November 2024

Strategic Environmental Assessment for the Cuando River Basin

FINAL REPORT – VOLUME 1

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SAIEA

FINAL DRAFT SEA REPORT

Windhoek, 4 November 2024

Dear Sir/Madam:

The Southern African Institute for Environmental Assessment (SAIEA), together with its partners and independent experts, hereby submits their FINAL SEA REPORT for the Strategic Environmental Assessment (SEA) for the Cuando River Basin (CURB), in accordance with our contract. This Main Report is Volume 1. Appendices have been placed in Volume 2, the Strategic Environmental Management and Monitoring Framework in Volume 3, and the Rapid Systematic Conservation Plan in Volume 4.

We hope that you will find this report to be of acceptable standard and that you will be in a position to sign off on it – thus enabling us to finalise the posters and leaflet. Kindly advise should you require further elaboration or clarification.

Yours sincerely,

Dr Peter Tarr (Executive Director)

Vision

A sustainable and resilient Cuando Basin for all by 2040.

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APPENDICES

- Appendices have been placed in Volume 2
- The Strategic Environmental Management and Monitoring Framework in Volume 3, and
- The Rapid Systematic Conservation Plan in Volume 4.

Report Quality Verification

Title:	SEA for Cuando River Basin FINAL SEA Report
Date of Report:	4/11/2024

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Quality Verification: This report meets the agreed scope of work and quality standard.

Name and Capacity	Signature	Date

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This is the FINAL DRAFT Main Report for the Strategic Environmental Assessment (SEA) of the Cuando River Basin (CURB), shared by Angola, Botswana, Namibia and Zambia (Figure E.1).

Strategic Environmental Assessment (SEA) is "a framework to assess the environmental and social implications of development policies, plans and programmes (PPPs) (Organisation for Economic Co-operation and Development - OECD, 2006). Also, SEA is increasingly used in a geographical area (e.g. the CURB) where there is no specific PPP, but rather an incremental increase in developments and resultant cumulative impacts.

Where a SEA is done early and where there is good integration between it and plan-making process, SEA has proven to be effective as "a plan shaper" (that helps make PPPs more sustainable), but may also be regarded as a "fine tuner".

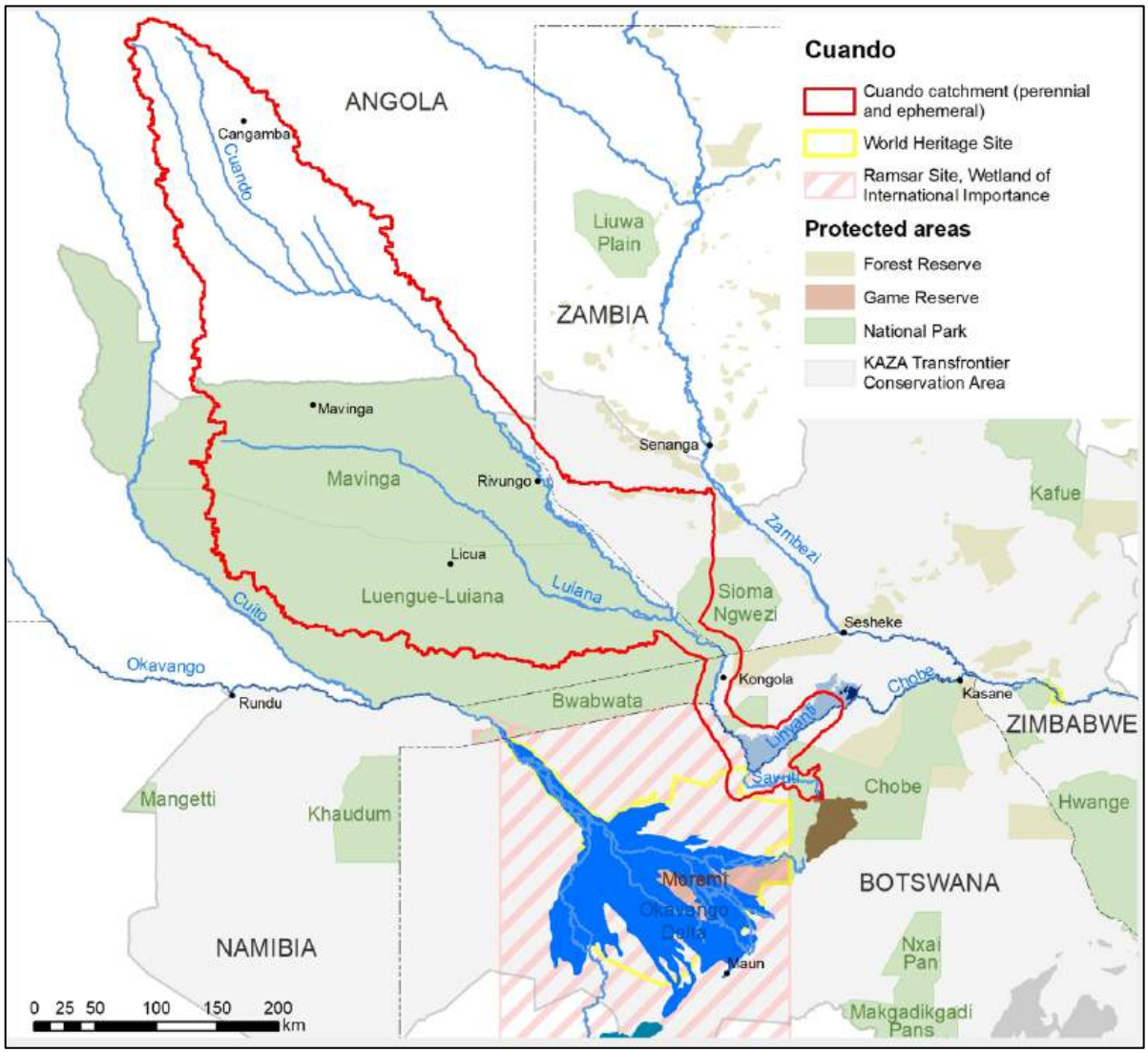


Figure E.1: The SEA Area of Focus

Chapter 1 is an introduction which describes the objectives of the SEA (table E.1), outlines the role of SEA and the main steps involved (figure E.2). Since the aim of the SEA is to provide a proactive instrument to guide sustainable development of the area, a holistic approach has been chosen in undertaking this assignment. System-wide risk factors such as climate change, socioeconomic and population dynamics, degradation of ecosystem-services etc. were taken into account. The following staged approach has been followed:

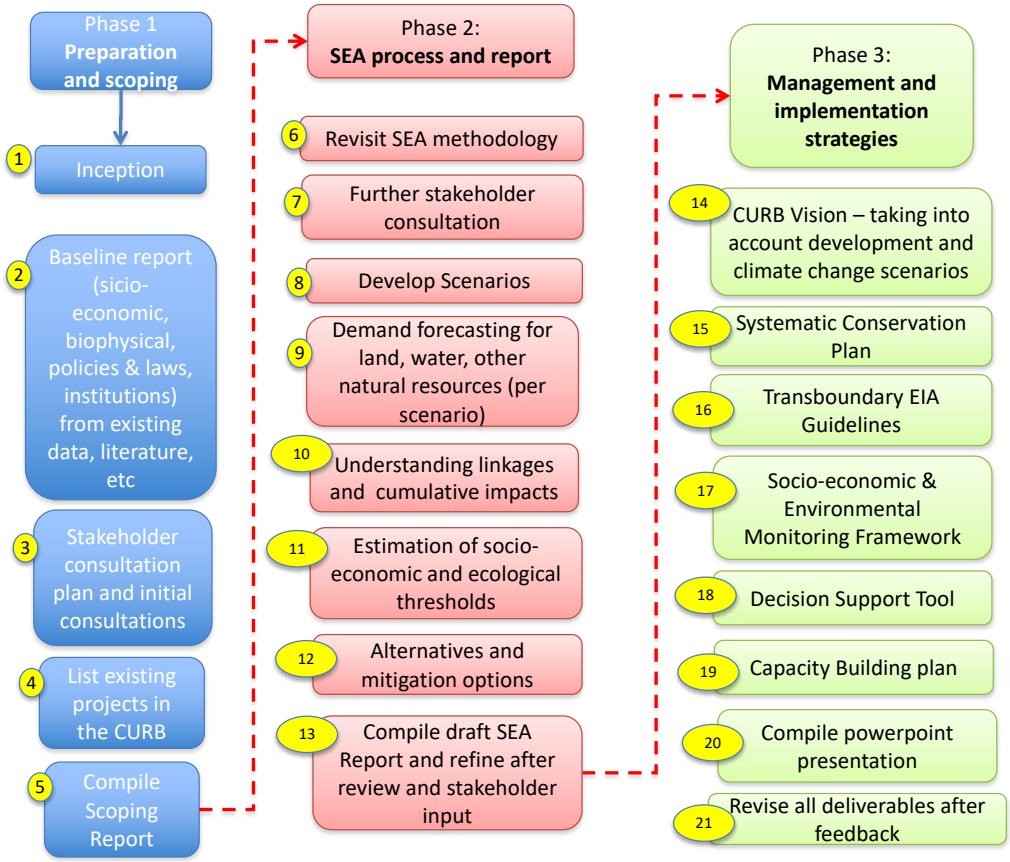


Figure E.2: Schematic illustration of methodology and sequencing of tasks

Table E.2: The SEA's direct and indirect objectives, and their relation to the United Nations (UN) sustainable development goals (SDGs).

THEME		OBJECTIVE	Applicable SDGs
Environmental			
Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services.	6, 14,15
	2	Reduce illegal activities relating to biodiversity, including poaching, unsustainable logging/deforestation, inappropriate use of fires.	15
	3	Reduce introduction and spread of invasive alien species.	15
	4	Maintain/enhance wildlife corridors, and ensure their integrity.	15
	5	Promote community-based conservation, and transboundary conservation through a landscape-level approach.	15, 16, 17
Waste and pollution	6	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial).	3,6,14
	7	Reduce all forms of pollution (air, land, water, noise, light, etc.).	3,6,14,15
	8	Minimise emissions of greenhouse gases.	13
Climate change and disasters	9	Reduce vulnerability to climate change and natural disasters (floods, droughts, etc.).	1,13
Land degradation	10	Minimise the footprint of transport services (rail, road, air, water-borne).	15
	11	Minimise erosion of river banks/water channels.	15
Land use change	12	Minimise loss of agricultural land required for rural livelihoods (e.g. its conversion to industrial agriculture).	15
Water	13	Maintain current/historical freshwater flow in the river.	6
Sediment	14	Prevent improper disposal of dredged sediments.	14,15
Socio-economic			
Economic growth	15	Ensure sustainable, diverse and inclusive development and growth, including greater community involvement in tourism.	8,9
Employment	16	Enhance opportunities for employment and new/improved livelihoods (particularly for forestry, fisheries, agriculture, eco-tourism).	8,9
Health and sanitation	17	Improve health services and health of society (e.g. by reducing vulnerability to diseases).	3
	18	Improve and extend water supply and sanitation services.	3,6
Women and children	19	Improve gender equality and empowerment of women.	4,5
Food	20	Improve food security.	2
Conflicts and security	21	Reduce conflicts over use of land, forests and water.	15
Connectivity, access and mobility	22	Connect communities, and improve access to infrastructure, services and facilities – though avoiding road networks that have negative uninented consequences, including undermining sense-of-place.	11
Agriculture	23	Improve agricultural production (though not necessarily expanding land used for agriculture).	2
Tourism	24	Promote eco-tourism (e.g. though avoiding over-tourism).	8

List of Sustainable Development Goals

1. **No poverty**: End poverty in all its forms everywhere
2. **Zero hunger**: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. **Good health and well-being:** Ensure healthy lives and promote well-being for all at all ages
4. **Quality education**: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. **Gender equality**: Achieve gender equality and empower all women and girls
6. **Clean water and sanitation**: Ensure availability and sustainable management of water and sanitation for all
7. **Affordable and clean energy**: Ensure access to affordable, reliable, sustainable and modern energy for all
8. **Decent work and economic growth**: Promote sustained and inclusive and sustainable economic growth, full and productive employment and decent work for all
9. **Industry, innovation and infrastructure**: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation
10. **Reduced inequalities**: Reduce inequality within and among countries
11. **Sustainable cities and communities:** Make cities and human settlements inclusive, safe, resilient and sustainable
12. **Responsible consumption and production**: Ensure sustainable production and consumption patterns
13. **Climate action**: Take urgent action to combat climate change and its impacts
14. **Life below water**: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. **Life on the Land:** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. **Peace, justice and strong institutions**: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. **Partnerships for the goals**: Strengthen the means of implementation and revitalise the global partnership for sustainable development.

Chapter 2 sets out the methodology followed in conducting the SEA. This included:

- Literature review;
- undertaking stakeholder engagement and analysis of stakeholder input;
- preparing baseline overviews and identifying the key environmental, social and economic issues and concerns on which the SEA focused;
- reviewing the legal and regulatory framework of CURB States;
- understanding likely development trajectories over approximately the next ten years;
- Identifying Valued Ecosystem Components (VECs) and assessing their vulnerability to impacts;
- Assessing cumulative impacts.

Chapter 3 describes the biophysical conditions in the CURB. These include overviews of climate, geology, topography and hydrology, soils, fauna and flora. The objective of this chapter is to have a good understanding of the current "state of the environment" so that the SEA can assess the significance of any likely changes as a result of future development. This has been drawn from the State of the Basin Report, and other literature. Since the Cuando is a transboundary system, this chapter shows the extent to which the biophysical environment "knows no political boundaries" – and thus the importance of a landscape management approach. In its current condition, the Cuando is regarded as one of the most pristine rivers in the world.

Chapter 4 has a similar objective as above, but describes the socio-economic conditions, including the communities within the basin, how they use the land and resources and how the area is organised administratively.

Chapter 5 is an overview of Valued Environmental Components (VECs). For the purpose of the CURB SEA**,** VECs are defined as components of the natural and human environment that are considered by KAZA/ZAMCOM/WWF, CURB residents, scientists and other technical specialists, government agencies involved in the CURB, and the SEA team, to have scientific, ecological, economic, social, cultural, archaeological, historical, or other importance.

Chapter 6 introduces the institutional framework, at the resepective national and transboundary levels within the CURB. It describes the mandates and roles of the main institutions involved in the development and implementation of a wide range of policies, plans, programmes and projects. These include (*inter alia*) the institutions responsible for planning, economic and infrastructure development, social services, environmental protection, security and law-enforcement, and Climate Change response. The CURB also has a number of NGOs and private sector organisations active in both socio-economic and biophysical support activities. This understanding of the institutional landscape is essential as implementing the SEA's key recommendations will require deliberate and committed collaboration from all relevant agencies and organisations across the entire landscape.

For this reason, this chapter also describes the legal and regulatory framework, focusing on laws and associated instruments concerned with managing the environmental and social safeguards framework in the CURB countries, particularly Environmental Impact Assessment (EIA). All the basin countries have introduced formal requirements for EIA, but only Botswana and Zambia have a legal framework for SEA. In spite of this, SEAs have been conducted in all CURB countries, some dating back to almost 20 years ago.

This chapter is brief as the details of institutional arrangements and legislation has been placed in Appendix 9.

Chapter 7 introduces Member States' development and management "directions" relevant to the CURB. These were analysed to determine the focus of the CURB SEA, as a result of their relevancy in terms of developments and cumulative effects. This is a brief chapter because the details of sector development trajectories are presented in Appendix 6.

Chapter 8 focusses on the expected cumulative impacts from multiple projects/activities in the CURB and surrounds. It builds on the initial overview conducted during scoping of the key "mega projects" and other notable activities likely to be initiated or implemented in the CURB over approximately the next ten years. The assessment of cumulative impacts is accompanied by suggestions for avoiding or minimizing undesirable impacts (unintended consequences) as well as enhancing positive impacts. The SEA is not the tool for implementing impact management, since this is the responsibility of individual governments. However, the SEA might assist ZAMCOM to strengthen its work in guiding the CURB states in managing development in the basin for sustainable outcomes, and achieving the CURB's vision for the future.

Chapter 9 consolidates the suggestions made earlier, about how best to avoid or minimize the likely unintended/undesirable cumulative impacts in the low-medium growth scenario. This chapter is thus "conclusions and recommendations".

Appendices

In order to reduce the bulk of the SEA, Appendices have been placed in a separate report (Volume 2). They are briefly described as follows:

Appendix 1: Vital statistics and scenarios of the CURB countries

This appendix provides:

- an inventory of programmes and projects – existing, planned and possible, in the CURB countries, and
- statistics regarding population growth, settlements and selected infrastructure, footprint creep (e.g. expanding settlements and land conversion), and resource utilisation.

The "existing, planned and possible" developments formed the basis for analyzing which of four possible growth scenarios are likely to emerge over approximately the next 10 years. The scenarios considered were low (essentially business as usual), medium and high-growth.

Appendix 2: Socio-economic and Environmental Management and Monitoring Framework (SEMMF)

The purpose of a SEMMF is to provide a practical framework to manage development and monitor key indicators related to environmental and social issues in the CURB. Whilst noted as an Appendix to this SEA, the SEMMF has been placed in Volume 3 to reduce the bulkiness of the appendices report.

Appendix 3: Systematic Conservation Plan

The purpose of the Systematic Conservation Plan (SCP) is to guide zonation of key and important biodiversity areas and ecological corridors in the basin. The SCP is a multi-component, stage-wise approach to identifying conservation areas and devising management policies, with feedback, revision and reiteration, where needed, at any stage. The goal is to ensure that critical biodiversity components, such as populations, species occurrences, migration corridors, refuges, critical ecosystems, or ecological processes, are adequately represented in protected areas, considering the existing ones plus the complementary areas that deserve formal protection. Implementing the

SCP for a region is challenging because local stakeholders and authorities from four countries must agree to put in practice the chosen plan. Whilst noted as an Appendix to this SEA, the SCP has been placed in Volume 4 to reduce the bulkiness of the appendices report.

Appendix 4: Record of stakeholder consultations

This appendix provides details of the consultations that were held with stakeholders during the SEA.

Appendix 5: Notification Mechanism

All four basin states have developed national environmental legislation and recognise the need for undertaking EIAs. Their respective legislation broadly follows a similar process of studies, consultation, report compilation and decision making. However, none of the countries has in their legislation or accompanying regulations or guidelines, detailed procedures for the assessment of transboundary impacts and the consultation of stakeholders in the potentially affected states.

Initially it was anticipated that Trans Boundary EIA guidelines would be developed as an adjunct to this SEA, but it was subsequently realized that ZAMCOM already has an approved Notification Mechanism, which is essentially the same as Trans Boundary EIA guidelines. For ease of reference, this appendix summarises ZAMCOM's 2017 Notification Mechanism (officially entitled Procedures for Notification of Plannned Measures).

Appendix 6: Major projects/activities expected to be implemented inn the CURB under different scenarios.

This appendix consists of tables that detail the major projects/activities that are currently known and expected to be initiated in the future.

Appendix 7: is a tabulated summary of **policies, plans and programmes** relevant to the CURB SEA, sector trends, key environmental and social concerns and sector-specific objectives.

Appendix 8: is a tabulated summary of relevant **constitutional commitments and EIA legislation** in the CURB countries.

Appendix 9 is a tabulated summary of relevant **institutions** in the CURB countries.

Appendix 10 is a tabulated summary of the relevant **multilateral environmental agreements** to which the CURB countries are a Party**.** This includes international protocols and conventions applicable in the CURB.

Appendix 11: The CVs of the SEA team

Due to space/file size limitations, the full CVs of the core team that conducted the SEA are not included, but are available on request.

Appendix 12: The Terms of Reference for the SEA assignment

Due to space/file size limitations, the SEA ToRs are not included, but are available on request.

Conservation priority areas

The Systematic Conservation Plan identified areas of highest value for sustainable management and conservation actions, and aligned these with the VECs identified in the SEA. The landscape was categorised into Critical, High, Medium and Lower Value Areas (see Volume 4 for more details and methodology).

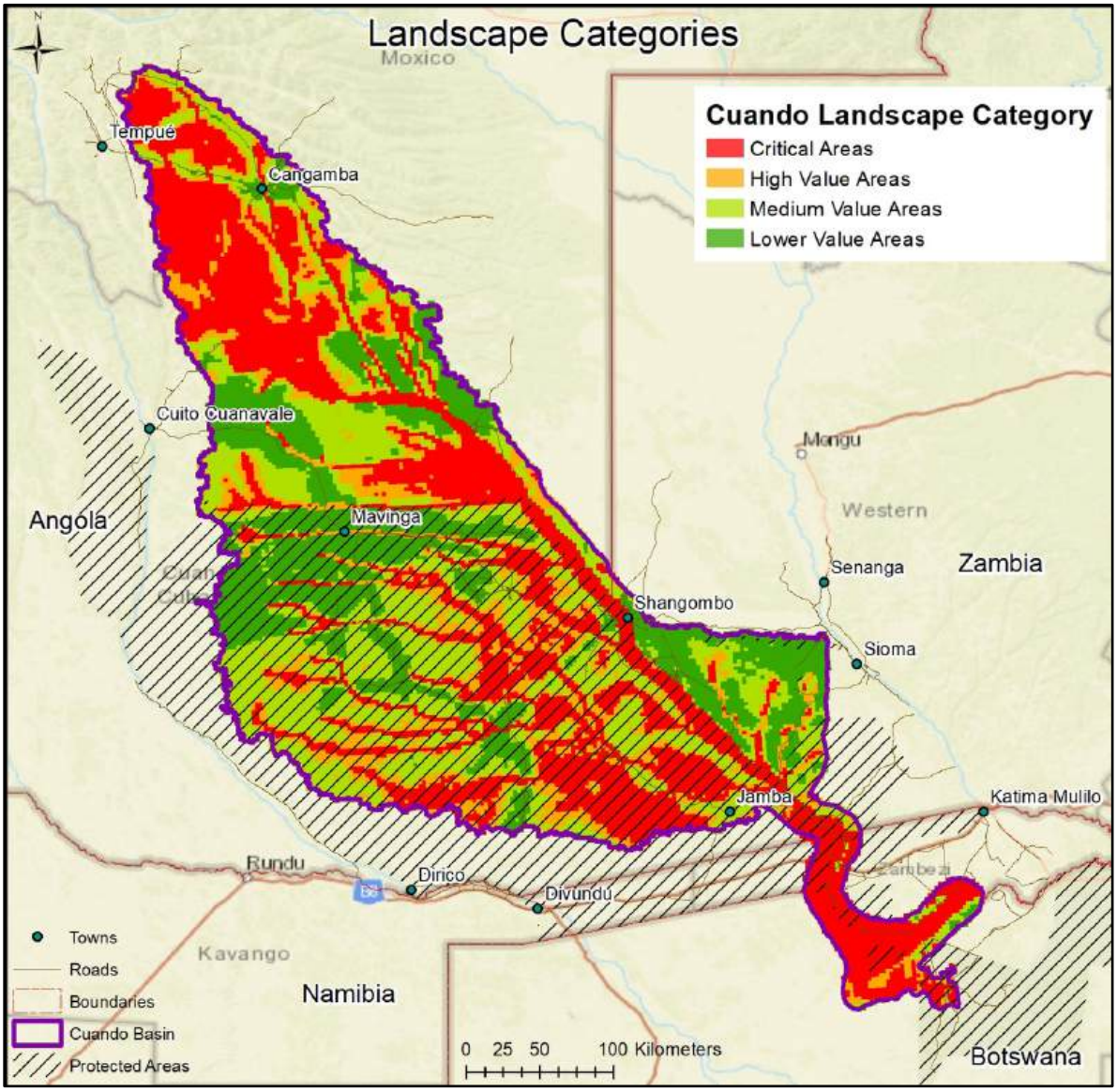


Figure E.3: The four landscape categories for sustainable management and conservation actions.

Together, the Critical and High Value Areas, include the most important VECs and areas supporting VECs, and should be a clear focus of conservation and landscape management practices supporting sustainability. Combined, these areas are of highest value as potential protected areas sites for conserving biological diversity and are highlighted as the most important for immediate conservation actions. The Medium Value Areas are generally less fragmented, have overall higher

irreplaceability values than the remainder of the basin, and represent areas with strong wilderness and connectivity characteristics (where these have not already been included in the Critical or High Value categories). These areas are important for overall landscape linkages. Their loss would result in a significant decrease in landscape connectivity. Retaining the overall connectivity and function of these areas should be a focus for landscape management activities. The remaining Lower Value Areas are of significantly lower value (relative to the rest of the basin) for supporting VECs than the other landscape categories. However, given the high value of the basin as a whole, on a national or regional scale these sites would undoubtedly be identified as valuable. Significant loss of these areas could undermine the overall integrity of the Cuando River Basin and its VECs. Key tools and mechanisms to achieve landscape sustainability and conservation outcomes are highlighted for each landscape category, and guidance is provided incorporation into the Draft Strategic Environmental Management and Monitoring Framework (SEMMF).

Whilst not within the Cuando River Basin, it is relevant to emphasise that the nearby Okavango Delta in Botswana was listed as a UNESCO World Heritage Site (WHS) in 2014[1] and is often referred to as the 'Jewel of the Kalahari'. The Okavango Delta is one of the very few major interior delta systems in the world and hosts outstanding biodiversity, including part of the largest remaining population of African elephants on the planet and some of the most endangered species of large mammals (e.g. lion, rhino, cheetah, wild dog). The Delta also has an ancient and ongoing human history, with strong links to another Word Heritage Site (Tsodilo Hills WHS), reflected in the governance and management of the World Heritage property, which is comprised of a mosaic of land use models.

The Okavango Delta is embedded within a large ecological and hydrological system that extends well beyond the Cubango-Okavango River Basin (CORB) into the Cuando River Basin (CURB) and forms a vibrant part of the Kavango Zambezi Transfrontier Conservation Area (KAZA) – the world's largest terrestrial TFCA. The extension of the Okavango Delta WHS to include key upstream areas in Angola and Namibia as well as other areas in Botswana has been recognised as a way to improve its ecological integrity and conservation of key wildlife corridors and facilitate the sharing of benefits from conservation between the riparian countries.

The three Partner States of Botswana, Angola and Namibia met at the 42nd session of the World Heritage Committee in Manama in July 2018 and agreed to examine the feasibility of a potential transboundary extension of the World Heritage property. The UNESCO World Heritage Centre has since been accompanying Botswana, Angola and Namibia in the implementation of an action plan for the transboundary extension of the Okavango Delta World Heritage property, adopted by a tripartite Steering Committee created for this purpose in April 2020, and supported the development of a feasibility study to assess the options for an extension.

The study identified a series of potential areas for the extension, including areas within the CURB. These areas largely overlay with some critical areas for sustainable management and conservation

[1] https://whc.unesco.org/en/list/1432/

actions identified in the CURB SEA Systematic Conservation Plan (SCP) (Volume 4), particularly the following Valued Ecosystem Components (VECs):

- VEC 3 – Linyanti Swamps and Savuti area,
- VEC 4 – Western flanks of the Cuando,
- VEC 5 – Wildlife corridors and ecological connectivity.

The successful implementation of the CURB SEA recommendations will therefore be crucial to maintain the integrity of these critical areas in view of a potential extension of the Okavango WHS. Concurrently, it is recommended that the CURB SEA Socio-economic and Environmental Management and Monitoring Framework considers future advancements of the Okavango Delta World Heritage site extension process.

Challenges

This SEA has confirmed that the major challenges in the CURB include habitat loss, fragmentation, and degradation; human wildlife conflict; wildlife crime; inadequate community empowerment and engagement; poorly planned infrastructure development and climate change, leading to increasing pressure for land and resources from a growing but unevenly distributed human population.

Climate change models forecast that the average total annual precipitation averaged over the whole of KAZA is expected to decrease by 4.6% by 2050, relative to historical precipitation. It is generally expected to get hotter and drier whilst mean annual temperatures are expected to increase by 3°C.

The situation described above is a classic example of cumulative impacts that challenge the concept of limits of acceptable change – or tipping points.

As in many parts of rural Africa, people within the CURB are caught in a poverty trap driven by poor agricultural potential, isolation, and only localized and limited tourism opportunities. Rural communities rely largely upon ecosystem services, remittances, social grants and low yielding subsistence agriculture. They grow part of their food requirements and have free housing, water, fire wood etc. but all other needs come from cash which very largely comes from off-farm sources.

The concentration of growing human populations along the river and shrinking corridors for wildlife to access the important water resources further exacerbates the hardships for both people and wildlife through increased human wildlife conflict. This highlights the need for inclusive regional fine scale planning to identify and secure wildlife corridors and human development areas in order to reduce HWC. Hopefully this SEA can help guide solutions.

Whilst the Cuando river is largely pristine, it is under increasing pressure from a growing population that, whilst relying mostly on subsistence farming and natural resource exploitation, is rapidly urbanising[1]. Towns are small but are growing fast and physical, social and institutional infrastructure is struggling to cope with the current growth. Botswana and Namibia, have established good (though relatively small) tourism industries in the lower Cuando area that are increasingly important to local economies. This industry is based on comparative advantages

offered by exceptional wildlife resources and intact sense-of-place, helped by the fact that CURB countries have established various levels of conservation measures in the area.

However, there are competing land uses, notably livestock ranching, dryland cropping and wildlife harvesting on a subsistence level. Illegal wildlife offtake is a concern, and increasing.

Thus, sensitive forms of wildlife are under pressure and numbers of some key species are in decline. The upper part of the catchment has lost most of its wildlife, but habitats are generally intact and wildlife are gradually returning[1].

Many impacts are masked due to the lag effect between developments being implemented and the impact being felt. Often the system may appear to be moving away from a critical threshold during normal or wet years, but when a set of cumulative impacts combine or events come together in the "perfect storm" then the system may be pushed over a threshold, re-establishing another but less desirable state, or collapsing entirely.

For the purposes of this SEA, various internal drivers (generated within the Basin) and external drivers (from outside the Basin, even regional or global) are regarded as the root causes that result in cumulative impacts. The main external drivers which affect the CURB are climate change, the global economy and to a lesser extent, international environmental agreements.

The four main basin-wide (internal) drivers are:

- The desire for accelerated economic growth and diversification, and from this, job opportunities and poverty alleviation;
- The need for food security;
- Population growth; and
- Poverty.

Based on literature, expert opinion and stakeholder input, the cumulative impacts of greatest concern (either existing or expected in the future) are summarised as follows:

- Lowered ecosystem resilience and functioning because of reduced hydrological flow and volume, (caused by irrigation schemes, impoundments, growing settlements, tourism and perhaps other industries, water transfers and climate change);
- Biodiversity loss because of land degradation (as above plus poor land-use practices for subsistence agriculture);
- Biodiversity loss and increased human-wildlife conflicts because of habitat fragmentation and wildlife movement barriers (because of fences, crop production, livestock, settlements);
- Loss of livelihoods and economic options because of reduced ecosystem services (linked to compromised hydrological functioning, but added to that is impacts of land degradation from deforestation and burning, resource overexploitation, etc);
- Health, livelihood and ecological risks because of reduced water quality; and
- Increased prevalence/spread of communicable diseases because of increased mobility of people and the influx of workers (including foreign) to project sites in predominantly poor rural areas.

A key outcome of the SEA is recommending what CURB states need to do to keep the basin in a relatively pristine state, whilst still enabling sustainable development. These recommendations are contained in the **Strategic Environmental and Monitoring Framework** (SEMMF) – volume 3.

The SEMMF has recommended various high-level targets, which are summarised as follows[2]:

Strategic, trans-frontier level

- The Member States must agree on what activities to allow in their part of the basin.
- Improved transboundary conservation and wildlife mobility between the participating States.

Strategic, local level

- Reduce barriers that prevent wildlife from moving freely. Fences (or critical sections) should be removed, and corridors kept open between human settlements and fields. These corridors must correspond with known wildlife movement paths, and the gaps need to be wide enough so that they are used.
- Avoid allocating exploration or mining/petroleum licenses anywhere within the basin.

Local level

- Build on existing successful CBNRM programmes, thus supporting communities that otherwise have few incentives to tolerate or conserve wildlife.
- Promote climate-smart agriculture, so that people in certain areas can grow crops in an ecologically appropriate way for the best possible yields.
- Get the tourism sector to commit to achieving 'best practice', by implementing existing or emerging Ecotourism Certification Systems.
- Actively protect (especially) the riparian woodland by whatever means possible, especially enforcing a ban on logging within the CURB, and preventing fires.

Proposed targets

1) Hydrological functioning, water quality and biodiversity

- No significant human-induced change in the natural flood pulse peak or loss of permanent swamp. Annual offtake from the entire basin must not exceed 600Mm^3 per annum (based on inflow at the Kongola measuring station).
- No upriver dams or other impoundments.
- Water quality to be within 5% of current fluctuations as measured over the past 15 years.
- Existing fences are removed wherever possible, especially in between Namibia and Botswana.
- Reverse declines of indicator species.
- Reverse large mammal species population declines to 1994 levels; e.g. lechwe, buffalo, tsessebe, and zebra.
- Maintain integrity of the riparian fringe – no more clearing of riparian habitat for agricultural or any other form of land use and implement rehabilitation of already impacted areas.

[2] This is a summary only – more details in Volume 3

- No introduction of alien invasive species (especially plants and invertebrates) and eradication of aliens where they exist already.
- Reduce human-wildlife conflicts: farming must avoid prime wildlife areas and designated wildlife corridors, and installation of protection devices/ strategies used to mitigate further conflict.
- Implement the KAZA Elephant Management Plan.
- Maintain viable populations of endemic, rare and endangered species.
- Promote and improve support to CBNRM projects.
- Reduce poaching to zero (CBNRM and law-enforcement are key tools in this regard).
- Reduce fire frequency to a rate of one in 3-5 years and promote cool burns.

2) Livestock farming

- Limit livestock to rangelands further away from key biodiversity areas (e.g. riparian fringe) and stock appropriately (recommended stocking rate -16ha/LSU in sandveld).
- No fenced commercial ranches or disease-control fences – unless EIAs show they will not impact biodiversity significantly.

3) Arable agriculture

- Water offtake (all sectors combined) should be limited to less than 600 Mm^3/a so as not to compromise ecological integrity of the wetlands.
- Future molapo/dambo and horticulture farms should not be placed within nor extract wood from, the riparian fringe for any purpose whatsoever.
- Reduce Human-wildlife conflicts by locating fields away from prime wildlife areas, including migration routes.
- Principles of climate-smart agriculture[3] should be rigorously applied to reduce habitat alteration and soil exposure while improving farming efficiency and crop yields.
- Levels of fertiliser and chemical inputs need to be controlled to minimise toxic inputs into return flows to surface waters or pollution of groundwater.

4) Tourism

- Maximum 700 beds in the Namibian and Botswana area, but expansion possible in Angola.
- Improve equity (through local ownership and improved benefit sharing).
- Reduce conflicts with subsistence fishers/villagers.
- Improve general housekeeping at tourism establishments.

5) Mining

- No prospecting and/or mining licenses issued within the CURB and existing licenses to be withdrawn by the Member State as soon as they are relinquished by the current license-holder.

[3] https://www.fao.org/climate-smart-agriculture/en/

ACKNOWLEDGEMENTS

This SEA was commissioned by ZAMCOM through the WWF-Namibia office. The Southern African Institute for Environmental Assessment is grateful to ZAMCOM and WWF for entrusting our organisations with conducting this SEA. The team would like to acknowledge Dr Mike Knight for his support and leadership, and the SEA Steering Committee. Dr Nyambe Nyambe, Mr Obrian Chalo Mwanza, Mr Evans Kaseke, Ms Beauty Shamboko-Mbale and Ms Ethel Mudenda are thanked for the time they invested in providing comments on earlier drafts. We extend gratitude to the local teams that provided invaluable support during the fieldwork and consultation. These included Daniel Morais and Diaz Silubanga.

Grateful thanks are especially due to all stakeholders, organisations and individuals who have provided perspectives, information, advice and support, and participated in physical and virtual meetings to discuss key issues as well as the approach and focus of the SEA.

TRANSPARENCY STATEMENT

This Scoping Report and all other reports prepared during the SEA process are intended as open access documents for sharing with all stakeholders, all those who have participated in the SEA process, and any other interested individuals or organisations. All documents will be made available at the earliest opportunity to download on an appropriate website.

ABBREVIATIONS AND ACRONYMS

AIDS - Acquired Immune Deficiency Syndrome

CCA – Climate Change Adaptation

CBD – Convention on Biological Diversity

CBNRM – Community Based Natural Resources Management

CIA - Cumulative Impact Assessment

CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora

CLB – Communal Land Boards

CLRA – Communal Land Reform Act

CORB – Cubango-Okavango River Basin

CURB – Cuando River Basin

CRIDF – Climate Resilient Infrastructure Development Facility

CV - Curriculum Vitae

DFRR – Department of Forest and Range Resources

DPWM – Directorate of Parks and Wildlife Management

DSF – Decision Support Framework

DSS – Decision Support Systems

DST – Decision Support Tool

DWNP – Department of Wildlife and National Parks

EAP – Environmental Action Programme

EIA – Environmental Impact Assessment

EWS – Early Warning Systems

FAO – Food and Agriculture Organization of the United Nations

GEF - Global Environment Facility

GIS - Geographic Information System

HIV - Human Immunodeficiency Virus

IAIA - International Association of Impact Assessment

ICT – Information, communication, and technology

IDP – Integrated Development Plan

IFC - International Finance Corporation

IRLUP – Integrated Regional Land Use Plan

IWRM – Integrated Water Resources Management

KAZA – Kavango-Zambezi Transfrontier Conservation Area

LAC – Limits of Acceptable Change

LEAP – Law Enforcement and Anti-Poaching Strategy

MAR – Mean Annual Runoff

MEFT – Ministry of Environment, Forestry and Tourism

M&E - Monitoring and Evaluation

MS – Member States

NAP – National Action Plan

NBSAP – National Biodiversity Strategy and Action Plan

NCCSAP – National Climate Change Strategy and Action Plan

NDP – National Development Plan

NDRMP – Disaster Risk Management Plan

NGO – Non-Governmental Organization

OKACOM – The Permanent Okavango River Basin Water Commission

PPP – Plans, Programmes and Policies

PES – Payment for Ecosystem Services

RBMP – River Basin Management Plan

SADC – Southern African Development Community

SAIEA - Southern African Institute for Environmental Assessment

SAP – Strategic Action Programme (or plan)

SAREP – Southern African Regional Environmental Program

SCR – Stakeholder Consultation Report

SEA – Strategic Environmental Assessment

SEMF – Socio-Economic Monitoring Framework

SES - Social Ecological System

SME – Small and Medium Enterprises

SWOT – Strengths, Weaknesses, Opportunities and Threats

TA – Traditional Authorities

TBEA – Transboundary Environmental Impact Assessment

TFCA – TransFrontier Conservation Area

TOR - Terms of Reference

UN – United Nations

UNCCD – United Nations Convention to Combat Desertification

UNEP – United Nations Environment Programme

UNFCCC – United Nations Framework Convention on Climate Change

USAID – United States Agency for International Development

VEC - Valued Environmental Components

WDA – Wildlife Dispersal Area

WMA – Wildlife Management Area

WWF – Worldwide Fund for Nature

DEFINITIONS

Alternatives	A possible course of action in place of another that would meet the same purpose and need. An alternative can include other locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The 'without project' (or no-go) alternative provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid negative impacts.
Baseline data	Data that describes issues and conditions at the inception of the SEA. Serves as the starting point for measuring impacts, performance, etc., and is an important reference for evaluation.
Cumulative effects/impacts	Are combined or additive effects on the environment over time or space when added to other past, present or reasonably foreseeable actions. They may seem to be insignificant when seen in isolation, but collectively they have a significant effect.
Drivers of change	The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) refers to drivers of change as all those external factors that affect nature, and, as a consequence, also affect the supply of Nature's contributions to people. The IPBES conceptual framework[4] includes drivers of change as two of its main elements: indirect drivers, which are all anthropogenic, and direct drivers, both natural and anthropogenic.
Ecosystem approach	As advocated by the Convention on Biological Diversity (CBD), the ecosystem approach recognises that people and their environment are part of the broader ecosystems on which they depend. Environmental management should therefore be implemented in an integrated way.
Environment	The physical factors of the surroundings of the human being including land, water, atmosphere, climate, and the biological factors of fauna and flora as well as the cultural, social, and economic aspects of human activity.
Environmental Assessment	Generically, a method or procedure for predicting the effects on the environment of a proposal, either for an individual project or a higher-level "strategy" (a policy, plan or programme), with the aim of taking account of these effects in decision making.

[4] https://www.ipbes.net/glossary-tag/drivers-change#:~:text=Drivers%20of%20change%20include%20institutions,drivers%20result%20from%20human%20decisions.

Environmental impact	Effects on the environment and natural resources that may be positive and/or negative and produce benefits and/or costs. • *Direct impacts* are those that take place at the same time and in the same space as the activity. • *Indirect impacts* occur later in time or at a different place from the activity. • *Cumulative impacts* are the combined or additive effects on the environment of individual projects over time or of several projects in one geographical area. They may seem to be insignificant when seen in isolation, but collectively they may have a significant effect. • *Irreversible impact* are impacts that cannot be reversed in time, it results in the irreplaceable loss of a resource.
Environmental Impact Assessment (EIA)	The application of impact assessment to a specific project. Typically, an EIA is carried out on a project that is already defined (i.e. in feasibility stage) and seldom considers landscape scale or cumulative impacts. An EIA may consider cumulative impacts, e.g. in respect of similar existing or planned projects, especially in the absence of a strategic framework for development (or a SEA). An EIA is the systematic evaluation of a project to determine its impact on the environment and natural resources.
Inter-generational equity	Inter-generational equity implies that the current generation chooses a development path that does not jeopardize the ability of future generations to achieve similar or better development options.
Issue	A context-specific question that asks 'what, or how severe, will the impact of some activity/ aspect of the development be on some element of the environment?'
Limits of Acceptable Change (LAC)	Extremes of environmental quality beyond which society would find further change unacceptable. The LAC thus relate to levels of environmental quality (biophysical) that are either desired by or would be tolerable to society (largely qualitative values)
Mitigation	means actions to avoid, reduce, control or offset the potential adverse environmental and socio-economic consequences of a PPP, and include engineering works, technological improvements, management measures and restitution through replacement, restoration,

	compensation or any other means, to minimise harm to human health or the environment
Monitoring	Actions taken to observe, take samples or measure specific variables in order to track changes, measure performance of compliance, and/or detect problems. The objective of monitoring should always be to improve management.
Objective	A statement of what is intended, specifying the desired direction of change in trends.
Policy	A broad statement of intent that reflects and focus the political agenda of government and initiate a decision cycle; a general course of action or proposed overall direction that a government is or will be pursuing that guides ongoing decision making.
Plan	A purposeful forward-looking strategy or design, often with co-ordinated priorities, options and measures that elaborate and implement policy.
Precautionary principle	Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.
Project	Means the execution of construction or renovation work or other developments, installations, schemes, activities or other interventions linked to a specific development that can be "ring-fenced".
Programme	A coherent, organized agenda or schedule of commitments, proposals, instruments and/or activities that elaborate and implement policy. A programme usually has a number of projects that cascade below it
Scoping	The process of deciding the scope and level of detail of an SEA, including the environmental effects and alternatives which need to be considered, the assessment methods to be used, and the structure and contents of the Environmental Report.
Significance	Determination of severity of an impact taking into account objective or scientific data as well as societal values. Any exercise in judging the significance of an impact should thoroughly consider (a) the importance of the environmental or social attribute in question to project decision makers, (2) the distribution of change in time and

	space, (c) the magnitude of change, and (d) the reliability with which change has been predicted or measured.
Stakeholder	Individuals or organisations who may be interested in, potentially affected by, or influence the implementation of a PPP. In the context of an SEA applied to development co-operation, stakeholders may include the government, donor agencies, local community, NGOs and civil society
Strategic Environmental Assessment (SEA)	Generic term used to describe environmental assessment as applied to policies, plans and programmes (PPPs). Refers to a range of analytical and participatory approaches that aims to integrate environmental consideration into PPPs and evaluate the interlinkages with economic and social considerations. Impact assessments at strategic level encourage an 'opportunities and constraints' type approach to development, where such things as natural resources and ecosystem services at landscape scale define the 'framework' within which development can take place and the types of development that could be sustained.
Transboundary impacts	Means an environment, health or social impact on another state.
Threshold	Levels that should not be exceeded; points at which irreversible or serious damage could occur, either to ecosystems and/or to social systems (health, safety or wellbeing). Could also be described as a tipping point.
Trade-offs	Refers to losing one quality or aspect of something in return for getting another quality or aspect. It implies a decision made with the full comprehension of both the upside and down side of a particular choice.
Uncertainty	The inherent unpredictability of response of the environment to an impact, the lack of knowledge and/or understanding of cause-effect-impact relationships between the development activity and the environment, and/or gaps in information that do not allow confidence in predictions of impacts.
Vulnerable communities	Those communities who rely heavily on those ecosystem goods and/or services likely to be affected or who live in dynamic, sensitive or harsh ecosystems, where extreme conditions make them particularly vulnerable to additional negative impacts.

INTRODUCTION

1 INTRODUCTION

This is the FINAL Draft Report for the Strategic Environmental Assessment (SEA) of the Cuando river basin (CURB). It represents the third deliverable by the consultant. The first deliverable was the Inception Report, the second was the Scoping Report, and the third was the first draft SEA report, includindg the SEMMF.

The OECD SEA Guidance (2006) sets out the aims of an SEA – it should:

- Establish (during scoping) the focus of the SEA, i.e. the key issues that the SEA should focus on;
- Identify the relevant criteria for assessment, e.g. goals and objectives set out in national policies and strategies, preferably those that focus on sustainable development;
- Take a pragmatic view on how much can be achieved given the time-scale, available resources, and existing knowledge about key issues;
- Follow an open and systematic process;
- Actively engage key stakeholders to identify significant issues;
- Set objectives based on the identified key issues. Such objectives should represent goals to achieve such as reducing loss of biodiversity or improving employment opportunities (table 1.1). These objectives will be used later to assess the impacts likely to arise when implementing PPPs;
- Identify decision criteria and suitable 'indicators' of desired outcomes; and
- Recommend alternatives to be considered, suitable methods for analyses of key issues and sources of relevant data.

This is the approach that has been followed. It has provided an opportunity to focus the SEA on the important issues to maximise its usefulness to the authorities, decision-makers and public. It does not preclude changes in the scope of the SEA if the need for them arises at a later stage. To the extent possible the process has been open and iterative, involving key stakeholders.

Table 1.1: The SEA's direct and indirect objectives, and their relation to the United Nations (UN) sustainable development goals (SDGs).

THEME		OBJECTIVE	Applicable SDGs
Environmental			
Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	6, 14,15
	2	Reduce illegal activities relating to biodiversity, including poaching, unsustainable logging/deforestation, inappropriate use of fires.	15
	3	Reduce introduction and spread of invasive alien species	15
	4	Maintain/enhance wildlife corridors, and ensure their integrity	15
	5	Promote community-based conservation, and transboundary conservation through a landscape-level approach	15, 16, 17
Waste and pollution	6	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	3,6,14

	7	Reduce all forms of pollution (air, land, water, noise, light, etc.)	3,6,14,15
	8	Minimise emissions of greenhouse gases	13
Climate change and disasters	9	Reduce vulnerability to climate change and natural disasters (floods, droughts, etc.)	1,13
Land degradation	10	Minimise the footprint of transport services (rail, road, air, water-borne)	15
	11	Minimise erosion of river banks/water channels	15
Land use change	12	Minimise loss of agricultural land required for rural livelihoods (e.g. its conversion to industrial agriculture)	15
Water	13	Maintain current/historical freshwater flow in the river	6
Sediment	14	Prevent improper disposal of dredged sediments	14,15
Socio-economic			
Economic growth	15	Ensure sustainable, diverse and inclusive development and growth, including greater community involvement in tourism	8,9
Employment	16	Enhance opportunities for employment and new/improved livelihoods (particularly for forestry, fisheries, agriculture, eco-tourism)	8,9
Health and sanitation	17	Improve health services and health of society (e.g. by reducing vulnerability to diseases)	3
	18	Improve and extend water supply and sanitation services	3,6
Women and children	19	Improve gender equality and empowerment of women	4,5
Food	20	Improve food security	2
Conflicts and security	21	Reduce conflicts over use of land, forests and water	15
Connectivity, access and mobility	22	Connect communities, and improve access to infrastructure, services and facilities – though avoiding road networks that have negative uninented consequences, including undermining sense-of-place	11
Agriculture	23	Improve agricultural production (though not necessarily expanding land used for agriculture)	2
Tourism	24	Promote eco-tourism (e.g. though avoiding over-tourism)	8

1.1 CURB VISION

There was previously no agreed vision for the Cuando Basin. The following has been agreed:

Vision: A sustainable and resilient Cuando Basin for all by 2040

OBJECTIVES

Objectives are specific, actionable targets that need to be achieved to reach certain goals. The following objectives describe the actions or activities needed to ensure that the CURB's vision is upheld:

- Effective protection and management of the Cuando's natural resources;
- Maintain ecosystem functioning, linkages, connectivity and services;
- Secure management to ensure river flows and water quality required to maintain fully functioning wetlands and associated habitats;
- Limit and manage infrastructure, agriculture and industrial development and resource use in rural areas to keep their environmental and social impacts within sustainable limits;

- Advance urban and peri-urban development to provide decent livelihoods for the residents of the basin and concentrate environmental damage to already developed areas;
- Advance peaceful co-existence between rural residents and wildlife; and
- Promote the basin as KAZA's ecological hub and take advantage of its comparative advantages, notably wilderness and wildlife.

For the vision to be upheld, the following guiding principles, which are fortunately reflected in the national Constiutions and policies of the CURB States, need to be adhered to:

- Good governance, peace, security and political stability through democracy, human rights, individual freedoms, civil liberties and open market economy;
- Partnership, through the creation of a conducive and incentivised policy environment, that promotes gender equity and outcomes oriented collaboration between government and civil society, including the private sector, NGOs, CBOs, tertiary training institutions, individuals and development partners;
- Capacity enhancement, that recognises that people are the CURB's most important resource, and that investment in people and in local institutions is a critical precondition for sustainable development;
- Comparative advantage, that capitalises on the key assets of the basin, provides incentives and reduces obstacles to their productive management and development;
- People-centred economic development, that promotes diversification, equity, balanced growth and a conducive macro and micro economic environment within the context of traditional practices, knowledge systems and cultures;
- Sustainable development, that meets the need of the present without limiting the future generations to meet their own needs, within a clean, productive and healthy social and ecological setting.

The CURB vision provides a strong framework for collaboration and cooperation. Its implementation requires a paradigm shift from un-coordinated sector development to integrated approaches through strategic partnerships. This means that some structural changes may be necessary, as well as innovative thinking. The following "new ways" of thinking and working are important:

- Move from developing and implementing fixed plans which get increasingly out of date, towards operating an adaptive, dynamic system or process than can continuously evolve;
- Move from a view that it is the government alone that is responsible for sustainable development towards one that sees responsibility to society as a whole – a full partnership, where the State helps guide the identification of goals and helps create the enabling environment;
- Move from centralised and controlled decision-making towards sharing results and opportunities, transparent negotiations, cooperation and concerted actions;
- Move from a focus on outputs (e.g. projects, laws,) towards a focus on outcomes (i.e. fundamental impacts) that actually contribute towards achieving visions; and

- Move from sectoral planning towards integrated planning, within and between sectors and institutions.

1.2 WHAT IS STRATEGIC ENVIRONMENTAL ASSESSMENT?

Strategic Environmental Assessment (SEA) is "a framework to assess the environmental and social implications of development policies, plans and programmes (PPPs) (OECD, 2006)[5]. Also, SEA is increasingly used in a geographical area (e.g. the CURB) where there is no specific PPP, but rather an incremental increase in developments and resultant cumulative impacts.

Where a SEA is done early and where there is good integration between it and plan-making process, SEA has proven to be effective as "a plan shaper" (that helps make PPPs more sustainable), but may also be regarded as a "fine tuner".

Global experience[6] has shown that SEA requires a flexible and iterative process. There is no template of procedures and methodologies such as those available in the application of project-level EIA. The methodology varies according to the purpose of the SEA. However, there is a growing set of evolving principles and criteria, which typically includes a range of analytical and participatory approaches. These aim to integrate environmental considerations into PPPs and evaluate the inter linkages with economic, social and other considerations. SEA can be described as a family of approaches, which uses a variety of tools, rather than a single, fixed and prescriptive methodology.

Thus, a good SEA is adapted and tailor-made to the context in which it is applied. This can be thought of as a continuum of increasing integration: at one end of the continuum, the principle aim is to integrate environment, alongside economic, social and other concerns, into strategic decision making; at the other end, the emphasis is on the full integration of the environmental, social and other factors into a holistic sustainability assessment.

SEA is not a substitute for, but complements, EIA and other assessment approaches and tools (Figures 1.1 and 1.2).

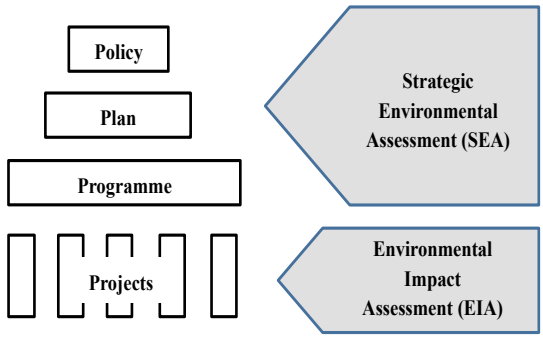


Figure 1.1: Hierarchy of common environmental safeguard tools (SEA and EIA).

Used in this way, SEA has an important role in informing the planning process and helping to deliver more sustainable development outcomes. It will indicate whether the key long-term focuses of envisaged PPPs, and the goals set for them, can be driven forward in a way that balances the

[5] https://www.oecd.org/dac/environment-development/strategicenvironmentalassessment.htm
[6] https://www.tandfonline.com/doi/full/10.1080/14615517.2019.1601432

different pillars of sustainability, and to indicate whether there are likely synergies that would deliver sustainable development objectives more effectively.

The diagram below shows the linkage between SEA and project-level EIAs.

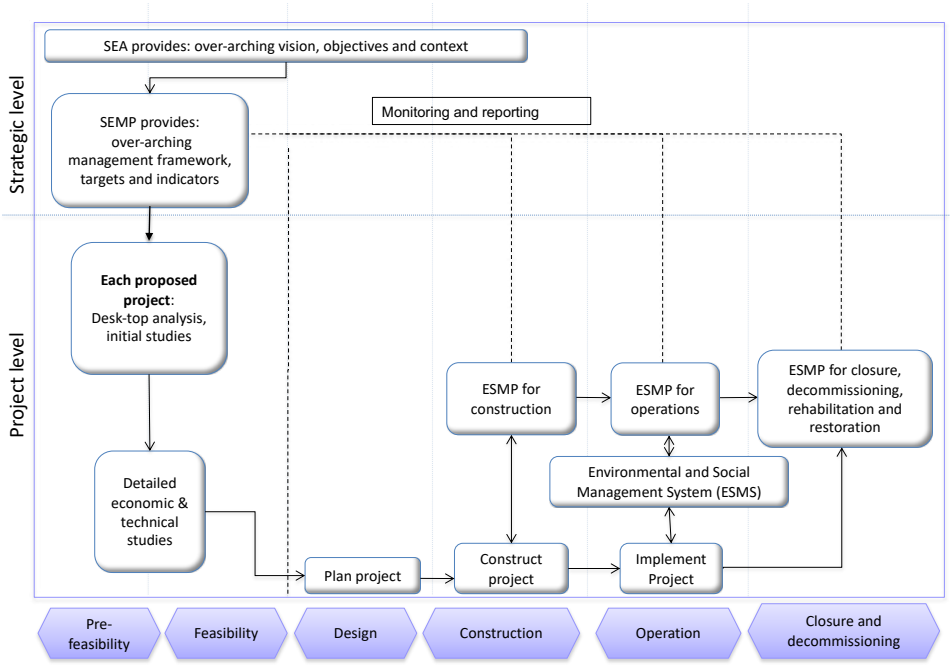


Figure 1.2: Linkages between SEA and downstream project-level EIAs

1.3 OBJECTIVES OF THE SEA

The Terms of Reference of this SEA required the consultant team to:

- Compile a conscise overview of baseline conditions;
- Identify potential significant cumulative effects on the environment of key policies, plans and programmes (PPPs) (and associated projects);
- Undertake inclusive stakeholder engagement that builds ownership and buy-in;
- Provide a GIS-based decision-support-tool and a user-friendly knowledge product to help decision makers and other stakeholders make informed decisions on PPPs and developmental proposals;
- Compile a systematic conservation plan that will guide zonation of key biodiversity areas, including ecological corridors; and
- Develop a monitoring and evaluation framework to assess delivery on the SEA and guide adaptive management over time.

The consultant team was expected to coordinate and interact with local/central government, traditional authorities, developers, private sector, communities, and other stakeholders in order to understand the magnitude and location of current and envisaged projects and their potential individual and collective impacts on the CURB. They were also expected to develop an inclusive

vision for the CURB, with an emphasis on strong links to sustainable freshwater flows in the Cuando River and taking into account different development scenarios.

