STRATEGIC PLAN FOR THE
Zambezi Watercourse
2018-2040

BACKGROUND DOCUMENT

Basin Investment Scenarios

ZAMCOM

ZAMBEZI WATERCOURSE COMMISSION

win-win cooperation / cooperacao, ganhas tu, ganho eu

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Capex	-	Capital expenditure
CMI	-	Climate Moisture Index
CRIDF	-	Climate Resilient Infrastructure Development Facility
DMs	-	Delivery Models
EIA	-	Environmental impact assessment
EPC	-	Engineering, procurement and construction
GCF	-	Green Climate Fund
GDP	-	Gross Domestic Product
GIS	-	Geographic Information System
HCB	-	Hidroeléctrica de Cahora Bassa
HDI	-	Human Development Index
JPSC	-	Joint Project Steering Committee
ICA	-	Infrastructure Consortium for Africa
ICSID	-	International Centre for the Settlement of Investment Disputes
IRR	-	Internal rate of return
MSIOA	-	Multi-Sector Investment Opportunities Analysis
NASC	-	National Stakeholder Committee
NPV	-	Net Present Value
ODA	-	Official development assistance
PPA	-	Power purchase agreements
SADC	-	Southern African Development Community
SAPP	-	Southern African Power Pool
SEA	-	Strategic Environmental Assessment
SPV	-	Special Purpose Vehicle
SRBDP	-	Songwe River Basin Development Programme
TANESCO	-	Tanzania Electric Supply Company Limited
UNCITRAL	-	United Nations Committee on International Trade Law
WEAP	-	Water Evaluation and Planning
WHAT-IF	-	Water, Hydropower, Agriculture Tool for Investment and Financing
ZAMCOM	-	Zambezi Watercourse Commission
ZAMCOM Agreement	-	Zambezi Watercourse Agreement

ZAMSEC	-	Zambezi Basin Secretariat
ZAMSTRAT	-	The Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin
ZESA	-	Zimbabwe Electricity Supply Authority
ZESCO	-	Zambia Electricity Supply Corporation Limited
ZPC	-	Zimbabwe Power Company (ZPC)
ZRA	-	Zambezi River Authority
ZSP	-	The Strategic Plan for the Zambezi Watercourse

Executive Summary

Contextualising the Basin Investment Scenarios Report

The objective of the Strategic Plan for the Zambezi Watercourse (ZSP) is to develop a basin-wide general planning tool and process for the identification, categorization and prioritization of the projects and programmes for the efficient management and sustainable development of the Basin. It provides the basis for harmonised, regional cooperation among Riparian States and the implementation of projects and programmes that provide shared, basin-wide benefits.

The ZSP is being developed in a multi-stage, cooperative and consultative manner and comprises a number of activities and deliverables. This report, the ***Basin Investment Scenarios Report*** *(D5), is therefore only one component of a larger process that comprises the development of the ZSP. The report presents a framework for structuring projects and programmes, using identified criteria to balance investment needs and inform the ZSP. It derives information from the preceding deliverables, building these into a tool that may be used to determine the opportunity and risk of financing and implementing identified projects in the Zambezi, at both a transboundary and national scale. It includes an analysis of various models and options for financing key investments in priority sectors and identifies opportunities for regional development through cooperative investments. Importantly, it provides a critical platform for the ultimate Strategic Plan for the Zambezi Watercourse (D6 and D7), which in turn will provide the strategy to enable the implementation of the Basin Investment Framework.*

Identifying Strategic Directions and Basin Development Scenarios

The Basin countries face a number of interrelated challenges to their ***economic and social development*** *– including a high dependence on subsistence rain-fed agriculture, a substantial infrastructure deficit across the energy, food and water sectors, and growing degradation of the Basin environment due to the impacts of poverty and unplanned developments. These challenges will be further exacerbated by the increasing prevalence of climate change impacts, with the Basin already experiencing persistent floods and droughts that are expected to become more extreme and unpredictable over time.*

Yet despite these issues, there are opportunities for economic and social development of the region – provided it is sustainable, inclusive and resilient. The Zambezi Riparian States must therefore undertake a collective, well-considered ***development path*** *that contributes to economic growth, whilst helping to restore the environment by reversing the impacts of poverty and detrimental water use.*

The process of identifying this preferred development path requires in-depth analysis of the underlying issues and objectives of each Riparian State and determining how these collectively impact the future state of the Basin. The preceding ZSP deliverables therefore focussed on deriving ***Strategic Directions*** *for future development, outlining Riparian States' visions for addressing their* ***Strategic Issues****. These findings informed the development of a series of* ***Basin Development Scenarios****, each one describing a single hypothetical version of the Basin's future.*

Detailed hydro-economic modelling was conducted on seven Preferred Basin Development Scenarios, to provide insights about their performance, as measured by a wide range of numerical indicators. The results generated through this process identified three candidates for the final choice of ***Recommended Basin Development Scenario****:*

- *A Scenario that Maximizes Economic Benefits, designed to develop the Basin in such a way as to maximize economic growth without requiring any environmental or disaster risk reduction constraints.*
- *A Scenario Resilient to Climate Variability, with the objective to maximize economic growth, but subject to high levels of environmental protection.*

- *A Scenario Resilient to Climate Change, with the objective to maximize economic growth, but subject to moderate levels of environmental protection.*

Selecting a Single Basin Development Scenario to Inform Investment Planning

The necessity to select a single Basin Development Scenario is underpinned by the fact that specific focus for investment planning is required, rather than developing multiple, potentially conflicting Investment Scenarios with differing priorities and criteria. This, together with the previous observation that all the projects listed in the Infrastructure Inventory can be supported by the water resources in the Basin (provided cooperation enables effective management and maintenance of shared benefits across the basin during periods of stress), indicates that different investment scenarios are not appropriate and that a single Basin Investment Framework is more useful.

The selection process was informed by an analysis of regional and national development priorities, which indicated that the poverty eradication and economic growth goals that underpin the Southern African Development Community's (SADC) Regional Indicative Strategic Development Plan are mirrored at the national level in the Riparian States' National Development Plans. Furthermore, these plans consistently emphasise the need for ***inclusive growth*** *and* ***livelihoods improvement -*** *meaning the single Basin Development Scenario selected should not just achieve poverty eradication and economic growth but prioritize these occurring in an inclusive and equitable fashion. Intrinsically entwined with the achievement of inclusive growth in the Basin is some degree of environmental protection, given the reliance of many livelihoods in the Basin on the continued health of the shared water resources.*

For these reasons, the Basin Development Scenario carried forward into the analysis of Basin Investment Scenarios is a scenario focused on Inclusive Growth. This ***Inclusive Growth Scenario*** *corresponds to the scenario previously described as the* ***Scenario Resilient to Climate Change****, which strives to maximize economic growth subject to moderate levels of environment and delta/flood protection constraints.*

Developing an Approach to Formulate the Basin Investment Framework

Following the motivation for selecting a single Basin Development Scenario, a number of additional considerations need to be highlighted around the approach used to develop the Basin Investment Framework:

- *The diversity and scale of projects and their primary mix of benefits restricts simplistic ranking for the purposes of investment. Thus, the approach taken here has been to structure projects into programmes that respond to the differing needs of the countries and the Basin, rather than sequence or rank them. This has culminated in an envelope of investment over the next 20 years, together with the identification of specific projects that can move forward into implementation in the next decade with information on attributes around scale, cost, returns and risks.*
- *The Basin Investment Framework is built around the platform of the Infrastructure Inventory (D3), which is largely focused on built infrastructure, and does not capture many of the softer investments that would also be required in the ZSP. This focus on hard infrastructure is appropriate as mobilising finance for infrastructure is a critical need in the basin and should attract specific focus. The development of the final Strategic Plan for the Zambezi Watercourse (D6) will bring in the enabling strategies and required investments, while limitations and possible future extensions of the Basin Investment Framework are outlined in this report.*
- *The Basin Investment Framework makes a significant contribution to aligning the opportunities and strategies of previous work (Multi-Sector Investment Opportunities Analysis (MSIOA), The Integrated Water Resources Management Strategy and Imple-*

mentation Plan for the Zambezi River Basin (ZAMSTRAT) and the national development strategies) by providing a framework for financing and identifies the actual projects that fill in the framework.

The process to develop this Basin Investment Framework was broken down into distinct stages, detailed as follows:

Characterising Projects from the Infrastructure Inventory
It is fundamental to simplify the existing Infrastructure Inventory so that it can be interpreted and digested, as a structured and simplified list has a better chance of appealing to financiers. This characterisation process comprised:

- *Filling data gaps to sanitise the list and develop distinct and coherent projects.*
- *Applying assumptions to help simplify the complex list of potential investment opportunities, and to assist in structuring an initial list of over 500 projects into a clear set of projects and portfolios.*
- *Further defining and grouping projects according to key characteristics – to be used as the basis for phasing projects, evaluating them against key criteria, and structuring them into coherent investment programmes.*

For the purpose of this Basin Investment Framework, projects and portfolios were categorised according to key project criteria that financiers typically use to evaluate the attractiveness of an investment. These include: maturity (differentiating between completion horizons of 2018-2027 and 2028-2040), single versus multipurpose projects and portfolios, transboundary versus national projects, geographic location and national prioritization.

Developing the Programmatic Structure
The majority of investments in the Infrastructure Inventory relate to water resources infrastructure for energy (and power generation), agriculture, and water supply (to cities, rural towns or mines). While there are a number of ways in which this infrastructure could be clustered, the Basin Investment Framework should lead to mobilising finance, and as such sectoral clustering is the most relevant. A project's contribution towards economic growth, livelihood related poverty reduction, environmental protection, information acquisition or flood management is then an attribute of the investment, rather than the base for programmatic structuring. Following this, the first three programmes in the Basin Investment Framework are sectoral:

- ***Programme 1: Energy*** *– including large and microhydro schemes and thermal power*
- ***Programme 2: Agriculture*** *– including commercial and small-holder schemes*
- ***Programme 3: Water supply*** *– including urban, rural, and mining supply schemes*

In addition to these investments, there are a few investments in hydromet, flood management, sediment management, and catchment conservation, which are related to catchment and aquatic resources management and are typically financed together with built infrastructure, or as part of basin governance and management programmes. As such a fourth broad and cross-cutting programme has been proposed:

- ***Programme 4: Catchment and riparian asset management***

Building a Framework for Project Prioritisation
As previously noted, previous modelling output has demonstrated that there is essentially enough water in the Basin to cater for the existing and planned energy, agriculture and water supply projects. This means there are no significant conflicts between the water resource demands of these sectors, and thus no need to explicitly rank investments. However, given the anticipated stress on the Basin due to the potential drying climate, development decisions must be informed by the benefits and trade-offs of projects and portfolios - with a view to ensuring these benefits are equitable and can be maintained even during periods of climate variability and stress.

It is therefore important to characterize and rationalize suites of projects based on their collective impact/contribution to the future state of the Basin. Preliminary hydro-economic modelling and poverty vulnerability hotspot mapping[1] were used to determine the ability of the basin's water resources to support development at a transboundary and national scale and inform decisions around balancing these trade-offs. These considerations, combined with the aforementioned key project characteristics, informed the selection of six criteria to guide the development, and subsequent prioritisation, of the Basin Investment Framework: ***maturity; national priority; transboundary impact; economic return; resilience to climate variability and climate change; and contribution to livelihoods development and environmental preservation.***

The methodology of prioritisation presented in the report demonstrates how one should think about each project and portfolio against the criteria.

Analysing the Programme Investment Framework

The outcome of developing this rationalised Framework for Project Prioritisation is a clear overview of the project and portfolio costs and characteristics, which differentiates between the two completion horizons and forms the basis for investment structuring and packaging. However, given the Inventory's data limitations, the figures derived from the hydro-economic modelling are based on assumptions, rather than hard data - meaning the resultant outcomes of the analysis should be interpreted as ***proxy*** *representations of the type of results this approach derives. That is, incomplete data has been used to illustrate an effective, robust prioritisation process applicable to the Zambezi's highly complex, dynamic context.*

A critical conclusion of this analysis is that there are too few investment opportunities identified at this stage. The Programme Investment Framework currently totals 28 billion USD[2], which equates to less than 1,000 USD per person in the Basin. This is clearly an underestimate and reflects the lack of preparatory work at all stages (from Master Planning to project identification via feasibility studies, to bankable projects).

Exploring Financing Options in the Basin

To help ZAMCOM start thinking about the financing projects in the Zambezi Basin, it is valuable to understand the 'universe' of external funders and financiers currently investing in the water sector in Africa and the Zambezi – who they are, what their appetite is, and how and where they are investing. A review of this water infrastructure funding and financing landscape finds that

- *Of total commitments to African infrastructure in 2016, 17% (US$10.5 billion) was committed to the water sector. While funding and financing flows into the African water sector have remained relatively stable over the previous five years, funding and financing in the African water sector cannot currently match that invested in transport and energy.*
- *Established contributors (i.e. G7 countries, the European Commission, World Bank Group, European Investment Bank, and African Development Bank), committed the largest amount of support ($4.7 billion) to the water sector in 2016, followed closely by African national governments (US$4.4 billion). Over the last five years African governments have been the largest single source of funding and financing for African water infrastructure.*
- *There are a number of newer sources of development finance emerging on the African continent (e.g. China, Arab entities, India, South Korea, and Brazil). As an example, China announced investments of US$6.4 billion in Africa in 2016, however, none of these were ostensibly earmarked for water infrastructure. China does have some substantial commitments to hydropower developments on the continent (this is counted under the energy, not the water sector).*

[1] Conducted by the Climate Resilient Infrastructure Development Facility.

[2] Noting that total costing figures are not yet available for a number of projects in Programmes 1, 2, 3 & 4.

- *While difficult to estimate accurately, it is clear that the water sector plays a very small role in private sector financing in Africa.*

Thus, it seems clear moving forward that funding and financing from national treasuries will play a key role in enabling further development of the water sector in the Zambezi Basin. This will include acting as leverage to crowd-in other sources of funding and financing. This is obviously dependent on the ongoing economic and fiscal ability of these governments to sustain or grow budget allocations to the sector.

With these funding and financing trends in mind, the programmatic characterisation and clustering of transboundary and national projects provides a basis for the Zambezi Watercourse Commission (ZAMCOM) to think in broad terms about the different approaches to financing projects in the Basin and consider its own role in transboundary projects of varying types and levels of complexity. In some national projects this role may focus on urging and supporting inter-country notification. In others, particularly where complex joint ownership of assets is required, it may extend to providing specific advice on governance, ownership and oversight functions.

A set of institutional and financial unilateral, bilateral and multi-lateral 'delivery models' (DMs) have therefore been considered within the context of how ZAMCOM and Ministries can begin exploring common financing issues between the particular and distinct structures of individual projects and portfolios. DMs can serve as the building blocks to codify specific project structures and inform the likely financing options and associated funding sources. The graduation of DMs from simple to complex structures is usually commensurate with (1) the number of infrastructure development counterparts, (2) the supply of transboundary resources, and (3) the demand for transboundary resources.

DMs are pivotal in identifying potential financiers of water-oriented infrastructure assets in Sub-Saharan Africa. These financiers can be readily be grouped into a few subsets due to common characteristics: investment mandates (including appetite for investment in distinct project phases), funding conditionality, return aspirations, risk appetite, thematic interests (i.e. sectors/programmes) and magnitude of funding.

The type of financing required to implement large developmental infrastructure varies across different infrastructure types (energy, agriculture etc.) as well as over the different phases of project or programme development. This is increasingly challenging in a transboundary context due to the imperative need for cooperation between Riparian States. These complexities, coupled with the sheer extent of the Infrastructure Inventory, mean it is not possible at this stage to match sources of financing to specific projects and portfolios at the scale of the Basin Investment Framework. However, this report's framework of analysis enables the appropriate questions to be asked in thinking about finance of these projects through the project preparation cycle. Application of this thinking is illustrated through a series of case studies, each representing one or more of the programme areas which have been used to structure the Infrastructure Inventory. This analysis demonstrates the process of assessing possible DMs and financiers, and unpacks the likely challenges faced by projects in the same programme area, at either a transboundary or national level.

Key Considerations for Future Stages of the ZSP

The report presents a structured approach to developing a Basin Investment Framework within the highly complex context of the Basin – including differing sovereign development trajectories, climate change impacts on select sub-basins, and ongoing degradation of the shared water resources.

Several overarching conclusions can be drawn from the report, to be taken forward in the preparation of the ultimate ZSP in D6:

- *In average years, there is enough water to sufficiently meet the demands of the planned energy, agriculture and water supply projects, but the anticipated deficiencies in dry years in specific sub-basins will require collective management and decision-*

making around watershed protection and storage to ensure shared benefits can be maintained. Regional cooperation, and subsequent peace and security, is therefore a fundamental component of the ZSP and must be driven by ZAMCOM.

- *Despite notable costing gaps in the Infrastructure Inventory, it is evident that the planned projects will be inadequate to address the socio-economic and environmental development demands of the Basin over the next 20 years. There is therefore a need to both identify new developments that speak to the Inclusive Growth Scenario and mobilise finance to develop the early-stage/conceptual projects into bankable programmes of projects.*
- *Linked to the above point, the roles of ZAMCOM and SADC in attracting finance to promote investment preparation must be further explored.*

1 Introduction

The Zambezi Basin is the fourth-largest in Africa, covering some 1.37 million km². The Basin is shared by eight Southern African States, namely Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. The Zambezi River is a highly valuable resource for the Riparian States, with each of these countries preparing plans to develop the water resources of the Basin for use in a variety of sectors including agriculture, energy, water supply, mining and industrial development, and for transportation. Most of these development plans have been prepared unilaterally by individual Riparian States and without much reference to other planned developments, especially in other sectors.

In 2004, the eight Riparian States of the Zambezi Basin signed the Zambezi Watercourse Agreement (ZAMCOM Agreement) in 2004 with the aim of promoting the equitable and reasonable utilisation of the water resources of the Zambezi Watercourse as well as the efficient management and sustainable development thereof[3]. The Strategic Plan for the Zambezi Watercourse (ZSP) is one of the core projects initiated by the Zambezi Watercourse Commission (ZAMCOM) as called for in the ZAMCOM Agreement.

The objective of the ZSP is to *develop a basin-wide development plan comprising a general planning tool and process for the identification, categorization and prioritization of the projects and programmes necessary for the efficient management and sustainable development of the Zambezi Watercourse*. It provides the basis for harmonised, basin-wide cooperation in the management and development of the water resources of the Zambezi Watercourse.

The ZSP is being developed in a multi-stage, cooperative and consultative manner and includes a number of different activities focused first on assessing the current situation in the Basin, and then on conducting strategic planning focused on future action. Previously completed phases of the ZSP include the completion of a **Situation Analysis and Strategic Directions Report** (D2), a **Basin Development and Infrastructure Inventory Report** (D3), and a **Basin Development Scenarios Report** (D4). A select number of preferred Basin Development Scenarios identified in D4 serve as input into a framework that structures projects and programmes for financing and development, as described in this report, the **Basin Investment Scenarios Report** (D5). The final **Strategic Plan for the Zambezi Watercourse** (D6 and D7) will be crafted based on this analysis of investment scenarios and drawing from all the studies undertaken earlier in the project. The final output will be an **Online Monitoring Tool** (D8).

1.1 Report Objectives

The objectives of this report are to:

Objective 1: Summarize key findings from previously completed reports, including the Situation Analysis and Strategic Directions Report (D2), the Basin Development and Infrastructure Inventory Report (D3) and the Basin Development Scenarios Report (D4).

Objective 2: Define realistic development parameters within the Zambezi Basin, consider financing opportunities, and opportunities for transboundary cooperation.

Objective 3: Develop a framework for the structuring of investment projects and programmes.

Objective 4: Outline finance options for projects with a transboundary dimension.

[3] ZAMCOM. 2004. Agreement on the Establishment of the Zambezi Watercourse Commission.

1.2 Structure of this Report

This report is divided into two halves. The first, Part A, is largely a review of work done and conclusions drawn in the previously completed phases of the ZSP, while Part B presents new material, namely the details of the development and analysis of the Basin Investment Framework. Grouping the chapters of this report into these two halves allows readers who are already familiar with the ZSP project to skip directly to the new material presented in Part B, while readers who have less awareness of work done to date have a convenient summary of the previous phases of the project available in Part A.

PART A: INTRODUCTION, BACKGROUND & REVIEW (Objective 1)

Following this introduction (Chapter 1), Part A presents a background chapter (Chapter 2) which offers an overview of the physical characteristics of the Zambezi Basin, reviews the mandates of ZAMCOM and summarizes the current investment situation in the Basin. This is followed by a summary of the key findings presented in three previously completed reports (Chapter 3), namely the Situation Analysis and Strategic Directions Report (D2), the Basin Development and Infrastructure Inventory Report (D3) and the Basin Development Scenarios Report (D4), as well as a discussion of how these previous phases of work feed into the final development of the ZSP.

PART B: INVESTMENT PRIORITIZATION FRAMEWORK, (Objectives 2, 3 & 4)
ANALYSIS, FINDINGS & CONCLUSIONS

Part B starts by revisiting the three Recommended Basin Development Scenarios identified in D4 and justifies the selection of one single Basin Development Scenario (Chapter 4) - this forms a critical link between the work done to date on Basin Development Scenarios and their translation into a single actionable and financeable Basin Investment Scenario as completed in this report. Chapter 4 goes on to focus on the development of a Basin Investment Framework, describing how projects in the Infrastructure Inventory were evaluated and structured into programmes and portfolios. Chapters 5 builds on this Basin Investment Framework by looking at financing aspects of the programmes, with Chapter 6 presenting a preliminary packaging of projects to appeal to specific funders. Chapter 7 provides a summary of the key findings of Part B and presents a number of key conclusions to be carried forward into the ultimate development of the ZSP.

2 Background

This chapter summarizes important background information relevant to the development of the ZSP: Section 2.1 describes key physical, socio-economic and geopolitical features of the Zambezi Basin; Section 2.2 examines ZAMCOM as an institution and Section 2.3 presents an overview of the current investment situation in the Basin. This section serves as a brief summary of information that has already been presented in much greater detail in the previously completed Situation Analysis and Strategic Directions Report (D2), Basin Development and Infrastructure Inventory Report (D3) and Basin Development Scenarios Report (D4).

2.1 The Zambezi Basin

The Zambezi River Basin is the fourth largest river basin in Africa, covering 1.37 million km². The Zambezi River Basin is shared by eight Riparian States: Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe, with 85% of the Basin's population living in Malawi, Zimbabwe and Zambia[4]. The Basin population is growing rapidly, from 31.7 million in 1998 to 40 million in 2008, reaching an estimated 51 million by 2025[5]. Currently more than 60% of the population is comprised of rural dwellers reliant on rain-fed subsistence agriculture[6]. Apart from Botswana and Angola, which are classified as lower-middle income countries, all the Riparian States are classified as low-income countries with high proportions of their economies dependent on agriculture[7]. Levels of poverty and income disparity are very high throughout.

The Zambezi rises in north-western Zambia and flows for some 2,700 km before entering the Indian Ocean in Mozambique[8]. The Basin can be categorised into three distinct stretches based on varying hydrology and topography: upper, middle, and lower Zambezi. The hydrology of the Basin is complex, with each portion associated with distinct hydrological characteristics. The climate of the Basin varies throughout, from the Kalahari Desert in the south to tropical rainforests in the north[9]. Rainfall occurs during a 4 to 6 month summer season[10]. Evaporation rates are high, with only about 10% of the runoff reaching the Indian Ocean due to evaporative losses from wetlands and lakes[11]. The mean annual runoff into the Indian Ocean is about 130 km³/year[12]. Most of the Basin is covered by forests and bushland, with considerable areas of cropped land and grassland. In each Riparian State, the proportion of agricultural area ranges between 30% and 50% of the countries' total land area[13]. The Basin is facing accelerated levels of environmental stress and degradation due to population pressure, poor agricultural practices, deforestation, forest fires and the effects of poverty, all of which are set to be exacerbated by climate change.

The Basin's water is currently utilised for hydroelectric power, irrigation, domestic and industrial supply, and mining as well as for tourism, navigation, transport, and support of unique aquatic ecosystems and wildlife habitat in a number of wetlands and the delta[14]. Current water demand is significantly less than the

[4] World Bank. 2010. The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis: Vol 1, Summary Report.
[5] ZAMCOM, SARDC, SARDC. 2015. Zambezi Environment Outlook 2015. ZAMCOM, SADC, SARDC. Harare, Gaborone.
[6] ZAMCOM, 2017. Situation Analysis and Strategic Directions Report.
[7] ZAMCOM, 2017. Situation Analysis and Strategic Directions Report.
[8] ZRA. 2008. Transboundary Issues on Sustainable Hydropower Development in the Zambezi River Basin in the Eyes of the Zambezi River Authority.
[9] ZAMCOM, SARDC, SARDC. 2015. Zambezi Environment Outlook 2015. ZAMCOM, SADC, SARDC. Harare, Gaborone.
[10] ZAMCOM, SARDC, SARDC. 2015. Zambezi Environment Outlook 2015. ZAMCOM, SADC, SARDC. Harare, Gaborone.
[11] ZAMCOM, SARDC, SARDC. 2015. Zambezi Environment Outlook 2015. ZAMCOM, SADC, SARDC. Harare, Gaborone.
[12] ZAMCOM, 2017. Situation Analysis and Strategic Directions Report.
[13] FAOSTAT. 2017. http://www.fao.org/faostat/en/#data. Accessed: 7 March 2017.
[14] ZAMCOM, 2017. Situation Analysis and Strategic Directions Report.

available resource. However, water demands will continue to increase as a result of economic and population growth. Furthermore, most of the existing development plans have been prepared unilaterally by individual Riparian States, without reference to planned developments in other sectors or countries.

A range of institutions govern usage of the Zambezi waters at various levels:

- At the **continental level** water resources management and development is governed by the African Ministerial Council on Water, of which all Riparian States are active members.
- At the **regional level** the Zambezi Basin is governed through the Regional Economic Communities: all the Zambezi Riparian States are members of the Southern African Development Community (SADC), with Tanzania also a member of the East African Community, and Angola also a member of the Economic Community of Central African States. Governance of the Zambezi Basin including the establishment of ZAMCOM is called for by the SADC Protocol on Shared Watercourses (ZAMCOM as an institution is revisited in more detail in Section 2.2 below).
- At the **bilateral level**, Joint Permanent Technical Commissions are responsible for the management of either a specific watercourse or water resources of common interest between participating countries. For example, the Joint Water Commission between Malawi and Mozambique was signed in 2005, and between Mozambique and Zimbabwe in 2001. Special purpose vehicles (SPVs) aimed at implementing specific bilateral projects have also been established by the Zambezi Riparian States. The Zambezi River Authority (ZRA) is a corporation jointly and equally owned by the governments of Zambia and Zimbabwe, with the primary function of operating and maintaining the Kariba Dam on the Zambezi River.
- At the **national level** the institutional and governance structures in the Zambezi Riparian States are governed by national water legislation which also defines the institutional structure for water resources management and development. While efforts are underway to decentralise the management of water resources to the lowest appropriate levels, at present water resources policy and regulation has remained the function of the Central Government in all the Riparian States.

2.2 ZAMCOM

The ZAMCOM was established through the ZAMCOM Agreement, signed in Kasane, Botswana on 13 July, 2004. The Agreement came into force on June 19, 2011 after six of the eight Riparian States had deposited their ratification instruments with the SADC Secretariat. The aim of the Agreement is the promotion of the equitable and reasonable utilisation of the water resources of the Zambezi Watercourse as well as the efficient management and sustainable development thereof[15]. The Agreement defines the governance structure for the management of the Zambezi Basin. ZAMCOM comprises multi-layered governance institutions that include grass-roots stakeholder structure at Riparian States level and regional stakeholder structures (Basin-wide Stakeholder Coordination Committee and Basin Forum).

While the implementation of projects in the Zambezi Basin remains the responsibility of the Riparian States, the role of ZAMCOM is to facilitate, advise and coordinate the implementation of programmes and projects between the Riparian States as well as to promote (transboundary) cooperation in this implementation. The SADC Protocol on Shared Watercourses is the principal legal instrument governing transboundary water management in the region, while the ZAMCOM Agreement provides a framework for transboundary water cooperation specific to the Zambezi Basin. The Zambezi Basin Secretariat (ZAMSEC) was established in Harare in 2014 and coordinates the activities of ZAMCOM.

[15] ZAMCOM. 2004. Agreement on the Establishment of the Zambezi Watercourse Commission.

The ZAMCOM Agreement makes provisions for the preparation of a master development plan, which includes a general planning tool and the identification, categorisation and prioritisation of projects and programmes for the sustainable development and efficient management of the Zambezi Watercourse.

A strategy for the operationalisation of the ZAMCOM Agreement was prepared under the SADC-supported ZACPRO project (ZACPRO 6.2). This culminated in the preparation of an Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin (ZAMSTRAT), which was completed in 2016[16]. The development of the ZSP builds upon the ZAMSTRAT in striving to implement the provisions of the ZAMCOM Agreement. The ZSP provides the basis for harmonised, basin-wide cooperation in the management and development of the water resources of the Zambezi Watercourse.

