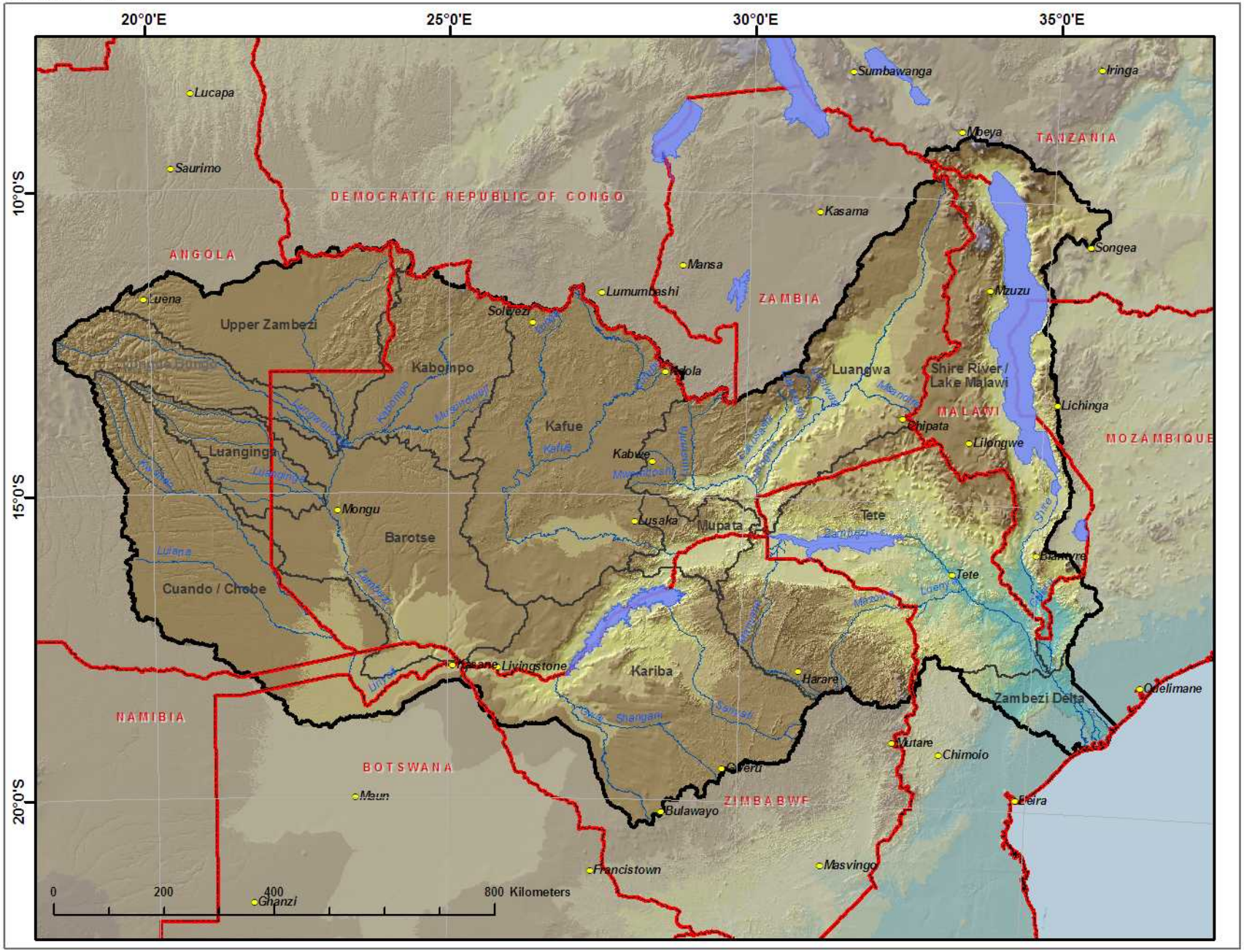
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 1 - Locality Map



Legend

- Cities and Major Towns
- Lakes
- International Borders
- Subbasins
- Rivers

Topography

- 1 - 200m
- 200 - 400m
- 400 - 600m
- 600 - 800m
- 800 - 1 000m
- 1 000 - 1 500m
- 1 500 - 2 000m
- 2 000 - 2 500m
- 2 500 - 3 000m
- 3 000 - 3 500m
- 3 500 - 4 000m

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
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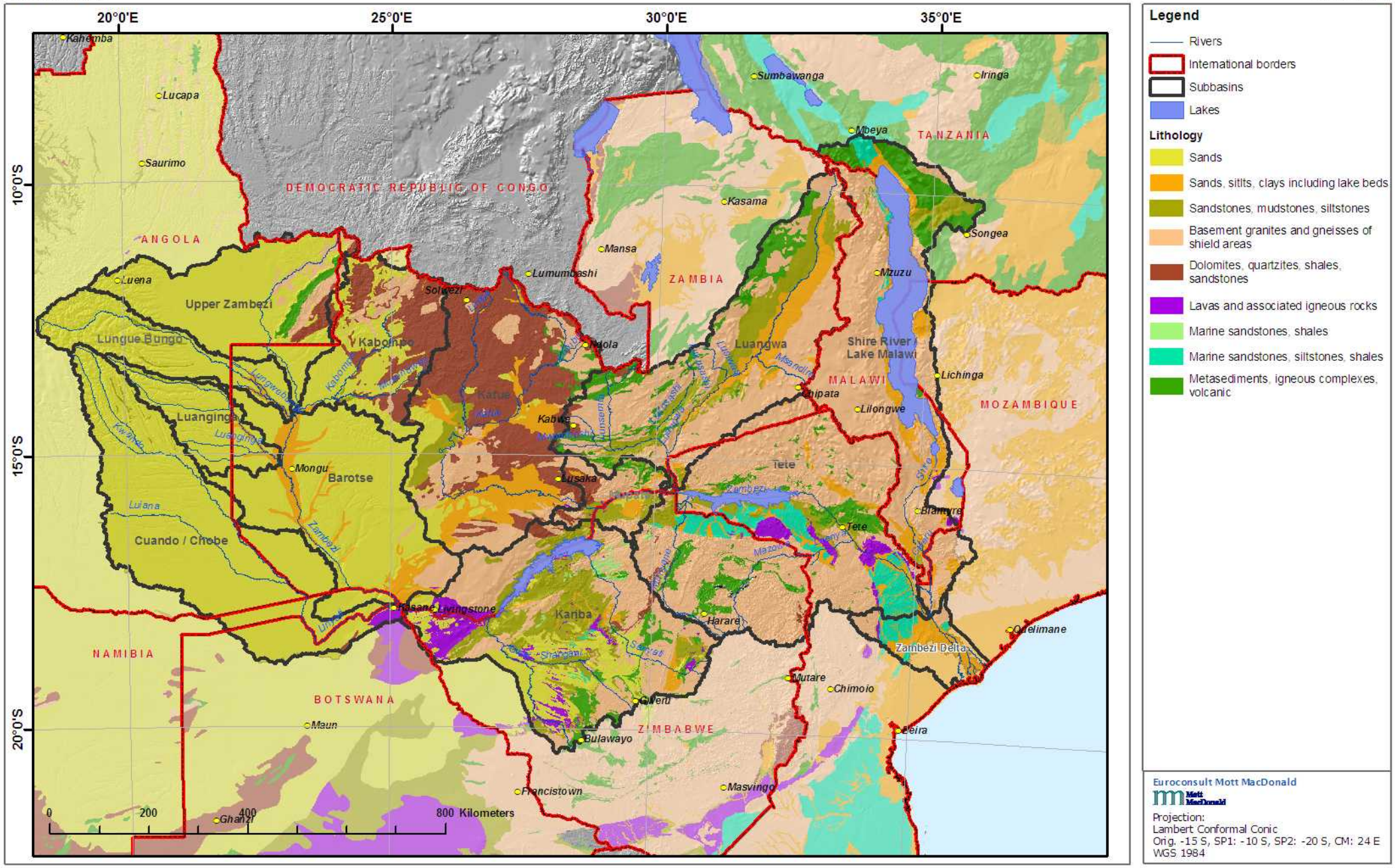
IWRM Strategy for the Zambezi River Basin

Map 2 - Topography

NORWEGIAN EMBASSY



Legend

- Rivers
- International borders
- Subbasins
- Lakes

Lithology

- Sands
- Sands, sitlts, clays including lake beds
- Sandstones, mudstones, siltstones
- Basement granites and gneisses of shield areas
- Dolomites, quartzites, shales, sandstones
- Lavas and associated igneous rocks
- Marine sandstones, shales
- Marine sandstones, siltstones, shales
- Metasediments, igneous complexes, volcanic

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
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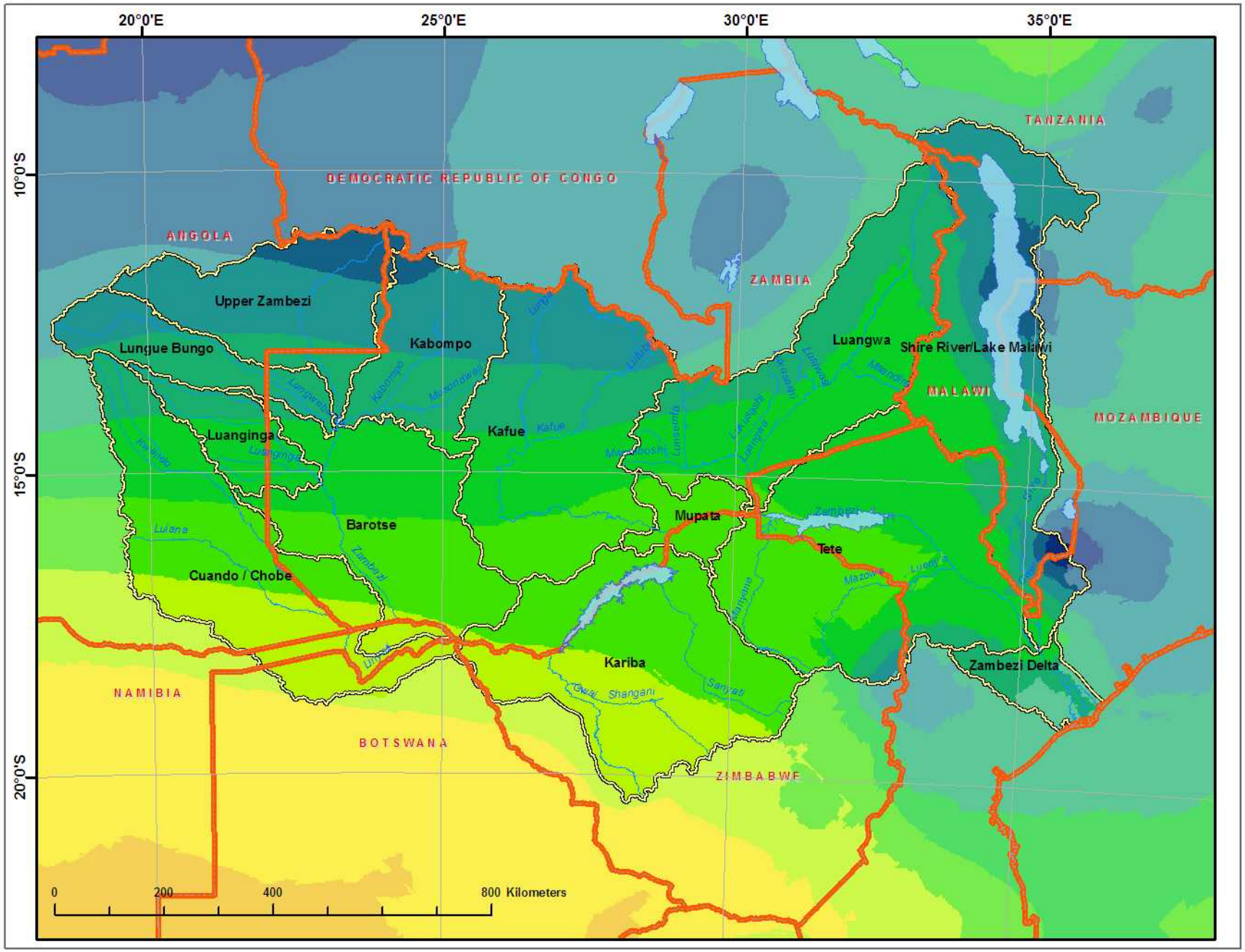
IWRM Strategy for the Zambezi River Basin

Map 3 - Lithology



Legend

- International Borders
- Subbasins

Mean Annual Rainfall [mm]

- < 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 550
- 550 - 700
- 700 - 850
- 850 - 1000
- 1000 - 1150
- 1150 - 1300
- 1300 - 1450
- > 1450

Data Source:
GHCN V2 Database.
Rainfall surface developed by ZAMWIS team

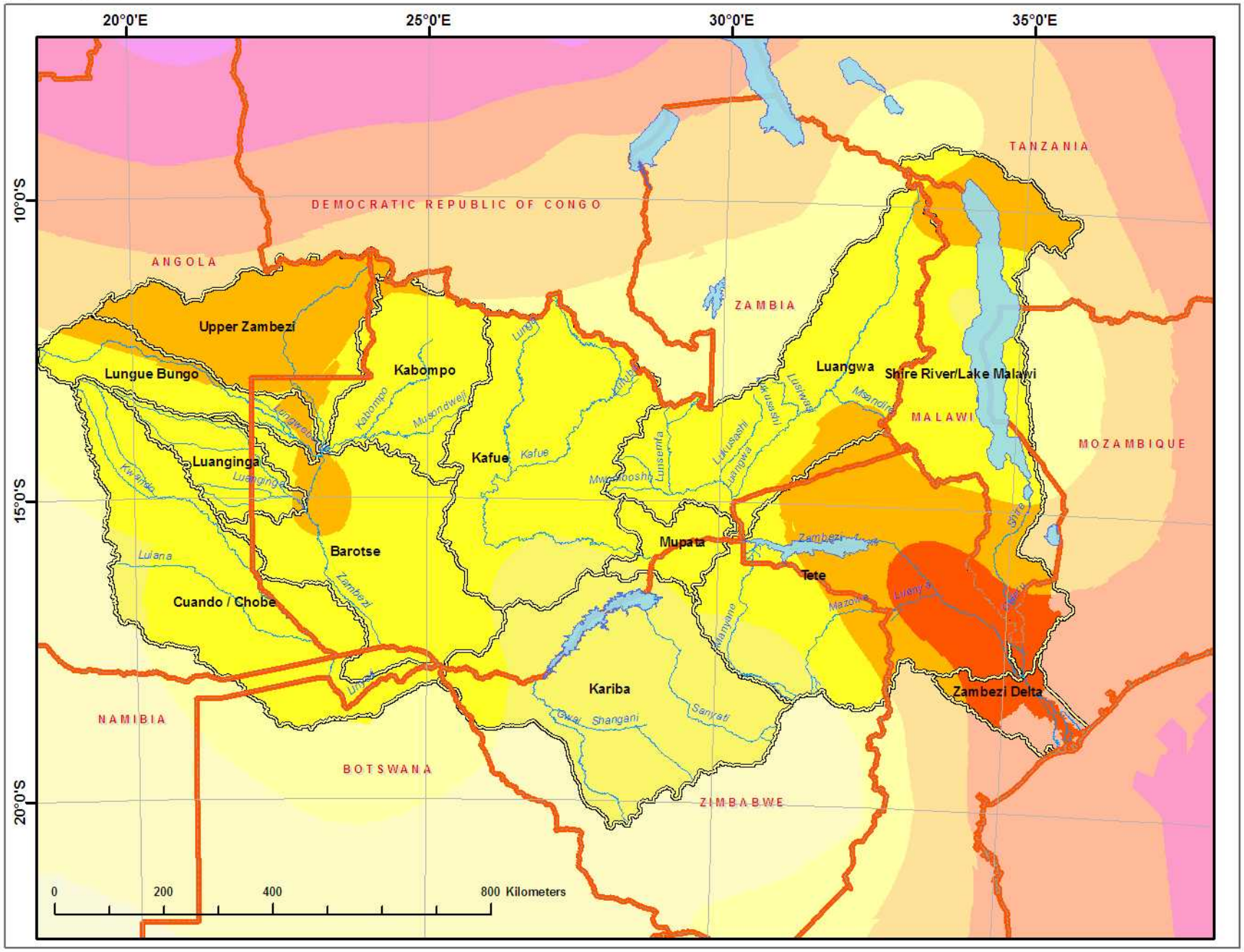
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 4 - Mean Annual Rainfall

NORWEGIAN EMBASSY



Legend

- International Borders
- Subbasins

Avg. July Temp.
Deg. Celsius

- <12
- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 28
- > 28

Data Source:
GHCN V2 Database.
Temperature surface developed by ZAMWIS team

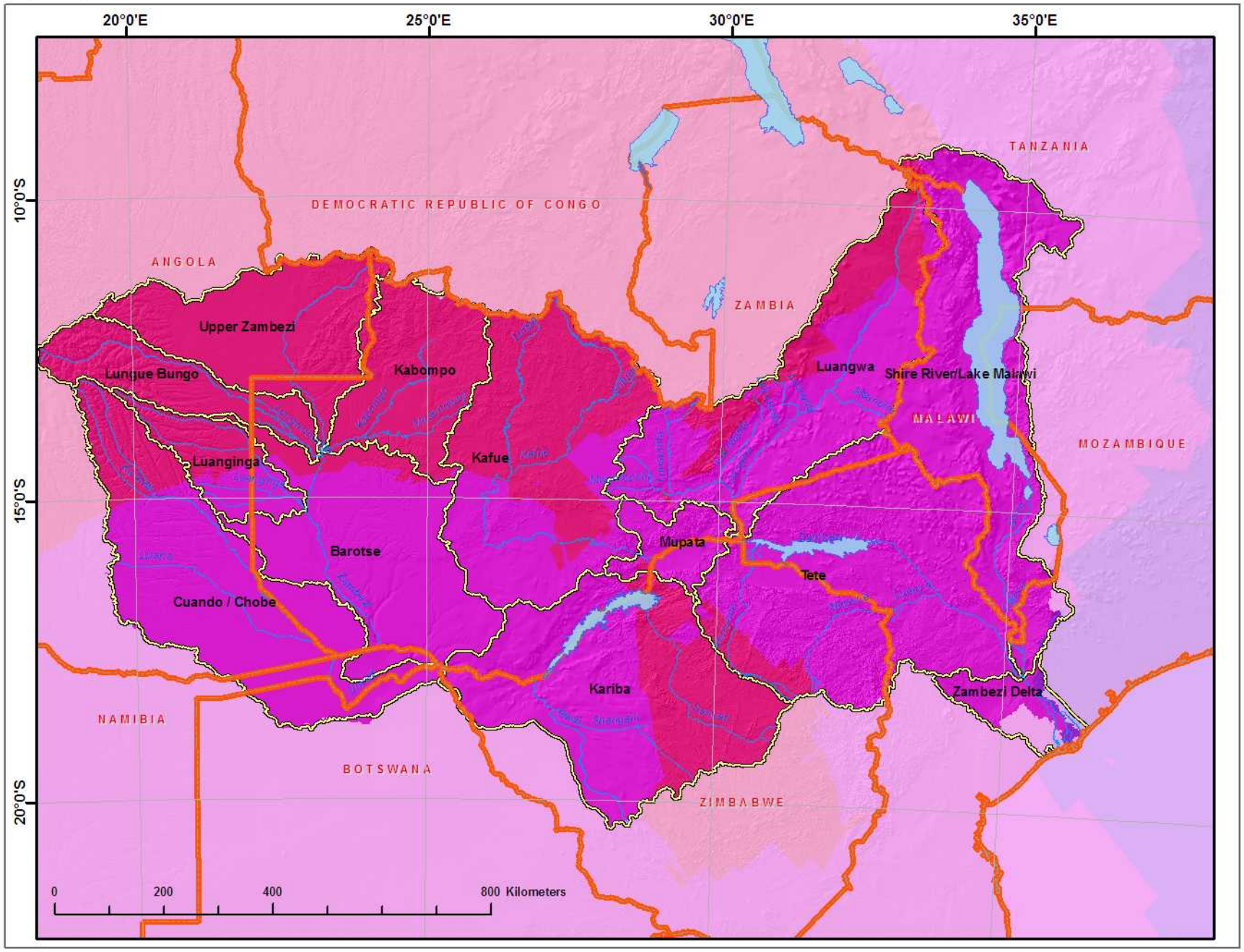
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 5 - Average Temperature in July