Another important objective is that the SEA serves as an important decision-aiding tool that incorporates a range of analytical and participatory approaches. These should aim to integrate environmental considerations into policies, plans and programmes and evaluate the inter-linkages with economic and social considerations. This will help to ensure that the prudent management of natural resources and the environment provide the foundations for sustainable economic growth which, in turn, potentially supports livelihoods and socio-political stability. In addition, a transboundary SEA offers the opportunity to promote greater international cooperation, information sharing, and stability. It can build stakeholder engagement for improved governance, facilitate trans-boundary co-operation around shared environmental resources, and contribute to conflict prevention. Whilst the ToRs did not require the compilation of transboundary EIA guidelines, the consultants undertook to include the delivery of these as an accompaniment to the SEA. However, it was subsequently realized that the Zambezi River Basin Commission (ZAMCOM) already has an approved Notification Mechanism, which is essentially the same as transboundary EIA guidelines.

METHODOLOGY

2 METHODOLOGY AND THE SEA PROCESS

Since the aim of the SEA was to provide a proactive instrument to guide sustainable development of the area, a holistic approach was chosen in undertaking this assignment. System-wide risk factors such as climate change, socioeconomic and population dynamics, degradation of ecosystem-services etc, were considered. The following staged approach was followed:

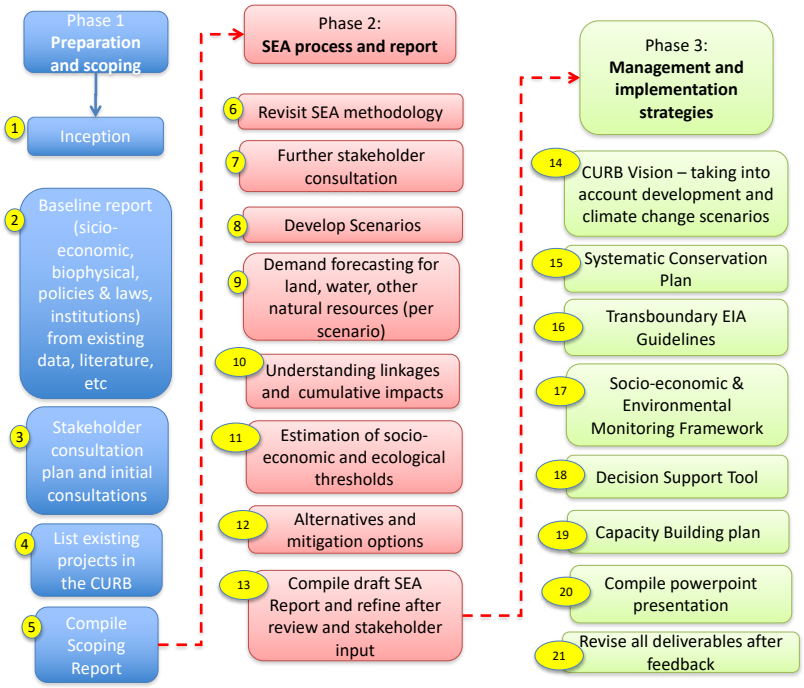


Figure 2.1: Schematic illustration of methodology and sequencing of tasks

As illustrated above, there were four key deliverables, with all the sub-components mentioned in the ToRs, being contained within these key deliverables.

This SEA was led by the Southern Institute for Environmental Assessment (SAIEA), supported by a multi-sector team of experts from Ecosurv (Botswana); Holisticos and ACADIR (Angola); Anchor Environmental Consultants (South Africa); SAIEA and RAISON, University College Cork (UK) and individual specialists. These were (in alphabetical order) Antonio Chipita, Stephen Holness, Rodgers Lubilo, Owen Mcintyre, John Mendelsohn, John Pallett, David Parry, Vladdy Russo, Peter Tarr and Jane Turpie. Maps were compiled by Katharina Dierkes.

2.1 Scoping

The purpose of scoping was to plan in detail how to conduct the SEA, and fine-tune its focus. During scoping the team referenced existing knowledge, including published and grey literature, and undertook a consultation process to gain insights from basin stakeholders and key informants. This improved the understanding of key direct and indirect drivers, which affect the maintenance of ecosystem services, including the resultant negative impacts on livelihoods and prospects for local communities, barriers to action, governance and policy implementation in the basin.

2.2 Stakeholder consultations

As required by the TORs, a Stakeholder Engagement Plan (SEP) was prepared and submitted in January 2023 – at the onset of scoping. The SEP noted that engagement of the public and effective stakeholder consultation is an extremely important process for SEA; it promotes a sense of ownership and trust.

The specific objectives of the stakeholder engagement were stated to include:

- building ownership and buy-in amongst decision makers and other interested and affected stakeholders;
- providing information to decision makers;
- gathering information about development proposals and human activities in the basin;
- discuss and agree on Valued Environmental (and Social) Components (VECs); and
- Input for a Vision for the basin.

The SEP required country team members to set up and run stakeholder meetings in their respective countries. They also attended local meetings, where relevant and useful to the SEA process. Consultations were in English, except for Angola where they were undertaken in Portuguese, with translation into indigenous languages.

Stakeholders were from all levels, in the following groups:

- Government Ministries/Departments in the four states, including regional/provincial and local authorities;
- Multilateral development institutions such as ZAMCOM and KAZA;
- Universities and research institutions/organisations;
- Chambers of commerce and local businesses (including tourism);
- Local communities; and
- Local and international environmental and social NGOs.

The agenda of the Scoping meetings was:

- Introduction of the consultants and the project;
- Description of the aims and expected outcomes of the SEA;
- Brainstorm present and expected projects and activities within the basin;
- Identify critical resources and demands on them;
- Invite inputs on concerns and issues in the basin;
- Identify VECs and data sources for them; and
- Brainstorm the Vision for development of the basin.

In **Angola** ACIDIR conducted consultations and data collection within the Cuando Cubango province, specifically in Jamba, Licua, Mavinga, Rivungo and Chipundo. The methodology included focus group discussions (ensuring participation of women), one-on-one interviews with key informants (notably the Regional Council) and completion of survey questionaires. 22

questionnaires were answered (9 in Jamba/Luengue Luiana, 4 Licua, 4 Mavinga, 4 Rivungo and 1 in Chipundo/Rivungo). 130 stakeholders participated in the consultations (45 in Jamba, 17 Licua, 46 Mavinga, 38 Rivungo and 2 Chipundo/Rivungo). Stakeholders included administrators and vice-administrators, local administration members, Police, Military Commander, Teachers, Nurses, Clinic manager, TAs Chiefs and political party representatives, Cooperative members, local community and church leaders.

Towards the end of the process (7 October 2024), the Final-Draft SEA report was presented to government officials in Luanda (attendees listed in annex 4).

In **Botswana**, Ecosurv convened Focus Group Meetings with community leadership from Parakarungu and Satau villages. Furthermore, online consultative meetings were undertaken with key government stakeholders including; Chobe District Land Use Planning Unit, Okavango Land Use Planning Unit, North West District Development Committee, Department of Wildlife and National Parks among others. As part of the consultations, survey instruments were sent to other key stakeholders. The above were undertaken during the scoping phase.

During the full SEA phase, the SEA was presented during a workshop in Gaborone - attended by a diverse range of government agencies, and discussions were held with the DEA in Gaborone. (attendees listed in annex 4).

In **Namibia** SAIEA conducted Focus Group Discussions in Okavango East and Zambezi Regions. The Okavango meeting was with the Kamatjonga Inland Fisheries Institute (KIFI), to gather the opinions and data from their work conducted on the Cuando, and sharing pertinent information from the Okavango River which is similar in some respects. Subsequent FGDs were with conservancies, tourism operators and authorities in areas adjoining the Kwando and Linyanti Rivers. These meetings included men and women representing local conservancies, lodges and tourism operators, and officials from Fisheries, Environment and Forestry, and the Regional Council. In Katima Mulilo, discussions were held with officials from Regional Planning, Agriculture, Environment and Forestry, and the local coordinator of the Namibian Wetlands Route. Subsequent follow-ups for data were made by email, whatsapp and telephone, with local stakeholders such as researchers, farm owners, lodge owners and Councillors. At a more strategic level, a briefing was provided to the Sustainable Development Advisory Council, and an invitation extended to its members to participate in more detailed discussions should they wish to. The above were undertaken during the scoping phase.

During the full SEA phase, high-level discussions were held with members of the Sustainable Development Advisory Council in Windhoek, and on 1 October 2024, the draft SEA report was presented to mid-high level government officials in Windhoek (attendees listed in annex 4).

In **Zambia** five meetings were held at Sioma DNPW headquarters, Sioma District, Shangombo District 2 and 3, and with the Zambia CBNRM forum. These were attended by over 50 participants representing various government agencies, local authorities, security/immigratioin, health and education, conservation/forestry and CBNRM, community development and CSOs. The final draft SEA report was presented to government officials and other stakeholders in Lusaka on 23 August 2024 (attendees listed in annex 4).

Kwando Joint Action Group (KJAG)

At both scoping, mid term and at the end of the SEA, meetings were held with the KJAG, and draft chapters were shared with the members at various intervals. The KJAG's membership appears in Appendix 4.

2.3 Identifying scenarios

Identifying scenarios was key to the process of assessing cumulative impacts. The methodology included gathering "vital statistics" of the baseline situation and then projecting these into the future – for a timeframe of approximately 10 years. Projecting further into the future becomes a "guessing game" and is thus not useful.

During Scoping, the team attempted to "validate country projects" – essentially an updated inventory of programmes and projects – existing, planned and possible, in the CURB.

The "existing, planned and possible" developments form the basis of four scenarios, which were business as usual, low, medium and high-growth. The tables in Annex 6 provide a summary of the information that was gathered regarding major projects/activities expected to be implemented in the CURB over approximately the next 10 years.

Scenario 1 was termed "business as usual" where approximately 50% of already planned/approved projects are likely to be implemented. This scenario assumes that physical and social infrastructure will mostly be maintained. Environmental & social impacts of "organic growth" are expected to follow current trends, as do HWC, wildlife populations and fish stocks. It is likely that there will be low or no real economic growth.

Scenario 2 was "low growth" where >70% of category A projects/policy initiatives (see box 1) will probably be implemented (though maybe not fully), positive impacts will likely not materialize as expected, mainly because of a downturn in the economies of the region, political instability, low commodity prices, disease outbreaks, etc. Economic growth will be low but slightly better than scenario 1.

Scenario 3 was defined as "medium growth" where category A projects/policy initiatives are likely to be fully implemented, and most Category B projects initiated. This scenario assumes that KAZA economies are doing relatively well but there is inadequate synergy between the donor and government projects. There is some gradual interest in the KAZA area from investors. Some project interventions are successful, but in other cases, disappointing.

Box 1

Explanation of categories

Category A: plans, projects and activities (PPAs) that have already been approved/authorised and budgets have been secured. Feasibility studies have been completed. Design is underway. There is a 90% + chance that they will be implemented

Category B: PPAs that are in advanced stages of discussion. Not yet approved/authorised. Pre-Feasibility studies have been initiated. The chances of these going ahead are 50/50

Category C: ideas for new PPAs are only in the conceptual phase. Some may just be a "pipe dream". Maybe only 10% of these will see the light of day.

Scenario 4 was regarded as "high growth" where category A and B projects/policy initiatives are likely to be fully implemented, and most Category C projects will be initiated. >80% of these developments will likely be highly successful, global and regional economies are assumed to be strong, there are excellent synergies between the governments and the private sector. Governance institutions are all functioning well (e.g. governments). Corruption is low.

Based on the information gathered, and the understanding of both the CURB baseline and future potential, it is assumed that a low-medium growth future is likely over approximately the next ten years – essentially something between scenarios 2 and 3.

2.4 Identifying Valued Environmental Components

For the purpose of the CURB SEA, VECs are defined as components of the natural and human environment that are considered by KAZA/ZAMCOM/WWF, CURB residents, scientists and other technical specialists, government agencies involved in the CURB, and the SEA team, to have scientific, ecological, economic, social, cultural, archaeological, historical, or other importance. Though there has been no previous identification of VECs specifically in the Cuando Basin, a number of contributions have been made to identify areas important for conservation and the provision of ecosystem services to the basin's people. Identifying VECs relied on a combination of referencing a range of literature including the 2021 Cuando River Basin Report Card, the 2022 Cuando State of the Basin Report, the 2023 KAZA Policy Brief on elephant movement and connectivity, soliciting

expert opinion, and input from specialists within the SEA team. The views epressed by stakeholders was also extremely important in this process.

Once the SEA team had identified a preliminary list of VECs, these were shared with a reference group and the KJAG for further input and refinement.

2.5 Understanding cumulative impacts, alternatives and mitigation options

Cumulative Impact Assessment (CIA) is the cornerstone of the SEA. The importance of understanding the cumulative environmental and social impacts from multiple projects, actions, or activities—or even from the same actions over an extended period of time—located in the same geographic region or affecting the same resource (e.g., watershed) has been acknowledged for decades. In some cases, the most ecologically devastating environmental effects and subsequent social consequences may result not from the direct effects of a particular action, project, or activity but from the combination of existing stresses and the individually minor effects of multiple actions over time.

CIA is evolving and there is no single accepted state of global practice. What is important, is that during the process of identifying environmental and social impacts and risks, planners and developers are committed to avoiding and/or minimizing negative impacts to the greatest extent possible, whilst maximising benefits. Furthermore, decision-makers need to understand that some developments may be at risk because of an increase in cumulative effects over ecosystem services they may depend on.

CIA transcends the responsibility of a single basin State or project proponent. It is a multistakeholder, iterative, expert-input process that requires the involvement of a multidisciplinary team and an effective, efficient and transparent process. Figure 2.2 illustrates the CIA process that was followed in this SEA.

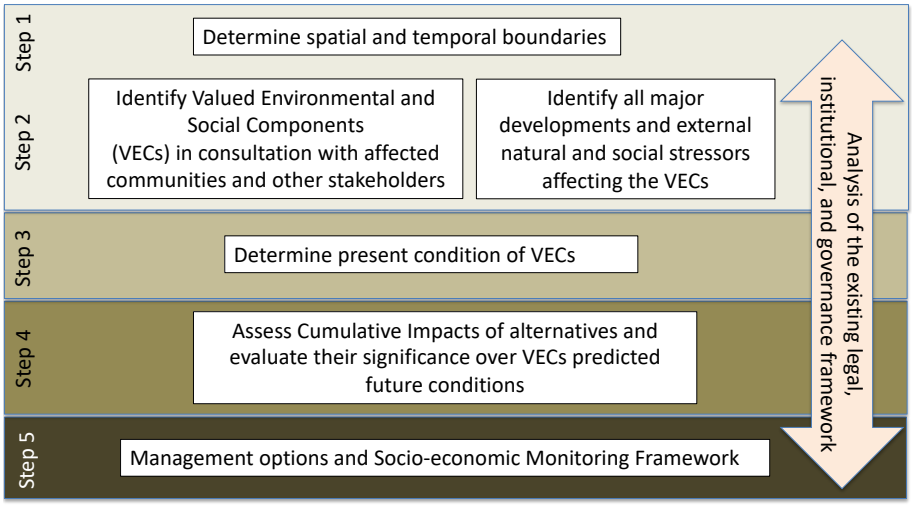


Figure 2.2: Process for assessing cumulative impacts (Source: modified from IFC Cumulative Impact Assessment Good Practice Handbook, 2013).

A key methodology for understanding cumulative impacts was the construction of linkage diagrams. The sectors chosen for this analysis are those already present in the CURB (e.g. agriculture, urban expansion, tourism) and logically likely to persist in one form or another in the foreseeable future. However, the information gathered during the SEA process indicated that other types of development/landuse might be initiated in the future. For example, fish farming, dams and mining are not currently present but are under discussion. Even though some future development ideas may not happen in the low-medium growth scenario over the next decade or so, it was deemed necessary to include these in the SEA so that decision-makers are aware of their likely intended and unintended consequences.

Once key linkages were understood, the team brainstormed how the respective sectors could choose better development alternatives and thus reduce unintended consequences. In some cases, the SEA has recommended that certain types of development (e.g. dams and mining) be disallowed in the CURB because the negative impacts are judged to be too severe (essentially recommending the application of the precautionary principle).

Eleven linkage diagrams were constructed by the SEA team. These were shared with a reference group for further input and refinement.

2.6 Systematic Conservation Plan

Systematic Conservation Planning (SCP) (see volume 4) follows a multi-component, stage-wise approach to identifying conservation areas and devising management policies, with feedback, revision and reiteration, where needed, at any stage[7]. The methodology required a set of sequential steps to define a comprehensive system of protected areas (and other areas with sufficient conservation management or land use controls). The goal is to ensure that critical biodiversity components, such as populations, species occurrences, migration corridors, refuges, critical ecosystems, or ecological processes, are adequately represented in protected areas, considering the existing ones plus the complementary areas that deserve formal protection. The following steps were followed in compiling the CURB SCP:

[7] Kukkala and Moilanen, 2013

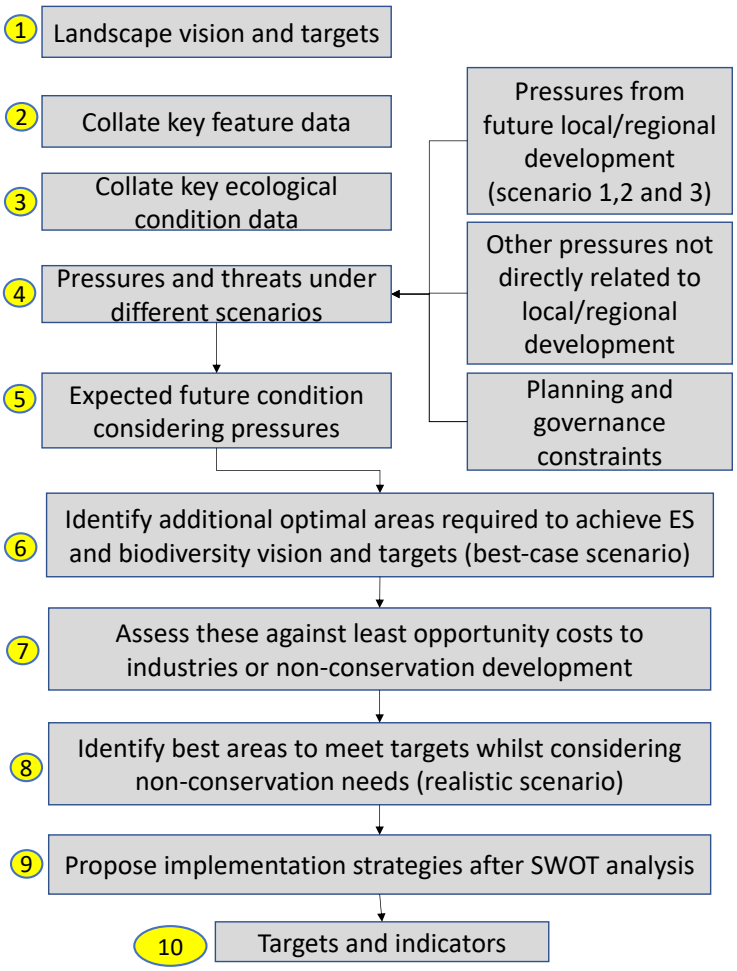


Figure 2.3: Process for undertaking the SCP

Step 1: **Landscape vision and targets (for both ES and biodiversity components)**

- The draft vision for the CURB was agreed earlier during the SEA process.

Step 2: **Collate key feature data (ES, biodiversity components and PAs)**

- Mapping existing PAs, and accompanying brief narrative;
- Identifying areas important for ES, mapping and based on expert opinion – generated from previous studies and deliberated within the team, areas were ranked for relative ES importance – and justification for scoring (an important input in this regard was the identification of VECs); and
- Mapping other important biodiversity features for use in the SCP.

Step 3: Collate key ecological condition data

- Mapped current ecological condition of landscape, focusing on capacity to deliver ecosystem services;
- Based on expert opinion – generated from previous studies (an important input in this regard was the identification of VECs)and deliberated within the SEA team, assessed current condition of ES; and
- Above input depicted on maps.

Step 4: Pressures and threats under different scenarios

- Collated data on pressures and threats to ES and biodiversity;
- SEA earlier summarized baseline developments and projections under low, medium and high-growth scenarios; and
- Mapping included pressures not directly related to local/regional development (done earlier as part of VEC assessment).

Step 5: Expected future condition considering pressures

- Based on outcome of step 3, the SEA team assessed expected future condition – partially as part of VECs; and
- depicted on maps.

Step 6: Identify additional optimal areas required to achieve ES and biodiversity vision and targets (best-case scenario)

- Based on steps 1-5, the team identified an optimal set of areas to achieve the landscape vision and targets (for both ES and biodiversity components)
- This included identifying ES priorities and additional areas (if any) required to achieve the vision and targets. These were tabulated and justifications provided. They were also depicted on maps.

Step 7: Assess these against least opportunity costs to industries or non-conservation development

- The additional areas proposed were assessed in terms of opportunity costs they might present for non-conservation objectives. Some ideas of possible future developments and where they might be located were provided in the data sets described in step 4.

Step 8: Identify best areas to meet targets whilst considering non-conservation needs (realistic scenario)

- This step was a "reality check" to see whether the proposed additional areas are likely to be contested or vetoed because of conflicting interests; and
- The assessment was tabulated and justifications provided.

Step 9: Propose implementation strategies after SWOT analysis

- This step was a culmination of all the previous steps – a conclusion after all things had been considered;
- The team conducted a SWOT analysis to ensure a robust framework for the proposed implementation strategy; and
- The proposed strategies were tabulated and justifications provided.

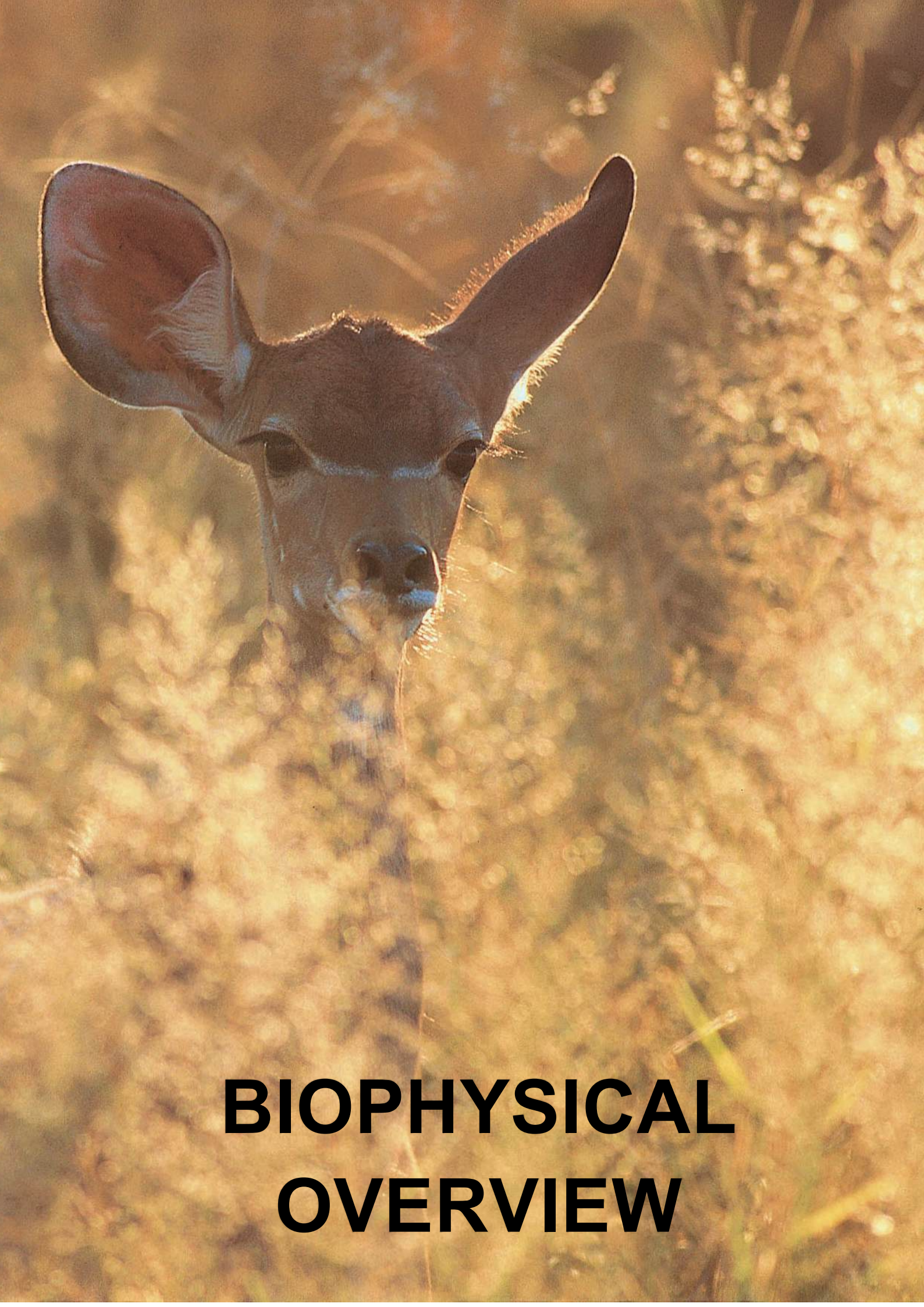
Step 10: Targets and indicators

- Targets and indicators for all the key strategies proposed, were tabulated; and
- The sufficiency of the proposed priority areas evaluated against the targets to ensure that proposed options can robustly deliver the vision and targets.

2.7 Socioeconomic and environmental management and monitoring framework

The ToRs require a monitoring and evaluation framework with action plan. For consistency, this plan is structured along the same lines as the one recently completed for the Okavango basin. The plan is referred to as the Social and Environmental Management and Monitoring Framework (SEMMF) (see Volume 3).

Developing this framework was delayed until after the main SEA had been completed. This was necessitated by the fact that the first task was understanding the likely trajectory of the key sectors and their expected cumulative impacts. Thereafter, the team could brainstorm a monitoring and evaluation framework and a practical action plan. The ToRs required that this monitoring tool be able to flag events outside the agreed land-use plans and alert local and central governance agreements. Therefore, the team also needed to properly understand the land use plans of the CURB states and how circumstances might result in deviations from these plans.



BIOPHYSICAL OVERVIEW

3. BIOPHYSICAL OVERVIEW

3.1 Climate

The far northern part of the Cuando Basin has a tropical climate, with average annual rainfall at about 1,200 mm, up to 140 days of rain per year, and warm temperatures almost year-round. Most of the upper and middle basin is sub-tropical, with annual average rainfall decreasing southwards to about 600 mm at Licua (Figure 3.1).

The southernmost area, covering south-eastern Angola and those parts of the Basin in Namibia and Botswana, receives roughly 500 mm of annual rain and experiences high potential evaporation of about 2,500 mm (measured at Katima Mulilo). The expected gradual drying of the climate makes the Cuando a linear oasis running through dry surroundings in its central and southern parts[8].

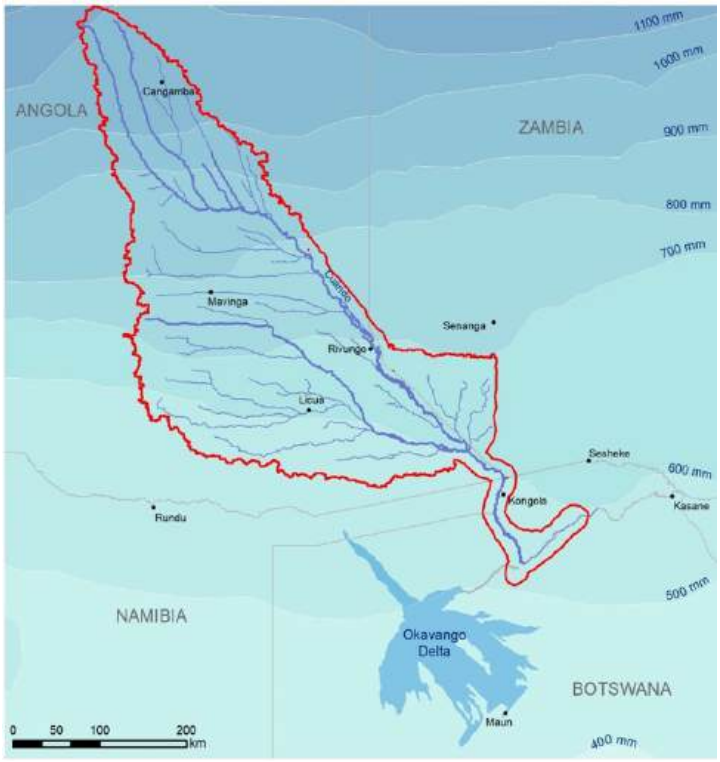


Figure 3.1: Isohyets showing the gradual decrease of annual average rainfall from north to south across the Cuando River Basin (source: Pallett et al 2022).

[8] Pallett et al 2022

3.2 Topography and geology

3.2.1. Topography

The entire Cuando River lies in within the geological limits of the Kalahari Basin (Figure 3.2).

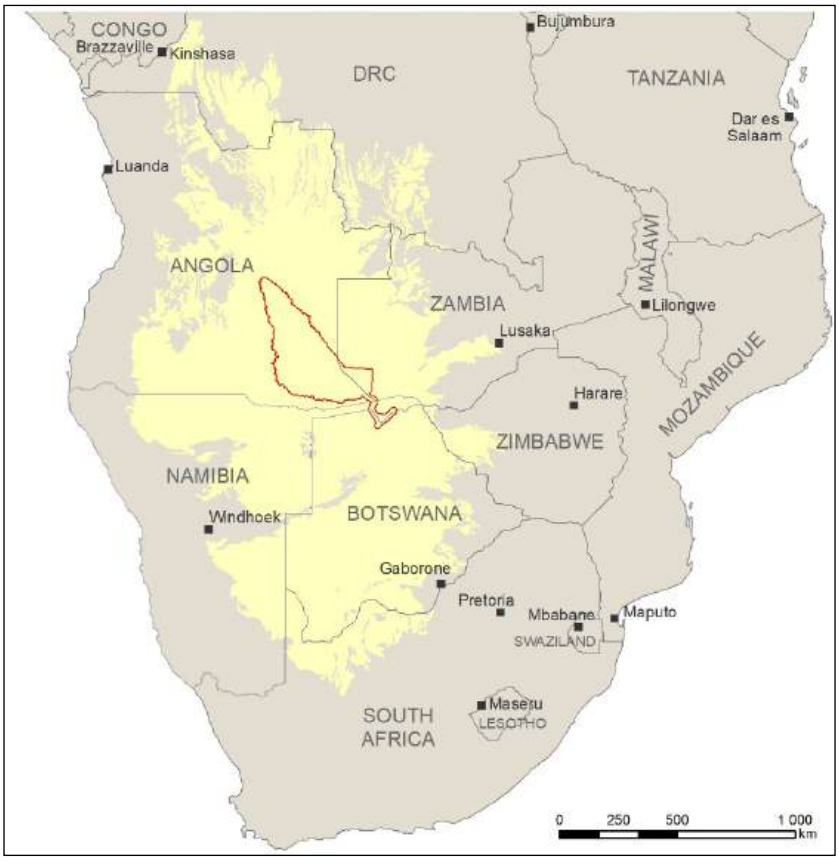


Figure 3.2: The hydrological Cuando Basin within the geological Kalahari Basin (source: Pallett et al 2022)**.**

The northern-most parts of the Cuando Basin with relatively high relief make up a rather small proportion of the total basin area (Figure 3.3). This is an area of rolling hills above 1,200 m altitude. Downstream of that the landscape becomes very flat with a very shallow downward slope to the southeast. Over the lower 800 km of its length, the river drops only 250 metres in elevation. The very flat terrain explains why the river is so sluggish, and how this gives rise to its meandering course and wide floodplain (Ibid).

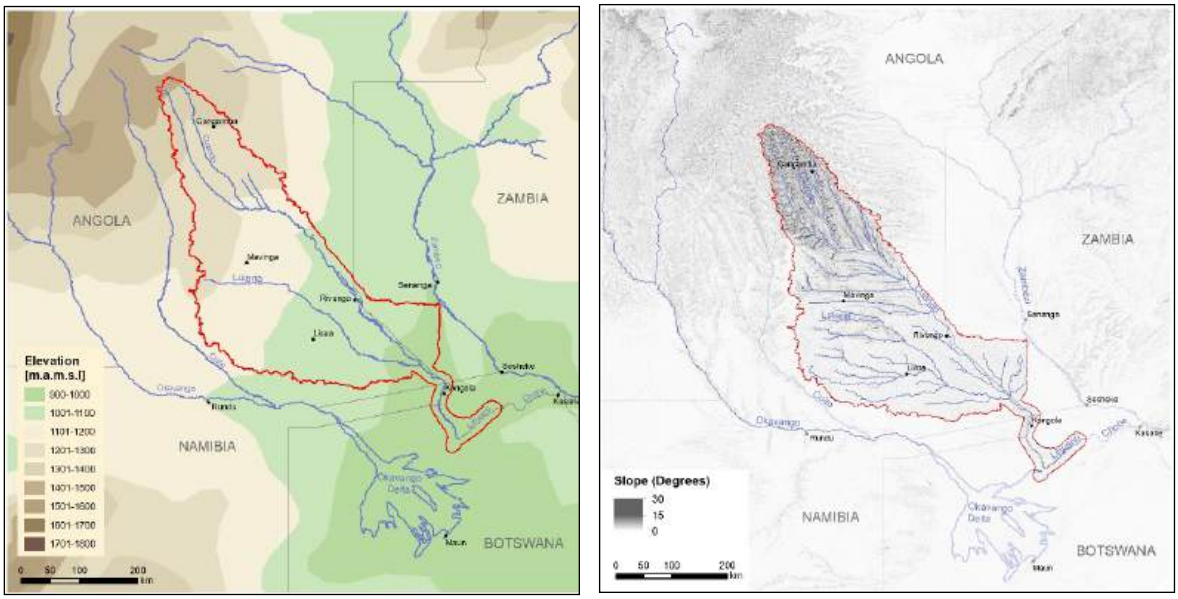


Figure 3.3: Elevation and slope of the land in the Cuando Basin (source: Pallett et al 2022)**.**

3.2.2. Geology

The basement rocks in the northern part of the Cuando Basin basin comprise metamorphosed sediments of the Damara Group, and sedimentary and basaltic rocks of the Karoo Group. Kimberlite pipes occur, which are the likely origin of diamonds sought by artisanal miners along the Longa, Cubia and Utembe rivers. Conglomerates are exposed along some the eastern tributaries, derived from erosion of the Karoo basalts. Most of these above-mentioned rocks are now blanketed by Kalahari sand but there are scattered exposures, depicted in Figure 3.4.

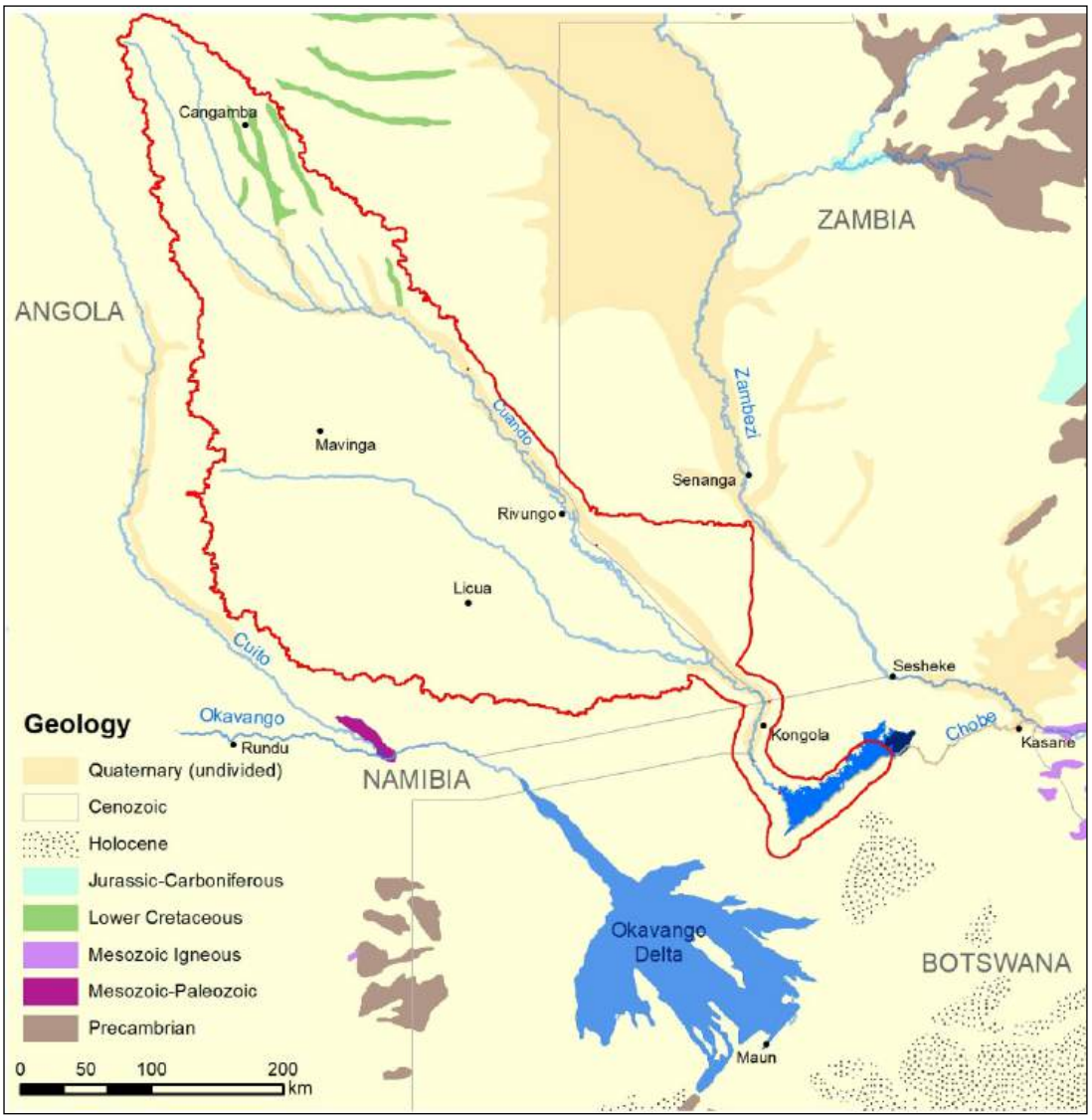


Figure 3.4: Geological features of the Cuando River Basin (source: Pallett et al 2022).

Structural features in the basement dictate the route and pattern of the rivers on the surface. In the northern section, a set of parallel faults determines the south-eastwards orientation of the main tributaries, namely the Kembo, Cuando, Cubangui and Cussivi rivers. The larger of these faults extend 400 km south-eastwards, creating a long thin slice in the basement which the Cuando follows to the Namibian border.

The unusual sharp turn of the river at its lower end, where it makes a 90 degree angle, is determined by the Linyanti Fault. The upside of the fault lies on the southeastern bank, making a clearly defined linear obstacle, forcing the water to spread out into the Linyanti Swamp on the lower, northwestern side of the fault (Figure 3.5). The Linyanti continues in a north-east direction determined by the Linyanti Fault, and the Chobe River is similarly structurally determined by the Chobe Fault.

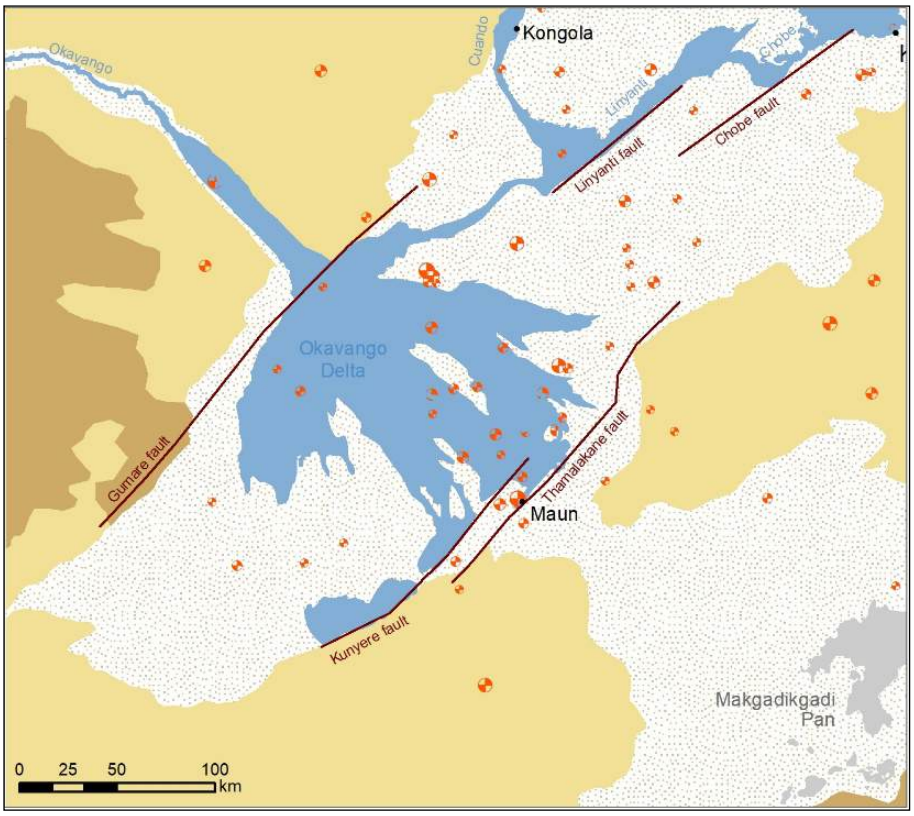


Figure 3.5: The Linyanti Fault and Chobe Fault determine the unusual route of the Cuando River, and are related to other major faults that determine the overall pattern of surrounding rivers (source: Pallett et al 2022).

3.3 Hydrology

The water in the Cuando is derived almost entirely from Angola, where there are a number of tributaries that collect rainfall in the highlands of the Bie Plateau, and channel it towards the main stem of the river that flows south-eastwards towards the south-eastern corner of Angola (Fig 3.6). This area of perennial flows makes up about 42% of the total basin area. The areas of ephemeral flows in scattered tributaries in south-eastern Angola and western Zambia contribute only small volumes of water, and only sporadically, to the total discharge of the river. No significant tributaries enter the main stem of the river in Namibia and Botswana.

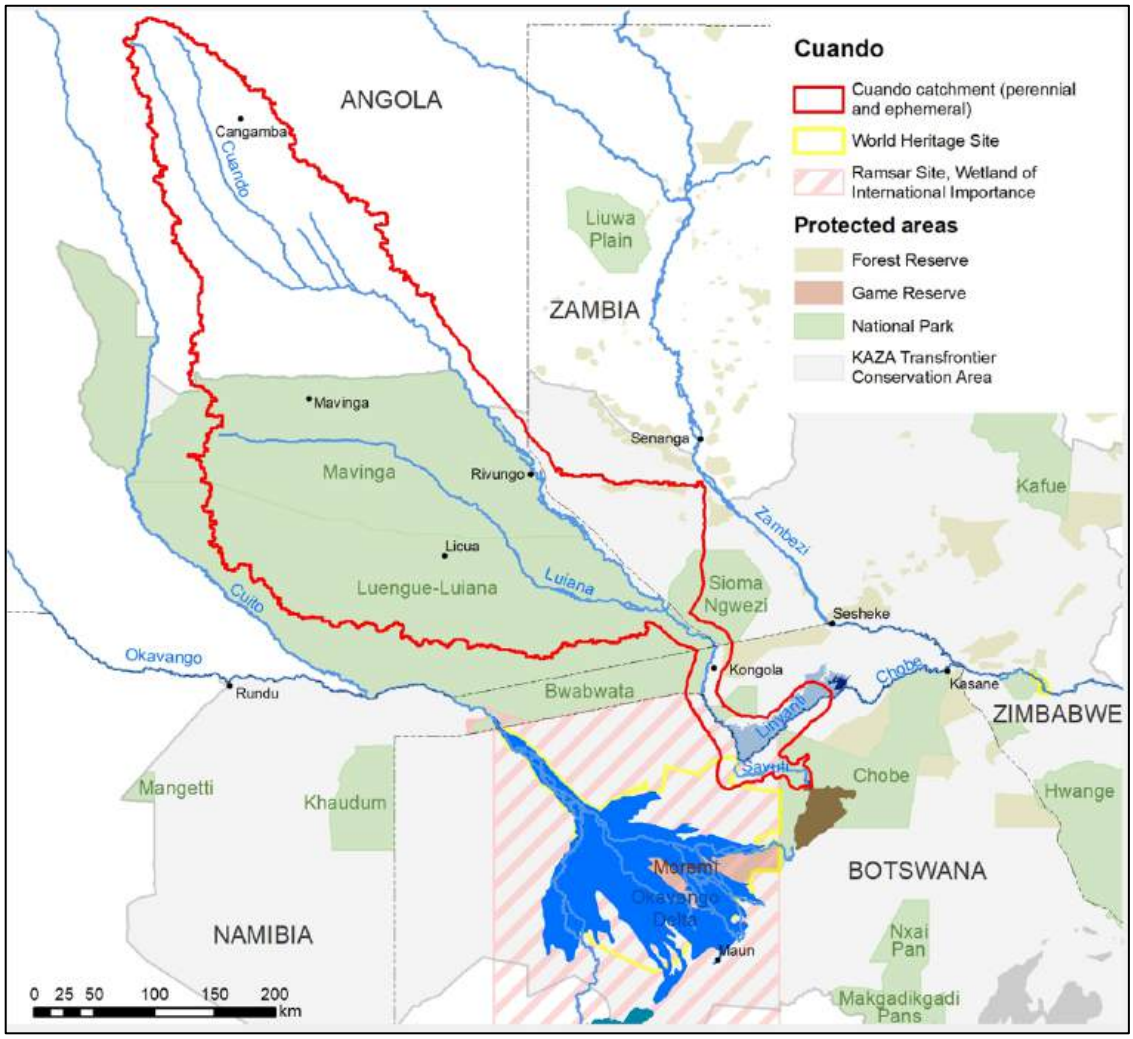


Figure 3.6: Cuando River Basin.

Table 3.1: The four basin states of the Cuando, showing area and contributions to the total discharge (From Pallett et al 2022[9]).

Country	Area of the basin with perennial flows and 10 km buffer (km^2)	Area of the basin with ephemeral flows	Total area within each country, and contribution to total discharge of the river	Percentage of the river basin area
Angola	50,343	52,177	102,520 km^2, contributes almost entire discharge of the river	86.3%
Zambia	2.424	6,928	9,352 km^2, contributes rare (unquantified) flows from ephemeral tributaries, and local rains.	7.9%
Namibia	4,373	0	4,373 km^2, contributes only local rainfall	3.7%
Botswana	2,538	0	2,538 km^2, contributes only local rainfall	2.1%
	59,678 km^2 (=50.2% of total area)	59,105 km^2 (=49.8% of total area)		

[9] Pallett J, Mukumbuta-Guillemin I, Mendelsohn J. 2022. Cuando State of the Basin Report.

About half of the basin experiences perennial flows in the main river and its tributaries, while in the other half the tributary flows are ephemeral or non-existent. This is because the rainfall decreases in a southerly direction, and there is almost no surface runoff on the flat, sandy, porous substrate in southern Angola, Zambia, Namibia and Botswana. In this area the river acts as a linear oasis, with a relatively small channel that meanders over a very wide floodplain that is covered in reeds.

The area of the basin is defined, like all rivers, by the area of its catchment where perennial and ephemeral tributaries contribute flows to the main stem of the river. In the southern part, where there are no tributaries, the limit of the basin is rather arbitrarily defined by a 10 km distance from the river and the margin of its floodplain.

The Cuando is made more unusual by the anomaly that its river channels cross the boundaries of the basin in the south-western and south-eastern reaches. These links only occur in years when the water levels in the rivers are exceptionally high, and the direction of flow is determined by the relative height of water in the Okavango, Cuando and Zambezi Basins (Pallett *et al.* 2022). In the south-western corner of the Cuando, water may spill into the Savuti Channel, or towards the Okavango River Basin via the Selinda Spillway. At the south-eastern end of the Cuando, water can connect with the Zambezi Basin via the Linyanti Swamps and Lake Liambezi. Using remote sensing images, this was observed to occur in only 3 out of 40 years that clear images were available from 1972 -2002 (*ibid*). It is more common for Lake Liambezi to receive water from the Zambezi via the Bukalo Channel, and when the water is this high, the Chobe Swamp may push water towards Lake Liambezi. Lake Liambezi, when it holds water, should therefore be considered as a backwater of the Zambezi River.

These connections to the Okavango and Zambezi Basins only occur sporadically, when water levels are high from exceptional rains in their catchments. The links are infrequent (less than 10% of time in the recent reliable record), so the Cuando should more correctly be considered as a river basin in its own right, not as a sub-basin of the Zambezi.

3.3.1 Discharge of the Cuando

Annual total discharge of the Cuando River has been consistently measured at the Kongola gauging station since the 1969-70 season. The annual average discharge is 1,0 million Mm^3. The Cuando is therefore a significantly smaller river that its neighbours the Okavango (annual average discharge = 9 million Mm^3), and the Zambezi (annual average discharge = 34 million Mm^3) (ibid). Being such a small river, the Cuando has very limited potential for large-scale offtake for irrigation schemes and other commercial-scale uses. This is important when considering the potential future uses of Cuando water.

The long-term record of Cuando flows measured at the Kongola gauging station (Figures 3.7) show great variability, with the maximum of 2,200 Mm^3 being 4.5 times higher than the minimum of 490 Mm^3. This further underscores the risk of abstracting large volumes of water from the Cuando, as this could dry up much of the flow at the distal end of the Basin in low-flow years.

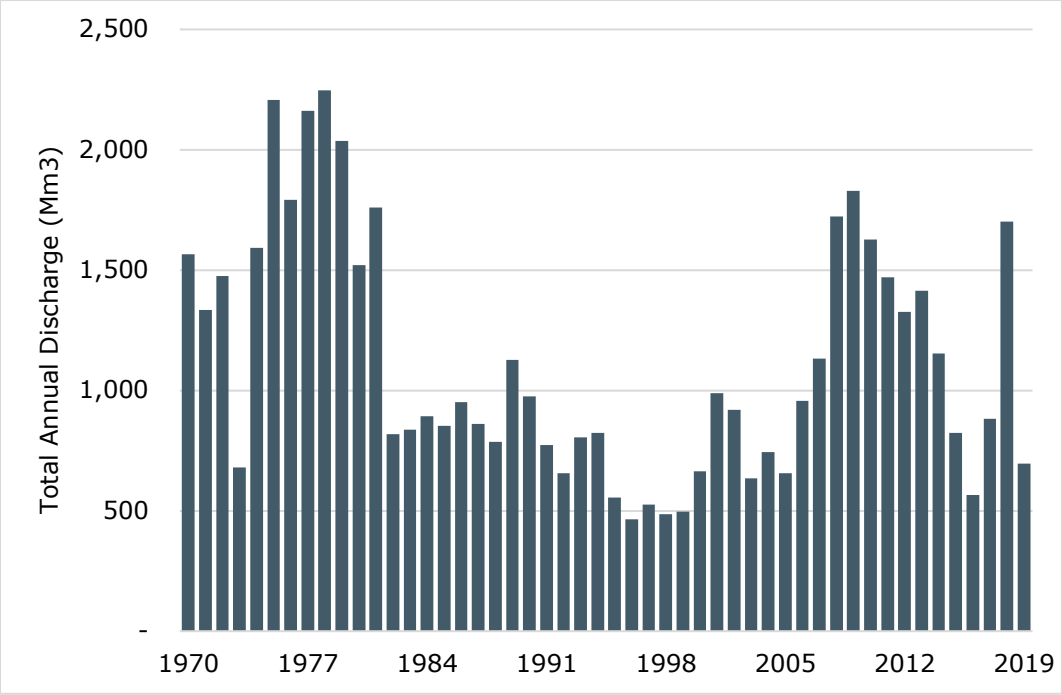


Figure 3.7: Discharge of the Cuando River measured at the Kongola gauging station over 50 years to 2019[10].

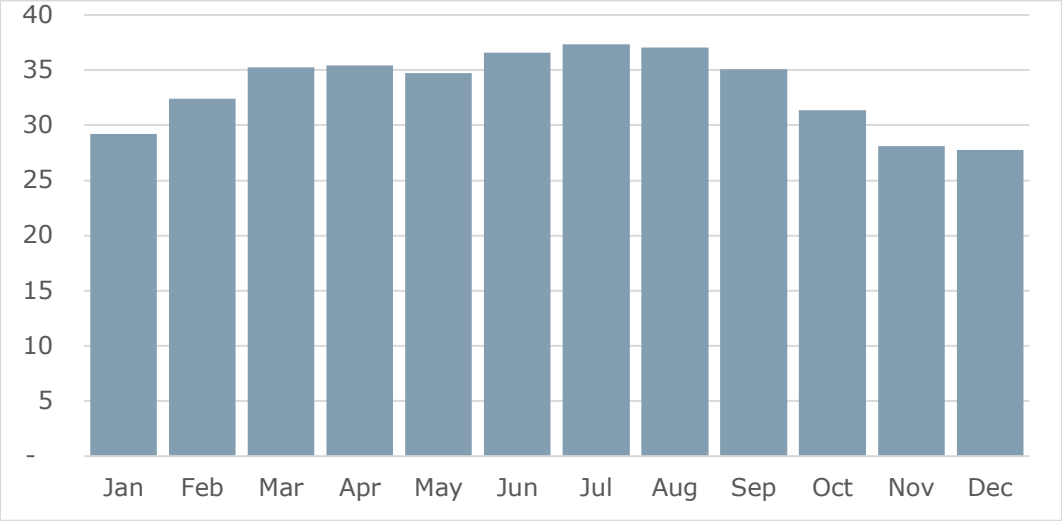


Figure 3.8: Average monthly flows (in m^3/s) of the Cuando measured at the Kongola gauging station.

The monthly records of flow from the Kongola gauging station show that the flow of the Cuando is relatively constant through the year (figure 3.8). Differences between the highest and lowest flows during the year are very modest: from an average of about 27 m^3/s in December to 39 in July. The July peak is about six months later than the peak rainfall month in the upper catchment. The reason for this rather unvarying flow is the Cuando's enormous floodplains, which cover about

[10] Pallett J, Mukumbuta-Guillemin I, Mendelsohn J. 2022. Cuando State of the Basin Report.

3,450 km^2 over a straight line distance of just over 500 km of the river. The main river channel is small, but the marshy area on either side is covered in tall grasses, phragmites reeds and papyrus. These cause huge evapotranspiration losses, and slow down the flow.

3.3.2 Water quality

Cuando River water is exceptionally clear, because it is derived from areas of sand that add no fine sediment or clay minerals, which typically cloud the water of other rivers. There is very little input of human-derived pollutants because there are so few humans in the upper parts of the Basin. Short sections of the channels downstream of towns such as Cangamba and Mavinga carry pollution, but the purifying effect of the floodplains absorb this within a few tens of kilometres downstream. All the indices for water quality measured upstream of Rivungo – pH, Oxidation-Reduction Potential, Total Dissolved Solids, Dissolved Oxygen, Conductivity and Salinity – showed healthy water conditions (NGOWP 2020[11]).

Figure 3.9: Semi-submerged aquatic vegetation in upper Cuando. Photo: NGOWP 2017[12].

There is no data on water quality in the stretches downstream of Rivungo, but the water is still clear in its distal reaches in the Linyanti. There are concerns about effluent flows and seepage of sewage into the river from Kongola and villages close to the river in Namibia (from stakeholder consultations in March 2023), and probably similar conditions prevail in the portions of Zambia and Botswana.

3.3.3 Groundwater

In the upper parts of the Basin, water held in the sand moves laterally where it meets subsurface hardpan layers, and this contributes water to the river. The sands therefore function like a sponge, absorbing and then gradually releasing water, which keeps the river channels flowing. However in

[11] National Geographic Okavango Wilderness Project, 2020. Final Report: Scientific Exploration in Angola During 2018. Pp 70
[12] NGOWP. 2017. Report 1: Initial Findings from exploration of upper catchments of the Cuito, Cuanavale and Cuando Rivers in Central and South-Eastern Angola. NGOWP annual report 2015-2016. 347pp.

the southern part of the basin, where hardpan layers are absent, this does not occur, and the river loses water by infiltration out of the channels. Groundwater benefits from this within only a few kilometres of the river. This explains why groundwater resources in the Namibian part of the Basin are patchy, both in quality and quantity; many boreholes immediately north of the Linyanti Swamps yield unpalatable water (DWA 2005[13]). This is from the Upper Kalahari Aquifer. There is a purported much deeper Lower Kalahari Aquifer (130 – 250 m deep) but its existence is unclear. The Cuando Basin groundwater overall is poorly understood and deserves further attention.

3.4 Soils

Almost the entire Cuando Basin has a substrate of sand, as it sits within the geological Kalahari Basin (Figure 3.10), the largest continuous area of sand on Earth. The deep arenosols have very low fertility and very low water retention. Organic matter in the soil is confined to the uppermost horizon, originating from what leaf litter accumulates and decomposes on the surface. Thus any removal of the vegetation cover (such as for cropping) depletes the soil of its main nutrient source and shade, and leads to rapid degradation of the soil quality. The arenosols in the upper parts of the Basin have hard cemented layers called hardpans which play an important role in directing water laterally into the river channels.