2.3 The Current Investment Situation in the Basin

The present investment situation in the Basin is one characterized by a long-term infrastructure deficit. There has been no new major infrastructure built on the Zambezi Watercourse since 1979, 38 years ago (see Table 1).

Table 1: Major Infrastructure on the Zambezi Basin

Infrastructure	Country	Date	Age in 2018
Kariba Dam	Zambia / Zambezi	1958	60 years
Kamuzu Barrage (Liwonde)	Malawi	1965	53 years
Cahora Bassa Dam	Mozambique	1974	44 years
Itezhi Tezhi Dam	Zambia	1976	42 years
Kafue Gorge Upper	Zambia	1979	39 years

While there are a number of water-related developments at varying stages of design and implementation in Riparian States (see Section 3.3.2 for more detail), most of these are national projects being undertaken by individual Riparian States, which cannot be regarded as "integrated and coordinated" projects at a Basin level. The following large, national or bi-lateral level projects related directly to the Zambezi River Basin are currently at advanced stages of preparation or are being implemented:

Botswana:

Chobe/Zambezi Water Transfer Scheme: This project involves the transfer of 150 million m^3/ year water to the south of the country and 345 million m^3 for irrigation in Pandamatenga. The Zambezi Commission has approved the use of 495 million m^3 per year of water from the Zambezi for this project. The project is at a preliminary design stage and is estimated to cost US$1 billion[17].

Malawi:

Shire River Basin Management Programme including the Kamuzu Barrage Rehabilitation project and other components such as catchment management, institutional support, rural livelihoods support, flood control and disaster management. This project is financed by the World Bank and the Global Environment Facility (total value US$145.6 million) and is currently under implementation[18].

Tedzani Electricity Hydropower Station rehabilitation on the Shire River[19].

[16] ZAMCOM. 2016. Integrated Water Resource management strategy and Implementation Plan for the Zambezi River Basin.

[17] SADC Regional Development Infrastructure Master Plan, 2012.

[18] World Bank, 2012.

[19] Schwarz, 2016.

Mozambique:

Mphanda Nkuwa dam: This project involves the construction of a dam and installation of a 1,500 MW hydropower at an estimated cost of US$4.2 billion plus US$1 billion for electricity transmission. The current status of the project is unknown[20].

Cahora Bassa North Bank extension: This project involves the construction of a hydropower generation unit of 1,245 MW on the north bank of Cahora Bassa[21].

Zambia:

Water Resources Development: US$50 million World Bank credit together with other partners for water resources management, water resources development (including small scale water infrastructure) and institutional support[22].

Lusaka Water Supply and Sanitation Project: This project involves the rehabilitation and expansion of the water supply and sanitation infrastructure for the city of Lusaka. The Project is financed by the United States Agency for International Development at a cost of about US$350 million. The Project is at the construction stage[23].

Zimbabwe:

Bulawayo water supply: This project includes the abstraction from the Zambezi main stem of 31.5 million m^3 per year and storage in Gwayi-Shangani dam, pumping and pipeline to Bulawayo. Project stalled and no current information is available[24].

There are currently two planned projects that involve two or more countries and can therefore be considered 'integrated and coordinated' projects:

Zimbabwe & Zambia

Batoka Gorge: This is a Zambezi River Basin Development Project implemented by the ZRA with World Bank finance valued at US$6 million[25].

Kariba Dam Rehabilitation: This is a ZRA implemented project financed by the World Bank to the tune of about US$294.2 million[26].

[20] SADC Regional Development Infrastructure Master Plan, 2012.
[21] SADC Regional Development Infrastructure Master Plan, 2012.
[22] World Bank. 2013. Zimbabwe: Water Sector Investment Analysis.
[23] USAID. 2013.
[24] SADC Regional Development Infrastructure Master Plan, 2012.
[25] World Bank. 2012.
[26] World Bank. 2015. Accelerating Climate-Resilient and Low-Carbon Development: The Africa Climate Business Plan.

3 Backward and Forward Linkages

This particular report, the **Basin Investment Scenarios Report** is only one component in a larger, multi-stage process that comprises the development of the ZSP. The material presented in this report builds on insights from previous phases of work towards the ZSP, and will feed directly into subsequent stages of the ZSP development. The forward and backwards linkages of this work are critical and are thus briefly outlined here.

3.1 The Strategic Plan for the Zambezi Watercourse

Figure 1 shows how the various stages of work fit together and contribute to the ultimate development of the ZSP, highlighting this report, namely the Basin Investment Scenarios Report.

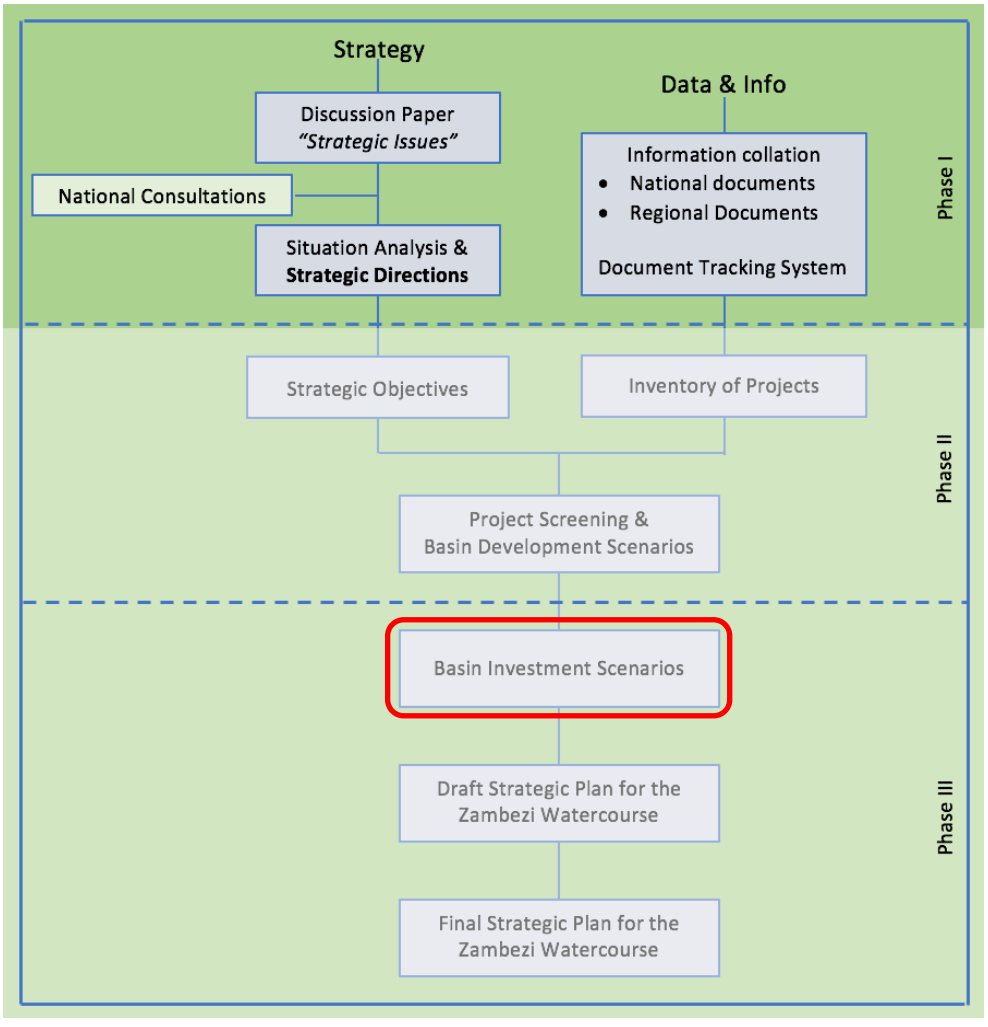


Figure 1: ZSP Development Process

The process of developing the ZSP started with the creation of a **Situation Analysis and Strategic Directions Report** (D2). Key findings from this report are summarized in Section 3.1 below. This led into the **Basin Development and Infrastructure Inventory Report** (D3), summarized in Section 3.2 and

the creation of Basin Development Scenarios, as described in the **Basin Development Scenarios Report** (D4) and summarized in Section 3.3.

These Basin Development Scenarios serve as direct input to the development of **Basin Investment Scenarios** (D5) described in this volume. Within this Basin Investment Scenarios Report, a framework for structuring projects and programmes will be proposed using identified criteria to balance investment needs and inform the strategic plan. This will include an analysis of various models and options for financing key priority investments in the sector and identify opportunities for regional development through cooperative investments.

As shown in Figure 1, the ultimate **Strategic Plan for the Zambezi Watercourse** (D6 and D7) will be crafted based on the Basin Development and Investment Scenario analyses and drawing from all the studies undertaken earlier in the project. The plan will be a fully-fledged document with background, objectives and targets, measures (hard and soft), an implementation or action plan and a proposal for monitoring. This Draft ZSP is one of the deliverables that will be used for widespread consultation with the ZAMCOM Organs (Zambezi Watercourse Commission Technical Committee, Zambezi Watercourse Commission Secretariat, National Stakeholder Committees (NASCs), Basin-wide Stakeholders Coordination Committees, as well as other stakeholders including the SADC Secretariat and the International Development Partners.

The final output will be an **Online Monitoring Tool** (D8). This tool will provide users with access to the vast amount of data collected and synthesized in the initial part of the study. It will contain information on model inputs and assumptions and will be an archive for raw model results and final ZSP products. These products will include both reports and searchable data from findings and recommendations. It will be an extension of the Infrastructure Inventory database produced as output D3.

3.2 Situation Analysis and Strategic Directions

The Situation Analysis and Strategic Directions Report (D2) was the diagnostic phase of the development of the ZSP. It had two primary objectives: it presented a detailed analysis of the current water resource, social and economic situation, identifying five key Strategic Issues facing the Basin. These five **Strategic Issues** served as the basis for a series of country consultations held in each of the Riparian States, seeking not just to validate the Strategic Issues identified, but also to solicit possible solutions by which to address them. The results of these consultations were collated and from them, **Strategic Directions** for future development were derived, outlining Riparian States' vision for addressing the Strategic Issues. The Strategic Issues and Strategic Directions are summarized briefly in Sections 3.2.1 and 3.2.2 respectively below.

3.2.1 Situation Analysis and the Identification of Strategic Issues

The Situation Analysis identified the following five emerging **Strategic Issues** facing the Basin:

- **Strategic Issue 1:** Persistent poverty – the need for equitable development
- **Strategic Issue 2:** Competing uses – the need for balanced development
- **Strategic Issue 3:** Infrastructure deficit – the need for infrastructure development
- **Strategic Issue 4:** Environmental degradation – the need for sustainable development
- **Strategic Issue 5:** Disaster risk – the need for climate resilient development

Further details on each of these Strategic Issues can be found in the Situation Analysis and Strategic Directions Report (D2). **It is critical to appreciate that all these Strategic Issues are interrelated** – under-investment in water security for agriculture and energy (at all scales- large, medium and small scale), poverty, land and catchment degradation, deteriorating water quality, food insecurity, environmental asset loss, etc. all impact each other. All of these factors are exacerbated by an over-riding external

factor – the climate of the region – which is both highly variable and changing. Because these factors are interrelated, solutions need to be integrated. Together, these Strategic Issues support the identification of the strategic options which feed into the process of developing the ZSP.

3.2.2 Strategic Directions

The Strategic Issues identified in the Situation Analysis served as the basis for a series of consultations with NASCs held in each of the Riparian States in April and July 2017, seeking not just to validate the Strategic Issues identified, but also to solicit possible solutions by which to address them. The results of these consultations were collated and from them, **Strategic Directions** for future development were derived, outlining Riparian States' vision for addressing the Strategic Issues. In broad terms, the Strategic Directions drawn from these consultations were as follows:

- **Strategic Direction 1: Infrastructure deficit -** there is a desire among Riparian States to invest in sound, sustainable, resilient infrastructure to underpin equitable economic growth.
- **Strategic Direction 2: Watercourse management –** there is a desire among Riparian States to move towards greater collaboration and cooperation through ZAMCOM and promote interaction between Riparian government departments.
- **Strategic Direction 3: Regional/basin cooperation –** there is a desire among Riparian States to move towards greater cooperation and coordination through ZAMCOM and other regional & continent-wide mechanisms.
- **Strategic Direction 4: Institutional –** there is a desire from Riparian States to see the continuing emergence of a river basin organisation, which is fit-for-purpose and which actively promotes, facilitates, coordinates sound management and development of the Zambezi Watercourse.

Further details on each of these Strategic Directions can be found in the Situation Analysis and Strategic Directions Report (D2).

3.3 Basin Development and Infrastructure Inventory

In contrast to the Situation Analysis and Strategic Directions Report (D2), which focused mainly on assessing the current situation in the Basin, the Basin Development and Infrastructure Inventory Report (D3) transitioned towards looking at future actions. It first collated and reviewed existing national-level policies, strategies and plans for each of the Riparian States, as well as reviewing existing plans in each country's water-using sectors. Having established the Riparian States' future development priorities at a national and sector-specific level, this assessment of future actions in the Basin was further refined through the development of an Infrastructure Inventory, documenting existing and planned infrastructure projects. It thereby produced two main outputs, namely an overview of the development aspirations of Riparian States, and an Infrastructure Inventory, documenting existing and planned infrastructure projects. Each of these are summarized briefly in Sections 3.3.1 and 3.3.2 respectively below.

3.3.1 Basin Development

The first half of the Basin Development and Infrastructure Inventory Report presents a detailed review of existing national-level policies, strategies and plans for each of the Riparian States, as well as sector-specific plans for each of their main water-using sectors (i.e. agriculture/irrigation; hydropower/energy; water supply and sanitation; mining; and transport and navigation). All of the national policies, strategies and plans and sector-specific documents examined share several recurring features, including a desire to achieve:

- The modernisation and industrialisation of national economies;
- The diversification of national economies to reduce reliance on single dominant sectors, thereby minimizing the negative influence of shocks such as drops in global commodity pricing and climate impacts;
- The development of the infrastructure required to underpin economic growth;
- The productive use of resources including water;
- Food and energy security, and, in many instances, self-sufficiency;
- Sustainable growth and development in terms of climate resilience and environmental protection; and
- Equitable development, such that all citizens benefit from development and the reduction of poverty.

Further details on this analysis can be found in the Basin Development and Infrastructure Inventory Report (D3). In summary, there is strong alignment between many of the ambitions expressed by Riparian States through their national level policies, strategies and plans. However, there are differing degrees of congruence between these individual National Development Plans and the basin-level perspective applied in the development of the ZSP. Thus, the need to further harmonise the water resources management and development policies of different Riparian States is an ongoing activity where facilitation by ZAMCOM could reap substantial rewards.

3.3.2 Infrastructure Inventory

Having established the Riparian States' future development priorities at a national and sector-specific level, this assessment of future actions in the Basin was further refined through the development of an Infrastructure Inventory, a database documenting existing and planned infrastructure projects.

The Infrastructure Inventory was developed using information about water resource-related infrastructure development projects drawn from a variety of existing water resources, operational and infrastructure planning reports. The Infrastructure Inventory contains details on 251 existing projects, including:

- 12 hydropower projects;
- 50 urban, rural and multipurpose projects;
- 186 agriculture projects; and
- 3 mining and other projects.

The Infrastructure Inventory additionally contains details on 282 planned projects, including:

- 26 hydropower projects;
- 116 urban, rural and multipurpose projects;
- 120 agriculture projects; and
- 20 mining and other projects.

Further details on the projects contained in the Infrastructure Inventory can be found in the Basin Development and Infrastructure Inventory Report (D3). While this synopsis offers a high-level, static overview of the current contents of the Inventory, the dynamic digital Infrastructure Inventory tool should be consulted for the most up to date information.

3.4 Basin Development Scenarios

Taken all together, this review of the present situation (documented in the Situation Analysis and Strategic Directions Report – Section 3.2) and future development aspirations (documented in the Basin Development and Infrastructure Inventory Report – Section 3.3) contributed directly to the identification of a number of **Strategic Objectives** that underpin the development of the ZSP:

- **Strategic Objective A:** To promote and facilitate regional cooperation and good neighbourliness;
- **Strategic Objective B:** To promote and facilitate equitable, safe and optimal development and utilisation of the resources of the Zambezi Watercourse for economic growth and prosperity;
- **Strategic Objective C:** To promote and facilitate sustainable and ecologically sound development and utilisation of the resources of the Zambezi Watercourse;
- **Strategic Objective D:** To promote and facilitate climate resilient infrastructure and development to manage and reduce (investment and societal) risk and promote economic growth and prosperity;
- **Strategic Objective E:** To promote and facilitate public access to sufficient and safe water supplies, and related essential services, for basic needs and livelihoods; and
- **Strategic Objective F:** To promote and facilitate capital mobilisation and investment implementation.

The subsequent report, the **Basin Development Scenarios Report** (D4) took a first step towards realizing these Strategic Objectives, looking in more detail at the desires of the Riparian States to develop in a certain way in the future. This was done by developing a series of **Basin Development Scenarios,** each describing one single hypothetical version of the Basin's future.

Basin Development Scenarios were conceptually and quantitatively described in two parts: **an objective** and **a number of constraints**. The objective describes what the core priority of a particular scenario is, while the constraints describe any limits that are placed on this priority. Together, the objective and constraints uniquely describe the development priorities that an individual Basin Development Scenario focuses on. Based on insights from previous phases of the ZSP development, the following objectives and constraints were considered:

Objectives: Future Basin Development Scenarios were considered that either maximized

- economic growth;
- energy security; or
- food security.

Constraints: Each of the Future Basin Development Scenarios was subjected to meeting minimum levels of environmental protection, by ensuring

- the provision of minimum river flows i.e. environmental flows;
- the provision of minimum wetland flows;
- the provision of minimum flows to the Delta; or
- maximum flows to the Delta are not exceeded i.e. flood protection.

An initial set of close to 500 Basin Development Scenarios were generated, simply by varying both the objective and the flow levels associated with each constraint. These were incrementally and systematically narrowed down through a combination of applying a screening model tool, completion of multi-criteria analysis, consultation with Riparian States' national development plans, National Stakeholder Consultations

and insights from experts with extensive experience on the Zambezi River Management to seven Preferred Basin Development Scenarios. These seven Preferred Basin Development Scenarios are shown in Table 2.

Table 2: The Seven Preferred Basin Development Scenarios

	Preferred Scenario Name	Objective	Constraint			
			Environmental Flows (volume expressed as percentile of naturalized flow)	**Wetlands** (volume expressed as percentile of naturalized flow)	**Delta** (minimum flow in cms during month of February)	**Floods** (maximum flow in cms)
1	**Energy Security**	Maximize energy security	**-**	**-**	**-**	-
2	**Food Security**	Maximize food security	**-**	**-**	**-**	-
3	**Maximize Economic Benefits**	Maximize economic benefits	**-**	**-**	**-**	-
4	**High Environmental Flows**	Maximize economic benefits	**High** (20th percentile)	**High** (95th percentile)	**Low** (6,000 cms)	**Low** (11,000 cms)
5	**High Delta and Flood Protection**	Maximize economic benefits	**Low** (5th percentile)	**Low** (50th percentile)	**High** (8,000 cms)	**High** (15,000 cms)
6	**Moderate Environment and Delta/Flood Protection**	Maximize economic benefits	**Medium** (10th percentile)	**Medium** (75th percentile)	**Medium** (7,000 cms)	**Medium** (13,000 cms)
7	**Ambitious Environment and Delta/Flood Protection**	Maximize economic benefits	**High** (20th percentile)	**High** (95th percentile)	**High** (8,000 cms)	**High** (15,000 cms)

Detailed hydro-economic modelling was subsequently conducted on these seven Preferred Basin Development Scenarios, to provide insights about the performance of these scenarios, as measured by a wide range of numerical indicators. The subsequent hydro-economic modelling results ultimately resulted in the selection of a short-list of three of the seven Preferred Basin Development Scenarios as candidates for the final choice of Recommended Basin Development Scenario:

Recommended Basin Development Scenario #1: A Scenario that Maximizes Economic Benefits

The first shortlist candidate selected was the **Maximize Economic Benefit** scenario, where the sole emphasis is on economic growth. This scenario (= Preferred Scenario #3 from Table 2 above) is designed to develop the Basin in such a way as to maximize economic growth without requiring any environmental or disaster risk reduction constraints.

Recommended Basin Development Scenario #2: A Scenario Resilient to Climate Variability

Given that ZAMCOM desires to address the five Strategic Issues identified in Section 3.2.1 as part of the ZSP with the revealed preferences of the NASCs and range of stakeholders, the second shortlist candidate selected was the **Ambitious Environment and Delta/Flood Protection** scenario. The emphasis in this scenario (= Preferred Scenario #7 from Table 2 above) is more balanced than the Recommended Basin

Development Scenario #1, with the objective still to maximize economic growth, but subject to high levels of environmental protection.

Recommended Basin Development Scenario #3: A Scenario Resilient to Climate Change

The third shortlist candidate selected was the **Moderate Environment and Delta/Flood Protection** scenario. Similar to the previous shortlist candidate, the emphasis in this scenario (= Preferred Scenario #6 from Table 2 above) is also balanced, with the objective to maximize economic growth, but subject to moderate levels of environmental protection.

The three Recommended Basin Development Scenarios are highlighted in red in Table 3 below.

Table 3: Three Recommended Basin Development Scenarios

	Preferred Scenario Name	Objective	Constraint			
			Environmental Flows (volume expressed as percentile of naturalized flow)	**Wetlands** (volume expressed as percentile of naturalized flow)	**Delta** (minimum flow in cms during month of February)	**Floods** (maximum flow in cms)
1	**Energy Security**	Maximize energy security	**-**	**-**	**-**	-
2	**Food Security**	Maximize food security	**-**	**-**	**-**	-
3	**Maximize Economic Benefits**	Maximize economic benefits	**-**	**-**	**-**	-
4	**High Environmental Flows**	Maximize economic benefits	**High** (20th percentile)	**High** (95th percentile)	**Low** (6,000 cms)	**Low** (11,000 cms)
5	**High Delta and Flood Protection**	Maximize economic benefits	**Low** (5th percentile)	**Low** (50th percentile)	**High** (8,000 cms)	**High** (15,000 cms)
6	**Moderate Environment and Delta/Flood Protection**	Maximize economic benefits	**Medium** (10th percentile)	**Medium** (75th percentile)	**Medium** (7,000 cms)	**Medium** (13,000 cms)
7	**Ambitious Environment and Delta/Flood Protection**	Maximize economic benefits	**High** (20th percentile)	**High** (95th percentile)	**High** (8,000 cms)	**High** (15,000 cms)

3.5 Looking Forward to the Basin Investment Scenarios

The work done on the ZSP so far has emphasized that the Basin countries face a number of challenges to their **economic and social development**, including:

- 64.8% of the Basin's population is rural[27], depending largely on rain-fed subsistence agriculture and is extremely vulnerable due to little or no investment in local water infrastructure.

[27] ZAMCOM, 2017. Situation Analysis and Strategic Directions Report.

- The two main water using sectors in the Basin are agriculture and hydropower. Water for urban, industrial and mining uses is critical for the economies of all Zambezi Riparian States but requires much smaller quantities. Balanced investments require an equitable sharing of the benefits of development between Riparian States and carefully determined trade-offs between different inter-related water uses, particularly energy and food production.
- There is a substantial infrastructure deficit across the whole of the Zambezi River Basin (e.g. of the total estimated 5.2 million hectares of arable land in the Basin, 183,000 or 3.6% is equipped for irrigation; of the total estimated potential hydro-power capacity of 13,000 MW in the Basin 5,000 MW or 38% has been developed)[28]. Without infrastructure, specifically large, medium and small-scale water storage facilities, the different growth sectors of the economy and the economy as a whole will remain vulnerable to regional rainfall variability and will lack resilience to climate change.
- A number of recent studies highlight the wealth of the natural resources of the Zambezi Basin, of which water is a key part. Currently the Zambezi Basin environment faces serious challenges caused by the growing impacts of poverty and unplanned development, exacerbated by climate change and variability (e.g. 51% of land in the Zambezi Basin is moderately degraded and 14% is highly degraded with growing negative impacts on the population and on water resources)[29].
- There is extensive documentation on the economic and human impacts of floods and droughts in the Zambezi River Basin. There is evidence that climate change will exacerbate the current situation and accentuate the extremes of floods and droughts. Increasing poverty throughout the Basin and its accompanying impacts on land use and catchment degradation will also exacerbate the impacts of extreme weather events. Measures will have to be undertaken to manage the risk of water related disasters as effectively as possible.

Yet, despite these issues, **there are opportunities for economic and social development of the region – provided it is sustainable, inclusive and resilient**. Shared water resources present the opportunity for integrated development, regional cooperation and peace and security, particularly as facilitated by ZAMCOM. The Zambezi Riparian States must therefore undertake a collective, well-considered development path that contributes toward economic growth, whilst helping to restore the environment by reversing the impacts of poverty and detrimental water use.

In average years, there is enough water in the Basin to cater to all the existing and planned hydropower, agriculture and water supply projects. This means there are no significant conflicts between the water resource demands of these sectors, and thus no need to explicitly rank or prioritise investments. However, given the anticipated future stress on the Basin due to the potential drying climate, **regional cooperation** will be fundamental to ensuring developments are jointly communicated, planned and managed. This requires establishing a clear understanding of the benefits and trade-offs of development decisions, including climate resilience, economic growth, improved livelihoods and national priorities – with a view to ensuring these benefits are equitable and can be maintained even during periods of water stress.

The remainder of this report is focused on the development of a Basin Investment Framework. To this end, **this Basin Investment Scenarios report (D5) characterises and rationalises suites of projects based on their collective impact/contribution to the future state of the Basin and presents a programmatic structure for financing developments that recognises these trade-offs.**

[28] ZAMCOM, 2017. Situation Analysis and Strategic Directions Report.
[29] ZAMCOM, 2017. Situation Analysis and Strategic Directions Report.

4 Formulation of the Basin Investment Framework

4.1 Definition of a Single Basin Development Scenario

Chapter 3 provided a brief summary of the stages of work on the ZSP that have been completed to date. It ended by describing the process of selecting three Recommended Basin Development Scenarios. This brief section forms a crucial link between these three Recommended Basin Development Scenarios and the selection of a single Basin Development Scenario that is carried forward into this present work on the **Basin Investment Framework.** The necessity to select a single Basin Development Scenario is underpinned by the fact that specific focus for investment planning is required, rather than developing multiple, potentially conflicting Investment Scenarios with differing priorities and criteria. This, together with the previous observation that all the projects listed in the Infrastructure Inventory can be supported by the water resources in the Basin (provided cooperation enables effective management and maintenance of shared benefits across the basin during periods of stress), indicates that different investment scenarios are not appropriate and that a single Basin Investment Scenario developed into a single Basin Investment Framework is more useful.

With the three Recommended Basin Development Scenarios shown in Table 3 in mind, the regional and national development aspirations of the Riparian States were revisited to help with the selection process.

At a regional level, the SADC Regional Indicative Strategic Development Plan for 2015 to 2020 states an objective to "deepen the integration agenda of SADC, with a view to accelerating **poverty eradication** and the attainment of other **economic and non-economic development goals**".

These poverty eradication and economic growth goals are consistently mirrored at the national level in the Riparian States' National Development Plans:

- **Angola's Plano de Desenvolvimento (2013-2017)** includes objectives to
    - Reduce bureaucracy and other economic policy reforms **to promote growth** and wealth distribution especially in agriculture; and
    - Addressing **rural poverty**.
- **Namibia's 5th National Development Plan (May 2017)** includes objectives to
    - Achieve rapid industrialisation and integrating marginalised communities into mainstream economy strategies by ensuring sustainable livelihoods.
- **Botswana's 11th National Development Plan (2017 – 2023)** includes the objective
    - **Inclusive growth** for the realisation of sustainable employment creation and **poverty eradication.**
- **Malawi's Growth and Development Strategy III (2017 – 2022)** includes objectives to
    - **Reduce poverty** and create wealth through sustainable economic growth and infrastructure development.
- **Mozambique's Programa Quinquenal do Governo (2015 – 2019)** includes objectives to
    - Improve the **living conditions** of the Mozambican people.
- **Tanzania's National Five-Year Development Plan (2017 – 2021)** includes objectives to
    - Focus on **economic growth** and transformation, and **poverty reduction**.
- **Zambia's Seventh National Development Plan (2017 – 2021)** includes objectives to
    - Create a diversified and resilient economy for **sustained growth and socio-economic transformation** driven, among others, by agriculture, tourism, manufacturing and mining.
- **Zimbabwe's Agenda for Sustainable Socio-Economic Transformation (2013 – 2018)** includes objectives to

- Address on a sustainable basis, the numerous challenges affecting **quality service delivery and economic growth**.