NORWEGIAN EMBASSY



Legend

- International Borders
- Subbasins

Avg. November Temp.
Deg. Celsius

- <12
- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 28
- > 28

Data Source:
GHCN V2 Database.
Temperature surface developed by ZAMWIS team

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 6 - Average Temperature in November

NORWEGIAN EMBASSY

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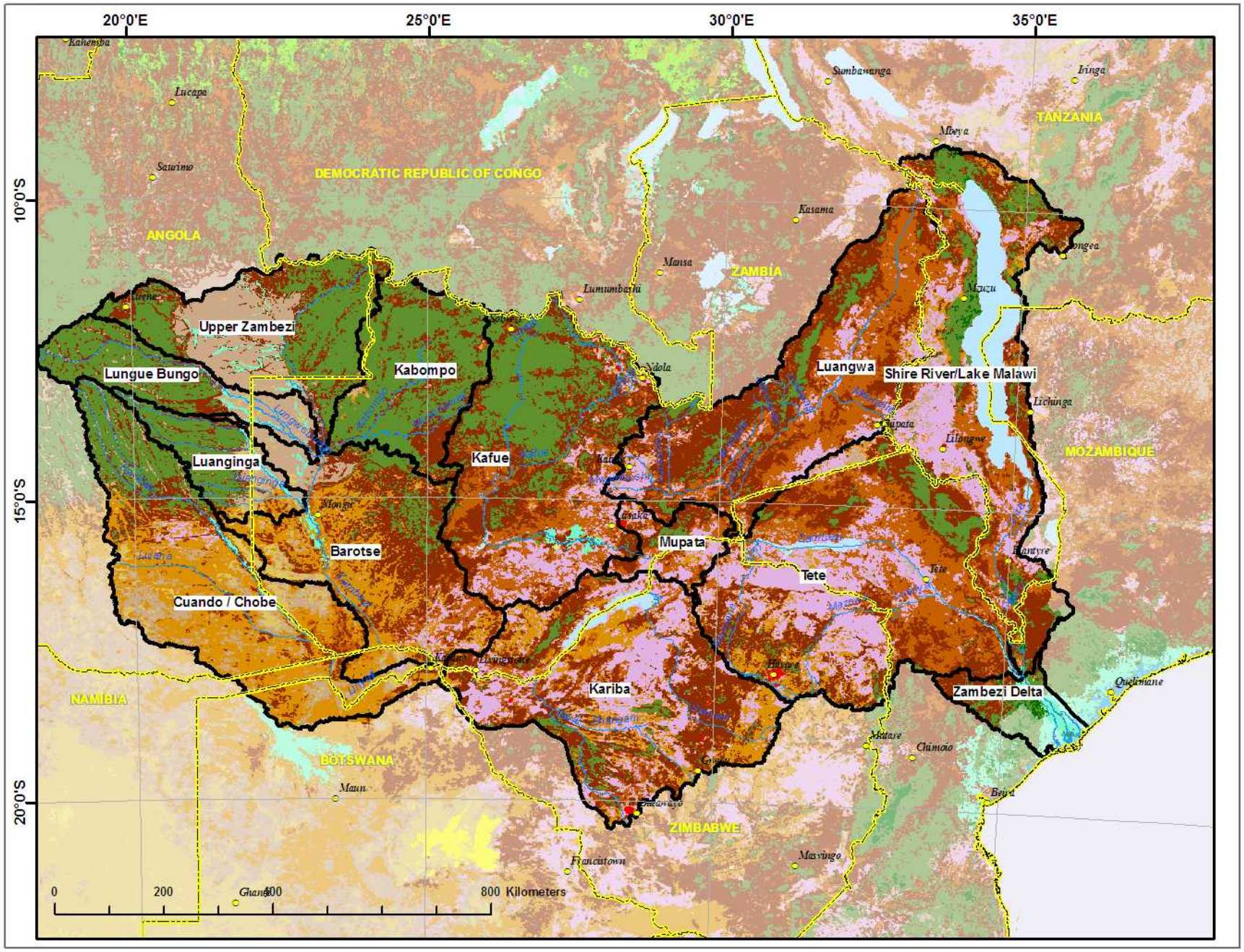
LCU-02 (v1.3)



Legend

Land Cover

- Background
- Bare rock
- Cities
- Closed deciduous forest
- Closed evergreen lowland forest
- Closed grassland
- Croplands (>50%)
- Croplands with open woody vegetation
- Deciduous shrubland with sparse trees
- Deciduous woodland
- Degraded evergreen lowland forest
- Irrigated croplands
- Mangrove
- Montane forest (>1500 m)
- Mosaic Forest / Croplands
- Mosaic Forest / Savanna
- Open deciduous shrubland
- Open grassland
- Open grassland with sparse shrubs
- Salt hardpans
- Sandy desert and dunes
- Sparse grassland
- Stony desert
- Submontane forest (900 -1500 m)
- Swamp bushland and grassland
- Swamp forest
- Tree crops
- Waterbodies

Data Source:
The Land Cover Map for Africa in the Year 2000.
GLC2000 database. European Commision
Joint Research Centre. 2003.
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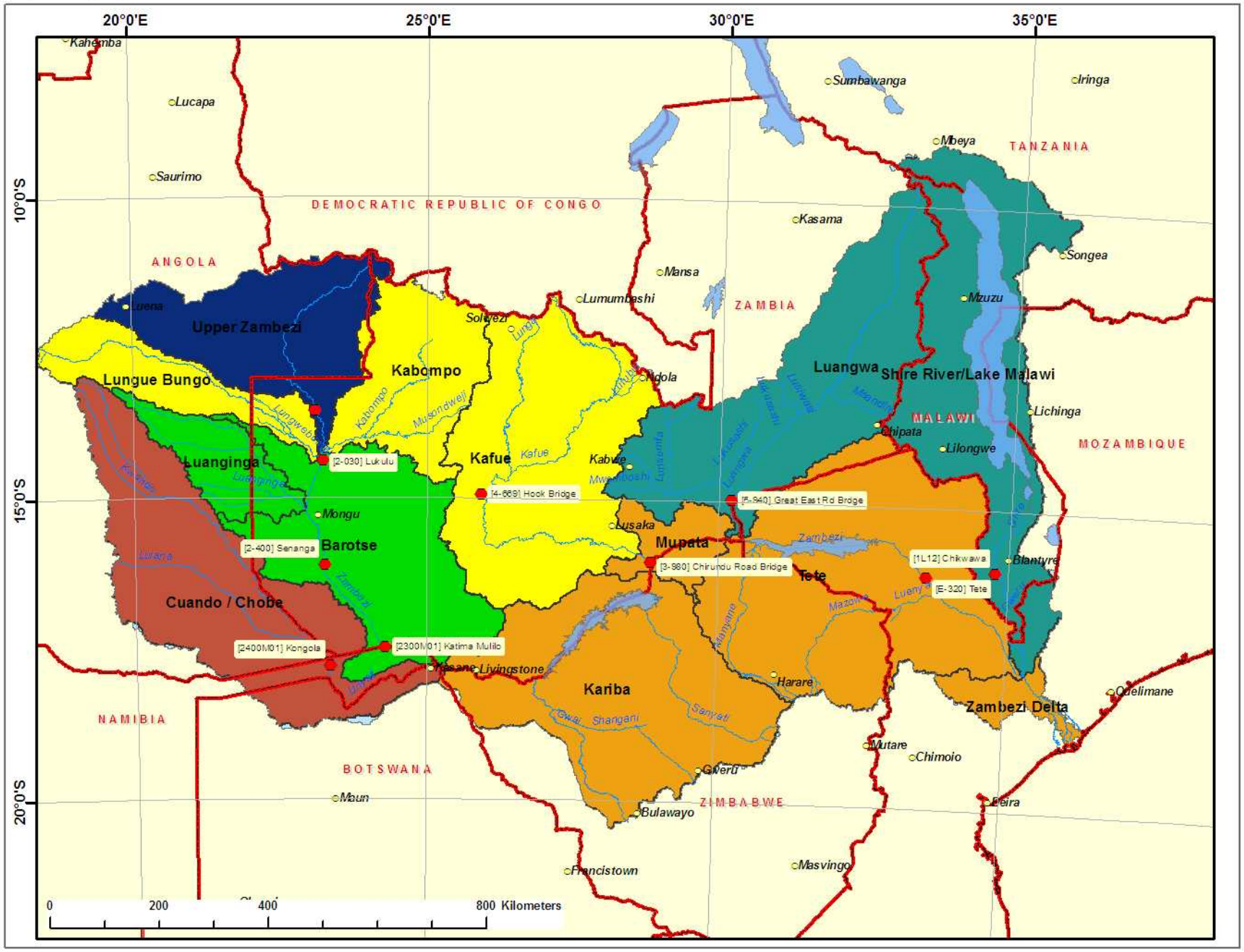
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Lonic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 7 - Year 2000 Land Cover

NORWEGIAN EMBASSY



Legend

- Flow Measuring Stations
- Cities and Major Towns
- International Borders
- Rivers

Mean Annual Runoff [mm]

- 0 - 10
- 11 - 40
- 41 - 80
- 81 - 120
- 121 - 160
- > 160

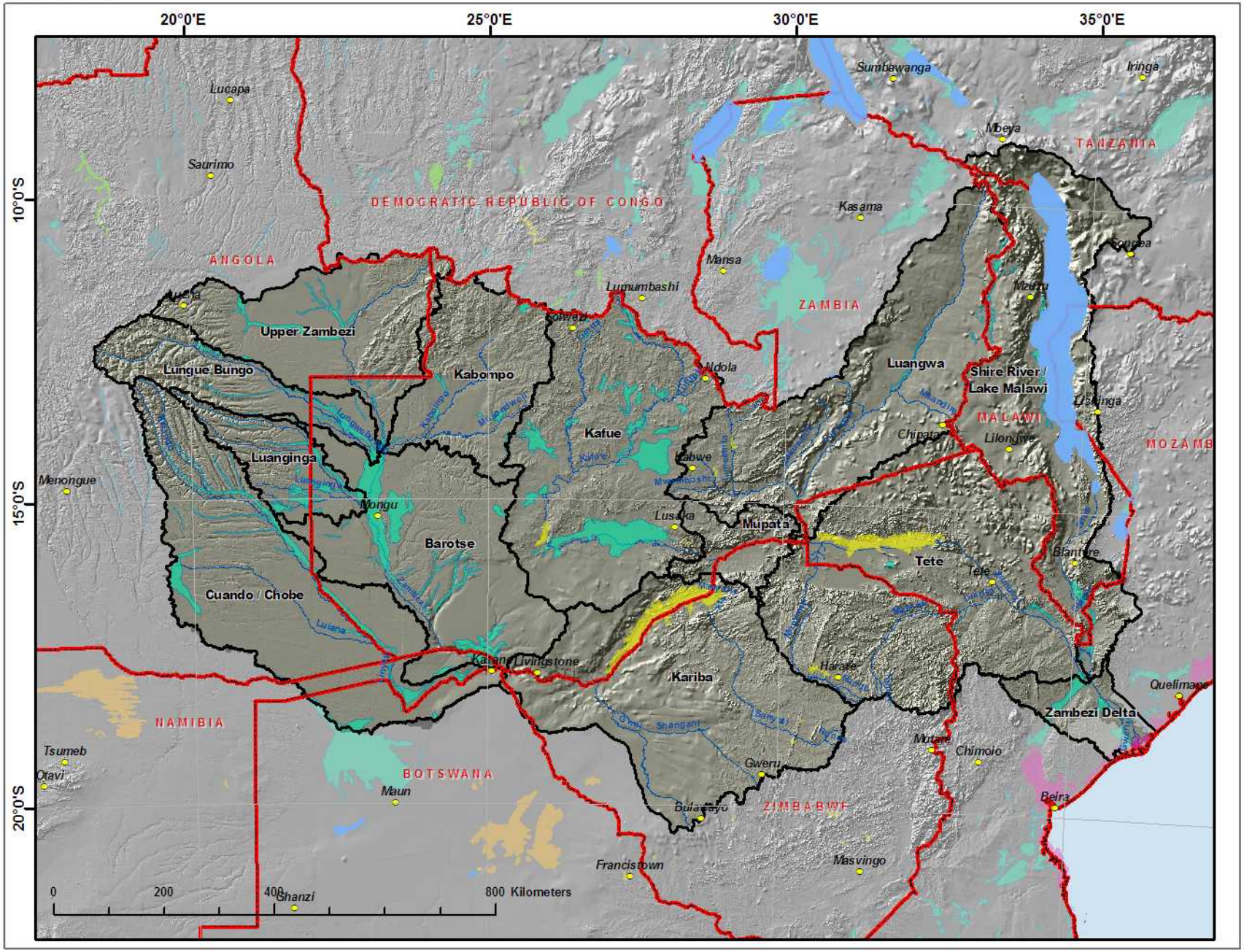
Data Source:
Zambezi IWRM Rapid Assessment.

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 8 - Mean Annual Runoff



Legend

- Cities and Major Towns
- Rivers
- Subbasins
- International borders

Wetland Types

- Lake
- Fresh water marsh
- Impoundment
- Mangrove
- Salt pan
- Swamp forest

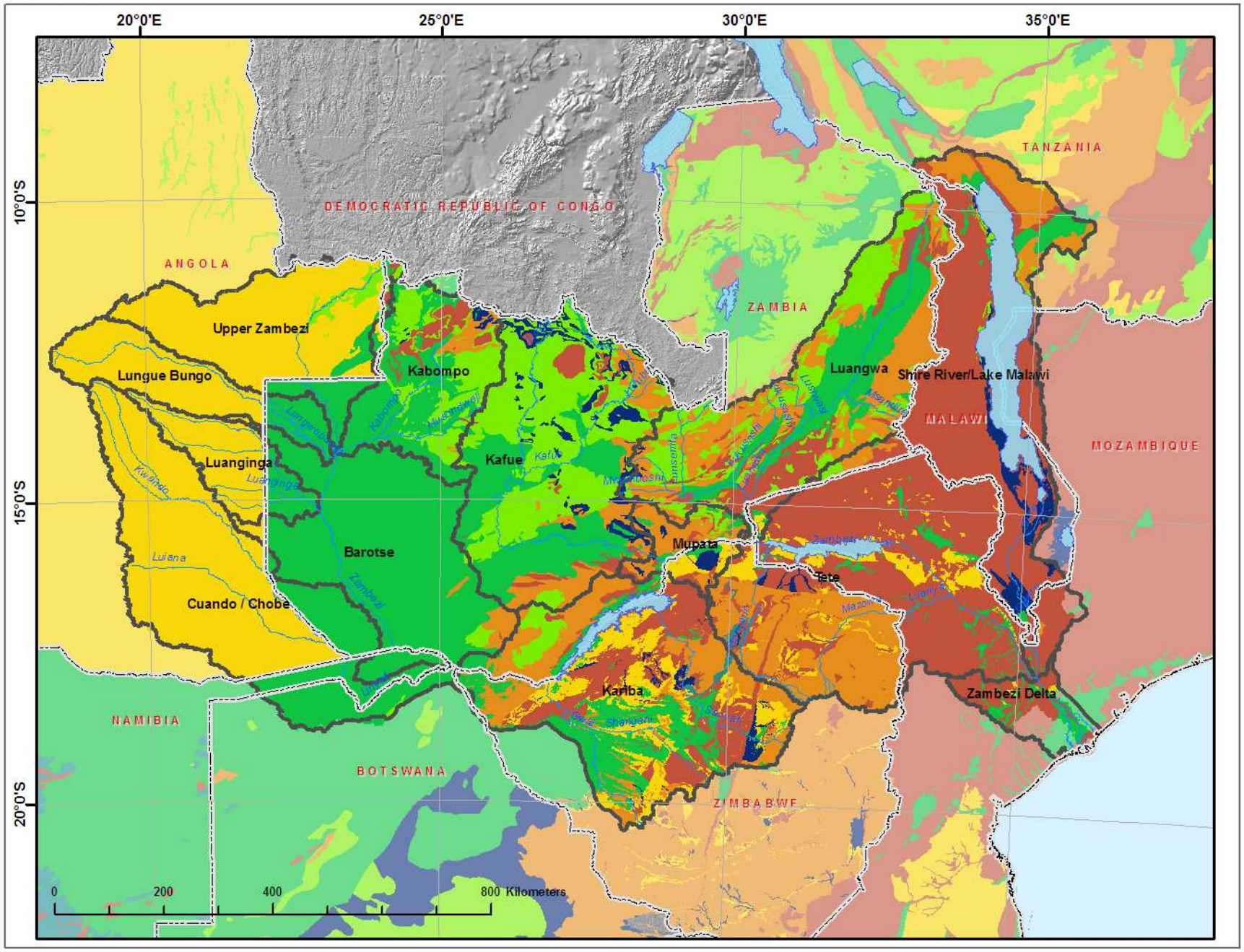
Data Source :
Peace Parks Foundation

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 9 - Wetlands



Aquifer Yield liters/s

- 0.00 - 0.30
- 0.31 - 1.00
- 1.01 - 3.00
- 3.01 - 5.05
- 5.06 - 10.00
- 10.01 - 22.50
- 22.51 - 35.50

Data Source:
Southern Africa FRIEND Phase II
SPATIAL DATA

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Cone
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 10 - Aquifer Yields