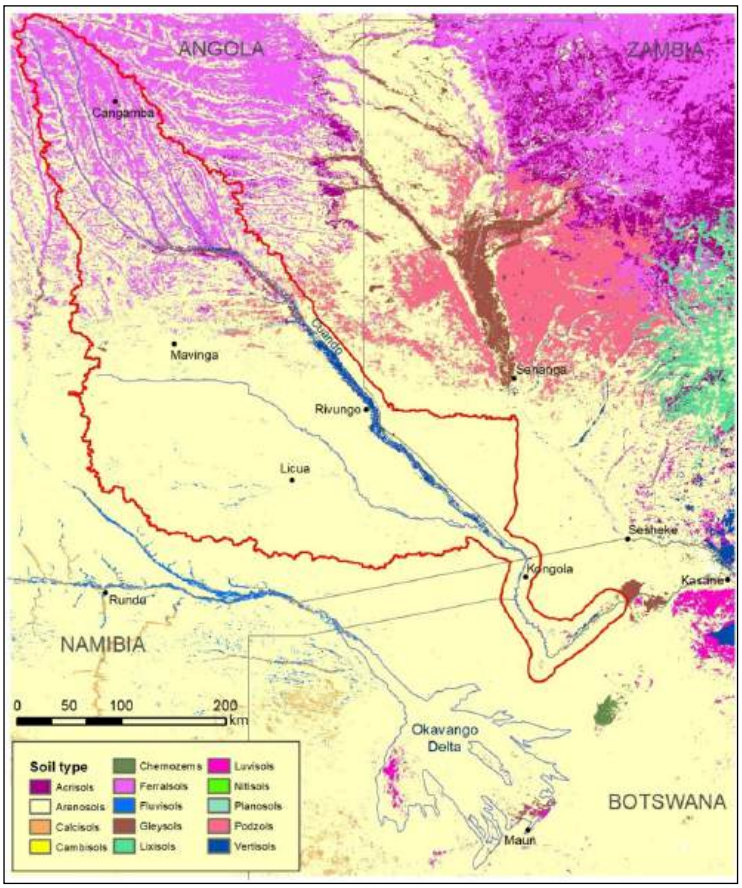


Figure 3.10: Major soil types of the Cuando River Basin (Source: Pallett et al. 2022)

[13] DWA. 2005. Investigation of Groundwater Resources and Airborne-Geophysical Investigation of Selected Mineral Targets in Namibia Volume IV.GW.2.1. Groundwater Investigations in the Eastern Caprivi Region. Main Hydrogeological Report. Department of Water Affairs, Ministry of Agriculture, Water and Forestry, Windhoek.

The northern part of the Basin is dominated by deeply weathered, acidic soil known as ferralsols, even though they are, on the basis of their sandy texture, also arenosols. The red, orange and yellow-coloured ferralsols indicate the presence of iron and aluminium, which derive from very weathered clay material, which in turn derive from the basement rocks they sit on. These soils are also very low in nutrients and have limited use for cultivation. Fields are established on a short-term, shifting basis, for cultivation of maize, sorghum, millet and cassava, but yields are very low.

The broad marshes of the middle and lower Cuando have a bed of alluvial sediments of silt and clay, deposited during periodic floods. These fluvisols may appear to be ideal for crop production but they are derived from acidic parent material, and that acidity increases from being frequently saturated, so they are also poorly suited for cultivation. Peat deposits are a prominent feature of the marshes. They are important as they act like a sponge, becoming fully saturated then releasing the water slowly into river channels, keeping them steadily recharged.

The main point about Cuando soils is they are exceptionally poor in terms of fertility and water-holding capacity. For example, yields of maize and millet average about 700 and 300 kilograms per hectare, which are among the lowest in Africa (https://datamarket.com). Soil productivity does increase towards the south, probably because soils there are less leached than in the higher rainfall areas in the north.

3.5 Flora

A vegetation map of the Cuando Basin generated from satellite imagery is shown in Figure 3.11. Five vegetation types are identified in the Basin:

(1) Fairly open Miombo woodland dominated by *Brachystegia* spp. and *Julbernardia aniculate;*

(2) Closed dry forest woodlands dominated by Guibourtia coleosperma, Cryptosepalum exfoliatum and Marquesia macroura;

(3) Grasslands, with some areas co-dominated with geoxylic suffrutices – plants that have most of the body of the plant underground, with only seasonal above-ground shoots bearing leaves, flowers and fruit.

(4) Dry deciduous woodland in the south, dominated by *Baikiaea plurijuga.* These areas are frequented by fires, giving rise to their rather 'bushy' nature because fires kill the large standing trees and these get replaced by bushy undergrowth.

(5) Floodplains dominated by Cyperus papyrus and Phragmites mauritianus.

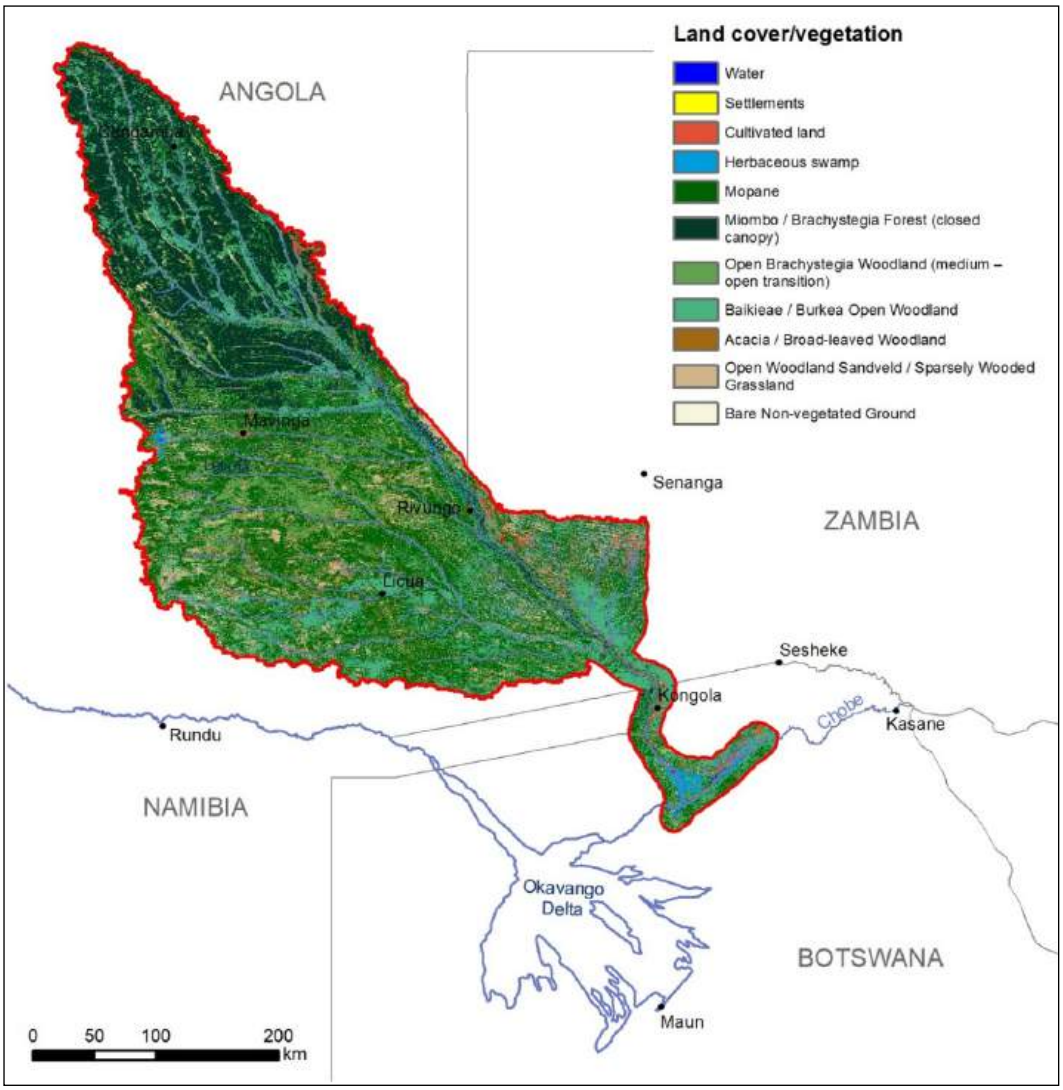


Figure 3.11: Vegetation map of the Cuando River Basin[14].

Large areas of the Cuando Basin burn regularly, more so in the southern and middle parts of the Basin than in the north. Some fires burn on unchecked over weeks, covering tens of thousands of hectares. Such fires take a heavy toll on the trees, especially when intense fires burn annually over many successive years which eventually kills the trees so that they fall over and become fuel for future fires. Much of the savannas would probably have taller and denser tree cover if intense fires were less frequent. Fires in the upper parts of the Basin are largely confined to floodplain grasslands and open wooded grasslands adjacent to the water courses. There is relatively little combustible material in the miombo woodlands and so fires seldom penetrate these densely wooded habitats. However, at times fires fanned by strong winds rage through the woodland canopy, killing most trees.

[14] Wild Bird Trust South Africa. 2019. Okavango Catchments Vegetation, Land-cover, and Land-Use Classification, Derived From Sentinel-2 Satellite Imagery, circa 2017-18. Compiled by Geoterra Image (Pty) Ltd, South Africa.

Woodland and forest regeneration throughout the Basin is extremely slow because of the shortage of nutrients and water in the soil. In southern areas, fire is a prominent factor in preventing young trees from reaching maturity (Kayofa 2015[15]).

3.6 Fauna

3.6.1 Mammals

Currently the far northern part of the basin has relatively few large mammals but further south in the Luengue-Luiana National Park, carnivores and ungulate populations are recovering. Wildlife populations are well established in the Namibia and Botswana part of the basin. The Cuando Wildlife Dispersal Area is important for transboundary movements of elephants, lions and other animals, and is pivotal to the success of KAZA as a wildlife landscape.

Large carnivores are relatively well established in the Luengue-Luiana National Park in far south-eastern Angola, as shown from the census of large animals in this and Mavinga National Park in 2015-16[16] (Figure 3.12). Spotted hyaena, leopard, African wild dog and cheetah occur here, while lion numbers are very low. There is a great diversity of typical savanna species of small carnivores such as serval, caracal and African wild cat, civet and genets (small-spotted and rusty-spotted), honey badger, striped polecat, jackals (predominantly side-striped, with low numbers of black-backed), spotted-necked otter, and six species of mongoose. Populations of large ungulates in south-eastern Angola vary, with populations of some species (such as blue wildebeest, Cape buffalo and sable antelope) greatly reduced due to the civil war and current offtake for bushmeat[17].

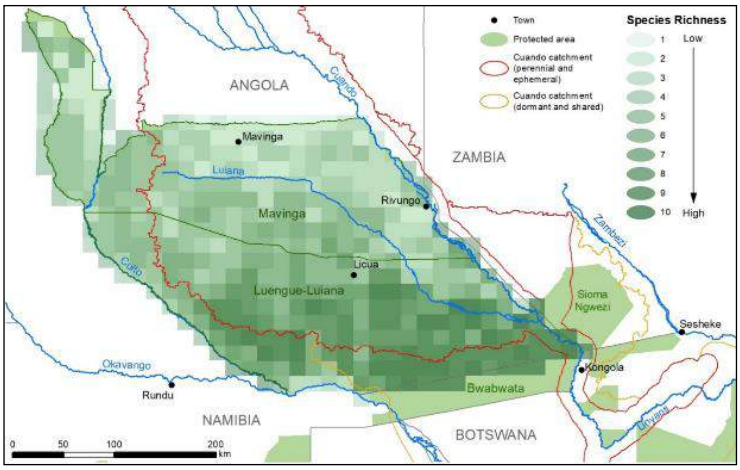


Figure 3.12: The number of 11 large carnivore and herbivore species predicted to occur across Mavinga and Luengue-Luiana National Parks[18].

[15] Kayofa F. 2015. Natural Regeneration Potential of *Pterocarpus angolensis* (Kiaat Tree) in the dry forests of northern Namibia. MSc dissertation, University of Stellenbosch.
[16] Funston P, Henschel P, Petracca L, Maclennan A, Whitesell C, Fabiano E & Castro I. 2017. The distribution and status of lions and other large carnivores in Luengue-Luiana and Mavinga National Parks, Angola. KAZA TFCA Secretariat (KAZA). As reported in Pallett et al., 2020.
[17] Beja P, Vaz Pinto P, Veríssimo L, Bersacola E, Fabiano E, Palmeirim JM, Monadjem A, Monterroso P, Svensson MS, Taylor PJ. 2019. The Mammals of Angola. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola Science and Conservation A modern synthesis. Springer https://doi.org/10.1007/978-3-030-03083-4
[18] Funston P, Henschel P, Petracca L, Maclennan A, Whitesell C, Fabiano E & Castro I. 2017. The distribution and status of lions and other large carnivores in Luengue-Luiana and Mavinga National Parks, Angola. KAZA TFCA Secretariat (KAZA).

Large herbivore populations in north-eastern Namibia are generally high across the national parks and conservancies (Figure 3.13). Recoveries over the past 20 years have been largely due to successful breeding, wildlife introductions, and reduced poaching, all of which are consequences of the CBNRM approach and improved local attitudes towards wildlife conservation (CCN 2023[19]).

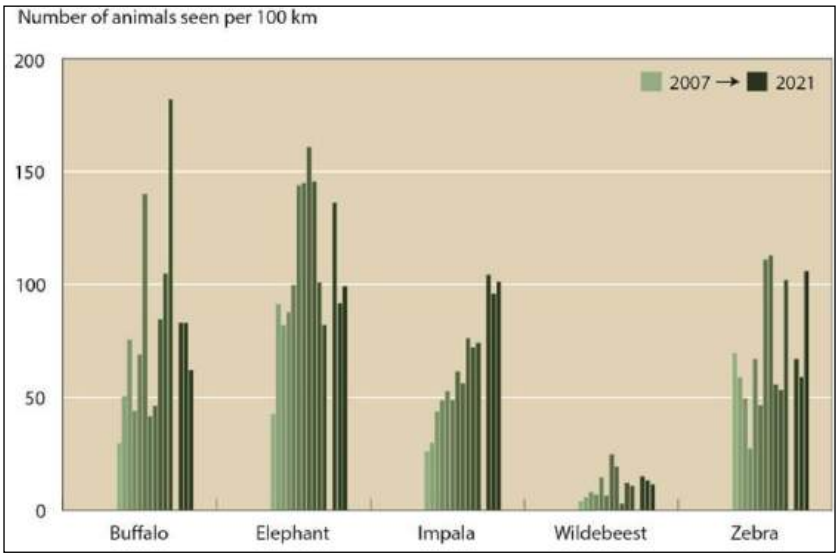


Figure 3.13: Game count data from ground-based game counts in Kavango East and Zambezi Regions, Namibia. From CCN 2023.

Elephants occur sporadically in the far northern reaches of the Basin. The elephant population declined severely during the Angolan war and recovered slightly after that, but poaching levels have curtailed the recovery. The Great Elephant Count in south-eastern Angola in 2015 calculated a high level of mortality, and that the population was in decline[20]. Elephant populations further south, in the areas of Zambezi Region and north-western Botswana, are high and these animals move widely over this part of the KAZA landscape.

The 2022 KAZA survey estimated the elephant population for the region at at 227,900, indicating that the population appears stable. However, the overall carcass ratio was high at 10.47%. Several factors are likely contributing to the somewhat elevated mortality, including aging populations, improved sampling methodologies, environmental conditions, and poaching[21].

Hippos are mostly confined to the river and immediately adjacent areas. North of the Kembo-Cuando confluence they are rare, probably due to the small size of the channels, but further downstream in Angola and Namibia they are fairly common. Hippos are important to the ecosystem for their role in keeping river channels open and making new channels, but they also damage crop fields and they are the third-highest conflict species in Namibia's Zambezi Region (Figure 3.14[22]).

[19] Community Conservation Namibia. 2023. Wildlife populations. https://communityconservationnamibia.com/support-to-conservation/natural-resource-management/ wildlife-populations

[20] i) Chase MJ, Griffin CR. 2011. Elephants of south-east Angola in war and peace: their decline, re-colonisation and recent status. African Journal of Ecology 49: 353-361. ii) Chase MJ, Schlossberg S. 2016. Dry-season fixed-wing aerial survey of elephants and other large mammals in southeast Angola – A Great Elephant Census Project. Elephants Without Borders, Kasane, Botswana.

[21] https://africa.panda.org/?uNewsID=45604

[22] Community Conservation Namibia. 2023. Human wildlife conflict. https://communityconservationnamibia.com/support-to-conservation/natural-resource-management/human-wildlife-conflict

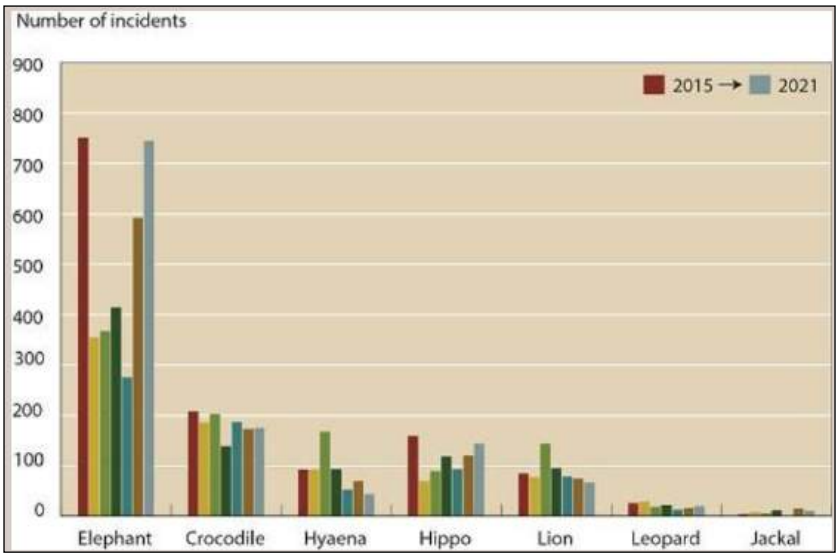


Figure 3.14: Wildlife conflict species in Namibia's Zambezi Region, 2021 data. (CCN 2023).

3.6.2 Wildlife movements

One aim of the KAZA landscape is to facilitate transfrontier dispersal of wildlife, but movements are still constrained by various factors such as major roads, fences and human settlement (Cushman et al 2010[23], Huang 2022[24]). The Cuando Wildlife Dispersal Area is part of an important route allowing elephants to move between areas north of the Okavango Swamps, Bwabwata National Park in Namibia, and Angola and Zambia (Figure 3.15). This map also shows the importance of the formally protected areas in all four countries, as well as the Zambezi State Forest in Namibia, to these animals. The Cuando Dispersal Area and its associated National Parks are also important for lions, as shown from collar data for individuals in this area[25] (Figure 3.16).

[23] Cushman SA, Chase M, Griffin C. 2010. Mapping landscape resistance to identify corridors and barriers for elephant movement in southern Africa. In Cushman SA, Huettmann F (eds) Spatial Complexity, Informatics and Wildlife Conservation. Springer, pp 349-367.
[24] Huang RM, van Aarde RJ, Pimm SL, Chase MJ, Leggett K. 2022. Mapping potential connections between Southern Africa's elephant populations. PLoS ONE 17(10): e0275791. https://doi.org/10.1371/journal.pone.0275791
[25] MEFT data, 2020. ii)Hanssen L, Kukuwe L, Sililo C. 2020. Human-Lion Conflict Mitigation in the Zambezi Region, Namibia. Kwando Carnivore Project, June 2020. iii) FunstonP, Beytell P, Hanssen L, Singwangwa M, Tchadau BA. 2017. Status Report: Lions of the Kavango and Zambezi Regions.

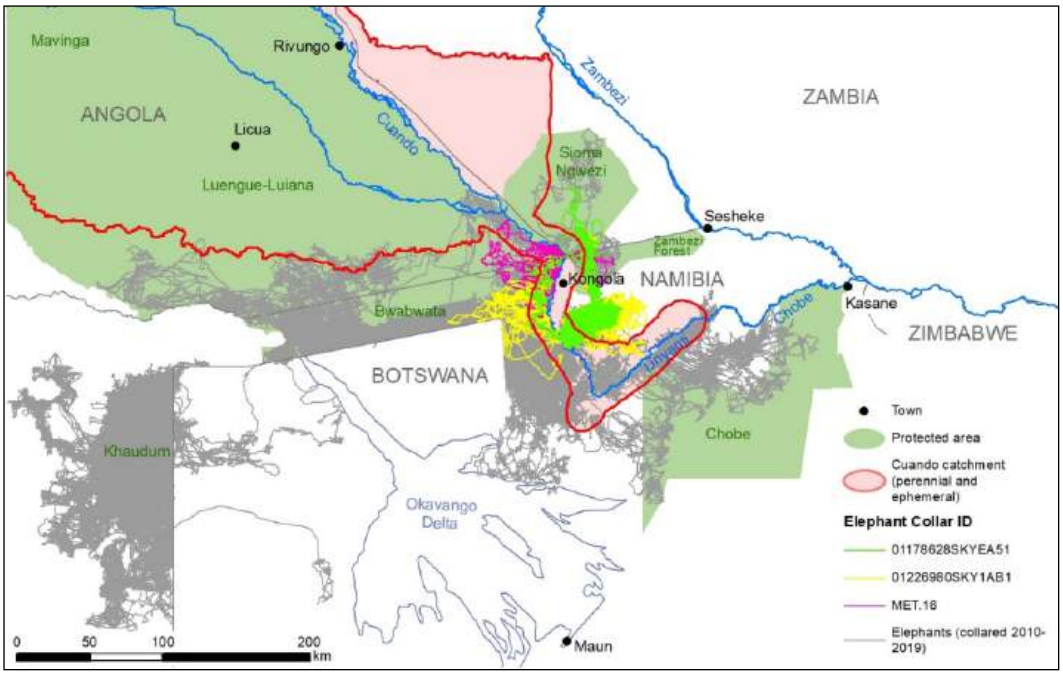


Figure 3.15: Elephant movement derived from collar data (2010-2019). (MEFT 2020).

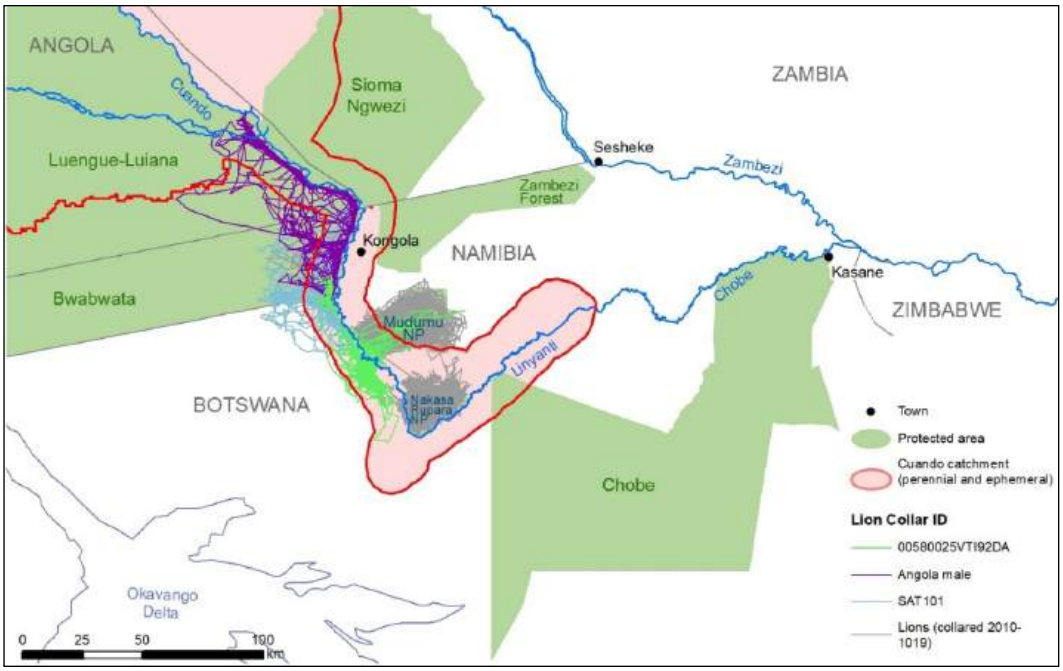


Figure 3.16: Lion movement derived from 2010-2019 collar data. (MEFT 2020**).**

3.6.3 Birds

Brown and Meyer-Rust (2004) reported that the Cuando system, though not highly productive, supports significant numbers of species associated with the north-eastern perennial river systems. During their survey, Pied and Malachite Kingfishers were found to be fairly common, as were African Fish Eagles and African Marsh Harriers. Of the herons, Goliath, Purple, Squacco and Rufousbellied were observed, as were large numbers of Hadeda Ibis and Pygmy Geese. Bee-eaters are a characteristic sight along the river (notably Carmine, Whitefronted and Little).

The relatively remote areas of south-eastern Angola are poorly known bird-wise[26] but data from the National Geographic expedition down the Cuando suggests that priority species such as bateleur eagle, white-headed vulture, wattled crane and southern ground hornbill occur in the area. Wetlands are known to support relatively higher diversity and abundance of birds[27] and the downstream reaches of the Cuando are recognized as a linear oasis, further emphasizing the value of its wetlands. The huge floodplain areas of the Cuando are a possible refuge for southern African priority wetland birds such as flufftails, crakes and cranes.

3.6.4. Fish

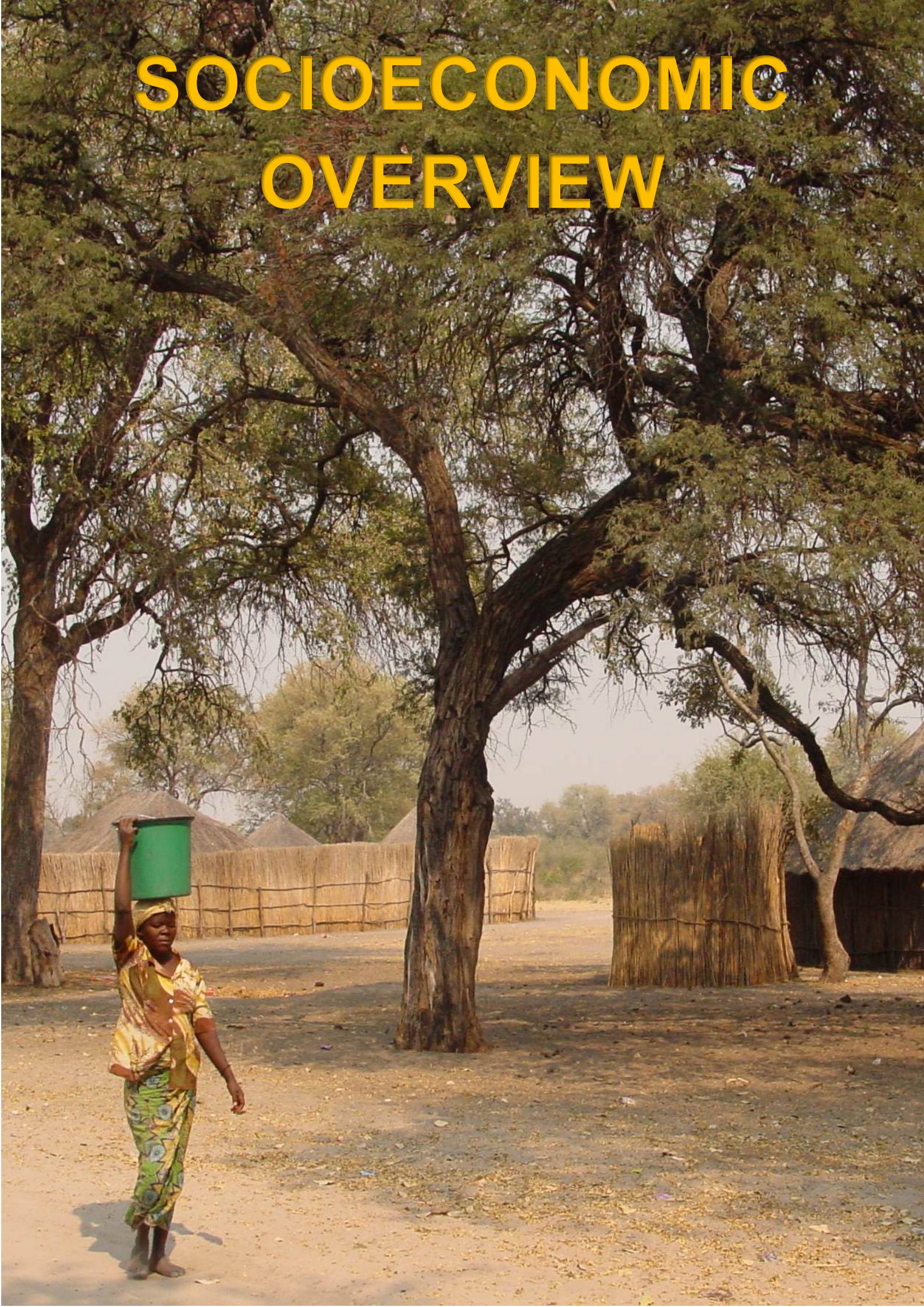
Fish populations in the Cuando are generally in a good state, largely because of the extensive floodplains of the river which serve as a refuge and protection from excessive fishing[28]. Also, fish surveys in the Cuando have shown that the general health of fishes was good. Fishing is an important aspect of the local economy and food security for areas close to the main channels and floodplains of the Cuando.

[26] Dean WRJ, Melo M, Mills MSL (2019) The avifauna of Angola: richness, endemism and rarity. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: a modern synthesis. Springer Nature, Cham

[27] i)Simmons RE, Boix-Hinzen C, Barnes K, Jarvis AM, Robertson A. 2001. Namibia. In: Fishpool LDC & Evans MI (eds.) Important Bird Areas in Africa and associated islands. Priority sites for conservation. Pp639-660. Birdlife Conservation Series, Cambridge, UK. ii) Mendelsohn J, Roberts C. 1997. Environmental profile and atlas of Caprivi. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek.

[28] Personal communication, F.Jacobs, Feb 2023. ii) F Jacobs 2015 https://namibia533.rssing.com/chan-62911740/all_p2.html

SOCIOECONOMIC OVERVIEW



4. SOCIO-ECONOMIC OVERVIEW

4.1 Administrative Regions

The Cuando River Basin covers four countries: Angola, Zambia, Namibia, and Botswana. The areas covered by the various provinces and regions of these four countries are set out in Figure 4.1 and Table 4.1.

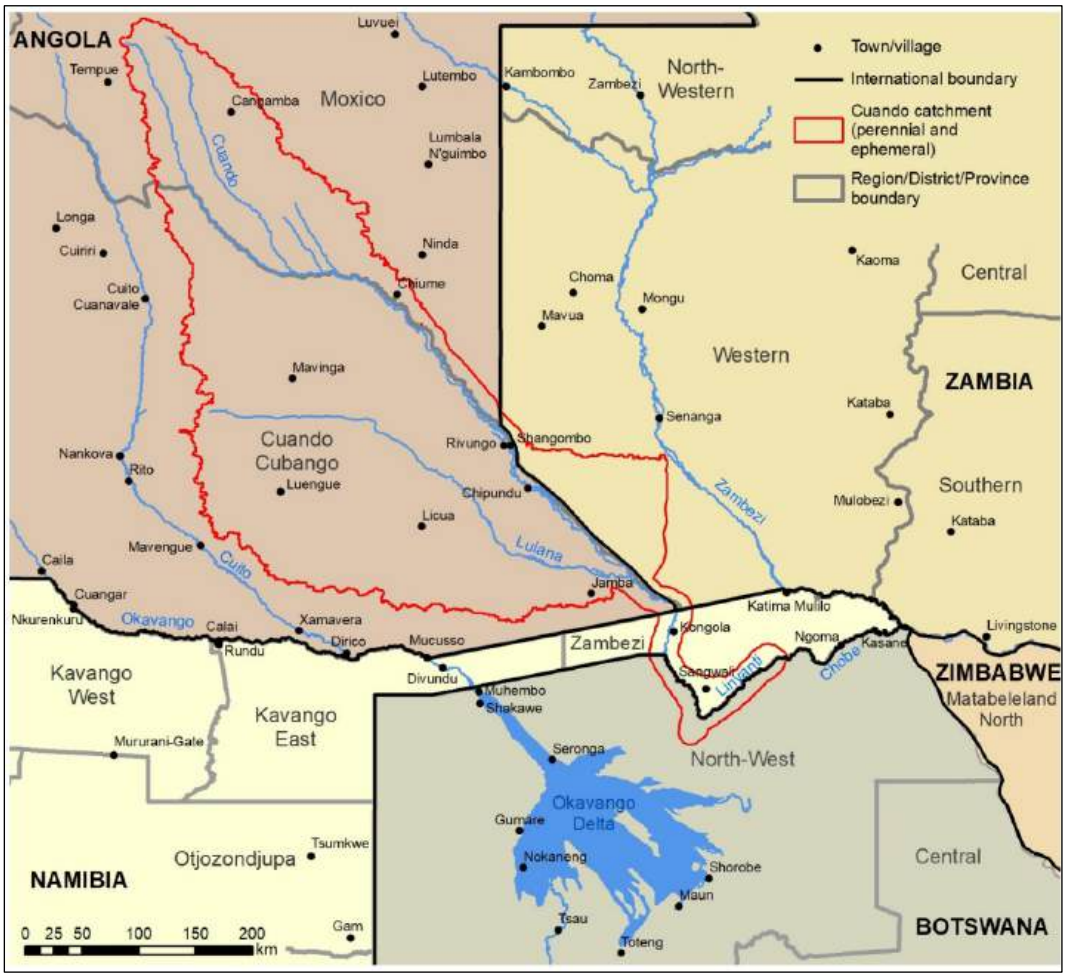


Figure 4.1: Administrative boundaries within and surrounding the Cuando River Basin. (source: Pallett et al 2022).

Table 4.1: Areas under the various administrative parts of the Cuando River Basin.

Country	Province / Region	Area in perennial / ephemeral parts of the Cuando River Basin (km^2)		Sub-totals		Percentage
		Perennial	Ephemeral			
Angola	Moxico Province	25,604	492	26,096	102,520	86.3
	Cuando Cubango Province	24,739	51,685	76,424		
Zambia	Western Province	2,424	6,928	9,352	9,352	7.9
Namibia	Zambezi Region	4,373	0	4,373	4,373	3.7
Botswana	North-West Province	2,538	0	2,538	2,538	2.1
Sub-totals		59,678	59,105			
Total					118,783	

A small but important detail concerns the border between Angola and Zambia where it runs along the Cuando. The border lies on the eastern edge of the floodplain. That is, none of the Cuando River and floodplain officially lies in Zambia.

4.2 Population

The 2022 State of the Basin Report calculated the total population of the Basin by mapping all of the homesteads on remote sensing images. This arrived at a figure of about 274,000 people[29], extrapolated from 39,190 homesteads, distributed as shown in Figure 4.2 and Table 4.2.

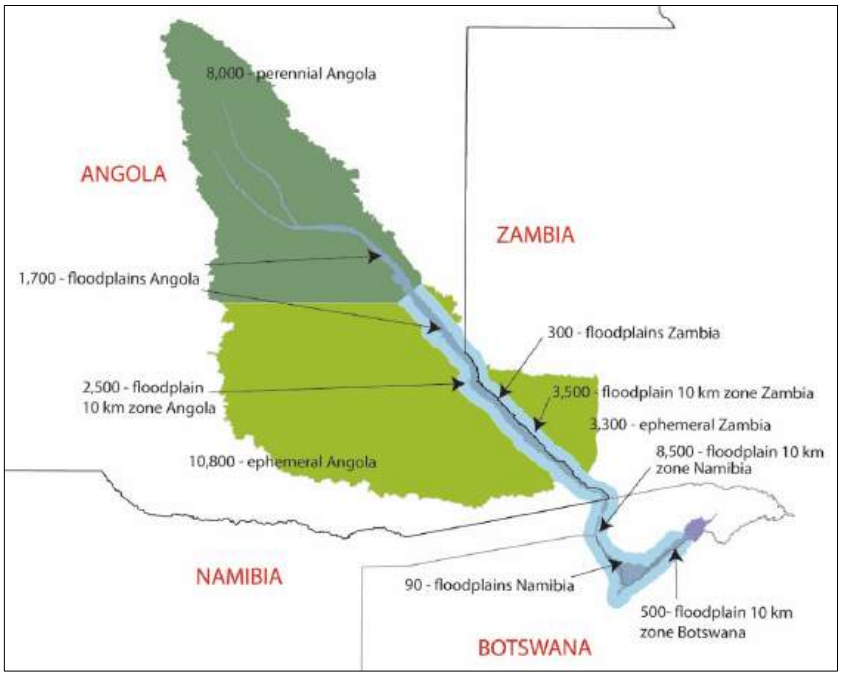


Figure 4.2: Number of homesteads in the various zones of the Cuando River Basin. (Source: Pallett et al. 2022).

Table 4.2: Distribution of households in the Cuando Basin.

Country	Zone	Number of households	Household sub-totals	Percentage
Angola	Perennial	8,000	23,000	58.7%
	Ephemeral	10,800		
	Floodplain	1,700		
	Floodplain 10 km zone	2,500		
Zambia	Ephemeral	3,300	7,100	18.1%
	Floodplain	300		
	Floodplain 10 km zone	3,500		
Namibia	Floodplain	90	8,590	21.9%
	Floodplain 10 km zone	8,500		
Botswana	Floodplain 10 km zone	500	500	1.3%
Total			39,190	

[29] There is no definitive population estimate – this needs verifying

About half of the Angolan Cuando Basin population lives in isolated settlements or small villages close to the main channels of the Cuando and its perennial tributaries. These people live a very remote, subsistence life. Roads in this area are few and very rough; most transport is by mokoro on the river.

Another roughly 11,000 households exist in the ephemeral areas of the Basin. Many of these people are concentrated in a few main villages, notably Mavinga, Licua and Jamba, and there are other small scattered settlements in places, usually next to ephemeral river beds where water can be accessed. Livelihoods are similar to those described above; entirely subsistence and very marginal.

Population densities are higher in the Zambian part of the Basin, again concentrated along the main river and around the main town of Shangombo, and with scattered settlements in the ephemeral zone east of the river.

Moving southwards, about one fifth of the total Basin population is found in Namibia, living mostly in rural and small urban settlements next to the main roads. Kongola is the largest town and is spread linearly along the three main roads, heading northwards and southwards parallel to the river, and east-west along the main B8 road. Other villages are Sangwali, Linyanti and Chinchimane, connected to Kongola and Katima Mulilo along a tarred road, and there are other smaller settlements close to the floodplain.

The Botswana population is very small, making up only 1% of the total Basin population, and is concentrated in two small villages.

Overall, the population is low and much of the Basin area in Angola is empty of people. People are concentrated along the river channels in Angola and Zambia, and along main roads in Namibia. The distribution is shown in Figure 4.3.

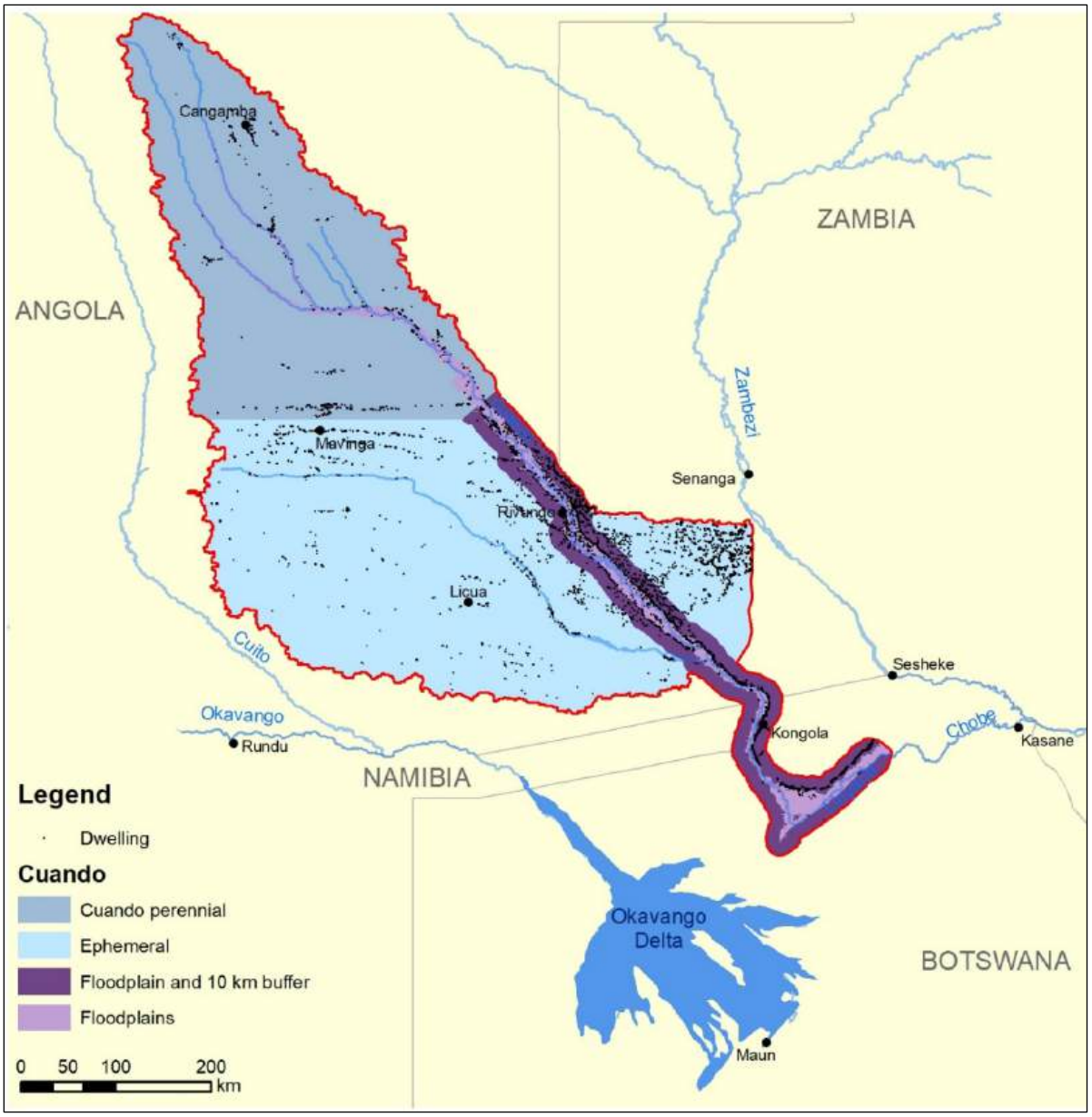


Figure 4.3: Distribution of households in the Cuando River Basin. (source: Pallett et al 2022).

4.3 Land use

There are so few people in the Angolan Cuando Basin because soils are poor and farming is difficult. Where settlements exist, there are usually a few cleared fields, growing crops such as manioc, maize, sweet potatoes, beans and melons. As one moves south and rainfall decreases, maize and millet become more prevalent. There is some diversity in cultivation: the staples are maize, millet and sorghum, and these are complemented with pumpkins, groundnuts and beans[30]. Fields are typically used only for a few years before being abandoned, requiring new areas to be cleared. The only livestock are poultry; fish and bushmeat also supplement the diet. Livestock are surprisingly

[30] Information drawn from Raison, 2019. River catchments and development prospects in south-eastern Angola.
DoF. 2014. Forest management plan, Lubuta community. Unpublished report, Directorate of Forestry, Ministry of Agriculture, Water and Forestry, Windhoek.

absent apparently due to the effect of the civil war, when armies commandeered all livestock for rations, and diseases have subsequently kept numbers very low since then. The occurance of tsetse fly is another factor that limits livestock keeping.

The system of dryland cropping is used almost entirely for own consumption; grain storage rooms stand off the ground and can keep grain safe and fungus-free for less than a year, holding enough for a family's own use until the next crop is harvested. Some marketing of local produce happens in the scattered towns, but this probably makes up a very small proportion of total production. The town of Shangombo on the Zambian side of the river has a rather small market selling small quantities of foodstuff such as beans, groundnuts and locally caught fish, and there is a small butchery area for slaughtered livestock. Overall, there is relatively little money in circulation, and people rely heavily on what resources they can harvest from the natural environment. Approximately 60% of the Cuando Basin in Angola comprises the Mavinga and Luengue-Luiana National Parks that fill the south-eastern corner of the country.

At the southern end of the Basin, small-scale mixed crop and livestock farming in Namibia is both subsistence level and commercial, with surplus crops of maize and sorghum going to markets in Katima Mulilo and further afield. Stock farming is dominated by cattle, which are valued for their draught power, milk, meat and cash income, and they give status in terms of rights to land and social standing[31]. Cattle are slaughtered in bush markets, and at the Katima Mulilo abattoir when Foot and Mouth Disease (FMD) restrictions imposed by Government are not in force[32].

Since 1990, Namibia has emphasised conservation as a viable land use and approximately 80% of the Namibian part of the Cuando Basin is Protected Area or communal conservancies (see Conservation section).

Overall, the human footprint over the northern 90% of the Basin is relatively light, particularly over the ephemeral part of the Basin in Angola. Human occupation and development is more intense in the southern remainder of the Basin.

4.3.1 Crops

Subsistence farming activities in the Basin are described above. Commercial, irrigated crop production is mostly absent in the Basin but various agriculture schemes do sporadically get suggested and initiated. For example, an irrigation scheme (for an unknown crop) using water from the Linyanti close to Chinchimane was established in the late 1980s, but had to close down after about three years because the water supply in the Linyanti River dried up (MLR 2015). An unspecified irrigation scheme close to Kongola in Namibia was suggested in 2014 but did not even reach feasibility study stage, possibly because it was opposed by the subsequent Land Use Plan for the region (MLR 2015[33]). Lastly, in Shangombo (Zambia) in November 2021, a sugar plantation was 'on the cards' immediately north of the town, but no work on the ground had been started.

[31] Mendelsohn J, Roberts C. 1997. Environmental profile and atlas of Caprivi.

[32] The Katima Mulilo abattoir is approved for regional beef exports and supplies deboned meat to Angola and Ghana. Due to FMD the whole Zambezi Region is classified as an 'Infected Zone' and the abattoir is closed every time there is an FMD outbreak.

[33] MLR 2015. Integrated Regional Land Use Plan for Zambezi Region. Compiled by SAIEA for Ministry of Lands and Resettlement, Windhoek.

4.3.2 Fishing

Fish populations are relatively small in the Angolan Cuando because of the low nutrient levels in the river waters. Nevertheless fish are, of course, utilised by the people living close to the waters. Fresh and dried fish are evident in markets in local towns; this rather low level of consumption appears not to have reached large-scale, commercial levels.

Lake Liambezi at the lower end of the river system is much more productive and when it carries water it supports a high diversity and abundance of aquatic flora and fauna. The fishing industry was valued at N$34 million per year in 2011[34] and provided employment, livelihood support and cash income for households adjacent to the lake and further afield. Fish are an important source of protein in the region for all households.

4.3.3 Livestock

As described above, there are very few livestock in the northern part of the Cuando Basin: some poultry and a few goats, and virtually no cattle. Cattle and goat numbers increase slightly as one moves southwards in Angola, but everywhere the numbers are small.

Livestock numbers are much higher in Namibia, Zambia and Botswana, where they play an important role in subsistence livelihoods and the commercial economy. There were close to one million cattle in Zambia's Western Province in 2016[35]. In Zambezi Region in Namibia in 2012, there were about 136,000 cattle and 10,000 goats[36].

While cattle form an important aspect of rural livelihoods in Namibia, only about 60% of households – the relatively richer ones - actually own cattle[37]. Cattle densities in Zambezi Region are highest on the eastern Zambezi River floodplains, and they are also high in areas alongside the Linyanti Swamps and the areas along the river north and south of Kongola[38]. Poorer households rely on goats and poulty. This situation is roughly similar in the Zambian and Botswana parts of the Basin[39].

4.3.4 Forestry

Wood is an important resource for people in the Basin. Local users mainly collect firewood for cooking, and harvest standing trees for construction purposes[40].

The woodlands in Namibia and south-eastern Angola contain a few species that have recently become a focus for commercial logging: rosewood (*Guibourtia coleosperma*), Zambezi teak (*Baikaiea plurijuga*) and Angolan teak (kiaat, *Pterocarpus angolensis*) are the main targets. Large

[34] Tweddle D, Weyl O, Hay C, Peel R, Shapumba N. 2011. Lake Liambezi, Namibia: fishing community assumes management responsibility. WWW Project.
[35] CSO. 2018. Zambia in figures 2018. Central Statistics Office, Lusaka.
[36] MLR 2015. Integrated Regional Land Use Plan for Zambezi Region. Ministry of Lands and Resettlement, Windhoek.
[37] Mendelsohn J. 2006. Farming systems in Namibia. RAISON.
[38] Mendelsohn J, Roberts C. 1997. Environmental profile and atlas of Caprivi.
[39] NNF 2022. Scoping Report for the KAZA Equitable livelihoods diversification strategy.
[40] De Cauwer V, Knox N, Kobue-Lekalake R, Lepetu JP, Matenanga O, Naidoo S, Nott A, Parduhn D, Sichone P, Tshwenyane S, Yeboah E & Revermann R. 2018. Woodland resources and management in southern Africa. In: Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions (ed. by Revermann R, Krewenka KM, Schmiedel U, Olwoch JM, Helmschrot J & Jürgens N), pp. 296-308, Biodiversity & Ecology, 6, Klaus Hess Publishers, Göttingen & Windhoek. doi:10.7809/b-e.00337

specimens of these slow-growing trees are over 100 years old[41], so there are concerns about over-exploitation and an upsurge in illegal logging in Zambia, Angola and Namibia[42].

Extensive wood resources are also lost to uncontrolled fires and land clearing for cropping. Clearing of land for fields is ongoing due to the growing population and the short lifespan of fields which is a consequence of the low fertility of the sandy soils. The extent of land cleared – and therefore areas where large trees lost – in the Namibian part of the Cuando Basin is shown in Figure 4.5.

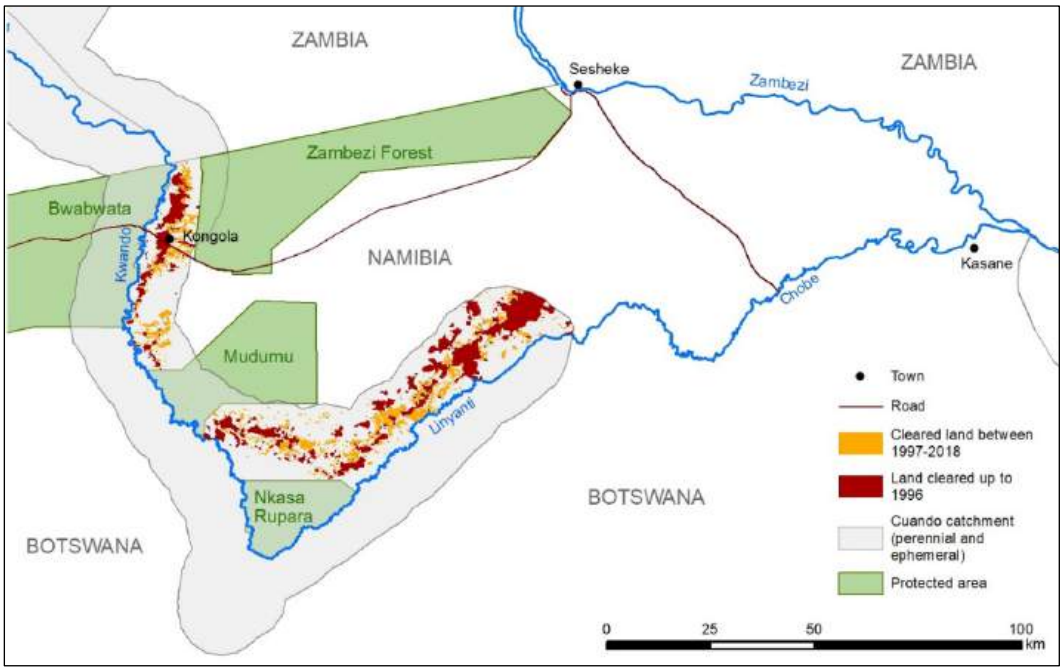


Figure 4.5: Land clearing in the Namibian part of the Cuando River Basin[43].

In Namibia and southern Angola, large areas of *Baphia-Baikaiea* shrubland are a consequence of frequent fires. The extent of tree loss over the past two decades is shown in Figure 4.6.

[41] i) Kayofa F. 2015. Natural Regeneration Potential of *Pterocarpus angolensis* (Kiaat Tree) in the dry forests of northern Namibia. MSc dissertation, University of Stellenbosch ii) Mendelsohn J, el Obeid S. 2005. Forests and woodlands of Namibia. Research and Information Services of Namibia (RAISON), Windhoek.

[42] https://www.traffic.org/news/angola-namibia-and-zambia-vow-to-take-action-on-illegal-timber-trade/

[43] Calculated for the Cuando State of the Basin Report, 2021, based on remote sensing images.

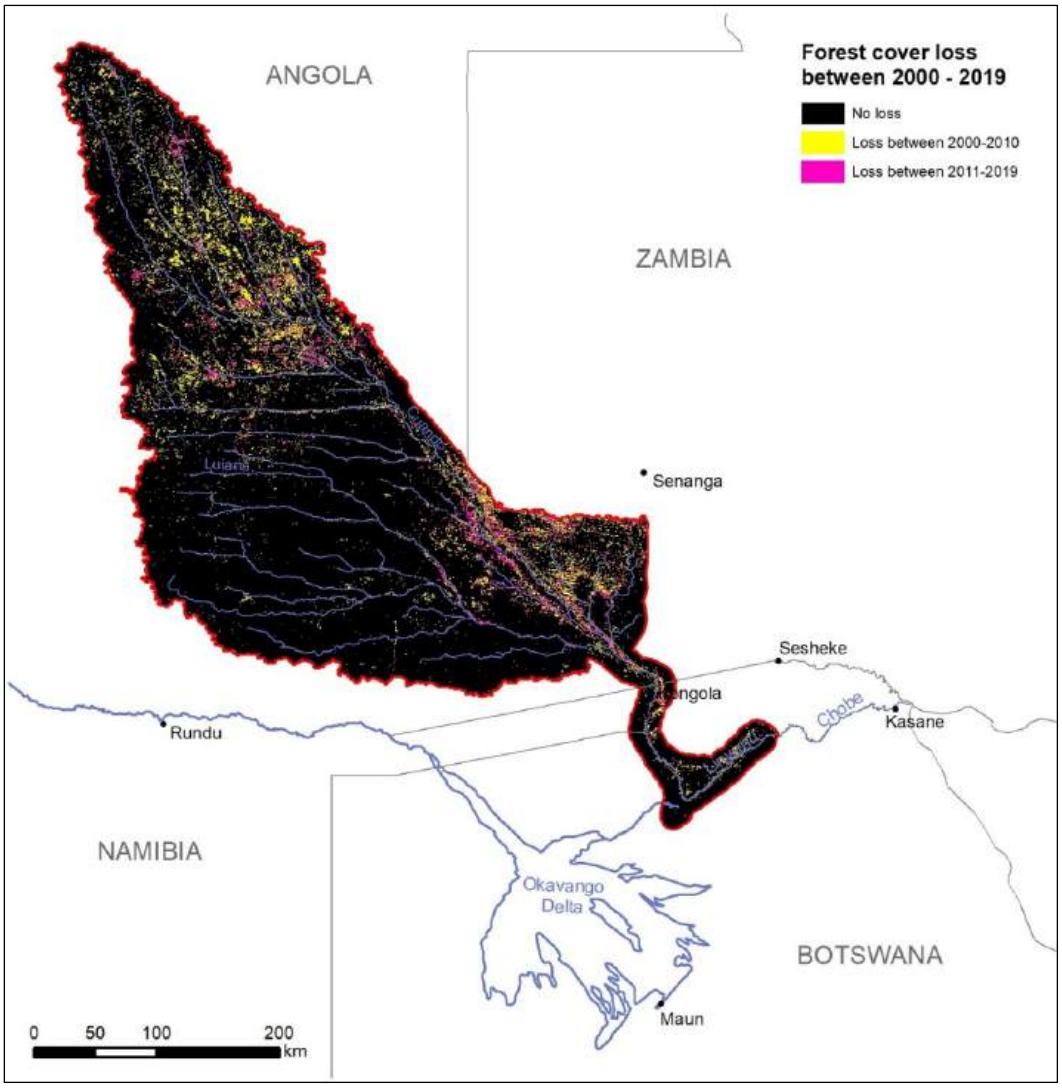


Figure 4.6: Loss of tree cover from 2000 to 2019 across the Cuando River Basin[44].

4.3.5 Mining

There is no conventional mining in the Basin. Small numbers of artisanal miners dig for diamonds in river channels in the upper and middle parts of the basin[45]. There is no further information on the extent of these operations or their environmental impact.

In Namibia, an application for an Exclusive Prospecting Licence for diamonds in the area of the Sobbe Conservancy was turned down after opposition from the conservancy[46].

[44] Calculated for the Cuando State of the Basin Report, 2021, based on Hansen MCPV, Potapov R, Moore M, Hancher SA, Turubanova A, Tyukavina D, Thau SV, Stehman SJ, Goetz TR, Loveland A, Kommareddy A, Egorov L, Chini CO, Justice, Townshend JRG. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest .

[45] i)Funston P, Henschel P, Petracca L, Maclennan A, Whitesell C, Fabiano E & Castro I. 2017. The distribution and status of lions and other large carnivores in Luengue-Luiana and Mavinga National Parks, Angola. KAZA TFCA Secretariat (KAZA). ii) Mendelsohn J, Martins A. 2018. River catchments and development prospects in south-eastern Angola. RAISON.

[46] Stakeholder engagements for this project, Namibia, March 2023.