Crucial to notice here is the emphasis not just on poverty eradication and economic growth, but on **inclusive growth** as well as **livelihoods**, which is mirrored in both regional and national development priorities. In other words, revisiting the development plans of the countries in Basin indicates an explicit desire to conduct development and economic growth in an inclusive way, such that the poorest of the poor are not left behind in the face of growth for the country as a whole. Having identified this critical nuance, it became clear that the single Recommended Basin Development Scenario selected should not just achieve poverty eradication and economic growth, but prioritize these occurring in an inclusive and equitable fashion. Intrinsically entwined with the achievement of inclusive growth in the Basin is some degree of environmental protection, given the reliance of many livelihoods in the Basin on the continued health of the Zambezi River, its wetlands, and Delta, as well as the conservation of critical catchment areas upon which communities depend.

For these reasons, the single Basin Development Scenario carried forward into the analysis of Basin Investment Scenarios is a scenario focused on Inclusive Growth. **This Inclusive Growth Scenario corresponds to the scenario previously described as the Scenario Resilient to Climate Change, which maximizes economic growth subject to Moderate Environment and Delta/Flood Protection constraints** (=Scenario #6 from Table 3 above). The remainder of this chapter discusses in greater detail how this Basin Development Scenario is used to create a corresponding Basin Investment Framework.

4.2 Overview of Basin Investment Framework Development Process

The ZSP is a development plan comprising a general planning tool and process for the identification, categorization and structuring of the projects and programmes for the efficient management and sustainable development of the Zambezi Watercourse. As shown in Figure 2 below, the Basin Investment Framework derives information from the three preceding deliverables and builds these into a tool that may be used to determine the opportunity and risk of financing and implementing the identified projects in the Zambezi, at both a transboundary and national scale. Importantly, it provides a critical platform for the development of the next phase of the ZSP, which in turn will provide the strategy to enable the implementation of the Basin Investment Framework.

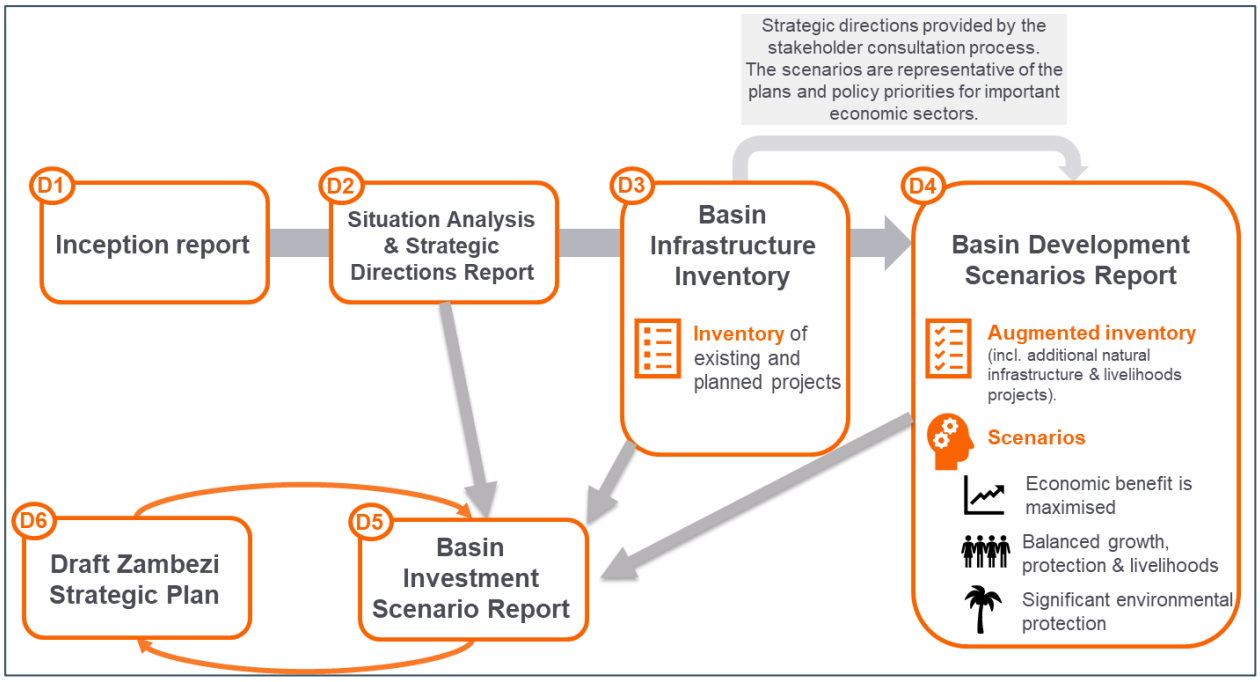


Figure 2: Linking this Basin Investment Framework to Previous Deliverables

A number of considerations need to be highlighted around the approach used to develop the Basin Investment Framework.

- Firstly, the selection of a single Basin Development Scenario, together with the observation made in the Basin Development Scenarios Report (D4) that the listed projects can be supported by the water resources in the basin (as long as cooperation enables effective management of the basin during drought periods), indicates that different investment scenarios are not appropriate and that a single Basin Investment Scenario and subsequent Basin Investment Framework is more useful. The remainder of this report follows this philosophy.
- Secondly, the diversity and scale of projects and their contributions to development, restricts the simplistic ranking for the purposes of investment. Thus, the approach has been to structure the projects into programmes that respond to the differing needs of the countries and the Basin, rather than to sequence of rank the projects (Appendix A offers information on accessing the full Infrastructure Inventory, while Appendix B provides the full project list broken down into programmatic areas). This has culminated in an envelope of investment over the next 20 years, together with the identification of specific projects that can move forward into implementation in the next decade, with information on attributes around scale, cost, returns and risks.
- Thirdly, this Basin Investment Framework is built around the platform of the Infrastructure Inventory, which is largely focused on built infrastructure, rather than the softer investments that would also be required in the ZSP. Mobilising finance for infrastructure is a critical need in the Basin and should attract specific focus, however, to a large extent it is not always the available finance that is the bottleneck, but it can also be a lack of well formulated projects. The development of the draft ZSP (D6) will bring in the enabling strategies and required investments, while limitations and possible future extensions of the Basin Investment Framework are outlined in the following sections.
- Finally, this Basin Investment Framework builds on work that has gone before, such as the Multi-Sector Investment Opportunities Analysis (MSIOA), ZAMSTRAT and the national development strategies, but has made a significant contribution in aligning the ambitions in those strategies with specific projects that have been identified on the ground.

The process to develop this Basin Investment Framework can be broken into four stages, as shown below in Figure 3.

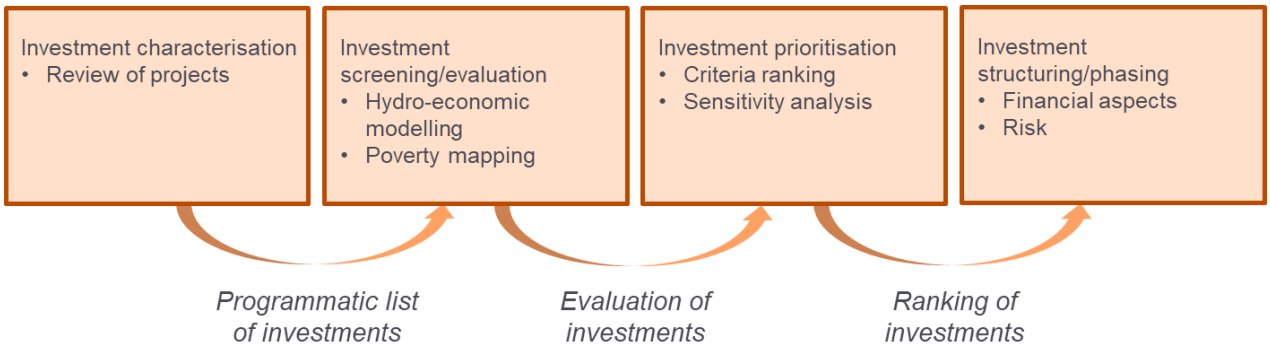


Figure 3: Framework Development Stages

- Step 1: Review and characterise projects contained in the Infrastructure Inventory, so that they can be clearly packaged from a financing perspective.
- Step 2: Preliminary hydro-economic modelling and poverty mapping to determine the ability of the basin water resources to support development at a transboundary and national scale.
- Step 3: Programmatic structuring and phasing of projects and portfolios, and evaluation against key economic and livelihoods criteria, as well as resilience to climate variability and change.
- Step 4: Investment structuring and packaging of selected projects with a focus on large transboundary investments and potential sources of finance.

4.3 Characterising Projects from the Infrastructure Inventory

To build a reliable and coherent Basin Investment Framework from the previously completed Infrastructure Inventory, the following three steps were necessary:

- First, data gaps were filled, using online primary and secondary sources (desktop research), and from discussion with stakeholders with relevant (project, sector or country) knowledge, in order to sanitise the existing Inventory and develop distinct and coherent projects.
- Second, assumptions for simplification, described in Section 4.3.2, helped simplify a complex list of potential investment opportunities, and assisted in the structuring of an initial list of over 500 projects into a coherent set of projects and portfolios.
- Third, defining and grouping of projects (discussed in Section 4.3.3) according to key characteristics was completed as the basis for the phasing, evaluation of projects against key criteria and structuring into coherent investment programmes.

It is important to recognise that this investment plan only had available financing figures for 28 billion USD worth of projects, which is less than 1,000 USD per person in the basin. This is a clear underestimate, and is representative only of the available finance related data, rather than the actual need in the basin. While this indicates a clear need to identify new developments that speak to the Inclusive Growth Scenario, it also emphasises the importance of mobilising finance to develop the Inventory's early-stage projects, that currently lack primary data on capacity, cost and location, into bankable programmes of projects. It is therefore important to note that whilst the rationalisation, structuring and prioritisation process presented in this report demonstrates a robust framework of analysis, the outcomes (Section 4.6) can only be qualified once more detailed project-level data is available.

4.3.1 Programmatic Structure for the Basin Investment Framework

The majority of the investments in the Infrastructure Inventory relate to water resources infrastructure connected to energy, agriculture and water supply (to cities, rural towns or mines). While there are a number of ways in which this infrastructure could be clustered, the Basin Investment Framework should lead to mobilising finance, and as such sectoral clustering is the most relevant. The contribution of projects towards economic growth, livelihood-related poverty reduction, environmental protection, information acquisition or flood management is then an attribute of the investment, rather than the basis for programmatic structuring. Following this, the first three programmes in the Basin Investment Framework are sectoral:

- **Programme 1:** Energy – including large and micro hydro schemes, and thermal power
- **Programme 2:** Agriculture – including commercial and small-holder schemes
- **Programme 3:** Water supply – including urban, rural, and mining supply schemes

In addition to these investments, there are a few investments in hydromet, flood management, sediment management, and catchment conservation, which are related to catchment and aquatic resources management and are typically financed together with the built infrastructure, or as part of basin governance and management programmes. As such, a fourth broad and cross-cutting programme is proposed:

- **Programme 4:** Catchment and Riparian Asset Management

The definition and imperatives for these programmes are outlined in Section 4.4 below.

4.3.2 Assumptions, Simplifications and Limitations

Putting together an investment framework is a complex process; various factors that influence the efficiency, resilience, sustainability, and equity of the plan must be considered to provide a robust approach to understanding the way in which investment can be harmonised and promoted across the basin. To be able to make sense of the vast number of projects in the list, many of which do not have adequate information to provide a solid, holistic picture, a series of assumptions and simplifications were made. This section also acknowledges some limitations with regard to the compilation of the framework, based on the scope of the original terms of reference. Many of these limitations should guide further evolutions of the Basin Investment Framework, and recommendation have been made in this regard.

Grouping Projects into Portfolios

To make sense of the many projects in the Infrastructure Inventory, some projects listed in the Inventory were grouped into "portfolios" of projects. Portfolios represent a number of projects that either fall under the same programme within a country (such as a national rural water supply) or are located in the same catchment or development area (as would be in a multipurpose catchment development plan). What makes these portfolios relevant, is that on a basin scale, they enable the simplification and clustering of the total project list into coherent investment opportunities, which would typically be financed or implemented together.

Grouping projects into a portfolio is a useful method to simplify the Inventory and offer a clearer overview of investment opportunities; however, it is acknowledged that this grouping might come with shortcomings, as in any other simplification process.

For each of the four programmes, a detailed list of the projects and portfolios has been provided at a national and transboundary level. A further detailed breakdown of the projects that have been grouped into each portfolio is presented in Annex A. In some instances, the connection between the grouped projects is clear. In other cases, assumptions have been made regarding these connections (in the project tables, asterisks signal such assumptions). Where available, the table includes a breakdown of data used to build the total portfolio value presented in the main programme tables.

A Need to Increase Livelihoods and Environmentally Focused Projects

A paper published by the Climate Resilient Infrastructure Development Facility (CRIDF) notes that, "Approximately 60% of the people of Southern Africa subsist on rain-fed agriculture in the vast forgotten rural hinterlands of the region. Rain-fed agriculture fails frequently, trapping the invisible 60% in endless deprivation and hardship. Whilst the proportion of people living in rural areas is decreasing with urban drift, the actual size of rural populations continues to increase."[30]

In the Zambezi Basin, the adoption of projects to enhance livelihoods, thus serving this 60%, and protect natural ecosystems that enable the 60%'s fundamental survival is critical. While the worth of these projects is without question, they were under-represented in this drafting of the Investment Inventory, and therefore in this Basin Investment Framework. This version is therefore primarily a water resources infrastructure-related framework, but has the scope and structure to be broader in the future.

Livelihoods and environmental protection projects encompass a wide variety of initiatives, including water infrastructure projects.[31] Although there are features of livelihood projects in each programme, for the purpose of this Basin Investment Framework, a programme entitled "catchment and riparian asset management" has also been proposed, which by its definition would have a strong livelihoods focus for the use of natural catchment land assets for rain-fed agriculture, including aspects of rainwater harvesting. A further typology of livelihoods initiatives, with a corresponding discussion on poverty-related vulnerable zones and hotspots, has been provided in Annex B as a means of capturing this important dimension. [This work

[30] CRIDF. 2015. A CRIDF+ Briefing Paper: The Invisible 60%.
[31] These can include small irrigation schemes for small-scale farmers or water supply and sanitation schemes for local communities.

was directly supported by CRIDF]. These hotspots were initially derived using desk-based analysis and GIS metadata. Subsequent workshopping with national stakeholders from key sectors (as part of the NASC consultations) drew on critical knowledge and local perspectives to enhance the narratives and project typologies. This process stimulated discussions on specific projects within this category, which would complement the larger infrastructure inventory and target core issues in the identified hotspots. Further stakeholder input is required to translate these typologies and concepts into a repository of livelihood projects eligible for external funding. As this Basin Investment Framework evolves, greater attention should be afforded to livelihoods and natural infrastructure projects. Facilities and initiatives relevant to the Zambezi basin, such as CRIDF, have identified the need to prioritise investments in water-related livelihoods-focused rural infrastructure by governments, especially water storage for productive use.[32] Future plans should aim at understanding how rain-fed agriculture is vulnerable to climate variability and change, to better identify future irrigation needs to sustain livelihoods. Similarly, there should be increasing emphasis on other livelihoods aspects, such as the role that fisheries and wetlands have in supporting rural food production, noting they are vulnerable to environmental changes impacting catchment and/or aquatic assets. This helps understand the dependency of people on a functioning Zambezi Basin system.

Supporting the invisible 60% is critical to alleviating poverty, diminishing food imports, and decreasing food insecurity in the region. The ZSP and other regional development and growth strategies should therefore fill the gaps of the present investment plan and prioritise projects supporting these populations.

The Critical Role of 'Soft' Infrastructure: A Gap in the Current Infrastructure Inventory

The sustainability of 'hard' infrastructure investments lies largely in accompanying 'soft' infrastructure interventions – such as management and institutional capacity building, development of governmental frameworks, and allocation of operational resources for data management and dissemination. These become even more pertinent within a regional context, where establishing appropriate mechanisms for joint management and cooperation is critical to the successful design and implementation of transboundary projects. Riparian States primary focus on solely hard infrastructure identification during the D3 process (Basin Development and Infrastructure Inventory Report) has resulted in a notable gap of soft infrastructure in the project list. Therefore, whilst it is recognised that a sufficiently developed portfolio of investment depends on large 'soft' projects, the identification and development of such projects extends beyond the scope of this study, and as such these interventions will need to be included in future components.

A Basin-wide Perspective on Water Availability, Flood Requirements and Ecosystem Functioning

A basin-wide perspective has been adopted for review, modelling and structuring of the investments, in line with the transboundary nature of the ZSP. The focus has been on understanding the aggregate impacts of water interventions on the Basin. For example, while examining the environmental flow and flood requirements for the Basin's rivers, wetlands and the delta, the hydro-economic model used to help evaluate the investment represents the amount of water available to enable the functioning of the Zambezi's hydrological and aquatic systems.

4.3.3 Characterisation: Objectives and Description

Using the previously developed Infrastructure Inventory, this Basin Investment Framework looked to classify investments based on a series of characteristics. There are two objectives to the characterisation process: first, it is fundamental to **simplify** the Infrastructure Inventory in order to interpret and digest it. Second, a structured and simplified list has a better chance of **appealing to financiers**. Financiers are interested in a set of key project information on which to evaluate the attractiveness of an investment. These can include:

[32] CRIDF. 2015. A CRIDF+ Briefing Paper: The Invisible 60%.

- the nature and objective of the investment – this helps investors and development funds identify whether a project speaks to their mandate;
- the project context – this helps investors understand whether a project is standalone, or whether it is part of a bigger portfolio; and
- the implementation timeline – this helps investors understand how mature the project preparation process is and how much time and investment will be required before implementation.

These parameters have been taken into account in the accompanying classifications, and inform the key criteria for framing the Investment List (see Section 4.4.2).

Maturity

The Project Development Lifecycle, as shown in Figure 4 below, has three main phases: early-stage concept development, mid-stage feasibility and structuring, and late-stage promotion and transacting. Each of the activities under the different stage is describe in Figure 4. The Basin Investment Framework draws on this Project Development Lifecycle with regard to its approach to phasing, as discussed here, and in Chapter 5 with regard to the financing of projects.

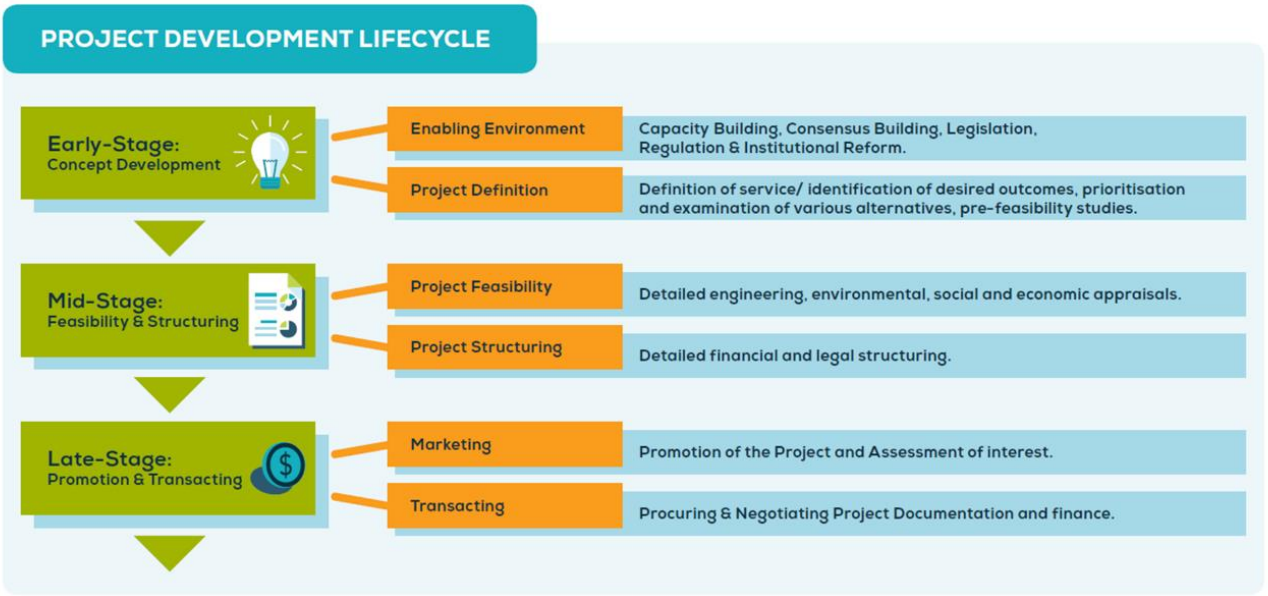


Figure 4: Project Development Lifecycle (Source: Global Water Partnership)

For the purpose of this framework, projects and portfolios have been categorised according to their completion horizon, 2018-2027 or 2028-2040. This assessment of the maturity, as it corresponds to the project development lifecycle of each project or portfolio was based on information provided in the Infrastructure Inventory, and through further desktop and stakeholder research. When no information on completion was provided in the Inventory, the projects or portfolio were examined and classified according to a set of rules, discussed below.

Projects and portfolios were grouped into the 2027 horizon provided that:

- The project was at feasibility stage when captured in the Infrastructure Inventory; and/or

- There was sufficient information on capacity and cost[33] to imply the project is either:
    - advanced enough in the project preparation process; and/or
    - of small enough scale, to be implemented in the next nine years; for example, renovation and expansion projects are often deemed feasible in this period. Similarly, small-scale water supply projects and small-scale irrigation projects (less than 1000 ha) may be implementable in the next decade; or
- The project is a national priority and is therefore likely to be implemented in the first phase.

Projects and portfolios with a 2040 horizon were deemed to be in the second phase of implementation on the basis that they are larger projects that are at early-stage project development, and thus require feasibility studies though to commissioning. This does not imply that these projects would not start now, but rather that they would need further development as they are in an early concept stage.

When a portfolio consists of a wide range of projects with different timelines for completion, or a lack of information to estimate completion horizon, these were indicated as "2027 & 2040".

Single versus Multipurpose Projects and Portfolios

A project is classified as multi-purpose when its purpose and impact fall under multiple programme areas, for example a dam that provides irrigation, hydropower and water supply. Where possible, the framework has classified these multi-purpose projects under the project's primary purpose.

Similarly, portfolios that encompass multi-purpose projects have been classified under the project's primary purpose. Certain project names in the Infrastructure Inventory indicated this multi-purpose characteristic; in other cases, data available indicated the dual nature of projects or portfolios.

Transboundary versus National Projects

In terms of international law, transboundary projects are any that have a potential impact on another country within the Basin, whether this requires joint implementation between two or more countries, or can be implemented nationally but with notification of other Riparian States.

However, following common terminology, each project and portfolio listed in the Infrastructure Inventory was classified as either national or transboundary, indicating the potential degree of sovereign autonomy or necessary joint collaboration, respectively. Transboundary (transnational joint) projects have been classified based on the following justification:

- the project or portfolio of projects is jointly implemented by two or more Riparian States;
- the project is implemented on – or abstracts water from – a shared boundary river or resource;
- the project is implemented at the national level by a Riparian State, but has significant regional benefits and requires offtake agreement; and/or
- the project is a water transfer out of the Basin.

National projects are implemented by a single Riparian State, on – or abstracting from – a national river, and benefit a single nation. While the investment plan will be a transboundary plan for the eight Zambezi Basin Riparian States, it is also important to consider the role that national projects play in supporting the overall basin development. National projects can have profound cumulative consequences on the Basin, and as such require notification. Therefore, exclusively considering transboundary joint projects would deliver a partial picture of the development plan and investment opportunities in the Zambezi.

[33] Some irrigation schemes are not costed in the inventory, but the what-if model has calculated costs based on area and cropping assumptions. Costing therefore hasn't been treated as a critical screen for irrigation projects

Moreover, national projects can be financed and/or enabled by the participation of multiple states. Multilateral cooperation for the development of national and transboundary projects across the basin is often crucial to enable resilient interventions in transboundary basins. Coordinated action is needed at both regional and national levels to effectively overcome challenges due to fragmentation of water resources and to build resilience. While acting exclusively at the national level can lead to maladaptive and non-resilient outcomes, focusing solely on transboundary projects is insufficient. Regional and national coordination is needed. Cooperative action can outweigh transaction costs and bring about efficiency gains. As cited by the World Bank, cooperation also helps countries adopt more "future-oriented" behaviour, which can lead to greater water and economic security in the longer term.[34]

Geographic Location

Different ways of defining the geographic location of the projects and portfolios were explored: using country and region, sub-basins,[35] and catchment and river nodes as points of reference. For efficiency and simplicity, the basin has been classified into three sections: upper, middle or lower basin.

- The upper basin starts at the source of the Zambezi and stops at Victoria Falls;
- The middle basin goes from the falls and ends where the river enters Lake Cahora Bassa; and finally,
- The lower basin goes from Cahora Bassa to the Indian Ocean.

In addition, projects were also associated with their location as defined on the water evaluation and planning (WEAP) system, an integrated water resources planning software used as part of the hydro-economic model.[36] Projects located in the same node have been classified in the same sub-catchment, and, it is assumed, draw water from the same source. In some cases, these catchment nodes were used to define portfolios of small distinct projects.

National Prioritization

During the compilation of the Infrastructure Inventory, Malawi, Zambia, and Zimbabwe each prioritised five national projects. Given Namibia and Botswana each had less than five projects in total, those projects were automatically deemed as national priority projects. The three remaining Riparian States – Angola, Mozambique and Tanzania – did not voice their preference, and have more than five projects on the list. During the national consultations, these three countries may want to highlight their priority projects.

4.4 Building a Framework for Project Prioritisation

4.4.1 The Hydro-Economic Model

As explained in the previously completed Basin Development Scenario Report (D4), the purpose of hydro-economic modelling is to provide context and linkages between social, hydrologic and economic components, and help to place the water resources, agricultural and energy systems in socio-economic terms.

[34] World Bank. 2017. Cooperation in International Water (CIWA) Programme, The Benefits of Transboundary Cooperation, Draft document.
[35] The sub basins are Kabompo, Upper Zambezi, Lungue Bungo, Luanginga, Barotse, Cuando/Chobe, Kafue, Kariba, Luanagwa, Mupata, Shire River – Lake Malawi/Niassa/Nyasa, Tete, Zambezi Delta.
[36] WEAP divides rivers in seven types of nodes, connected by river reaches: reservoir, run-of-river hydropower, flow requirement, withdrawal, diversion, tributary, return flow, streamflow gauges nodes.

This includes not only water mass balances to ascertain whether there is enough water present in the system to meet all the Riparian States' individual development goals, but also the estimation of costs and economic welfare gains across diverse sectors, Riparian States and stakeholders. Under previous deliverables, the team has relied on the core modelling tool "WHAT-IF" (Water, Hydropower, Agriculture Tool for Investment and Financing) - an economic assessment tool that values the use of water for food, energy and other purposes.

WHAT-IF is an optimization model with a basic assumption of full collaboration and perfect foresight under given constraints.

The model simulates the Zambezi Basin system by allocating water to various users while meeting the constraints. The model then estimates the revenues of the system as well as costs from new investments. This simulator sits inside an optimization shell that then "attempts" various build schedules until it finds the build schedule that produces the highest "value" of the system, given constraints. This "value," or optimization target, is modified based on stakeholder input and varies across or within economic sectors: agriculture, energy, among others. For example, the model can optimize total net present value (revenue minus cost) of hydropower, optimize total energy production from hydropower, or some combination of the two based on weights (i.e. multi-objective optimization). Thus, an outcome of the model may be to identify and evaluate which projects are best suited for the Investment Framework.

The different types of models that feed into WHAT-IF are explained in Figure 5 below.