NORWEGIAN EMBASSY

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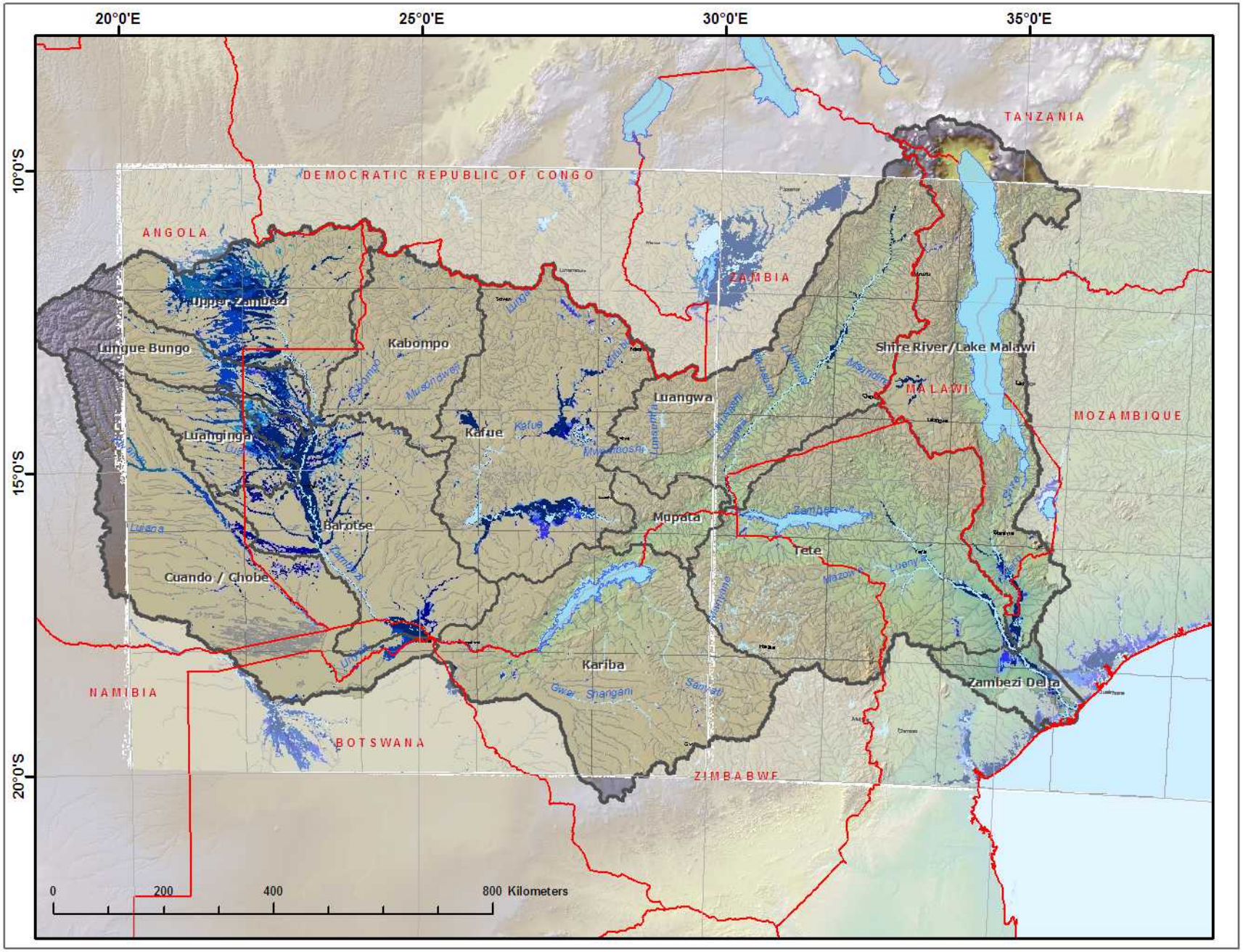
SWR-04 (v1.2)



Legend

- Lakes
- International Borders
- Sub-basins

Flooded Lands in:
2007
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997

Data Source:
Brakenridge, G.R., Anderson, E., Caquard, S., 2003, Flood Inundation Map DFO E20S10 and E30S10, Dartmouth Flood Observatory, Hanover, USA, digital media, http://www.dartmouth.edu/~floods/

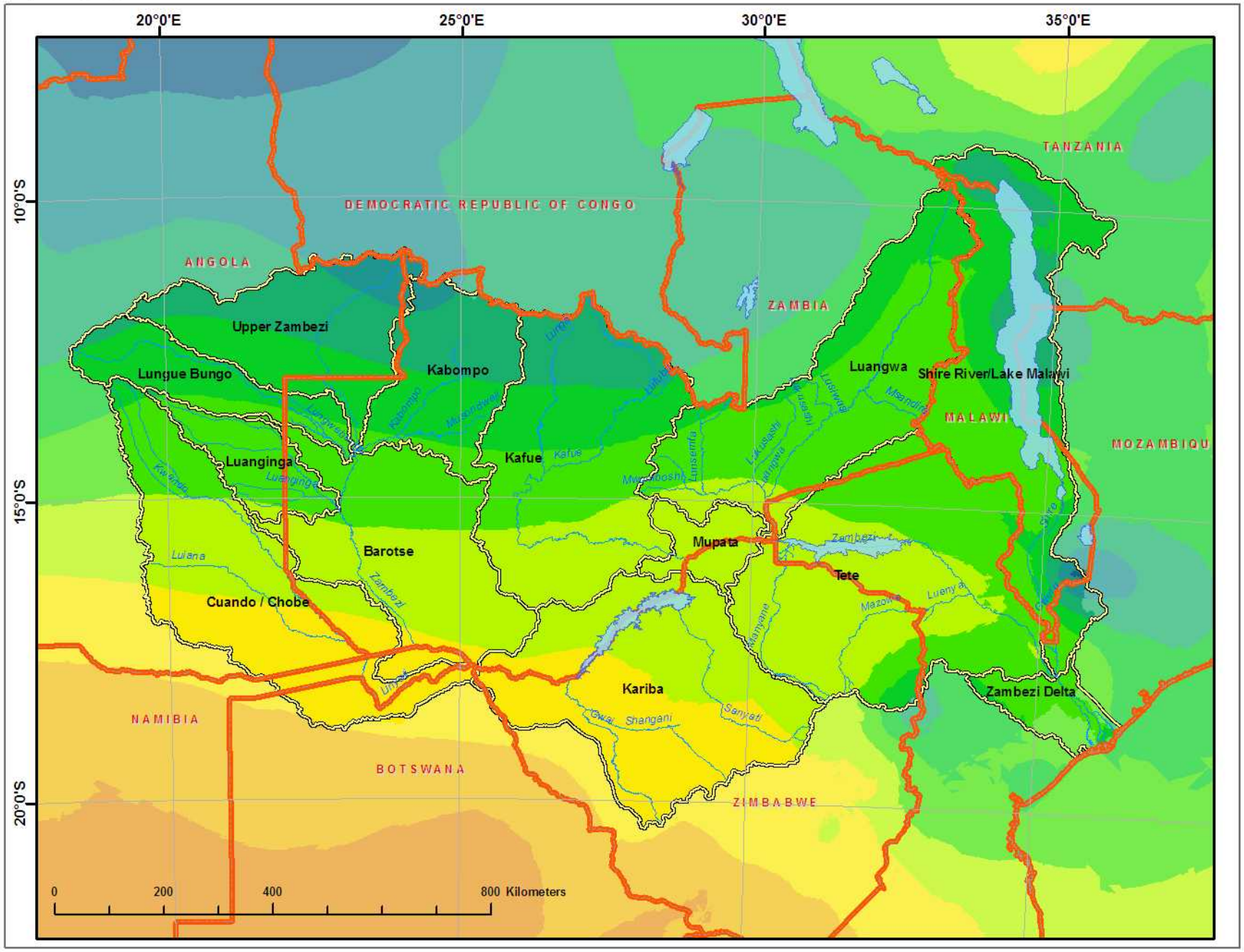
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 11 - Flood Prone Areas

NORWEGIAN EMBASSY



Legend

- International Borders
- Subbasins

Driest Year in 5 [mm]

- < 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 550
- 550 - 700
- 700 - 850
- 850 - 1000
- 1000 - 1150
- 1150 - 1300
- 1300 - 1450
- > 1450

Data Source:
GHCN V2 Database.
Rainfall surface developed by ZAMWIS team

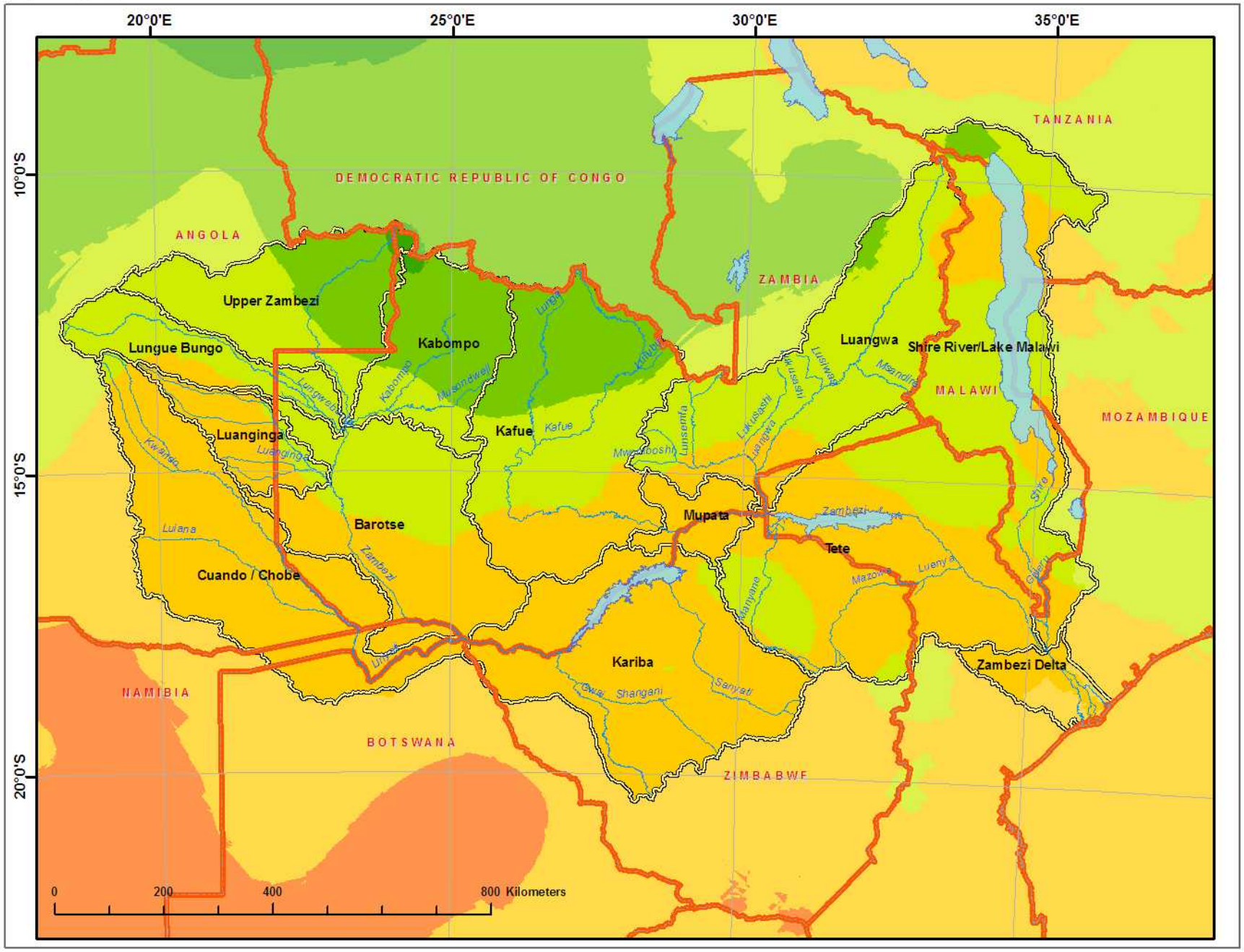
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Cubic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 12 - Driest Year in 5

NORWEGIAN EMBASSY



Legend

- International Borders
- Subbasins

Drought Index

%

- < 10
- 10 - 15
- 15 - 20
- 20 - 30
- 30 - 40
- > 40

The Drought Index is calculated as the percentage deviation of the driest year in 5 from mean annual rainfall, i.e:

Index =
([Mean Annual] - [Driest in 5]) / [Mean Annual] x100

Data Source:
GHCN V2 Database.
Rainfall surface developed by ZAMWIS team

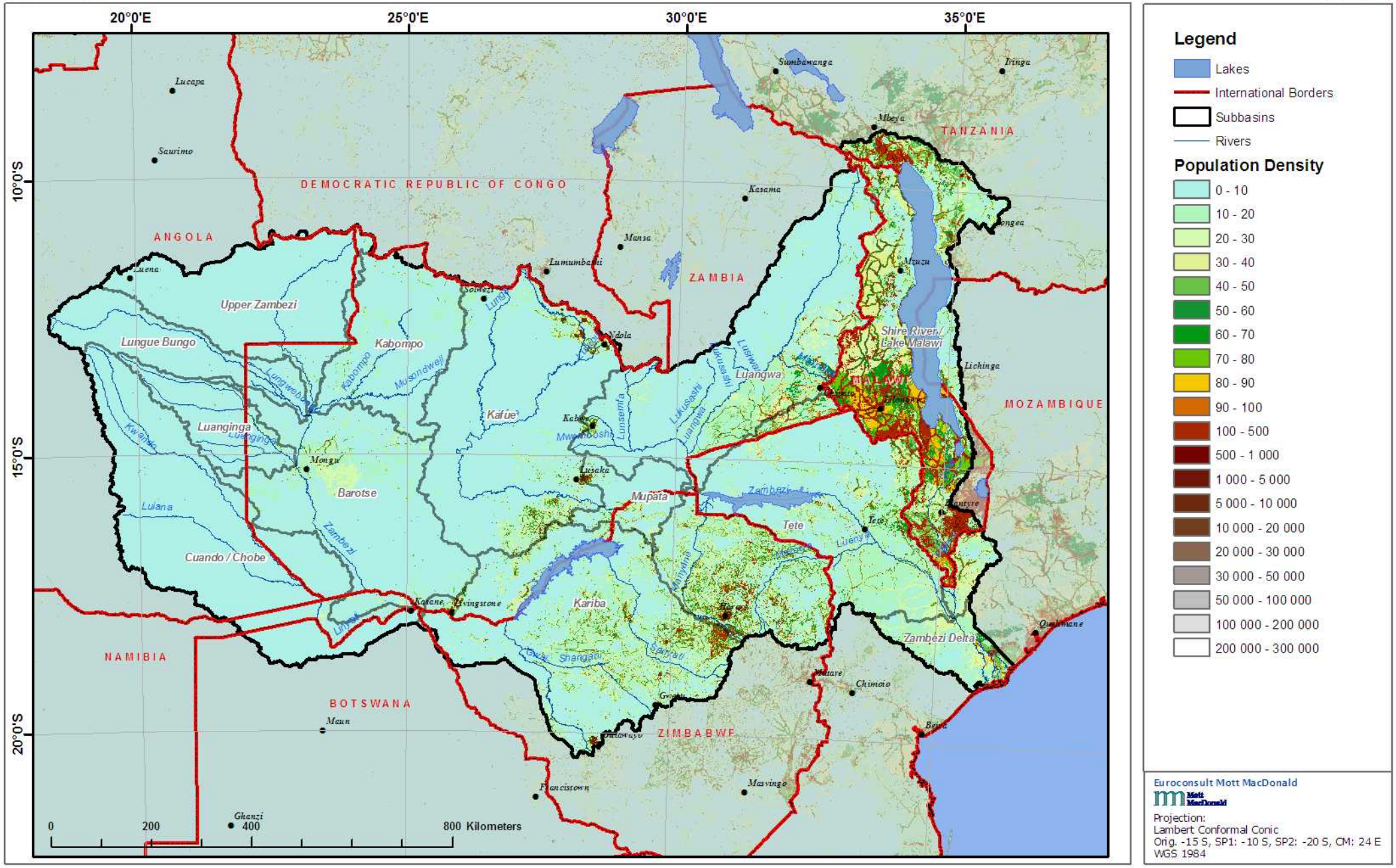
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 13 - Drought Index

NORWEGIAN EMBASSY



Legend

- Lakes
- International Borders
- Subbasins
- Rivers

Population Density

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- 100 - 500
- 500 - 1 000
- 1 000 - 5 000
- 5 000 - 10 000
- 10 000 - 20 000
- 20 000 - 30 000
- 30 000 - 50 000
- 50 000 - 100 000
- 100 000 - 200 000
- 200 000 - 300 000

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 14 - Population Distribution

SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

NORWEGIAN EMBASSY

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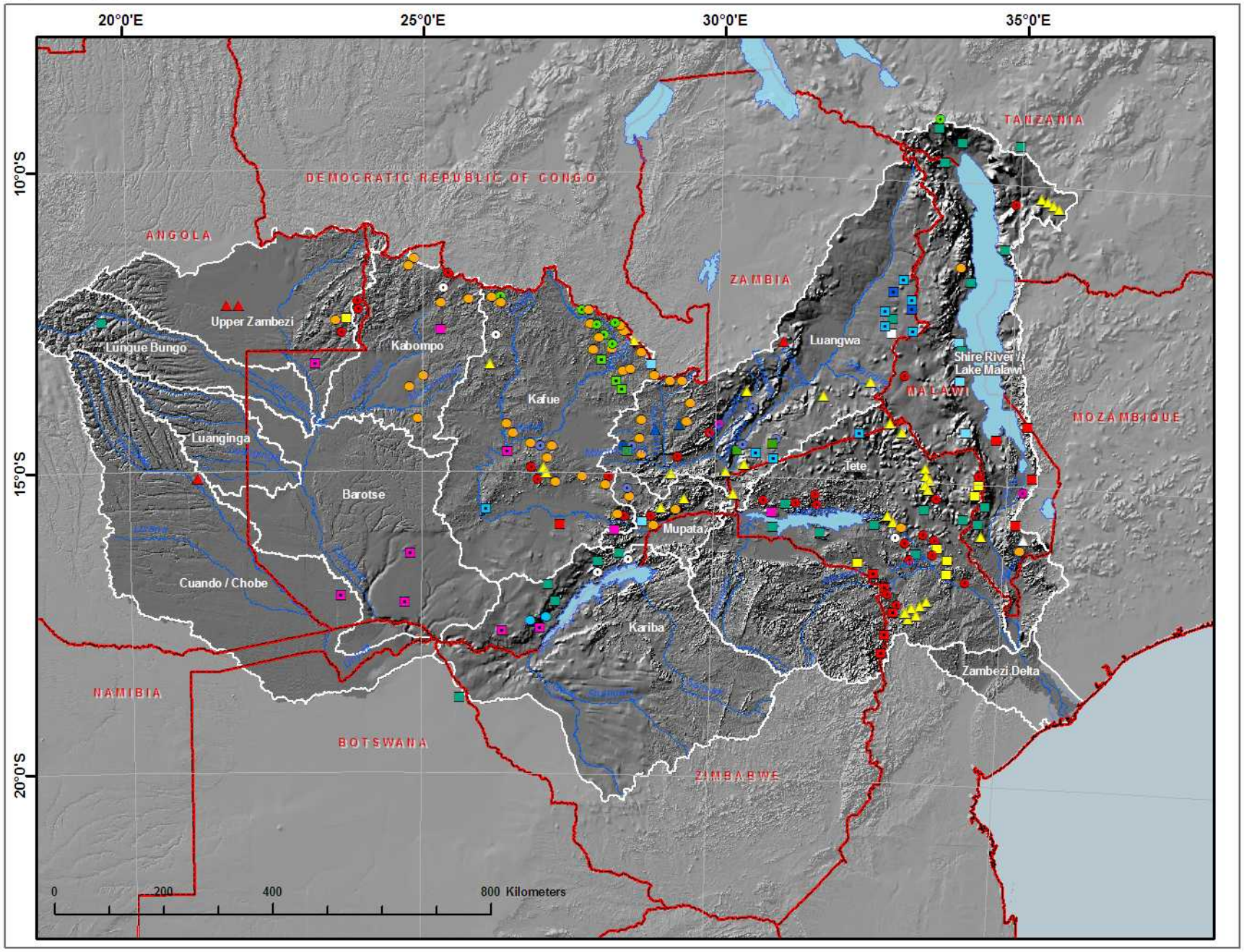
LCU-03 (v1.3)