Geophysical and geological prospecting for ore bodies is likely to continue, stoking hopes by entrepreneurs for economic growth from proposed mines. However the deep blanket of Kalahari sand that covers the bedrock is a significant obstacle for development of a viable mine.

4.3.6 Conservation

Fifty five percent of the Cuando Basin is under general conservation land use (Table 4.3, Figure 4.7). South-eastern Angola is occupied by the Mavinga and the Luengue-Luiana National Parks, making up 43% of the total Basin area.

In Zambia, the Sioma Ngwezi National Park is surrounded by the Lower West Zambezi Game Management Area, which combined occupy all of the Basin area in this country. Sioma Ngwezi is largely undeveloped but is expected to grow its tourism facilities through the KAZA initiative. The park is not fenced and allows movement of animals from the bordering parks of Botswana and Namibia, following the corridor along the Cuando River.

In Namibia, the Kwando Core Conservation Area on the eastern side of Bwabwata National Park is an important component of the wildlife corridor along the Cuando River. The formally protected areas of the Mudumu and Nkasa Rupara National Parks are surrounded by communal conservancies, which also facilitate wildlife movements, although the corridors are not entirely free of crop field and settlements, and are coming under increasing pressure to allow more human habitation.

Chobe National Park in Botswana has a fairly small area of frontage on the Linyanti Swamp, and land to the south and west of this is occupied by the Okavango Wildlife Management Area.

The entire Cuando River Basin lies within the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA), and is an important component of KAZA due to its protected areas and the relatively strong status of conservation in the downstream parts of the Basin. At 520,000 km², KAZA is the largest trans-frontier conservation area in the world, and brings together five signatory countries - Angola, Botswana, Namibia, Zambia, and Zimbabwe. A key objective of KAZA is to join fragmented wildlife habitats into an interconnected mosaic of protected areas and transboundary wildlife corridors, which facilitates movement of animals across international boundaries.

Country	Protected area	Area (km²)	Area within Cuando River Basin (km²)	Percentage of Cuando Basin	Percentage of Basin in each country
Angola	Mavinga National Park	46,076	34,557	29.1%	43.4%
	Luengue-Luiana National Park	22,610	16,957	14.3%	
Zambia	Sioma Ngweze National Park	5,276	1,760	1.5%	7.5%
	Lower West Zambezi Game Management Area	25,424	7,200	6.1%	
Namibia	Bwabwata National Park	6,274	620	0.5	2.5%
	Mudumu National Park	737	184	0.2	
	Nkasa Lupala National Park	320	320	0.3	
	Kwandu Conservancy	190	190	0.2	
	Mayuni Conservancy	151	136	0.1	
	Mashi Conservancy	297	223	0.2	
	Wuparo Conservancy	148	148	0.1	
	Balyerwa Conservancy	223	223	0.2	
	Dzoti Conservancy	287	215	0.2	
	Bamunu Conservancy	556	417	0.4	
	Salambala Conservancy	930	100	0.1	
	Zambezi State Forest	1,503	150	0.1	
Botswana	Chobe National Park	11,700	351	0.3	1.6%
	Okavango Wildlife Management Area		1,938	1.3	
Total				118783	

Table 4.3: land under general conservation land use

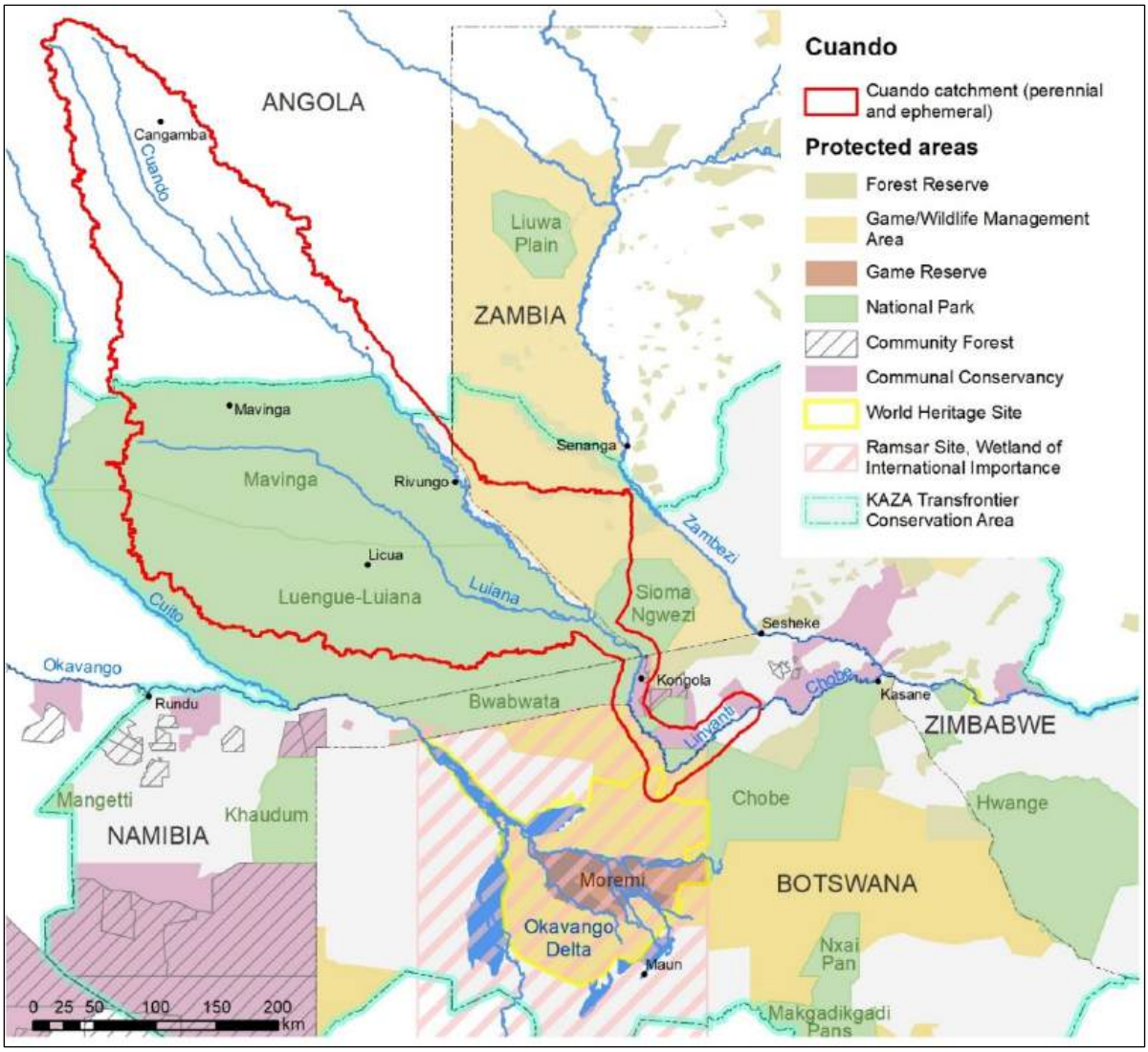


Figure 4.7 :Conservation areas in and surrounding the Cuando River Basin. (source: Pallett et al 2022).

4.3.7 Tourism

Tourism is barely developed at all in the Angolan and Zambian parts of the Cuando Basin. There are accommodation facilities in the small towns, but no tourism activities such as game drives or boat cruises. Indeed, this part of the basin is difficult to access by road and most of the area is well 'off the beaten track', and has relatively low scenic value. The low and dispersed wildlife populations also do not, at present, create a strong tourism product.

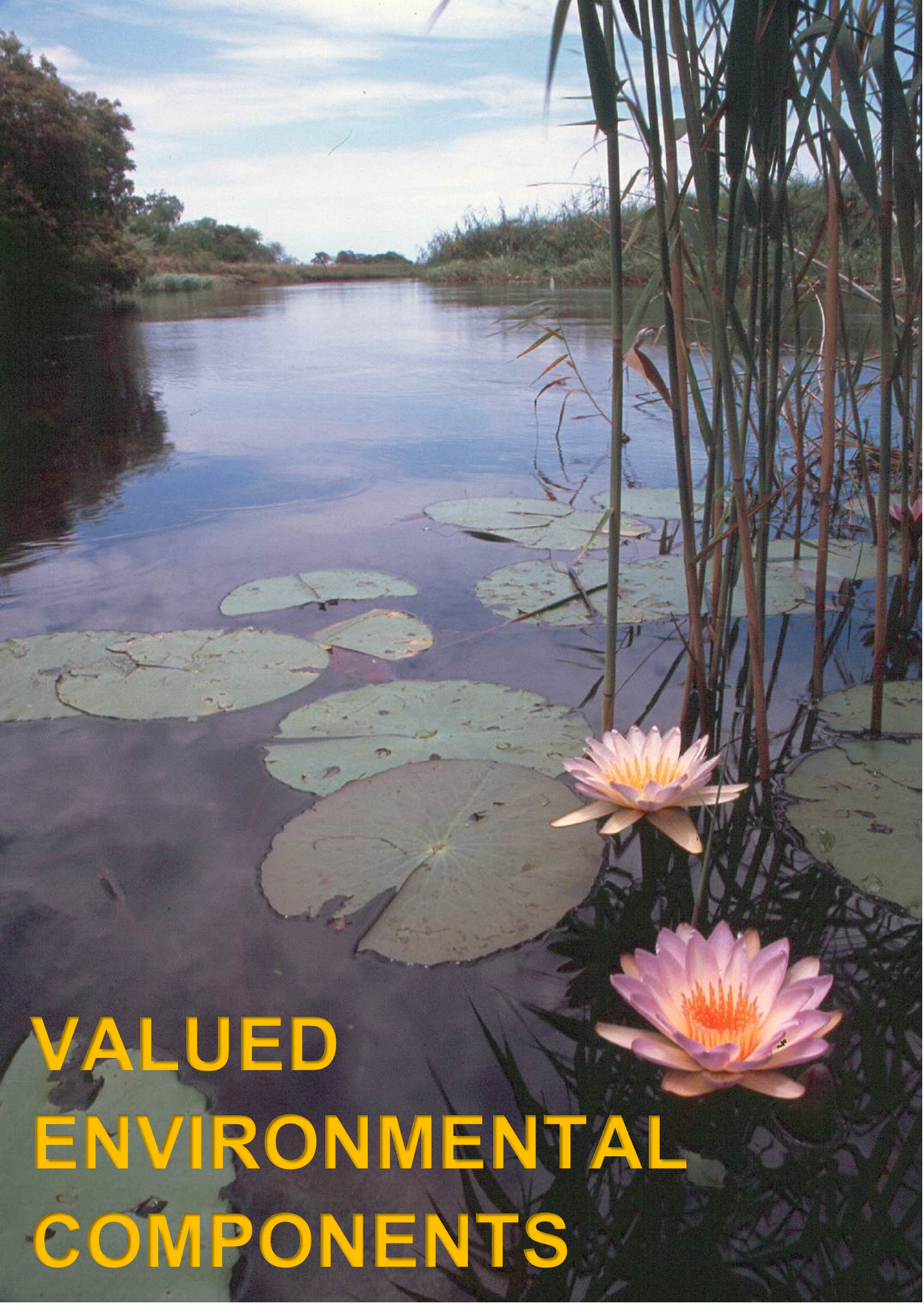
The situation is very different in the Namibian and Botswana portions of the Basin, where tourism and wildlife make a substantial (though not quantified) contribution to the local economy. There are 18 tourism establishments along the Kwando and Linyanti Rivers in Namibia, and nine in Botswana. Tourist activities offered include boat cruises, game drives, cultural visits to traditional villages, hunting and fishing. The lodges and camp sites are usually set up in Joint Venture arrangements with local conservancies, and pay a proportion of their profits to the conservancies.

They also provide some employment to local people: in the Namibian establishments, about 190 people are employed.

An opinion voiced during stakeholder engagements for this SEA was that there are now enough tourism establishments on the Namibian section of the river, and that the carrying capacity has been reached. There was general disillusionment with the prospect of new, large, luxury lodges being tendered in the National Parks.

4.3.8 Urban development

Urbanisation and the growing population drive relatively high rates of urban growth in towns in the Angolan part of the Basin. Towns throughout the Basin serve as local service centres offering markets to the surrounding areas. In Namibia, this role is made less effective because people tend to settle along the main roads in 'ribbon development'. This brings other negative impacts such as safety risks to children and livestock, and interference with wildlife corridors.


VALUED
ENVIRONMENTAL
COMPONENTS

5. VALUED ENVIRONMENTAL COMPONENTS

As noted earlier, Valued Environmental Components (VECs) are defined as components of the natural and human environment that have special scientific, ecological, economic, social, cultural, archaeological, historical, or other importance.

Selecting VECs is a core step of SEA as it gives direction to cumulative impact analysis, mitigation and monitoring. It also identifies major issues for which information and improved understanding is required. Though there has been no previous identification of VECs specifically in the Cuando Basin, a number of contributions have been made to identify areas important for conservation and the provision of ecosystem services to the basin's people. Key resources are the 2021 Cuando River Basin Report Card, the 2022 Cuando State of the Basin Report, and the 2023 KAZA Policy Brief on elephant movement and connectivity.

Key points:

- The Cuando River is central to KAZA, in distributing water and facilitating the movement of wildlife across much of the landscape.

- Much of the basin has few people and little environmental degradation. The more pristine areas happen to be contiguous: in the upper catchment and adjacent to the entire western bank of the Cuando in Angola, Namibia and Botswana. Cumulatively, these contiguous areas are substantial.

- Environmental degradation is likely to be driven progressively and stepwise as a result of increasing and expanded human settlement together with increasing harvesting of natural resources, the clearing of woodland and forest for shifting agriculture, and as a result of the cumulative effect of frequent intense fires. Systems and procedures to regulate or control these degrading processes are generally weak, even in areas that are legally protected as national parks.

Defining impact thresholds for VECs is important because the viability or sustainability of VECs, whether ecological, biological, or related to human communities, is their capacity to endure - i.e., for the ecosystem, community, or population to remain diverse and productive over time (meaning that it retains its inherent resilience). This is reflected in the definition of *sustainable use* in the Convention on Biological Diversity: using the "components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of future generations."

The viability or sustainability of VECs depends upon both the forces that affect them and their social and ecological vulnerability (sensitivity), i.e., the degree to which they are susceptible to and unable to cope with injury, damage, or harm. The attributes related to a VEC can include biological, cultural, ecological, environmental, physical and social issues.

Figure 5.1 below[47] shows the 8 steps in the process of VEC assessment – described briefly as follows:

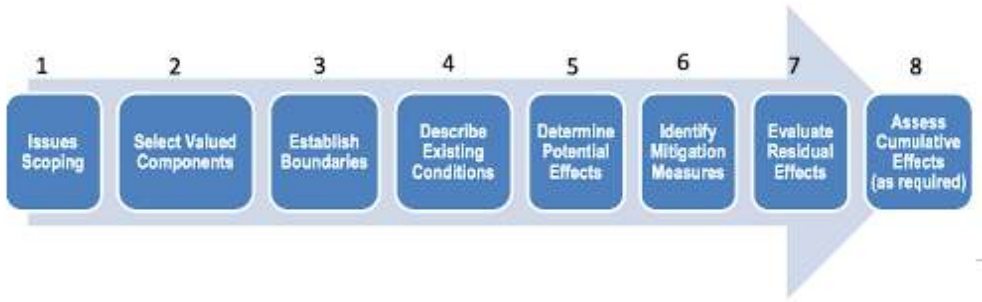


Figure 5.1 The 8-step VEC assessment process

Issues Scoping

The scoping phase has been concluded with the first draft scoping report delivered on 30 April 2023. A revised scoping report incorporating changes based on comments received, was submitted on 29 July 2023.

Selection of VECs

Usually VECs are identified through a combination of literature research, stakeholder input and expert opinion. In some cases (though not in the Cuando Basin), certain areas have already been identified as VECs by other declarations (e.g. a Ramsar site). As noted earlier, the 2021 Cuando River Basin Report Card and the 2022– Cuando State of the Basin Report have provided good guidance. Key VECS identified by this SEA are as follows (not in order of priority):

VEC 1 – The Angolan Highlands Water Tower and perennial supply of water along the length of the Cuando River. This supply is fundamental to the structure, functioning and value of the entire river basin. Stop or change the supply of water and the Cuando Basin will cease being what it is!

VEC 2 – The immense area of swamp or reedbeds. Covering up to 4,000 square kilometres or 400,000 hectares, this is amongst the biggest expanse of reeds, papyrus and sedges in Africa. Such a large area likely supports many animals, some of which may be rare. The aquatic plants transpire substantial volumes of Cuando water as well as stemming its flow, and thus are fundamental in making the Cuando River system what it is.

VEC 3 – Linyanti Swamps and Savuti area. The Cuando feeds water, dissolved minerals and suspended solids into the Linyanti Swamps, the Savuti River and Savuti Marsh where the water disappears, and the minerals and sediments remain trapped to feed concentrations of plants and

[47] Modified from 2013 British Columbia (BC) guidelines on Valued Components and Assessment of Potential Effects

wildlife. This rich resource, in turn, nurtures the livelihoods of local residents and a tourism industry that contributes much to the economy of northern Botswana and Namibia's Zambezi region.

VEC 4 – Western flanks of the Cuando. Areas immediately west of the Cuando River and its swamps once supported an abundance of wildlife as a result of supplies of surface water in the Cuando and its ephemeral tributaries and the area's diverse habitats and relatively fertile soils. Wildlife numbers are likely to recover if the area is managed for conservation.

VEC 5 – Wildlife corridors and ecological connectivity, notably for Elephant, Buffalo and predators such as lions. Without these corridors, various species of wildlife would be trapped and their numbers would decrease. Also, the wildlife corridors must be kept open to reduce Human-Wildlife Conflicts. The integrity of wildlife corridors is an important aspect of KAZA as a whole, as described in the KAZA Policy on Elephant Movements and Connectivity.

VEC 6. Cuando aquifers Known groundwater resources in the Cuando Basin are generally rather poor, but are still an important resource for rural people who live some distance from available surface water. Groundwater is therefore a valued resource. The suspected presence of deep (still unknown) aquifers could provide an alternative to Cuando River water for development projects. This would be a game-changer for the Basin, and should be investigated as a matter of priority.

Whilst all these VECs are ecological, most have profound implications for ecosystem services, the livelihoods of the people dependent on them, and the broader economy. They all contribute to maintaining the functioning and integrity of the Cuando Basin, and supporting the small but very important tourism industry. Thus, they are all part of the functioning of the Basin's social-ecological system, and the central value they add to the entire KAZA.

The following description of each VEC incorporates steps 2 – 8 as shown in Figure 5.1.

Mitigation measures (step 6 in Figure 5.1)

The ToRs require a monitoring and evaluation framework with action plan (MEF) to be part of the SEA. The ToRs state that the "MEF should be able to flag events outside the agreed land-use plans and alert local and central governance agreements". Whilst step 6 in figure 5.1 stipulates "mitigation measures" (which in many SEAs equates to a Strategic Environmental Management Plan, or SEMP), the ToRs for the Cuando SEA instead require a MEF. This is because the individual Basin States will have their own mandates and institutions for managing impacts. The MEF, however, is a basin-wide framework that enables ZAMCOM and partners to monitor impacts from a big-picture, landscape perspective and advise the Basin States as appropriate.

Where potential impacts are identified and if these are unavoidable, the SEA has, in cpater 8, proposed suitable mitigation measures to reduce impacts. Consistent with best practice, the "Mitigation Hierarchy" – avoid and mitigate before considering compensation/offsets, is advocated.

In practice, most impacts will arise from implementing individual development projects or activities (which the SEA does not address on an individual basis). Routinely, such project-level impacts will be identified during project environmental impact assessments (EIAs) and relevant mitigation measures then recommended in project environmental management plans (EMPs). Given that the CURB is shared by four countries, the need for Transboundary EIA (or a Notification Mechanism) becomes obvious.

As noted earlier, mitigation measures have been proposed (in broad terms) in chapter 8 (cumulative impacts), since these are linked to sector activities rather than VECs.

Residual effects

Residual effects (step 7 in Figure 5.1) can only be determined during future assessment of individual projects and activities. At this strategic level, there is inadequate information to provide definitive analysis of residual effects.

Cumulative impacts (step 8 in Figure 5.1)

In this chapter the term "effects" as illustrated in Figure 5.1, has been re-phrased as "potential vulnerability to cumulative impacts". During Scoping, an attempt was made to validate country projects/activities – essentially an updated inventory of programmes and projects/activities – existing, planned and possible, in the Cuando Basin. Programmes and projects/activities are what cause the cumulative impacts, in addition to population growth and spread, increasing use of natural resources, woodland and forest loss to shifting agriculture, and externalities (e.g. climate change). The "existing, planned and possible" developments formed the basis of four scenarios, which are (1) business as usual, (2) low growth, (3) medium growth and (4) high-growth. The Scoping Report includes the tables that summarise the data/information that has been gathered.

Based on the information gathered during scoping, the SEA has assumed a low-medium growth likelihood over the next ten years or so. The sectors most likely to grow, albeit modestly, are agriculture, tourism, towns and villages, local trading and new or upgraded roads and other infrastructure (e.g. schools, clinics, administration buildings, sheds for produce, telecommunications, etc). Impacts will also be influenced by population growth. There will likely be an increase in water abstraction to supply villages and towns. So, if one imagines some growth in these sectors, one can try and assess the likely cumulative impacts on the VECs specifically, but also on the Basin more generally. In a "hub SEA" (which is what the CUANDO SEA is), the assessment of cumulative impacts is not confined to the VECs. For example, impacts on society, health, gender etc might not feature in the discussion about VECs, so therefore the assessment goes beyond just the VECs.

The table below summarises the comparative scoring of each VEC against possible growth/pressures in the Cuando Basin under the assumed low-medium growth scenario. Growth might be the sector performing better economically, but it could also just mean "more activities" or expanded footprint. High scores mean the VECs are in good shape and are able to handle more impacts. Low scores are cause for alarm. *Scoring assumes impact avoidance or mitigation measures*

*have **NOT** been put in place.* Note that this table is a summary, and a more detailed analysis is provided under each VEC.

The Basin is divided into sections (a) to (d), referring to:

(a) the upper fully perennial area of the Basin,
(b) the ephemeral mid-Basin area,
(c) the lower Cuando, from where the Luiana tributary joins the main Cuando, to the start of the distal swamps,
(d) the distal swamp areas of the Linyanti and Savuti.

Table 5.1 Summary of the comparative vulnerability scoring of each VEC against possible growth/pressures in the Cuando Basin under the assumed low-medium growth scenario. For ease of reference, vulnerability has been summarised as "high", "medium" and "low".

SECTOR	VEC 1 Perennial water in the Cuando	VEC 2 Reedbeds in Angolan area	VEC 3 Linyanti Swamps and Savuti Marsh (= 1d)	VEC 4 Western flanks of the Cuando	VEC 5 Wildlife corridors	VEC 6 Cuando aquifer
Expanding irrigated agric	1a Low 1b High 1c V high 1d V high	1b High	1d Very high	1b Low 1c Low	1a ? 1b Low 1c High 1d V high	1a ? 1b ? 1c ? 1d ?
Expanding livestock	1a Low 1b Med 1c Med 1d Med	1b Med	1d Very high	1b Low 1c Low	1a ? 1b Low 1c High 1d V high	1a Low 1b Low 1c Low 1d Low
Expanding tourism	1a Low 1b Low 1c Low 1d Low	1b Low	1d Med	1b Low 1c Low	1a ? 1b Low 1c Low 1d Low	1a Low 1b Low 1c Low 1d Low
Dams and weirs	1a High 1b V high 1c V high 1d V high	1b High	1d V high	1b Low 1c Low	1a ? 1b Low 1c High 1d High	1a Low 1b Low 1c Low 1d Low
Groundwater abstraction (for devt and people)	1a Low 1b Low 1c Low 1d Med	1b Low	1d Low	1b Low 1c Low	1a ? 1b Low 1c Low 1d Med	1a ? 1b ? 1c ? 1d ?
Growing and expanding	1a Med 1b Med	1b Low	1d Low	1b Low 1c Low	1a ? 1b High	1a ? 1b ?

human pop, settlements	1c High 1d High				1c V high 1d V high	1c ? 1d ?
Trans-Zambezi railway	1a NA 1b NA 1c Low 1d Low	N A	1d Low	1a NA 1b NA 1c Low	1a NA 1b High 1c V high 1d NA	1a NA 1b NA 1c NA 1d NA
Expanded road network (leading to increased access)	1a Low 1b Low 1c Low 1d Low	1b Low	1d Low	1b Med 1c Med	1a ? 1b High 1c V high 1d V high	1a Low 1b Med? 1c Med? 1d Med?
Nature conservation	1a Low 1b Low 1c Low 1d Low	1b Low	1d Low	1b Low 1c Low	1a ? 1b Low 1c Low 1d Low	1a Low 1b Low 1c Low 1d Low
Mining and petroleum	1a High 1b High 1c V high 1d V high	1b High	1d V high	1b V high 1c V high	1a V high 1b V high 1c V high 1d V high	1a High 1b High 1c High 1d High
Increased logging	1a Low 1b Low 1c Low 1d Low	1b Low	1d Low	1b High 1c High	1a High 1b High 1c High 1d High	1a Low 1b Low 1c Low 1d Low
Fish farming and processing	1a Low 1b Low 1c Med 1d Med	1b Low	1d Low	1b Low 1c Low	1a Low 1b Low 1c Low 1d Low	1a Low 1b Low 1c Low 1d Low
Increased fires	1a Low 1b Low 1c Low 1d Low	1b High	1d High	1b V High 1c V High	1a ? 1b High 1c V High 1d V high	1a Low 1b Low 1c Low 1d Low
Climate change	1a V High 1b V High 1c V High 1d V High	1b V High	1d V High	1b V High 1c V High	1a ? 1b V High 1c V High 1d V high	1a V High 1b V High 1c V High 1d V High

The above table focuses on sectors but it should be borne in mind that overall rates of exploitation of all natural resources will grow, and therefore result in cumulative impacts. Since all components of the environment have some ability to absorb additional impacts, the SEA team had to (first) think about how the existing VECs might cope with the low-medium growth scenario and then thereafter (secondly), the components of the environment beyond the VECs.

Table 5.2 shows the method that was used to assess the environment's ability to absorb additional impacts. In this case, the colours are the opposite to those commonly used in EIAs to illustrate impacts.

Table 5.2 The extent to which a given Social-Ecological System (SES) has the ability to absorb more impacts

Assessment rating	Interpretation
VERY HIGH (score 5)	The SES has extensive latitude to accommodate change (impact). Such change would typically be novel developments introduced into the SES.
HIGH (score 4)	The SES has sufficient latitude to accommodate change. Such change would typically be either novel developments introduced into the SES, or relatively limited expansion of existing activities already present in the SES.
MEDIUM (score 3)	The SES has latitude to accommodate change. Care should however be taken with introducing such change as the SESIA is nearing its capacity to accommodate further change and, as a result, could assume a LOW or VERY LOW rating. Such change would generally be novel additions or expansions of activities already present within the SES.
LOW (score 2)	The SES has very little latitude to accommodate change. Changes should be approached with caution or avoided altogether as the SES should shift into an (undesirable) alternate state should further pressure be placed on it. Such change would generally be associated with either novel additions or extensions or expansions or expansions of activities already present within the SES.
VERY LOW (score 1)	The SES has no latitude to accommodate change. Changes should be approached with extreme caution or preferably be avoided altogether as the SES could easily shift into an (undesirable) alternate state. Such change would generally be associated with either novel additions and extensions or expansions of activities already present within the SES.

A SES rating has been provided under each VEC, but for convenience, a comparative summary has also been provided in table 5.3.

Table 5.3 Summary of the comparative SES (resilience) of each VEC against combined possible growth/pressures in the Cuando Basin under the assumed low-medium growth scenario.

	VEC 1 Angolan Water Tower and perennial water along the Cuando	VEC 2 The immense area of swamps and reedbeds	VEC 3 Linyanti Swamps and Savuti Marsh	VEC 4 Western flanks of the Cuando.	VEC 5 Wildlife corridors	VEC 6 Cuando aquifer
Ability to absorb additional impacts based on low-medium growth scenario	1a High	1b Low	1d Low	1b Med	1a ?	1a High
	1b Med				1b Med	1b Med
	1c Low			1c Low	1c Low	1c Low
	1d Low				1d Low	1d Low

For the assessment of cumulative impacts, the following criteria had to be met:

- a clear social/environmental effect of the likely activity or process;
- the effect must be demonstrated to operate cumulatively with the effects from other projects or activities;
- it must be known that the other projects or activities have been or will be carried out and are not hypothetical; and,
- cumulative effects must be likely to occur.

As per standard definition, the assessment of cumulative effects should consider other past, present, and reasonably foreseeable projects and activities.

VEC 1: The Angolan Highlands Water Tower and perennial supply of water along the length of the Cuando River

Spatial extent

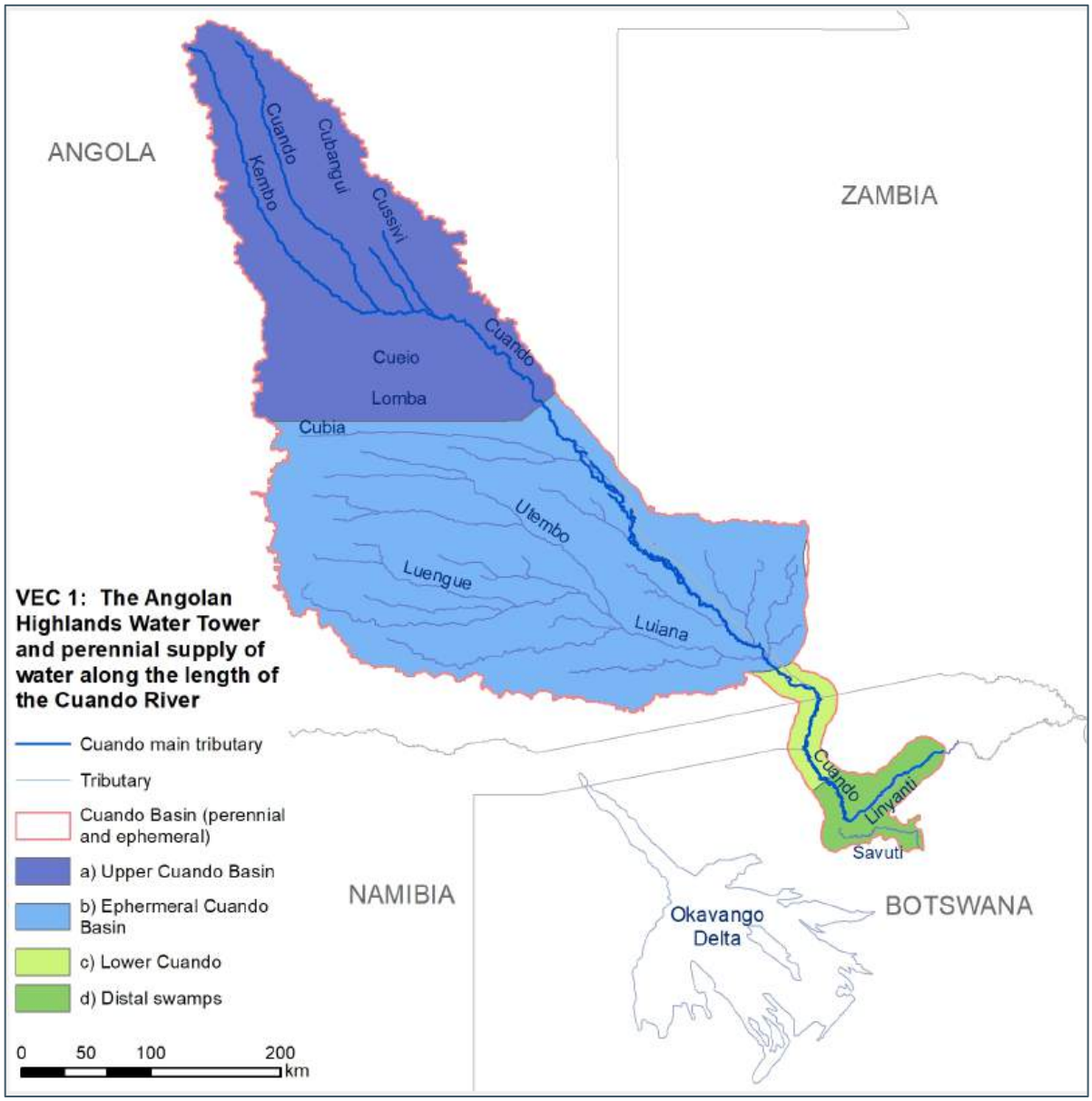


Figure 5.1: The areas of perennial supply of water along the Cuando River.

Description

Water in the Cuando River is derived almost entirely from Angola[48]. For the purpose of this assessment, the Basin is divided into 4 parts:

- (1a) The uppermost part of the basin is situated in the Bié Highlands, and all channels and tributaries are perennial. This area forms part of the Angolan Highlands Water Tower,

[48] Table 3.1 (p 47) of Scoping Report of this SEA.

where the Cuando makes up a relatively small component of the total area of the 'Tower'[49]. The main tributaries in this area are the Kembo, Cubangui, Cussivi, Cueio and Lomba Rivers.

- (1b) Downstream of this, the main river receives ephemeral contributions from tributaries such as the Luiana, which occasionally supply relatively small amounts of water from areas of the basin in south-eastern Angola. Other tributaries in this area include the Cubia, Utembo and Luengue Rivers.
- (1c) Further downstream, the Cuando enters Namibia and can be described as a linear oasis, a source of permanent water in relatively dry surroundings.
- (1d) At its most distal parts, the flows disperse and finally end in the Linyanti Swamps and very rarely as far as Lake Liambezi, and sometimes sending water into the Savuti Channel and Marsh.

The Cuando River is relatively small in total discharge, compared to other rivers rising from the Angolan Highlands[50]. Although the channels are small and flow is very slow in the middle and downstream sections, there is no other surface water over this expansive area. Small towns along the main stem of the river, such as Cangamba, Cangombe, Rivungo, Shangombo and Kongola, and many villages, depend entirely on Cuando water.

The year-round presence of water with secondary channels, backwaters and disconnected channels (Figure 5.3), sustains huge areas of reedbeds and swamps. These wetlands are vital components for local livelihoods in all four of the basin states, including the isolated scattered homesteads of people who live on small islands in the floodplains in Angola.

The distal parts of the system comprise swamps (Linyanti and Nkasa Ruparo) that are smaller versions of the Okavango Swamps, and these areas are important contributors to the tourism industries of Namibia and Botswana.

[49] Lourenco M, Woodborne S. 2023. Defining the Angolan Highlands Water Tower, a 40 plus-year precipitation budget of the headwater catchments of the Okavango Delta. Environmental Monitoring and Assessment 195:859 https://doi.org/10.1007/s10661-023-11448-7

[50] Huntley, B.J., Russo, V., Lages, F. and Ferrand, N. (2019). *Biodiversity of Angola: Science & conservation: A modern synthesis* (pp. 552). Springer Nature. https:// library. oapen.org/ handle/ 20. 500. 12657/ 22908 .

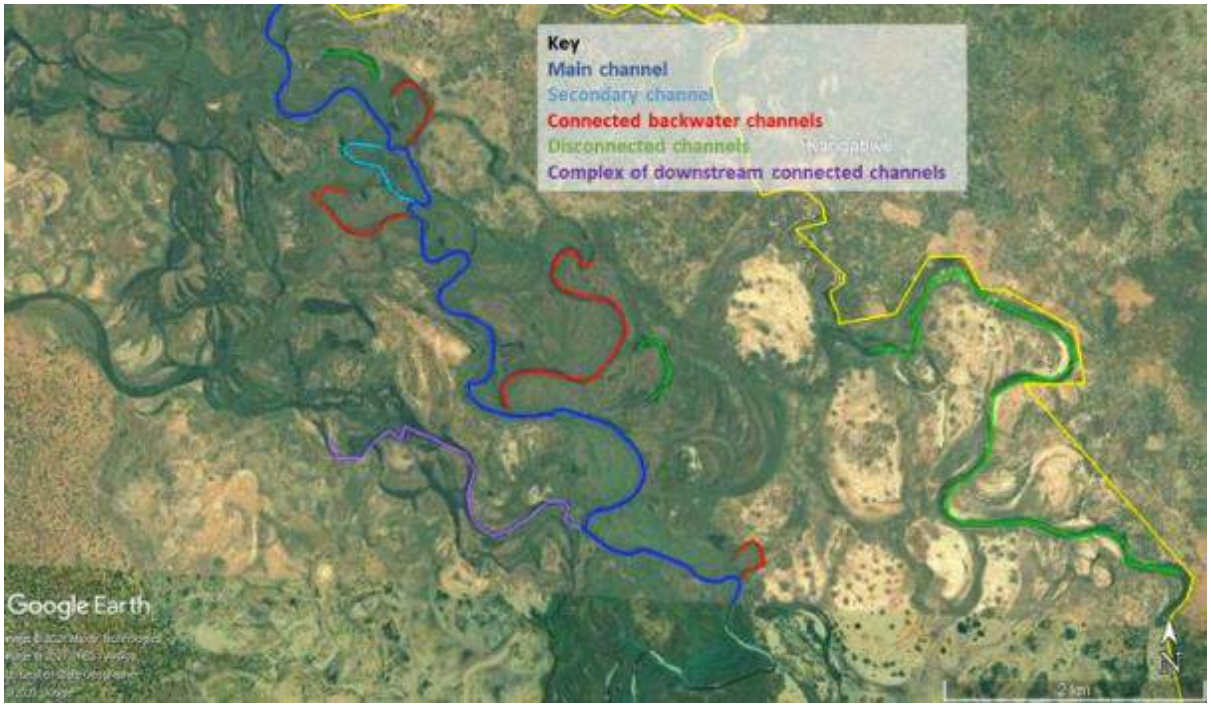


Figure 5.17 Showing the meandering nature and complex of channels that make up the Cuando River. Coordinates -17.5997854S 23.377336E. From presentation by D.Hughes & E.Kapangaziwiri, 2021: Hydrological modelling of the Kwando River.

Figure 5.3 The clear, unpolluted water of the Cuando River. Photo taken on the NGOWP 2018 expedition down the Cuando.

Figure 5.4 Shangombo, a small town in Zambia alongside the Cuando River. Photo J.Mendelsohn

Motivation for its inclusion as a VEC

The water supply is fundamental to the structure, functioning and value of the entire Cuando River Basin. Stop or change the supply of water and the Cuando Basin will cease being what it is, which will also eliminate its benefits for the functioning of the wider KAZA landscape.

Current state, existing conditions

The average annual discharge of the Cuando, measured over 50 years up to 2020 at the Kongola gauging station, is just over 1,000 Mm^3 per annum, with annual variations between 2,200 Mm^3 and 490 Mm^3 over that period[51].

Flows in the Cuando river system are very sensitive to quite small variations in total rainfall, and consequently the extent of floodplain inundation is also expected to be highly variable as well[52]. Further investigations will be required to determine the extent to which the high variability in both upstream flows and floodplain inundation are likely to be impacted by future variations in land-use and climate change.

[51] P 48, and Figure 3.7 (p49), Scoping Report of this SEA. Mendelsohn J. 2022. The Angolan catchments of northern Botswana's major rivers: The Cubango, Cuito, Cuando and Zambezi Rivers. In Eckardt FD (ed.), Landscapes and Landforms of Botswana, World Geomorphological Landscapes, Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-86102-5_2

[52] Hughes D, Kapangaziwiri E. 2021. Developing an understanding of the hydrology (water resources) of the Kwando River basin. Deliverable 6 of Hydrological modelling and e-flow assessments for the Cuando (Kwando) River. Unpublished report to WWF Zambia.

The Namibian Government has plans to abstract water from the Cuando for the provision of rural settlements and livestock along the C49 road between Kongola and Linyanti[53]. Abstraction will be at a rate of 0.5 Mm^3/annum, over and above the existing abstraction of 0.135 Mm^3 per annum that is permitted by the Namibian Department of Water Affairs, bringing the total abstraction to 0.635 Mm^3 per annum. The EIA for this project calculated this consumption to be 0.4% of the minimum annual flow of 6 m^3/s, and concluded that there was no significant impact. The report does warn that there are risks of possible prolonged drought conditions in future under climate change, and that increased water abstraction in Angola and Zambia could reduce the available flow at Kongola. These risks could make the proposal unviable.

Water quality in the Basin is generally good. Indices for water quality measured upstream of Rivungo – pH, Oxidation-Reduction Potential, Total Dissolved Solids, Dissolved Oxygen, Conductivity and Salinity – showed healthy water conditions[54]. There is very little input of human-derived pollutants in the upper and middle Cuando because there are so few people in these areas. Short sections of the channels downstream of towns such as Cangamba and Mavinga carry pollution, but the purifying effect of the floodplains probably absorbs this within a few tens of kilometres downstream[55].

Cuando water in the lower parts of the Basin contains more dissolved solids as the water becomes enriched with organic matter as it heads downstream. To illustrate, conductivity values rose from 90 measured at Kongola to 300 µs/cm in the Linyanti Swamps[56], while Grade A drinking water in Namibia is less than 1,500 µs/cm [57]. There is no further water quality data on the river downstream of Kongola but water quality is thought to be slightly lower as one moves downstream - but remains excellent overall.

The current state of the VEC is illustrated using a 'dashboard'. The scoring for the dashboard is subjective, given that there are inadequate data for any of the VECs that would enable a more robust score being assigned. Instead, the SEA team has relied on professional judgement based on available literature and personal knowledge of the Cuando. Where the needle is adjacent to the green spectrum, the VEC is regarded as being in a healthy state. If the ecological functioning or health of the VEC deteriorates over time, the needle will move towards the yellow and eventually into the red. The value of the dashboard is simply to illustrate, at a glance, the state of the VEC. Future monitoring will hopefully refine the scoring parameters and thus enable updating of the dashboard.

[53] Ministry of Agriculture, Water and Forestry. 2016. Environmental Impact Assessment for the Katima Mulilo – Kongola Water Supply Project – Phase 3, Zambezi Region, Namibia. Final EIA Report, compiled by Lithon Project Consultants, Windhoek.
[54] National Geographic Okavango Wilderness Project, 2020. Final Report: Scientific Exploration in Angola During 2018. Pp 70
[55] Mendelsohn J, Martins A. 2018. River catchments and development prospects in south-eastern Angola. RAISON
[56] Van der Waal B. 1976.
[57] Water Act, 1956 and its requirements in terms of water supplies for drinking water and for waste water treatment and discharge into the environment.

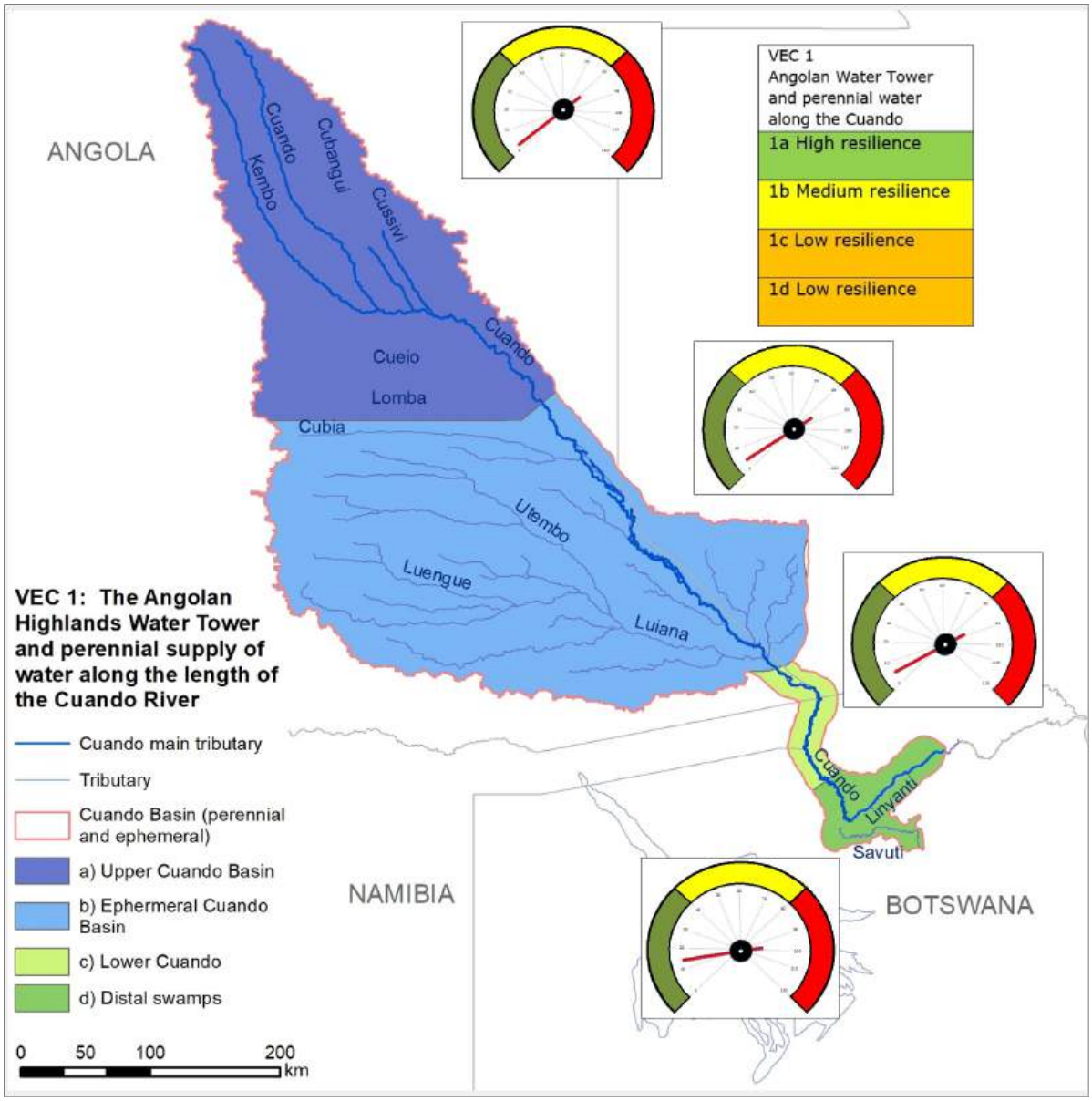


Figure 5.5: VEC "health scorecard" for sub-components 1a, 1b, 1c and 1d.

Vulnerability to cumulative impacts

The proposed abstraction in Namibia provides a measure of the scale of water consumption for domestic use in the Basin, which will probably always be low. Even with increased urban growth, the proportion of water abstracted for this use is expected to be within safe limits (see table below). Pollution from urban sources is expected to be relatively quickly mitigated by the purifying effects of the Cuando's reedbeds.

Water consumption of main towns and villages in the Cuando Basin		
	2022	Projected 2033 (assume 20l pp/d)
Angola	2,093,100	3,033,860
Botswana	34.300	38,860
Namibia	714,000	812,420
Zambia	1,194,000	1,372,660
Water used litres p/a	4,035,900	5,257,800

Although Zambia has at times planned large irrigation schemes using Cuando water, these appear to have been abandoned, and to our knowledge there are presently no firm plans to abstract water from the Cuando for irrigation. It is more than likely, however, that more irrigation schemes will be mooted and planned and some may be implemented. Regardless of the country, irrigation demand will far exceed any demand for human consumption in the Cuando, and is predicted to significantly impact the hydrology of the river system, as well as the delicate water balance of the distal swamps[58].

An example of an early irrigation farm, now abandoned, is available from near Linyanti, where the pre-Independence Namibian Government established a 30 hectare centre-pivot irrigation project, drawing water from a side-channel of the main river. The scars from this project are now largely invisible, but were conspicuous in a 2015 Google Earth image (Figure 5.23 below). The scheme was abandoned shortly after being established as the water at the abstraction point dried up. It is not known whether this was solely due to the abstraction from the river or if it was brought on by abnormally low flows. Whatever the case, it illustrates the vulnerability of irrigation projects relying on Cuando water.

[58] MAWF 2016 Katima Mulilo - Kongola Water Supply Project Phase 3. EIA Specialist Report: Hydrology. Compiled by Lithon Project Consultants, Windhoek.

Figure 5.6: The faint scar of an irrigation scheme established near Linyanti in ~1988, and subsequently abandoned due to insufficient water. The waypoint is at roughly 18.068159S, 24.028285E.

The effect of climate change on the Cuando system is a concern. Rainfall patterns across the broad catchment areas of the Okavango, Cuando and Zambezi between 1950 and 2005 showed that years of less rainfall were associated with warm phases of El Niño Southern Oscillation events[59]. Up to a 4% decrease in precipitation and warmer conditions are expected for the Angolan highlands by 2100, and the drought history of the highlands indicates negative trends in precipitation and increased drought frequency since 1981[60].

These changes, coupled with rising water demand, were modelled to cause a 100% decline in water availability in the Cuando-Chobe component of the Zambezi River Basin by 2050[61], meaning that the Cuando-Chobe 'link' would no longer contribute any water to the Zambezi system. This is not surprising, considering that there is already no link between the Linyanti and Chobe in dry years[62].

The Beck & Bernauer 2011 paper is perhaps not very helpful to understanding the effects of climate change on the Cuando. A more recent study focused on KAZA[63] warned that the Cuando River was vulnerable to climate change. Their predictions for 2050, relative to 1960-1990 records, showed for the whole KAZA region:

[59] Gaughan AE, Waylen PR. 2012. Spatial and temporal precipitation variability in the Okavango-Kwando-Zambezi catchment, southern Africa. Journal of Arid Environments 82: 19-30. doi:10.1016/j.jaridenv.2012.02.007
[60] Carvalho SCP, Santos FD, Pulquerio M. 2016. Climate change scenarios for Angola: an analysis of precipitation and temperature projections using four RCMs. International Journal of Climatology 37(8): 3398-3412. https://doi.org/10.1002/joc.4925
[61] Beck L, Bernauer T. 2011. How will combined changes in water demand and climate affect water availability in the Zambezi river basin? Global Environmental Change, 21(3), pp.1061-1072.
[62] See Scoping Report to this SEA, which draws on information from Pallett *et al.* 2021 State of the Cuando River Basin Report.
[63] Anchor Environmental Consultants 2020. Climate Change Vulnerability and Adaptation Assessment for Protected Areas of the Kavango–Zambezi (KAZA) Landscape. Prepared for WWF Madagascar by Coldrey K, Turpie J, Anchor Environmental Consultants, RSA.

- Decrease of total annual precipitation by 4.6%;
- Hot dry season drier by 33%;
- Hot wet season drier by 3.3%;
- Cool dry season drier by 22%;
- Increase in mean annual temperature by 3 ^{0}C (14%).

The report predicts that the north-western parts of the landscape (Angola and parts of Zambia and Namibia) will get substantially drier, and that the western parts of the landscape (Angola and parts of Botswana and Namibia) will warm more than the rest of the landscape.

All of these various climate change predictions have major implications for the Cuando because of the sensitivity of downstream flows to rainfall variations in the upper catchment, pointed out in the Hughes 2023 study. Also, the whole KAZA area, particularly its ecological dependence on wetlands, is closely tied to the integrity of the Okavango, Cuando and Zambezi river systems, which all rise in Angola.

Cumulative impacts

The most likely development that would decrease flow volume in the Cuando would be large-scale irrigation projects. On top of abstracting large volumes of water, the quality of river water might also be reduced through return flows carrying nutrients and pesticides, which would be detrimental to the downstream river vegetation and fauna.

Increased use of Cuando water could also occur through activities such as mining, which usually uses large amounts for mineral processing, and expansion of road and rail infrastructure which would allow many other projects to then accelerate, such as growth of towns and tourism, and a general upscaling of development activities. These activities would all add to water consumption from the river.

Climate change is likely to reduce the total volume of water in the river, due to lower precipitation and higher evaporation and evapotranspiration rates. Dams and weirs across the channels are only viable in the upper parts of the Basin where relief is great enough to create a reservoir of water. In the middle and lower parts of the Basin, the landscape is so flat that a dam would be grossly inefficient due to the small volume of water held relative to the large surface exposed to evaporation.

The impacts of less water in the Cuando are likely to be reduced extent of the inundated floodplains and swamps downstream, and reduced likelihood of water reaching its usual endpoints in the lower Linyanti and Savuti swamps. Aquatic habitat will likely be reduced, with a consequence for populations of hippos and other large fauna. Livelihoods for people living on and close to the floodplain may become more difficult, due to reduced water availability in the backwaters and secondary channels. It is difficult to predict the consequences because there is fortunately so little disturbance of the river and thus no case studies to learn from.

An Ecological Flow Assessment for the Cuando is necessary to identify what level of abstraction could be sustained without causing significant harm to the social and biophysical environment. This assessment should identify the maximum abstraction that could be permitted at the various sections of the river, and any seasonal or annual variations that might have influence. Also, the consequences of climate change need to be included in the assessment, as a major factor affecting total water availability for human activities.

Recommended mitigation measures

Cuando flows would be better understood with more flow gauges installed at strategic places in the basin. The first priority would be a flow gauge at the lower end of the perennial area of the Basin, point CHB1A in Hughes & Kapangawiziri (2021)[64].

An Ecological Flow Assessment for the Cuando is a necessary precondition for understanding the impact of thirsty developments, such as large-scale irrigation projects. All EIAs for projects in the Basin should address their water consumption and how they contribute to the total abstraction for the entire river basin.

All development activities in the Basin should be undertaken under strict guidelines for water conservation. For instance, large-scale, centre-pivot spray irrigation projects should be prohibited, as this method of irrigation is very wasteful of water.

Residual effects

The presence of perennial water in the main river and tributaries in the upper Cuando Basin is considered to have High resilience to absorb the impacts of low-medium growth (see Table 5.4 above). This level of resilience drops to Medium in the wide floodplains, and Low in the lower parts of the Basin.

Any residual effects from individual projects can only be assessed when the project details are known, and when these have been subjected to specific EIAs.

[64] Hughes D, Kapangaziwiri E. 2021. Developing an understanding of the hydrology (water resources) of the Kwando River basin. Deliverable 6 of Hydrological modelling and e-flow assessments for the Cuando (Kwando) River. Unpublished report to WWF Zambia.

VEC 2 – The immense reedbeds adjoining the Cuando River channel

Spatial extent

The reedbeds cover an area 5-15 km wide for about 500 km of river length, making up about 3,450 km^2 overall.

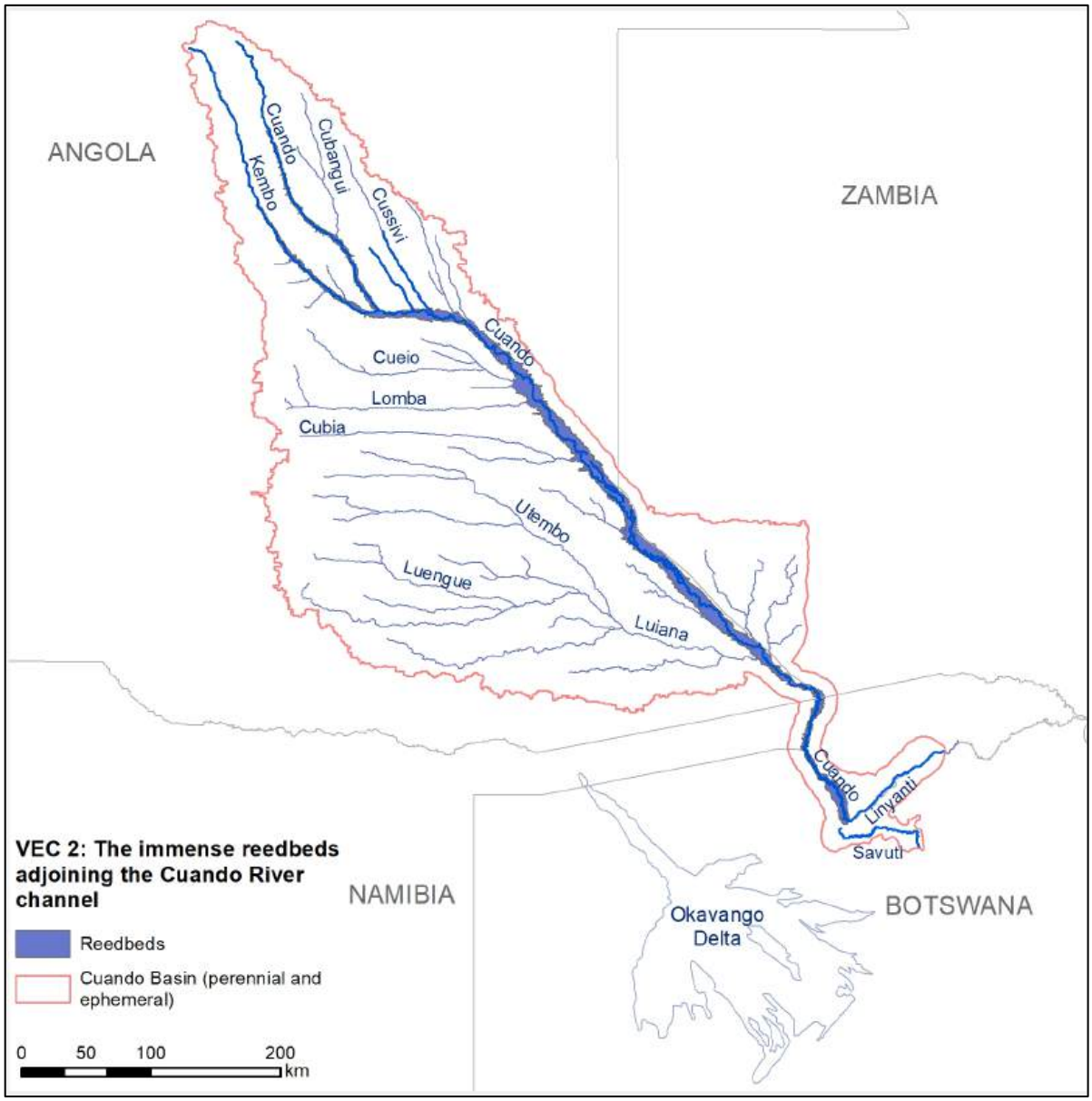


Figure 5.7: The area of wide reedbeds along the Cuando.