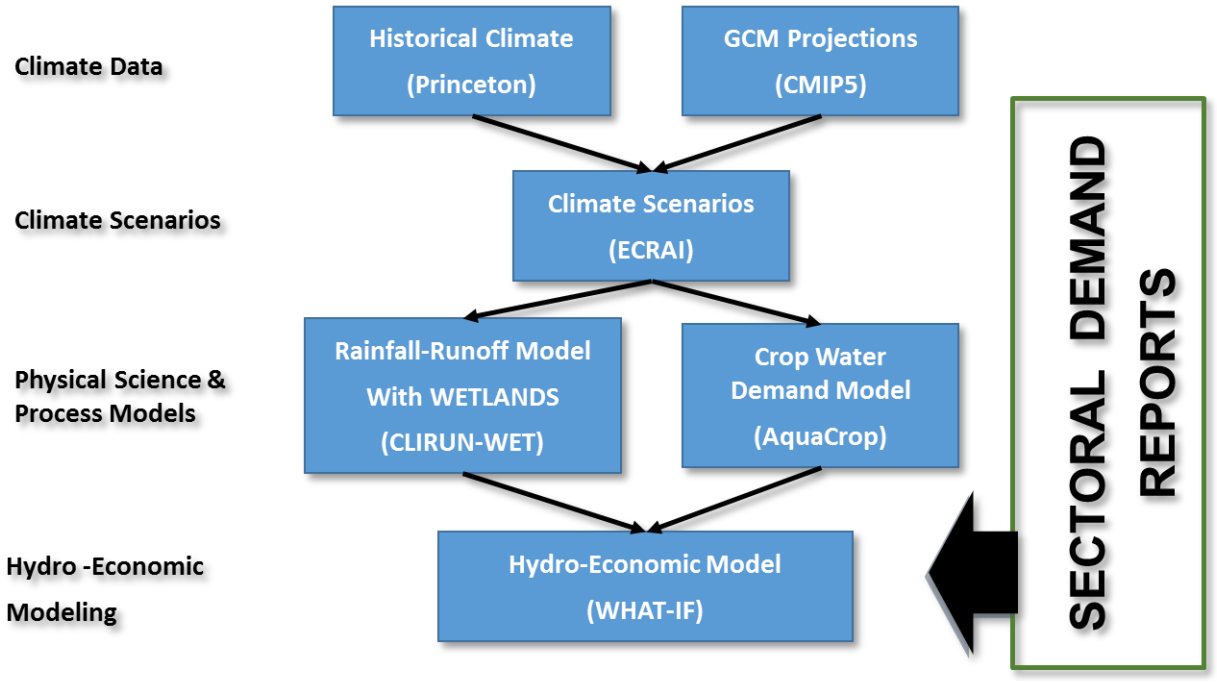


Figure 5: Framework for the Hydro-Economic Model

The WHAT-IF hydro-economic model functions as explained below:

- **Step 1:** Historical climate data and future climate projections from General Circulation Models, in the form of temperature and precipitation time series, are the first input to the modelling process. Together, these projections of precipitation and temperature form climate scenarios.

- **Step 2:** These climate scenarios are in turn inputs into: (a) a rainfall-runoff model (called CLIRUN-WET), which is used to simulate monthly runoff in each of the river basins; and (b) a crop water demand model, which projects the water requirements of the agriculture sector. The output of the rainfall-runoff model is in the form of future runoff projections while the output of the crop water demand model is in the form of future water demand projections.
- **Step 3:** These runoff and demand projections finally feed into the WHAT-IF model. The water resources systems model within WHAT-IF produces a time series of reservoir storage, reservoir releases, and allocation to the various demands in the system, which include municipal and industrial, agriculture, mining, environmental flows, transboundary flows, hydropower, and others. The WHAT-IF model produces output in the form of a range of economic, water resource, agricultural, energy and social indicators, which can then be used to compare the various Basin Development Scenarios' impact on different groups of people in each of the Riparian States.

WHAT-IF is a decision support system that facilitates putting a "value on water use", thereby supporting sustainable use of water resources in countries' development. In most other river basin planning models, water is allocated up front using fixed demands and/or prioritization schemes that satisfy some water uses before others (e.g. household use may take priority over irrigation). In the WHAT-IF representation, water is allocated according to economic optimization criteria that are based on the principles of effectiveness, efficiency and equity. In other words, water is preferentially allocated first to high value users, before then being incrementally allocated to lower value users.

The WHAT-IF model takes demands for water from diverse users and surface water availability as inputs. These inputs are routed through a river network and set of linked reservoirs (informed by current and future reservoir development plans in the Basin) to generate information on hydropower generation and unmet water demand in each sector. This produces estimates of the welfare changes associated with changes to how water is allocated between the different Riparian States and the various water-using sectors.

The model is able to calculate a range of different indicators. Given that there are many possible indicators that could be computed to track development outcomes in the Basin, a set of nine indicators was agreed upon during an interactive session of the Joint Project Steering Committee (JPSC) members, ZAMSEC and the consultant held on 27 September 2017. These indicators are listed in Table 4 below.

Table 4: Objectives and Indicators

	OBJECTIVE	INDICATOR
1	Economic Benefits	Net Present Value
2	Energy Security	Firm Energy
3	Food Security	Calories
4	M&I Water Supply	% Reliability
5	Disaster Risk Reduction-Floods	% of years over target
6	Disaster Risk-drought	Calories 90% reliability
7	Env. Protection- Delta	Flows entering Delta
8	Env. Protection- Wetlands	Wetland Areas
9	Env. Protection- e-flows	Flows at specific locations

As part of building the model, a climate change impact or vulnerability analysis was performed. The previously completed *Enhancing the Climate Resilience of Africa's Infrastructure* study developed approximately 121 climate change projections for the region. Each of these 121 scenarios is considered equally likely and can be represented by an indicator of its potential magnitude of change. The change in Climate Moisture Index (CMI) over the decade 2041 to 2050, averaged over the entire Zambezi basin, was used to select four representative future climates, which were then used in this study to demonstrate the potential vulnerabilities of the selected Basin Development Scenario to the range of projected future climates. The results of this evaluation were presented in the Basin Development Scenarios Report (D4), but for the purposes of evaluating climate change vulnerabilities and risks of projects in the Basin Investment Framework, only the Semi-wet and Semi-dry scenarios (reflecting the 25th and 75th percentile of the change in CMI, respectively) were considered - the extreme climate scenarios are less likely and are only relevant late in the 21st century.

Ultimately, WHAT-IF helps us to understand:

- Indicators rooted in the concepts of welfare economics;
- The ability of the basin water resources to achieve the development trajectories;
- Account for relevant synergies between agriculture and energy projects, as well as between hydropower and the rest of the power system; and
- Describe the different sectors' responses to changed physical and economic circumstances.

4.4.2 Criteria for Prioritising the Investment List

The development of the Basin Investment Framework is ultimately guided by six key criteria, which were presented and validated in the 14 June 2018 JPSC Meeting.

1. **Maturity**: For the purpose of this Investment Framework, projects and portfolios have been categorised according to their completion horizon, 2018-2027 or 2028-2040. This assessment of project maturity, as it corresponds to the project development lifecycle of each project or portfolio was based on information provided in the Infrastructure Inventory, and through further desktop and stakeholder research. When no information on completion was provided in the Inventory, the projects or portfolio were examined and classified accordingly.
2. **Top 5 National Priority Projects:** During the compilation of the project inventory, Malawi, Zambia, and Zimbabwe each prioritised five national projects. Given that Namibia and Botswana each had less than five projects, those projects have been deemed as national priority projects. The three remaining Riparian States – Angola, Mozambique and Tanzania – did not voice their preference, and have more than five projects on the list. During a later stage of consultation, these three countries may want to highlight their priority projects.
3. **Transboundary Impact:** Identifying projects with transnational implications requiring explicit cooperation efforts, potentially driven by/channelled through ZAMCOM. These include:
    - a project or portfolio of projects jointly implemented by two or more riparian states;
    - a project implemented on – or abstracts water from – a shared boundary river or resource;
    - a project implemented at the national level by a riparian state, but has significant regional benefits and requires offtake agreement; and /or
    - a project that is a water transfer out of the basin.

4. **Economic Return**: Based on Riparian States' expressed desire to pursue rapid economic growth, particularly focus has been paid to rates of economic return. Internal rate of return, and cost/benefit ratios are useful in understanding how each project contributes to the rapid economic growth.
5. **Resilience to Climate Variability and Climate Change**: Given the anticipated stress on the Basin due to the potential drying climate, investment decisions must be informed by a project's ability to sustain operations and planned benefits under differing climate futures. This consideration is unpacked on a programme-level basis, given differing data is required to derive a quantitative reflection of resilience per programme (detailed in Section 4.6).
6. **Contribution to Socio-economic, Livelihoods Development and Environmental Preservation:** There is clear evidence discussed in this report and in its predecessors, that a very high proportion of the population, mainly in the rural areas, is extremely vulnerable and yet enjoy very little prioritisation in terms of investments in local water infrastructure. Large programmes of small scale rural local infrastructure, together with other forms of support, have been shown to reduce the need for communities to resort to short-term coping strategies[37]. Poverty-driven catchment degradation has a direct impact on other sectors, especially agriculture and hydropower, by reducing soil fertility and reducing the storage capacity of reservoirs through high sedimentation. Therefore, investments that are able to support rural livelihoods, paying particular attention to schemes benefiting women, are critical to preserving (and where possible improving) the integrity of the natural resource base, and thus the Basin Investment Framework. A further discussion on climate resilient livelihood activities, with accompanying typologies, has been outlined in Appendix C.

The methodology of evaluation presented in the report demonstrates how one should think about each project and portfolio against the criteria. As the reader explores the next section, where an analysis of the projects and portfolios in each programme is provided, it is critical to keep these criteria in mind.

Furthermore, the list is separated in terms of the programme structure, as comparisons of the efficacy of energy over agriculture or water supply should not be made at a basin scale. Given that the modelling indicates that there is adequate water within the Basin to support the proposed investment ambitions, it is not necessary to make dramatic trade-offs between sectors. Rather an attempt has been made to identify projects within sectors and countries that achieve broader developmental objectives.

Lastly, it is critical to note, that due to the Inventory's data limitations described above, the figures derived from the hydro-economic modelling are based on assumptions, rather than hard data - **meaning the outcomes presented in 4.6 should be interpreted as *proxy* representations of the type of results this approach derives**. That is, incomplete data has been used to illustrate an effective, robust prioritisation process applicable to the Zambezi's highly complex, dynamic context. Once quality project-level information is sourced, the quantitative data and rankings in 4.6 *must* be revisited.

4.5 The Basin Investment Framework Programme Structure

The programmatic approach outlined in Section 4.3.1 above was used to simplify the Infrastructure Inventory and frame the Zambezi Basin Investment Framework and is defined more comprehensively here in terms of the imperatives for development of the Basin.

A large share of the more than 40 million people living in the Zambezi River Basin depend on the Zambezi and its tributaries for their socio-economic development.[38] As highlighted by many of the water reliant economic activities in the basin (fishing, mining, agriculture, tourism, and manufacturing, to name a few)

[37] CRIDF. 2015. A CRIDF+ Briefing Paper: The Invisible 60%.
[38] ZAMCOM River Basin Factsheet 2: Water-Energy-Food Nexus in the Zambezi River Basin. The Zambezi River Basin population was 31.7 million in 1998. Ten years later, in 2008, the population had reached 40 million, and it is estimated to reach 51 million by 2025.

continued economic benefit is underpinned by and fundamentally dependent on the Zambezi's rich water resources.

Investment in resilient water infrastructure is required to stimulate economic growth, as water is required in economic production activities. Water investments are also required to respond to that growth. Current economic growth and industrialisation will require a dramatic increase in water use in the medium and long term. The maintenance of functioning rivers, wetlands, lakes and aquifers will also be crucial to support growth and socio-economic development.

Though the Zambezi presents abundant opportunities for sustainable investment in hydropower and irrigated agriculture, in order to ensure continued economic investment, understanding the basin's water availability and reliability is critical. Moreover, understanding how each sectoral area of investment aligns with and contributes to one another (rather than viewing each area of investment in their unique sectoral silo) is critical to the shared success of the Basin.

To facilitate further investment in the Basin, particularly given this holistic, integrated lens, the four programmes indicated in Figure 6 were adopted for this Basin Investment Framework.

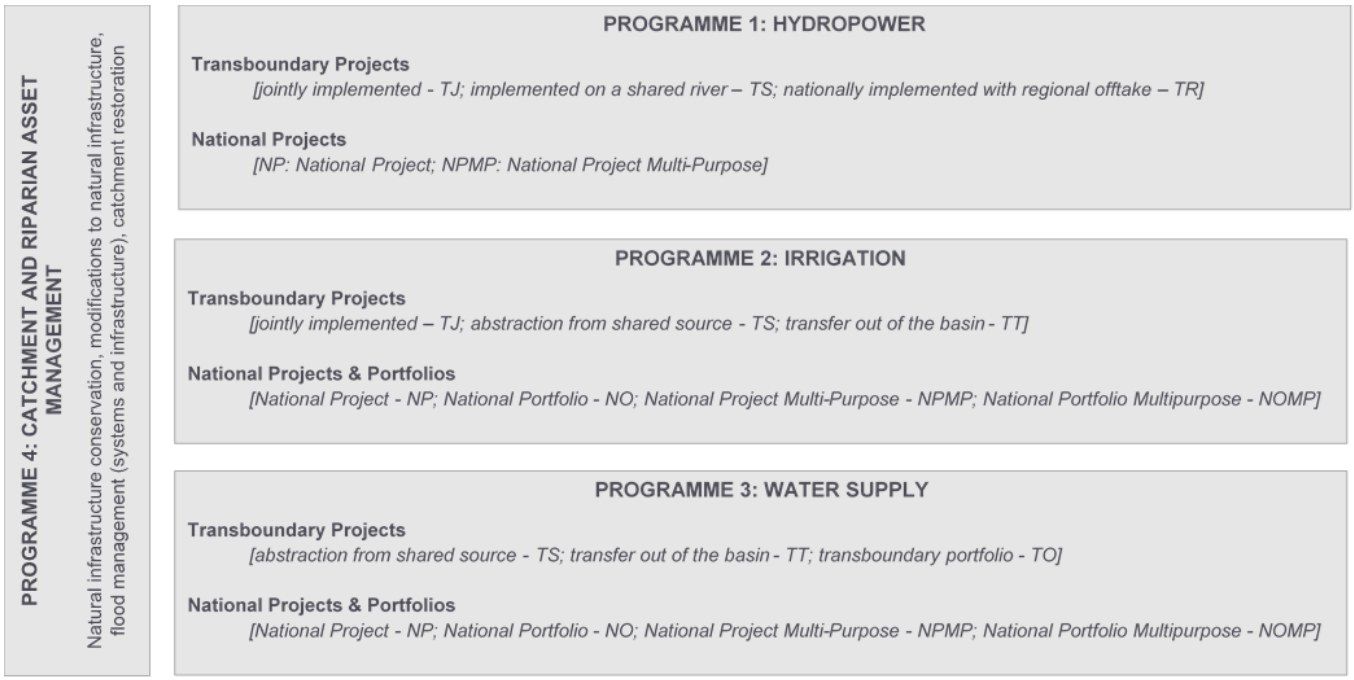


Figure 6: Programmatic Structure

4.5.1 Programme 1: Energy

Hydropower is a key catalyst to stimulate socio-economic development, as it supports the development of industry and is paramount to the electrification of households. Most Zambezi Riparian States recognise the potential of hydropower in stimulating growth in their national plans. The Southern African Power Pool (SAPP) also acknowledges this potential. The SAPP is an institution coordinating the collaboration of Southern African states in energy production to guarantee regional energy security. The SAPP comprises a diversified energy mix, including hydropower and thermal plants, both of which rely on water resources. Hydropower is a critical resource not only because it is renewable, but also because hydropower energy production is available on demand. As shown in Table 5 below, most Zambezi states are heavily dependent on hydropower to meet the needs of their population, cities, and industries.

Despite having abundant water resources, Zambezi states lack the technical and financial capacity to fully capitalize on their water resources. In the SADC region, power supply has improved, and excess power is now being generated, but inadequate transmission infrastructure and lack of funds have caused electricity deficits in some countries.[39] If no major investment is made in the energy sector in SADC, the energy deficit will have serious ramifications for local populations, as well as economic growth. With industrial productivity steadily increasing in the region, the World Bank anticipates that the demand for electricity in the SADC region will increase by 40% over the next 10 years.

Table 5: Hydropower Production in the Zambezi, per Country

Country	% of hydropower of total energy[40]	Current hydropower production in MW[41]
Angola	73.2	3,589
Botswana[42]	0	0
Malawi	98.4	897
Namibia	93.9	2,100
Mozambique	98.9	330
Tanzania	27.2	3,141
Zambia	93.3	14,042
Zimbabwe	66.2	978

With appropriate investment in hydropower as part of a renewable energy mix, the Zambezi Basin can meet growing domestic and industrial demand. The Basin has enormous potential for hydropower development; according to the World Bank, "with cooperation and coordinated operation of the existing hydropower facilities found in the Basin, firm energy generation can potentially increase by seven percent, adding a value of $585 million over 30 years with essentially no major infrastructure investment." In that scenario, average energy production would reach approximately 60,000 GWh/year, thereby meeting all or most of the estimated 48,000 GWh/year demand of the Riparian States.

Energy projects in the framework, as shown in Table 6 below: Nine transboundary, and 18 national energy projects have been identified.

[39] The Financial Gazette, SADC plugs power deficit, https://www.financialgazette.co.zw/sadc-plugs-power-deficit/
[40] Africa Energy Commission, 2015, https://www.afrec-energy.org
[41] World Bank. 2010. The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis: Vol 1, Summary Report.
[42] Ofetotse, L., and Essah, E. 2012. Botswana generates energy mainly from coal and imports electricity from South Africa. Energy Overview of Botswana – Generation and Consumption, In: Laryea, S., Agyepong, S.A., Leiringer, R. and Hughes, W. (Eds) Procs 4th West Africa Built Environment Research (WABER) Conference, 24-26 July 2012, Abuja, Nigeria, 1011-1021.

Table 6: Summary of the Energy Investments

PROGRAMME 1: ENERGY

Transboundary Projects *[jointly implemented - TJ; implemented on a shared river – TS; nationally implemented with regional offtake – TR]*

Country(ies)	Name	Transboundary type	Capacity (MW)	Implementation Horizon	Primary Mix of Benefits		
					Econ	Livelihood	Priority
Malawi, Tanzania	Songwe River Basin Development Programme: Hydropower	TJMP [IG, WS]	180	2027	X		X
Mozambique	Cahora Bassam 1	TR	850	2027	X		
Mozambique	Mphanda Nkuwa	TR	1500	2027	X		
Zambia (Zimbabwe)	Devils Gorge	TJ	1240	2027	X		X
Zambia (Zimbabwe)	Mupata Gorge	TJ	543	2027	X		
Zambia, Zimbabwe	Batoka Gorge	TJ	1600	2027	X		X
Zimbabwe	Kariba South	TS	750	2027	X		
Zimbabwe	Kariba South extension	TS	300	2027	X		X

National Projects *[National Project - NP; National Project Multi-Purpose: NPMP (FI – Flood Management, WS – Water Supply, Irrigation – IG; Hydropower - HP)]*

Country	Name	Project Type	Capacity (MW)	Implementation Horizon	Primary Mix of Benefits		
					Econ	Livelihood	Priority
Angola	Luanguinga 2	NP	2,35	2027		X	
	Lucula (Bunda)	NP	0,88	2027		X	
	Luizavo/Cazombo	NPMP [IG]	37,8	2027		X	
	Tchafinda 2	NP	4,59	2027		X	
Malawi	Kholombidzo	NP	240	2027	X		
	Lower Fufu	NP	100	2027	X		
	Tedzani	NP	88	2027	X		
	Upgrading Kazumu Barrage	NPMP [FI]	-	2027	X		X
Mozambique	Benga Coal Mines And Thermal Power Stations	NP		2027	X		
Tanzania	Rumakali	NPMP [IG]	222	2027	X		
Zambia	Lunsemfwa Mulungushi	NP	255	2027	X		
	Lusiwasi	NP	84	2027	X		
	Upgraded Maamba Colliery	NP		2027			
Zimbabwe	Gokwe Thermal Power Station	NP		2027			

As previously indicated, this list of projects is an important foundation for each programme area, but it is not exhaustive. It is also important to start building an understanding of what representative projects could be in each programme area, with both a livelihoods lens, as well as an overarching programmatic one.

Representative Projects

Below are three representative projects for the Energy Programme. Each of the projects will be financed in its own way, with the appropriate corresponding institutional and legal arrangements. Case studies of the representative projects can be found in Chapter 6.

- Large, joint infrastructure on a shared source;
- A large hydropower in a country exporting to a grid; and
- Small micro hydropower supporting the country and not in the main grid.

Livelihoods Representative Projects

- **Off-grid small-scale hydropower generation**, for household and productive use in remote locations –negating the need for (and reliance on) grid energy and reducing extensive fuelwood and charcoal production (thus reducing biomass, increase soil erosion, sedimentation and evapotranspiration).
- **Solar power generation for household and productive use**. Whilst not directly linked to the hydropower programme, expanding alternative sources of off-grid power increases the capacity of the power pool, and ultimately reduces the dependency on water for power generation.

4.5.2 Programme 2: Agriculture

Most people in the basin rely on agriculture to sustain their livelihoods. Roughly 5.2 million hectares of land are cultivated throughout the basin; 85% of that surface is located in Zimbabwe, Zambia and Malawi. Agriculture practices are central to guarantee food security and achieve the sustainable development goal of Zero Hunger.[43] Agriculture is also critical to enable sustainable economic growth.

About 96.5% of agricultural activity (by area) in the basin is rain-fed and the majority of this is smallholder farming in which two thirds of the population is engaged. Rain-fed agriculture is consequently a far higher cumulative 'user' of water than irrigated agriculture in the basin although this water, being rain-fed, is not included in the runoff-based hydrological balance of the Basin. Improving rainwater capture and storage, and improving soil moisture capture and retention through improved rain-fed agriculture techniques provides the greatest promise for poverty reduction, food production and resilience for the highest number of people in the Basin. There are, however, very few investment projects aimed at supporting rain-fed agriculture, particularly at smallholder level, in the Infrastructure Inventory of national plans.

Rain-fed agriculture has its associated challenges, as it is vulnerable to climate variability and change. Rainfall variability within the Basin is fundamentally linked to agricultural productivity and the primary cause of poverty related vulnerability. Throughout the Basin, climate change is expected to increase variability, and modify the frequency and intensity of rainfall, droughts and floods. Population growth will add additional pressure on agricultural practices to guarantee food security.

Irrigated agriculture increases the resilience of crops to long periods of aridity and droughts and thereby increases food security. Irrigated agriculture also allows for crop diversification, and for the production of high value crops such as sugarcane. Sugarcane covers most irrigated fields in the Basin, followed by perennial crops and cereals. Irrigation helps increase crops productivity, and irrigated fields are usually more profitable to farmers then rain-fed fields.

Agriculture projects in the framework, as shown in Table 7 below: Ten transboundary, together with 46 national agriculture projects or portfolios have been identified.

[43] WWF and ABinBev. 2017. Africa's Watershed Moment How Better Water Management Can Underpin Africa's Development.

Table 7: Summary of Agriculture Projects

PROGRAMME 2: AGRICULTURE

Transboundary Projects *[jointly implemented – TJ; abstraction from shared source - TS; transfer out of the basin – TT; Multipurpose – MP]*

Country(ies)	Name	Transboundary type	Area (ha)	Implementation Horizon	Primary Mix of Benefits		
					Econ	Livelihood	Priority
Malawi, Tanzania	Songwe River Basin Development Programme: Irrigation & Water Supply & additional social infrastructure	TJMP [WS]	6189 [950Mm^3]	2027	X	X	X
Zambia, Zimbabwe	Mid-Zambezi Delta Agricultural Water Management for Food Security Program*	TS	2956	2027	X	X	
Zimbabwe	Bulawayo-Zambezi Transfer Scheme*	TTMP [WS]	6500 [870Mm^3]	2027	X	X	

National Projects & Portfolios *[National Project - NP; National Portfolio - NO; National Project Multi-Purpose - NPMP; National Portfolio Multipurpose - NOMP]*

Country	Project or Portfolio Name *[see Annex 1 for portfolio details]*	Project/Portfolio Type	Area (ha)	Implementation Horizon	Primary Mix of Benefits		
					Econ	Livelihood	Priority
Angola	Cazombo/Lumbalo Nginbo Rice Irrigation Project	NPMP [HP]	5000	2027	X		
	Planned Small Irrigation Development with The Perimetro De Luena Model	NP	500	2027	X		
	Planned Sugarcane Irrigation Project	NP	5000	2027	X		
Malawi	Irrigation Schemes in Lower Shire*	NO	1878	2027	X	X	
	Irrigation Schemes in Upper Shire*	NO	2166	2027	X	X	
	Mombezi Multipurpose Dam	NPMP [WS]	500 [69.5Mm^3]	2027	X	X	X
	Diamphwe Multipurpose Dam	NPMP [WS]	1000 [140Mm^3]	2027	X		X
Mozambique	Rehabilitation of Irrigation Schemes*	NO	6710	2027	X		
	Luenya Irrigation Schemes*	NO	12140	2027	X		
	Lipaque Irrigation Scheme	NP	300	2027	X		
Namibia	New Small/Medium Irrigation Schemes	NO	300	2027	X	X	X
Tanzania	Ruhuhu Valley Irrigation Scheme (incl. Kikonge Hydro)	NPMP [HP]	4000 [330MW]	2027	X	X	
	Rumakali Irrigation Schemes* *Only schemes with known hectarage have been included in this portfolio for 2027 implementation horizon- see Annex 1 for schemes w. hectarage*	NOMP [HP]	5249	2027	X		
	Irrigation Schemes in Njombe* *Only schemes with known hectarage have been included in this portfolio for 2027 implementation horizon- see Annex 1 for schemes w. hectarage*	NO	620	2027	X		
	Nyasa Irrigation Schemes* *Only schemes with known hectarage have been included in this portfolio for 2027 implementation horizon- see Annex 1 for schemes w. hectarage*	NO	3020	2027	X		
Zambia	Cotton Development Trust on The Magoye River	NP	160	2027	X		
Zimbabwe	Mazowe/Luhenya Dams*	NOMP [WS, mini-HP]	3000 [633Mm^3]	2027	X		
	Kudu Dam	NPMP [HP]	30000 [1.5Bm^3, 9.9MW]	2027	X		X
	Amapongokwe	NPMP [WS]	350	2027	X		
	Dande Dam & Tunnel	NPMP [WS, mini-HP]	4000 [2.29Mm^3, 1MW]	2027	X		
	Tshatshani Scheme	NP	319	2027	X		
	Rehabilitation/Optimization of the use of Reservoirs (concerning 20% of the equipped area) *	NO	4584 *(20% of total area: 22 921)*	2027	X		

As previously indicated, the list of projects is an important foundation for each programme area, but it is not exhaustive. It is also important to start building an understanding of what representative projects could be in each programme area, with both a livelihoods lens, as well as an overarching programmatic one.

Representative Projects

Below are three representative projects for the Agriculture Programme. Each of the projects will be financed in its own way, with the appropriate corresponding institutional and legal arrangements. Case studies of the representative projects can be found in Chapter 6.

- Joint transboundary agriculture projects, like the Songwe;
- Big abstractions from joint infrastructure (Kariba); and
- Agriculture projects that are either commercial or smallholder, linked to multipurpose schemes.

Livelihoods Representative Projects

- **Sustainable rain-fed agriculture**, through the provision of accessible and sufficient storage and localised distribution facilities to bridge variations and mitigate risks during periods of low rainfall.
- **Small-scale irrigation**, using technology suited to local water availability and climate (e.g. channels, drip irrigation, tunnels, hydroponics, etc.) – with the intention of improving quality, quantity, diversity and consistency of produce to allow farmers to move beyond subsistence horticulture.
- **Climate smart agriculture practices**, adopting appropriate cropping schedules/rotations and modern agronomy techniques to optimize water usage and maintain the integrity of the soils. e.g. low/no-till.

4.5.3 Programme 3: Water Supply

The national development plans of Riparian States all address rural poverty, and the need to improve living conditions and service delivery in order to trigger inclusive growth. Better access to water supply in urban and rural settings is key to meeting these objectives.

Water supply projects use water for industrial use, domestic supply and sanitation, or transfers out of the basin, amongst other uses.[44] Water supply projects are important to support socio-economic development, as they are meant to provide access to clean water to the population, but also support industrial development. Industries depend on water for energy and production processes, as water can be a component or cooling liquid. Industries account for an important share of the gross domestic product (GDP) of Zambezi countries, a number that is growing. Table 8 below demonstrates this.

Table 8: Industries in the Zambezi River Basin

	Angola	Bots.	Malawi	Moz.	Namibia	Tanz.	Zambia	Zim.
GDP for industry (billion USD) (2017)	124	39.55	22.47	37.39	27.02	162.8	68.9	33.87
% of total GDP (2017)	61.4%	29.5%	15.6%	23%	25.8%	28.6%	35.6%	26.9%
Industrial prod growth rate	1.9%	3%	1.2%	10.5%	2.2%	8.8%	5.1%	2.1%

While the industrial sector currently accounts for less than 5% of water withdrawals in Africa,[45] that number will increase as African states pursue industrial development strategies. African economies are in the process of a structural transition from the primary to secondary and tertiary sectors. In North America and Europe, for example, the industrial sectors account for 47% and 54% of water withdrawals respectively.[46]

Water supply is also crucial to the development of cities, which are in turn vital to economic development. The Zambezi Riparian States' urban growth rate currently ranges between 1.4 and 5% (2017 numbers). According to projected rates of urbanisations, as shown in Table 9, the urban population will exceed the rural population of Sub-Saharan Africa by about 2040. Cities will, thus, be the drivers of economic growth, trade and diversification.

[44] Under the water supply category, we have also classified dam projects with no hectarage.
[45] Food And Agriculture Organisation, Nov 2016, AQUASTAT: Water withdrawal by sector, around 2010, http://www.fao.org/nr/water/aquastat/tables/WorldData-Withdrawal_eng.pdf
[46] Food And Agriculture Organisation, Nov 2016, AQUASTAT: Water withdrawal by sector, around 2010, http://www.fao.org/nr/water/aquastat/tables/WorldData-Withdrawal_eng.pdf

Table 9: Urbanisation in the Zambezi River Basin

	Angola	Bots.	Malawi	Moz.	Namibia	Tanz.	Zambia	Zim.
Urbanisation rate	4.6%	1.38%	4.02%	3.36%	3.63%	5%	4.35%	2.44%

Water supply projects in the inventory, as shown in Table 10 below: Four transboundary, and ten national projects and portfolios have been identified.