Legend

- Rivers
- Lakes
- Subbasins
- International borders

Mining Operations

- Gold
- Pegmatte/Mica
- Corundum(Ruby)
- Diamond-kimberlite
- Amethyst
- Emerald
- Aquamarine
- Kyanite
- Garnet
- Coal
- Nickel
- Fluorspar
- Lead
- Chrysotile
- Limestone
- Gypsum
- Vanadium
- Copper
- Tin
- Zinc
- Iron
- Cobalt
- Uranium/Thorium
- Monazite

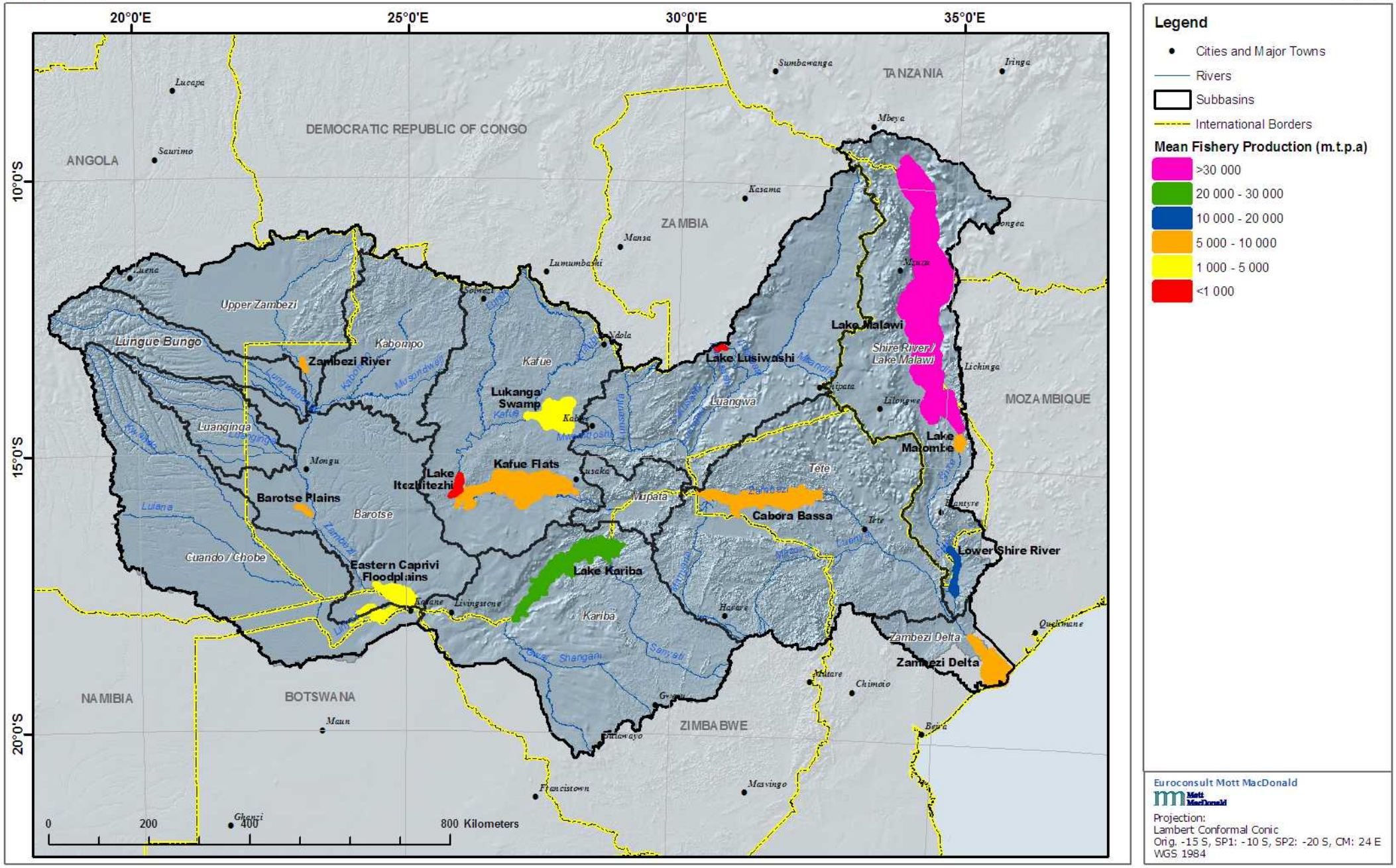
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 15 - Mining Operations

NORWEGIAN EMBASSY



Legend

- Cities and Major Towns
- Rivers
- Subbasins
- International Borders

Mean Fishery Production (m.t.p.a)

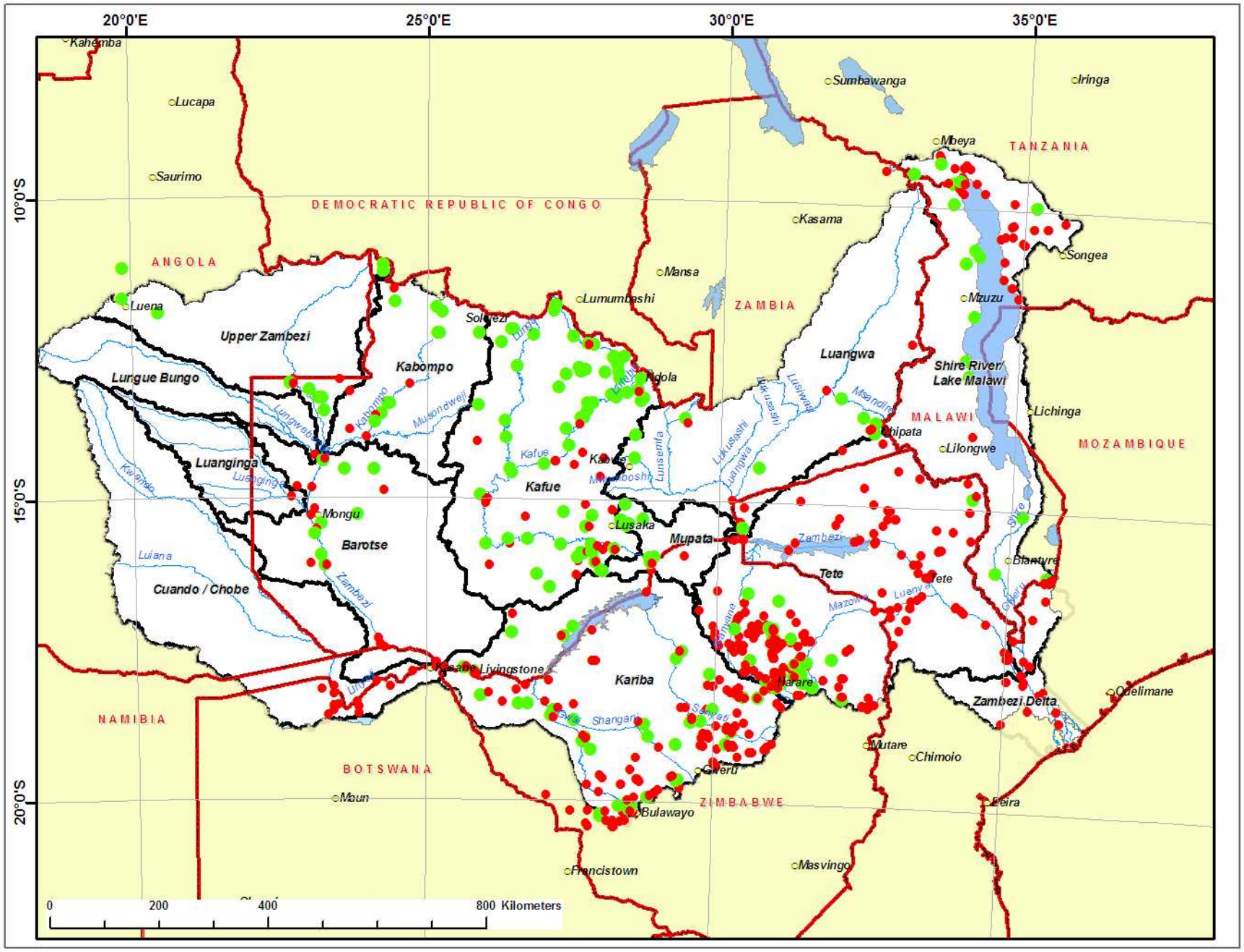
- >30 000
- 20 000 - 30 000
- 10 000 - 20 000
- 5 000 - 10 000
- 1 000 - 5 000
- <1 000

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 16 - Fishery Production



Legend

River and Reservoir Stations

Data in ZAMWIS

- NO
- YES
- Cities and Major Towns
- International Borders
- Rivers
- Subbasins

Data Source:
Zambezi IWRM Rapid Assessment.

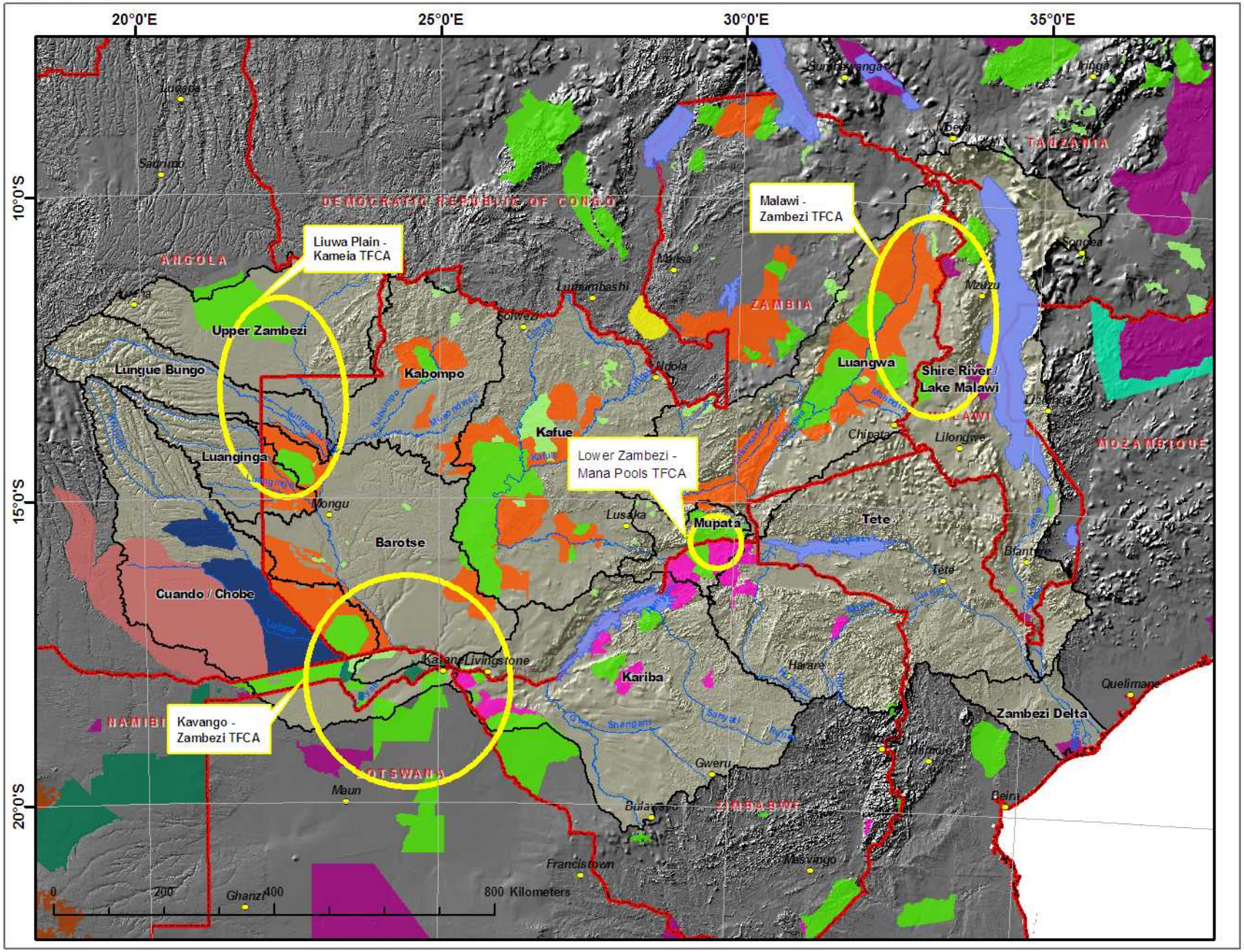
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 17 - Streamflow Measuring Stations

NORWEGIAN EMBASSY



Legend

- Cities and Major Towns
- Rivers
- Subbasins
- International borders
- Trans-frontier Conservation Areas (TFCAs)

Protected Areas

- Game Management Area
- National Park
- Safari Area
- Forest Reserve
- Elephant Reserve
- Partial Reserve
- Commercial conservancy on freehold land
- Game Reserve
- Protected Public Reserve
- Conservancy
- Hunting Areas
- Registered conservancy on communal land

Data Source :
Peace Parks Foundation

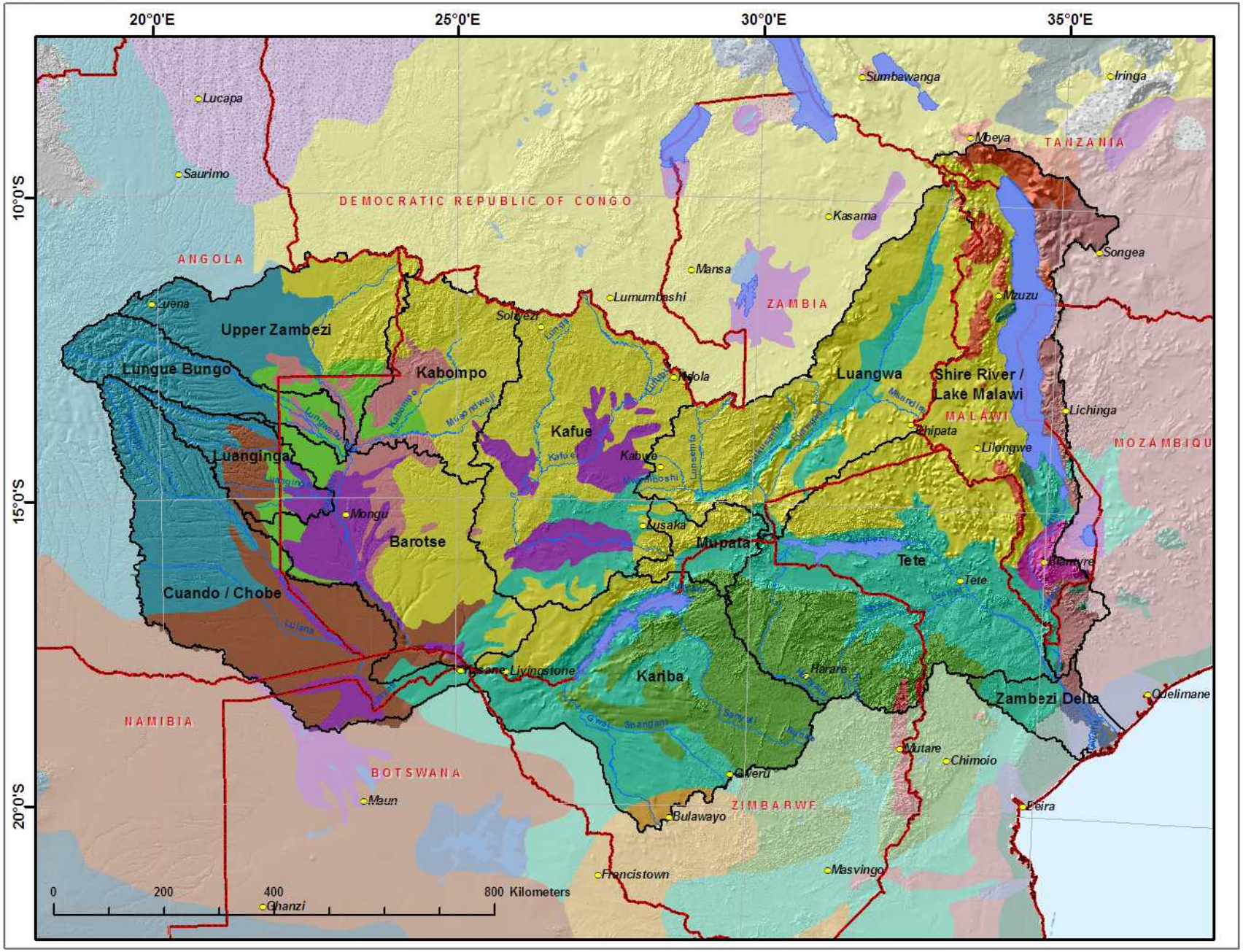
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 18 - Conservation Worthy and Protected Areas

NORWEGIAN EMBASSY



Legend

- Cities and Major Towns
- Rivers
- Lakes
- Subbasins
- International borders

Ecoregions

- Angolan Miombo Woodland
- Central Zambezian Miombo Woodland
- Eastern Miombo Woodland
- Kalahari Acacia-Baikiaea Woodland
- Magkadikadi Pans Halophytics
- South Malawi Montane Forest Grassland Mosaic
- Southern Africa Bushveld
- Zambezian Flooded Grassland
- Southern Miombo Woodland
- Southern Zanzibar-Inhambane Coastal Forest
- Western Zambezian Grassland
- Zambezian Coastal Flooded Savanna
- Zambezian Cryptosepalum Dry Forest
- Zambezian and Mopane Woodland
- Southern Rift Montane Forest
- Eastern Zimbabwe Montane Forest Grassland Mosaic
- Southern Acacia-Commiphora Bushland and Thicket