Description

The extensive reedbeds of the Cuando are the feature that most characterise this river. The term 'floodplain' is also used to describe this habitat but is not really accurate for the Cuando because these areas are not subjected to seasonal floods. They are mostly permanently inundated or kept permanently wet from the lateral seepage of water from the main channels.

The reedbeds begin approximately at the confluence of the Kembo and the main river, and extend to close to the border with Namibia, where they narrow sharply. The Cuando reedbeds in Angola, shown in the images below, create an extensive area of dense – almost impenetrable - stands of tall grasses, phragmites and papyrus reeds. This area is much larger than other such floodplains on the Cubango and Cuito Rivers in Angola, and the Barotse floodplain on the Zambezi in Zambia.

Figure 5.8 Aerial view of Cuando reedbeds north of Rivungo. From NGOWP 2018.

Figure 5.9 Reedbeds covering the Cuando floodplain. From NGOWP 2018.

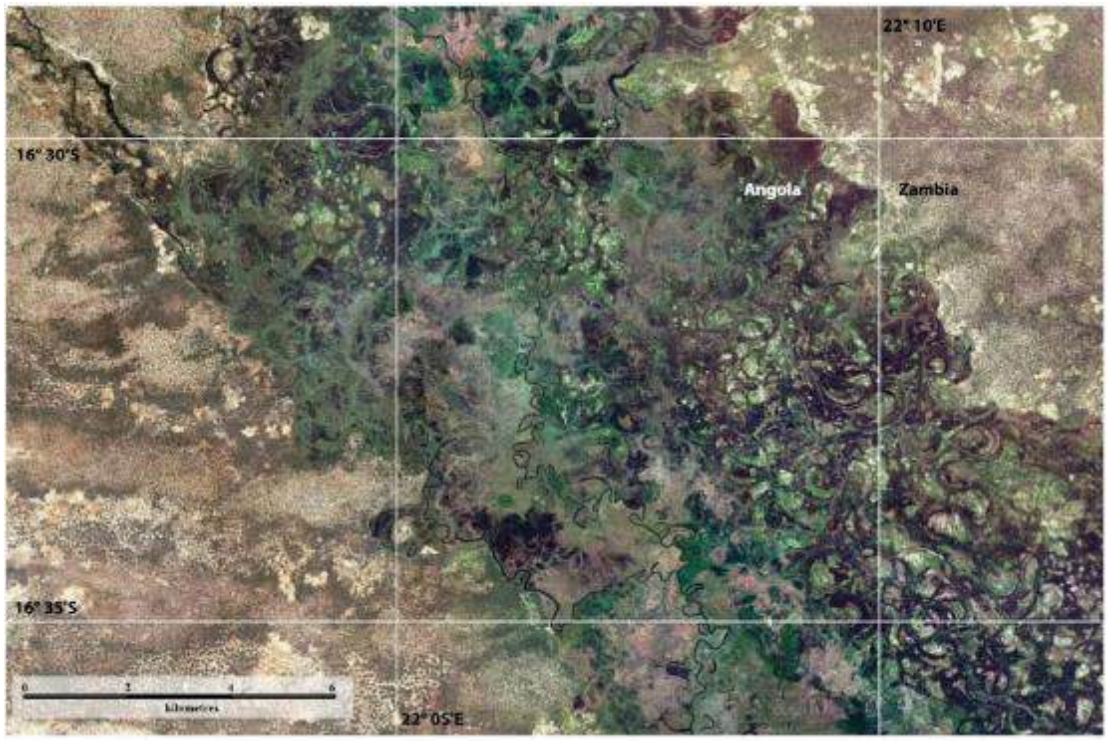


Figure 5.10 Satellite image of part of the Cuando floodplain south of Rivungo. The meandering main channel, seen as a thin black line in the image, is about 10-20 m wide. From Mendelsohn 2018 .

The floodplains arise from the extremely flat terrain of the Kalahari Basin that the river flows over. The vegetation perhaps grows on peat deposits, formed from years of accumulation of dead plant material.

Motivation for its inclusion as a VEC

The Cuando reedbeds in Angola form a large continuous habitat that is likely to form a refuge for many rare southern African wetland animals, such as waterbirds and sitatunga. The peat beds store carbon, purify water and reduce flooding and soil erosion.

Current state, existing conditions

There is almost no data to quantify the status of the floodplains. There are a few places where the floodplain has been physically changed, such as the ~2017 dredging of the canal between Rivungo and Shangombo to facilitate passage for small boats and barges (Figures below).

Figure 5.11 Ground-level and water-level views of the Cuando floodplain at the edge of the man-made canal that connects Rivungo and Shangombo. Photos: J.Mendelsohn.

Figure 5.12 The Shangombo-Rivungo canal.

In the area close to Rivungo, there is very little evidence of aquatic wildlife living in the floodplain, such as hippo paths or scats of otters. However, Zambian people living close to the river do talk about crocodiles and hippos causing conflict with dogs, livestock and people. Also, the 2018 NGOWP expedition down the Cuando was abandoned downstream of Rivungo due to frequent hostile interactions with hippos. Such anecdotes confirm the presence of wetland wildlife and suggest that the area is quite 'wild'. A Government official in Shangombo (2021) referred to the Cuando reedbeds as a kind of "no-mans land", since the area alongside the international border is officially in Angolan territory and is not heavily utilised from the Zambian side.

Fire could potentially damage large areas of floodplain at a time, but there appears to be little record of the extent or frequency of fires over the floodplains. Presumably, burned areas would

quickly recover. Fires might even have a positive impact by getting rid of old moribund plants, clearing the way for fresh growth.

People use reeds in crafts and domestic utensils, such as mats and shelters, but this is surely an insignificant use that is quickly renewed by natural growth.

In the absence of any information to the contrary, the tentative score for the reedbeds in Angola is Good.

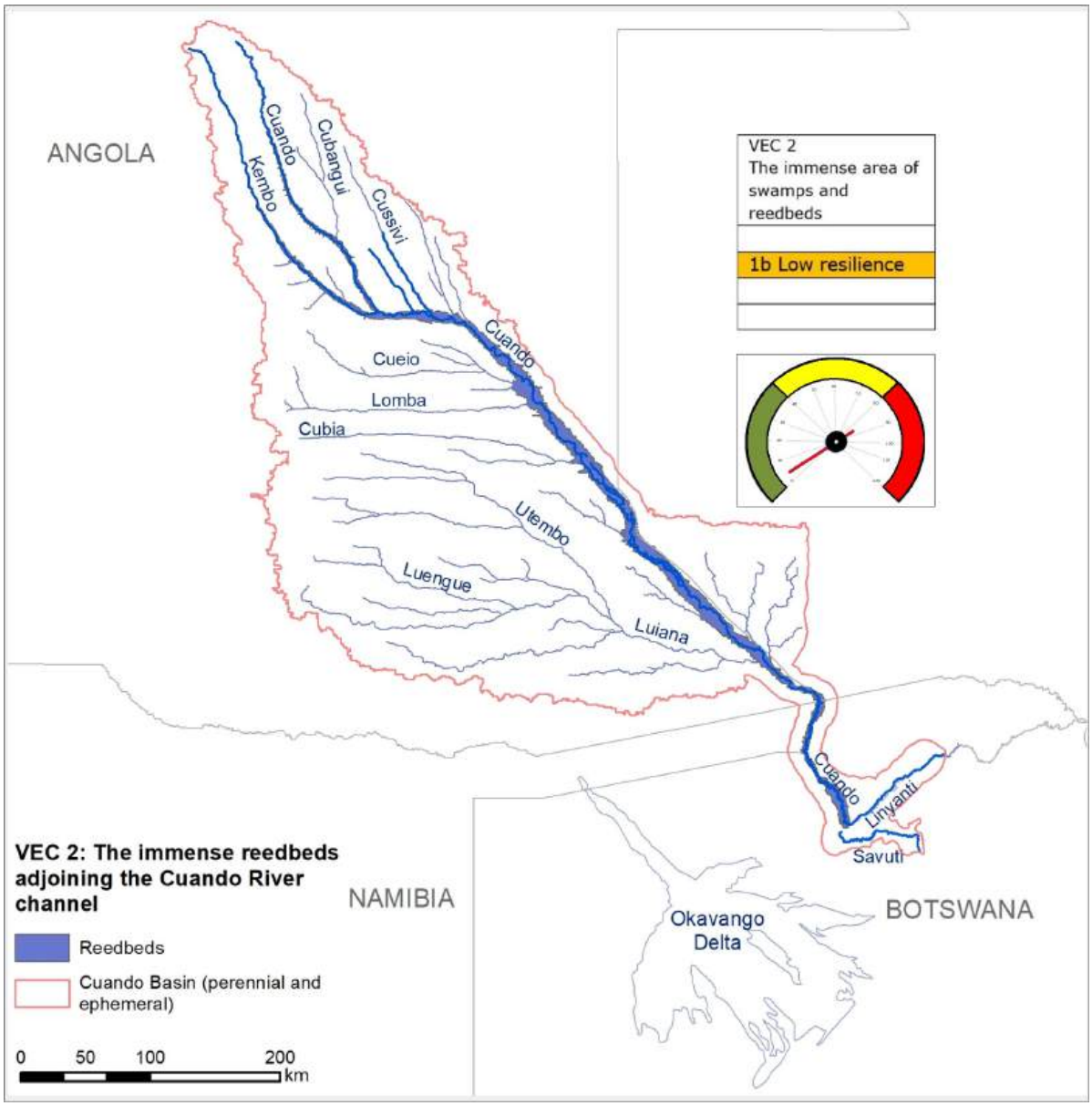


Figure 5.13: VEC "health scorecard" for Cuando sub-component 1b, the floodplains in Angola.

Vulnerability to cumulative impacts

The extent of the floodplains is considered to be very sensitive to the total amount of precipitation in the Angolan highlands[65].

Cumulative impacts

Sectors that are likely to cause changes to the floodplains are those that abstract large volumes of water, notably large-scale irrigation and mining. As described above for VEC 1, this would probably lead to a decrease in the floodplain area, and changes in the floodplain vegetation as permanently wetted areas dried out. It is difficult predict how these changes would proceed: patches of reedbeds would die, possibly giving way to open grasslands growing on the fertile peaty substrate.

Expansion of road infrastructure in Angola is likely to include west-east linkages extending into Zambia, with the need for road crossings over the floodplain. This is likely to include embankments over the floodplain and constriction of channels, which would probably lead to dying back of reeds in those patches starved of water. Again, the vegetation changes that would follow are difficult to predict.

It is likely that severe fires in the reedbeds would occur, given the masses of dried out fuel available, and hot, windy conditions to intensify the flames. Also, peat beds would be ignited or might spontaneously ignite, as occurred in Lake Liambezi in the past[66], creating dangerous underground fires that smoulder for weeks. In those situations, animals and people walking on the surface are at risk of falling through the surface crust to become instantly burned alive and buried.

These conditions will be exacerbated by climate change which is expected to reduce total water flow in the river and cause the floodplains to shrink. The vegetation changes in a warmer and drier climate, with hot destructive fires, are even more difficult to predict.

Recommended mitigation measures

Any developments that abstract large quantities of water from the Cuando should not be permitted. The thresholds for such abstraction need to be identified in a specific Ecological Flows Assessment.

All development activities in the Basin should be undertaken under strict guidelines for water conservation, to minimise total water abstraction from the river.

Any linear infrastructure crossing the floodplain should be designed to allow unhindered flow of water downstream, modelled on high water conditions so that periodic high-water events are also not constrained. There should be minimal footprint on the reedbeds themselves. Solid embankments, such as the river crossing at Kongola in Namibia, should especially not be allowed to cross the wide floodplain, as this would starve areas immediately downstream of water.

[65] Hughes D, Kapangaziwiri E. 2021. Developing an understanding of the hydrology (water resources) of the Kwando River basin. Deliverable 6 of Hydrological modelling and e-flow assessments for the Cuando (Kwando) River. Unpublished report to WWF Zambia.
[66] Grobler M, Ferreira J. 1990. The dying of Lake Liambezi. Custos 19(6): 40-47.

Residual effects

The Cuando floodplains are considered to have Low resilience to developments in the low-medium growth scenario (Table 5.3).

The floodplains are rated as Very Highly vulnerable to climate change (Table 5.1), which will be imposed on the Basin as a consequence of human activities worldwide.

Any residual effects from individual projects can only be assessed when the project details are known. The Terms of Reference for any EIA in the Cuando Basin should include consideration of both individual and cumulative impacts, on total flow and on the floodplains in particular.

VEC 3 – Linyanti Swamps and Savuti Marsh in the lower Cuando

Spatial extent

This VEC covers all swamp habitat around and downstream of Nakatwa Island in Namibia, including the entire Nkasa Rupara National Park, the Linyanti Swamps and Savuti Marsh.

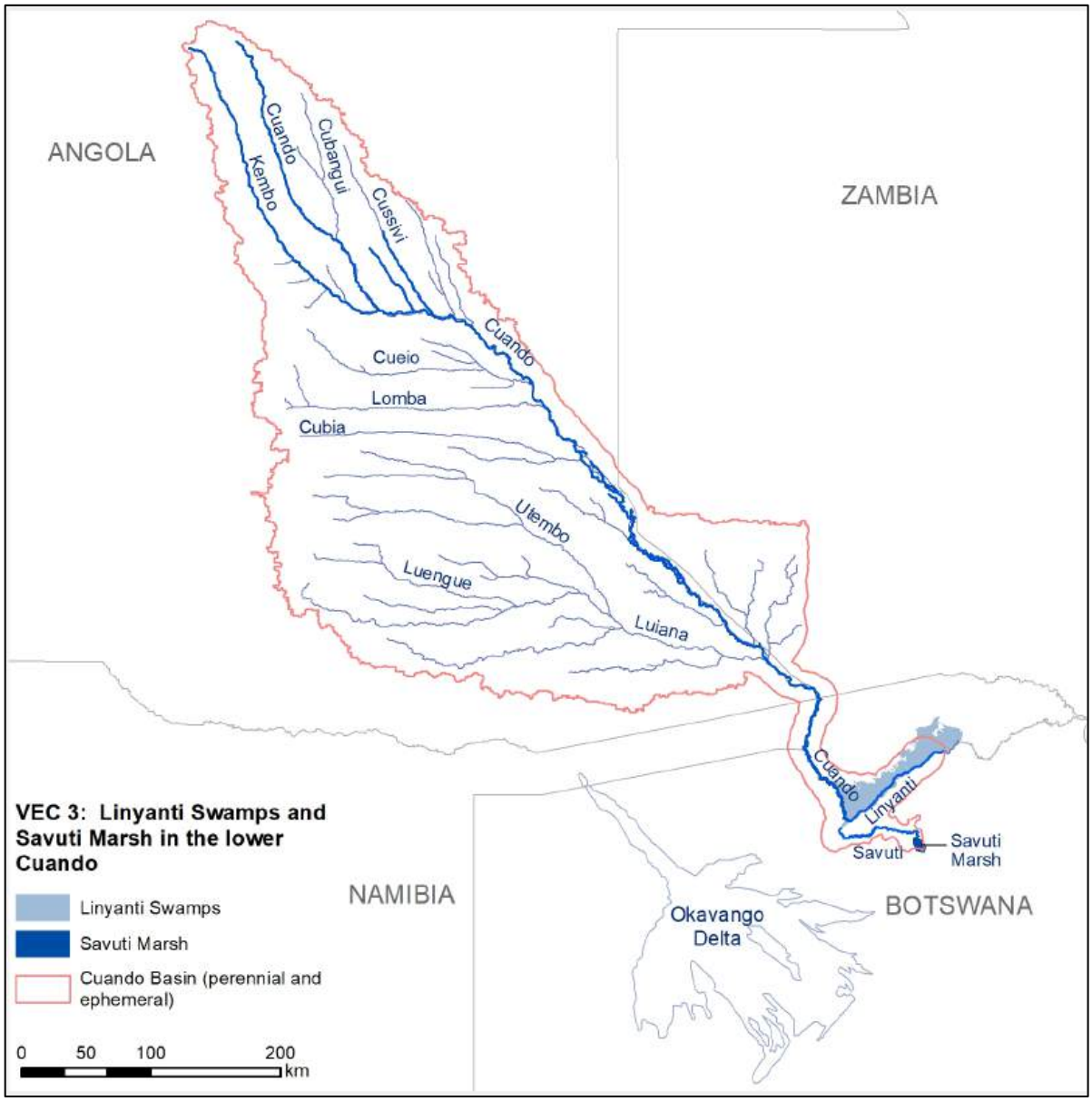


Figure 5.14: Swamp areas of the Linyanti and Savuti in the distal end of the Cuando.

Description

The wetlands of the lower Cuando cover an extensive area of floodplain and swamps, with meandering channels and oxbow lakes, interrupted by islands of slightly higher ground such as the large Nkasa and Rupara islands in the National Park with that name. The Cuando ends not as a discrete river but as an extremely long marsh with indefinite and varying end points. In dry years,

areas with surface water in the distal part of the Linyanti dry up progressively in an upstream direction, and the Savuti is reduced to just a single seep.

The Linyanti Swamp and marshes in Nkasa Rupara are essentially similar to other areas of permanent and seasonal swamps in and around the Okavango Delta. They can be thought of as 'mini' versions of the Okavango Delta, in the sense that they are smaller and receive less water, but are functionally very similar. In years of high rainfall, the waters in these systems do join together, so it is not surprising that their habitats and animal biodiversity are also shared.

A key feature of this swamp habitat is the diversity of micro-habitats in close proximity[67]. Plant growth is largely determined by the frequency and level of inundation and nutrients available. The close proximity of channels, reedbeds, islands and their margins, with varying soils dominated by sands or silts or peat, create varying conditions that attract different animals. The wetland areas are adjacent to extensive woodlands in Namibia and northern Botswana, again with a variety of dominant species such as mopane, teak and terminalia, where grasses and trees provide forage and refuge for a variety of herbivores (e.g. buffalo, roan and sable antelope, zebra, wildebeest, elephant), which in turn are prey for carnivores.

The two important factors in the system are:
i) the provision of water, in changing quantities and times from year to year, that sustains the wetlands and that creates the diversity of habitats within and around them.
ii) the relatively nutrient-rich status of the soils, arising from accumulation of nutrients as Cuando water moves downstream. Seasonal and ephemeral wetlands on rich soils are able to support an abundance and diversity of wildlife.

Figure 5.15 Linyanti Swamp at Mavunja Campsite, Namibia.

[67] i) Sianga K, Fynn R. 2017. The vegetation and wildlife habitats of the Savuti- Mababe-Linyanti ecosystem, northern Botswana. Koedoe 59(2), a1406. https://doi. org/10.4102/koedoe. v59i2.1406 ii) Mendelsohn J. 2010. Floods of life.

From a conservation perspective, the Savuti–Mababe–Linyanti ecosystem is part of the large conservation area of northern Botswana, more than 80,000 km^2 in size, forming one of the largest relatively unfragmented wildlife regions in Africa[68]. This area is contiguous with protected areas and community conservancies in Namibia.

Motivation for its inclusion as a VEC

This extensive Linyanti swamp and Savuti Marsh habitat is, together with the larger Okavango Swamps to the south-west, part of a relatively unfragmented ecosystem which offers a mix of wetland, woodland and grassland habitats that support a wide diversity of wildlife. For instance, as part of the Chobe National Park, this is the northern component of the long distance migration by Burchell's zebra from Nxai Pan National Park, recently noted as one of the longest ungulate migrations in Africa.

Large numbers of mammals use and move through this area which is part of a network of corridors to the south, west and east (see VEC 6). The Savuti channel and Marsh is a core visitor attraction in Chobe National Park in Botswana (figure 5.33). In Namibia, the Linyanti Swamp covers the entire Nkasa Rupara National Park and forms part of four communal conservancies; all these protected areas have tourism facilities in the Linyanti.

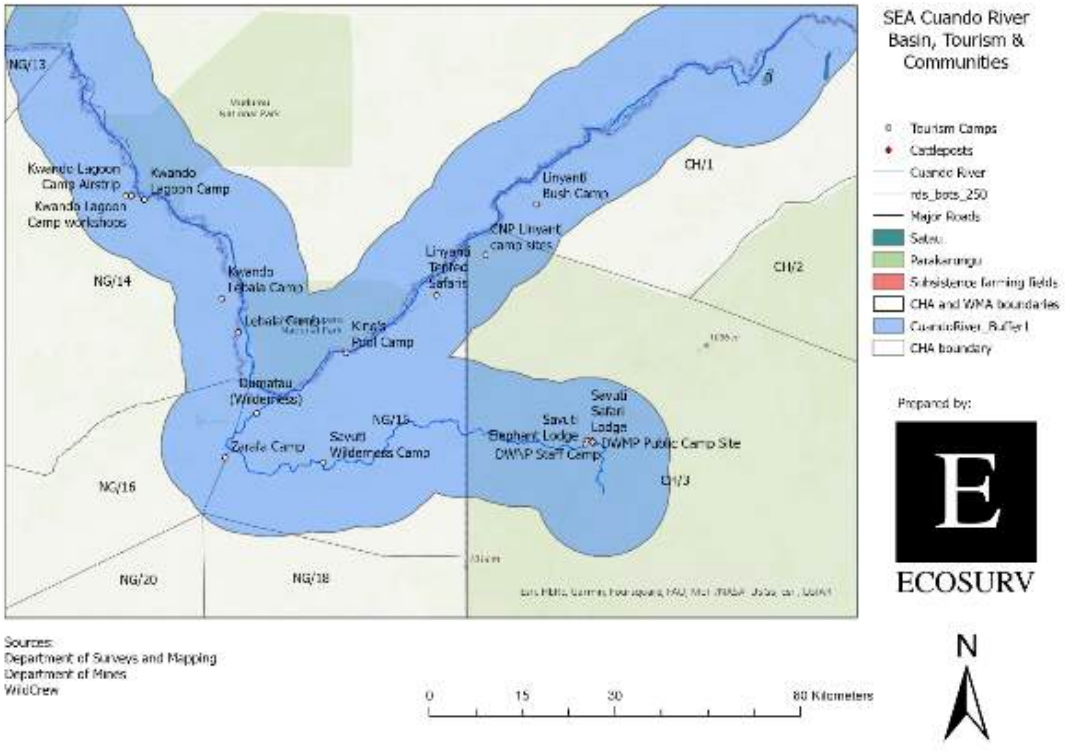


Figure 5.16 Tourism establishments in the Linyanti - Savuti areas of the Cuando River Basin.

[68] i)Bartlam-Brooks, HLA, Bonyongo MC & Harris S. 2011. Will reconnecting ecosystems allow long-distance mammal migrations to resume? A case study of a zebra *Equus burchelli* migration in Botswana. Oryx 45, 210–216 (2011).68. ii) Sianga K, Fynn RWS & Bonyongo MC. 2017. Seasonal habitat selection by African buffalo *Syncerus caffer* in the Savuti–Mababe– Linyanti ecosystem of northern Botswana. Koedoe 59(2), a1382. https://doi. org/10.4102/koedoe. v59i2.1382 iii) Naidoo R. *et al.* 2016. A newly discovered wildlife migration in Namibia and Botswana is the longest in Africa. Oryx 50, 138–146.

Current state, existing conditions

The Linyanti and Savuti wetlands are largely intact. The main human activities in the area revolve around tourism, with facilities at various places where there are waterfront views, and accompanying boat- and land-based wildlife viewing.

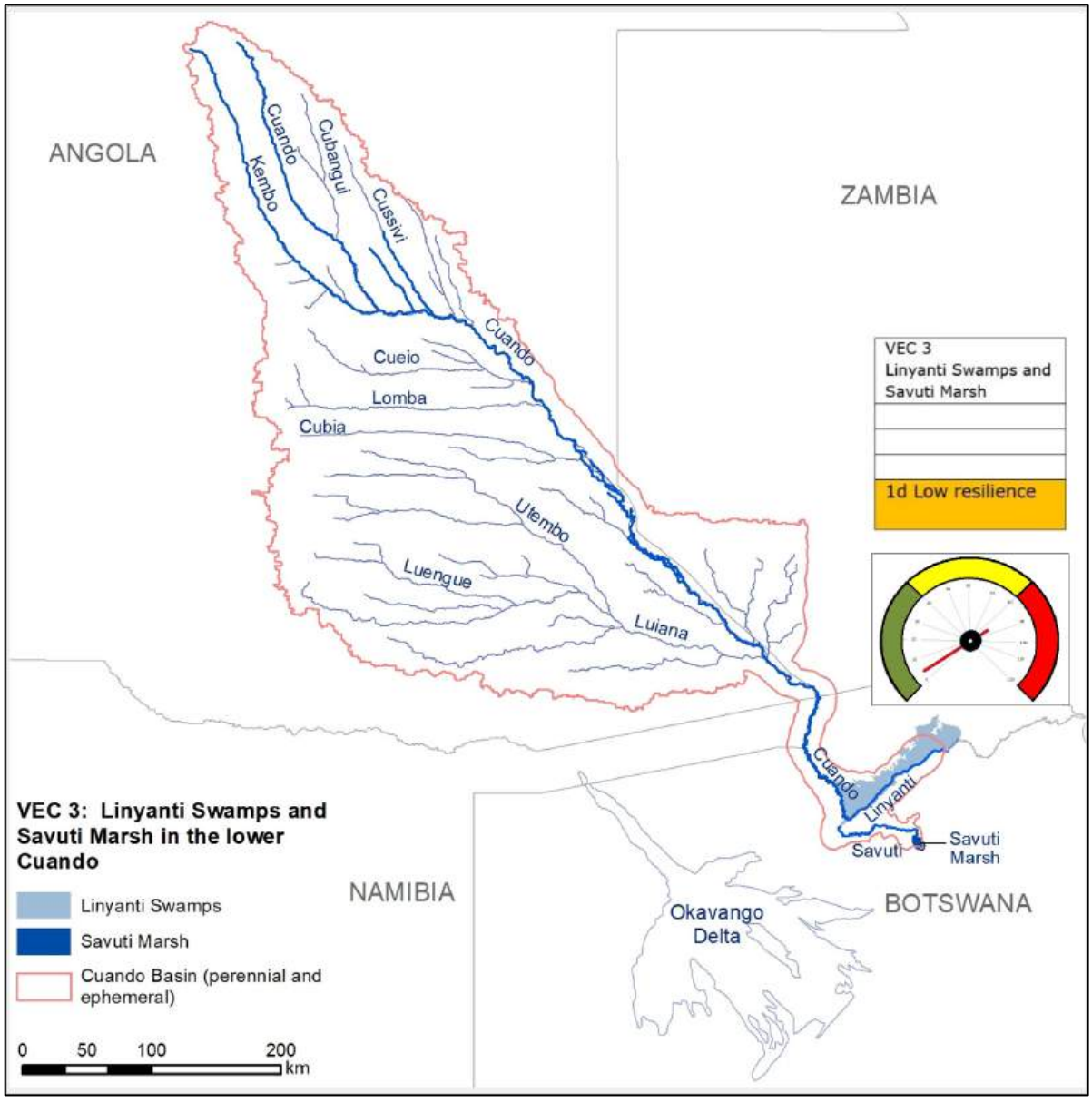


Figure 5.17 VEC "health scorecard" for Cuando sub-component 1d, the Linyanti Swamps and Savuti Marsh.

The variations in the extent of surface water in the marshes are driven by natural variations in the total volume of water in the river, which is largely intact, as shown for VEC 1 above.

Vulnerability to cumulative impacts

The distal points of the Cuando are vulnerable to diminishing volumes of water in the river, which could be caused by human activities such as abstractions for irrigation projects, and from climate

change induced reduced precipitation and increased evaporation and evapotranspiration in upstream areas.

Over the long term, the swamp areas rely on channel switching and episodic high-water events to distribute water and nutrients over the broad areas of swamps. These ecological processes might be affected by the narrow, permanent fixture of the channel at the Kongola bridge.

Cumulative impacts

A decrease in the extent of the Linyanti and Savuti marshes would cause severe impacts for the wildlife that depend on these wetlands. It is important to note that the conservation value of this central area of KAZA depends in part on these wetlands. Wildlife depend on the wetlands for water, food and shelter; they move to and from the wetlands seasonally in long-distance migrations, and they follow paths determined by the presence of water in the system. If these wetlands and water points are jeopardised, wildlife numbers and diversity are likely to suffer.

Shrinkage and drying up of the Linyanti and Savuti wetlands could negatively impact the livelihoods of local people who depend on that water, as well as the tourist industry that thrives here because of the wetlands and the wildlife they attract.

Changes in the vegetation would be expected as permanently and seasonally wetted areas dried out. As noted before, it is difficult predict how these changes would manifest. It is likely that severe fires would be experienced in the dried out swamp areas, and peat fires would also burn. These conditions will be exacerbated by climate change. The vegetation changes in a warmer and drier climate, with hot destructive fires, are difficult to predict.

Recommended mitigation measures

Any developments that abstract large quantities of Cuando water, or that restrict downstream flows to the distal parts of the system, should not be permitted. The thresholds for such abstraction need to be identified in a specific Ecological Flows Assessment.

All development activities in the Basin should be undertaken under strict guidelines for water conservation, to minimise total water abstraction from the river.

If the proposed upgrading of the Trans-Zambezi corridor plans are carried through with introduction of a railway, then the existing road crossing over the Cuando floodplain should be re-designed with a high bridge and minimal footprint on the floodplain. This recommendation goes for any river crossing over the Cuando. The crossing must be designed to allow unhindered passage of water downstream, and free movements of animals on the floodplain.

Residual effects

The distal swamps of the Cuando floodplains are considered to have Low resilience to developments in the low-medium growth scenario (Table 5.3).

Any residual effects from individual projects can only be assessed when the project details are known. The Terms of Reference for any EIA in the Cuando Basin should include consideration of both individual and cumulative impacts, on total flow and on the distal swamps.

VEC 4 – Western flanks of the Cuando in Angola and Namibia

Spatial extent

The Western Flanks cover the Cuando's ephemeral catchment and are included within the Luengue-Luiana, Mavinga and Bwabwata National Parks as well as Wildlife Management Areas in Botswana (Figure 5.35). This is the area adjacent to and on the western side of the main stem of the Cuando, in the middle and lower sections of the river.

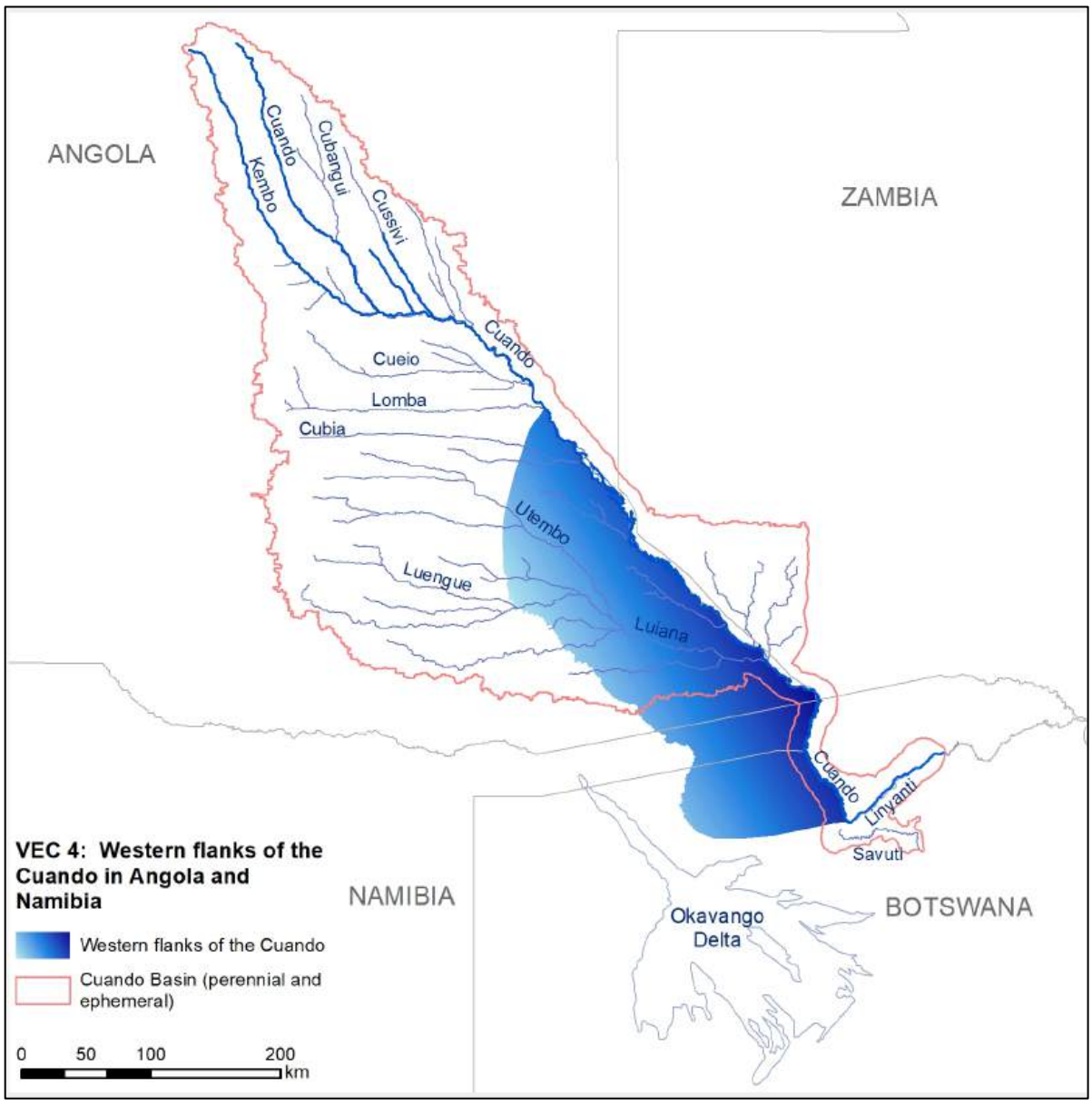


Figure 5.18: Western flanks of the Cuando River.

Description

A variety of features indicate that the western flanks of the Cuando River are comparatively rich in soil nutrients, plant cover and diversity, large mammal numbers and diversity, and tourism potential. The relative wealth of these features is highest close to the Cuando, especially in its southern areas. From there the values of the Flanks generally decline north-westwards. However, ephemeral drainage lines, such as the Luengue, Utembo and Luiana Rivers, add considerable heterogeneity to the landscape in their effect on vegetation types and communities (such as riparian woodland and floodplain grasslands) and the formation of clayey soils which hold water temporarily in pans and pools.

Soils in the Western Flanks may also be relatively more fertile, perhaps because of prevailing easterly winds which scoured silty, fine soils and their nutrients out of the Cuando river valley during occasional hyper-arid arid periods during the last few million years[69]. The scoured sediments were blown west and deposited on the western flanks of the Cuando, as demonstrated most clearly by the linear dunes in southern Angola and Bwabwata National Park (Figure 5.20).

Figure 5.19: Headwaters of the Luiana River at 16.34 South, 20.70 East (Photo J.Mendelsohn)

[69] (i) Burrough SL, Thomas DSG. 2013. Central southern Africa at the time of the African humid period: A new analysis of Holocene palaeoenvironmental and palaeoclimate data. *Quaternary Science Reviews*, *80*, 29–46. https://doi.org/10.1016/j.quascirev.2013.08.001 (ii) Garzanti E, Pastore G, Stone A, Vainer S, Vermeesch P, Resentini A. 2022. Provenance of Kalahari Sand: Paleoweathering and recycling in a linked fluvial-Aeolian system. *Earth-Science Reviews*, *224*, 103867. https://doi.org/10.1016/j.earscirev.2021.103867
(iii) Jolivet M, Dauteuil O, Gaudaré L. 2022. Blowing the rivers: Regional-scale control of the drainage network by wind in northern Kalahari (Africa). *Geomorphology*, *398*, 108039. https://doi.org/10.1016/j.geomorph.2021.108039

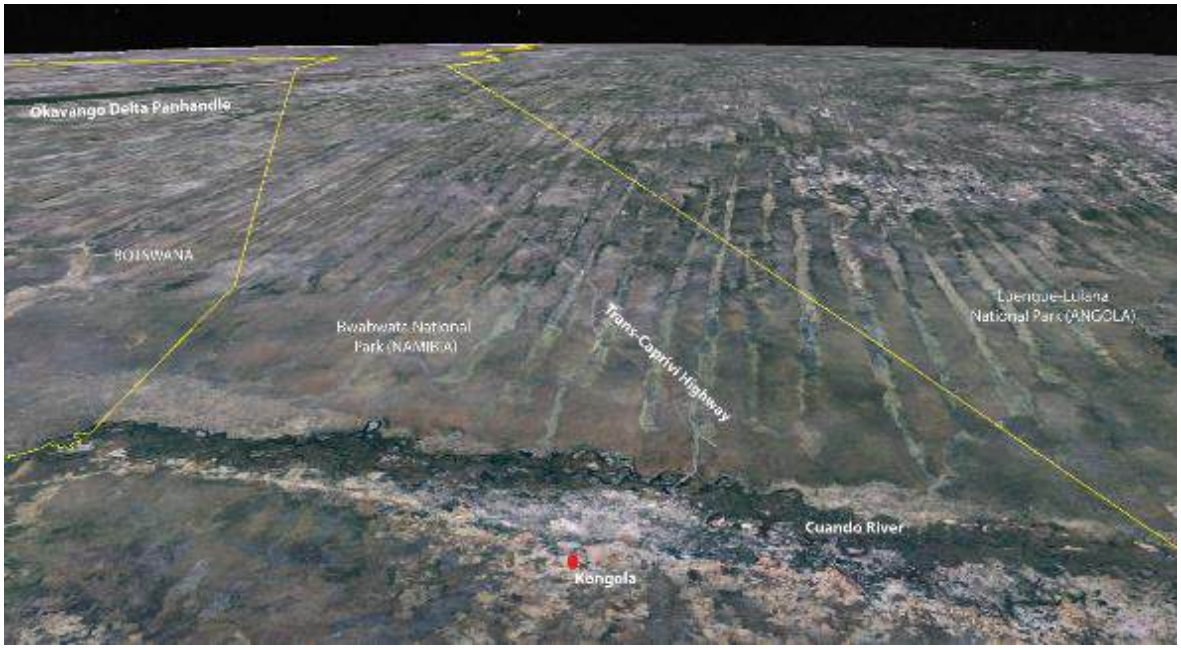


Figure 5.20: Perspective over the Western Flanks from the Cuando River looking west (adapted from Google Earth)

Motivation for its inclusion as a VEC

Most large mammals in the Cuando Basin live in the Western Flanks. A high proportion – if not the majority – of the locations of collared elephants between 2010 and the present were recorded in the Western Flanks (Figure 5.21). The highest diversity of large mammals in southern Angola is in the southern areas of the Western Flanks, a condition likely to be the same in Bwabwata National Park and northern Botswana's section of the Western Flanks. Several tourism establishments have been developed in this area of Botswana and tourists accommodated in Namibian lodges along the Cuando often visit the Western Flanks as day visitors.

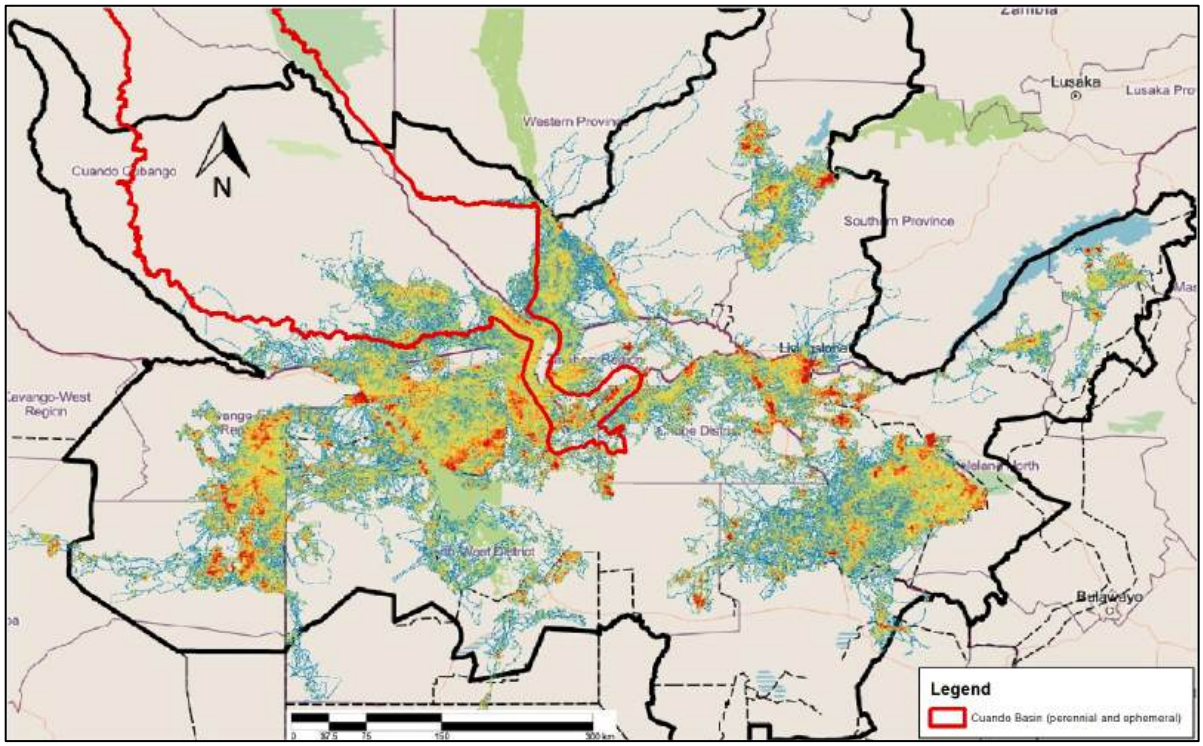


Figure 5.21: Intensity of use by 500-m grid cell of collared elephants in the Kavango-Zambezi Transfrontier Conservation area. From KAZA 2023[70].

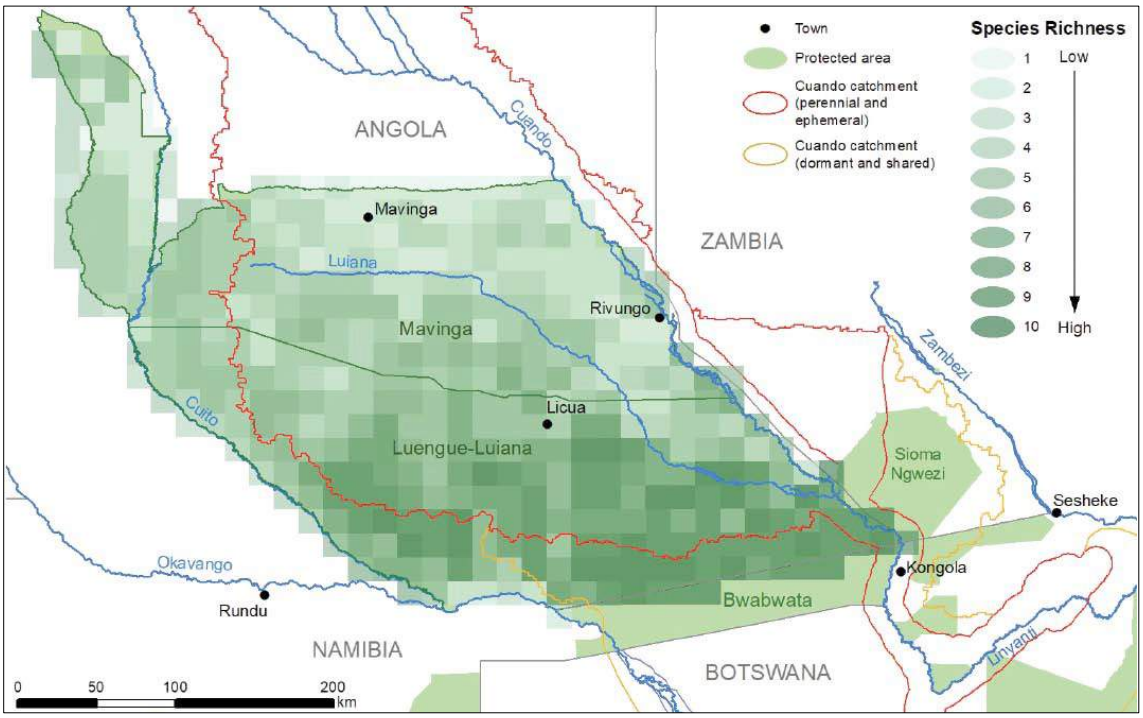


Figure 5.22 The number of 11 large carnivore and herbivore species predicted to occur across Mavinga and Luengue-Luiana National Parks (from Funston et al. 2017).

[70] KAZA Elephant Sub Working Group. 2023. KAZA POLICY BRIEF. Elephant Movements and Connectivity in the Kavango Zambezi Transfrontier Area (KAZA TFCA). Kasane, Botswana

The Western Flanks and Major Corridors overlap considerably, but they are treated as separate VECs. While the corridors offer ways for large mammals to move around the Cuando and KAZA[71], the Western Flanks offer relatively undisturbed natural habitats where browse, grazing and other food sources are available. During the wet season freshwater is often temporarily available for drinking in small pans and ephemeral river channels, while water in the perennial Cuando maintains mammal populations during the dry season[72].

Together with the Linyanti-Savuti delta system, the Western Flanks of the Cuando support the greatest numbers of large, iconic mammals and birds, and have the greatest potential for tourism and its value to the Cuando and people in the Basin.

[71] (i) KAZA Elephant Sub Working Group. 2023. Elephant Movements and Connectivity in the Kavango Zambezi Transfrontier Area (KAZA TFCA). Kavango Zambezi Transfrontier Conservation Area. (ii) Huang RM, van Aarde RJ, Pimm SL, Chase MJ, Leggett K. 2022. Mapping potential connections between Southern Africa's elephant populations. PLoS ONE 17(10): e0275791. https://doi.org/10.1371/journal.pone.0275791 (iii)

[72] Fynn RW, Chase M, Roder A. 2014. Functional habitat heterogeneity and large herbivore seasonal habitat selection in northern Botswana. South African Journal of Wildlife Research 44(1), 1-15.
Funston P, Henschel P, Petracca L, Maclennan A, Whitesell C, Fabiano E & Castro I. 2017. *The distribution and status of lions and other large carnivores in Luengue-Luiana and Mavinga National Parks, Angola*. KAZA TFCA Secretariat (KAZA).

Current state, existing conditions

The most important characteristic of the Western Flanks is the small population of people (Figure 5.23). Little of the area has thus been cleared for agriculture, the only fences are Botswana's veterinary control fences, and human population densities are very low in most areas. Small settlements are present in Bwabwata National Park and scattered in southern Angola where there are also small towns at Licua, Jamba, Chipundu and Rivungo.

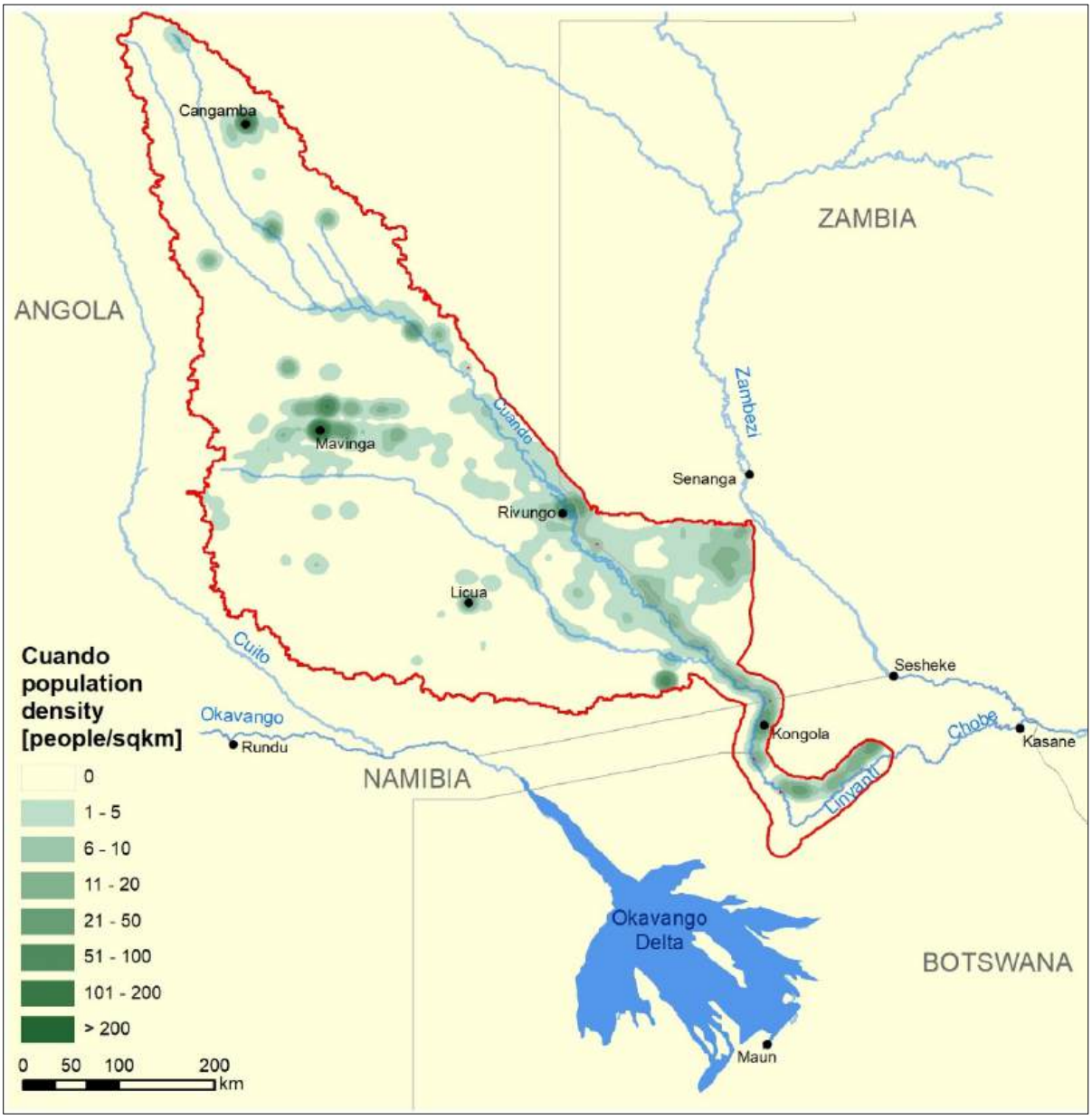


Figure 5.23: Population density in the Cuando River Basin. (From Pallett et al. 2021)

One major road – the so-called Trans-Zambezi Highway – traverses the area from west to east through Bwabwata National Park. All other access is along tracks or small sandy roads. There are no industrial activities or commercial farms in the area.

Although the Western Flanks are in declared conservation areas, management for conservation can be improved in many areas. Poaching of elephants and other herbivores for bush meat is a problem in Angola, especially in more settled and accessible areas close to the Cuando River from where ivory is traded into Zambia. Increasing numbers of people and their livestock are settling in areas of Bwabwata National Park which are zoned for exclusive wildlife protection and tourism.

The Western Flanks are frequently burnt, often by intense, hot fires which have led to the conversion of open savannas with large trees to dense shrubland in many areas[73].

In considering likely changes in land uses and other anthropogenic influences, cognisance must be taken of the socio-economic circumstances of residents in the Western Flanks. Apart from some paid employees or shop owners in towns, most people are extremely poor, their livelihoods dependant on subsistence crops, natural plant (for fuel, housing, food and medicines) and animal (fish and bush meat) resources. Angolans are remote from public services and economic activities elsewhere in Angola. Most Namibians resident in the Western Flanks are marginalised Khoe who rely on local resources and moderate social welfare grants. Residents in Botswana live in similar circumstances but also receive some proceeds from tourism and trophy hunting.

Therefore, almost everyone everywhere in the Western Flanks has minimal sources of income which means (a) that they are impoverished and (b) likely to seek any opportunities to earn incomes as their need to have money and necessities increases. Most of those incomes will come from harvesting and selling natural resources.

[73] (i) Mendelsohn JM.& el Obeid S. Forests and woodlands of Namibia. RAISON, Windhoek.
(ii) Eastment C. 2020. How has Bwabwata National Park's woody vegetation changed in response to fire, rainfall and land use? MsC thesis, University of Cape Town.

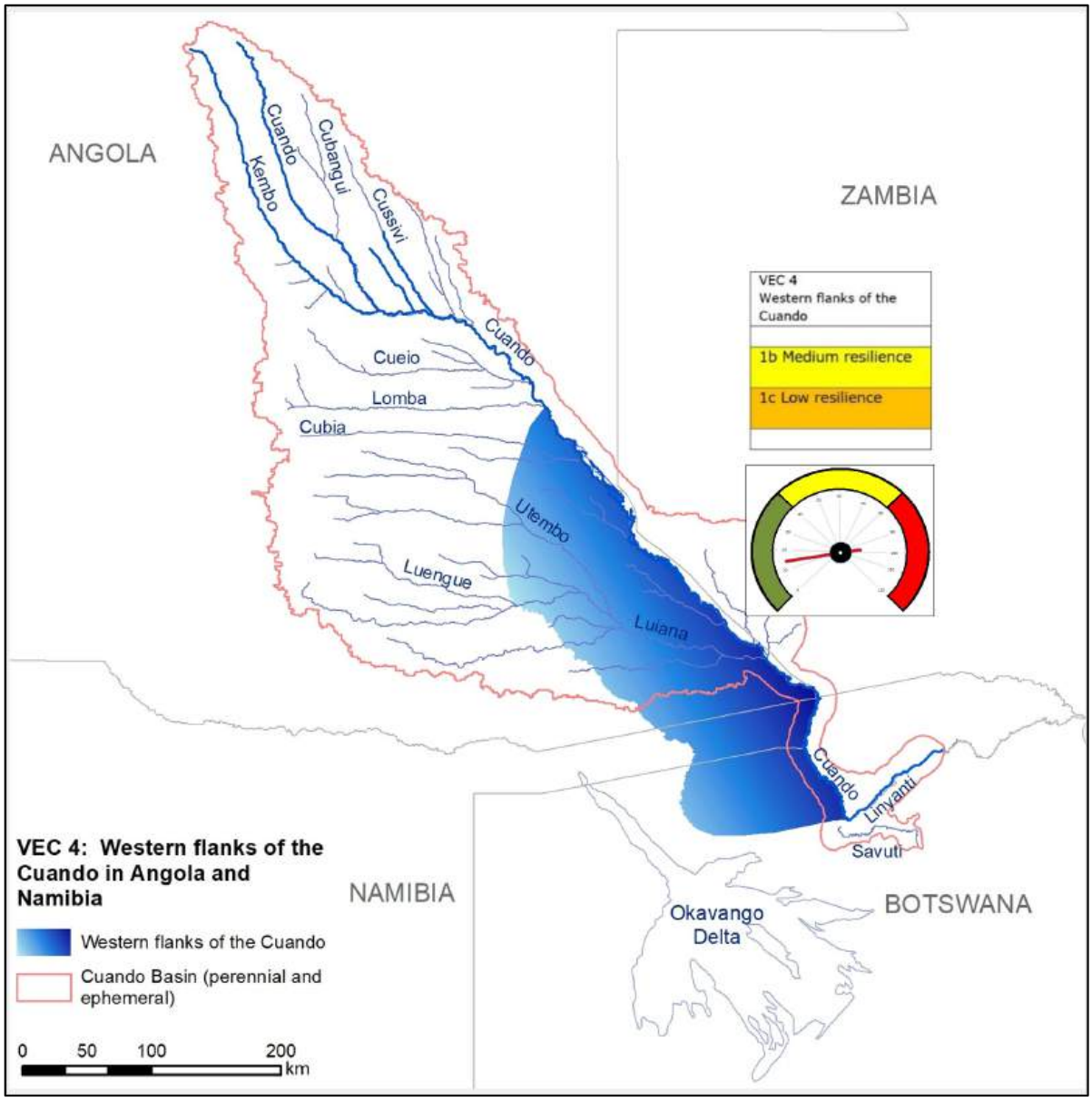


Figure 5.24 VEC "health scorecard" for the Western Flanks in sub-components 1b and 1c.

Vulnerability to cumulative impacts

Poor management of the national parks and other protected areas leads to the Western Flanks being vulnerable to:

- The spread and growth of rural human populations;
- The increasing harvesting, hunting and sale of natural resources by rural populations;
- The removal of vegetation for shifting agriculture; and
- Frequent, intense fires.

The longer management of the Western Flanks is unable to regulate the spread and increased use and sale of natural resources, the harder it will be to limit these degrading effects. Similar cumulative effects are to be expected as a result of uncontrolled burning.