Table 10: Water Supply Projects

PROGRAMME 3: WATER SUPPLY

Transboundary Projects *[abstraction from shared source; transfer out of the basin; transfer into the basin]*

Country(ies)	Name	Transboundary type	Transfer volume or Storage (Mm^3)	Implementation Horizon	Primary Mix of Benefits		
					Econ	Livelihood	Priority
Angola, Botswana, DRC, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe	Water Supply and Sanitation To 12 Locations *sourced from SADC RIDMP – completion date is 2020; likely already under implementation.	TO	-	2027	X	X	
Botswana	Utilization of the Water Resources of the Chobe/Zambezi River *new project added due to regional significance; linked to Irrigation project: *Zambezi Integrated Agro-Commercial Development Project*	TT & TS MP	495Mm^3/annum	2027	X	X	X
Malawi	Lake Malawi Water Project	TS	-	2027	X	X	
Zambia	Kafue - Luapula Water Transfer Scheme	TT	-	2040	X		X

National Projects & Portfolios *[National Project - NP; National Portfolio - NO; National Project Multi-Purpose - NPMP; National Portfolio Multipurpose - NOMP]*

Country	Project or Portfolio Name *[see Annex 2 for portfolio details]*	Project/Portfolio Type	Storage (Mm^3)	Implementation Horizon	Primary Mix of Benefits		
					Econ	Livelihood	Priority
Angola	Water Supply Schemes in the Cuando*	NO	-	2040	X		
Mozambique	Luia Dams 1, 2, 3	NOMP [IG, FI]	21.2	2027	X		
	Revubue Condezi Dams & Irrigation Schemes*	NOMP [IG, FI]	56.2	2027	X	X	
Tanzania	Town Water Supply Improvement Schemes in Shire Catchment*	NO	-	2027	X	X	
	Muira Dam	NP	2000	2040	X		
Zambia	Water Supply and Sanitation Improvement for Cities and Towns*	NO	-	2027	X	X	
	Integrated Small Town Water Supply and Sanitation Schemes for Western Province	NO	-	2027	X		
	Dams in Kafue*	NOMP [IG]	-	2027	X		
Zimbabwe	Sanyati Dams*	NOMP [HP]	333	2027	X		
	Kunzvi Dam	NP	146	2040	X		X

As previously indicated, the list of projects is an important foundation for each programme area, but it is not exhaustive. It is also important to start building an understanding of what representative projects could be in each programme area, with both a livelihoods lens, as well as an overarching programmatic one.

Representative Projects

Below are three representative projects for the Water Supply Programme. Each of the projects will be financed in its own way, with the appropriate corresponding institutional and legal arrangements. Case studies of the representative projects can be found in Chapter 6.

- Large abstractions for urban water supply from the mainstem river;
- Small, rural distributed water supply; and

- Large multipurpose initiatives.

Livelihoods Representative Projects

- **Assured water supply for domestic and small-scale productive use**, noting different sources (ground vs. surface water), infrastructure, governance and tariffing/payment mechanisms will be required for urban, peri-urban and rural areas

4.5.4 Programme 4: Catchment and Riparian Asset Management

Catchment management aims to adequately manage naturally occurring water within a catchment area by managing or accounting for all aspects of the hydrological cycle. In other words, catchment management is balancing the use and conservation of natural resources on a catchment basis. A body of evidence shows that catchment management practices help improve the quality of water. Managing catchment can be a cost-effective way to reduce water treatment and purification costs to produce potable water. Other benefits of catchment management practices include the protection of biodiversity and the management of floods. Protecting biodiversity leads to a better provision of ecosystem goods and services, which are often crucial to local communities for food provision and to support livelihood activities. Catchment management can also help improving a catchment's carbon storage capacities.

This category of projects includes hydrometric stations, reservoirs for structural flood protection and sediment management, navigation projects, as well as knowledge enhancement and information system projects. Information gathering and management systems (including hydrometric stations) and flood protection systems are crucial to protect environment, livelihoods and economic activities. Floods in the Zambezi destroy natural and man-made infrastructure and disrupt economic activities.[47] Sediment management projects also help prevent deterioration of infrastructure downstream, such as water supply schemes or hydropower stations.

Catchment and riparian asset management projects in the inventory, as shown in Table 11 below: Four national projects have been identified.

Table 11: Summary of Catchment and Riparian Asset Management Projects

PROGRAMME 4: CATCHMENT AND RIPARIAN ASSET MANAGEMENT

Projects & Portfolios *[National Project - NP; National Portfolio – NO]*

Country	Project or Portfolio Name *[see Annex 3 for portfolio details]*	Project/Portfolio Type	Implementation Horizon	Primary Mix of Benefits		
				Econ	Livelihood	Priority
Angola	Hydrometric Stations*	NO	2027	X		
Mozambique	Cahora Bassa Reservoir - Structural Flood Protection Interventions*	NO	2027	X	X	
	Cahora Bassa Reservoir - Sediment Management – Investments in Bottom Outlets	NP	2027	X	X	
Tanzania	Enhanced Knowledge and Information System - Phase II	NP	2027	X		

Representative Projects

[47] For example, in 2015, the south of Malawi and central Mozambique (along the Shire river) were affected by devastating floods caused by heavy rainfalls following Cyclone Bansi. These were disrupted industrial activities and affected economic growth in the Shire Basin and throughout Southern Africa.

Projects in this programme need to be linked to other infrastructure, and they need to be cross-cutting. These projects have a more explicit livelihood focus and have therefore been merged with the representative project section. Some representative projects are:

- Flood management, through:
    - Early warning flood systems that can be managed, interpreted and communicated by local communities.
    - Dyke construction and related flood protection infrastructure, as appropriate.
    - Aquatic ecosystem management/enhancement, promoting fisheries and related aquaculture activities (including harvesting reeds and herbs for medicinal purposes).
- Woodland management and forestry restoration, protecting, and promoting sustainable use of, woodland resources and forests through the provision of assured, alternative energy sources.
- Maintaining and/or recovering wildlife corridors and dispersal areas, by identifying opportunities for local communities to accrue direct benefits from wildlife and surrounding protected/conservation areas through increased participation in formal tourism value chains. Critical to this is improved land use planning (i.e. ensuring irrigation schemes do not encroach on wildlife corridors), which will reduce human wildlife conflicts and maintain the integrity of the ecosystem.
- Catchment restoration and management, through interventions such as agroforestry, erosion control, terracing and buffer strips.
- Green infrastructure, such as wetland health restoration, increased green and blue space in urban areas, riparian buffers, etc.
- Urban food security interventions, through low-water use vertical food gardening in urban areas.

4.5.5 Summary of Costs in the Programme Investment Framework

Although each programme is a comprehensive sanitised representation of the previously developed Infrastructure Inventory provided in D3, this Basin Investment Framework should be treated as a living inventory of the projects and portfolios in the Basin, against programmes that may attract different sources of finance.

The total costing for each programme (where data is available) is listed in Table 12 and Table 13 below, inclusive of portfolios and programmes in Phase 1 and Phase 2. Total costing figures are not yet available for a number of projects in Programmes 1, 2 and 3, as well as for Programme 4. Moreover, further costing research can be done into Programmes 1 and 2 in order to understand the estimated costs associated with identified projects at early phase development, as well as infrastructure needs that may not be present in the Inventory but have been implied through national development trajectories.

Table 12: Summary of Available Costs 2027

	CapEx (million USD)
Energy	
Transboundary projects	11 360
National projects	1 704
Agriculture	
Transboundary projects	67
National projects	455
Water Supply	
Transboundary projects	68
National projects	60
Catchment and Riparian Assets Management	
Transboundary projects	-
National projects	-
TOTAL COSTS	**13 714**

Table 13: Summary of Available Costs 2040

	CapEx (million USD)
Energy	
Transboundary projects	19 384
National projects	7 158
Agriculture	
Transboundary projects	55
National projects	549
Water Supply	
Transboundary projects	1 068
National projects	60
Catchment and Riparian Assets Management	
Transboundary projects	-
National projects	-
TOTAL COSTS	**28 274**

4.6 Identifying Key Projects for Phase 1 of the ZSP

The framework for project prioritisation (detailed in Section 4.4) has been applied to the programmatic structure using the six prioritisation criteria previously defined in Section 4.4.2: maturity; national priority; transboundary impact; economic return; resilience to climate variability and climate change; and contribution to livelihoods development and environmental preservation.

These criteria are informed by a range of quantitative and qualitative information drawn from the existing Infrastructure Inventory, hydro-economic modelling results, and additional desk-based research:

- **Maturity**: The framework prioritises projects which are more mature in their preparation, i.e. they often have feasibility studies attached to them or have been indicated by countries that they are 'implementation ready.' These projects are therefore more likely to be implemented in the near

term, and therefore may be driven forward in the 2027 horizon. All projects that have been presented as part of Phase 1, projects to be implemented in 2027, have been identified in Section 4.6.1. Although many of the projects in Phase 1 have completed feasibility studies, further costs will also be incurred in preparing these projects to receive funding and begin implementation.[48]

- **National priority:** The 'top 5' projects identified by Riparian States are considered investment priorities (noting that this information has not been provided consistently by all eight countries, with inputs still required from Angola, Mozambique and Tanzania).
- **Transboundary impact:** Whilst the transboundary nature of a project can be interpreted with relatively high-level information, the extent of its transboundary implications can only be defined during a detailed feasibility study, meaning this criterion is not reflected in the key programme tables below.
- **Economic return:** Internal rate of return (IRR) has been derived from the hydro-economic model's calculations, using the project's estimated capital cost, and based on the control period. Where capital cost data is lacking, this criterion is incomplete. An IRR is considered low if ranging between 0 and 5%, medium if ranging between 5 and 15%, and high if above 15%.
- **Resilience to climate variability and climate change:** This criterion assesses a project's resilience under differing future climate scenarios – considering both climate variability and change. The data used to derive and rank these values differs for energy and agriculture programmes. For energy projects, we compare the firm power under different scenarios to develop each indicator (climate vulnerability and change indicators). For irrigation projects, we compare the IRR under different scenarios to develop each indicator (climate vulnerability and change indicators). Further clarifications can be found in footnotes of the relevant tables below (Table 14 through 17). The following ranges have been adopted for comparison purposes: a ratio between 0-30 is considered an indicator of very low resilience to climate variability or change; between 30 and 50, low; between 50 and 70, medium; between 70 and 90, high; and, finally, between 90 and 100, the resilience of a project is considered very high.
- **Contribution to livelihoods development and environmental preservation:** This criterion examines the project's contribution to livelihood and ecosystem enhancements, thereby contributing to overall poverty reduction. In order to determine this, the project requires localised analysis, typically conducted at feasibility stage[49]. This criterion is therefore not reflected in the key programme tables below.

Figure 7 shows a schematic representation of the prioritization criteria as applied to the first phase (2017 – 2027) of the projects currently captured under the ZSP.

[48]Project preparation is a critical phase in a project's lifecycle, concerned with transforming an idea or concept into a viable, fully-defined, structured, bankable, and ultimately financed and sustainable initiative. Data collected from previous projects show preparation costs can amount to as much as 10% of overall development costs. Large hard infrastructure projects typically incur higher preparation costs due to the need for detailed engineering assessment and design, and for these initiatives the estimate is at the upper-end of the range, up to 10%. On the other hand, project preparation costs for Knowledge Systems and Information Management projects, which do not require intensive feasibility processes, should be projected at 2.5%.

[49] Addendum B provides a high-level indication of livelihoods' responses appropriate to areas of the basin, but extensive ground-truthing is required to inform the identification and anticipated impact of specific interventions.

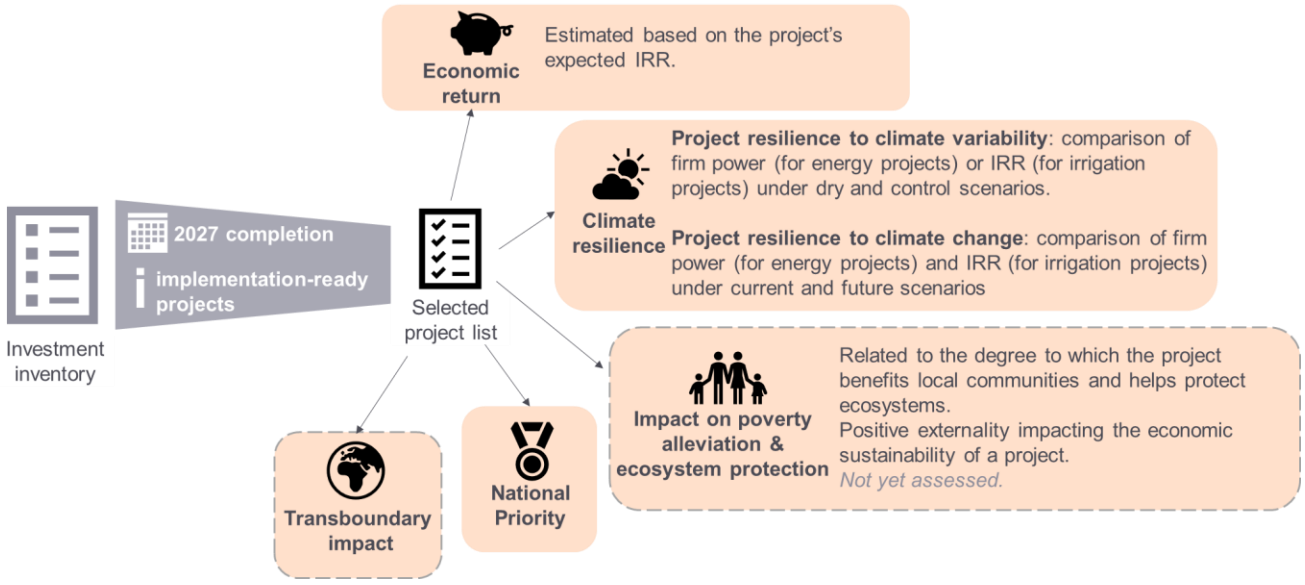


Figure 7: Criteria for Prioritisation

It must be re-emphasised that the outcomes presented in this section are derived based on assumptions rather than hard data and are therefore proxy representations of prioritised programme lists; it is therefore critical that they be revisited once further project-level information is sourced.

4.6.1 Details of the 2027 Priority Project List

Programme 1: Energy

As shown in Table 14, the energy project information includes proposed generation capacity, estimated capital cost, IRR (from the hydro-economic model's calculations, based on the control period), climate variability resilience indicator (% of firm power produced in the driest decade compared with firm power produced under climate associate with the median hydrological decade) [50] and climate change vulnerability indicator (% of firm power produced under the semi-dry climate scenario compared with firm power produced under current climate). [51]

Table 14: 2027 Priority Projects from Programme 1- Energy

Location	Name	Type	Capacity (MW)	CAPEX (million USD)	IRR	Climate variability resilience	Climate change resilience	National priority
Mozambique	Cahora Bassa 1	TR	850	786	High	Medium	Low	
Mozambique	Mphanda Nkuwa	TR	1500	2 467	High	Medium	Medium	
Zambia (Zimbabwe)	Devils Gorge	TJ	1240	1 750	High	Very high	Very high	✓
Malawi, Tanzania	Songwe River Basin Development	TJMP [IG, WS][53]	180	550	High	High	High	✓

[50] The climate variability resilience indicator compares firm hydropower production under s027 (2039-2048 under current climate) and under s025 (2035-2044, current climate).
[51] The climate change resilience indicator compares firm hydropower production under s027 and s007 (2016-2025 under a semi dry climate). The comparison is presented in the form of a percentage variation value.
[53] Due to the significance (in scale and cost) of the other multipurpose components of the Songwe River Basin Development Project, they are included as a standalone multipurpose project linked to this hydropower component in the Agriculture table below, Table 15.

Location	Name	Type	Capacity (MW)	CAPEX (million USD)	IRR	Climate variability resilience	Climate change resilience	National priority
	Programme: Hydropower[52]							
Zambia (Zimbabwe)	Mupata Gorge	TJ	543	1 215	High	Very high	Very high	
Zambia, Zimbabwe	Batoka Gorge	TJ	1600	3 004	High	High	High	✓
Zimbabwe	Kariba South	TS	750	1 738	Medium	Very high	Very high	
Zimbabwe	Kariba South extension	TS	300	400	High	Very high	Very high	✓
TOTAL TRANSBOUNDARY			6 963	11910				
Angola	Luanguinga 2	NP	2,35	-				
	Lucula (Bunda)	NP	0,88	-				
	Luizavo/Cazombo	NPMP [IG]	37,8	-				
	Tchafinda 2	NP	4,59	-				
Malawi	Kholombidzo	NP	240	291	High	High	Very high	
	Lower Fufu	NP	100	135	High	High	High	
	Tedzani	NP	88	204	Medium	Very high	Very high	
	Upgrading Kamuzu Barrage	NP						✓
Mozambique	Benga Coal Mines and Thermal Power Stations	NP						
Tanzania	Rumakali	NPMP [IG]	222	570	Medium	Low	Very high	
Zambia	Lunsemfwa Mulungushi	NP	255	340	High	Very high	Very high	
	Lusiwasi	NP	84	164	Low	High	High	
	Upgrading Maamba Colliery	NP						
Zimbabwe	Gokwe Thermal Power Station	NP						
TOTAL NATIONAL			989	1 704				
GRAND TOTAL			**7952**	**13614**				

Note: TJ= Jointly implemented; TS= Implemented on a shared river; TR= Nationally implemented with regional offtake; TT= Transfer out of the basin; MP= Multipurpose; NP= National Project; NO= National Portfolio; NPMP= National Project Multipurpose; NOMP= National Portfolio Multipurpose; HP= Hydropower; IG= Irrigation; WS= Water Supply

Programme 2: Agriculture

As shown in Table 15, the agriculture project information includes proposed irrigated area, estimated capital cost, IRR (from the hydro-economic model's calculations over the control period), climate variability resilience indicator (% of NPV in the driest decade compared with NPV under climate associate with the median hydrological decade)[54] and climate change resilience indicator (% of NPV under the semi-dry climate scenario compared with NPV under current climate).[55]

The modelling results indicate that under current climate, and with moderate level of environmental protection, there is, on average, enough water in the Basin to satisfy the irrigation water demand of all projects

[52] The IRR, climate variability resilience, and climate change resilience indicators for Songwe were modelled as a single programme under irrigation. The same numbers were used for Songwe as a hydropower project.
[54] The climate variability resilience indicator compares IRR under s027 (2039-2048 under current climate) and s025 (2035-2044, current climate).
[55] The climate change resilience indicator compares IRR under s027 and s007 (2016-2025 under a semi dry climate).

in the Infrastructure Inventory.[56] The model also predicts that the water demand of all water projects will be satisfied during very dry periods, both under current climate and under a future dry climate scenario. The IRR of each project under different climates or at different periods of time therefore remains constant, illustrating the relatively high resilience of agriculture in the Zambezi.

However, these findings should be nuanced, as the model is based on several assumptions that require further interrogation. It assumes that all irrigation projects will be connected to the main river stem or one of its main tributaries, which may not be the case for several of the irrigation projects in the Infrastructure Inventory list. The assumptions on water availability at the Basin level can therefore only be used as a guiding principle. It is absolutely critical that pre-feasibility and feasibility studies for the irrigation projects are conducted in order to assess the specific water risk for each project, based on its location and size, amongst other factors.

Moreover, it must be noted that that having "enough water" in the system does not mean that water users in the Zambezi will never face water shortage; water availability varies widely in time and space. As future water infrastructure projects are added to the Basin, basin-wide planning and joint cooperation is absolutely critical.

Table 15: 2027 Priority Projects from Programme 2- Agriculture

Location	Name	Type	Area (ha)	CapEx (million USD)	IRR[57]	Climate variability resilience[58]	Climate change resilience	National priority
Tanzania, Malawi	Songwe River Basin Development Programme: Irrigation & Water Supply & additional social infrastructure	TJMP [WS]	6189	153	High	High	High	✓
Zambia, Zimbabwe	Mid-Zambezi Delta Agricultural Water Management for Food Security Program*	TS	2956	4	Medium	High	High	
Zimbabwe	Bulawayo-Zambezi Transfer Scheme	TTMP [WS]	6500	33	Medium	High	High	
TOTAL TRANSBOUNDARY			15645	190				
Angola	Cazombo/Lumbalo Nginbo Rice Irrigation Project	NPMP [HP]	5000	-	-	-	-	
	Planned Small Irrigation Development with The Perimetro De Luena Model	NP	500	3	Medium	High	High	
	Planned Sugarcane Irrigation Project	NP	5000	25	Medium	High	High	
Malawi	Irrigation Schemes in Lower Shire*	NO	1878	5	Medium	High	High	
	Irrigation Schemes in Upper Shire*	NO	2166	3	Medium	High	High	
	Mombezi Multipurpose Dam	NPMP [WS]	500	3	Medium	High	High	✓

[56] The model shows that there is also enough water for the driest decade (12.5th percentile) of the semi-dry climate scenario. Even when developing all the projects listed in the inventory (2027 and 2040 horizon lists), there is enough water under the driest scenario).

[57] For irrigation portfolios, the IRR was calculated as an average of the projects' individual IRRs (using available data for all projects).

[58] When it comes to portfolios, the IRR values of the largest project in the portfolio, in terms of hectarage, were used to build the indicators. For *Irrigation Schemes in Lower Shire*, the IRR of MW-013 was used; for *Irrigation Schemes in Upper Shire*, MW-023; for *Rehabilitation of Irrigation Schemes*, MZ-067; for *Luenya Irrigation Schemes*, MZ-065; for *Rumakali Irrigation Schemes*, TZ-056; for *Irrigation Schemes in Njombe*, TZ-027; for *Farm Extension in the Kafue*, ZM-033; for *Mazowe/Luhenya Dams*, ZM-026; and for *Rehabilitation/Optimization of the use of Reservoirs*, ZM-116.

Location	Name	Type	Area (ha)	CapEx (million USD)	IRR[57]	Climate variability resilience[58]	Climate change resilience	National priority
	Diamphwe Multipurpose Dam	NPMP [WS]	1000	5.0	-	-	-	✓
Mozambique	Rehabilitation of Irrigation Schemes*	NO	6710	23	Medium	High	High	
	Luenya Irrigation Schemes*	NO	12140	61.0	-	-	-	
	Lipaque Irrigation Scheme	NP	300	2	Medium	High	High	
Namibia	New Small/Medium Irrigation Schemes	NO	300	2	Medium	High	High	✓
Tanzania	Ruhuhu Valley Irrigation Scheme (incl. Kikonge Hydro)	NPMP [HP]	4000	20	High	High	High	
	Rumakali Irrigation Schemes*	NOMP [HP]	5249	3	High	High	High	
	Irrigation Schemes in Njombe*	NO	620	2	High	High	High	
	Nyasa Irrigation Schemes*	NO	3020	-	-	-	-	
Zambia	Cotton Development Trust on The Magoye River	NP	160	1	High	High	High	
Zimbabwe	Mazowe/Luhenya Dams*	NOMP [WS, mini-HP]	3000	10	Medium	High	High	
	Kudu Dam	NPMP [HP]	30000	150	Medium	High	High	✓
	Amapongokwe	NPMP [WS]	350	-	-	-	-	
	Dande Dam & Tunnel	NPMP [WS, mini-HP]	4000	20	Medium	High	High	
	Tshatshani Scheme	NP	319	2	Medium	High	High	
	Rehabilitation/Optimization of the use of Reservoirs (concerning 20% of the equipped area) *	NO	4584	115.0	-	-	-	
TOTAL NATIONAL			90 796	455				
GRAND TOTAL			**106 441**	**645**				

Note: TJ= Jointly implemented; TS= Implemented on a shared river; TR= Nationally implemented with regional offtake; TT= Transfer out of the basin; MP= Multipurpose; NP= National Project; NO= National Portfolio; NPMP= National Project Multipurpose; NOMP= National Portfolio Multipurpose; HP= Hydropower; IG= Irrigation; WS= Water Supply

Programme 3: Water Supply

As shown in Table 16, the water supply information includes storage capacity (where dams are included) and estimated capital cost – the hydro-economic model does not estimate economic return on these projects.

Table 16: 2027 Priority Projects from Programme 3- Water Supply

Location	Name	Type	Transfer volume *or* Storage (Mm^3)	CapEx (million USD)	IRR	Liveli-hood im-pact	Climate resilience	National Priority
Botswana	Utilization of the Water Re-sources of the Chobe/Zam-bezi River	TT & TS MP	495	-	-			✓
Malawi	Lake Malawi Water Project	TS	-	68	-			
TOTAL TRANSBOUNDARY			495	68				
Mozam-bique	Luia Dams 1, 2, 3	NOMP [IG, FI]	21.2	-	-			
	Revubue Condezi Dams & Irrigation Schemes*	NOMP [IG, FI]	56.2	60	Me-dium			
Tanzania	Town Water Supply Im-provement Schemes in Shire Catchment*	NO	-	-	-			
	Muira Dam	NP	2000	-	-			
Zambia	Water Supply and Sanitation Improvement for Cities and Towns*	NO	-	-	-			
	Integrated Small Town Wa-ter Supply and Sanitation Schemes for Western Prov-ince	NO	-	-	-			
Zimbabwe	Sanyati Dams*	NOMP [HP]	333	-	-			
	Kunzvi Dam	NP	146	-	-			✓
TOTAL NATIONAL			2556.4	60				
GRAND TOTAL			**3 051**	**128**				

Note: TJ= Jointly implemented; TS= Implemented on a shared river; TR= Nationally implemented with regional offtake; TT= Transfer out of the basin; MP= Multipurpose; NP= National Project; NO= National Portfolio; NPMP= National Project Multipurpose; NOMP= National Portfolio Multipurpose; HP= Hydropower; IG= Irrigation; WS= Water Supply

Programme 4: Catchment and riparian asset management

As shown in Table 17, there is not sufficient information available on the catchment and riparian asset management projects and portfolios to evaluate them in more detail.

Table 17: 2027 Priority Projects from Programme 4- Catchment and Riparian Asset Management

Country	Project or Portfolio Name	Type	CapEx (million USD)	National Priority
Angola	Hydrometric Stations*	NO	-	
Mozambique	Cahora Bassa Reservoir - Structural Flood Protection Interventions*	NO	-	
	Cahora Bassa Reservoir - Sediment Management – Investments in Bottom Outlets	NP	-	
Tanzania	Enhanced Knowledge and Information System - Phase II	NP	-	
Malawi, Mozambique	Shire-Zambezi Waterways Development Project	TP	-	
Malawi	Construction Of Likoma Jetty	NPB	-	

Note: TJ= Jointly implemented; TS= Implemented on a shared river; TR= Nationally implemented with regional offtake; TT= Transfer out of the basin; MP= Multipurpose; NP= National Project; NO= National Portfolio; NPMP= National Project Multipurpose; NOMP= National Portfolio Multipurpose; HP= Hydropower; IG= Irrigation; WS= Water Supply

5 Exploring Financing Approaches and Trends in the Basin

Chapter 4 characterised and grouped transboundary and national projects into four categories or programmatic areas. This rationalisation provides a basis on which ZAMCOM can start to think in broad terms about the different approaches to financing programmes and specific projects in the Basin.

This chapter begins with a quick refresher on the infrastructure project development cycle, and specifically the roles of funding and financing in supporting that development (Section 5.1). Following this, Section 5.2 then looks at water infrastructure funding and financing trends across the African continent, and where data allows, in the Zambezi Basin region - who is investing in the water sector, how much are they investing, where are they investing, and by what means are they investing. This information will provide ZAMCOM and related decision makers with valuable insight to guide their strategies in sourcing funding and financing for the programmes and projects shortlisted in this ZSP. Section 5.3 provides brief economic snapshots of the eight Riparian States. Finally, Section 5.4 through 5.6 introduce a set of concepts to help ZAMCOM and relevant decision makers explore the available approaches for delivering water infrastructure, at both a transboundary and non-transboundary level. This includes the establishment and introduction of a set of institutional and financial 'delivery models' that can serve to guide consideration of financing approaches and issues between the particular and distinct structures of individual projects.

By exploring these delivery models, ZAMCOM will be able to consider its own role in projects of varying types and levels of complexity. In national projects, this role may focus on urging and supporting inter-country notification. In others, particularly transboundary where complex joint ownership of assets is required, it may extend to providing specific advice on governance, ownership and oversight functions.

5.1 The Infrastructure Project Development Cycle – A Refresher

In evaluating means by which the identified priority projects can be fully developed, and development costs covered, it is helpful to first relook at the infrastructure project development cycle.