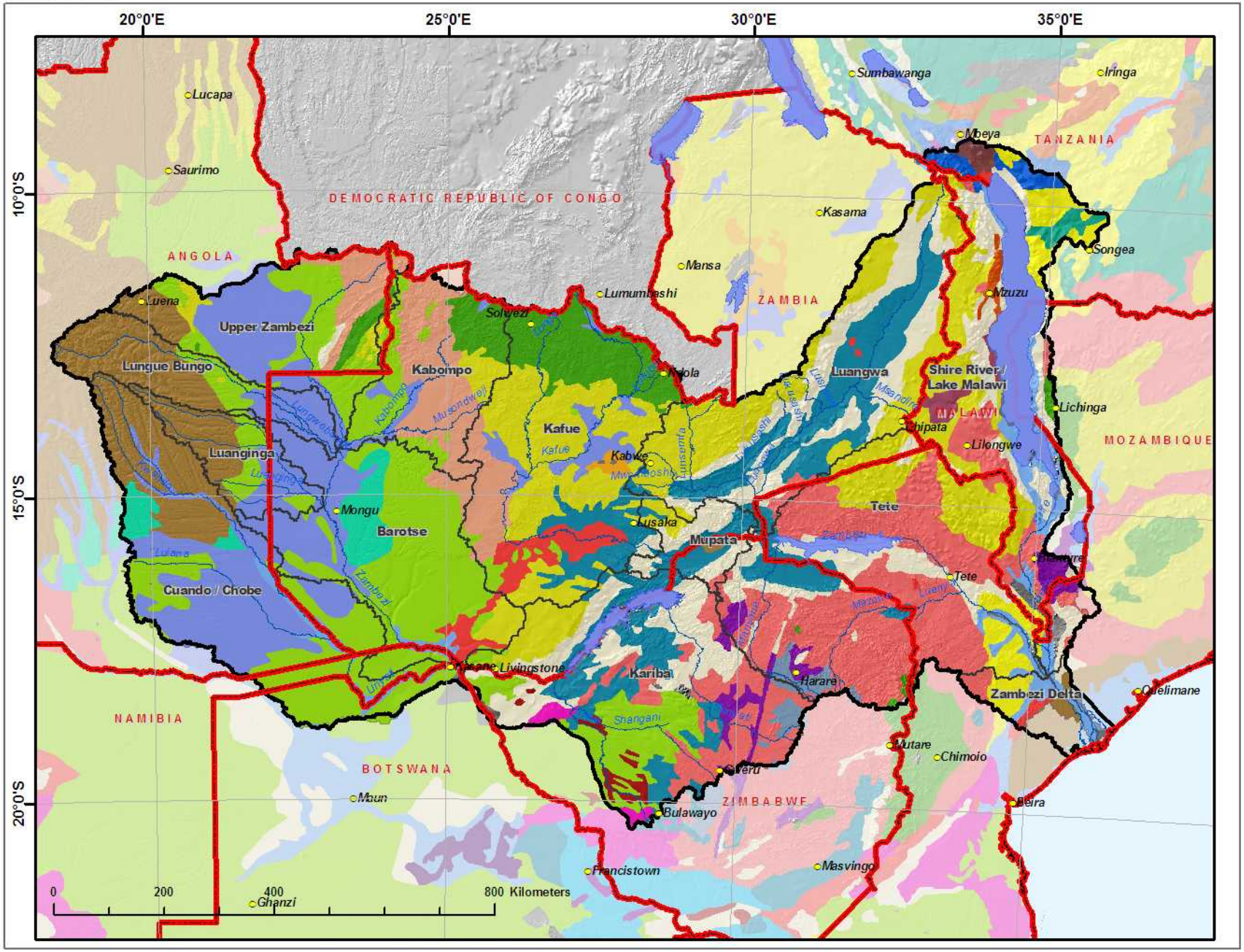
Data Source :
Peace Parks Foundation, WWF

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 19 - Ecoregions



Legend

Soil Types

- Ferric Acrisols
- Orthic Acrisols
- Chromic Cambisols
- Plinthic Ferralsols
- Vertic Cambisols
- Orthic Ferralsols
- Rhodic Ferralsols
- Xanthic Ferralsols
- Eutric Gleysols
- Lithosols
- Eutric Fluvisols
- Chromic Luvisols
- Ferric Luvisols
- Gleyic Luvisols
- Calcic Luvisols
- Dystric Nitosols
- Eutric Nitosols
- Eutric Histosols
- Humic Podzols
- Mollic Andosols
- Dystric Regosols
- Cambic Arenosols
- Ferralic Arenosols
- Luvic Arenosols
- Pellic Vertisols
- Vertisols
- Eutric Planosols
- Orthic Solonchaks

Data Source :
FAO 1:5 000 000 Soils Map of the world

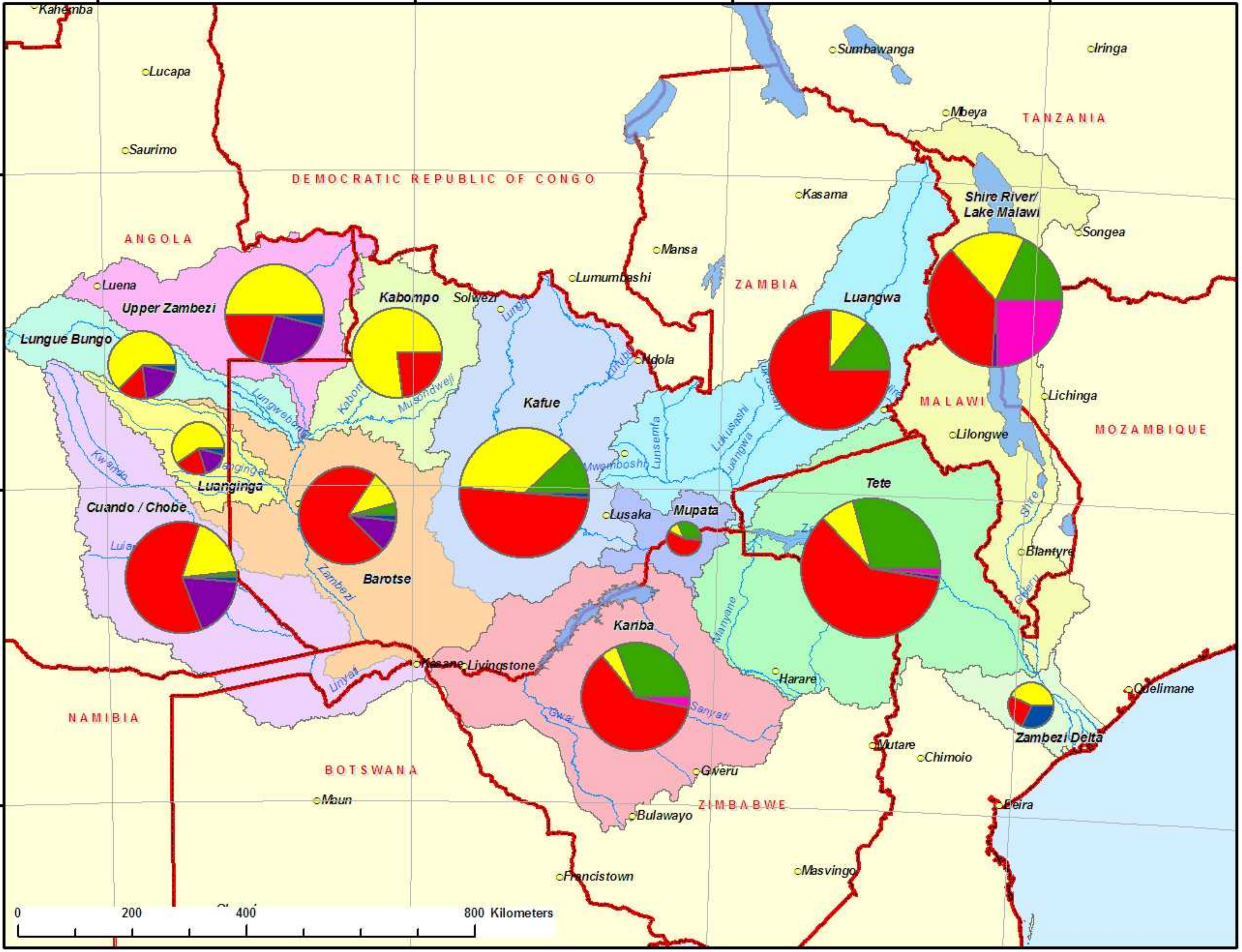
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 20 - Soils

NORWEGIAN EMBASSY



Data Source:
Zambezi IWRM Rapid Assessment.

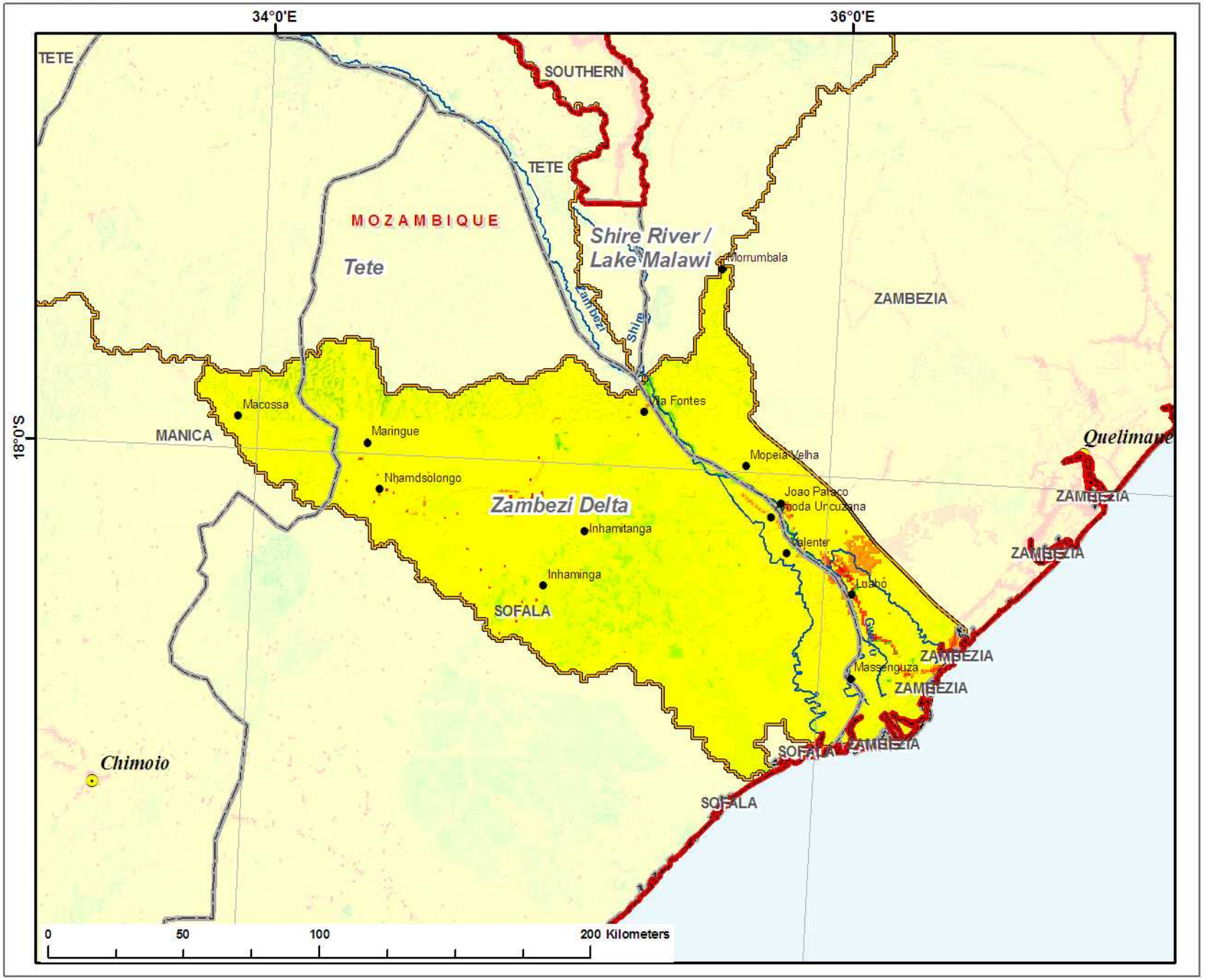
Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 21 - Water Balance : Distribution of Water Use (Ea)

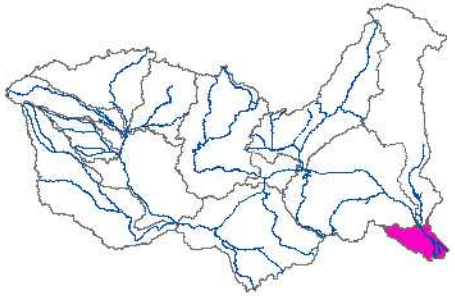
NORWEGIAN EMBASSY



International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall

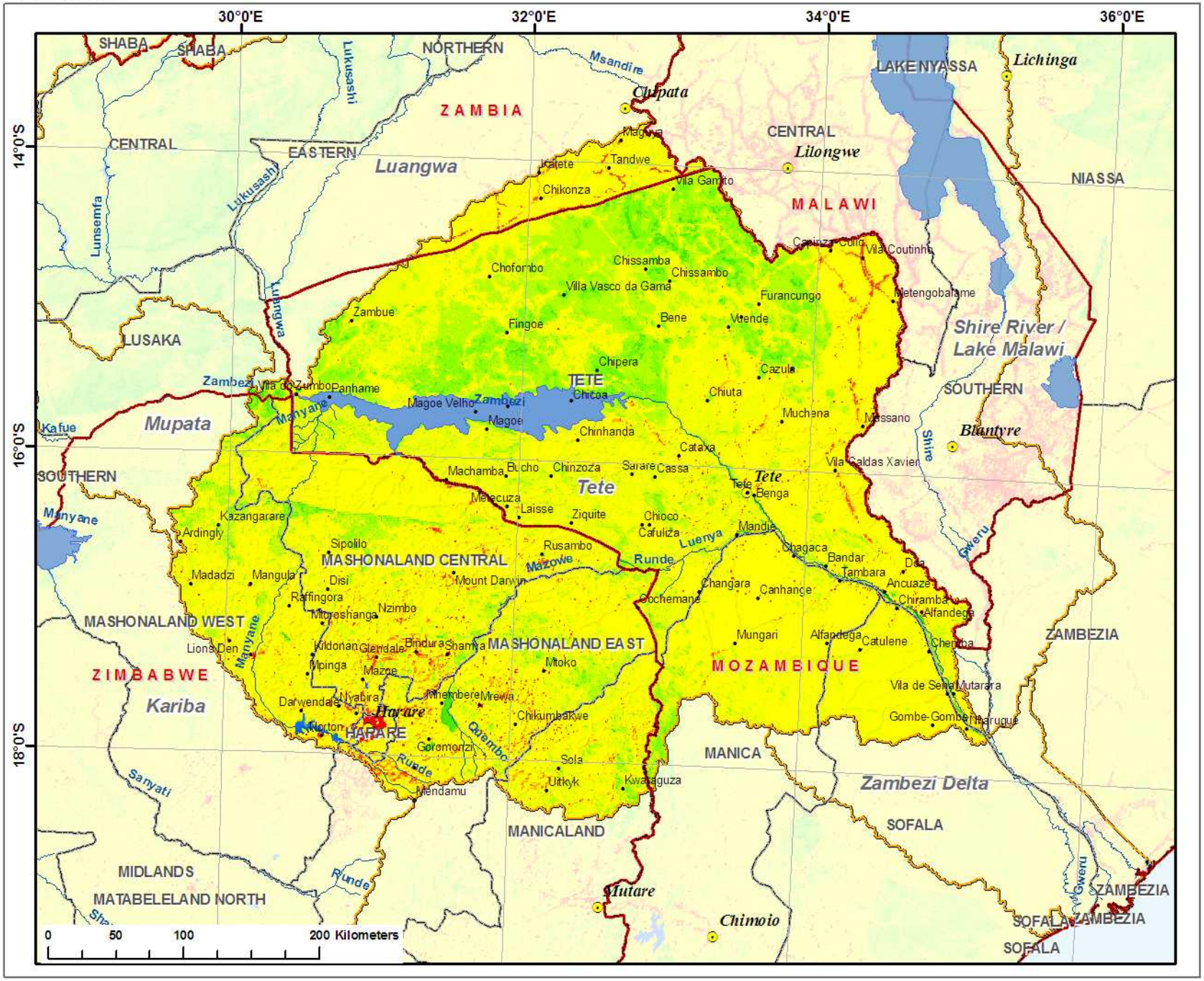
Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