Cumulative impacts

- Increasing rural human population scattered and unregulated across the Western Flanks;
- Increasing per capita dependence on monetary incomes;
- Increasing harvesting and poaching and sale of natural resources; and
- Cumulative impacts of frequent, intense fires that destroy woodlands which are then replaced with dense bush

Recommended mitigation measures

- Given the minimal opportunities to earn incomes and have decent livelihoods in most parts of the Western Flanks, measures are recommended to encourage people to live in urban or peri-urban areas where they have much greater access to public services, incomes and other necessities;

- Measures should be taken to develop urban areas, their services and economic values in strategic places where they both attract people and cause limited environmental degradation;

- Management of the Western Flanks needs to be improved to curtail the spread of people and their unsustainable use and sale of natural resources. All these areas are protected areas for conservation; and

- Ways must be found for herds of buffalo and elephants to cross the Trans-Zambezi Highway and veterinary fences more readily.

Residual effects

The Western flanks of the middle Cuando are considered to have Medium resilience to developments in the low-medium growth scenario (Table 5.3). Further downstream, in the lower Cuando, that resilience drops to Low.

Any residual effects from individual projects can only be assessed when the project details are known.

VEC 5 – Wildlife corridors and ecological connectivity

Spatial extent

The broadest and longest corridors in KAZA are closely linked to the Cuando River where their overall extent has been modelled based on the movements by 291 elephants tracked between 2010 and 2022 (Figure 5.25). This map shows how elephant movements are concentrated in a core belt along the southern and western margins of the Cuando between the eastern end of the Linyanti Swamps, Nkasa Ruparo National Park and north to about Luiana and Jamba in Angola. From this core, elephants are further concentrated in a north-westerly swathe along the Luiana and Utembo rivers in the Cuando's Western Flanks, across the Cuando into Zambia, west to the Mahango National Park and headwaters of the Panhandle area of the Okavango Delta, north-east into Mudumu National Park and then north into Zambia's Sioma Ngwezi NP; south to the Savuti Marsh and Kwai River in Botswana, and east to Victoria Falls and Hwange National Park in Zimbabwe and north to Kafue National Park in Zambia.

Movements by Buffalo, African Wild Dogs, Lion and Burchell's Zebra are also concentrated in the corridor area west of the Cuando from where lions too cross the river into Mudumu National Park (Figure 5.26). These are movements by species that have been tracked, and it is probable that some other large mammals are present and move within the same corridors.

Many smaller corridors are used for local movements, often to water or to navigate between populated areas (Figure 5.28). Most of these corridors developed as a result of repeated use by animals while others have been planned with the agreement of local residents.

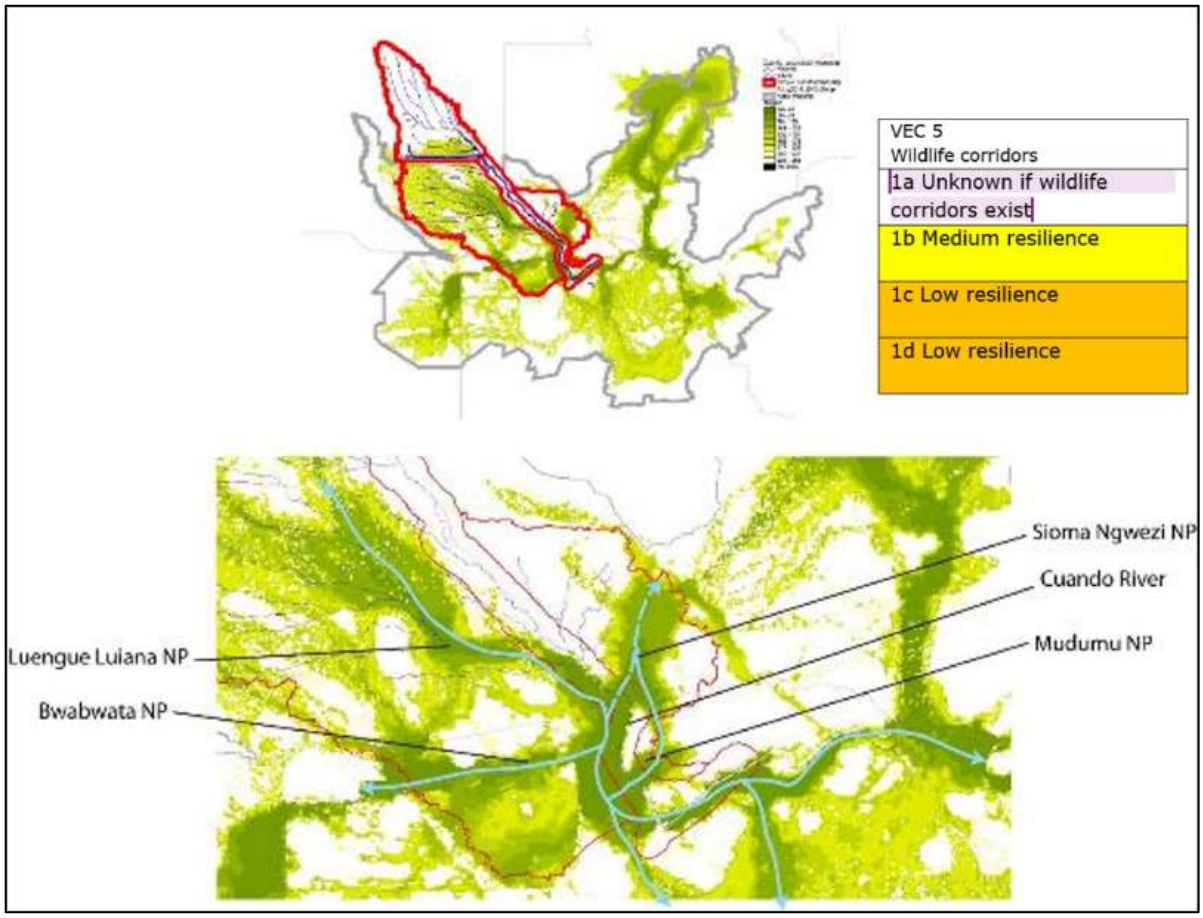


Figure 5.25: The frequency of elephant presence and movements by 291 collared elephants (165 females and 126 males) tracked between 2010 and 2023. Darker colours reflect greater presence and movements. Major corridors in and around the Cuando Basin are indicated by cyan lines. Adapted from KAZA Elephant Sub Working Group (2023).[74]

[74] KAZA Elephant Sub Working Group. 2023. KAZA POLICY BRIEF. Elephant Movements and Connectivity in the Kavango Zambezi Transfrontier Area (KAZA TFCA). Kasane, Botswana

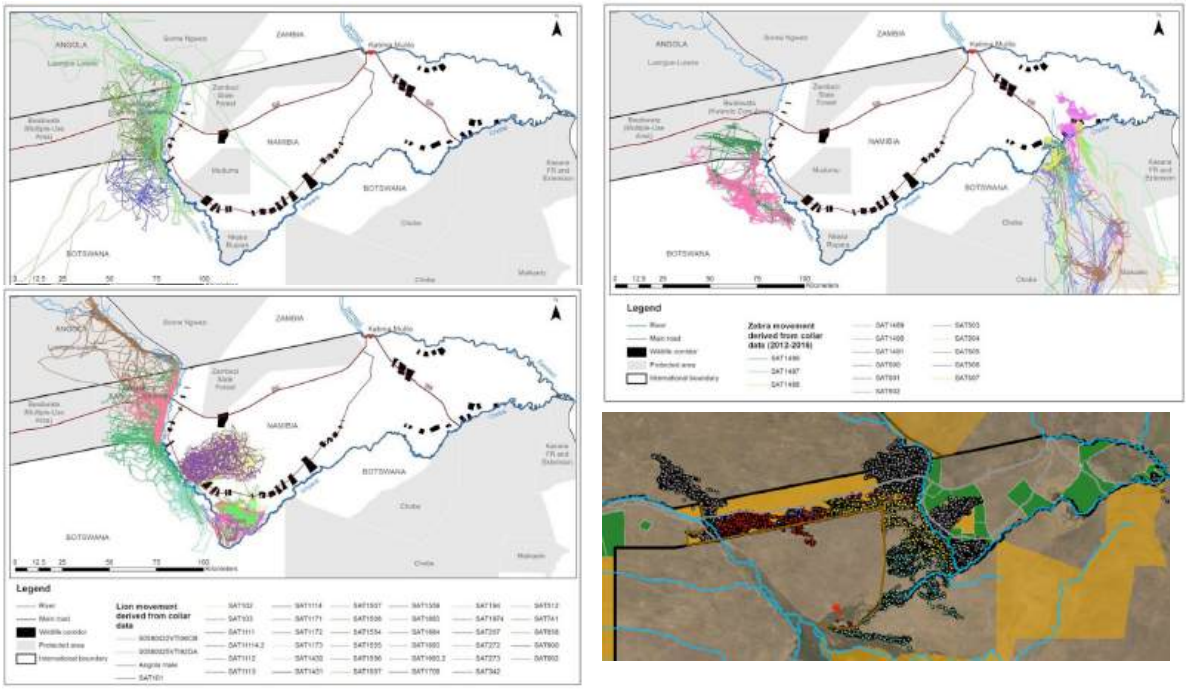


Figure 5.26: Local movements around the Cuando in Eastern Zambezi by African Wild Dog (top left), Burchell's Zebra (top right), lion (bottom left) all from MEFT (2021) and buffalo (bottom right) from Naidoo et al. (2014)

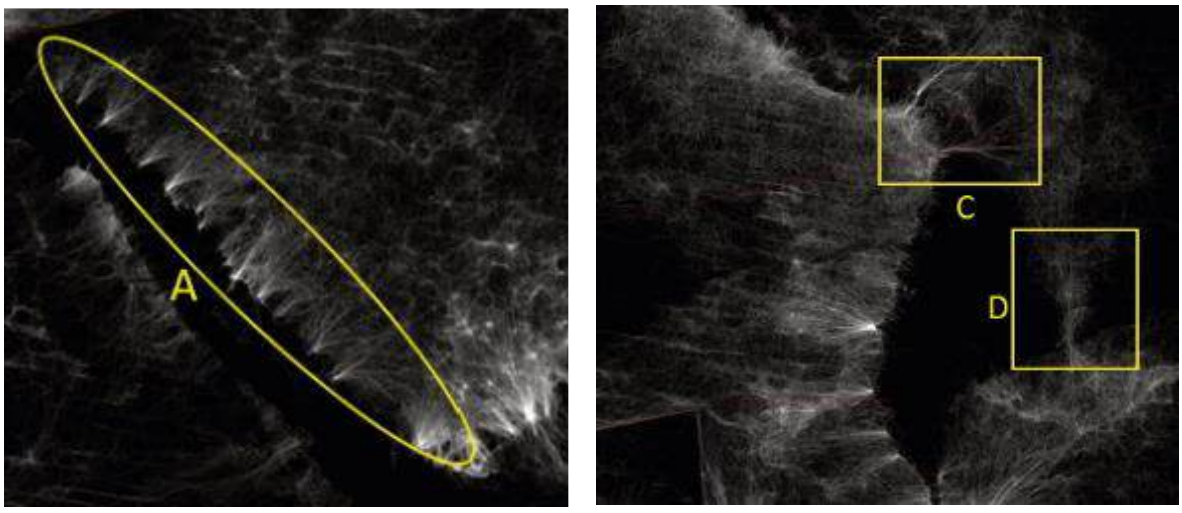


Figure 5.27: Local corridors formed by elephants repeatedly using the same pathways along the Okavango Delta Panhandle (left) and the Cuando (right). Reproduced from KAZA Elephant Sub Working Group (2023).

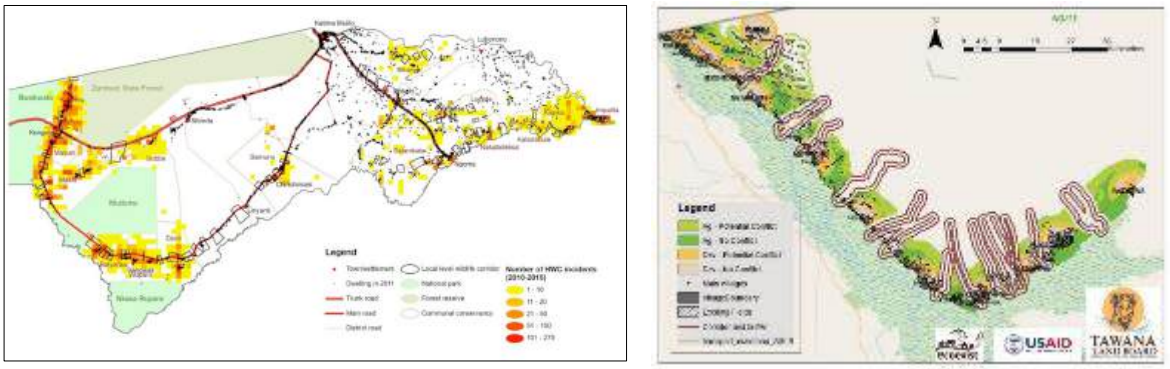


Figure 5.28: Frequencies of human-wildlife conflict and planned corridors in eastern Zambezi (left) and planned corridors along the Panhandle (right).

Description

There are three sorts of corridors in and around Cuando. First, are the broad and long corridors that connect areas tens and hundreds of kilometres apart across the KAZA landscape. These were probably formed over many years of repeated migration, the routes seemingly memorised by animals as traditional fixtures of the landscape where they could circumvent areas occupied by people. In places, the corridors apparently adhere to boundaries that could easily be crossed, these 'virtual borders' having probably been established from memories of human disturbances long ago. Examples are the long section of the Trans-Zambezi Highway that buffalos and female elephants avoid crossing, and the Cuando River which probably forms a traditional border between the unpopulated and protected area to the west and the eastern area populated by people. Lions, African Wild Dogs, Burchell's Zebra, buffalo and elephants seldom cross the Cuando in areas where people live east of the river.

It is apparently not yet known whether these long, broad corridors are so large because they are based on movements by many animals which have cumulatively been tracked over large areas, or whether substantial numbers of individual elephants have journeyed up and down and across this extensive network of broad corridors.

A second group are the many short, localised corridors or routes. These are most conspicuous close to water where animals follow well-used game trails to and from water. Figure 5.27 illustrates example of the trails that converge on narrow 'access corridors' to the Okavango Delta's Panhandle and the Cuando River where elephants from Bwabwata National Park drink.

Those on the western margins of the Cuando are natural or traditional game trails established and maintained in specific places by elephants and perhaps other mammals, probably over many years. No people live immediately west of the Cuando, unlike on the eastern margins of the Panhandle. Here, elephants probably established and maintained paths along corridors between villages. Functionally these are similar to corridors planned by conservancy members and other wildlife managers around the Panhandle and in eastern Zambezi. Once planned and agreed by conservancies and land managers, the corridors are intended to remain unused by people for crops

or settlement. There are a number of studies of potential corridors and the factors that facilitate or limit movements in and around eastern Zambezi and the Cuando.[75]

Motivation for its inclusion as a VEC

The corridors or broad swathes in which movements of at least five large mammals are focussed allow these animals to live and move in areas close to the Cuando and its water and in areas where they are not disturbed by people. Moreover, food sources for herbivores are probably more abundant in the corridor areas west of the Cuando (see Western Flanks VEC).

While these corridors are largely within the Cuando Basin they also provide animals with connections to areas south in Botswana and north in Zambia. It is probable, even likely that these corridors play a fundamental role in facilitating the movements of much of the wildlife in KAZA and south-central Africa.

In as much as the Cuando is a linear oasis, much of the river and its surrounds also serve as a corridor for the movement of many large mammals.

Current state, existing conditions

Most of the corridors are in protected areas in Angola, Namibia and Botswana and where few people live. Thus, most of the large corridors are little affected by human habitation, habitat degradation and farming. However, movements are impeded by the veterinary fences between Botswana and Bwabwata National Park and south into Botswana. As a virtual barrier, the Trans-Zambezi Highway also blocks the movements by buffalo and elephants (see above).[76] It is not known to what degree movements are affected by the main roads from Singalamwe south to Kongola and Linyanti and Chinchimane, and from Kongola east to Sibbinda.

As noted, many large mammals in the Cuando Basin avoid contact with local residents. This is demonstrated by the close inspection of the tracks and data in Figure 5.26 which show that few animals ever cross the Cuando from west to east in Namibia.[77] The exception is in Mudumu National Park where animals cross from Botswana directly into the Park and from where they seldom venture out. Indeed, most animals apparently avoid the very areas where most incidents of human-wildlife conflict have occurred.

[75] Munthali, S.M., Smart, N., Siamudaala, V., Mtsambiwa, M. and Harvie, E., 2018. Integration of ecological and socioeconomic factors in securing wildlife dispersal corridors in the Kavango-Zambezi transfrontier conservation area, Southern Africa. *Selected studies in biodiversity*, *181*.
Naidoo, R., Kilian, J.W., Du Preez, P., Beytell, P., Aschenborn, O., Taylor, R.D. and Stuart-Hill, G., 2018. Evaluating the effectiveness of local-and regional-scale wildlife corridors using quantitative metrics of functional connectivity. *Biological Conservation*, *217*, pp.96-103.
Lines, R., Bormpoudakis, D., Xofis, P. and Tzanopoulos, J., 2021. Modelling multi-species connectivity at the Kafue-Zambezi interface: implications for transboundary carnivore conservation. *Sustainability*, *13*(22), p.12886.
Ministry of Environment, Forestry and Tourism, 2021. Wildlife corridors of the Zambezi Region - A Strategy for their Maintenance, Conservation, Socio-Economic Development and Human Wildlife Conflict Management. Windhoek, Namibia.
Huang RM, van Aarde RJ, Pimm SL, Chase MJ, Leggett K (2022) Mapping potential connections between Southern Africa's elephant populations. PLoS ONE 17(10): e0275791. https:// doi.org/10.1371/journal.pone.0275791

[76] KAZA Elephant Sub Working Group. 2023. KAZA POLICY BRIEF. Elephant Movements and Connectivity in the Kavango Zambezi Transfrontier Area (KAZA TFCA). Kasane, Botswana.
Naidoo, R., Du Preez, P., Stuart-Hill, G., Beytell, P. and Taylor, R., 2014. Long-range migrations and dispersals of African buffalo (*Syncerus caffer*) in the Kavango–Zambezi Transfrontier Conservation area. *African Journal of Ecology*, *52*(4), pp.581-584.

[77] Note that the Cuando River is usually shallow and narrow, and could therefore easily be crossed by large mammals.

Vulnerability to cumulative impacts

Movements are likely to be increasingly impeded by new human settlements and the construction of major roads, railway lines are veterinary fences. A major danger is that each or many of these developments may seem isolated, small or moderate in size. Each such development may therefore seem to have minimal environmental impact. Taken together, however, their cumulative impacts may be severe, indeed so severe that unanticipated tipping points of environmental health may be breached. These effects are the consequence of the so-called 'tyranny of small decisions'.[78]

The wildlife corridors are highly vulnerable because individual or isolated blockages may impede the use and value of entire corridors.

Cumulative impacts

Infrastructure developments, for example of roads, railway lives, towns and major agricultural schemes will potentially have negative impacts on the corridors. Damage to the largest and longest corridors will be most concerning.

Progressive increases in the number of people, settlements, and demands for incomes will have cumulative and destructive effects on the comparative pristine condition of most corridors. These processes and changes are explored in the Western Flanks VEC.

Recommended mitigation measures

Explore and implement ways to create crossing points for elephants and buffalo, and perhaps other large animals, along the Trans-Zambezi Highway in Bwabwata National Park, and Botswana's Northern Buffalo Fence and the fence on the southern border of Bwabwata.

Respect and strengthen existing corridors. At present, the corridors exist where people are sparse. It is therefore recommended that the Cuando Basin countries put in place measures (e.g. zonation and no land allocation) to prevent expansion of human settlements and activities in the existing corridors. Moreover, the authorities need to ensure that people do not settle within these corridors.

[78] *Odum, William E. (1982). Environmental Degradation and the Tyranny of Small Decisions. BioScience.* ***32*** *(9): 728–729. doi:10.2307/1308718*

VEC 6. Cuando groundwater resources

Description and spatial extent

As described in the Scoping Report, groundwater resources in the Cuando Basin are generally rather poor. A recent mapping exercise assessed groundwater potential based on seven criteria, namely geology, soil, slope, land use and land cover, drainage density, lineament density and rainfall. The results are shown in Figure 30. When combining both quantity and quality of groundwater, 49% of the area was classified as having moderate potential, and 21.7% had good potential. Areas of poor and very poor groundwater potential were concentrated in the distal end of the Basin.

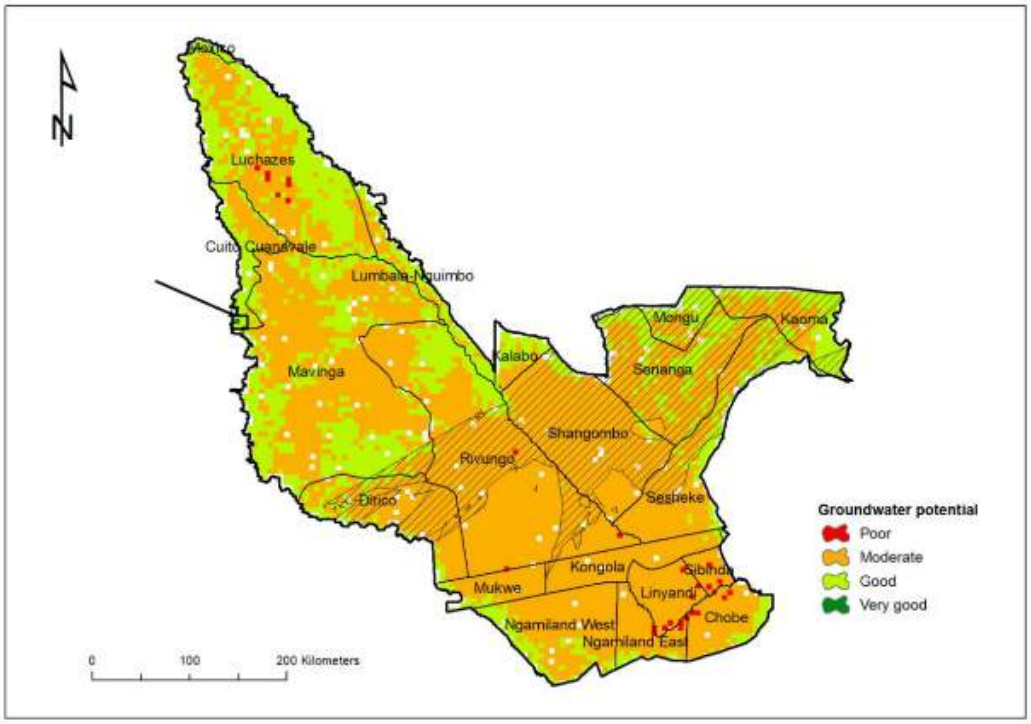


Figure 5.29 Groundwater potential map of the Cuando Basin and the Kwando Wildlife Dispersal Area. The hashed area depicts saline groundwater (>500 mg/l). Less than a quarter of the total area has good groundwater potential, with only one small area in western Cuito Cuanavale District where it is very good. From Ebrahim & Magombeyi, 2022[79]. (The study area combined the true Cuando River Basin area with the Kwando Wildlife Dispersal Area, thus covering an area greater than the formal study area of this SEA.)

Data from existing and attempted boreholes in Zambezi Region show that water quality is highly variable in the region[80]. Close to the river, groundwater quality and yields can be good, but at the same time many boreholes have low yields and poor quality water, with high concentrations of iron. The unreliable nature of the groundwater resources is the motivation for establishing a pipeline carrying Cuando River water from Kongola to villages and settlements downstream.

[79] Ebrahim GY, Magombeyi MS. 2022. Hotspots for Groundwater Development in Kwando River Basin and Wildlife Dispersal Area (Final Report). Sustainable Groundwater Development and Management for Humans, Wildlife, and Economic Growth in the Kavango Zambezi Transfrontier Conservation Area. KAZA-GROW Project, International Water Management Institute, Pretoria, South Africa.
[80] MAWF 2016. Katima Mulilo - Kongola Water Supply Project Phase 3. EIA Specialist Report – Hydrology. Unpublished report compiled by Lithon Project Consultants, for Ministry of Agriculture, Water and Forestry.

There is a deeper aquifer underlying Zambezi Region and areas further north and south, which include the lower parts of the Cuando River Basin (Figure 5.30). This Nata-Karoo / Caprivi deep-seated Aquifer provided 15.5 Mm^3 of water in Namibia and Zambia (2010 data)[81] .

The existence of a further deep, extensive aquifer underlying the Cuando is suspected. This is based on the fact that rainwater infiltrates the sandy surface throughout the Basin and possibly accumulates in a large deep underground reserve, similar to the Ohangwena II Aquifer recently discovered in the Cuvelai-Etosha Basin to the west in Namibia and Angola[82]. If such a resource exists, it would open up the possibility of agricultural developments in the Cuando Basin, which are presently not viable due to insufficient water.

Figure 5.30 The Nata-Karoo / Caprivi Deep-seated Aquifer. From TWAP 2015[83].

Motivation for its inclusion as a VEC

People in the Cuando Basin, particularly in the southern more densely populated areas, have a strong dependence on groundwater. Moderate to poor groundwater resources are closely correlated with overall vulnerability to water scarcity in the Cuando Basin[84]. Therefore the availability of sufficient groundwater, and of satisfactory quality, is a valued environmental component.

[81] TWAP. 2015. AF14 Nata Karoo Sub-Basin / Caprivi Deep-seated Aquifer. Transboundary Aquifer Information Sheet, Transboundary Water Assessment Programme.
[82] TWAP. 2015. AF13 - Cuvelai and Etosha Basin / Ohangwena Aquifer System. Transboundary Aquifer Information Sheet, Transboundary Water Assessment Programme.
https://ggis.un-igrac.org/documents/1619/link
[83] TWAP. 2015. AF14 Nata Karoo Sub-Basin / Caprivi Deep-seated Aquifer. Transboundary Aquifer Information Sheet, Transboundary Water Assessment Programme.
[84] Magombeyi M, Villholth KG. 2022. Water Scarcity Vulnerability Map of the Kwando River Basin and Kwando River Wildlife Dispersal Area. Sustainable Groundwater Development and Management for Humans, Wildlife, and Economic Growth in the Kavango Zambezi Transfrontier Conservation Area KAZA-GROW Project, International Water Management Institute, Pretoria, South Africa.

Current state, existing conditions

There is evidence of some pollution of boreholes in Zambezi Region, and many boreholes experience poor quality water arising from natural causes such as excessive fluoride and high iron concentrations.

Tentative score on the dashboard is Medium (Figure 5.31).

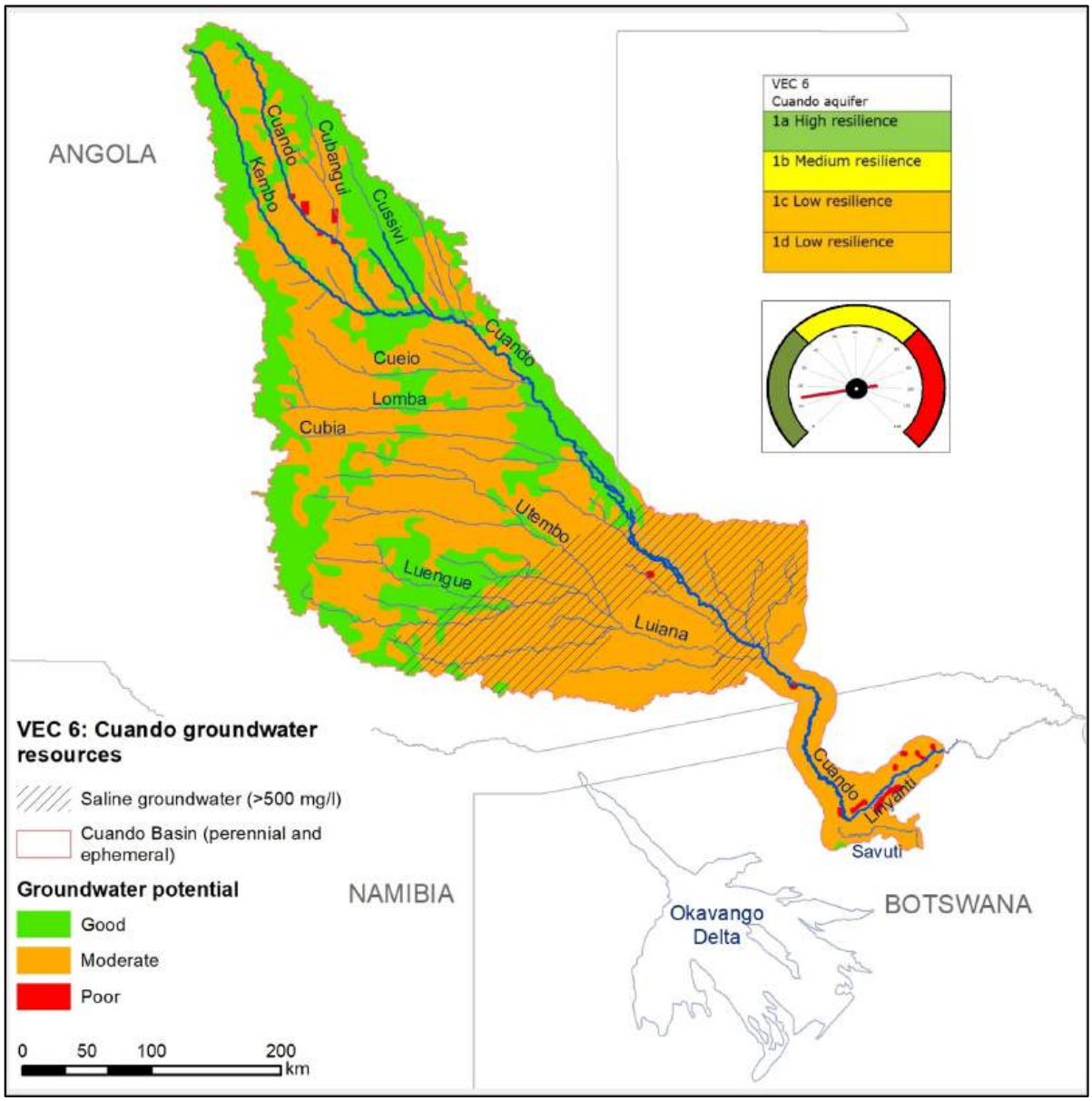


Figure 5.31 VEC "health scorecard" for groundwater in sub-components 1a, 1b, 1c and 1d.

Vulnerability to cumulative impacts

The effect of climate change on the Cuando system is raised as a concern for VEC 1 – the perennial water supply of the river – and is equally important for the groundwater reserves. A warmer climate with less rainfall and greater evapotranspiration is likely to exacerbate the rather poor groundwater situation across the Basin. Increased reliance on groundwater by rural people will follow as

availability of surface water declines. These factors will cumulatively make rural people more vulnerable to water shortages in future.

Given the porous nature of the sandy substrate, boreholes are prone to contamination from surface sources such as nearby livestock kraals, pit latrines and landfills[85]. Contamination from industrial pollutants, such as drilling muds and cuttings, is also a risk from any deep geological drilling. Aquifers are particularly susceptible where faults and dykes in the bedrock act as 'primary flowpaths' for groundwater. This aspect has been noted in the Okavango Basin, where wastewater from exploration oil drilling is highlighted as a potential source of contamination of groundwater[86]. Faults, fracture zones and dykes act as preferential pathways that allow migration of contaminants such as drilling fluids and cuttings. This is particularly the case in seismically active regions, which is the case for the Okavango and Cuando area.

The map below is focused on the Okavango Delta, but is relevant also to the lower Cuando in the north-eastern corner of the map, which is influenced by the same geological structures. This highlights the risks imposed by groundwater contamination, and emphasises the need for strong environmental protection and monitoring for any geological exploratory drilling in the Cuando Basin.

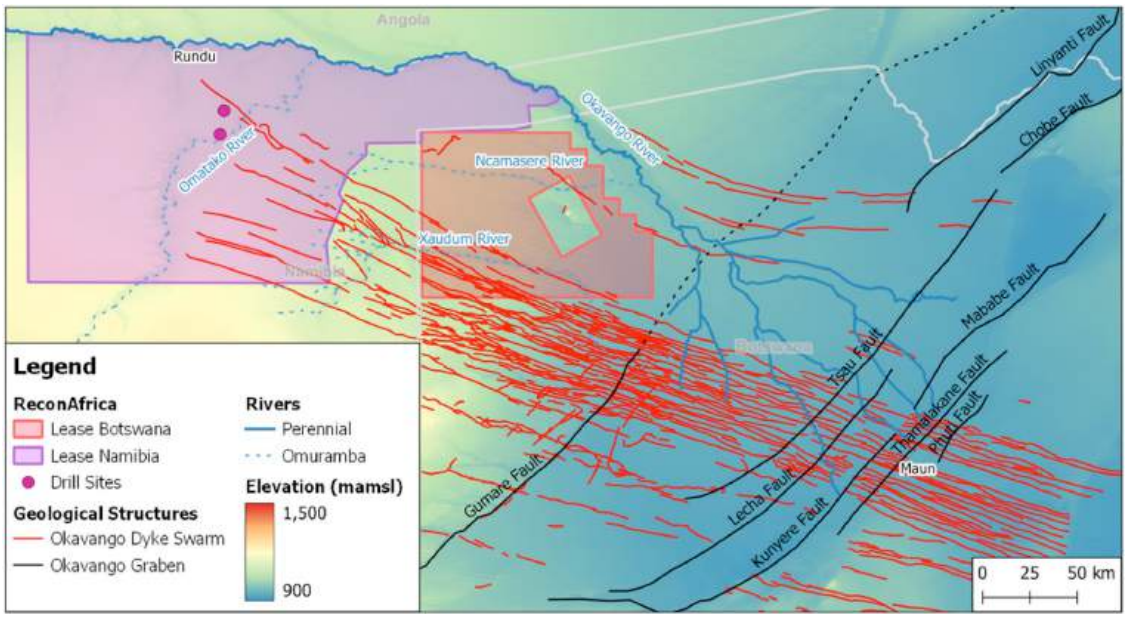


Figure 5.32 Map of the Okavango region illustrating the main faults of the Okavango Graben and its extension northeastward to the Cuando (Linyanti and Chobe Faults), and the dolerite dykes of the Okavango Dyke Swarm. This is in relation to the exploration drilling for oil by ReconAfrica in Namibia and Botswana. From Sheldon et al. 2023.

[85] MAWLR Geohydrology of Namibia

[86] Sheldon R, Esterhuyse S, Lukas, Greenwood. 2023. Potential groundwater contamination from oil drilling in the Okavango. Physics and Chemistry of the Earth 131. https://doi.org/10.1016/j.pce.2023.103430

Cumulative impacts

The main concern for Cuando groundwater reserves is contamination from pollutants. Any development projects may consider using this resource, but the highest risks arising from human activities are from geological drilling and from construction works for linear infrastructure, such as roads and railways. Climate change is likely to have a profound effect on the demand for groundwater, and the availability of such resources.

Recommended mitigation measures

The relatively low groundwater potential across the Basin means that this resource needs to be used carefully and with full protections against contamination or wasteful use.

Any mineral or oil drilling in the Cuando Basin (and anywhere in the geological Kalahari Basin) needs full protection against contamination, such as adequate casing and plugging, and full lining of surface ponds where drilling effluents are expelled. Such precautions need to be advised by independent, experienced geohydrologists to ensure adequacy (i.e. not from the proponent who does not necessarily have long-term safety, or the precautionary principle, as the priority). Also, the results from any deep drilling should be made available to the appropriate government department, to show whether there was any potential for deep water aquifers or unexpected mineral occurrences.

Residual effects

Any residual effects from individual projects can only be assessed when the project details are known.

6. EIA LEGISLATION AND INSTITUTIONAL OVERVIEW

All the CURB countries have important and conducive commiments regarding sustainable development and environmental protection in their respective National Constitutions. These are summarised in Appendix 8.

Also, Environmental assessment (EA) is recognised in the legislative and regulatory instruments in all the CURB countries. However, Botswana and Zambia are the only CURB countries with a legal framework that regulates and guides the performance of SEA, as shown in Appendix 8.

The 2003 SADC (Revised) Protocol on Shared Watercourses, ratified by the four CURB States, is the water specific regional legal instrument applicable to the basin, through its legal norms for shared watercourses. This SADC Protocol is complemented by international agreements, such as the United Nations Convention on Biological Diversity (UNCBD) and the Ramsar Convention (which Angola has not ratified); and complemented at the Policy level – by the SADC Regional Water Policy; SADC Regional Water Strategy.[87]

[87] Modified from CORB SEA 2022

Several other SADC Protocols also apply to the CURB – the Protocol on Forestry; Protocol on the Development of Tourism; Protocol on Wildlife Conservation and Law Enforcement and the Protocol on Fisheries. Among other aspects, these aim at promoting food security; alleviate and eradicate poverty; safeguard the livelihoods; create economic opportunities; and ensure a sustainable use of natural resources. Other relevant conventions applicable to the CURB include: the African (Revised) Convention on the Conservation of Nature and Natural Resources, ratified by Angola and Namibia, which outlines the goal to promote environmental protection; foster conservation and sustainable use of natural resources; and harmonise and coordinate policies in the field of environmental protection and conservation; United Nations Educational, Scientific and Cultural Organization (UNESCO) conventions such as the 1972 Convention for the Protection of the World Cultural and Natural Heritage; other United Nations Conventions such as the United Nations Framework Convention on Climate Change (UNFCCC), ratified by all Member States (MSs). The conservation objectives of the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) also apply in the CURB (*ibid*).

Institutions

The leading entities with planning and management responsibilities in the basin, and whose visions and actions play a crucial role for the future development of the CURB, with particular emphasis on the water sector, are summarised in Appendix 9.

All CURB countries have an established institutional setup regarding natural resources management. In all Member States, water resources management is clustered in one ministry (e.g. Ministry of Energy and Water in Angola; Ministry of Land Management, Water and Sanitation Services in Botswana; and Ministry of Agriculture, Water and Land Reform in Namibia, Ministry of Water Development and Sanitation in Zambia). Still, the inclusion of different areas, in each of these ministries, can lead to the undervaluation of water resources, in relation to others integrated into the ministry (such as energy, land management, agriculture). Similarly, environmental issues are grouped with other areas in the ministries (Ministry of Culture, Tourism and Environment in Angola; Ministry of Environment, Natural Resources Conservation and Tourism in Botswana; and Ministry of Environment, Forestry and Tourism in Namibia; Ministry of Lands and Natural Resources in Zambia).

Regulatory bodies for water services and advisory bodies are set up in the four countries, and all countries provide water services through parastatals. Moreover, all countries have replaced (or, at least, are in the process of doing so) previous water legislation with legislation based on Integrated Water Resources Management (IWRM), which emphasises the need for integrated management and provides the legal mechanism for its implementation in practice. Still, constraints remain, including the fragmentation of management responsibilities; difficulties in intersectoral planning; underdeveloped coordination; weak institutional structures at the local level; and limited capabilities.

7. KEY STRATEGIC DEVELOPMENT DIRECTIONS[88]

Member States' development and management "directions" relevant to the CURB comprise five key sectors (figure 7.1). These were analysed to determine the focus of the CURB SEA, as a result of their relevancy in terms of developments and cumulative effects.

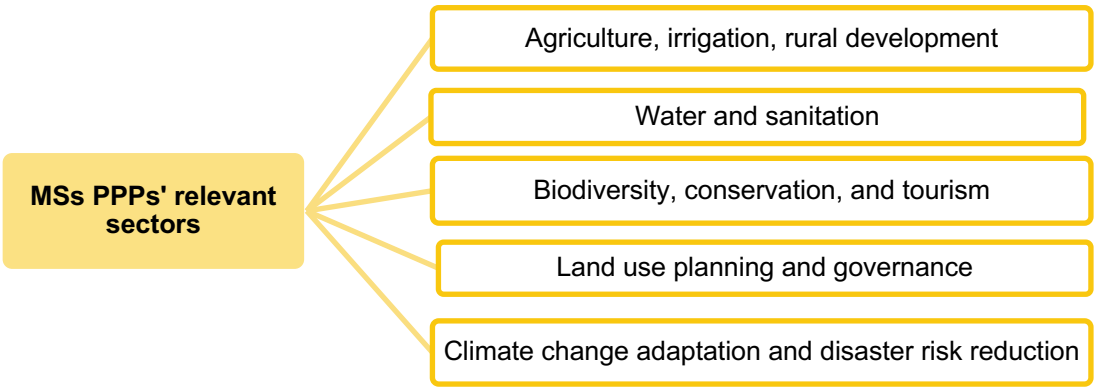


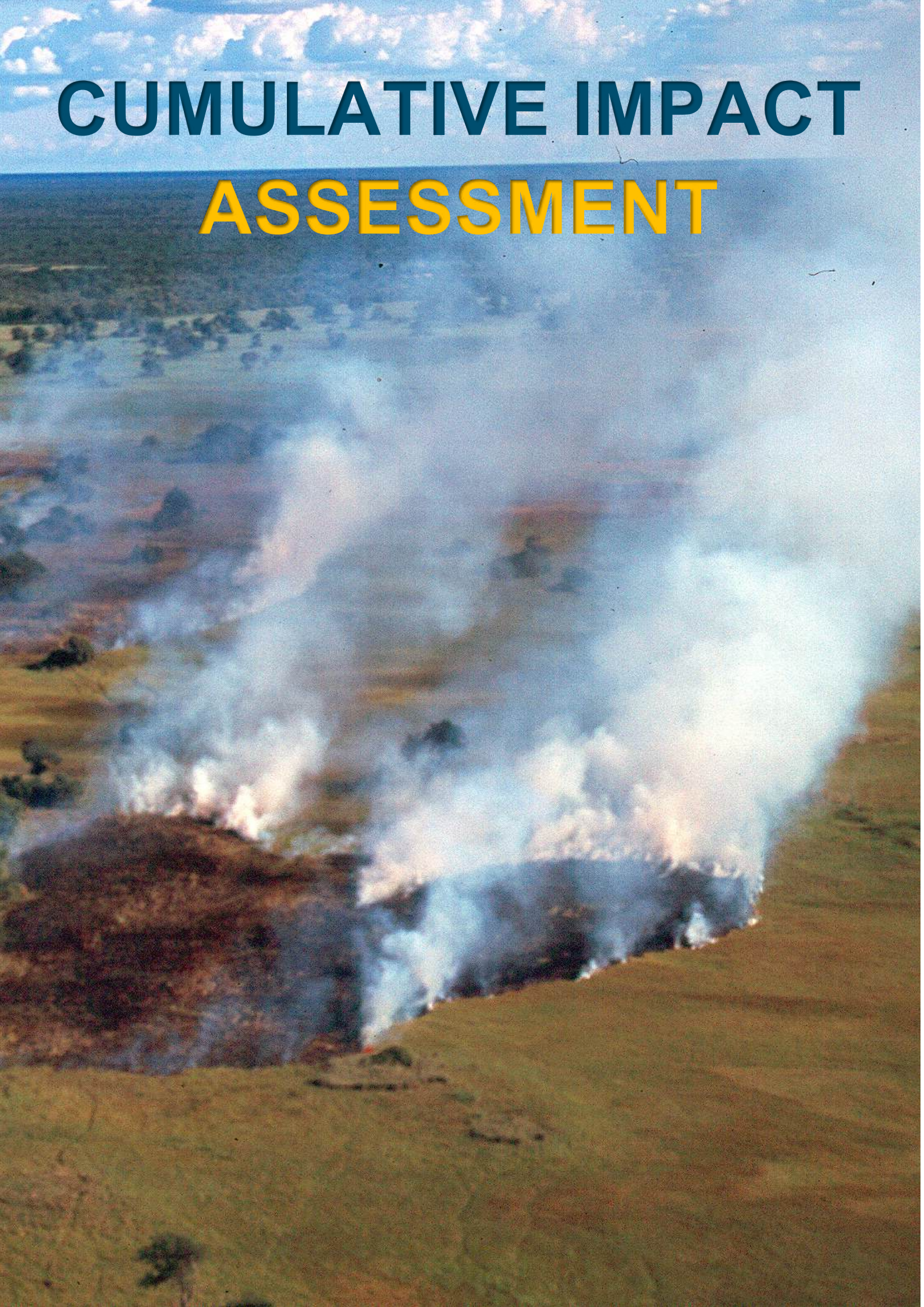
Figure 7.1 – Critical sectors and areas of action highlighted in Member States' PPPs

Appendix 7 outlines the PPPs relevant to the CURB SEA, grouped by those five sectors. For each sector, the initial understanding of relevant trends in the CURB are presented, followed by the identification of key concerns that aim to be addressed by the Member States' PPPs.

The abovementioned sectors were the focus of the cumulative impact assessment (see next section).

[88] Modified from CORB SEA 2022

CUMULATIVE IMPACT ASSESSMENT



8. CUMULATIVE IMPACTS OF LIKELY OR POSSIBLE SECTOR DEVELOPMENTS IN THE LOW/MEDIUM GROWTH SCENARIO

INTRODUCTION

Pallett et al (2021) state that the Cuando is "probably one of the most pristine of all rivers on Earth today. Much of the upper and central parts of the basin are inaccessible to vehicles due to the extensive floodplains and lack of roads or bridges. Consequently, these parts are sparsely populated and human impacts and human-based threats are negligible. There are only six significant towns on the Cuando river, namely Cangamba and Rivungo in Angola, Shangombo on the Zambian side opposite Rivungo, and Kongola, Linyanti and Chinchimane in Namibia".

Availability of water is very often the main constraint to settlement and development. Settlements close to the main rivers rely on river water, and the almost non-existent provision of piped water in the towns in Angola means that most residents use the rivers for their domestic consumption and use, including laundry, washing and sanitation. Whilst the impacts of these domestic activities are unclear, it is likely that there must be some pollution downstream of the towns of Cangamba, Mavinga, Rivungo and Shangombo (*ibid*).

Major challenges in the CURB include habitat loss, fragmentation, and degradation; human wildlife conflict; wildlife crime; inadequate community empowerment and engagement; poorly planned infrastructure development and climate change, weak management of natural resources and protected areas leading to increasing pressure on land and resources from growing and more widely distributed human populations[89]. In short, the currently small and fairly concentrated human footprint will grow and expand, often in uncontrolled and unplanned ways.

Climate change models forecast that the average total annual precipitation averaged over the whole of KAZA is expected to decrease by 4.6% by 2050, relative to historical precipitation. It is generally expected to get hotter and drier whilst mean annual temperatures are expected to increase by 3°C (*Source: ToRs*).

The situation described above is a classic example of cumulative impacts that challenge the concept of limits of acceptable change – or tipping points.

As in many parts of rural Africa, people within the CURB are caught in a poverty trap driven by poor agricultural potential, isolation, and negligible incomes. Rural communities rely largely upon harvests of natural resources, remittances, social grants and low yielding subsistence agriculture. They may grow part of their food requirements and have free housing, water, firewood etc. but all other needs come from cash which very largely comes from off-farm sources.

The concentration of growing human populations along the river and shrinking corridors for wildlife to access the important water resources further exacerbates the hardships for both people and wildlife through increased human wildlife conflict in the CURB. This highlights the need for inclusive

[89] Terms of reference

regional fine scale planning and measures to implement secure wildlife corridors and human development areas, while concomitantly reducing HWC. Hopefully this SEA can help provide solutions.

Whilst the Cuando river is largely pristine, it is under increasing pressure from a growing population that, whilst relying mostly on subsistence farming and harvests of natural resources, is rapidly urbanising. Towns are small but growing fast and physical, social and institutional infrastructure is struggling to cope with the current growth. Botswana and Namibia have established good (though relatively small) tourism industries in the lower Cuando area that are increasingly important to local economies. This industry is based on comparative advantages offered by exceptional wildlife resources and intact sense-of-place, helped by the fact that countries have established various levels of conservation measures in the area.

However, there are competing land uses, notably livestock keeping[90], dryland cropping and wildlife harvesting for subsistence and sale as bush meat and for ivory. This illegal wildlife offtake is a concern. These activities are already placing sensitive forms of wildlife under pressure. Fortunately, habitats are mostly intact and wildlife are generally returning to areas where they were lost during the 1976-2002 Angolan civil war.

Many impacts are masked due to the lag effect between developments being implemented and the impact being felt. Often the system may appear to be moving away from a critical threshold during normal or wet years, but when a set of cumulative impacts combine or events come together in the "perfect storm" then the system may be pushed over a threshold, re-establish another but less desirable state, or collapse entirely, such as occurred in the case of the Aral Sea[91].

For the purposes of this SEA, various internal drivers (generated within the Basin) and external drivers (from outside the Basin, even regional or global) that are the root causes of cumulative impacts, were recognised. The main external drivers which affect the CURB are climate change, the global economy, non-supportive or conflicting national legislation and to a lesser extent, international environmental agreements.

The four main basin-wide drivers are:

- The desire for accelerated economic growth and diversification;
- The need for formal or informal incomes and income/food security;
- Population growth; and
- Loss of natural resources as a result of shifting agriculture and harvesting.

[90] The majority of livestock this agro-pastoral economy are kept to serve as capital to be used or sold to meet the costs of emergencies and investments.
[91] https://globalstudiesoutreach.harvard.edu/files/globalstudiesoutreach/files/brite-aral-sea-harvard_edited_compressed.pdf

Based on literature, existing knowledge and expert input, the cumulative impacts of greatest concern are:

- Lowered ecosystem resilience and functioning because of reduced hydrological flow variability and volume, (caused by a probable increase in irrigation schemes, impoundments, settlements, tourism and perhaps other industries, water transfers and climate change);
- Biodiversity loss because of reduced ecological functioning and land degradation (as above plus poor land-use practices for subsistence agriculture);
- Biodiversity loss and increased human-wildlife conflicts because of habitat fragmentation and wildlife movement barriers (because of fences, crop production, livestock, settlements, disease management protocols);
- Loss of livelihoods and economic options because of decreasing wildlife populations (and the concomitant reduced income opportunities), reduced ecosystem services (linked to compromised hydrological functioning, but added to that is impacts of land degradation from shifting agriculture and burning, resource overexploitation, depauperate soils, etc);
- Loss of tourism potential throughout the basin and further afield, should habitats become degraded and fragmented, and wildlife corridors are compromised;
- Health, livelihood and ecological risks because of reduced water quality; and
- Increased prevalence/spread of Sexually-Transmitted Diseases (because of increased mobility of people and the influx of workers (including foreign) to project sites in predominantly poor rural areas).

However, many existing and expected social and environmental pressures could be reduced or avoided, if projects and areas are better planned and managed, and sustainability principles incorporated. If governments and developers are committed to achieving sustainable development, there could be a number of positive cumulative impacts, (also referred to as synergistic impacts), including:

- Employment and income creation;
- Economic growth;
- Food security;
- Poverty reduction; and
- Restoration/maintenance of ecosystem services.

This chapter describes what cumulative impacts are and how they have been assessed using linkage diagrams and vulnerability of VECs. The discussion on VECs is presented in chapter 5.

The linkage diagrams indicate the pathways through which particular types of impacts resulting from implementing the principal development activities under each key sector (Figures 8.1 – 8.11.) are expected to become cumulative (e.g. pollution, biodiversity loss, deteriorating health). The sectors chosen for the analysis of cumulative impacts are those already present in the CURB (e.g. agriculture, urban expansion, tourism) and logically likely to persist in one form or another, in the foreseeable future. However, the information gathered during scoping indicated that other types of development/land use might be initiated in the future. For example, fish farming, dams, mining and petroleum exploration are not currently present but are under discussion. Even though some future development ideas may not happen in the low-medium growth scenario over the next decade

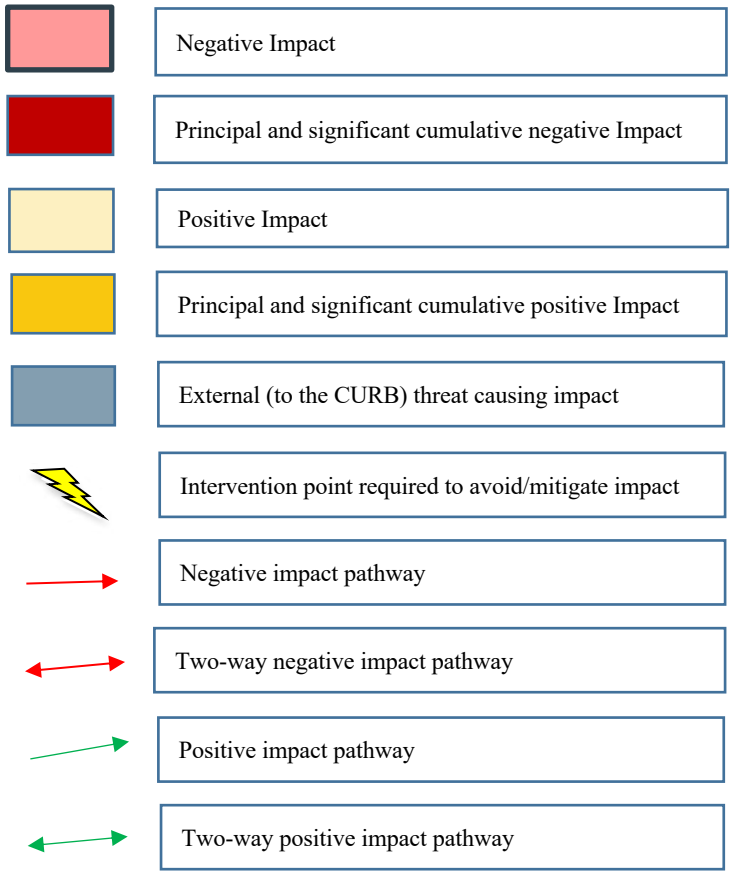
or so, it was deemed prudent to include these in the SEA so that decision-makers are made aware of their likely intended and unintended consequences.

Principal development activities for key sectors

Sector	Key activities expected during 2024-2034	Linkage diagram
Agriculture	Increase in livestock holding	Fig 8.1
	Increase in irrigated agriculture	Fig 8.2
	Increase in dryland shifting crop production	Fig 8.3
Conservation	Nature (wildlife) Conservation	Fig 8.4
Fisheries	Fish farming and processing	Fig 8.5
Industry	Mining (minerals and petroleum)	Fig 8.6
Tourism	Tourism expansion	Fig 8.7
Transport	Improving road access to remote areas	Fig 8.8
	Constructing the Trans-Zambezi Railway	Fig 8.9
Urban	Urbanisation and expansion of villages and towns	Fig 8.10
Water	Establishment of dams and weirs	Fig 8.11
Climate Change		Fig 8.12

Linkage diagrams for the principal activities for key sectors are presented in Figures 8.1 – 8.11. The box below explains the colours, shading and symbols used in the figures.

Box 8.1 Explanation of Linkage diagrams



Notes:

1. The darker shaded boxes in the diagrams indicate the principal and most significant cumulative impacts (dark green for positive impacts, dark red for negative impacts) that are expected to occur where different impact pathways result in the same final outcome, thus increasing its intensity or significance. Other cumulative impacts arise along the pathways, but to a lower intensity or significance. The justification for a darker rather than light shade is not only determined by the number of arrows leading to the box, but also by expert opinion and a judgement of significance.

2. The yellow "lightening bolts" indicate where interventions are needed to avoid or reduce unintended consequences. In some cases, even positive impacts can inadvertently lead to unintended negative impacts. For example, an increase in mining will generate economic growth but can also lead to an increase in pollution during construction and operations.

3. The positive impacts of an activity can also result in mutually reinforcing positive feedback loops. For example, where economic growth leads to more money being available for investment in social and physical infrastructure, that investment then creates further economic growth which, in turn can create more money for investment.

8.1. INCREASE IN LIVESTOCK FARMING

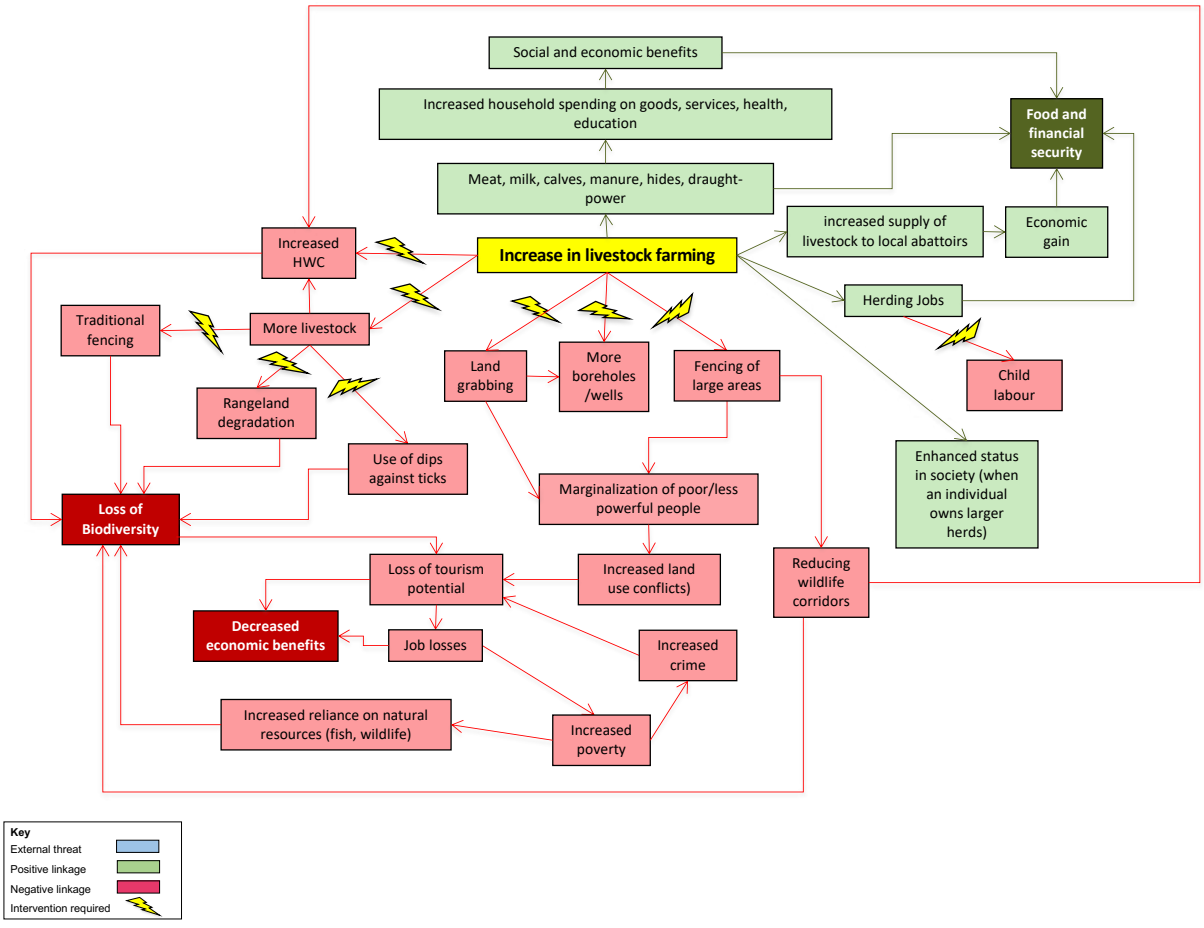


Figure 8.1 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of an increase in livestock farming in a communal land setting in the CURB.