A project's cycle can typically be broken down into three broad components:

1. **Preparation** – the preparation phase is concerned with transforming a project from an idea into a viable, fully-defined, structured, bankable, and ultimately a fully financed concept;
2. **Implementation** – the implementation phase involves the execution of the business plan and models developed during the preparation phase, making the project ready for operation; and
3. **Operation** – proceeding implementation, this phase sees the project initiate and mature operations (including associated maintenance and refurbishment) into a steady and sustainable state.

5.1.1 Funding and Financing Across the Cycle

A typical water sector project incurs costs over its life-cycle, related to the three development phases it passes through. As shown in Figure 8, coverage of these costs will fundamentally be underpinned by three sources of funding – taxes, tariffs, and transfers (the so-called '3Ts') - which will ultimately pay for the project over the long term.

Figure 8: Sources of Funding Available for Water Sector Infrastructure (Source: OECD, Pegasys Analytics)

Funding flows are in many cases aligned with the stages of the project's cycle – most obviously, a project can only begin generating a large proportion of its revenue (tariffs) once it is operational. However, its development costs are heavily front-loaded, mostly in the form of capital for implementation, leading to funding deficits at key points in the cycle (see Figure 9).

Projects must identify and develop a viable mechanism to cover this funding gap, through sourcing financing. Appropriate financing will bridge the funding deficits, allow project sponsors to manage cash flows over the short term and enable delivery.

It is almost certain that most, if not all, of the projects proposed in the ZSP will require some form of financing (and related mechanism) to get off the ground. At the same time, a viable funding model will be required to sustain their 'operations' over the long term.

Understanding the funding available to a project will inform the funding models and financing mechanisms available to that project, and ultimately whether it is workable. Once the 3Ts are qualified and quantified for each specific project, bankability can be assessed, a funding model can be developed, and a financing mechanism designed. The latter will take a form somewhere along the public-private financing spectrum – predominantly public, predominantly private, or some combination and partnership of the two.

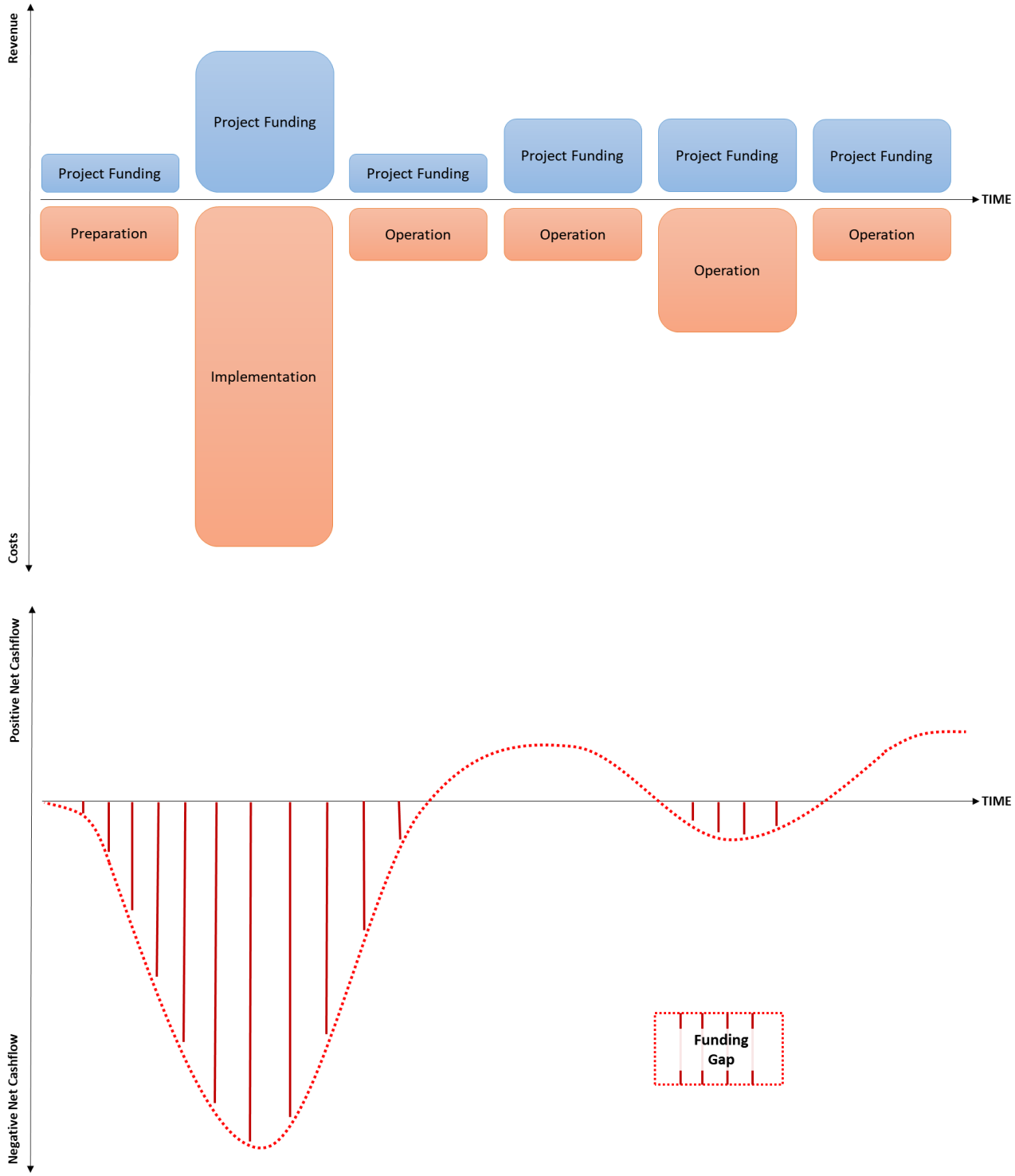


Figure 9: Indicative Example of Funding Gaps Incurred by Water Infrastructure Project over its Development Cycle (Source: Pegasys Analytics)

- **Funding and Financing Project Preparation**

Preparation costs are typically small relative to overall project costs, but the process of sourcing funding or financing to cover such costs is arguably the most difficult. In the case of the former, this is predominantly due to a lack of consideration of the importance of well-funded preparation. In the case of the latter, the high-risk nature of projects in the very earliest stages of development impacts on appetite. There is a high probability that a project will fail, given that extensive feasibility analyses are still to be conducted.

Furthermore, even if a project is successful, this success may take several years to materialise in the form of tangible returns.

As a result, the pool of financing with sufficient appetite to fund preparation costs is small. Preparation costs are almost always covered through the 3Ts, for example grants from national governments, bilateral official development assistance (ODA), or from project preparation facilities.

- **Funding and Financing Project Implementation**

Implementation involves the execution of strategies and plans developed in the preparation stage of the project life cycle. Costs associated with implementation are incurred in a relatively short period of time, taking the entire project life cycle in account. Implementation costs are often capital in nature, requiring outlay on infrastructure. This represents a large 'spike' in a project's life cycle funding requirements, which available funding flows will in many cases not be able to immediately cover, hence requiring financing.

Relatively speaking, raising funding and financing for the implementation stage of a viable project is the 'easiest' across the three cycle phases, due to the large number of sources of both and a broader understanding of funding and financing project implementation. This could include contributions from national government, large grants made by ODA sources, and varied types of concessional and commercial financing across the public-private spectrum.

- **Funding and Financing Project Operations**

Compared to preparation and implementation, operational costs will be incurred over a much longer period of the project's life cycle. Broadly speaking, these ongoing costs after implementation include those directly involved in sustaining operations, expenditure on any maintenance, further capital investment as required periodically for refurbishment, and costs associated with repaying any financing raised.

At the operational stage, projects may also begin generating revenue through tariffs, which would be used to offset operational costs. However, in many cases in the water sector, the quantum of such revenue is too small (if any is generated at all) to fully cover all operational costs incurred. And historically, other sources of funding (taxes, transfers) to cover the shortfall over the entire operational life-span have been ill-considered and insufficient. This leaves a funding gap for which it can be difficult to source appropriate financing, often requiring some form of innovation.

5.2 Water Infrastructure Funding and Financing Trends in Africa

Project proponents should begin the process of identifying likely sources of external funds, and financing to cover any funding gaps, as soon as possible for their specific project or project archetype. For this purpose, it is valuable to understand the 'universe' of external funders and financiers currently investing in the water sector in Africa and the Zambezi Basin – who they are, what their appetite is, and how and where they are investing[59].

Notes for the data and analysis that follows:

- The figures include both ***external funding*** (ie. transfers from national fiscus, ODA grants) as well as ***financing*** amounts. It understandably does not include amounts from the 3rd 'T' of the funding pool - tariffs.
- The figures depicted typically refer to ***commitments*** – the direct amounts approved in a given year to projects over their lifetimes. This is distinct from ***disbursements*** – the amounts outflowing

[59] The African continent faces a significant paucity of consolidated and standardised data on its infrastructure development history, and future opportunities and needs. This is particularly apparent when looking to qualify and quantify financing inflows to infrastructure development, and accurately identifying financing sources and trends of importance. This means any desktop analysis will have some limitations – it should not be considered complete or definitive, but rather indicative.

to projects during a given year. Reliable and consistent data is much harder to come by for the latter, and insightful conclusions (e.g. disbursement rates, time for disbursement) more difficult to draw given typical multi-year durations of project development. Nevertheless, where the data does allow for trends to be reasonably discerned, this is mentioned.

5.2.1 An African Water Sector Investment Snapshot

Total commitments to African infrastructure in 2016 stood at US$62.5 billion, of which US$10.5 billion (or 17%) was committed to the water sector.

It should be noted that, in this case, the 'water sector' includes water resource infrastructure (including transboundary), water supply, sanitation, irrigation, and waste treatment and management. However, specific infrastructure investments related to hydro-power and thermal generation are counted under the 'energy' category. Unfortunately, separating that data out is currently not possible. Nevertheless, examining trends in more detail within the 'Water' category will remain valuable.

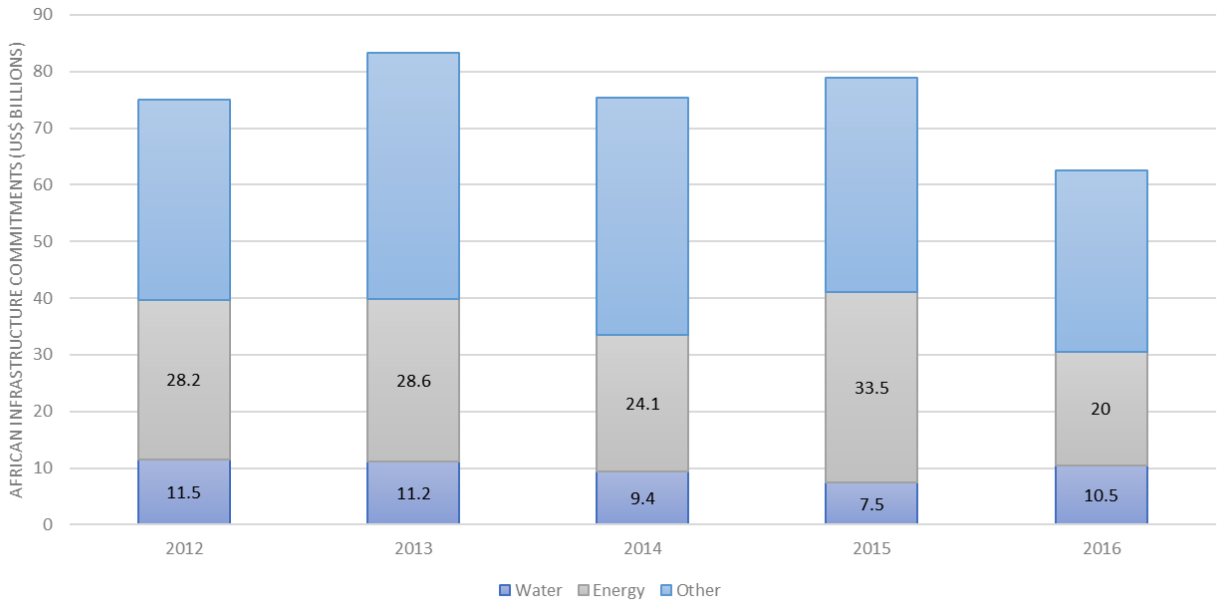


Figure 10: Total Funding and Financing Commitments to African Infrastructure 2012-16 (Source: ICA, World Bank, Pegasys Analytics)

As Figure 10 above highlights, funding and financing flows into the African water sector have remained relatively stable over the previous five years. This despite a dip in overall commitments in 2016 across all infrastructure types. However, as a proportion of overall numbers, funding and financing in the African water sector cannot currently match that invested in transport and energy.

Breaking down water sector funding and financing commitments by region in 2016 reveals a relatively even split between North, Southern, West, and East Africa (see Figure 11).

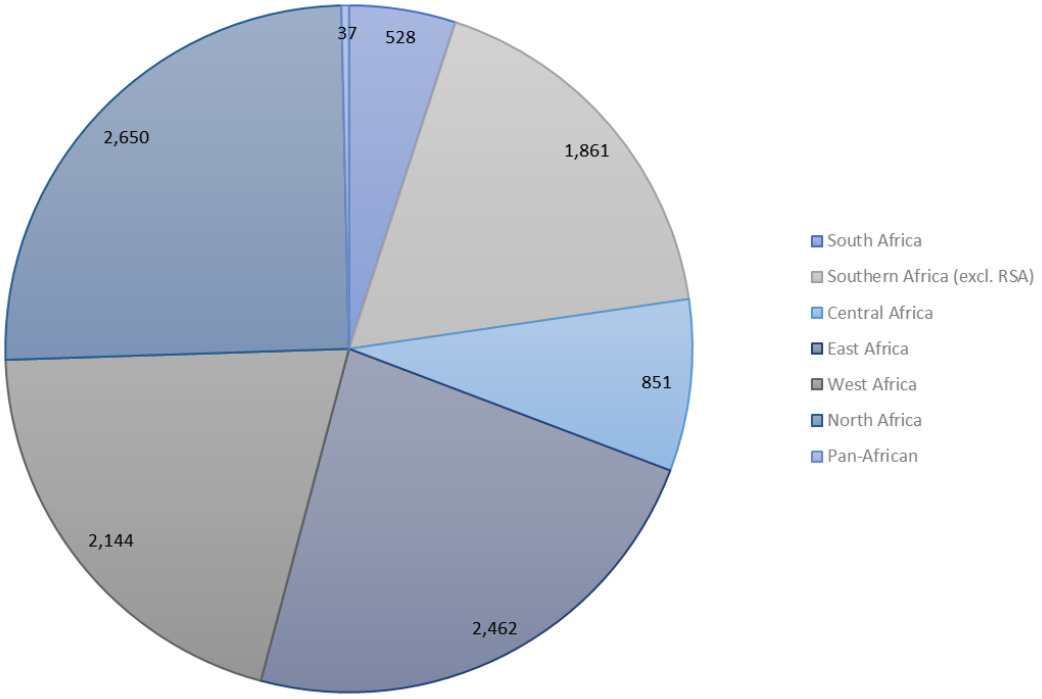


Figure 11: Total African Water Sector Commitments by Region in 2016, US$ millions

(Source: ICA, World Bank, Pegasys Analytics)

Of primary relevance to the ZSP is the volume of funding and financing flowing into Southern Africa, excluding South Africa. This amounted to approximately US$1.9 billion in 2016, a 28% increase from 2015's figure.

It is instructive, at a very basic level, to compare these figures of overall funding and financing commitments, with the capital expenditure volumes estimated for the four thematic programmes of the 2027 priority list in Section 4.6. Totalling capex requirements across all the listed programme projects comes to around US$14.4 billion, although noted that several of the interventions are yet to be costed. Putting aside any necessary phasing of funding and financing requirements, Southern Africa (excluding South Africa) commitments would need to be sustained at current levels (in real terms) for just under 8 years to meet the capex funding and financing needs of the ZSP.

Briefly considering disbursements in 2016, a disbursement rate of 96% was estimated – the amount of disbursements to water sector projects completed in 2016, as a percentage of original commitments to those projects in preceding years. For 2016 completed projects, the weighted-average year of funding and financing commitment was 2009.

5.2.2 Current Sources of African Water Sector Investment

A breakdown by source of the US$10.5 billion committed to the water sector on the continent in 2016 is provided in Figure 12 below.

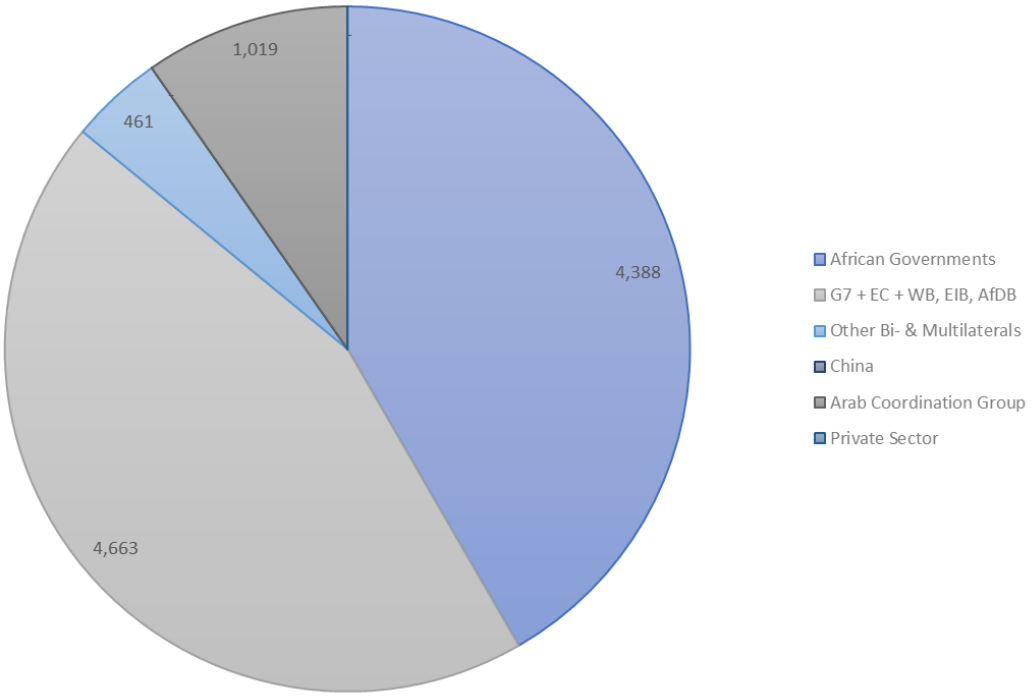


Figure 12: African Water Sector Commitments by Source in 2016, US$ millions
(Source: ICA, World Bank, Pegasys Analytics)

Established contributors, namely the G7 countries, the European Commission, World Bank Group, European Investment Bank, and African Development Bank, committed the largest amount of support to the water sector in 2016. This commitment totalled just shy of US$4.7 billion. This group is closely followed by African national governments with US$4.4 billion.

Looking further back, as per Figure 13 below, it is clear that over the last five years African governments have been the largest single source of funding and financing for African water infrastructure. This is closely followed by the established developmental collective, predominantly represented by funding and financing which would be classified development assistance from developed countries and international multilaterals.

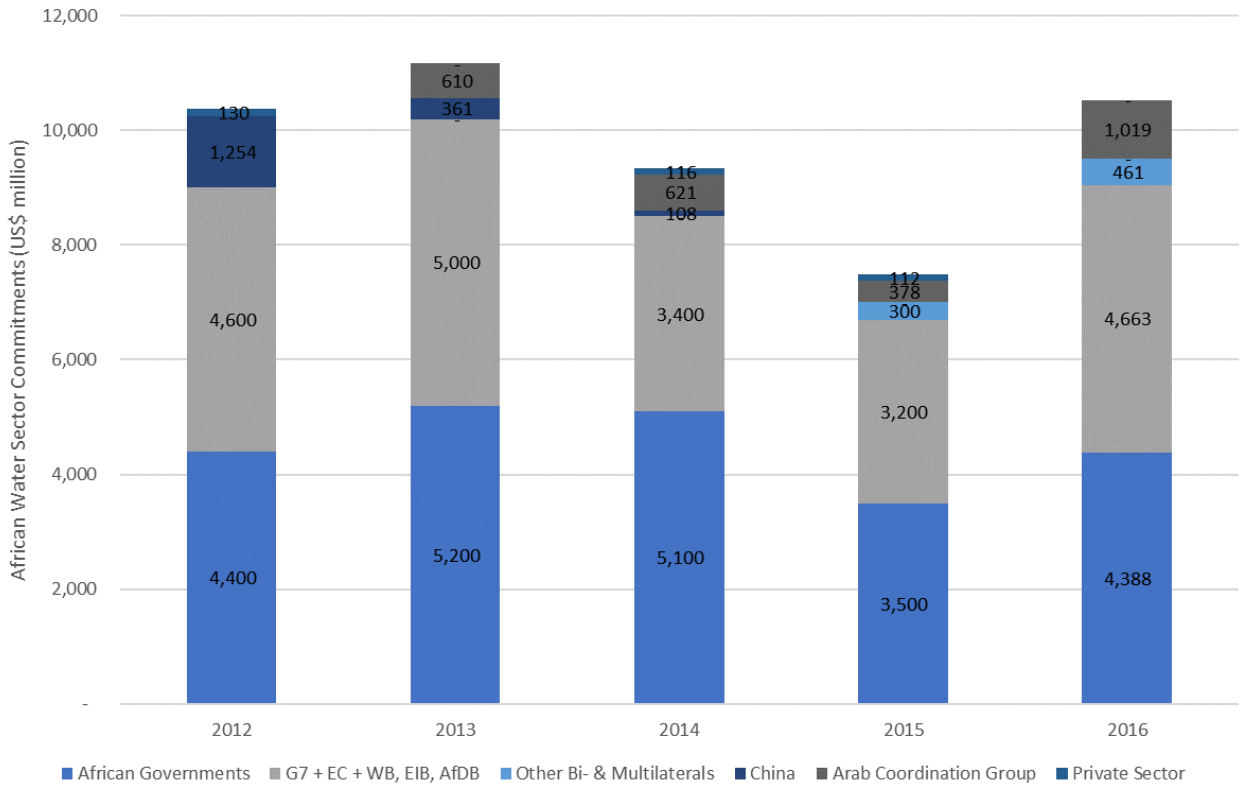


Figure 13: African Water Sector Commitments by Source 2012-16
(Source: ICA, World Bank, Pegasys Analytics)

Compared to these two amalgamated sources, the remainder of contributions are limited. Per available data, China made no commitments in 2015. In contrast, Arab development institutions' commitments appear to generally be trending upwards, albeit relatively small amounts and likely focused on Northern Africa. 'Other' bilateral and multilateral commitments are limited. The private sector made no commitments in 2016 and 2013, and around US$100 million is the other years.

It should be noted that, due to data limitations, this breakdown does not depict every single source of funding and financing committed to the water sector. In particular, capturing every private sector investment would be impossible, not least due to confidentiality non-disclosures. However, in identifying and quantifying the major sources, it likely captures a significant majority of the main contributing funders and financiers.

5.2.3 African Government Investment in the Water Sector

In 2016, African national governments contributed 42% (US$4.4 billion) of the overall funding and financing committed to water infrastructure on the continent. Examining national budgets across the continent, the water sector attracted the second largest combined amount allocated by government.

Figure 14 examines government water funding and financing on a regional basis, for 2016 and the preceding three years.

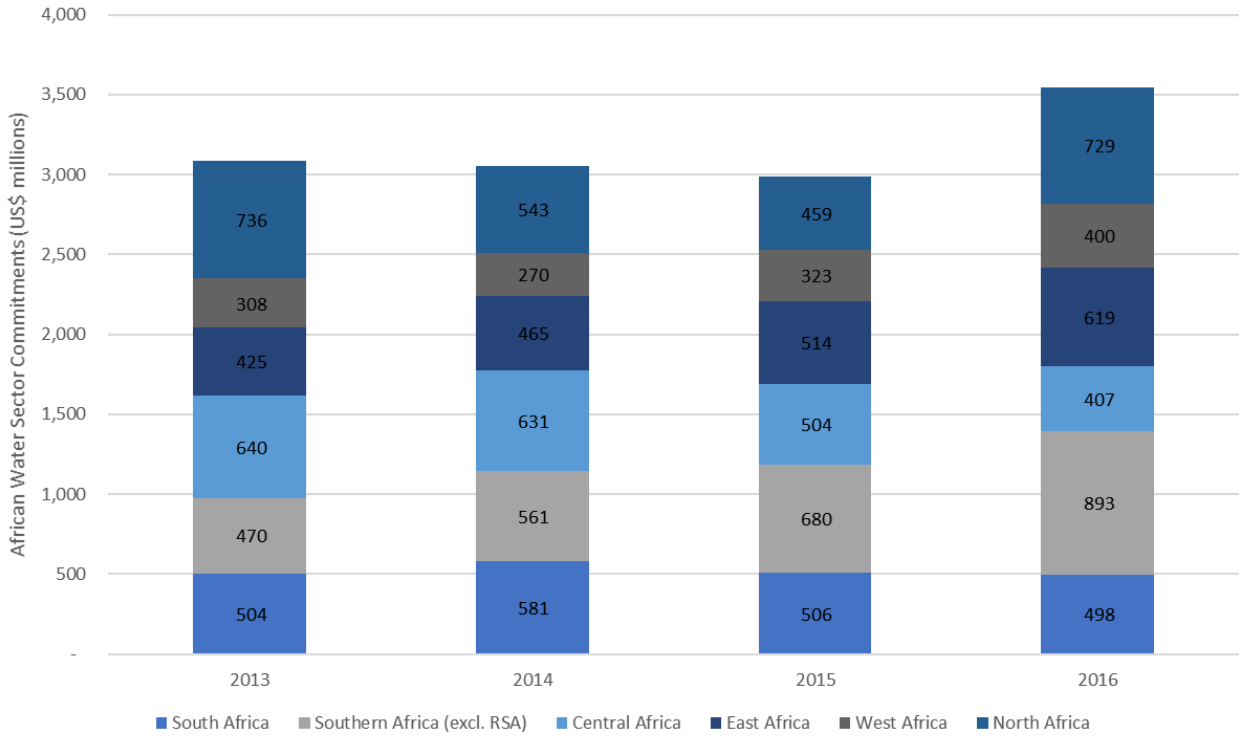


Figure 14: African Water Sector Commitments by National Governments per Region 2013-16 (Source: ICA, World Bank, Pegasys Analytics)

With the 'Southern Africa (excluding South Africa)' category comprising all ZAMCOM Riparian States except for Tanzania, its government commitment trends in the water sector are of particular interest. In 2016, this group of countries committed the largest total amount of funding (US$893 million) to water infrastructure out of all regions analysed. Since 2013, Southern Africa has increased its contributions to water sector initiatives by 90%.

Taking these findings into account, it seems clear moving forward that funding and financing from national treasuries will play a key role in enabling further development of the water sector in the Zambezi Basin. This will include acting as leverage to crowd-in other sources of funding and financing. This is obviously dependent on the ongoing economic and fiscal ability of these governments to sustain or grow budget allocations to the sector.

However, although the available data is not comprehensive, it is likely that significant country-to-country variation exists amongst riparian countries. As an example, Botswana prioritised the water sector with 40% of its budget in 2016. Conversely, Zimbabwe did not allocate anything to water infrastructure, despite having an overall budget roughly the same size as Botswana's (as far as the available data reveals).

5.2.4 Investment by Established Sources of Developmental Assistance in the Water Sector

The grouping of G7 nations, plus the European Commission, World Bank, European Investment Bank, and African Development Bank (as depicted previously in the discussions above) have a long-established role in the provision of substantial development financing, and represent the majority of developmental investment in the African continent.

In 2016, funding and financing committed by these entities towards water infrastructure in Africa totalled US$4.7 billion, approximately 25% of their total assistance provided (energy at 41% and transport at 27%).

Several other established bilateral and multilateral development entities (including the EBRD, Netherlands, Switzerland, and the Scandinavian countries), made total contributions worth some US$392 million to African infrastructure in 2016. However, it is believed that only a small proportion of this flowed into the water sector directly.

- **Entity Breakdown**

The data available did not reveal a breakdown of the specific developmental finance entities contributing to the water sector in the Southern African region in 2016. However, across all sectors (transport, energy, ICT, as well as water), the African Development Bank and France were the largest contributors (around US$270m each), followed by the World Bank Group, European Investment Bank, and Germany. Interestingly, South Africa also committed US$142 million – the fifth largest contribution. Outside of these entities, commitments to the region were minimal, suggesting that the water sector is of interest to some, if not all, of the sources named here.

- **Geographic Breakdown**

Figure 15 reveals the distribution of the total US$4.7 billion of commitments across the continent's main regions.