Map 22 - Subbasin Characteristics - Zambezi Delta

NORWEGIAN EMBASSY

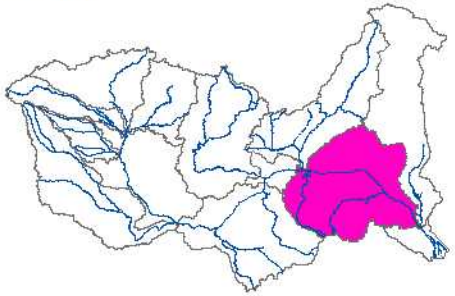


International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

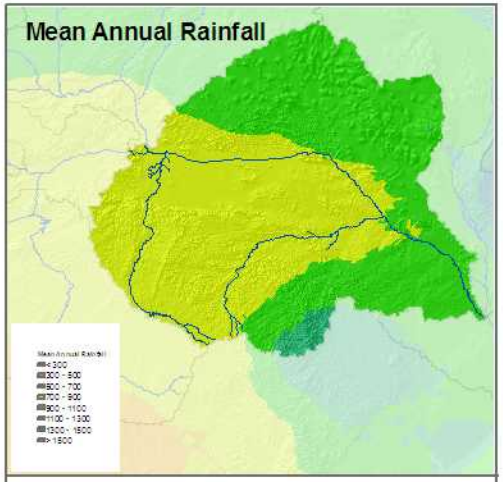
Population Density
<VALUE>

0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



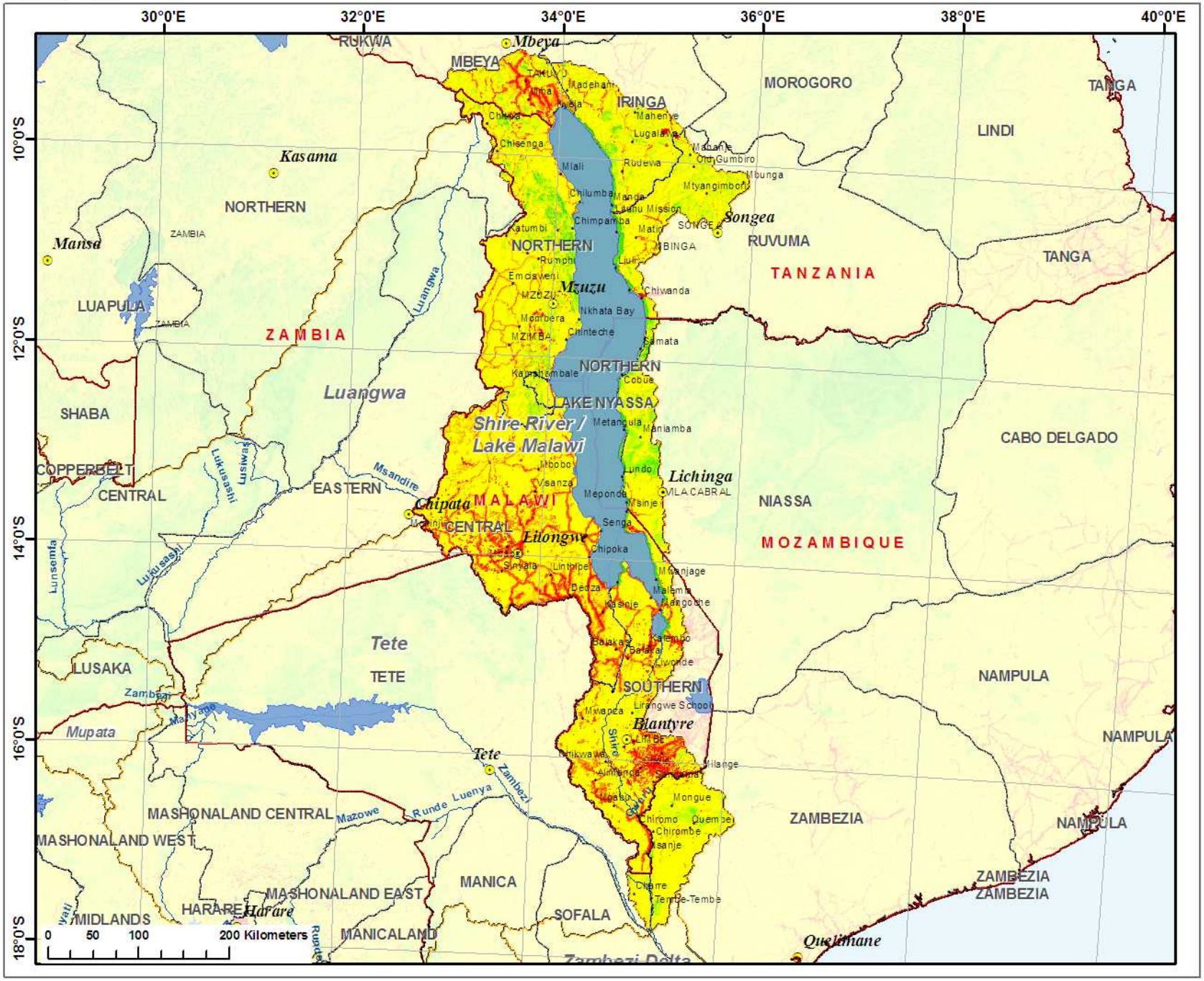
Mean Annual Rainfall

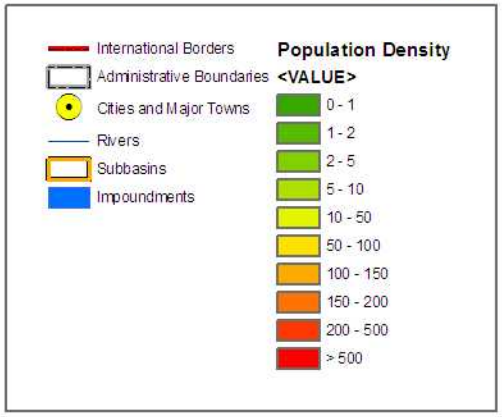


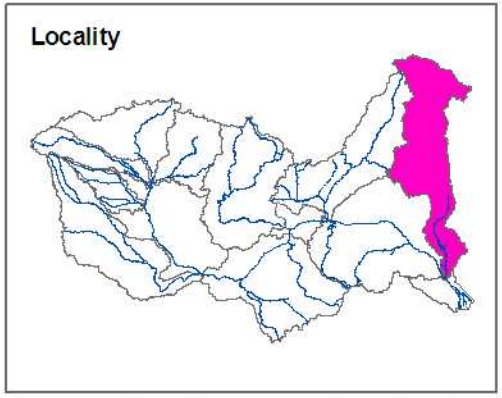
Euroconsult Mott MacDonald

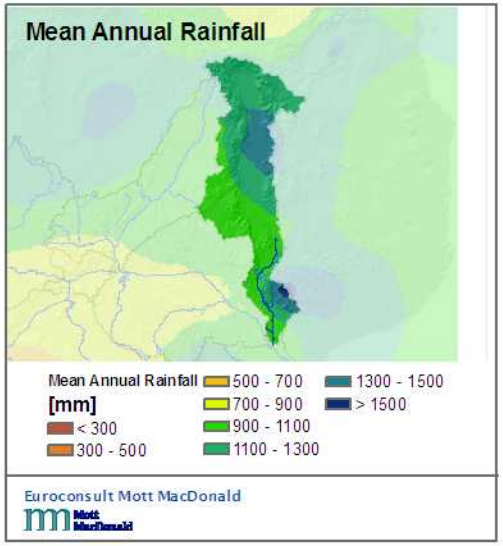
IWRM Strategy for the Zambezi River Basin

Map 23 - Subbasin Characteristics - Tete



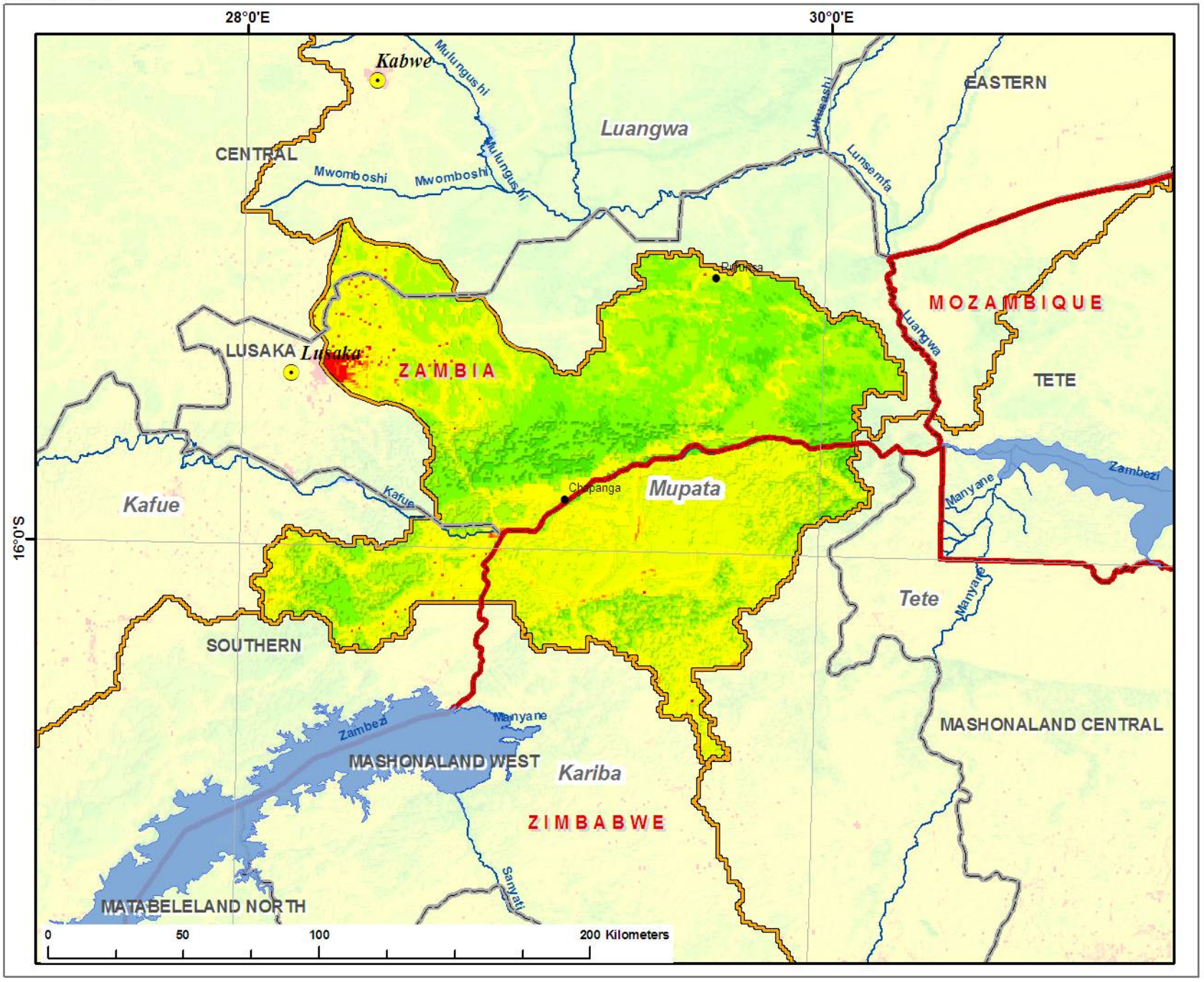






IWRM Strategy for the Zambezi River Basin

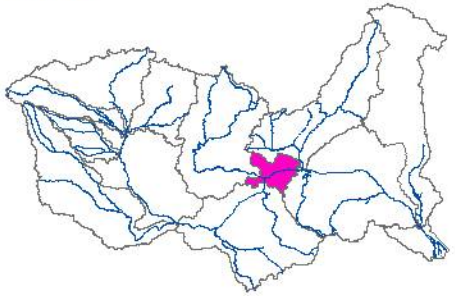
Map 24 - Subbasin Characteristics - Shire River / Lake Malawi



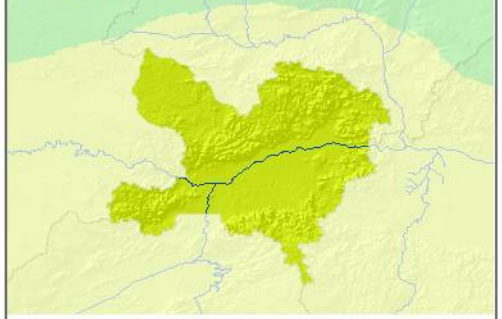
International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall



Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

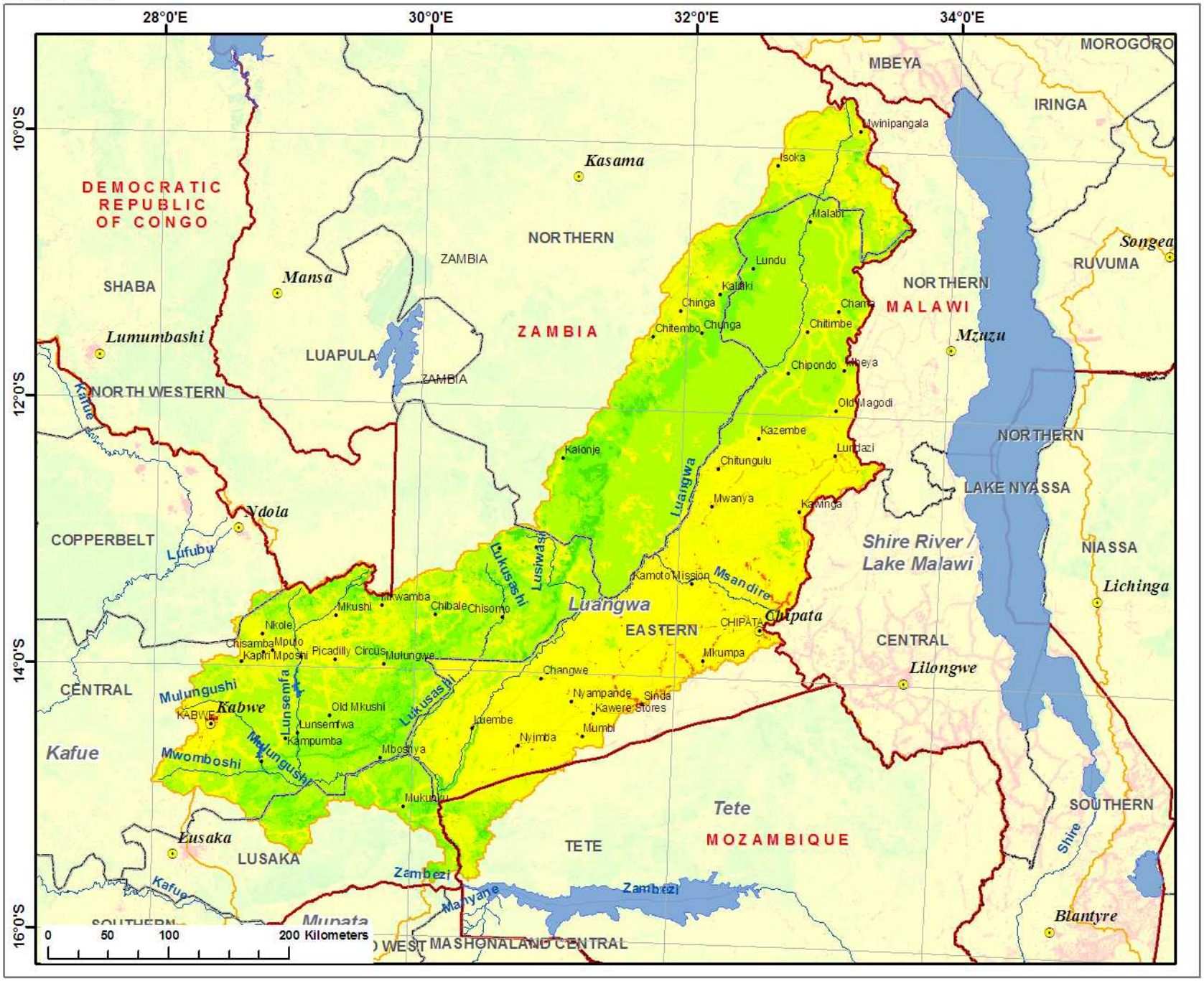
Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

Map 25 - Subbasin Characteristics - Mupata

SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

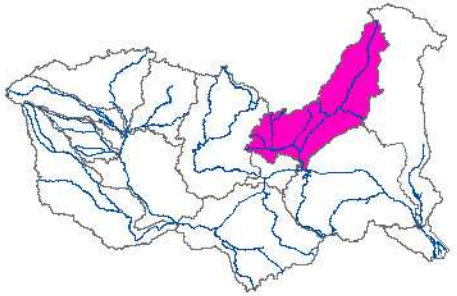
NORWEGIAN EMBASSY



International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall

Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

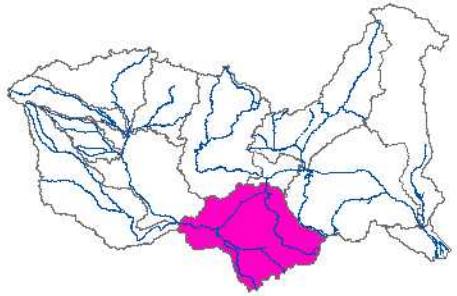
Map 26 - Subbasin Characteristics - Luangwa

NORWEGIAN EMBASSY

International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall

Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

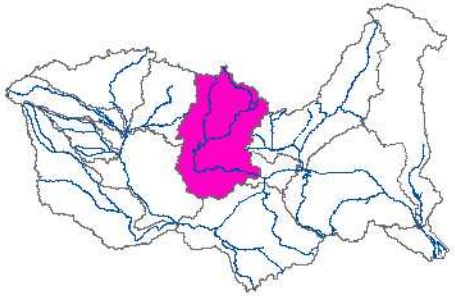
Map 27 - Subbasin Characteristics - Kariba

NORWEGIAN EMBASSY

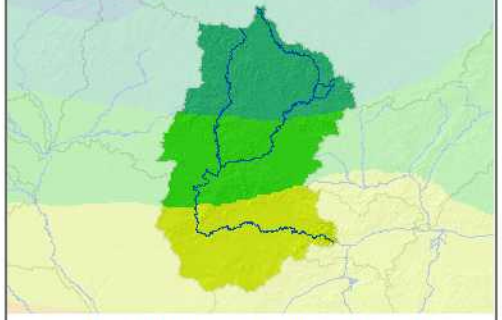
International Borders
Administrative Boundaries
Cities and Major Towns
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall



Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

Map 28 - Subbasin Characteristics - Kafue

SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

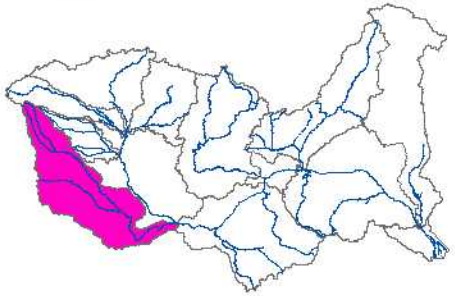
NORWEGIAN EMBASSY

International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density

0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall

Mean Annual Rainfall [mm]			
< 300	500 - 700	900 - 1100	1300 - 1500
300 - 500	700 - 900	1100 - 1300	> 1500

Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

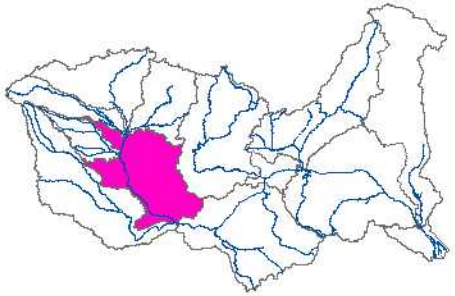
Map 29 - Subbasin Characteristics - Cuando / Chobe