According to the State of the Basin Report there are very few livestock in the northern part of the Cuando Basin: some poultry and a few goats, and virtually no cattle (perhaps because of the occurrence of tsetse fly). Cattle and goat numbers reportedly increase slightly as one moves southwards in Angola, but everywhere the numbers are small due to disease and the effects of civil war when the armies commandeered all livestock for rations. Livestock numbers are reportedly much higher in Namibia and Zambia, where they play an important role in livelihoods and the economy. The report states that there were close to one million cattle in Zambia's Western Province in 2016. Nevertheless, there appears to be an increasing interest in expanding livestock production in suitable areas. However, the marketing of cattle from this area is curtailed because of its disease status, so expected benefits may not materialise as hoped.

As elsewhere in Africa, the intended positive impacts of livestock include the availability of capital, resilience, savings, milk, meat, manure, hides and draught power for ploughing and transporting goods. There are also positive cultural reinforcements from cultural/social values placed on cattle by some tribal groups[92]. An increase in livestock could ultimately result in increased food and financial security as well as some employment opportunities.

However, livestock in areas that are communal, unfenced and home to free-ranging wildlife (including predators) face many challenges. Livestock share the land with wildlife such as buffalo, which can carry animal diseases like Foot and Mouth (FMD). However, the recently prevalent Type O strain is restricted and transmitted by livestock, not involving wildlife. Also, Brucellosis is a concern in communities and individuals who rely on livestock keeping for their livelihood. Many livestock diseases have transboundary implications – for example the prevalence of Bovine pleural pneumonia is what caused the border fence between northern Botswana and Bwabwata National Park to be put in place.The incidences of human-wildlife conflict are already high where livestock are kept, so this problem will certainly increase. Experience in some KAZA countries has shown that the elite often capture the best rangelands, erect fences and privatise waterpoints, thus marginalizing the poor. As evidenced elsewhere, inadequate requirements for stocking at sustainable rates will likely result in overgrazing of rangelands with a multitude of secondary impacts such as soil erosion, bush encroachment and eventual displacement of wildlife.
Also, since traditional fencing is likely for the construction of stockades, deforestation and habitat conversion can be expected. Cumulatively, an increase in livestock farming can contribute towards biodiversity loss - unless this type of farming is carefully managed and controlled. As illustrated in the linkage diagram, the unintended consequences described above will lead to a decline in economic benefits with the associated multiple negative social, health and probably gender impacts.

Climate change predictions for the CURB further heighten the risks associated with livestock farming (see climate change section – 8.11, and mitigation ideas in table 8.2).

[92] https://journals.co.za/doi/pdf/10.10520/AJA02580144_309

Table 8.1 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Expansion of livestock farming	**Is it necessary?** Given that the majority of people living in the CURB are extremely poor, it is understandable that communities are searching for ways of improving their food security. The fact that most parts of the CURB have so little livestock currently is an indicator of the general unsuitability of this area for this type of land use. **Is there a better strategic alternative?** It is hard to convince poor people to abandon the perceived benefits (inclusive of cultural value and status) of livestock farming when there are very few other viable alternatives for them to build capital resources. Whilst the area is regarded as highly suitable for wildlife and tourism, there is a limit to how many people these sectors can employ – especially given the objective of avoiding mass-tourism and relying instead on high-quality but low volume tourism. Perhaps the best strategic option is to help communities to engage in traditional land uses such as farming, but doing so using best-practice methods. Also, there needs to be a viable and convenient market to enable cattle offtake such as offered via commodity based trading (CBT)[93] in meat, herding for health (H4H) type programmes, especially when grazing deteriorates or herds exceed the carrying capacity of the land. **Location?** It is probable that people will keep livestock near to where they live, unless the authorities make grazing available elsewhere. There is thus no specific location where livestock farming will be established. **How should it be done?** Rather than being maintained as open, common property providing resources to benefit the poor, much communal land is progressively being taken by affluent people. As a result, the small numbers of animals kept by local, poorer residents can't compete for forage and water with the substantial numbers of cattle, sheep and goats belonging to people who have businesses and jobs in towns far away. The intention for communal land to be a safety net needs to be maintained. Promoting appropriate land uses and the orderly use of common-property natural resources requires firm controls. Forty eight years ago, Sir Seretse Khama, the first president of Botswana, made this clear in a speech that applies as much of the CURBs communal: "Under our communal grazing system it is in no one individual's interest to limit the number of his animals. If one man takes his cattle off, someone else moves in. *Unless livestock numbers are tied to specific grazing areas, no one has an incentive to control grazing*." Secure tenure over land is a necessity if its resources are to be managed for sustainable use and value for their intended beneficiaries. The idea that anyone can move in and around communal land to graze hundreds of livestock is not tenable.

[93] Thomson, G., Penrith, M.-L., Atkinson, S. J. and Osofsky, S. A. 2018. Guidelines on Commodity-Based Trade Approaches for Managing Foot and Mouth Disease Risk in Beef in Southern Africa. 3rd Edition. Technical Report on behalf of Cornell University's AHEAD Program. 17 pp.

	Rothauge (2007) advises that considerable input of management knowledge is required for this sector to succeed, especially of adaptive rangeland management, as rangeland condition is greatly influenced by the fickle and harsh climate, stocking rate of animals and the occurrence of drought and fires. He cautions that degradation occurs easily if wrong decisions are made at critical junctures. The most visible form of rangeland degradation in some countries is the escalating problem of bush thickening, or bush encroachment, and erosion around waterholes. The finely balanced grass-to-bush ratio of a savanna has been severely disrupted in a bush-encroached rangeland. However, even though the livestock sector performs relatively poorly (in GDP terms), it remains a cornerstone of rural economies and social fabric. This sector needs to be strengthened for social, employment and livelihood reasons, especially in rural areas where there are limited other economic development opportunities. From a sustainability perspective, key improvements should include improving herd quality but reducing overall herd size, developing intensive pastures through shifting night enclosures (bomas), fodder planting / hay making, and stall feeding ('cut-and-carry') in the more humid areas. Calving and offtake rates can be increased significantly (most hover around 50-60%), and better marketing and market diversification could be pursued. Farming with indigenous breeds will reduce input costs (dipping and feeding), whilst improving the resilience of herds to climate variability and change. As noted in the Scoping Report, climate change models forecast that the average total annual precipitation averaged over the whole of KAZA is expected to decrease by 4.6% by 2050, relative to historical precipitation. It is generally expected to get hotter and drier whilst mean annual temperatures are expected to increase by 3°C (*Source: ToRs*). Promoting Integrated Rangeland Management (IRM) is advised (see box 1 below), as there is a need to improve rangelands. Whilst subsidies in the livestock sector may be justified, these need to be better targeted to reach those most in need. This sector is dominated by beef, but there is an opportunity to improve the marketing of small stock (e.g goats) both locally and internationally. Another important factor in the success of this sector is establishing appropriate land rights (see box 2 below). All CURB countries have planning regulations and standards that pertain to agriculture, including veterinary requirements etc. These will have to be followed as per normal procedures. Perhaps the main challenge is formalising land tenure where appropriate, in addition to improving services. An important issue regarding agriculture is considering the vulnerability of this sector to climate change. Some suggestions for best practice are provided below. **Timing?** N/A

Box 8.1: Community-Based Rangeland and Livestock Management

GOPA (2014) made the following recommendations based on lessons learned from the Community-Based Rangeland and Livestock Management (CBRLM) project in northern Namibia:

- Continuation of support to grazing area communities is required. Projects should not be extended into other areas until such time as land rights legislation is in place that enables communities to control access to their rangelands to protect improvement gains made within their grazing area.
- In order to implement CBRLM with combined herding and planned grazing it is necessary to invest substantially in the upgrading of water supply. In order to avoid negative impacts through mismanagement, future water infrastructure provision should entail dedicated livestock-only water points which could be (temporarily) closed by the responsible entity in case of non-compliance to management rules. Legislation could make sound rangeland management compulsory and bring forward corresponding enforcement mechanisms.
- Future interventions should recognize and work with the mixed farming agricultural conditions of most communal farmers. Working more consciously on the interface between crop and livestock production poses opportunities for shorter term results (e.g. increased crop yield through the use of temporary mobile stockades for crop field fertilisation) that can help to motivate commitment to rangeland management strategies that produce outcomes over the longer term. This could also help reduce human-wildlife conflict.
- Functioning institutions are critical for development. Established agricultural cooperatives need further support to become viable on their own.
- Fire breaks that were established by over-trampling and overgrazing routes to and from grazing areas seem to be effective in stopping fires. This practise needs to be entrenched as does the development of fire breaks at the regional, constituency and national level.

Another important approach to promote, is Herding for Health (H4H)[1]. This is a community development activity that promotes conservation outcomes while supporting people living in rural areas to find their way out of extreme poverty. It does this by teaching community members to make use of what they already have – cattle and other livestock. The Peace Parks Foundation reports that while many view livestock as a threat to conservation and especially rangeland health, it is in fact through the correct management of livestock and unlocking their value in underserved communities that significant benefits for sustainable land use and biodiversity conservation can be achieved.

Box 8.2: Land rights

Wily (2003) reports that policy or legal commitment to decentralisation in the land sector is very widespread and often the centrepiece or anchor of more general reform. She argues that the trend is predominantly new, and quite commonly afflicted by characteristic shortfalls of top-down formulation, well-meaning as the intentions may be. Systems design is thus often awkward, unrealistic, expensive and liable to lack the simplicity and local ownership of procedure that will be essential to widespread adoption and sustainable use. There is also a great deal of risk as governments do not always sustain their enthusiasm for decentralised mechanisms when they confront the realities of implementation or the loss of control over the periphery that some of the more genuine moves towards decentralisation embody.

Decentralised approaches do not always sit easily with other common reform objectives, most particularly, a wish to free up the land market. This is because decentralised approaches tend to go hand in hand with heightened protective measures of majority land interests that may make land access by investors not as straightforward as they may wish. New attention to the nature of land rights themselves is also proving integral to decentralising land administration. Whilst in the main, a much wider range of land rights are being catered to than has been the case in the past, crucial insufficiencies remain. These centre upon how land interests are identified and recorded, and how far the results will afford genuine equity with existing systems of statutory entitlement and equivalent security of tenure. It is in this area that most diversity is apparent. It is also closely interlinked to diverse handling of customarily structured right holding and management.

Strategic exploration of ways to overcome the conundrums presented by the objectives of mass rights recordation is incomplete, but with important innovations emerging. New approaches have also raised new issues, or rather awakened long-standing issues, such as how far one must be a citizen, tribal member and/or local resident to qualify for recognition of land interests. Or, within the community, how different types of rights in the same land are to be ranked (and recorded) and overlapping interests extinguished or given a framework for co-existence. It seems to be the case that the more devolutionary the systemic approach being devised, the more progress is being made in recognising and dealing with these questions (*ibid*). There is plenty of evidence to suggest that only when land administration and management is fully devolved to the community level and with a reasonable measure of empowerment and flexibility to act provided, is there likely to be significant success in bringing the majority of land interests under useful and lasting record-centred management and in ways that are fair and relevant to the majority poorer right holder. That is, the more localised and more inclusively formed the institutions of administration and management (and the more integrated their functions), the more likely it will be that new legal and administrative opportunities will be relevant, accessed, used – and crucially, client-sustained.

Contrary technocratic approaches still fashion a significant number of developments, holding decentralisation to district or higher levels, and of necessity binding them to government support and thence control, and using community level authorities, traditional or elected, as more agents of the State, than leaders of more efficient and inclusive procedures (*ibid*).

Table 8.2: Examples of possible mitigation and enhancement measures for livestock agriculture in the context of climate change

Key objective	Measures to reduce climate change impacts and improve resilience to drought, floods, heat

Avoid/minimise industrial livestock farming that is a known GHG emitter.	• Promote grass-fed livestock projects and avoid/minimise feedlots.
	• Select appropriate livestock breeds that are adapted to local conditions (cattle and small-stock).
	• Improve herd health by:
	  ○ Promoting indigenous cattle (e.g. Sanga (aka Nguni) and small-stock breeds or cross-breeds that can survive and thrive on marginal rangelands and are more resilient to climate change.
	  ○ Better herd quality but reducing overall herd size (lower environmental impact but equal/better economic return).
	  ○ Cooperative type activities (e.g. breeding programmes, veterinary services, extension services, coordinated marketing) will improve the ability of small-scale farmers to improve herds and offtake.
	  ○ Grow fodder to improve production in areas where water and suitable soils are available.
	  ○ Promoting Herding 4 Health type schemes
	  ○ Promoting Commodity based trading of livestock/beef.

Reduce biodiversity loss.	• Farming with indigenous breeds will reduce input costs (dipping and feeding), whilst improving the resilience of herds to climate variability and change. • Avoid the use of polluting dips – rather use direct pour-on applications, or (as noted earlier), choose livestock breeds that are tick resistant. • Educate farmers about correct storage and handling procedures for dip chemicals. • Livestock farming needs to be avoided or minimised in wilderness areas that are highly sensitive and important for conservation and tourism. Also, the proximity of livestock to certain types of wildlife (e.g. buffalo) increases risks of disease transfers and human-wildlife conflicts.
Reduce rangeland degradation.	• Integrated rangeland management (IRM), Herding for Health (H4H), and Commodity based trading (CBT) need to be introduced/ promoted/ expanded • Guard against overstocking. • Fewer (though better quality) animals will reduce pressure on water resources and grazing, and deterioration of the "commons", thus reducing conflicts over grazing. • Ear tag and tracking system will improve herd management and reduce conflicts over animal ownership. • Educate farmers about the benefits of timeous selling (before drought hits) rather than keeping weak animals (investment needed in facilities and incentives for livestock marketing).

8.2. INCREASE IN IRRIGATED AGRICULTURE

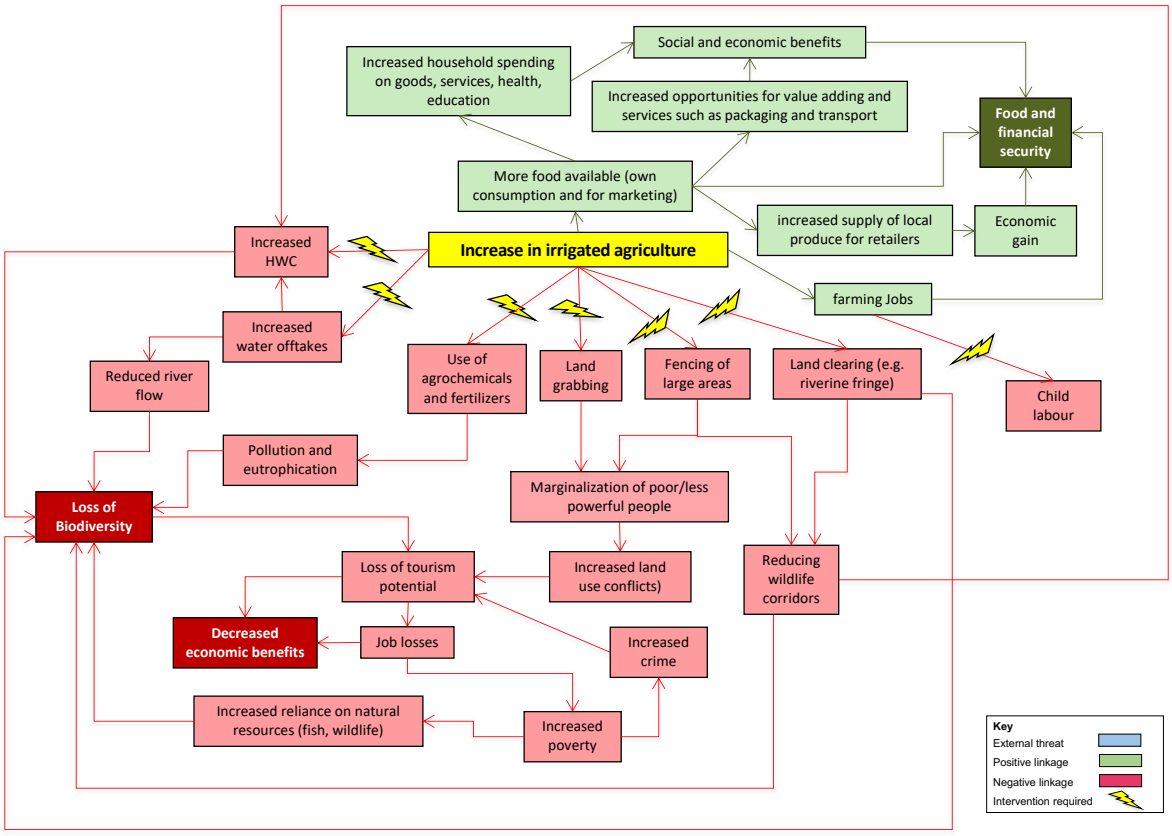


Figure 8.2 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of an increase in irrigated agriculture in the CURB.

According to the State of the Basin Report[94] there is relatively little crop cultivation in the upper Cuando Basin because of poor soils. Nevertheless, woodland areas are reportedly cleared for rainfed cropping, but then abandoned after a few years, requiring new fields to be cleared. Manioc (cassava) is the main crop in the upper parts of the Basin, supplemented with maize and often inter-cropped with melons and beans. Sweet potatoes are cultivated along the margins of water courses. In southern Angola people grow maize, bananas and sweet potatoes close to the river and on islands within the expanses of marshes. As one moves south and rainfall decreases, maize and millet become more prevalent. There is some diversity in cultivation. Staples are maize, millet and sorghum, and these are complemented with pumpkins, groundnuts and beans.

Whilst the report states that the river is not used for irrigation to any substantial extent anywhere, there appears to be some interest in escalating irrigated agriculture to improve food security in parts of the CURB. Whether this is likely to happen remains to be seen, but the SEA must recognise the possibility in the expected low-medium growth scenario. As illustrated in the linkage diagram, an increase in irrigated agriculture will boost local food production and create opportunities for value adding and farming-related services. These could include packaging, transport, refrigeration, warehousing, fertilizers, pest control, equipment provision and servicing. Unlike rainfed cropping, irrigated agriculture is intensive, with much greater multiplier effects. Also, it requires new skills and could thus attract better jobs than traditional types of farming. The likely social and economic benefits are self-evident.

However, there are many serious unintended consequences, particularly since the CURB is rich in wildlife with expected escalating HWC and thus loss of biodiversity. Also, land clearing, land grabbing and elite capture are possible as large areas of land are needed for irrigation projects and the investors are probably foreign (at least to the CURB). Local residents probably do not have access to adequate funding for large projects that require substantial start-up capital. Lands will have to be fenced (to keep out wildlife and cattle), further marginalising poorer communities and exacerbating social and gender impacts. As land is alienated, poor communities will likely increase their reliance on remaining natural resources such as fish and wildlife, with negative impacts in biodiversity and tourism. Irrigated agriculture, especially monocrops, require substantial chemical and fertilizer inputs to enrich poor soils, and poisons to control pests. These substances readily contaminate surrounding areas, especially waterbodies. Thus, the accumulation of unintended consequences include loss of biodiversity and decreased economic benefits for the broader community.

[94] Pallett et al 2022

Table 8.3 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Expansion of irrigated agriculture	**Is it necessary?** Given that the majority of people living in the CURB are extremely poor and there is limited economic activity, communities are searching for ways of improving their food security and livelihoods. The fact that most parts of the CURB have so little formal crop-farming currently is an indicator of the general unsuitability of this area for this type of land use. **Is there a better strategic alternative?** As noted elsewhere, it is hard to caution governments and communities against the perceived benefits of industrial agriculture when there are very few other viable alternatives for them in this area. Whilst the CURB is regarded as highly suitable for wildlife and tourism, there is a limit to how many people these sectors can employ – especially given the objective of avoiding mass-tourism and relying instead on high-quality but low volume tourism. Perhaps the best strategic option is to help communities to engage in land uses such as more intense farming using best-practice methods, but only where these increase productivity and profitability. **Location?** There is no specific location where irrigated farming is expected to be established, but most likely it will be close to the river, unless groundwater is used, in which case the projects could be further from the river. A concern is that projects too close to the river might result in fertilisers and pesticides being leached in the Cuando's clear, mineral-free water. **How should it be done?** There is an urgent need to find or develop appropriate techniques for agriculture - and thus limit landscape degradation. WWF promotes the concept of Agroecology, which is the application of ecological concepts and principles in farming. Agroecology can transform agricultural systems so that they support healthy populations of wild species while simultaneously improving productivity and reducing poverty. Agroecology promotes farming practices that: • **Mitigate climate change** - reducing emissions, recycling resources and prioritising local supply chains. • **Work with wildlife** - managing the impact of farming on wildlife and harnessing nature to do the hard work for us, such as pollinating crops and controlling pests. • **Put farmers and communities in the driving seat** - they give power to approaches led by local people and adapt agricultural techniques to suit the local area - and its specific social, environmental and economic conditions. Following Agroecology principles are particularly important in the biodiversity hotspots where most of the poor concentrate and have little choice but to exploit wild habitats for survival. Liniger et al (2011) refer to "Integrated Crop - Livestock Management" (ICLM) where crops and livestock interact to create synergies, making optimal use of resources. The waste products of one component serve as a resource for the other: manure from livestock is used

	to enhance crop production (improve soil fertility), whilst crop residues and by-products (grass weeds and processing waste) are supplementary feed for the animals. Conservation Agriculture (CA) has the potential to achieve these benefits. CA is a theoretical way of managing agro-ecosystems to achieve higher, sustained productivity, increased profits and food security while enhancing the environment. This is achieved through improved management and application of three key principles in conjunction with other good agronomic practices: • Minimal soil disturbance; • Maintenance of a permanent soil cover with mulch or cover crops; • Practising crop associations or rotations. All CURB countries have planning regulations and standards that pertain to formal agriculture. These will have to be followed as per normal procedures. Perhaps the main challenge is formalising land tenure where appropriate, in addition to improving services. An important issue regarding agriculture is considering the vulnerability of this sector to climate change. Some suggestions for best practice are provided below. **Timing?** N/A

Table 8.4: Examples of possible mitigation and enhancement measures for arable agriculture (irrigation and dryland) in the context of climate change.

Key objective	**Measures to reduce climate change impacts and improve resilience to drought, floods, heat**
Improve water use	• Reduce amount of water required through efficient irrigation technologies. • Improve soil's organic carbon content. This results in more effective use of available water. Also enhances biodiversity, soil structure, crop production. • Select climate-adapted crops/varieties. • Regularly maintain irrigation pipes to reduce water loss. • Cover reservoirs and canals to reduce evaporation. • Apply mulch to reduce evaporative losses.
Avoid large areas of mono cropping and associated inappropriate agricultural practices.	• Reduce size of agricultural projects, especially in biodiversity important landscapes. • Practice Agroecology where possible – intercropping, planting/preserving corridors of plants with nitrogen-fixing bacteria properties (e.g. *Acacia* and *Faidherbia*), • Establish intensive agro-hubs for small scale farmers, • Ensure large agricultural schemes are at adequate distances from rivers to reduce contamination from herbicides, pesticides and fertilizers, • Where herbicide use is unavoidable, only use approved chemicals and in prescribed applications and quantities, • Avoid/minimise soil salinisation by: • Increasing drainage for better flushing (to remove salts from the ground surface).

Key objective	Measures to reduce climate change impacts and improve resilience to drought, floods, heat
	• Planting salt-tolerant crops to manage economic risks and to ensure land cover. • Removing salt crystals from the surface mechanically. • Avoiding over-watering (i.e. efficient irrigation system as noted earlier).
Avoid/minimise removal of large trees, even within crop fields	• Preserve and where possible increase, the number of trees within crop fields – especially nitrogen-fixing trees (see above) but also trees that provide shade (in summer – but drop leaves in winter) - Favourable changes in micro-climatic conditions (shade trees) reduce temperature extremes.
Resilience to floods	• Avoid/limit infrastructure to above the 1:100 year flood line. • Reinforce embankments, stormwater drains, etc to withstand more frequent and larger floods.

8.3. INCREASE IN DRYLAND SHIFTING CROP PRODUCTION

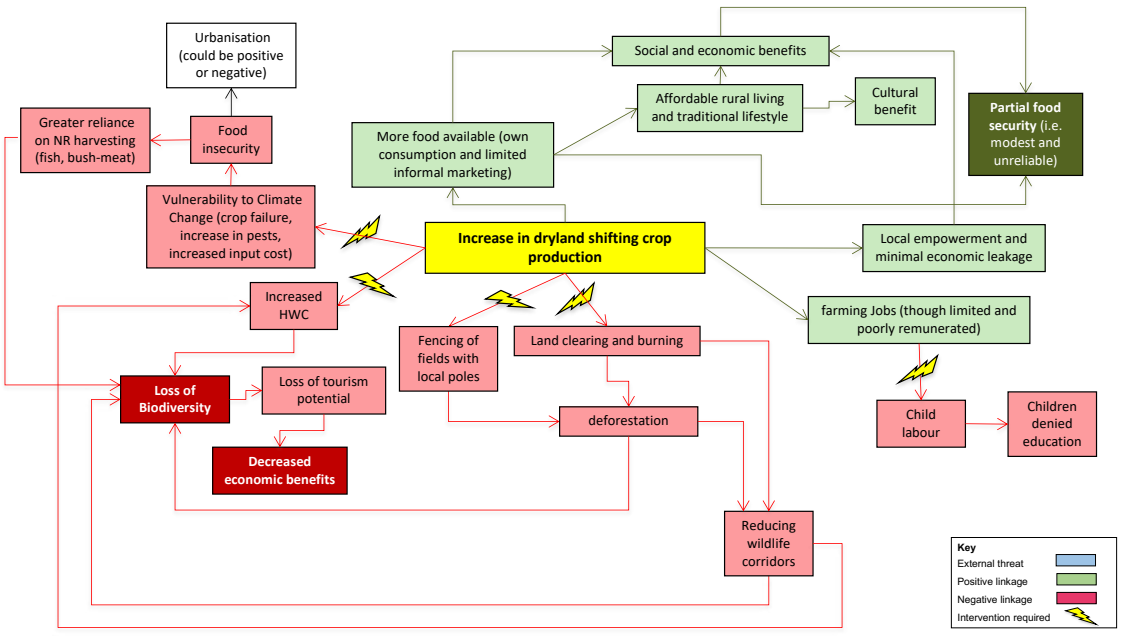


Figure 8.3 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of an increase in dryland shifting crop production in the CURB.

The scoping report states that whilst soils are poor, there are usually a few cleared fields around settlements. In the upper basin people grow crops such as manioc, maize, sweet potatoes, beans and melons. As one moves south and rainfall decreases, maize and millet become more prevalent.

There is some diversity in cultivation: the staples are maize, millet and sorghum, and these are complemented with pumpkins, groundnuts and beans[95]. Fields are typically used only for a few years before being abandoned, requiring new areas to be cleared.

The system of dryland cropping is used almost entirely for own consumption. However, some marketing of local produce happens in the scattered towns, but this probably makes up a very small proportion of total production. Overall, there is relatively little money in circulation, and people rely heavily on what resources they can harvest from the natural environment. At the southern end of the Basin, surplus crops of maize and sorghum are marketed in Katima Mulilo and further afield (ibid).

As indicated in figure 8.3, rainfed crop growing in this part of southern Africa is extremely vulnerable to climate change. Total annual precipitation averaged over the whole of KAZA is expected to decrease by 4.6% by 2050, relative to historical (1960-1990) precipitation. The hot dry season (August to October) is expected to get drier by 33%, the hot wet season (November to April) is expected to get drier by 3.3%, and the cool dry season (May to July) is expected to get drier by 22%. Mean annual temperature averaged over the whole of KAZA is expected to increase by 3°C (14%), with mean monthly temperatures reaching dangerously high levels (close to 30°C) for October and November. [96]

Whilst the various crops provide homegrown food (and thus food security) when the climate is conducive, more regular crop failures are expected. Thus, this type of crop-growing will be increasingly risky and unreliable in the future. Moreover, increased temperatures and changing precipitation patterns have significant impacts on agricultural insect pests. For example, they can expand their geographic distribution, survive during winters, and increase the number of generations[97]. An increase incidence of insect-transmitted plant diseases can be expected, as well as reduced effectiveness of biological control, especially natural enemies. As a result, there is a serious risk of crop-linked economic losses, and thus human food security (ibid).

An increase in crop failures will likely result in rural communities relying more on harvesting bush meat, fishing and selling wood for survival, with resultant negative impacts on biodiversity. Also, the expansion of fields through slash-and-burn practices results in deforestation and habitat loss, and may impact on wildlife corridors. Where this occurs one can expect an increase in human-wildlife conflicts.

[95] Information drawn from Raison, 2019. River catchments and development prospects in south-eastern Angola.
DoF. 2014. Forest management plan, Lubuta community. Unpublished report, Directorate of Forestry, Ministry of Agriculture, Water and Forestry, Windhoek.
[96] Source: 2020 Climate Change Vulnerability and Adaptation Assessment for Protected Areas of the Kavango–Zambezi (KAZA) Landscape: compiled for WWF by Anchor Environmental Consultants.
[97] Skendžić et al 2021.

Table 8.5 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Expansion of dryland shifting crop production	**Is it necessary?** Given that the majority of people living in the CURB are extremely poor, it is understandable that communities are searching for ways of improving their food security. The fact that most parts of the CURB have so little crop production currently is an indicator of the general unsuitability of this area for this type of land use. **Is there a better strategic alternative?** It is hard to convince poor people to abandon dryland shifting crop production when there are very few other viable alternatives for them to achieve food security. Whilst the area is regarded as largely unsuitable for crop growing, some yield improvements might be possible if more drought and pest-tolerant crop varieties become available. **Location?** Since people will only establish fields near to where they live, cultivated areas will be located around villages and towns. **How should it be done?** Ram et al (2012) report that in the changing climate scenario along with the need to feed the population and a highly degraded resource base (land and water), the current practice of crop production in drylands is no longer an option. Moreover, there are limited options for enhancing dryland cropping in this marginal area. However, Liniger et al (2011) refer to "Integrated Crop - Livestock Management" (ICLM) where crops and livestock interact to create synergies, making optimal use of resources. The waste products of one component serve as a resource for the other: manure from livestock is used to enhance crop production (improve soil fertility), whilst crop residues and by-products (grass weeds and processing waste) are supplementary feed for the animals. From a sustainability perspective, the expansion of dryland shifting crop production in the CURB should not be encouraged. **Timing?** N/A

8.4 NATURE CONSERVATION

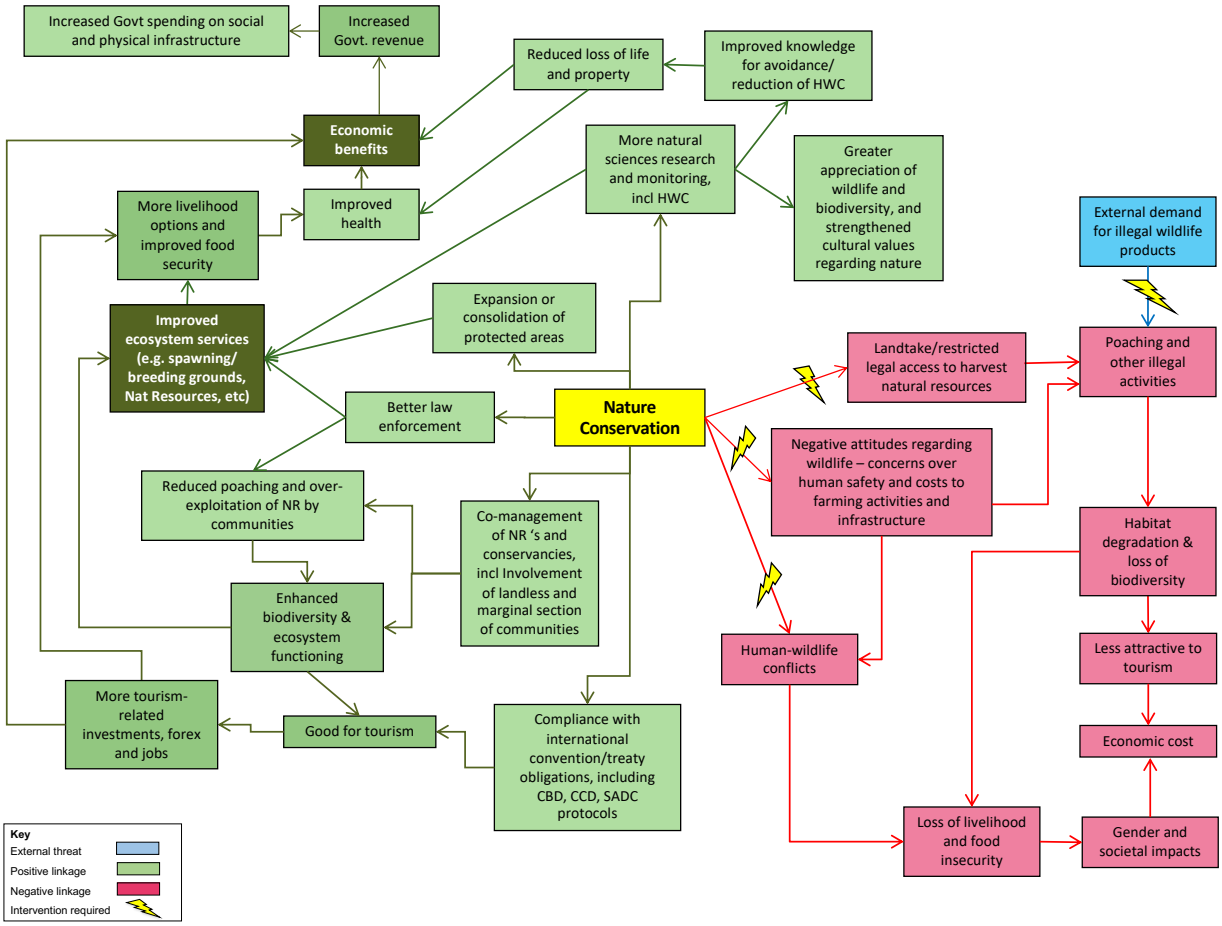


Figure 8.4 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of nature conservation

As illustrated above, the intended positive impacts of conserving the natural environment are potentially many and varied. Good conservation is likely to result in maintaining healthy natural habitats and associated wildlife populations (or at least maintaining those already there). This in turn will support the small but important tourism industry, and attract local and international investments (see separate tourism linkage diagram for elaboration). Given its central locality, protected areas in the CURB will have multiple benefits for conservation and tourism in the wider area, and KAZA as a whole. Since there are existing CBNRM initiatives in the CURB States, it is likely (hoped) that communities will continue to be regarded as conservation partners and that there will be linkages between state protected areas, conservancies and other areas with community-based conservation status. The combination of State and community conservation efforts, private sector and NGO partnerships, should improve law-enforcement practices and also cross-boundary cooperation in this regard. Ultimately, conservation will very likely support economic growth in the CURB.

All existing management plans for protected areas falling within the CURB, acknowledge the need for research and monitoring. The area has a long history of supporting a wide range of scientific work and it is hoped that there will be more emphasis on HWC, given that expanding conservation and resultant wildlife may cause an increase in HWC. Much of the research conducted in the CURB has been funded and led by overseas institutions and teams. Whilst this support is appreciated, greater involvement of local scientists and institutions is needed – both to nurture indigenous capacity but also to improve buy-in by decision-makers. Moreover, greater involvement by local/regional experts should minimise the imposition of external values and agendas from entities not supportive of sustainable resource use as an integral part of conservation in the region.

In theory, improving/expanding/consolidating nature conservation efforts may require some land-take and, depending on the nature of the land and its current use, there may be communities that lose their land (or access to grazing and river-front) and then suffer loss of livelihoods. However, it is more likely that protected areas will not be expanded and that existing boundaries will be maintained. Also, it is likely that the authorities will tolerate certain resource-utilisation activities and even settlements in the PAs – as is the case today. Thus, the status quo will probably be maintained.

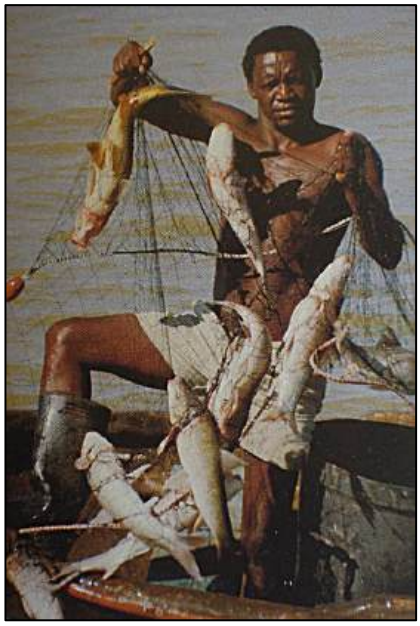
Ultimately, the cumulative impacts of poor planning and inadequate management, are economic losses and therefore costs.

Table 8.6 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Expansion of conservation	**Is it necessary?** Conservation is the foundation for safari tourism, which is the one sector that has a comparative advantage over all others in the CURB. As noted elsewhere, the basin has limited potential for agriculture and aquaculture, and even less for manufacturing, mining, logistics and other conventional industries. Because of its near-pristine natural habitats, abundant wildlife and locality within KAZA, conservation and tourism are sectors with the greatest potential for sustainable growth. However, the idea of actually expanding the size of protected areas in the CURB could be controversial, given that so much of the CURB is already protected. Probably a more realistic objective is consolidating existing PAs and improving their management, especially law-enforcement. A concern is that there is pressure on governments (especially in Angola) to downgrade their PAs to enable more development from various sectors on this land. Should this happen, it would be a major setback for conservation in the CURB and KAZA more broadly. There is much potential for greater community involvement and benefit-sharing in conservation. Training locals to play a greater role has been underway for decades, and can be improved. **Is there a better strategic alternative?** See above **Location?** It is unlikely that new PAs will be developed in the CURB over the next 10 years or so in the low-medium growth scenario. Instead, consolidation of existing PAs is expected. A likely positive development is that the Angolan authorities will allocate a management mandate to a reputable organisation for assisting with the management of their protected areas that fall within the CURB. **How should it be done?** Realising the potential positives requires a commitment to: • Maintaining the CURB as an "eco-hub" that builds its future development on intact natural habitats and ecological processes, abundant and free-moving wildlife, harmonious (as much as possible) human-wildlife co-existence. • Building local capacity for PA and natural resources management. • Improving cooperation between conservation and law-enforcement agencies, including at transboundary level. • Zoning PAs to achieve a balance between protecting critical habitats and wildlife populations, and enabling reasonable access (and rights) for communities to natural resources – this acknowledges the fact that the existing PAs (some established quite recently) have historically been occupied to some extent by people. Failure to do this will alienate local communities and result in conflicts.

	• Additionally, finding ways to enable local communities to derive greater and sustainable benefits from the PAs (e.g. tourism concessions, tourism value-chains, meat from trophy hunting, jobs, H4H, congregated farming, agri-hubs). • Pro-actively protect communities from impacts caused by wildlife (e.g. elephant, predators, hippos, crocodiles) – e.g. fencing crop fields, safe water offtake points (on riverbanks), early-warning systems, stockades for livestock, financial compensation in case of damages. • Avoiding allowance of settlements in key wildlife corridors. • Avoiding the establishment of fences in and between the PAs. • Ensuring that other sectors/agencies present in the PAs (e.g. military and police) are fully aware of the fact that they are residing/active in a PA and that they are expected to adhere to PA regulations and zonation. **Timing?** N/A

8.5 FISH FARMING AND PROCESSING



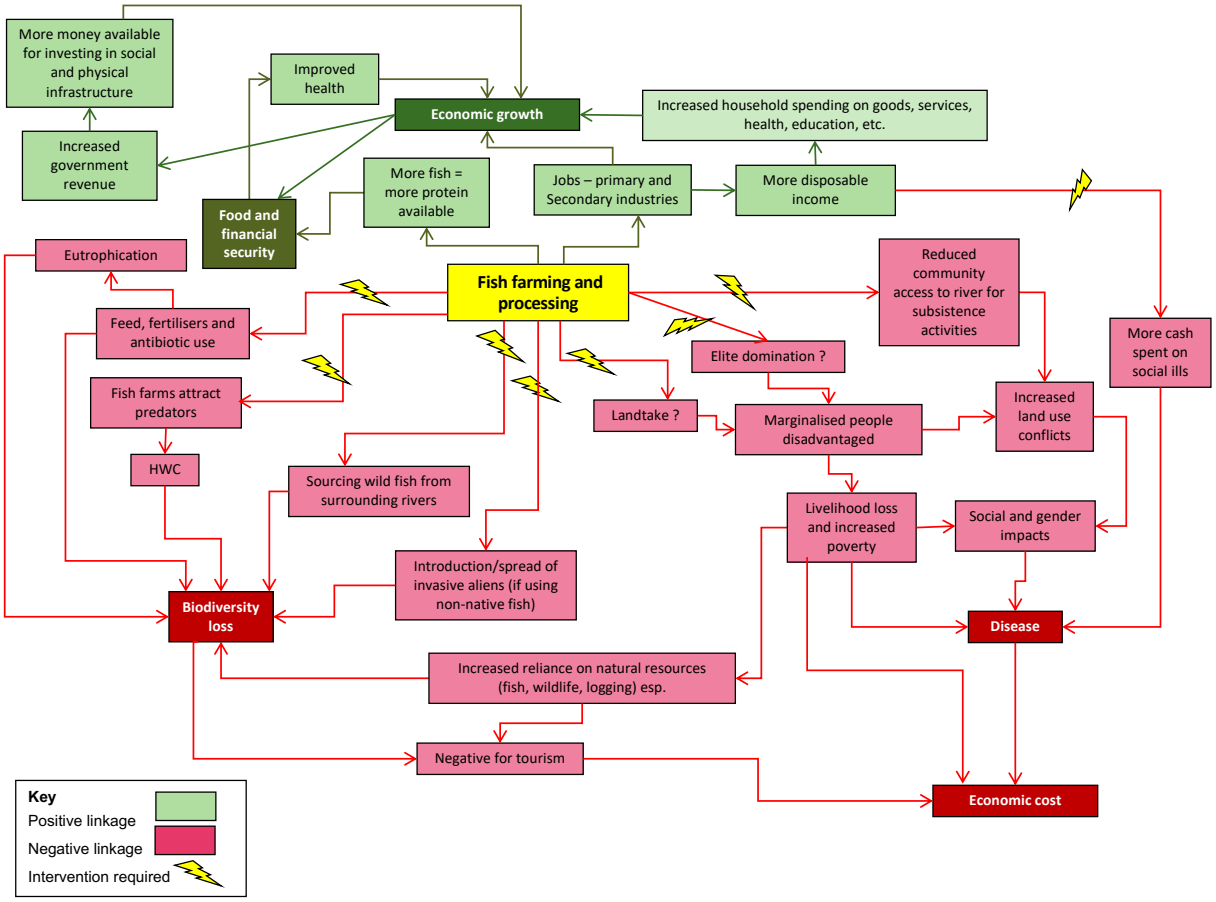


Figure 8.5 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of fish farming and processing.

Some stakeholders have suggested that fish farming might be a good option in the CURB, but there appear to be no firm proposals to date. As illustrated above, the intended positive impacts from this type of development are potentially many and varied, and ultimately could result in improved availability of locally-grown protein, employment, financial and food security, and economic growth in the area.

However, the fish farms may require some land-take and, depending on the nature of the land and its current use, there may be communities that suffer loss of livelihoods. Unless they are donor-funded and community-based, these kinds of projects, which require substantial investment, are likely to be owned and operated by (possibly from outside) wealthy developers who may not be willing (or able) to dilute their shareholding. Many might argue that entrepreneurship needs to be encouraged, rather than insistence on making projects "community-based". Either way, a large development will likely result in poorer communities having to make way for the project. This marginalizes those affected and could lead to conflicts. It is possible of course that fish farming could be on a much smaller scale following a cooperative approach. This model is common in developing countries, and is more organic and equitable, but probably not of sufficient scale to generate significant economic benefits.

In addition to social impacts, other key concerns are impacts on habitats and biodiversity. Depending on the type of fish being farmed, and other design and management details, a variety of negative impacts may occur. These include the use of artificial feed, fertilizers and antibiotics – to stimulate growth and manage diseases. These substances are very likely to find their way back into the water-body and pollute sections of the Cuando. Also, the species needed for a commercial fish farm may not occur (or not in sufficient numbers) in the Cuando, so they might be sourced from either the Okavango or Zambezi, or further afield. The species introduced might even be alien to the region and the chances are high that they will enter the Cuando and disrupt local biodiversity – even causing indigenous fish to become extinct. The concentration of farmed fish in ponds/reservoirs might attract a variety of predators, and thus result in human-wildlife conflicts.

In many parts of the world, highly productive cage systems facilitate sustainable aquaculture growth.[98] However, many current cage installations are poorly regulated, placed near waters that are vulnerable, and adhere only partially to good practices (*ibid*). Clearly, governments have a crucial role to play in regulating the expansion of cage aquaculture, especially in shared river systems such as the CURB.

Sustainable intensification of pond farming can also aid aquaculture growth. However, careful zoning and selection of sites suitable for aquaculture and improvements in resource-use efficiency, energy-efficient pond aeration, in-pond raceway systems, recirculating aquaculture systems and aquaponics can enable small-scale and medium-scale farmers to intensify and increase pond productivity (*ibid*).

[98] Ragasa et al 2022

Limited availability of skilled labour is an ongoing challenge for aquaculture firms. A lack of state-of-the-art knowledge and agribusiness skills, including poor recordkeeping, sanitation, stocking, feeding and water management practices, stifles productivity and profits of small-scale fish-farm enterprises. Therefore, CURB governments must invest in capacity strengthening for aquaculture-extension workers and fish-farmer associations to facilitate training and expand good aquaculture practices (*ibid*).

Table 8.7 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Fish farming and processing	**Are they necessary?** The only obvious alternative is the "no projects" alternative, and a continuation of subsistence fishing to satisfy protein demand. **Is there a better strategic alternative?** See above **Location?** • There are currently no specified localities. **How should it be done?** In addition to guidance provided above: • conduct EIAs for all major projects, in accordance with the relevant national laws, and ensure that each project has an outcomes-based EMP. • Based on EIA/EMP, ensure all projects obtain and comply with individual sector permits (including labour, pollution, water, land, biodiversity, transport in case of international boundaries, etc.) • Integrate EMP requirements into the project budget (whether in-house or sub-contracted) and ensure compliance by all contractors and sub-contractors • Ensure Interested and Affected Parties are adequately consulted during project planning and, where relevant and appropriate, during implementation • Integrate aquaculture projects with all other sectoral project interventions (e.g. infrastructure, tourism, conservation, agriculture). • Assign an environmental officer to supervise the construction and execution of projects, particularly for large-scale endeavours. • Use local resources (input materials, labour and service providers) wherever possible and practicable. • Monitor the implementation of the EMP and periodically assess the effectiveness of impact avoidance or mitigation measures. • Promote community fish reserves. **Timing?** • No specific advice offered.

8.6 MINING (MINERALS AND PETROLEUM)

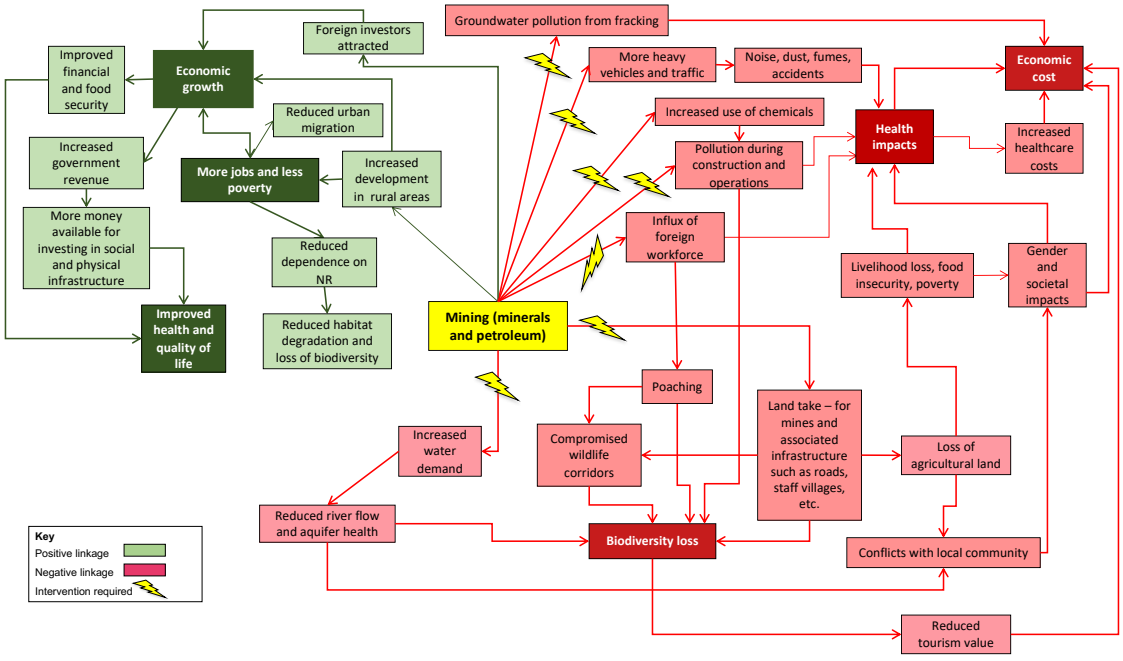


Figure 8.6 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of mining in the CURB.

According to the State of the Basin Report the thick covering of Kalahari sand throughout the Cuando Basin makes detection and recovery of minerals very difficult. There is currently no conventional mining nor petroleum exploration in the Basin. However, alluvial diamonds are not influenced by this factor, and these are sought by small numbers of artisanal miners in river channels in the upper and middle parts of the basin. Apart from the observations of scattered diamond mining activities, there is no information on the extent of these operations, the volumes that are processed, nor the degree to which local residents participate and benefit (*ibid*). We are

also unaware of any possibilities or prospects of diamond mining being expanded on a substantial scale in the diamond bearing sedimentary rocks of the Cuango (aka Kwango) geological group.

However, the nearby Okavango catchment is similarly overlain by deep Kalahari sand and is nonetheless currently being explored for gas and oil, using extensive seismic surveys and extremely deep drilling. Thus, there is no guarantee that the CURB is safe from mineral and petroleum exploration and production, though no suitable geology has been identified nor expected to be explored in the low-medium scenario over the next ten years or so.

As illustrated in the linkage diagram, mining/petroleum will boost development and attract foreign investment. However, this industry requires substantial capital and specialist skills, which are unavailable within the CURB or even the region. Also, it is unlikely that the prospecting phase will provide significant local employment. The likely benefits in the event of economically viable resources being found, are essentially employment and opportunities for service provision at local and regional level. However, the expectation of economic growth from active mining/petroleum production may not be realised within the CURB, as levies and taxes are paid to the national fiscus, though some may trickle back to the CURB via government services. It is not unusual that the costs of mining/petroleum are bourne locally, whilst the benefits are national and corporate. Moreover, a mine in a rural area with poor communities can be economically disruptive, especially when the mine closes and the "quick riches" disappear fast.

There are many well-documented negative impacts from mining/petroleum extraction. These are particularly important in the context of the CURB, which is environmentally very sensitive and rich in wildlife, some of it endangered and specially protected. Also, the landscape has a comparative advantage for development as an eco-hub based on high-quality, low volume tourism. Maintaining sense-of-place is essential for a sustainable tourism product. Mining/petroleum production will destroy that.

Should a mine develop, an influx of foreign (mostly male) workers is inevitable. There are volumes of case studies that document the serious and long-lasting social and health impacts of a foreign workforce in a remote setting. These ultimately translate into substantial economic and social costs.

Direct impacts are more obvious and equally substantial, including land degradation in the footprint of the mine (and ancillary infrastructure such as roads, pipelines, staff village, etc.). Almost all mining processes require chemicals for ore-leaching and tailings dams are seldom fully rehabilitated. Even with good planning, pollution of air, soil and water is usually a long term problem. Closed mines still leave massive holes in the ground and rock/sand stockpiles.

Whilst mining requires less land generally than other types of land use (e.g. farming, roads, towns), land take is inevitable and conflicts with local communities can be expected. This has recently happened in the adjacent CORB. Similarly, wildlife corridors – so vital in the CURB – will be severely disrupted, even with seemingly benign seismic exploration. Elephants are particularly sensitive to

this. Disruption of wildlife corridors will result in increasing HWC as animals will increasingly be restricted into ever-diminishing spaces.

Mines are notoriously water-hungry, so one can expect severe impacts on the Cuando river and associated aquifers, again resulting in escalating HWC and thus loss of biodiversity.

There are probably few places in Africa that are more vulnerable to prospecting and mining/petroleum than the CURB. The respective governments are urged to declare the CURB out-of-bounds for this industry, in spite of the lure of short-term riches.

Table 8.8 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Mining and petroleum	**Is it necessary?** It is very difficult to convince governments of developing countries to foreclose the option of allowing mining/petroleum exploration and development because of the need to conserve biodiversity and promote ecotourism. Even though it may be unlikely that this area contains minerals or petroleum resources, declaring the CURB as a no-go area for these industries is an opportunity cost. **Is there a better strategic alternative?** As noted elsewhere, it is hard to caution governments and communities against the perceived benefits of prospecting and mining/petroleum when there are very few other viable alternatives for the inhabitants in this area. Whilst the CURB is regarded as highly suitable for wildlife and tourism, there is a limit to how many people these sectors can employ – especially given the objective of avoiding mass-tourism and relying instead on high-quality but low volume tourism. Nevertheless, there are compelling arguments to encourage CURB governments to accept the opportunity cost of banning this sector completely and forever from the basin. **Location?** There is no specific location where prospecting/mining/petroleum production might be established in the future. **How should it be done?** As noted earlier, it should not be allowed at all. **Timing?** N/A

8.7 TOURISM EXPANSION

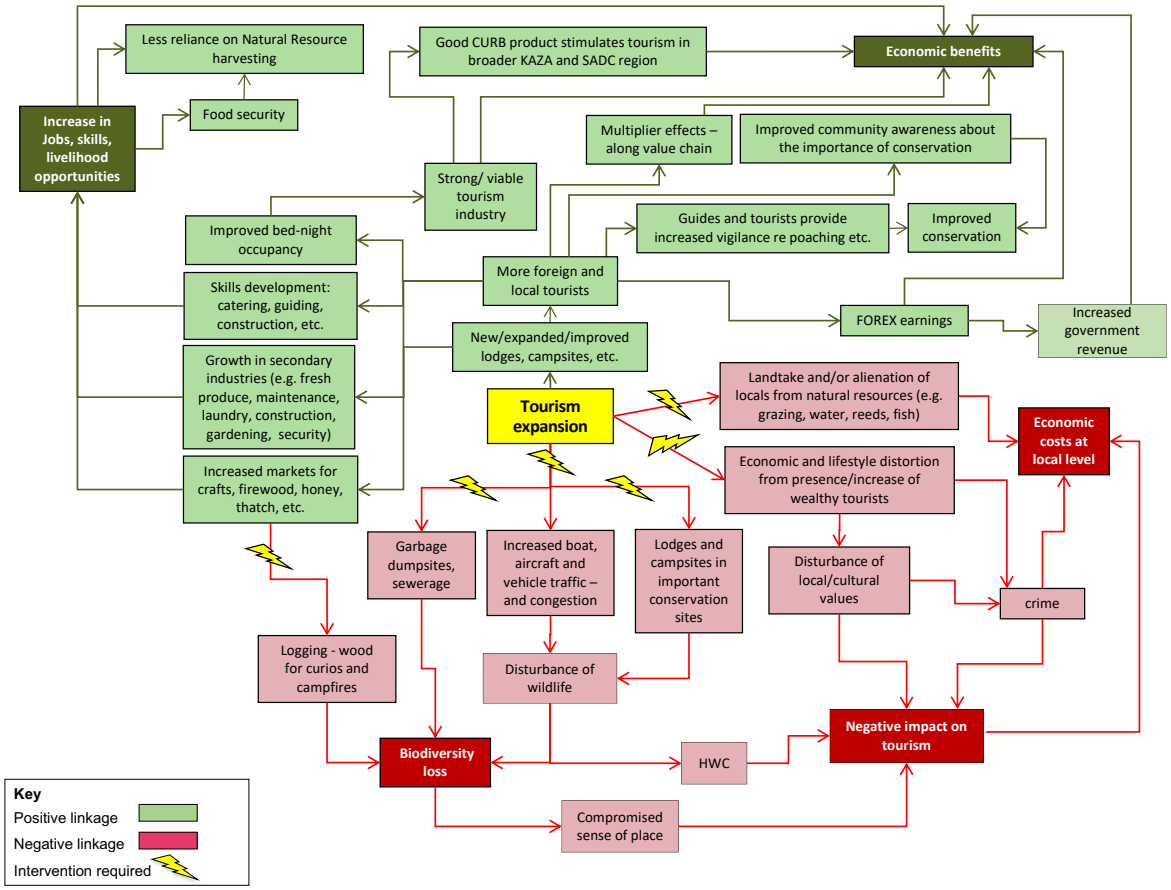


Figure 8.7 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of expected tourism expansion

As illustrated above, the intended positive impacts are potentially many and varied, and ultimately will likely result in modest economic growth (in the CURB generally), increased employment, skills development, growth of secondary service industries and trading opportunities in products such as crafts, fresh produce, firewood, thatching, honey etc. Given its central locality, a well-branded tourism product in the CURB will have multiple benefits for tourism in the wider area, and KAZA as a whole. It is likely that both local and foreign tourists will increasingly pursue multiple destinations as part of a regional trip, so the overall benefits of a thriving industry are spread across neighboring countries. Besides the resultant economic and employment benefits, one can expect improved cooperation between the countries on mutually-beneficial matters such as cross-border travel, conservation, safety, security, health, etc.