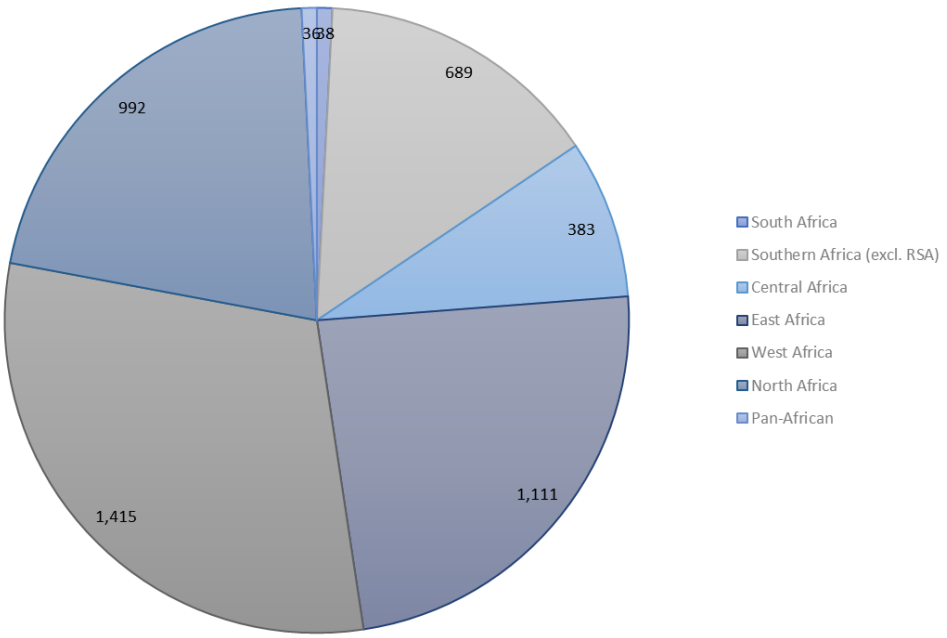


Figure 15: African Water Sector Commitments by Established Developmental Assistances Sources in 2016, by Region, US$ millions
(Source: ICA, Pegasys Analytics)

West Africa saw the largest share, perhaps commensurate with the lesser funding and financing contributed by the region's national governments to the sector. The Southern African (excluding South Africa) region, encompassing the majority of Zambezi Basin Riparian States, received commitments of US$689 million

from established developmental finance sources. This amount is 50% of the total committed to the region across all sectors.

- **Sub-Sector Breakdown**

A breakdown of the water sub-sector these commitments were made to, is shown in Figure 16 below.

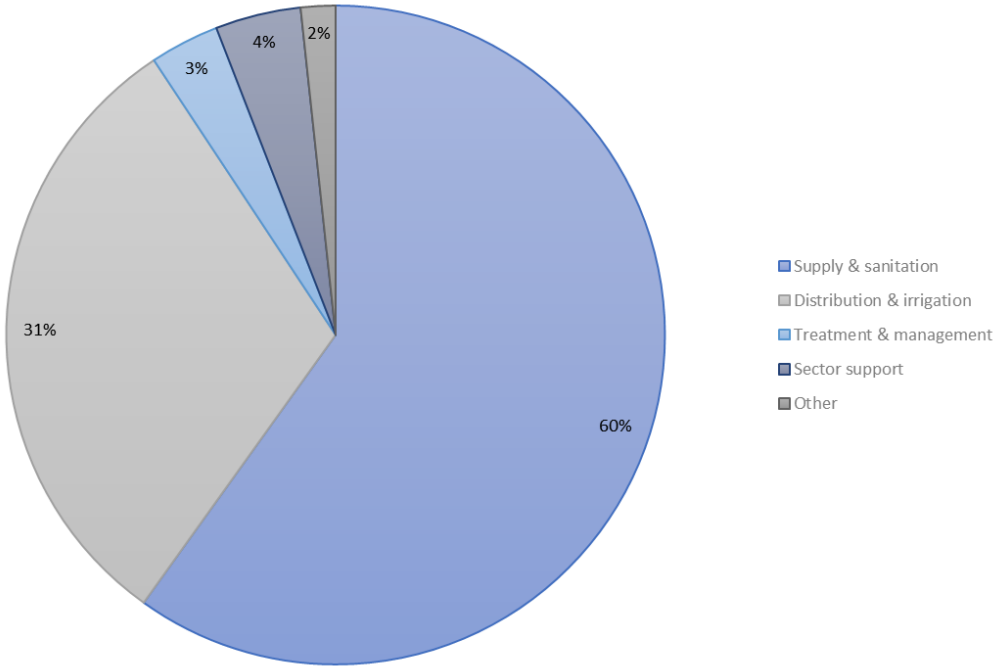


Figure 16: African Water Sector Commitments by Sub-Sector in 2016
(Source: ICA, Pegasys Analytics)

Perhaps not surprisingly, supply and sanitation is by some margin the largest water sub-sector of focus, followed by distribution and irrigation.

- **Funding and Financing Type Breakdown**

The data available did not provide any insight into the type of funding and financing committed to the water sector, either across the whole continent or in specific regions. Across all sectors, the breakdown is revealed in Figure 17 below, with loans forming the majority in 2016.

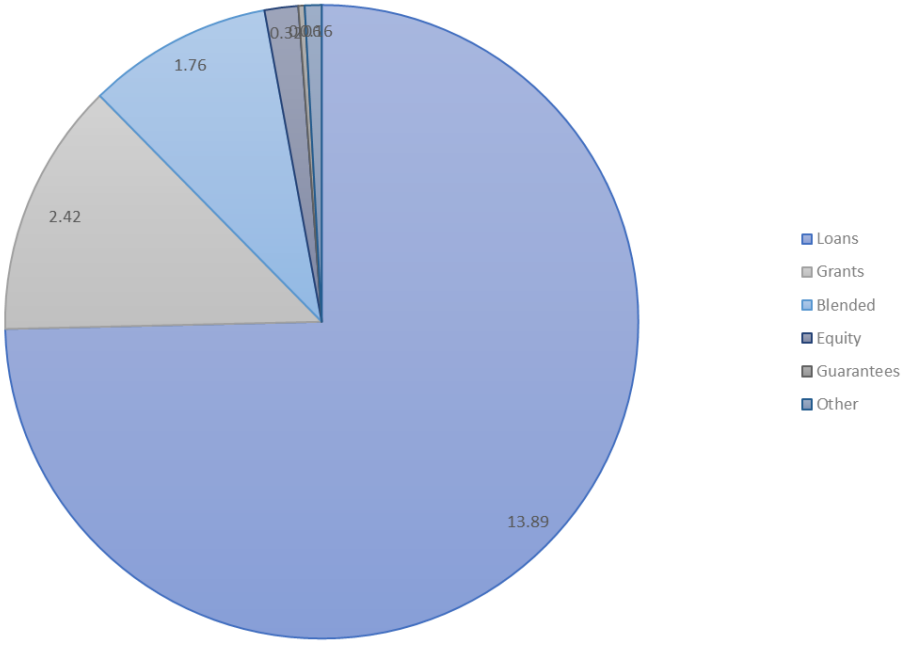


Figure 17: Type of Commitments by Established Developmental Assistances Sources in 2016, All Sectors, US$ billions
(Source: ICA, Pegasys Analytics)

Although this breakdown may provide some indication of the spread of funding and financing mechanisms provided to the water sector specifically, some caution is warranted in extrapolating the assumption too far. Different sectors derive very disparate project types, favouring varied funding and financing modalities – what may be viable in the transport sector (eg. concessions), may not work in enabling water infrastructure development.

Some additional pertinent data points for the amalgamated established financing source in 2016 (albeit not talking specifically to the water sector or the Southern African region) include:

- ODA funding and financing (being grants or concessional financing provided by donors) accounted for 54% of the total, compared to non-ODA at 46%
- Multilaterals contributed 58% of the total funding and financing committed, with bilateral entities the remaining 42% (but noting the latter also make uncounted contributions indirectly through multilaterals)

- **Project Preparation**

Limited data is available on the extent of project preparation commitments by the G7 plus compatriots group. Across all sectors, commitments in 2016 towards project preparation totalled US$245 million, around 1% of cumulative commitments for the year. Although no figures specific to the water sector are available, this would seem to back up a widely held assertion that sufficient financing for project preparation remains a challenge, and will be a hurdle for the ZSP. It is likely that national governments will need to further contribute towards covering this need.

5.2.5 Investment by Emerging Sources of Developmental Assistance in the Water Sector

China and the Arab entities making up the Arab Coordination Group are at the vanguard of newer emerging sources of development finance on the African continent. The likes of India, South Korea, and Brazil are also providing funding and financing to various initiatives.

- China announced investments of US$6.4 billion in Africa in 2016; however, none of these were ostensibly earmarked for water infrastructure. This follows water commitments of US$1.2 billion in 2012, tailing off to nothing in 2015 and 2016. It should be noted that China has some substantial commitments to hydropower developments on the continent – in the data however, this is counted under the energy sector. As an example, in the Zambezi, state-backed Chinese company Sino-Hydro has been appointed to construct the Kafue Gorge Lower through a deal co-financed by China ExIm Bank.

- The Arab Coordination Group reported commitments amounting to just over US$1 billion in the water sector in Africa in 2016. The majority of these are believed earmarked for the North African region.

- India's commitments to the continent are on the rise, with a total of US$1.2 billion contributed in 2016, following US$524 million in 2015. Of the 2016 commitments, US$262 million will flow into the water sector.

- Korea, via its Export-Import Bank, committed US$190 million to water projects in Africa in 2016.

- Although not announcing any new commitments in 2016, Brazil's BNDES invested US$500m in the Lauco hydropower plant in Angola in 2015.

Across these sources, where the details were reported, loans made up 75% of the total committed funding and financing to the water sector, concessional loans 0.1% and grants 0.4%.

African regional development banks are also increasingly playing a key role in the funding and financing of infrastructure development, albeit available data suggests little appetite for water sector investment so far.

5.2.6 Investment by Private Sector in the Water Sector

Accurately assessing private sector financing flows into infrastructure on the African continent is very difficult - inherently, private sector typically does not openly report details of its financing unless compelled, and much is governed by confidentiality. Collation of data that is available, is also subject to differing definitions of what exactly constitutes private participation and investment, making it challenging to categorise and discern trends.

Nevertheless, data sources like the World Bank's Private Participation in Infrastructure database, whilst not by any means a complete picture, provide an indication of private sector activity in primary infrastructure sectors across the continent.

According to this database, the water sector plays a very small role in private sector financing in Africa. In 2016, private sector commitments cross-sector totalled US$2.6 billion, of which none was allocated to the water sector. In 2015, the total was US$7.5 billion, with just 1.5% of this flowing into water projects.

These figures are perhaps not surprising – the Private Participation in Infrastructure database typically reports on large-scale, capital intensive infrastructure projects. In the water sector, many such projects have not historically been well suited to, or structured to attract, explicit participation of private capital. This may change in the future, as more innovative financing mechanisms are designed that allow for private sector participation, and the underlying commercials of (some) water sector projects in Africa shift.

It is also likely that what private sector investment in the broader water sector exists, may be targeted at power generation. As mentioned, funding and financing committed specifically to power generation, including hydro-power, is not included in the water sector figures discussed at length. Therefore it is instructive to analyse whether the trends identified – minimal private sector investment - are specific to the water sector alone, as categorised.

Figure 18 below reflects funding and financial commitments by source into the African energy sector for the period 2013 to 2016.

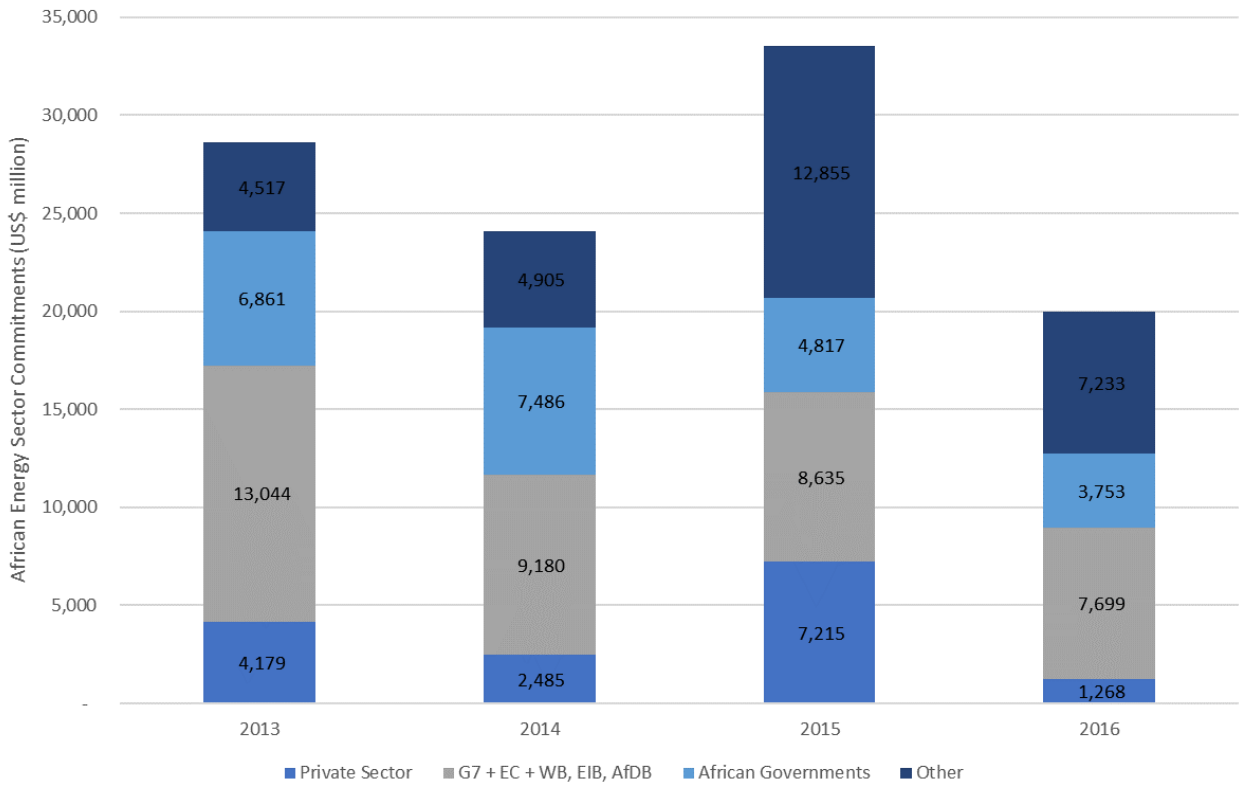


Figure 18: African Energy Sector Commitments by Source 2013-16
(Source: ICA, World Bank, Pegasys Analytics)

The figures highlight an increased proportion of investment into the energy sector from other sources besides African governments and established sources. This may be applicable to hydropower investment too, although given the data available, it is difficult to make this determination with any degree of confidence. However, even in the energy sector, African governments and established developmental assistance sources still tend to consistently commit the most capital to infrastructure development. Conversely, private sector, although more heavily invested here than in the water sector as previously defined, still contribute a relatively minor portion – an average of 13% over the period indicated. This figure is also likely inflated by heavy private sector investment into solar and wind developments across Africa, more so than hydropower.

5.3 Country Economic Snapshots

Some key macroeconomic indicators are useful for outlining investment opportunities for future analysis. Table 18 summarizes these indicators in relation to factors such as ease of doing business, corruption perceptions and credit ratings. For instance, while some countries have recently enjoyed positive annual GDP growth rates, unfavourable credit ratings may affect investment attractiveness and thus inflows of foreign investment. Although this background provides useful context, high-level data do not necessarily provide reflect the nuances of investments climates and the nature of structural constraints that many countries face. For instance, Mozambique and Tanzania have recently enjoyed large foreign direct investment injections, pointing to the need for dissecting the nature of this investment, including key sector recipients. Domestic investment policies are also important for future projections. Botswana's policies on capping external debt to GDP is one such example. While Table 18 shows Botswana has a relatively low share of inward foreign direct investment, its stringent debt policies mean that it will likely be able to borrow with relative ease and assurance in the future. Further exploration of the structural dynamics underlying macroeconomic indicators in relation to countries' fiscal outlooks, including domestic policies and global foreign direct investment projections, is recommended.

Table 18: Country Economic Snapshots

	Income	Population (2017) **(UNDP)**	GNI per capita[60] (2017)	GDP growth (%) (2017)[61]	Ease of doing business[62]	Corruption Perceptions Index[63] (CPI) 2017	External Debt as a Share of GDP[64] (2017)	Foreign direct investment inward[65] (FDI) (million)	Credit Rating[66]
ANGOLA	Lower middle income	29,784.193	3,330	0.7	175	19	65.1	- 2 255	B-

[60] Gross National income (GNI) converted to U.S. dollars (World Bank Atlas method) divided by the midyear population.
[61] Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars (The World Bank, 2017)
[62] Economies are ranked on their easy of doing business from 1-190. A high ease of doing business ranking means the regulatory environment is more conducive to the starting and operation of a local firm (Bank, 2018)
[63] The CPI ranks countries according to their perceived levels of public sector corruption on a scale of 0 to 100 where 0 is highlight corrupt and 100 is very clean. The global average for 2018 is 43. (Transparency.org, 2018)
[64] Used by investors to measure countries' ability to make future payments on debt, thus affecting country borrowing costs and government bond yields.
[65] FDI overview from the UNTAD World Investment Report 2018
[66] Ratings for Angola, Botswana, Malawi and Mozambique are provided by Standard & Poor. Due to no reporting, Fitch ratings are provided for Malawi, Namibia. Similarly, Moody's ratings are used for Tanzania and Zimbabwe

BOTSWANA	Upper middle income	2,291.661	6,820	2.4	81	61	22.3	401	A-
MALAWI	Low income	18,622.104	320	4.0	110	31	54.7	277	B-
MOZAMBIQUE	Low income	29,668.834	420	3.7	138	25	88.2	2 293	SD[67]
NAMIBIA	Upper middle income	2,533.794	4,600	-0.8	106	51	41.5	416	BB+
TANZANIA	Low income	57,310.019	910	7.1	137	36	37.4	1, 365[68]	B*
ZAMBIA	Lower middle income	17,094.130	1,300	4.1	85	37	55.6	1 091	B-
ZIMBABWE	Low income	16,529.904	910	3.4	159	22	77.6	289	Not assigned.

[67] In default with little prospect for recovery.
[68] 2016 values (UNCTAD, 2017)

5.4 Infrastructure Delivery Models

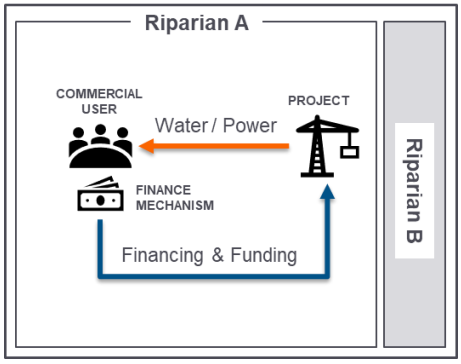
Simply speaking, a delivery model (DM) is the consolidated approach through which an infrastructure project can be viably implemented and operated. Numerous and varied infrastructure delivery models exist, but not all will be applicable to the water sector broadly, and less so to the specific projects and interventions proposed in this ZSP, particularly those involving transboundary development.

Delivery models are pivotal in informing the likely financing options and associated funding sources available to an undertaking. For this reason, it is critical to identify and develop the suite of delivery model typologies likely applicable to the projects at hand.

It is important to note that the delivery model typologies to follow, are just that - it is rarely a simple case of matching exact typologies to projects. Instead, they serve as building blocks to codify specific approaches and project structures, informed by their particular contexts. A certain transboundary project's tailored delivery model, may, for example, build upon one or more of the typologies offered below.

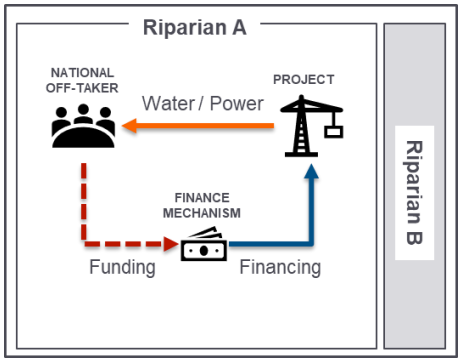
5.4.1 Delivery Model Typologies

Six delivery model typologies are proposed here[69]. These cover the broad spectrum of arrangements, ranging from the typically simplest unilateral structures, through to more complex multilateral initiatives.



1) Unilateral, Commercial Led

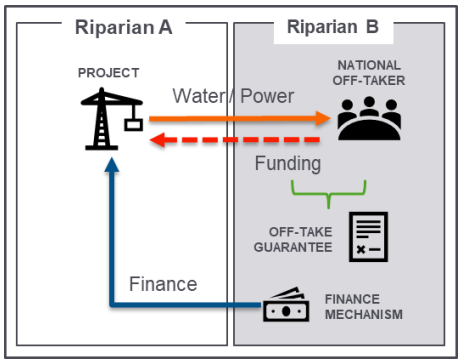
Infrastructure is developed by a private entity within a Riparian's own nation, for commercial benefit but within a transboundary context. This approach likely requires coordination with other Riparian States.



2) Unilateral, Sovereign Led

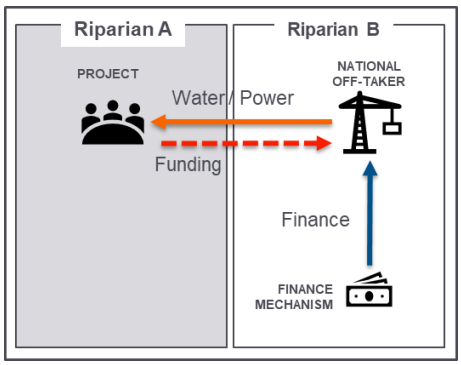
Infrastructure developed within a Riparian's own nation for its sole benefit but within transboundary context. This approach typically requires coordination with other Riparian States.

[69] Source: Pegasys Analytics



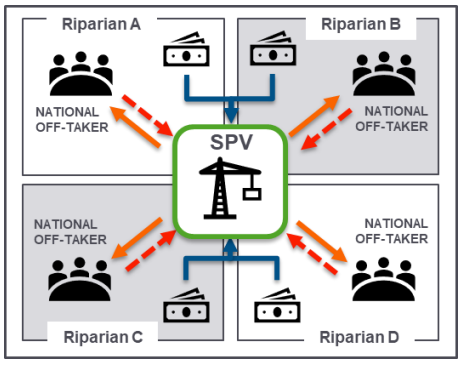
3) Bilateral, Exporter Led

Infrastructure developed within a Riparian's own nation but financing dependent on guarantees for the export of water/power to a neighbouring Riparian. Coordination between Riparian States is essential.



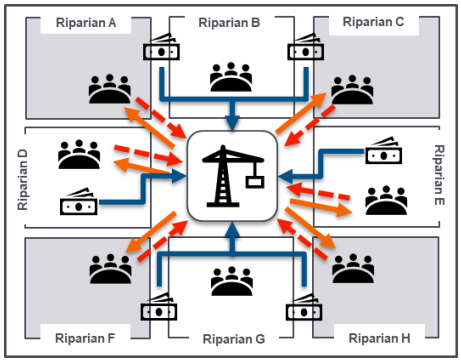
4) Bilateral, Importer Led

Infrastructure developed in another Riparian's territory but financed by the importer of the water / power, usually accompanied by benefit sharing agreements between the participating Riparian States.



5) Multi-Lateral, Joint Deployment

Developed by a sub-set of the Riparian States who agree to share costs and benefits. This approach typically requires an SPV to finance the project, and deploys funding under an agreed formula that allocates the proportional contributions made by each party.



6) Multi-Lateral, Basin Deployment

Developed by all Riparian States who share the costs and benefits according to an agreed formula. River Basin Organisation required to jointly plan and develop infrastructure across a single or multiple sites in line with overarching basin agreements.

The simpler delivery models tend to be unilateral, which usually have a relatively smaller magnitude of resource flows (water, energy, etc.) and financing requirements. The unilateral DMs also have the least complex contracting structures.

Whilst infrastructure scale is an important financing consideration, the gradation (see Figure 19 below) of DMs from simple to complex structures is usually commensurate with:

1) the number of infrastructure development counterparts,
2) the supply of transboundary resources, and
3) the demand for transboundary resources.

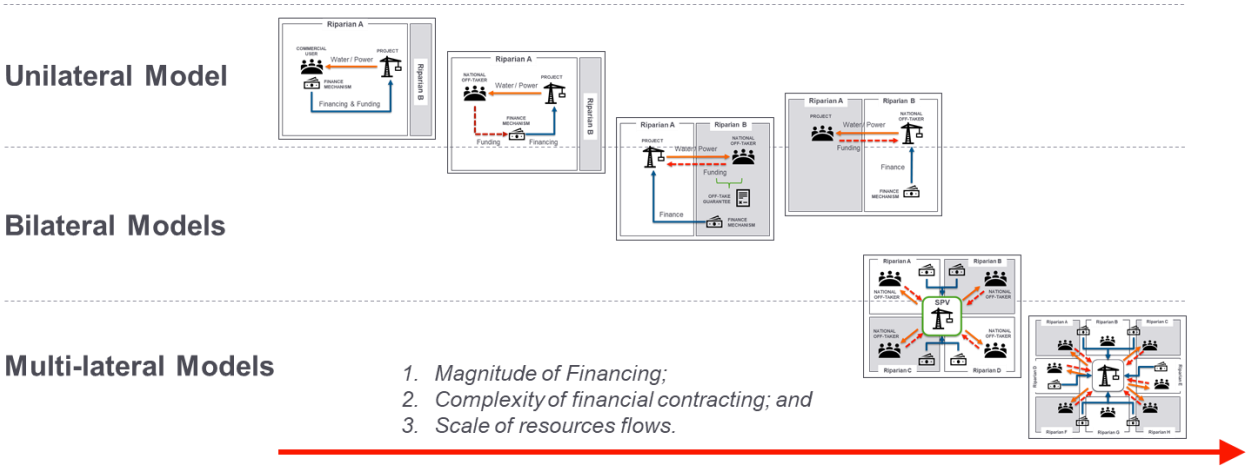
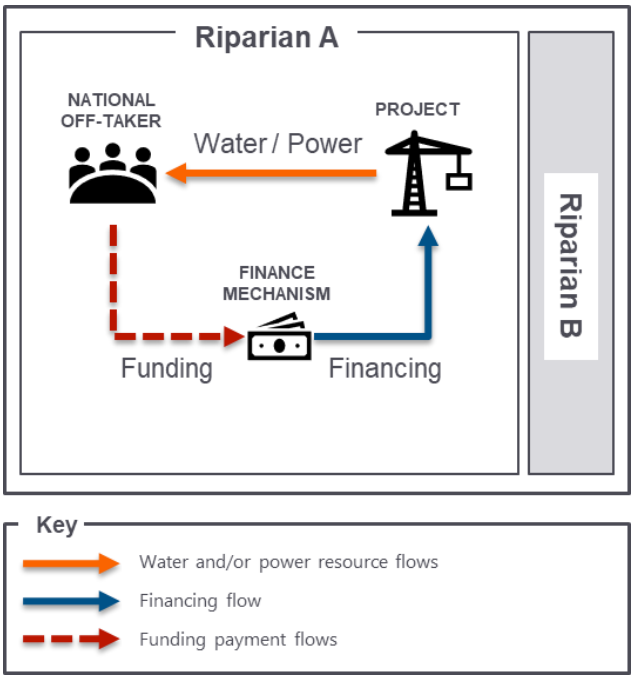


Figure 19: Gradation of Delivery Models (Source: Pegasys Analytics)

5.4.2 Typologies in More Detail

To provide more detail around the key elements common across the typologies offered above, the following two examples are explored. These examples also provide insight into the possible nature of the elements.

Unilateral, Sovereign Led



- ***Origination***

Project is typically originated by a national government institution for the benefit of the nation in which it is situated.

- ***Riparian Coordination***

  Typically requires coordination between affected Riparian States depending on the scale of resource use and magnitude of infrastructure

- ***Preparation***

  Run as a national process, and self-regulated according to national compliance requirements. Consultants are typically contracted to develop the project implementation parameters

- ***Implementation***

  National public procurement and contract administration process, according to national preferential procurement regulation and policies. Typically requires engineering, procurement and construction (EPC) contracting.

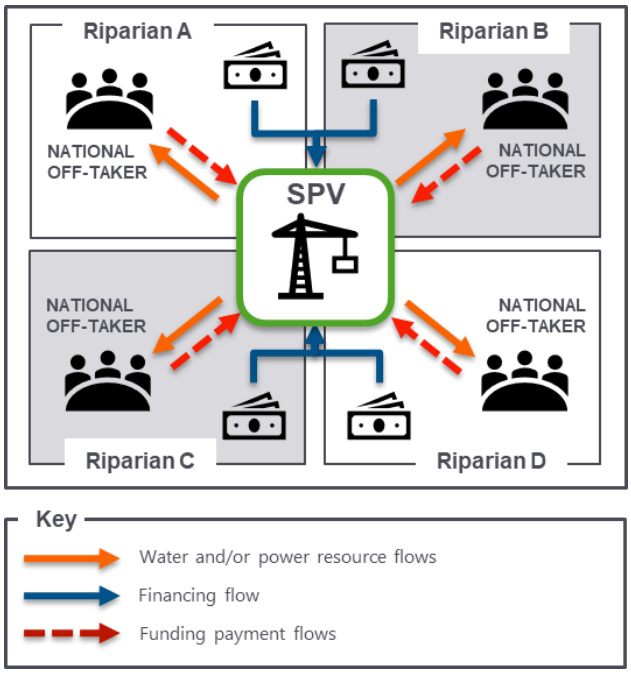
- ***Financing***

  Usually publicly financed through grants with ODA financing in the form of concessional loans. Larger projects typically require a combination of public and private finance structured in the form of a PPP contract

- ***Funding***

  The national off-taker for water and/or power typically contributes to the funding of the venture through direct tariffs on use, direct taxes, and/or through indirect taxes that contribute to repaying interest on external transfers, for instance, through ODA loans.