NORWEGIAN EMBASSY

International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall

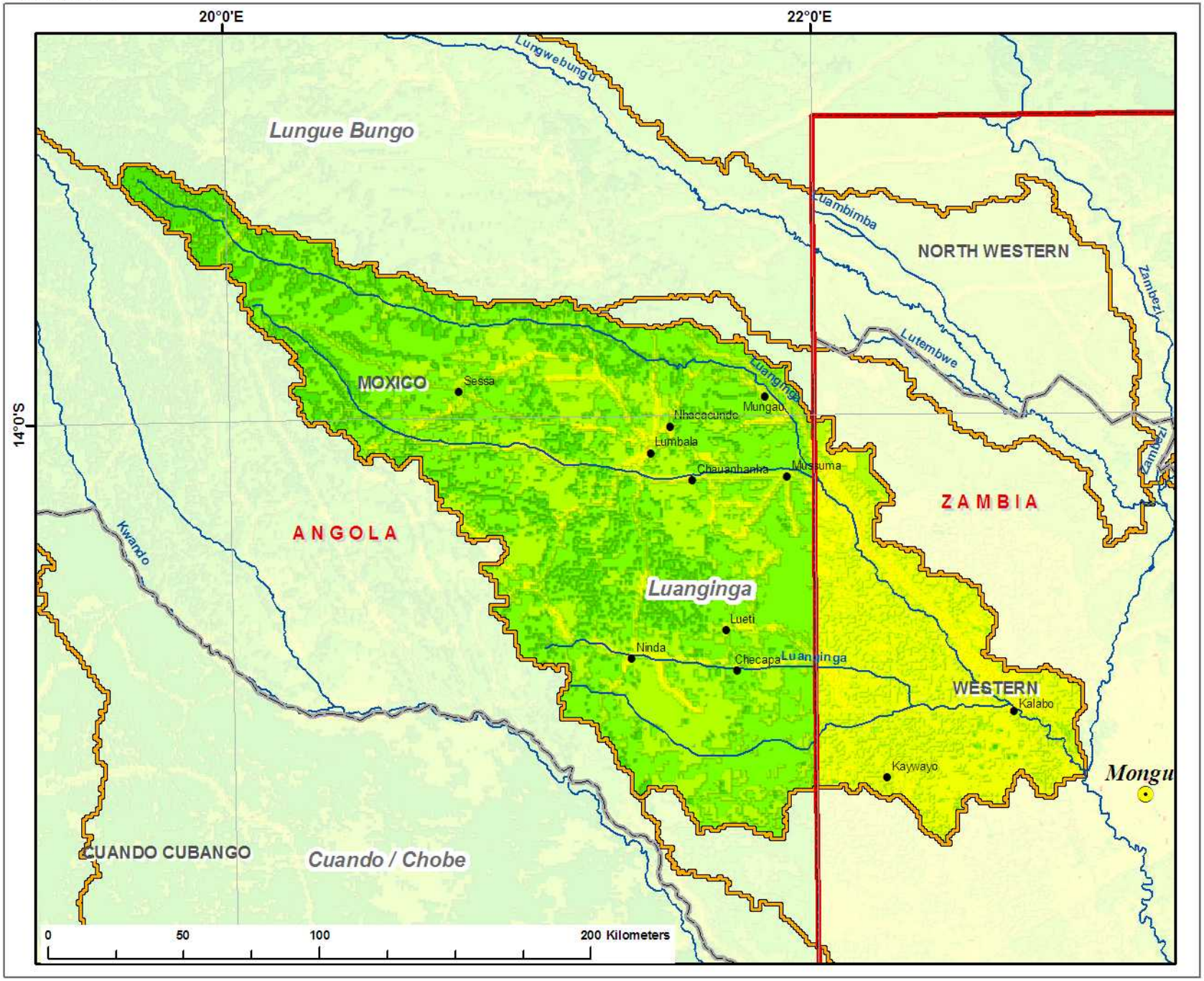
Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

Map 30 - Subbasin Characteristics - Barotse

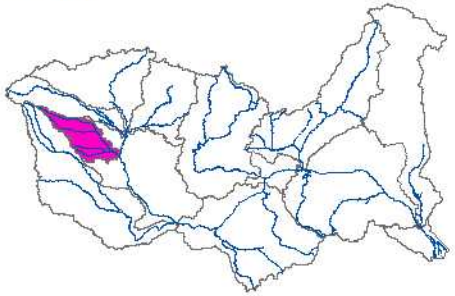
NORWEGIAN EMBASSY



International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall

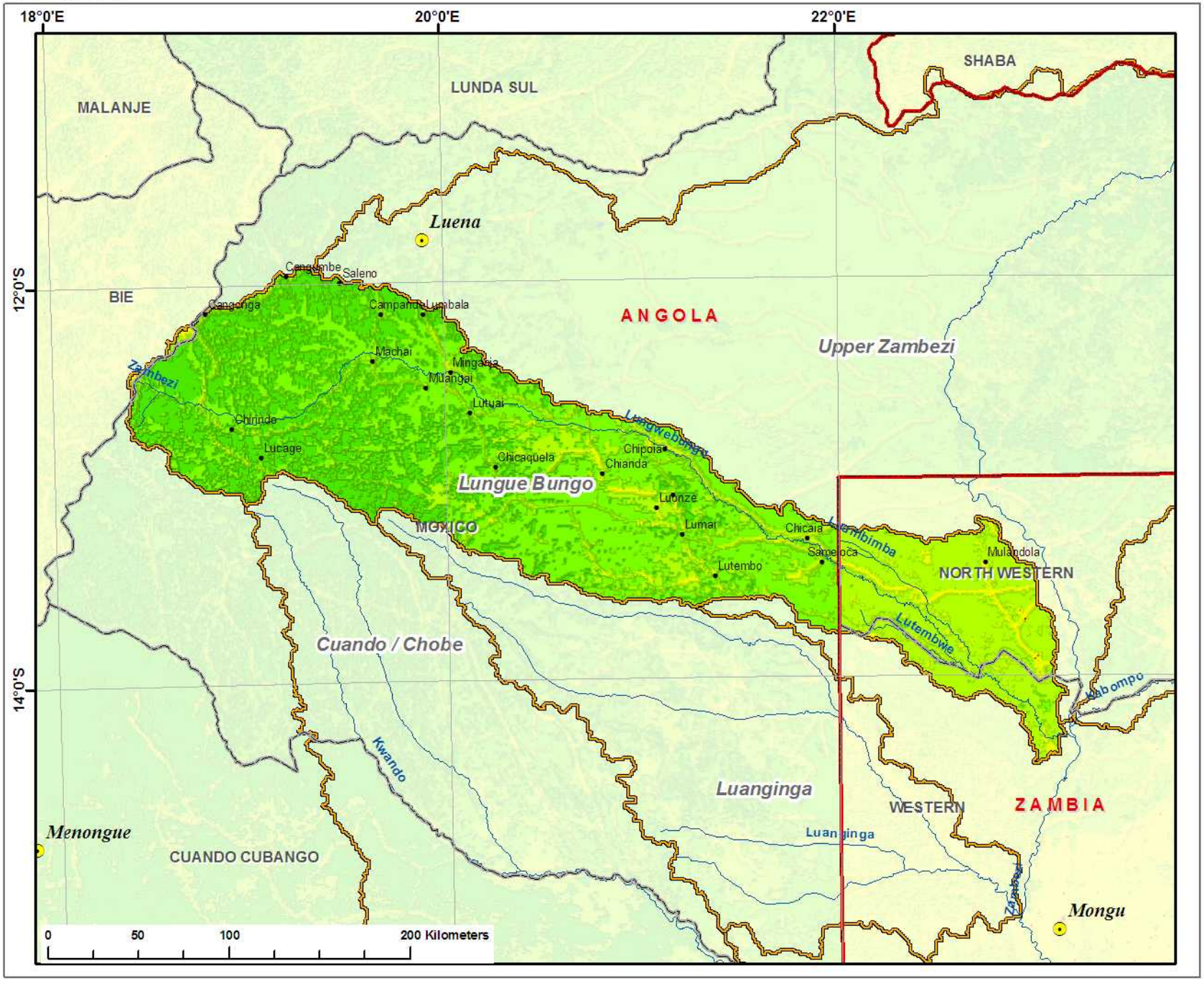
Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

Euroconsult Mott MacDonald

IWRM Strategy for the Zambezi River Basin

Map 31 - Subbasin Characteristics - Luanginga

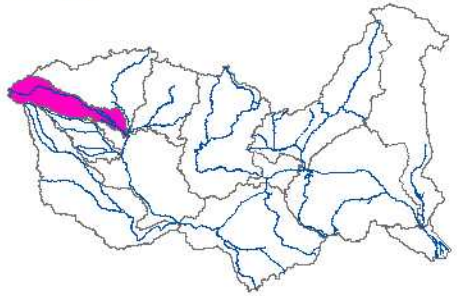
NORWEGIAN EMBASSY



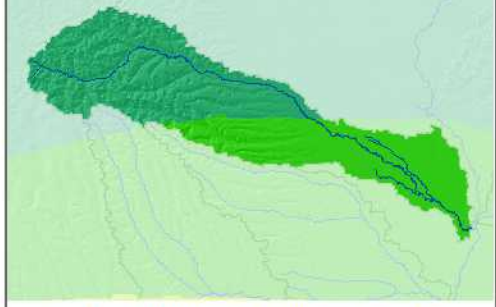
International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall



Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

Euroconsult Mott MacDonald

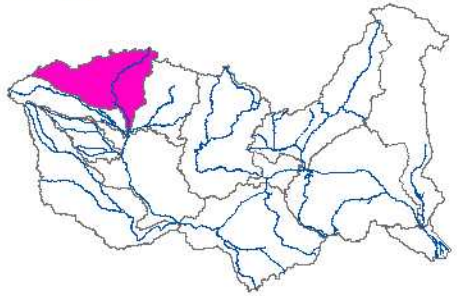
IWRM Strategy for the Zambezi River Basin

Map 32 - Subbasin Characteristics - Lungue Bungo

International Borders
Administrative Boundaries
Cities and Major Towns
Rivers
Subbasins
Impoundments

Population Density
<VALUE>
0 - 1
1 - 2
2 - 5
5 - 10
10 - 50
50 - 100
100 - 150
150 - 200
200 - 500
> 500

Locality



Mean Annual Rainfall

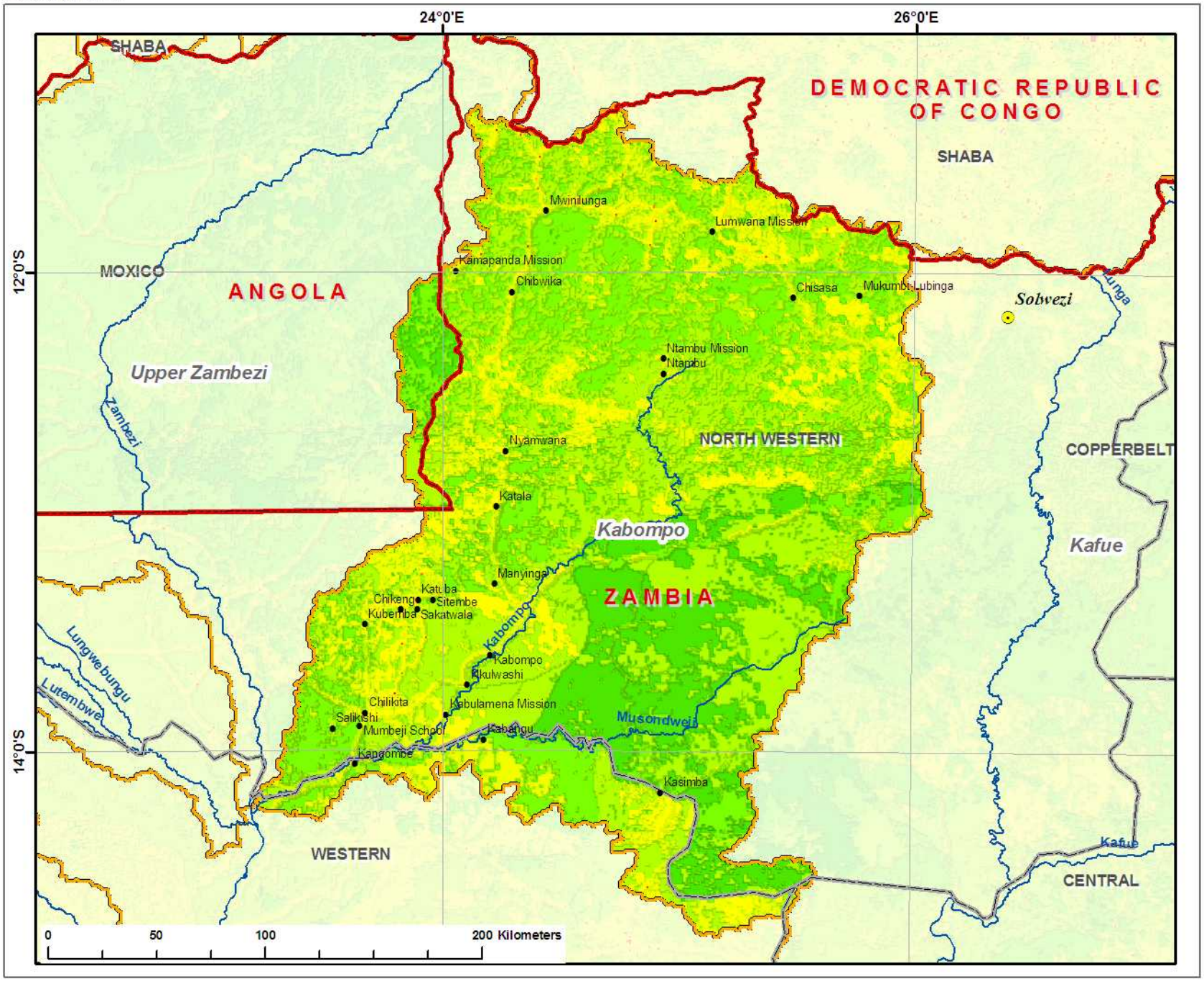
Mean Annual Rainfall [mm]
< 300
300 - 500
500 - 700
700 - 900
900 - 1100
1100 - 1300
1300 - 1500
> 1500

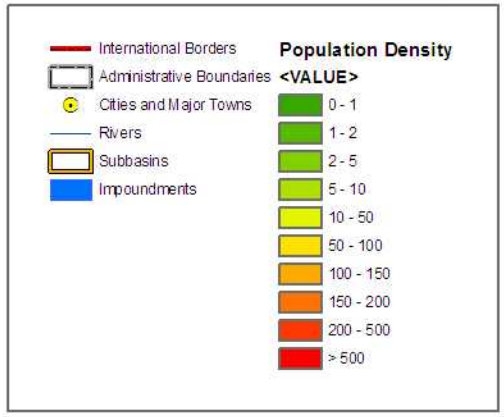
Euroconsult Mott MacDonald

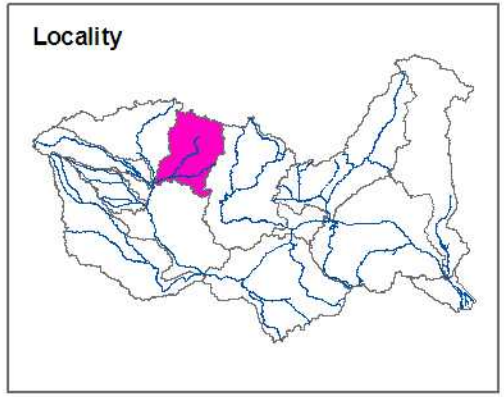
IWRM Strategy for the Zambezi River Basin

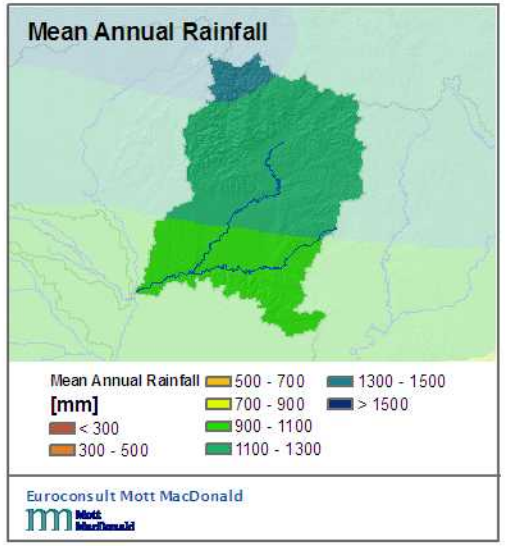
Map 33 - Subbasin Characteristics - Upper Zambezi

NORWEGIAN EMBASSY







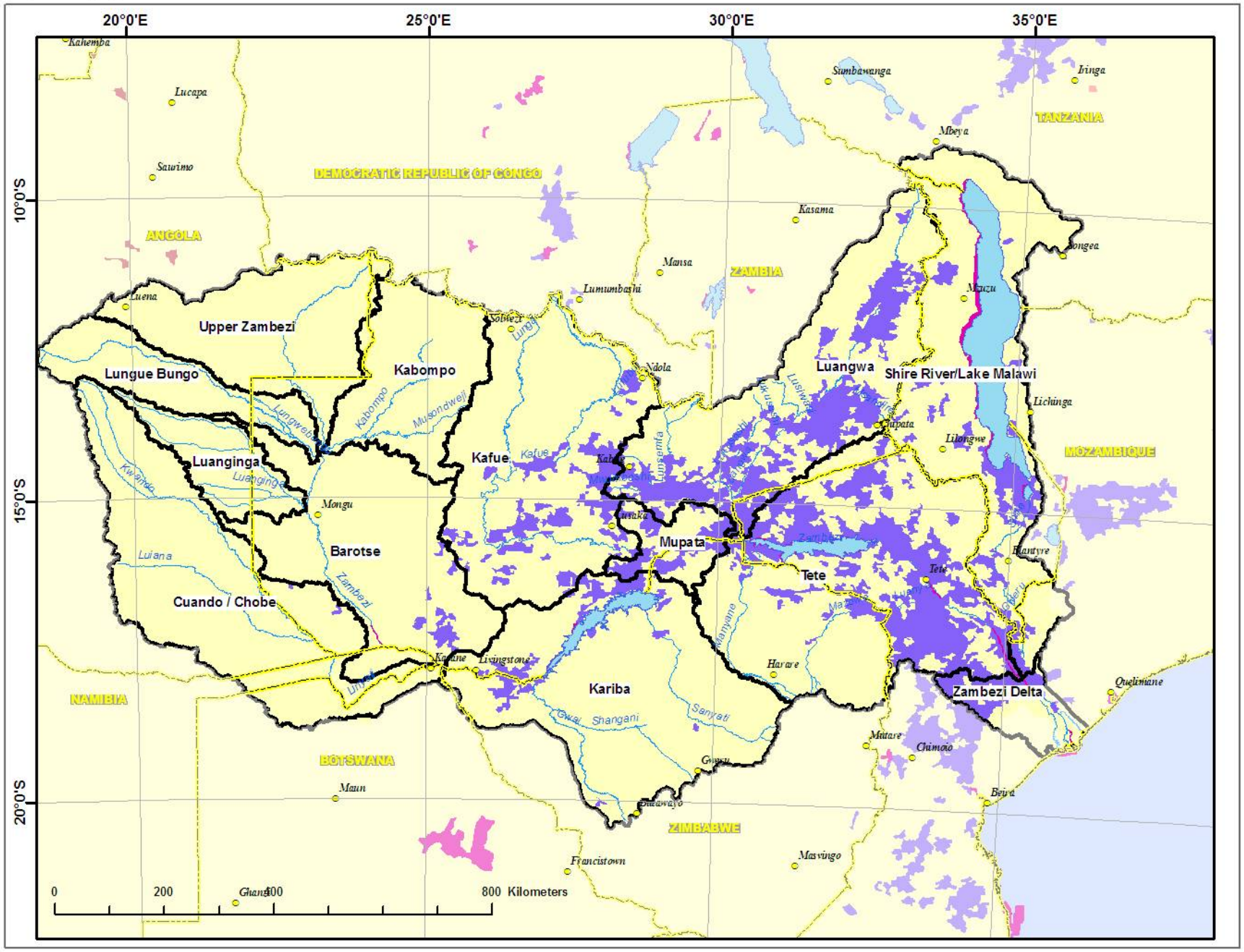


IWRM Strategy for the Zambezi River Basin

Map 34 - Subbasin Characteristics - Kabompo

...\Projects\lcu-05_v09_a4.mxd

LCU-05 (v0.9)



Legend

International Borders

Subbasins

Degraded Land

- Barren Or Sparsely Vegetated
- Cropland/Degraded Forest Savanna
- Degraded Forest/Savanna with Cropland
- Low Shrub-Bushland Savanna (Degraded from Miombo Woodland with Fire Burns)

Data Source:

Derived Land Cover in Southern Africa Development Communities (SADC).