This SEA assumes that reserving construction, supply and maintenance contracts and jobs for locals will be easy, given that most lodges and campsites have been built/renovated by local contractors – though not necessarily "local" to the CURB. Also, most of the timber, thatch etc. is currently sourced locally, and that trend should continue.

Depending on the localities, the new or expanding establishments will require some land-take and, depending on the nature of the land and its current use, there may be communities that 'lose' (or set aside) their land (or access to grazing and river-front) and then potentially suffer loss of livelihoods. It is likely that most (but not all) establishments will be located in or near the river/backwaters and within the riverine fringe. There may thus be losses to habitats important for conservation, the restriction of wildlife corridors, and thus increased HWC.

Also, wherever there are tourism facilities, there is an increase in waste generated and, if waste removal and management are inadequate, waste dumps rapidly become a health hazard – and a source of pollution that inevitably ends up in nearby streams and the Cuando itself. It is also common that poorly managed waste dumps attract vermin and a variety of other wildlife, which then results in HWC. All of this would impact the environment and tourism negatively.

BOX 8.3: Sense of Place

The term sense of place is a multidimensional, complex construct used to characterize the relationship between people and spatial settings. It is often used in relation to those characteristics that make a place special or unique. In the CURB context this would include attributes such as "unspoilt wilderness" where people feel close to nature and are able to experience wildlife without causing undue environmental and social impacts. It is generally understood that eco-tourism contributes to maintaining sense of place, but mass-tourism does the opposite.

Expanded tourism will result in an increase in road, river and small aircraft traffic – all of which are noisy and potentially degrade sense of place (see box). Boating has an additional concern because wakes can disturb the breeding areas of bank-nesting birds such as bee-eaters, and inundate crocodile nests and pollution from outboard motors (especially two stroke engines). Also, given that the Cuando is a narrow river, there is often inadequate space for hippo to escape boats, leading to conflicts, especially when pods have young.

A feature of high-end tourism in remote rural areas is that the presence of wealthy foreigners accommodated in luxurious lodges, driving around in 4x4s, and sporting expensive cameras and

designer safari-gear, is in great contrast to the poverty which most locals experience. This can result in resentment amongst locals, and petty crime. This is exacerbated when locals occupy only very menial positions in the industry and when they have no or insignificant shareholding/ownership in the establishments.

Ultimately, the cumulative impacts of poor planning, inadequate management and inclusivity of communities, are economic and social losses and therefore costs.

Table 8.9 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Expansion of tourism	**Is it necessary?** Tourism is the one development option that can be regarded as having a comparative advantage over all others in the CURB. As noted elsewhere, the basin has limited potential for agriculture and aquaculture, and even less for manufacturing, mining, logistics and other conventional industries. Because of its near-pristine natural habitats, abundant wildlife, accessibility (especially in the middle and lower sections), locality within KAZA and relative safety (compared to many other regional destinations), tourism is undoubtedly the sector with the greatest potential for sustainable growth. There is much potential for improving community involvement and ownership and sourcing a wide range of services and input materials locally. Training locals to capitalise on the rewards associated with tourism has been underway for decades and can be improved. **Is there a better strategic alternative?** See above where? **Location?** It is unlikely that many new lodges will be developed in the Namibian, Botswana and Zambian parts of the CURB over the next 10 years or so in the low-medium growth scenario. Instead, expansion (and thus extended footprint) of existing lodges and campsites is expected. Also, upgrading of existing establishments, many of which delayed upgrading during the COVID era, is expected. There might be new lodges/campsites established in the Angolan part, and possibly some smaller camps in the woodland habitats away from the river in Angola, Namibia and Zambia. This dry-woodland habitat has much less to offer as a tourism product because of a paucity of wildlife. However, remote bush camps (e.g. in the Angolan parks) will attract regional self-drive tourists especially if it is developed as a transboundary adventure tourism route. Overall, the concentration of accommodation establishments, tourism activities and tourists will be linear - along the Cuando river and associated backwaters. The Savuti

	establishments can be regarded as "separate" as their footprint and activities do not overlap with those on the main Cuando and they are managed via a government concessioning process. **How should it be done?** Realising the potential positives requires a commitment to: • Maintaining the CURB as an "eco-hub" that builds its future development on intact natural habitats and ecological processes, abundant and free-moving wildlife, harmonious (as much as possible) human-wildlife co-existence. • Ensuring that the CURB tourism product is "high quality, low impact" – and avoiding mass tourism. For the most part the product is rather linear and in a sensitive environment, so tourist numbers must be kept low. This is key to maintaining "sense of place" and providing visitors with both a great wildlife and wilderness experience. The CURB product should not mirror those of Chobe, which for the most part can be regarded as "mass tourism" in a landscape with a compromised "sense of place". • Given the linear nature of the CURB's tourism product, the number of vehicles driving around on the road network, the number of boats cruising along the river, and other activities must be limited. The following are recommended guidelines - individual parks and conservancies will have their own management plans, which should add more details and targets to the bullets below: **Lodges** o New lodges or other significant infrastructure developments to undergo EIAs as per national laws. o The CURB tourism industry must be inclusive (this is a key KAZA objective). Whilst some lodges will be "high-end" and possibly foreign owned, opportunities must be available for meaningful local involvement. Also, there must be space for facilities that are affordable for regional tourists, including campers. o Lodges/campsites should adhere to existing national and regional "eco-criteria" – e.g. Botswana Ecotourism Best Practice Manual, Namibian Eco-Awards, Zambian Tourism Investment Guide, KAZA sustainable tourism principles. Elements must include (inter alia): ▪ Responsible waste management, including properly designed and watertight septic tanks. ▪ Minimal use of polluting chemicals (use natural cleaning agents). ▪ Natural gardens only – zero alien plants (even though water may be regarded as "plentiful", lodges should not establish expansive lawns – indigenous bush should dominate the lodge surroundings). ▪ Zero/minimal removal of large trees and minimal earthworks. ▪ Aesthetically pleasing designs – preferably single-storey and using natural materials wherever possible. ▪ No feeding of wildlife and no caged birds or animals.

	▪ Quiet – CURB lodges should have a reputation for "back to nature" – not a destination for loud parties! o Campsites should be designed for privacy – enough space and screening (preferably natural bush) to enable campers to enjoy maximum privacy and a bush experience. Avoid a "public campsite" or "caravan park" feel where everyone is packed into a confined public space. o Waste reduction at source to be practiced but recycling also necessary. Landfills must be carefully located, well managed and secure against wildlife and human scavenging. o Electricity to be supplied from the national grid (where possible) and/or solar. Diesel/petrol generators not recommended (because of noise and fumes). o Lighting to be minimal – lodges are encouraged to adopt "dark sky" principles (https://www.darksky.org). o Use local contractors and labour wherever possible, and source as much construction material as possible locally. o No shore-based angling or swimming allowed except in designated areas. o Only "catch-and-release" angling allowed. **Boats/river cruises** o No additional boats allowed for existing lodges – and all boats must be similar to those currently used (no jet ski's or speedboats allowed) – outboard motors must be well maintained and with appropriate noise reduction measures in place. o New lodges may only have 2 boats each. o All refueling of boat motors (and maintenance) to be done in such a way as to avoid fuel spillage. o Strict speed limits for river cruises (less than 5km/hour). o Noise protocols to be enforced on river cruises – no shouting, music or partying. **Airfield and aircraft** o No new airfields, except in the Angolan section. o No drones or microlight aircraft allowed in or around protected areas, and no scenic flights – aircraft must fly a direct route between airfields. **Roads and vehicles** o All roads in PAs/conservancies/concession areas to be "offroad" type – offering a wilderness feel. None to be paved except localized areas where paving is required for access/safety. o The target density for the road network within PAs/conservancies/concession areas is approximately 5km of road per vehicle at any given time.

	○ All vehicles on roads in PAs/conservancies/concession areas to be "offroad" type – similar in size or smaller than typical l/cruiser, l/rover 10-seater safari vehicles – no busses or large overlander vehicles allowed. ○ Where suitable, hides should be established at selected viewing points so that people spend less time driving around. The hides need to be well designed for optimum game viewing and photography, of modest size (though adequate to seat at least 20 people). ○ No 4-wheelers (quad bikes) or motorcycles allowed in PAs/ conservancies/ concession areas. ○ All signage in protected areas to be modest in size and rustic – no lit-up signs, no "cartoon characters". **Timing?** Ongoing

8.8 IMPROVING ROAD ACCESS TO REMOTE AREAS

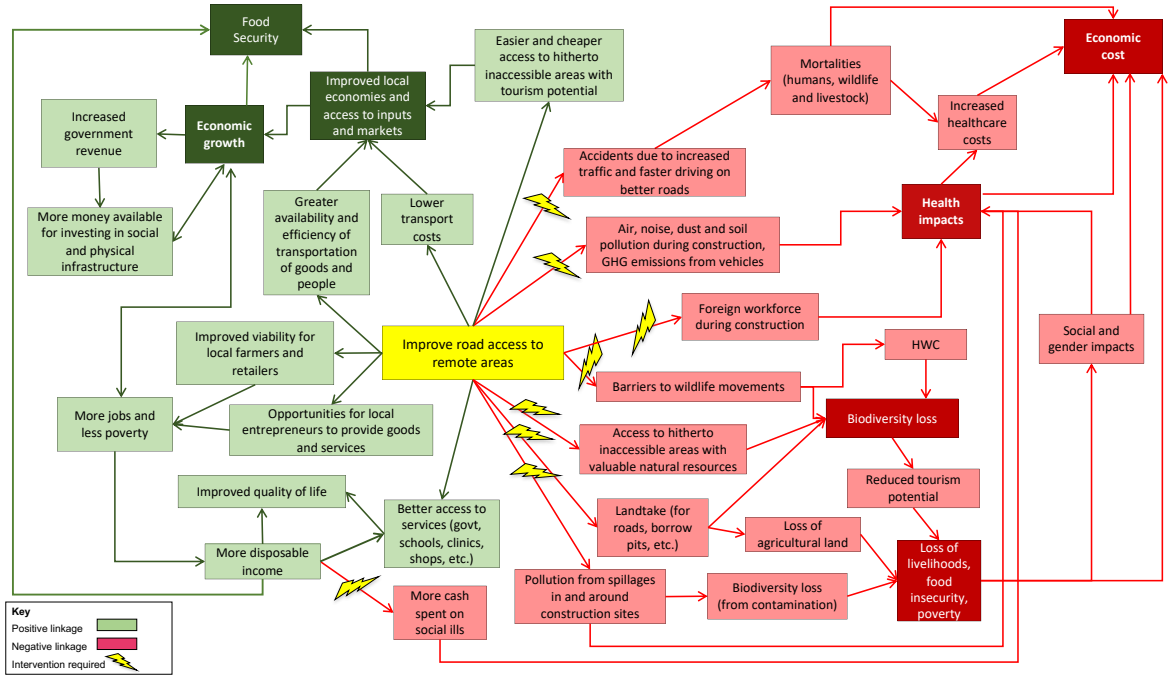


Figure 8.8 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of improving road access to remote areas

As illustrated above, the intended positive impacts are potentially many and varied, and ultimately will likely result in improved access for farmers and traders to markets, improved food security and economic growth and access to tourism attractions and accommodation. Better roads have many other benefits, including employment opportunities (though only during construction), lower transport costs and increased efficiency, enabling people to access public services (e.g. health, education, police, administration), etc. Realising some of the above positives requires a commitment to using local contractors and labour. This may not happen given the apparent advantages of foreign contractors over locals. The general impression is that the local construction industry (in the region generally) has declined and cannot compete with foreigners (notably Chinese contractors).

This SEA assumes that reserving contracts and jobs for locals may be difficult. As with all major construction activities in rural or remote areas, the expected influx of an outside (mostly male) workforce could result in a number of serious unintended consequences, including an increase in prostitution, spread of STDs, and a myriad of negative direct and indirect social, health and gender impacts.

The new roads may require some land-take and, depending on the nature of the land and its current use, there may be communities that suffer loss of livelihoods. An important secondary impact of new roads, is that they provide access to hitherto inaccessible places – for logging, poaching, prospecting/mining, agriculture, etc. So, whilst roads are positive in terms of improving accessibility and legitimate commercial activities, they can have the opposite effect if safeguards are not in place to counter the unintended negative consequences.

In addition to social impacts, other key concerns are impacts on habitats and biodiversity. The context for this is that much of the CURB lies at the heart of the five-country KAZA initiative. One of its key objectives is facilitating the movement of wildlife between CURB states and beyond. As noted elsewhere, the national parks in southern Angola have intact habitat, few people, very little wildlife and almost no tourism. The idea is to allow wildlife to drift into these parks and gradually, transform them into well-stocked protected and tourism areas. Whilst new roads in these parks may on the one hand be good for tourism, law-enforcement and park management, they may also enable a range of impacts that undermine wildlife and forest protection.

Table 8.10 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
New roads	**Are they necessary?** • Currently the Angolan section of the CURB has inadequate roads and a very limited network, leaving communities relatively isolated and unable to access social services and commercial opportunities. • The poor state of roads makes transport expensive and inefficient, and thus the current situation is an opportunity cost.

	• In principle, extending and/improving roads, especially in the Angolan section, is necessary from a socio-economic perspective. **Is there a better strategic alternative?** The only obvious alternative is the "no roads" alternative, which is unrealistic and improbable in the future. **Location?** • There are currently no specified localites/alignments for new/upgraded roads, but the most likely projects are west-east roads in the Angolan section of the CURB. There are no known proposals for new roads in the Namibian, Botswana or Zambian sections, though there have been suggestions for small bridges for expanding existing roads especially between Botswana and Namibia. **How should it be done?** • Conduct EIAs for all major projects, in accordance with the relevant national laws, and ensure that each project has an outcomes-based EMP. • When the roads have potential international linkages, the transboundary EIA notification guidelines should be used. • Based on EIA/EMP, ensure all projects obtain and comply with individual sector permits (including labour, pollution, water, land, biodiversity, etc.) • Integrate EMP requirements into the project budget (whether in-house or sub-contracted) and ensure compliance by all contractors and sub-contractors. • Ensure Interested and Affected Parties are adequately consulted during project planning and, where relevant and appropriate, during implementation • Integrate road projects with all other sectoral project interventions. • Assign an environmental officer to supervise the construction and execution of projects, particularly for large-scale endeavours. • Ensure safeguards are in place to avoid or minimize ribbon development, and especially to prevent people establishing informal housing or businesses in the registered servitudes. • Ensure that dredging and alterations to waterways do not undermine ecological processes and thus the provision of ecosystem services. • Apply or install best available technology to minimize pollution during construction. • Use local resources (input materials, labour and service providers) wherever possible and practicable. • Monitor the implementation of the EMP and periodically assess the effectiveness of impact avoidance or mitigation measures. • Locate construction camps carefully to avoid conflicts with wildlife and locals. • Apply all the necessary safeguards and restrictions for the construction period to minimise impacts such as poaching, fires, wood collecting, waste disposal, littering etc – all of this to be dealt with in an EIA-EMP. **Timing?** • If possible and practical, avoid construction during peak wildlife movement times (certain periods of the dry season).

8.9 CONSTRUCTING THE TRANS-ZAMBEZI RAILWAY

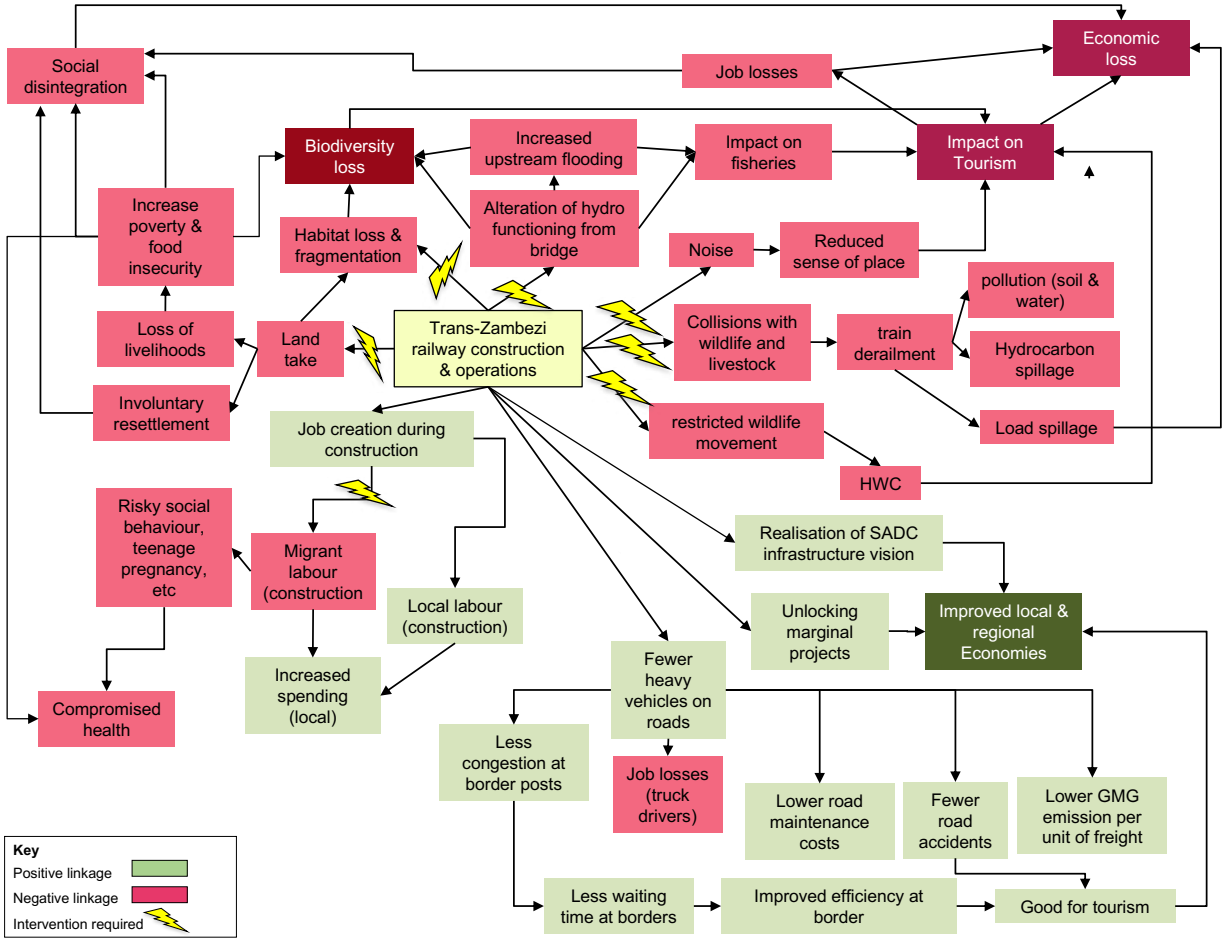


Figure 8.9 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of the proposed trans-Zambezi railway[99]

[99] Whilst this section focuses on the proposed Trans-Zambezi railway, there are also ideas for a rail line from Menongue to Rivungo, and even across into Zambia. That would link the CURB and Zambia to the harbour at Namibe.

As illustrated above, the intended positive impacts are potentially many and varied, and ultimately will likely result in improved economic growth (though not in the CURB), increased government revenues (particularly for Namibia), increased employment opportunities (though only during construction) and various other benefits. The most significant positive is potentially reducing the number of heavy vehicles on Namibia´s roads, but that depends upon the ability of the railway to provide a competitive advantage over road transport, which going by SADC examples appears not to be the case[100]. The escalation of the number of these vehicles is regarded as a major contributor to the deterioration of the roads, the spread of HIV-AIDS, road accidents, road kills (livestock and wildlife), noise (especially when trucks pass through towns, but also affecting rural areas) and congestion at border posts. Realising all of the above positives requires a high-level commitment to:

- Curtailing heavy vehicles on the roads. This is probably easier said than done, given the substantial investments made by road-haul operators, the door-to-door convenience of truck haulage, the fast(er) delivery times and the decades of "road mentality" that has taken hold as the railways became increasingly derelict and inefficient. Reversing the status quo will be a major challenge. Also, there will be pressure from trade unions over likely job losses (e.g. truck drivers, mechanics, etc.). In reality though, it is likely that whilst some freight will move from road to rail, road transport will probably not decrease significantly.
- Using local contractors and labour. As above, this is also easier said than done, given the current debates around the advantages of foreign contractors over locals. The general impression is that the local construction industry has declined and cannot compete with foreigners (notably Chinese contractors).
- Upgrading the Namibia-Zambia border post to enable efficient passage of rail-haul freight. This is essential for reducing the comparative disadvantage of rail over road, and also preventing the establishment of prostitution hotspots.

This SEA assumes that reserving contracts and jobs for locals will not be realistic. As with all major construction activities in rural or remote areas, the expected influx of an outside (mostly male) workforce could result in a number of unintended consequences, including an increase in prostitution, spread of sexually-transmitted diseases (STDs), and a myriad of very serious direct and indirect social, health and gender impacts.

Depending on the alignment, the new railway will require some land-take and, depending on the nature of the land and its current use, there may be communities that suffer loss of livelihoods. There may also be losses to habitats important for conservation.

Probably the biggest concern is the impacts on habitats and biodiversity, especially in Bwabwata National Park. The context for this concern is that Bwabwata lies at the heart of the five-country KAZA initiative. This is probably one of the most important transboundary wildlife areas in Africa. One of its key objectives is facilitating the movement of wildlife, especially elephants, from Botswana, through Bwabwata, into Angola and Zambia. Botswana has a large population of

[100] https://www.sadc.int/pillars/railways

elephant (which the Botswana government considers too large for the landscape)[101], mainly because their centuries-old north-south migration routes have been curtailed by fences, human settlements, the war in Angola and good management of its wildlife. The high population is resulting in increasing human-wildlife conflicts in Botswana and to a lesser extent, Namibia. There are fears that the new railway line will add to the barrier-effect of the existing highway, especially if the two combined result in a significant increase in freight and other traffic.

Importantly, the new national parks in southern Angola (directly to the north of Bwabwata) have excellent wildlife habitat, few people, very little wildlife and almost no tourism. The idea is to allow wildlife to drift into these parks and gradually, transform them into well-protected conservation and tourism areas. Thus, there are multiple socio-ecological gains from the KAZA initiative, and very serious consequences if the rail line undermines wildlife movements.

Table 8.11 Alternatives and mitigation

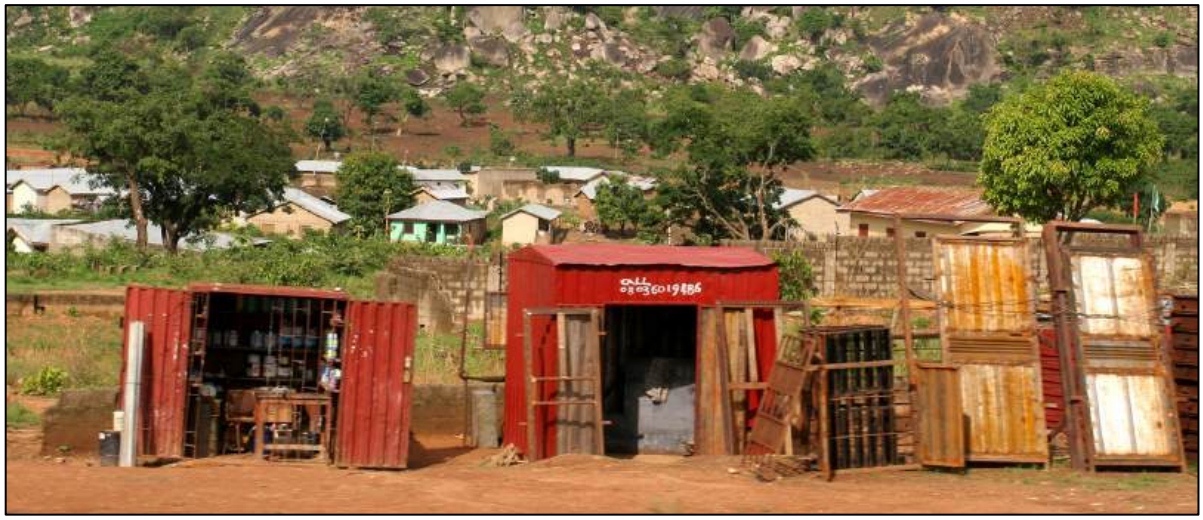
Programme component	Check against Hierarchy of Alternatives
New rail construction and operation between Grootfontein and Katima Mulilo	**Is it necessary?** • The current situation of having to transfer freight from road to rail at Grootfontein makes rail a poor option from the start, resulting in road haulage being the default choice by almost all transport companies and clients. • Not extending the rail thus reduces the economic return on investment in the maintenance and operation of the existing rail section (Walvis Bay -Grootfontein). • The efficiency and reliability of using the railway line would also be dependent upon the Zambian railway being upgraded. • The "no extension" option is thus an opportunity cost. • The "no extension" option will also result in an increase in road-haulage traffic. Thus exacerbating impacts on the roads, traffic inconvenience and accidents, road kills, HIV-AIDs, etc. • In principle, extending the line to destination markets is therefore accepted as necessary. **Is there a better strategic alternative?** • Linking Walvis Bay to target markets could also be achieved by an alternative alignment – notably via two route options through Botswana. • This might be shorter and cheaper, given the start point being Gobabis rather than Grootfontein. • This might also present greater economic opportunities through linking with the Botswana and Gauteng economies. Also, Botswana already desires constructing the Trans-Kalahari railway – thus there are opportunities for synergy. • This alternative is arguably better than the proposed Trans-Zambezi railway from an environmental perspective (mostly because of wildlife disruptions in Bwabwata NP) – ***except*** if the new railway following the Botswana alternative route ***does not*** result in reduced road haulage along the Trans-Zambezi Highway. If there will still be substantial road-haulage traffic along the Trans-Zambezi Highway, then it would be better to construct

[101] https://www.voanews.com/a/africa_botswana-proceed-elephant-hunts-despite-red-list/6203986.html

	the Trans Zambezi railway linkage. This is because the first prize environmentally is the reduce road-haul traffic through Bwabwata. • Assuming the Botswana option(s) are rejected, then the following "within project" alternatives should be considered: **Location?** • Place the railway line as close as possible to the existing road so as to concentrate the development in an existing and already disturbed servitude. In the Bwabwata section, it should be to the north of the road (but right next to the road). • There may be opportunities to minimise habitat loss by considering alternative areas of quarries/borrow pits (supplying crushed stone, gravel, sand), etc. **How should it be done?** • Combine the road and rail bridge across the Kwando river, and totally re-engineer the new bridge so that it is high above the ground (approx. 5 metres) and entirely on piles (stilts) from bank to bank. The reasons for this are two-fold: o The existing road bridge, constructed from earth, has inadequate culverts, thus resulting in the Kwando River being "pinned" to one spot. This has altered hydrological and ecological functioning. The resultant impacts on fish and other wildlife have not been researched but could be significant enough to justify the re-design and additional expenditure. o The existing crossing is a high embankment, and thus a barrier for almost all wildlife. By raising the new bridge on stilts, wildlife will be able to pass underneath the bridge. The floodplain will then be re-instated as a wildlife corridor. Therefore, the new railway provides an opportunity to fix a past design and engineering failure. • Where the line crosses known wildlife corridors, construct reinforced shallow tunnels (a rail underpass[102]), so that animals can move 'over' the line on natural habitat. There will likely be a need for six tunnels trough Bwabwata, and three between the Kwando and Katima Mulilo. Each tunnel should be approximately 300 metres long. Exact locations still to be determined. There are many ideas for helping wildlife and livestock get used to using these tunnels (e.g. revegetation, spreading dung, etc). These can be further elaborated at the EIA stage. • Place a sunset-sunrise curfew on train passage through Bwabwata – so as to limit collisions with wildlife. • Restrict the speed of trains through the Bwabwata section. • Locate construction camps carefully to avoid conflicts with wildlife and locals. • Apply all the necessary safeguards and restrictions for the construction period to minimise impacts such as poaching, fires, wood collecting, waste disposal, littering etc – all of this to be dealt with in an EIA-EMP. **Timing?** • If possible and practical, avoid construction during peak wildlife migration times (certain periods of the dry season).

[102] Or alternatively an overpass

8.10 URBANISATION AND EXPANSION OF VILLAGES AND TOWNS



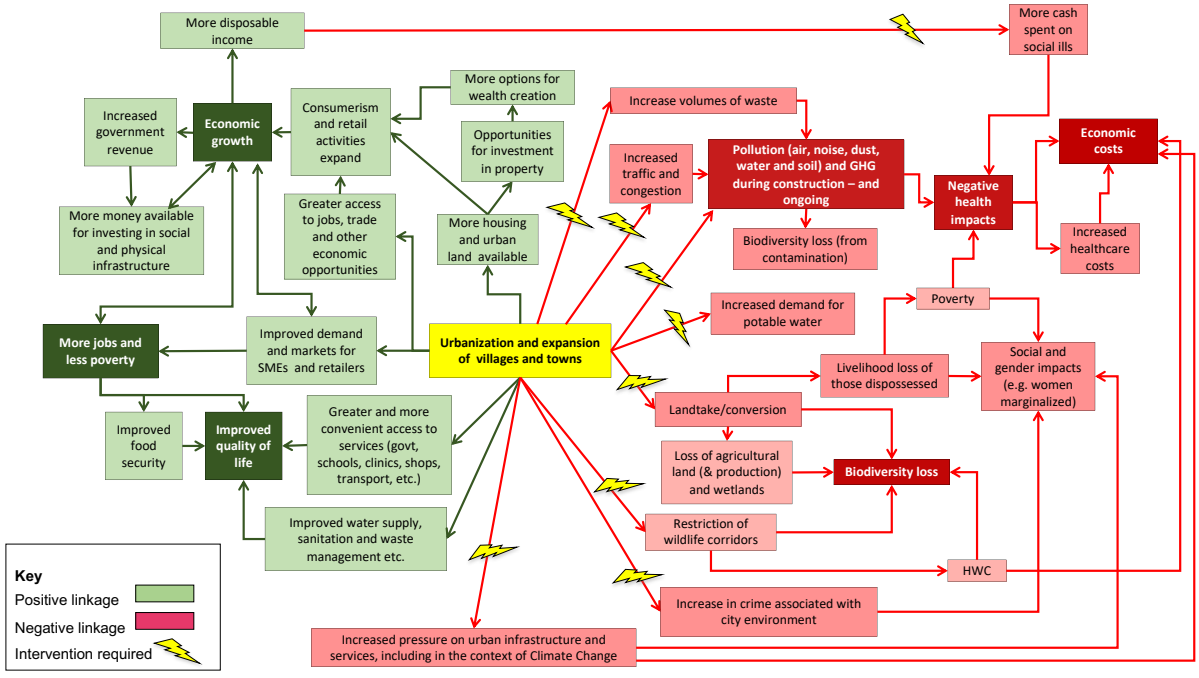


Figure 8.10 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of urbanization and the expansion of villages and towns

As illustrated above, the intended positive impacts are potentially many and varied, and ultimately will likely result in modest economic growth (in the CURB generally), increased employment and trading opportunities, better access to social services and, providing tenure issues are conducive, opportunities for people to have title and to make investments in property – which results in various other benefits. Realising all of the above positives requires a high-level commitment to:

- Proper town planning and providing quality physical infrastructure such as water and sanitation, electricity, roads, waste management, schools and clinics; and good governance such as land tenure, safety and security, efficient local authority management. Also, putting in place strategies to improve urban resilience in the face of expected climate change.
- Using local contractors and labour. This is a challenge given that foreign contractors easily dominate locals.
- Improving cross-border movement and trading opportunities.

This SEA assumes that reserving contracts and jobs for locals will not be easy. As with all major construction activities in rural or remote areas, the expected influx of an outside (mostly male) workforce could result in a number of unintended consequences, including an increase in prostitution, spread of STDs, and a myriad of direct and indirect social, health and gender impacts.

Depending on the localities, the new or expanding settlements will require some land-take and, depending on the nature of the land and its current use, there may be communities that lose their land and then suffer loss of livelihoods. There may also be losses to habitats important for conservation, increased harvesting of wood and wildlife around the towns, the restriction of wildlife corridors, and increased HWC.

Also, wherever there are villages and towns, there is an increase in waste generated and, if waste removal and management are inadequate, the towns rapidly become a health hazard – and a source of pollution that inevitably ends up in nearby streams and the Cuando itself. It is also common in the region that poorly managed waste dumps attract vermin and a variety of other wildlife, which then results in HWC. All of this would impact tourism negatively. Ultimately, the cumulative impacts of poor planning and inadequate management, are economic losses and therefore costs.

Table 8.12 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Expansion of existing villages	**Is it necessary?** Population growth and urbanization are transforming landscapes across Southern Africa. It is not being driven by any policy direction from any CURB countries. Instead, urbanization happens organically as communities feel the need to leave rural areas and move into villages. In the CURB, urbanization is probably "pushed" by limited opportunities in rural areas, rather than "pulled" by promises of jobs and prosperity in towns and villages. In the assumed low-medium growth scenario, it is unlikely that there will be any major changes to current "push-pull" factors.

	In most of the informal settlements in the CURB, people live on land with inadequate security of tenure, poor access to urban services, and inadequate shelters. This is undesirable socially, environmentally and economically, so expanding, improving and formalizing existing towns and villages is arguably a better alternative than the status quo. **Is there a better strategic alternative?** Given that urbanization occurs in the absence of any specific policy, the question of a strategic alternative is academic in this case. However, it can be argued that promoting urbanisation has a number of economic, social and environmental benefits, because it is easier and cheaper for planners to establish physical and social infrastructure in a town than in rural areas. Also, the critical mass of people in a town provides opportunities for people to become a service provider and thus earn an income. **Location?** It is unlikely that any substantial new villages or towns will be developed over the next 10 years or so in the low-medium growth scenario. Instead, a gradual growth (and thus extended footprint) of existing centres is expected. **How should it be done?** It is recommended that existing regional and town planning procedures are consistently implemented. Perhaps the main challenge however, is formalising land tenure where appropriate, in addition to improving services. An important issue regarding town and village planning is considering the vulnerability of urban areas to climate change. Some suggestions are provided below. **Timing?** N/A

Managing Climate Change risks in urban areas

Sub-Sahara's vulnerability to climate variability and climate change is due to its high levels of poverty, rapid population growth, high dependence on rain-fed agriculture and natural resources, and relatively low adaptive capacity to deal with expected CC. Challenges include the under-development of water resources, low health service coverage, low economic development, inadequate road infrastructure, weak institutional structures, and lack of a coordinated approach to the implementation of adaptation strategies [103].

As noted in the Scoping Report, climate change models forecast that the average total annual precipitation averaged over the whole of KAZA is expected to decrease by 4.6% by 2050, relative to historical precipitation. It is generally expected to get hotter and drier whilst mean annual temperatures are expected to increase by 3°C (*Source: ToRs*). This will place stress on already vulnerable food production systems. The population is likely to grow annually by at least 1.4%. The CC impact may potentially hold back economic progress, reverse the gains made in development, and thus exacerbate social and economic challenges.

CC affects various determinants of health – clean air, safe drinking water, food security and shelter (Table 8.13). Weather-related extreme events can result in deaths due to heat stress, the spread

[103] World Bank 2021

of infectious diseases, and increase in malaria, meningitis, and diarrhoea. Other effects include under-nutrition due to variability in agricultural production and food security.

Table 8.13 Examples of climate change impacts in urban areas[104]

Projected change	Examples of likely impacts	Implications for urban residents	Possible adaptation measures
Increase in the number and intensity of heatwaves	• Rise in mortality and illness from heat stress. • Extended range and activity of some disease vectors (e.g. mosquitoes) causing malaria, dengue fever and other related diseases.	• People will experience high indoor temperatures, especially in poorly constructed or low-cost housing • Crowding in urban environments exacerbates heat impacts.	• Improved building design. • Set up locally accessible health services. • Avoid clearing of trees and promote planting of indigenous trees and creation of urban green spaces
More intense precipitation events and floods.	• Increased floods and erosion, resulting in injury, loss of life, livestock, gardens and property. • Flooded areas often experience influx of disease vectors such as mosquitoes and species such as snakes. • Floods usually mobilise waste, including sewerage, thus contaminating water sources and spreading diseases.	• Risk of flooding with poor quality housing less able to withstand flooding. • Lack of risk-reducing infrastructure. • Increased disease burden including water-borne and vector-borne diseases.	• Better planning and enforcement of plans – so people are prevented from settling in flood-prone areas. • Well-planned infrastructure designs (e.g. culverts, bridges) that are resilient to climate change risks. • Improved flood protection. • Safeguarding water supplies. • Good waste management, as culverts and stormwater drains often get clogged by litter. • Improved early-warning systems so people have time to plan adaptation measures or evacuate.
Wind storms with higher wind speeds	• Damage to buildings, power and telephone lines and other urban infrastructure.	• Increases in wind speeds can damage buildings, leaving people vulnerable or homeless. • Informal utility services are likely to be damaged or cut. • Increased risk of shack fires.	• Improve construction and design of houses and infrastructure. • Plant windbreaks - bushes and trees (preferably indigenous). • Improve access within informal settlements for emergency services.
Increased drought	• Decreased water quantity and quality leading to water shortages. • Reduced crop yields. • Increased risk of fire.	• Increase in number of informal settlements (as rural people migrate to urban areas). • Informal settlement residents usually face	• Addressing socio-economic factors and poverty. • Improve water infrastructure and affordability.

[104] Adapted from Tarr, 2020 and IPCC, 2018

Projected change	Examples of likely impacts	Implications for urban residents	Possible adaptation measures
	• Increased risk of pest outbreaks such as locusts. • Higher food prices. • Increased out-migration from rural areas and in-migration to cities. • Reduced livestock and crop production and nutrition content. • Ecosystem degradation and its effect on ecosystem services.	more water constraints and are more vulnerable to food and water price rises. • Food shortages, possibly leading to increased cases of malnutrition.	

8.11 ESTABLISHMENT OF DAMS AND WEIRS

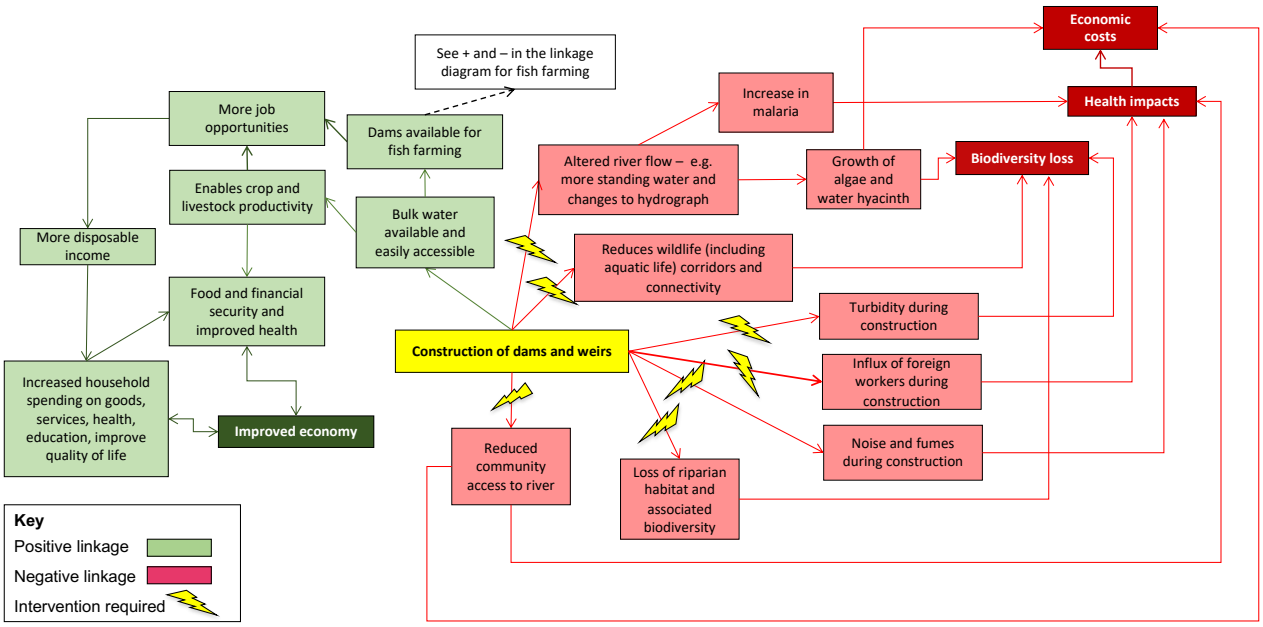


Figure 8.11 Linkage diagram illustrating the intended and unintended consequences, onward linkages, and cumulative impacts of dams and weirs in the CURB.

Whilst the State of the Basin Report makes no mention of dams and weirs on the Cuando, stakeholders raised the issue of dams as a concern should they be developed in the future. The small size of the Cuando river, the relatively flat topography and the lack of any steep gorges makes the main river unsuitable for a large dam that can support significant commercial developments. The Cuando is one of very few rivers in the world that has no dams or weirs. But, it is possible that small earth dams could be located on some of the tributaries. These might provide water for nearby

villages and/or support aquaculture and small irrigation projects. Whilst a single small dam would have negligible negative impacts, a greater number would have significant cumulative impacts.

As illustrated in the linkage diagram, the intended consequences would be enabling irrigation and fish farming, thus boosting food production in the area. This in turn will provide additional jobs and improve food and financial security, with an overall positive impact on the local economies. Unlike many other industries, these small-scale ventures result in minimal leakages from the local economy.

However, large or a number of small dams, would alter the natural river flow and thus impact on downstream ecological processes/ecosystem services, such as fish breeding, nutrient flows, water quality and flood control.

Dams are an unnatural habitat characterised by standing water and unusually elevated water temperatures and low dissolved oxygen levels. This can result in increased stress and death to fish, stream insects, and other aquatic organisms. They are ideal breeding areas for mosquitos (thus resulting in an increase in malaria) and other waterbourne diseases (e.g. bilharzia). Dams also provide a suitable habitat for the spread of weeds (including alien invasives) such as water hyacinth *Eichhornia crassipes*. Weirs are unlikely to significantly alter the hydrograph. Whilst they slow river flow, they do not pose the same health risks as dams. However, like dams, weirs also present a barrier to various forms of aquatic life, especially fish. The result is reduced connectivity and likely biodiversity loss.

An influx of foreign (mostly male) workers is inevitable for the construction of large dams. There are volumes of case studies that document the serious and long-lasting social and health impacts of a foreign workforce in a remote setting. These ultimately translate into substantial economic costs.

Direct impacts are more obvious and equally substantial, including habitat loss in the footprint of the dam (and ancillary infrastructure such as roads, workers village, etc.). Whilst dams require less land generally than other types of land use (e.g. farming, roads, towns), land take is inevitable and conflicts with local communities can be expected. Disruption of wildlife corridors will result in increasing HWC as animals will increasingly be restricted into ever-diminishing spaces.

Table 8.14 Alternatives and mitigation

Programme component	Check against Hierarchy of Alternatives
Dams and weirs	**Is it necessary?** In many parts of the Cuando, the running stream is inaccessible to communities because of dense reedbeds and floodplains, and also the danger posed by crocodiles. Thus, small dams might be justified so as to improve safe access to water. However, a better alternative is to install pumps on riverbanks and pump water into tanks situated at convenient localities, away from the river. Also, groundwater is available in many areas, and can likewise be abstracted and pumped into tanks where needed. Both of these alternatives are a better choice from an environmental and health point of view, and cheaper. **Is there a better strategic alternative?** See above. **Location?** There is no specific location where dams/weirs might be established in the future. **How should it be done?** Dams and weirs should not be allowed. **Timing?** N/A

8.12 CLIMATE CHANGE

Unlike the previous linkage diagrams in this chapter, climate change is not a sector nor is it an expected type of development. However, it is included here because of its significant cross-cutting implications. As illustrated below, the impacts of climate change are likely to be extensive and severe. In particular, the future sustainability of traditional land use such as livestock farming and dryland agriculture, appears to be in jeopardy. Also, expectations of growth from irrigated agriculture are in serious doubt, as is the possibility of tapping the waters of the Cuando for industrial use. Moreover, the CURB will likely suffer an increase in fires, pests, diseases and extreme weather events. These "inconvenient truths" need to be well understood by decision-makers so as to avoid costly mistakes in future development planning.

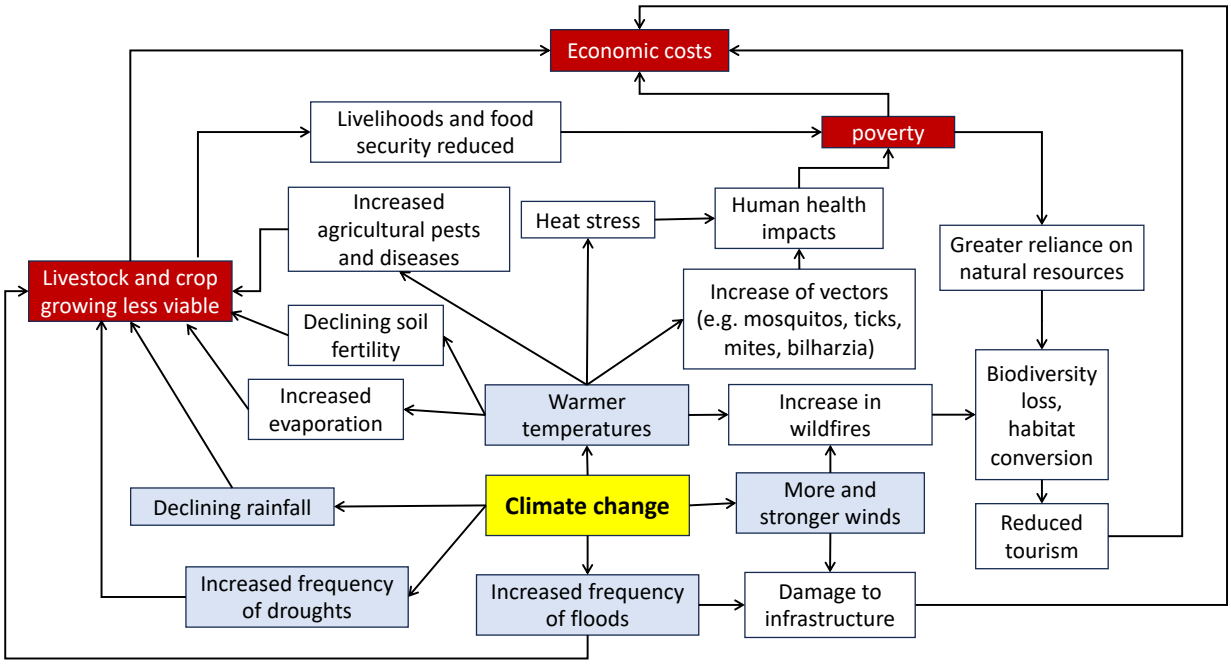


Figure 8.12 Likely impacts of climate change in the Cuando Basin

The Cuando State of the Basin Report states that climate change predictions for the KAZA Trans-frontier Conservation Area are that total annual precipitation is projected to decline by 4.6% by 2050, relative to historical (1960 –1990) precipitation, averaged over the whole TFCA. The prediction is reportedly worse for the north-western parts of the total area, with Angola and parts of Zambia and Namibia expected to get substantially drier. The average annual temperature over the whole of KAZA is expected to increase by 3^0C, and again the western parts of the area (Angola and parts of Zambia and Namibia) are expected to warm more than the other parts of the TFCA.

CONCLUSIONS AND RECOMMENDATIONS

9. CONCLUSIONS AND RECOMMENDATIONS

This SEA has confirmed that the major challenges in the CURB include habitat loss, fragmentation, and degradation; human wildlife conflict; wildlife crime; inadequate community empowerment and engagement; poorly planned infrastructure development and climate change, leading to increasing pressure for land and resources from a growing but unevenly distributed human population.

Climate change models forecast that future precipitation averaged over the whole of KAZA is expected to decrease whilst mean annual temperatures are expected to increase.

As in many parts of rural Africa, people within the CURB are caught in a poverty trap driven by poor agricultural potential, isolation, and limited development opportunities. Rural communities rely largely upon ecosystem services, remittances, social grants and low yielding subsistence agriculture. They grow part of their food requirements and have free housing, water, fire wood etc. but all other needs come from cash which very largely comes from off-farm sources.

The concentration of growing human populations along the river and shrinking corridors for wildlife to access the important water resources further exacerbates the hardships for both people and wildlife through increased human wildlife conflict. This highlights the need for inclusive regional fine scale planning to identify and secure wildlife corridors and human development areas in order to reduce HWC.

Whilst the Cuando river is largely pristine, it is under increasing pressure from a growing population that, whilst relying mostly on subsistence farming and natural resource exploitation, is rapidly urbanising. Towns are small but are growing fast and physical, social and institutional infrastructure is struggling to cope with the current growth. Botswana and Namibia, have established good (though relatively small) tourism industries in the lower Cuando area that are increasingly important to local economies. This industry is based on comparative advantages offered by exceptional wildlife resources and intact sense-of-place, helped by the fact that CURB countries have established various levels of conservation measures in the area.

However, there are competing land uses, notably livestock ranching, dryland cropping and wildlife harvesting on a subsistence level. Illegal wildlife offtake is a concern, and increasing.

Thus, sensitive forms of wildlife are under pressure and numbers of some key species are in decline. The upper part of the catchment has lost most of its wildlife, but habitats are generally intact and wildlife are gradually returning.

Many impacts are masked due to the lag effect between developments being implemented and the impact being felt. Often the system may appear to be moving away from a critical threshold during normal or favourable years, but when a set of cumulative impacts combine or events come together in the "perfect storm" then the system may be pushed over a threshold, re-establishing another but less desirable state, or collapsing entirely.

For the purposes of this SEA, various internal drivers (generated within the Basin) and external drivers (from outside the Basin, even regional or global) are regarded as the root causes that result in cumulative impacts. The main external drivers which affect the CURB are climate change,

regional trade and economic activities, and to a lesser extent, the dynamics of global economic changes.

The four main basin-wide (internal) drivers are:

- The desire for accelerated economic growth and diversification, and from this, job opportunities and poverty alleviation;
- The need for food security;
- Population growth; and
- Poverty.

Based on literature, expert opinion and stakeholder input, the cumulative impacts of greatest concern (either existing or expected in the future) are summarised as follows:

- Lowered ecosystem resilience and functioning because of reduced hydrological flow and volume, (caused by irrigation schemes, impoundments, growing settlements, tourism and perhaps other industries, water transfers and climate change);
- Biodiversity loss because of land degradation (as above plus poor land-use practices for subsistence agriculture);
- Biodiversity loss and increased human-wildlife conflicts because of habitat fragmentation and wildlife movement barriers (because of fences, crop production, livestock, settlements);
- Loss of livelihoods and economic options because of reduced ecosystem services (linked to compromised hydrological functioning, but added to that is impacts of land degradation from deforestation and burning, resource overexploitation, etc);
- Health, livelihood and ecological risks because of reduced water quality; and
- Increased prevalence/spread of communicable diseases because of increased mobility of people and the influx of workers (including foreign) to project sites in predominantly poor rural areas.

The rapid **Systematic Conservation Plan**[105] (SCP) developed as part of the Cuando SEA, identified areas of highest value for sustainable management and conservation actions. The SCP highlights the need to protecrt Critical Areas, as these are irreplaceable or practically irreplaceable. The SCP found that Critical Areas cover 36.7% of the Basin. Importantly, almost half of these Critical Areas are outside of existing Protected Areas. Also, High Value Areas cover an additional 15.2% of the Cuando River Basin, but 6.2% of these are also outside of existing Protected Areas.

Together, the Critical and High Value Areas include the most important VECs and areas supporting VECs, and should be a clear focus of conservation and landscape management practices supporting sustainability. Combined, these areas are of highest value as potential protected areas sites for conserving biological diversity, and are highlighted as the most important for immediate conservation actions. Even the Medium Value Areas are important for overall landscape linkages and landscape connectivity.

[105] See full SCP report in Volume 4

A key outcome of the SEA is recommending what CURB states need to do to keep the basin in a relatively pristine state, whilst still enabling sustainable development. These recommendations are contained in the **Strategic Environmental and Monitoring Framework** (SEMMF) – volume 3.

The SEMMF has recommended various high-level targets, which are summarised as follows[106]:

Strategic, trans-frontier level

- The Member States must agree on what activities to allow in their part of the basin.
- Improved transboundary conservation and wildlife mobility between the participating States.

Strategic, local level

- Reduce barriers that prevent wildlife from moving freely. Fences (or critical sections) should be removed, and corridors kept open between human settlements and fields. These corridors must correspond with known wildlife movement paths, and the gaps need to be wide enough so that they are used.
- Avoid allocating exploration or mining/petroleum licenses anywhere within the basin.

Local level

- Build on existing successful CBNRM programmes, thus supporting communities that otherwise have few incentives to tolerate or conserve wildlife.
- Promote climate-smart agriculture, so that people in certain areas can grow crops in an ecologically appropriate way for the best possible yields.
- Get the tourism sector to commit to achieving 'best practice', by implementing existing or emerging Ecotourism Certification Systems.
- Actively protect (especially) the riparian woodland by whatever means possible, especially enforcing a ban on logging within the CURB, and preventing fires.

Proposed targets

1) Hydrological functioning, water quality and biodiversity

- No significant human-induced change in the natural flood pulse peak or loss of permanent swamp. Annual offtake from the entire basin must not exceed 600Mm^3 per annum (based on inflow at the Kongola measuring station).
- No upriver dams or other impoundments.
- Water quality to be within 5% of current fluctuations as measured over the past 15 years.
- Existing fences are removed wherever possible, especially in between Namibia and Botswana.
- Reverse declines of indicator species.
- Reverse large mammal species population declines to 1994 levels; e.g. lechwe, buffalo, tsessebe, and zebra.
- Maintain integrity of the riparian fringe – no more clearing of riparian habitat for agricultural or any other form of land use and implement rehabilitation of already impacted areas.

[106] This is a summary only – more details in Volume 3

- No introduction of alien invasive species (especially plants and invertebrates) and eradication of aliens where they exist already.
- Reduce human-wildlife conflicts: farming must avoid prime wildlife areas and designated wildlife corridors, and installation of protection devices/ strategies used to mitigate further conflict.
- Implement the KAZA Elephant Management Plan.
- Maintain viable populations of endemic, rare and endangered species.
- Promote and improve support to CBNRM projects.
- Reduce poaching to zero (CBNRM and law-enforcement are key tools in this regard).
- Reduce fire frequency to a rate of one in 3-5 years and promote cool burns.

2) Livestock farming

- Limit livestock to rangelands further away from key biodiversity areas (e.g. riparian fringe) and stock appropriately (recommended stocking rate -16ha/LSU in sandveld).
- No fenced commercial ranches or disease-control fences – unless EIAs show they will not impact biodiversity significantly.

3) Arable agriculture

- Water offtake (all sectors combined) should be limited to less than 600 Mm^3/a so as not to compromise ecological integrity of the wetlands.
- Future molapo/dambo and horticulture farms should not be placed within nor extract wood from, the riparian fringe for any purpose whatsoever.
- Reduce Human-wildlife conflicts by locating fields away from prime wildlife areas, including migration routes.
- Principles of climate-smart agriculture[107] should be rigorously applied to reduce habitat alteration and soil exposure while improving farming efficiency and crop yields.
- Levels of fertiliser and chemical inputs need to be controlled to minimise toxic inputs into return flows to surface waters or pollution of groundwater.

4) Tourism

- Maximum 700 beds in the Namibian and Botswana area, but expansion possible in Angola.
- Improve equity (through local ownership and improved benefit sharing).
- Reduce conflicts with subsistence fishers/villagers.
- Improve general housekeeping at tourism establishments.

5) Mining

- No prospecting and/or mining licenses issued within the CURB and existing licenses to be withdrawn by the Member State as soon as they are relinquished by the current license-holder.

[107] https://www.fao.org/climate-smart-agriculture/en/

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