Peace Parks Foundation database on Africa and SADC compiled from various data sources and consolidated for PPF use.

Euroconsult Mott MacDonald

Projection:
Lambert Conformal Conic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

Map 35 - Degraded Land

NORWEGIAN EMBASSY

Legend

- International Borders
- Subbasins

Hydropower Sites

STATUS

- Existing
- Identified
- Planned
- Studied
- Under construction

Data Source:
Zambezi IWRM Rapid Assessment.

Euroconsult Mott MacDonald

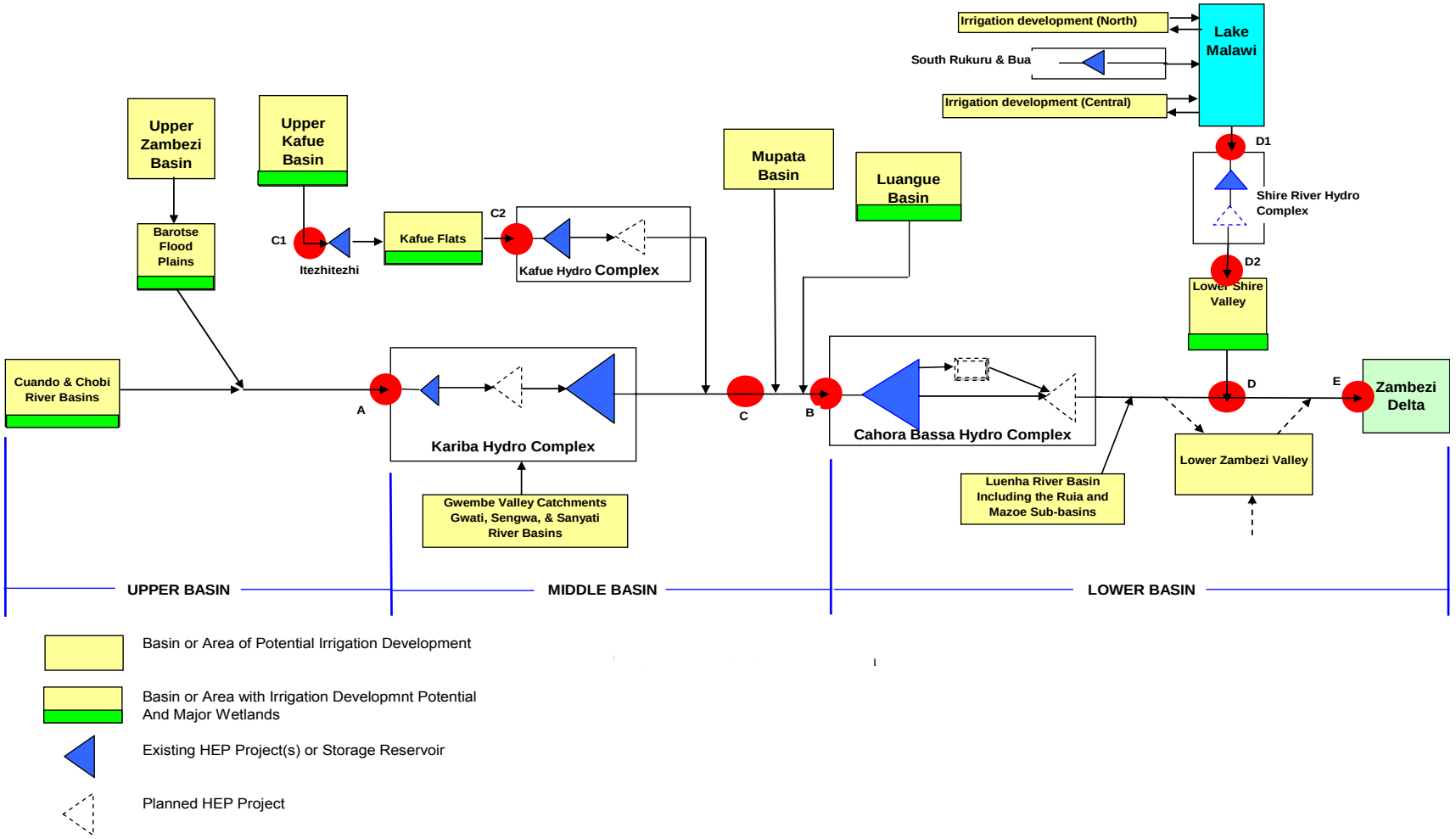
Projection:
Lambert Conformal Cnic
Orig. -15 S, SP1: -10 S, SP2: -20 S, CM: 24 E
WGS 1984

IWRM Strategy for the Zambezi River Basin

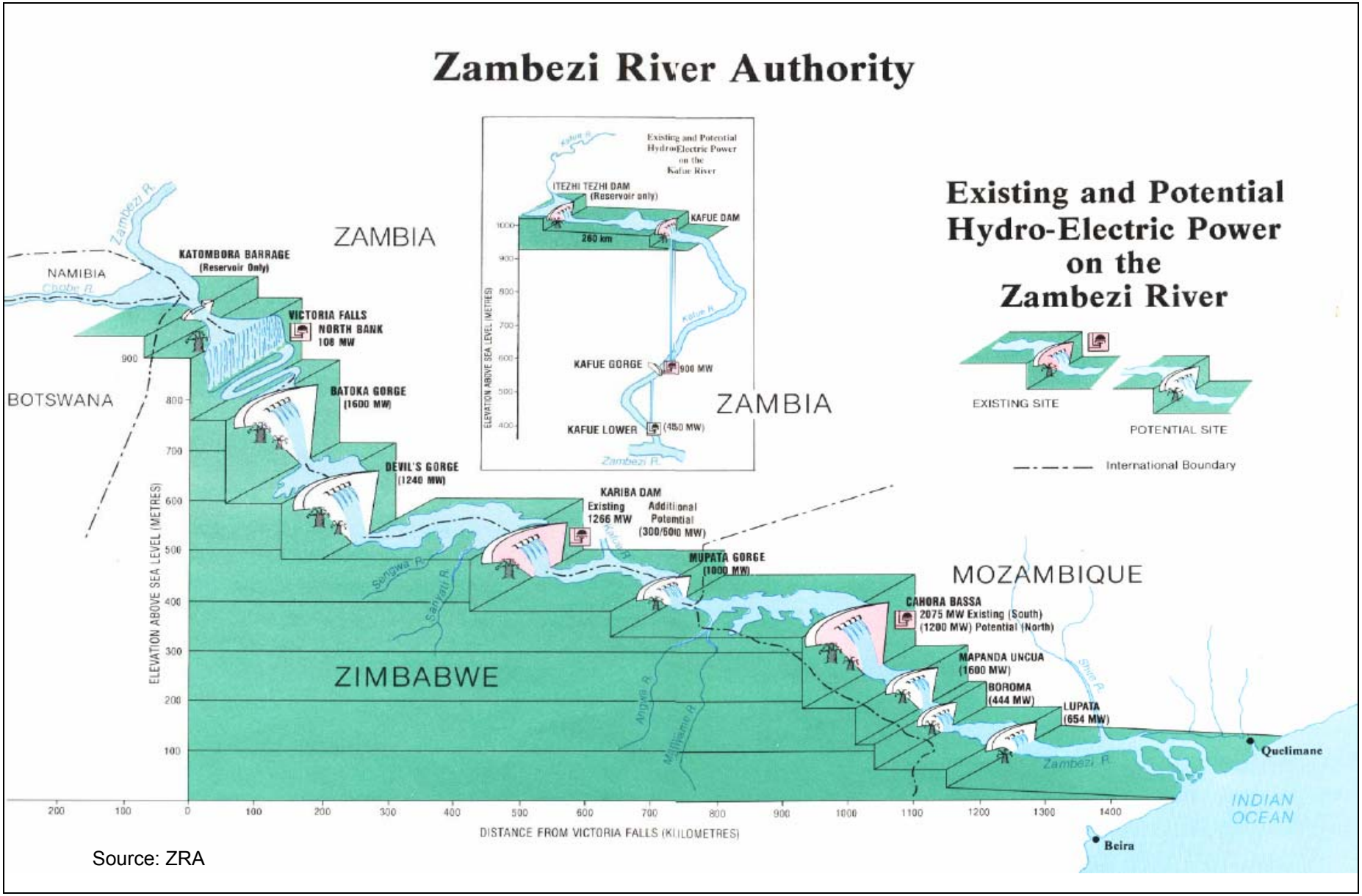
Map 36 - Hydropower Sites

Annex 2 Schematic of the Zambezi River System and Hydropower sites

SCHEMATIC OF THE ZAMBEZI RIVER BASIN



Source: ZRA


Zambezi River Authority
Existing and Potential Hydro-Electric Power on the Zambezi River
ZAMBIA
NAMIBIA
BOTSWANA
ZIMBABWE
MOZAMBIQUE
KATOMBORA BARRAGE
(Reservoir Only)
VICTORIA FALLS
NORTH BANK
108 MW
BATOKA GORGE
(1600 MW)
DEVIL'S GORGE
(1240 MW)
KARIBA DAM
Existing
1266 MW
Additional
Potential
(300/600 MW)
MUPATA GORGE
(1000 MW)
CAHORA BASSA
2075 MW Existing (South)
(1200 MW) Potential (North)
MAPANDA UNCUA
(1600 MW)
BOROMA
(444 MW)
LUPATA
(654 MW)
ITEZHI TEZHI DAM
(Reservoir only)
KAFUE DAM
260 km
KAFUE GORGE
900 MW
KAFUE LOWER
(450 MW)
EXISTING SITE
POTENTIAL SITE
International Boundary
Quelimane
Beira
INDIAN OCEAN
Zambezi R.
Kafue R.
Sengwa R.
Sanyati R.
Angwa R.
Mafungabusi R.
Shire R.
ELEVATION ABOVE SEA LEVEL (METRES)
DISTANCE FROM VICTORIA FALLS (KILOMETRES)

Source: ZRA

Annex 3 Summaries of Country Consultations

As part of the preparation of the IWRM Strategy a series of consultative meeting were organized at country level and at regional level (see Section1.3). This Annex summarizes the points raised at these meetings.

Botswana Country Consultation

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Water insecurity - Poor waste management - Floods - Droughts - Inadequate data and information sharing - HIV/AIDS	- Pollution - Proliferation of aquatic weeds - Management of wetlands - Water quality management program - Information and data exchange - Erosion - Veld fires	- Unreliable water supply - Lack of data - Water storage - Inter-basin water transfer - Groundwater quality - Air pollution - Food insecurity - Salinization	- Agreements - Lack of information - Public awareness - Basin wide management plan
Main suggestions	- Capacity building - Stakeholder participation - Water treatment - Enforcement of Waste Management Act - Integrated land use planning - Construction of water infrastructure - Sharing information	- Enforce legislation - Developing infrastructure - Raise public awareness - Develop water quality management plan - Carry out research - Develop land use plan	- Recycling water - Develop record management system - Carry out research - Develop water storage infrastructure - Management of groundwater quality - Growing tolerant varieties of crops - Desalination	- Signing and ratification of ZAMCOM - Carry out research - Raising public awareness - Develop management plan for the basin

Malawi Country Discussion

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Inadequate capacity for IWRM strategy development, updating and implementation - Conflicting and uncoordinated sectoral policies in IWRM - Inadequate investment in IWRM	- Wetland degradation and pollution - Pollution of water resources - Aquatic weed invasion/infestation	- Vulnerability to climate change and variability	- Uncoordinated and disintegrated management of Zambezi Basin Water Resources - Week institutional capacity of water management institutions - Poor knowledge base of basin water resources - Vulnerability to floods and droughts - Inadequate stakeholder participation
Main suggestions	- Improve and strengthen technical and institutional capacity in IWRM - Harmonisation of sectoral policies - Strengthen investment for IWRM	- Wetland protection and community based wetland management - Sustainable management and pollution control - Sustainable and integrated management of invasive weeds	- Development and implementation of mitigation measures	- Improvement of institutional capacity for coordinated and integrated management - Strengthening capacity of water management institutions - Updating knowledge base - Development and implementation of disaster management plans - Promotion of public awareness

Mozambique Country Meeting

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Extreme variability in rainfall and water resources - High demand for water structure - Basin-wide data collection - Inadequate financing	- Wetland management - Poor control of point pollution, especially untreated sewerage disposal is a major problem	- Difficult to predict the impact of climate change on water resources	- Integrated management of Zambezi basin water resources - Capacity of water management institutions
Main suggestions	- Information exchange on rainfall and runoff - Promote dams with small reservoirs to prevent evaporation losses - Develop water resources infrastructure - Establish joint basin system - Establish funds, explore other examples on fund development	- Develop and implement effective models for community based resource management - Establishment of basin-wide water quality standards including inspection and enforcement measures	- Promoting 'green revolution' - Water security against droughts - Flood protection works	- Establishment of ZAMCOM and necessary institutions - Improve capacity by establishing ZAMCOM

Namibia Country Meeting

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Extreme variability in rainfall - Water availability - Flood affected victim - Upstream/downstream linkages - Information exchange	- Control of point pollution - Human vs. wildlife conflict - Control of aquatic weeds	- Climate monitoring - Strengthening of agricultural institution and research - Adaptive infrastructural development - Better coordinated national planning	- ZAMCOM - Institutional capacity - Stakeholder participation - Awareness and education - Land us planning - Centralization of decision making over natural resources
Main suggestions	- Raising awareness - Build water infrastructure and Establish database - Immediate rescue-transport - Re-negotiate agreements - Developing newsletter	- Establish legislation - Encourage creation of conservancies - Awareness campaign	- Strengthening meteorological services - New research on new variety of crops - Strengthen environmental impact/ risk assessment - Strengthen national planning departments	- Lobby for other countries to cooperate - Increase financing of water institutions - Establish WUAs and strengthen local basin committee - Promote on radio and other media - Develop strategic plan - Management at appropriate level

Tanzania Country Consultation

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Extreme variability in rainfall and water resources - High demand for water infrastructure - Functioning of ZAMWIS - Inadequate financing of water resource management	- Wetland management - Control of point source pollution - Control of aquatic weeds	- Climate change adaptation	- Integrated management of Zambezi Basin - Weak institutional capacity - Poor knowledge base - Vulnerability to natural disasters - Harmonisation of policies
Main suggestions	- Implement Songwe River boarder stabilization proposal between Tanzania and Malawi - Implement multipurpose use - Capacity building of experts and finance ZAMWIS - Mobilize funds and institutionalize ZAMCOM	- Restore wetlands, implement incentive schemes, and build capacity - Monitor water quality, enforce water laws, and introduce incentives - Monitoring schemes, change land use	- Implement water conservation and water harvesting - Develop infrastructure - Develop early warnings - Enforce available laws	- Ratification ZAMCOM - Organize stakeholder dialogues - Establish and maintain Basin data collection networks - Procure hard- and software, implement management policies, and map the flood prone areas - Identify policies to be harmonised

Zambia Country Consultation

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Extreme variability in rainfall and water resources - High demand for infrastructure - Basin wide data collection - Inadequate financing of water resources management	- Control of point pollution - Control of aquatic weeds - Inadequate research - Population dynamics and settlement patterns	- Increased threat of climate change and variability - Vulnerability to natural disasters	- Absence of river basin organization - Limited institutional capacity - Poor knowledge base - Security of sharing information
Main suggestions	- Construct water storage infrastructure - Promote private public partnership in investment - Design and operationalise network - Mobilization of external funding	- Monitor water quality and harmonise water quality standards - Codification of laws on invasive aquatic weeds - Exchange visits on best practices, institutional collaboration, establish research unit - Undertake demographic surveys	- Information sharing among key players - Awareness and advocacy campaigns - Flood mapping - Improve infrastructure	- Reach national consensus - Strengthen organizational, financial, and human resource - Training needs assessment - Develop guidelines and regulations for sharing data - Member states should develop an information system for sharing strategic data

Zimbabwe Country Consultation

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Extreme variability in rainfall and water resource - High demand for infrastructure of water development - Improved operation of Major Dams in the basin - Basin-wide data collection - Inadequate financing	- Wetland management - Control of Point Pollution - Control of Aquatic weeds	- Climate change adaptation	- Regional cooperation
Main suggestions	- Develop Storage dams - Optimum development of infrastructure (political commitment, integrated water resources plans.) - Integrated operational plan - Construction and upgrading of hydrometric stations to augment existing station - Promotion of private and public partnerships	- Education and awareness, promotion of community based wetland management, and enforcement of regulations - Comply desired standards and minimize pollution to acceptable levels - Remove weed and carry out research on methods to remove weeds	- Capacity building and retention of skills - Efficient irrigation systems - Installation of early warning systems - Awareness and education	- Joint water commissions - Rehabilitate SADC HYCOS stations - Capacity building at local level - Water infrastructure development

Regional Expert Meeting, Maputo, 6-7 March 2008

	Integrated and coordinated water resources development	Environmental Management and Sustainable Development	Adaptation to climate variability and climate change	Basin-wide cooperation and integration
Main issues	- Inadequate infrastructure for energy, irrigation and water supply - Water not taken as driver for socio-economic development - Mismatch of demand centres with resource areas - Lack of human and financial capacity	- Wetland management - Control of water quality - Control of aquatic weeds - Water catchment degradation - Environmental effects of development - Groundwater management	- Climate variability - Adaptation to climate change	- Non-ratification of ZAMCOM treaty - Regional cooperation - Lack of common methodologies for assessments (operations, standards, procedures) - Poor coordination with regional and international organisations
Main suggestions	- Promote infrastructural development for multi-purpose uses - Institute water demand management measures - Need for Scenario Planning to appeal to Economic and Financial Planners - Mobilise financial resources using appropriate financial instruments (fiscus, pricing, PPP) -	- Strengthen wetland protection and management - Determine environmental flows - Control application of fertilizers and pesticides - Cross reference weed and water quality control - Develop regional catchment management plans - Develop capacity on use of EIAs and SEAs - Improve groundwater management	- Vulnerability assessment of basin water resources - Strengthen early-warning systems - Raise awareness, build resilience and develop adaptation framework for climate change	- Encourage all Zambezi riparian states to ratify ZAMCOM treaty - Improve and coordinate water resources planning - Review inter and intra basin-transfer opportunities - Develop and agree on basin water allocation mechanisms - Harmonize national policies - Develop data and information management protocols - Promote joint and transboundary projects between riparian countries - Strengthen data collection network and MIS/ZAMWIS - Streamline and capitalise on existing international/regional initiatives (preferably coordinated by ZAMCOM)

Project Steering Committee Meeting (4 April 2008) and Senior Expert Meeting (5 April 2008)

- There needs to be an explanation of the sedimentation processes in the Zambezi River
- NGOs like IUCN and WWF are shown as having primary responsibility for actions in the implementation plan, yet they need to work under the guidance of government or regional organizations.
- There was consultation on the criteria used to come from Options to the Strategies.
- Requests were made for a more extensive Executive Summary, the inclusion of the country flags on the cover and for a different report layout.