Multi-Lateral, Joint Deployment



- ***Origination***

  Project is typically originated by two or more national governments with representative institutions as custodians, for the mutual benefit of the nations in which it is situated.

- ***Riparian Coordination***

  Mandatory coordination between participating Riparian, in the form of joint technical committees and organs of existing RBOs.

- ***Preparation***

  International process, usually involving a multi-lateral implementation custodian. Consultants are typically contracted to develop the legal and institutional structures, and project implementation parameters.

- ***Implementation***

  International procurement and contract administration process, requiring regulatory compliance of participating Riparian States and implementation custodian.

- ***Financing***

  Financed through a Special Purpose Vehicle (SPV) such as a Joint Venture (JV) between governments or a separate nationally owned entity (e.g. ZRA). Financing sources typically include public issued senior debt and private equity, as well as ODA financed concessional loans.

- ***Funding***

  The national off-taker for water and/or power typically contributes to the funding of the venture through direct tariffs on use, direct taxes, and/or through indirect taxes that contribute to repaying interest on external transfers, for instance, through ODA loans.

5.4.3 Where Do Delivery Models Fit In?

Even though the financing of infrastructure is complex and highly project-specific, the DMs can be used to better understand resource flows and business models. All DMs assume an infrastructure development IMPACT on downstream waters as well as shared BENEFITS across the Riparian States. The DMs illustrate the basic resource flows and interdependencies between counterparties, thereby informing the financing options and likely funding sources (see Figure 20 below).

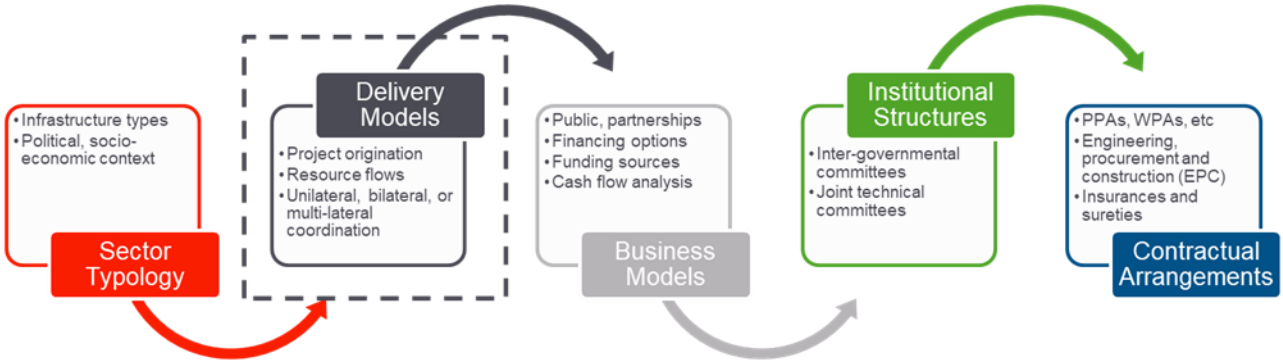


Figure 20: Pathways from Sector Typologies to Contractual Arrangements

5.5 Considerations for Financing Delivery Models

Section 5.4 demonstrates approaches to the financing and long-term funding of national and transnational water infrastructure, by illustrating how generic DMs inform their likely business models, finance options and corresponding contracting arrangements.

In practice, there are several key qualitative considerations that underpin the conceptualisation of infrastructure projects, the development of their DMs and the sources of funding and finance they are likely to be eligible for or attract. These thematic considerations inform a protocol – or high-level set of questions – that can help project proponents think through the potential financing sources available to them (see Figure 21 below) and most appropriate delivery model. Each key consideration is further discussed below.

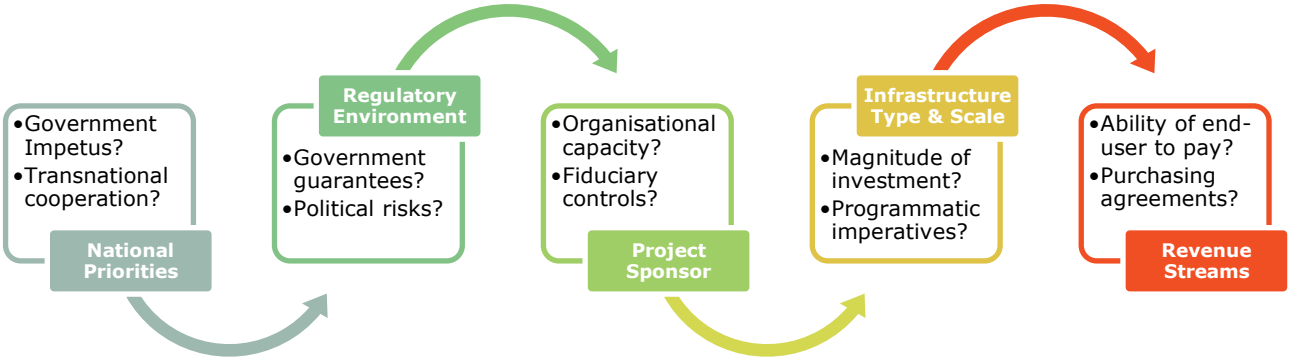


Figure 21: Protocol of Key Considerations to Inform Infrastructure Finance Sources

The first consideration, the **'national priority'**, considers:

- Whether a programme or project will be successfully developed, implemented and operated. In the near- and medium-terms, it considers whether the infrastructure is a national priority. In a transnational sense, the question evolves to consider a greater framework of bi- or multi-lateral cooperation.

- By way of example, Mozambique's highest poverty index is concentrated in its rural areas. According to the World Bank[70], the Government of Mozambique established that accelerating and expanding access to rural electricity is pivotal in addressing poverty. Therefore, as part of this growing political thrust over the past five years, Mozambique has fast become one of the countries in Sub-Saharan Africa with the highest rate of new connections, averaging 120,000 new connections per year. Furthermore, an increasing proportion of the power from Cahora Bassa' South Bank Power Station is bought back from ESKOM by the national utility in Mozambique, Electricidade de Moçambique. To enable sufficient supply for these new connections and the Country's increasing energy demand, Government's energy-mix plan is to maximize hydropower potential, especially through the Cahora Bassa hydropower extension (North Bank) as the primary source of electrification, while also investing in alternative sources of energy.

- Therefore, if the programme or project is a strong national priority, the infrastructure has a higher chance of being delivered, thereby being highly achievably and attracting multiple sources of finance. Where a programme or project is a national priority, with increasing cooperation between Riparians, it will likely attract the full spectrum of finance sources, including many private financing

[70] For more information see http://www.worldbank.org/en/news/feature/2017/03/01/world-bank-supports-rural-electrification-to-decisively-curb-poverty-in-mozambique

arrangements. Conversely, where the programme or project is not an immediate priority and co-operation between participating Riparians is poor, only public and concessional sources of finance are likely to be available, but not readily so.

The **'regulatory environment'** considers:

- The enforcement of legislation that can give financiers confidence that the project will succeed and original assumptions about project economics remain credible.

- For instance, this might include the availability and integrity of government guarantees over off-take from a project, or surety over the off-take of a state-owned enterprise. To take a historic example the ability of the Lesotho Highlands Water Project to ultimately obtain debt finance from regional and international capital markets at reasonable rates, depended in part on government guarantees. In this instance the government of South Africa provided a guarantee that payments for bulk water supply delivered from Lesotho would continue[71].

- Strong commitments from government can (all things being equal) often broaden the range of concessional and private financing options, as a result of confidence in higher levels of debt service coverage and debt repayments. Of course, the inability of government to act as a guarantor or stand surety will potentially diminish the ability to attract private sources of financing, and potentially reduce the magnitude and availability of concessional loans. Furthermore, political instability erodes the perception of good governance, pushing up the risk premium of commercial or concessional lending, whilst reducing the pool of non-public financing options.

The **'project sponsor'** considers:

- The organisational strength of the entity mandated to champion the development of the programme or project. 'Strong' organisation are typically characterised by adequate human capital, robust financial controls and expertise in raising and managing finance for project delivery. At least in terms of traditional financing organisations have also relied on their own resources and balance sheet for raising equity and debt financing.

- In a transnational sense, where governments establish and capacitate river basin organisations to champion shared infrastructure, well capacitated river basin organisations can improve bilateral cooperation for the delivery of infrastructure. For instance, the Senegal River Basin Development Organization is a regional cooperative management body of the Senegal River, established in 1972, which currently includes Guinea, Mali, Mauritania, and Senegal. The Senegal River Basin Development Organization is the project sponsor for the Manantali dam and hydropower project, which consists of the Manantali dam, a 200 MW power station and a network of transmission lines that carry power to the capitals of Mali, Mauritania and Senegal. According to The World Bank[72] the Senegal River Basin Development Organization is the only African river management entity that has systematically implemented the principle of equitable benefit sharing among member states in respect of ownership of infrastructure constructed in the river basin. The Senegal River Basin Development Organization is considered a strong and robust regional organization whose financial stability allows it to pursue technically feasible and politically supported transboundary projects. It

[71] In this case the Department of Water Affairs provided a 'income agreement' with TCTA a RSA parastatal organisation who took responsibility for delivering the project. This provided a guarantee that costs would be recovered from water users through a fixed Capital Unit Charge.

[72] For more information see http://blogs.worldbank.org/nasikiliza/setting-example-cooperative-management-trans-boundary-water-resources-west-africa

has the full support of its member states as its regional vision is aligned with the policies of its member countries. This contributed to the project being a major multi-donor initiative that included ten large-scale development financiers. As construction was awarded to a Swiss company, the Swiss government also provided an export guarantee for the civil works. Furthermore, KfW funding was reportedly covered by a Hermes guarantee provided by the German government. Donors provided both loans and grants to the three countries who were also required to provide funding from there national budgets.

- Therefore, strong organisations will be in a position to receive, manage and disburse larger sums of money than less experienced organisations. Strong organisations can potentially enable a wider range of infrastructure financing options to be accessed. Project sponsors who employ tight fiduciary controls are likely to benefit from lower concessional loan rates due to lower perceived risk by development financiers. Moreover, investment grade creditworthiness coupled with a strong balance sheet will enable the project sponsor to access a wide spread of financing options. The risk appetite of project sponsors may also differ. Project sponsors with a lower risk appetite will likely choose to transfer considerable risk to the private sector during design, procurement, construction and/or operations. A high transfer of risk would imply a significant equity position by the private sector, and a financial contracting arrangement that ensures the private counterparty is rewarded for performance. This can be an attractive model for commercial lenders and private infrastructure investors.

The **'infrastructure type and scale'** considers:

- The type of programme or project and how its physical scale might influence the magnitude of financing and finance sources. The type of financing required to implement large-scale developmental infrastructure varies across the different programmes (hydropower, irrigation, water supply, etc.) as well as over the different phases of project or programme development. This usually has direct implications on the sources of finance that may be applicable.

- The Water Finance Facility[73] is just one example of how smaller projects can potentially be aggregated to justify the project preparation and financial structuring support that smaller individual projects can struggle to secure. The Water Finance Facility mobilises large-scale private investment from domestic institutional investors, such as pension funds, insurance companies and other qualified investors, by issuing local currency bonds in the capital market in support of their own country's national priority actions on water and sanitation service delivery. The aim is to develop several country level water financing facilities, which can issue bond in their capital markets to provide long-term loans to public or private water utilities that have little or no access to commercial finance or that have access at unfavourable terms, such as short tenors. Through the pooling of credit worthy water projects, the bonds will have lower risk. This risk can be further reduced, if reserve funds, guarantees, soft loans or grants for blended finance can be incorporated into the capital market structures.

- Therefore, smaller projects with lower potential to deliver commercially attractive revenue streams tend to attract little-to-no private investment; unless of course the social or environmental impact attracts philanthropic organisations aligned to its goals. While government and development financiers have a mandate to support these projects it may be beneficial to adopt a programmatic approach and pool smaller projects with similar characteristics and capital requirements, as this re-

[73] For more information see https://waterfinancefacility.com/

duces individual transaction costs and may increase the attractiveness to public funds and development finance institutions. For example, in East Africa efforts are being made to pool demand for debt amongst water utilities in order to secure a combination of development and commercial finance. Conversely, large, conventional projects with clearer revenue streams (such as hydropower) tend to have access to a broader array of financing options. Their size may also mean that deploying a non-recourse project financing structure is feasible, where the transaction costs would be too high for smaller projects.

The **'revenue stream'** considers:

- The funding arrangements that will ensure an affordable infrastructure asset over the long-term. Fundamentally, one should consider whether the end-users and/or individual consumers can pay for the resource or service, and if this payment is truly cost-reflective. This will have implications for the sources of finance that can be considered.

- For example, under a project finance structure, the Batoka Gorge and Devils Gorge Hydroelectric Schemes will likely make use of two distinct revenue streams to enable the right mix of financing for their large-scale infrastructure components, being dams, hydropower stations and interconnectors. For the dam components, wholly owned by the Zimbabwean and Zambian governments, ZRA will be entitled to water payments (bulk tariffs) from the hydropower stations on each side of the Zambezi. These bulk tariffs will be structured to comprise both a capacity charge (to cover fixed costs and debt repayments) and a variable charge (to cover operating costs). The bulk tariff for the water supply agreement assumes that reduced power supply due to the hydrological causes will be borne predominantly by the utilities and ultimately power consumers. In terms of financing the hydropower stations, both the capex and opex will be passed on to ZESCO and ZPC by the SPVs, via the two PPAs. The PPA between the SPVs and ZESCO/ZPC will have a tariff structure which is split between: an availability charge for making their power plant available to provide power (to cover the power station capex, water payment capacity charges as well as its fixed operating expenditure), and a usage charge for the marginal cost of generating power as and when required (to cover the cost of the fuel and variable component of water payments required for the facility to generate power).

- Therefore, if user payments are feasible, and their payments are cost-reflective, this creates the conditions for a wide range of financing options, particularly non-concessional, commercial financing. This case also lends itself to exploring project finance structures, especially if the infrastructure asset is large enough. If, however, the end-users cannot pay, then government participation is required and government grants and low rate concessional loans ae more likely to be required. Furthermore, stable revenue streams also attract larger 'off-takers' whom may be willing to guarantee off-take of water, energy, etc.

5.6 Next Steps

This chapter has attempted to provide a basis for thinking about how each of the priority projects identified in this ZSP can be progressed through viable delivery and funding/financing models. This has included:

- A brief refresher on the infrastructure project development cycle, and the importance of matching appropriate financing, covering funding gaps, to the relevant phase of the cycle;
- A data-driven look at how water (and related) infrastructure is currently being funded and financed on the African continent, and within the Zambezi Basin area;

- The development of delivery model typologies to guide approaches to project development and operational structuring, particularly to raise and sustain appropriate funding and financing; and
- A discussion on important thematic considerations for funding and financing water infrastructure project delivery models.

Important takeaways from this chapter include:

- The critical importance of considering how all phases of a project's development cycle will be funded and financed (where necessary). In particular, the preparation and operation phases have their own funding characteristics and requirements, distinct from the better-understood implementation phase. The former two phases have often been neglected, to the detriment of the project's bankability and sustainability. In turn, sourcing appropriate funding and finance for these two phases is comparatively more difficult than for implementation. Project proponents must give due consideration to how preparation activities, and operations over the long term (including maintenance and refurbishment) will be funded and financed.
- An examination of water infrastructure funding and financing in Africa and the Zambezi Basin region reveals that funding and financing from more traditional sources – national governments, ODA from established bilateral and multilateral sources – dominates commitments. In comparison, private sector investment in water infrastructure projects on the continent and in the region over the last several years has been negligible. This should not detract project proponents from actively exploring more innovative or novel sources of funding and financing for their projects – this is critical. However, it must also be acknowledged that, in most cases for the identified priority projects in this document, national governments and established donor sources will provide the majority of capital for project delivery. This must be factored into project strategy and structuring for funding/financing.
- Delivery model archetypes, and the key thematic considerations around them, provide a valuable tool for project sponsors and designers to craft an institutional, governance, and commercial structure to best attract funding and financing for the project. This is critical to ensuring the short-term viability, and long-term sustainability, of the projects in question.

In the following Chapter 6, we build on from the contents and conclusions of this chapter in two ways:

1. The identification and categorisation of specific sources of funding and financing which may be well suited to the projects identified in the 2027 Priority List.
2. The structuring of a selected spectrum of the identified projects for development, providing case studies on how the delivery model archetypes and thematic considerations can be deployed to guide packaging of real-world project examples.

6 Programme and Project Financing and Packaging

Chapter 4 derived a *2027 Priority List* of projects, grouped by theme across four programmatic areas. Chapter 5 proposed and explored a number of delivery model typologies, providing frameworks by which the shortlisted projects may be structured to ensure viable development. Chapter 5 also took a closer look at current trends in water sector infrastructure funding and financing across Africa and in the Zambezi Basin region, providing insight into potential sources of funding and financing for the shortlisted projects.

This chapter now begins to identify specific sources of funding and financing which may be suited, and have appetite for, the shortlisted projects and wider programmatic areas. Further, this chapter also explores ways in which projects can be structured and packaged to most effectively attract and align with such sources. Finally, this chapter is complemented by Appendix E, which looks in more detail at joint cooperation, offering insights on principles for trans-boundary projects.

It should be kept in mind that this is the first step in a comprehensive process that will iteratively lead to the successful financial close of a number of bankable projects. As it stands, there are over 60 projects in the 2027 Priority List, covering numerous geographies, themes, sponsors, size, and maturity. It is beyond the scope of this document to propose a financing strategy for each. Moreover, details on certain of the shortlisted projects are incomplete. Nevertheless, this chapter will provide valuable guidance towards this objective.

6.1 Funding and Financing Project and Programme Development

As alluded to previously, a critical element of preparing and implementing the specific projects identified in this document, is understanding the funding and financing needs, and possible sources and mechanisms to meet those needs, as early in development as possible.

Capital is required to enable a project over its life cycle, from early-stage conceptualisation through to implementation, and then ongoing operations and maintenance. The nature and quantum of cashflow requirements over this period, to ensure project success and sustainability, will vary significantly from one lifecycle stage to another. Appropriate funding and financing must be sourced and integrated into an optimum financial model to cover these requirements. Both project-specific and thematic programme-level funding and financing modalities have potential in the context of this strategic plan, and should be explored. The former allows for flexibility in choosing appropriate funding and financing, whilst the latter would allow for programmatic allocation to a number of projects sharing a similar theme or sector, over several years.

Identification of potential sources of such funding and financing, and the role each is to play, must begin as early as possible. This exercise plays a critical role in project definition, conceptualisation, and preparation, firstly to identify potential sources of preparation funding and finance, and secondly to begin assessing the market for project implementation and operational funding and finance. Without adapting a project's design to take into account the characteristics and requirements of available funding and financing, viability will be affected. Project development choices must be aligned with appropriate funding and financing sources, and vice versa.

A comprehensive review was conducted to begin the process of identifying possible funding and financing for each of the projects, and collectively within each of the four thematic programme areas described in Chapter 4. A large number of funding and financing agencies with possible appetite for investing in the projects were analysed, and their potential as a funding or financing source for the indicated thematic programmes, or specific projects within those programmes, assessed. The following sections summarise the findings of that analysis and assessment.

A Programmatic Approach to Funding and Financing the ZSP

A programmatic structure has been proposed in Chapter 4, grouping shortlisted projects within four broad thematic programmes of action – Energy, Agriculture, Water Supply, and Catchment and Riparian Asset Management.

A programmatic approach to funding and financing the proposed investment framework, in part or whole, is a possibility and should be explored. Typically, this would see a financier or group of financiers sought to provide funding and financing for ZAMCOM and the riparian states to pursue preparation and/or implementation of several projects within a specific thematic programme area over a multi-year period.

A programmatic approach can take advantage of similarities in mandate, economies of scale, combined institutional resources, and cross-cutting linkages - it is often a more efficient and effective means of executing an investment plan of this nature compared to tackling projects individually. The approach also significantly reduces institutional and implementation risk.

There are several possible transactional mechanisms by which such an approach can be followed. Although a single investor is a possibility, it is more likely that a multi-lateral fund is established to consolidate and ring-fence resources from several financiers that share common investment traits. Such committed funding can then be effectively allocated towards development of a number of initiatives over a multi-year horizon in a structured manner.

Institutional structuring is key to the efficacy of such an approach. In designing an appropriate programmatic financing mechanism, it is necessary to understand how and where funding will flow and be managed at regional, national and/or local levels. The institutional and fiscal relationships between regional stakeholders and national government entities, and the policies governing the raising, deployment, and repayment of financing, need to be fully understood. In particular, the transboundary nature of nature of several of the shortlisted projects, and the geographic spread of national projects, make any programmatic approach complex. It is recommended, as a next step of this exercise, that these relationships and policies are explored and defined in preparation for structuring the programmatic funding approach.

6.1.1 Funds and Finance Review Considerations

The water-oriented infrastructure funding and financing landscape is extremely broad, consisting of numerous disparate sources with different characteristics, objectives, appetites, and conditionalities. It is unlikely that a single source will cover all costs through a project's life-cycle. Rather, any financial solution will likely consist of funding and financing from multiple sources in an appropriate investment structure. Hence this review has attempted to construct as large a pool of potential funding and financing sources as possible.

In assessing whether a funding or financing source was potentially suitable for each programmatic area or project, and if the programmatic area/project was eligible for the funding and finance source, the following main factors were considered at this preliminary stage. These factors complement the thematic considerations discussed in Section 5.5 – where relevant, specific notes are made on these considerations in the review of specific sources.

- **Geographic Location**

Almost every financial source targets certain countries and regions, whilst excluding others. Project location, and the perceived associated risk (eg. fiscal or political circumstances excluding certain funders) has an obvious impact on a project's eligibility for that particular source.

In addition, certain sources will only engage with projects in countries that form a part of a certain definition or grouping. Some of the most relevant to this initiative were the:

- Categorisation on the OECD's DAC List of ODA Recipients;
- Signatory to the UNFCC's Kyoto Protocol and/or Paris Agreement; and
- Member of the SADC Regional Block

- **Project Sector**

The sector(s) or theme(s) a project falls under will have an impact on the funding and finance it can potentially access. Many funds or financiers target specific sectors, which precludes projects that fall outside of these sectors even if overarching objectives (for example, climate change resilience of rural communities) are shared. Common developmental sectors targeted, that are relevant to the context of this document, include:

- Water (supply and sanitation, resources development and protection);
- Agriculture and food security;
- Energy, power generation, and access to eletricity; and
- Climate change resilience, adaptation, and mitigation

When conceptualising a project, it is important to consider its broader impact, and the implications this may have on the pool of potential funding and finance sources. For example, a hydro-power plant will primarily fall under "energy and electrification", and thus possibly be eligible for funding and finance targeted at this sector. However, if one of the spin-off benefits is water supply to and electrification of surrounding agricultural communities and an increase in agricultural production, then it is likely that the project would be considered by financial sources targeting the agriculture and food security sector.

In this regard, it is important when packaging and promoting the project, that both the direct and indirect outputs are emphasised to broaden the funding and finance pool and speak to the sectors being targeted by funders and financiers.

- **Funding/Financing Type and Capacity**

There are myriad forms of funding and financing available, ranging from grants to complex quasi-equity offerings. All of these are suited to specific types of projects, or particular development phases of a project. In addition, each source may have upper and lower bounds (brackets) with regards to the amount it is prepared to offer, or a total capacity which may limit the quantum any single project receives. Numerous sources are only focused on larger-scale projects with a minimum value hurdle. Each has their own appetite in terms of the investment risk they are willing to take on.

Certain sources may also provide non-monetary assistance, such as technical expertise, which would otherwise have to be financed.

At this preliminary stage, for many sources, this information is not readily available without a more in-depth engagement.

- **Project Form and Beneficiaries**

Related to several of the above considerations, each project can assume an institutional form (and ultimately a financial modality/structure) which has an impact on the funding and finance available to it. These include:

  - Public – the project is entirely public-sector entity led, developed, and operated
  - Private – the project is private sector developed and operated
  - Public-Private Partnership (PPP) – the project is developed and operated in partnership between public and private sector entities

Certain funding and financing sources will only consider projects that fall into one of these forms e.g. a developmental finance institute may only consider projects in the private sector for its various financing offerings, excluding pure public sector owned and run projects from consideration.

It should be kept in mind that different project phases may assume different institutional forms. For example, projects may be public sector-led during the preparation phase, which may make them ineligible for preparation funding and finance earmarked for private sector beneficiaries. However, during the implementation and operation phases, a project may involve private sector participation in some form, opening up new funding and finance opportunities.

- **Geographic Reach**

Many sources of funding and finance will only consider projects that have regional or national impact, disqualifying initiatives at a sub-national level. Conversely, some sources will not consider transboundary projects for various reasons. Each project's reach needs to be considered carefully – whilst the physical project may only have a sub-national footprint, it's up- or downstream impact may be national or regional.

- **Project Stage**

Another major consideration is that of the project's development stage. The majority of potential funding and finance sources do not provide funding and finance for the project preparation phase. Conversely, there are sources specifically established to fund the preparation phase of a project. Operational financial needs are often somewhat neglected or viewed optimistically during the preparation and implementation stages, but are critical to a project's long term sustainability.

- **Revenue Generation and Commercial Viability**

A project's capacity to generate revenue has especially important implications in terms of its ability to attract and source certain types of funding, financing, and private participation, most notably those that require commercial returns.

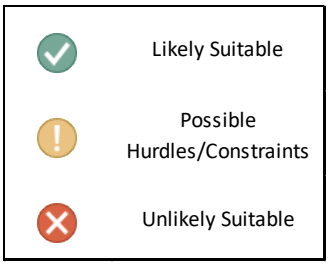
Depending on the level of financial sustainability and scope of the returns achievable, this opens up possibilities with respect to commercial loans, bonds, public-private partnerships, private equity funds, and financing sources that target private sector entities involved in developmental projects (such as numerous developmental finance institutions), amongst others.

Although not always possible, particulary where projects are intended to directly benefit the poor or underserved, it is important that every avenue is explored in project conceptualisation and preparation.

6.1.2 Utilising and Interpreting the Funds and Finance Review

The funds and finance review summaries that follow list a number of possible funding and financing sources that offer potential to support shortlisted projects within the four programmatic themes identified in Chapter 4. The results are displayed by theme, indicating where it may be possible to structure thematic programme funding mechanisms.

Each source is 'ranked' according to a traffic light system – green means that at least one project within the overlying theme is likely a strong candidate for funding and finance from that source. Yellow represents possible caveats to suitability, whilst red signifies that the source is unlikely to be suitable for any of the identified projects under the programme in question.



This ranking is complicated to some extent by the relatively broad nature of each theme, and diversity of underlying projects. As a notable example, there are many sources of funding and financing for renewable energy development which would be well suited to several of the shortlisted projects under the Energy theme. However, whilst they may have appetite for hydropower, they would not have an interest in the thermal power initiatives. This means that, in some cases, the traffic light ranking for a particular source is applicable only to a subset of underlying projects, and not the programmatic area as a whole.

Further intricacy is manifested in the geographic variety of projects, both transboundary and national/sub-national. Certain sources may have appetite for a large number of project types under a particular theme, but be restricted to investing in only those that fall within their geographic mandate. In a small number of cases, despite a theme/sector match, none of the underlying projects may be eligible due to their location.

Theme and location are the two fundamental factors reflected in the summary of the review depicted below. However, as alluded to in Section 6.1.1 above, there are several others that impact the suitability of a funding or financing source of a particular project, and vice versa. Such details are elucidated in the full Financial Review Table, an excel workbook referenced in Appendix D and available as a digital file.

Ultimately it means that, if a programmatic financing approach is followed, a number of more focused themes and programmatic areas should be defined, and the pool of potential financiers carefully identified.

The inputs and assumptions utilised in conducting the finance review, and the detailed findings, are contained within the Financial Review Table, and should be referred to on identifying sources of further interest in the summaries here. The detailed information includes specifics on eligibility hurdles, the application process, contacts, and links to further information, amongst others. ***The Financial Review Table is sortable and searchable, and will be a valuable tool in kicking off and informing the process of developing a detailed funding and financing strategy for programmes or specific underlying projects.***

6.1.3 Potential Sources of Funding and Financing

Sources of funding and financing that can be considered for development of the 2017 Priority List include the following:

1. **Internal Revenue Generation**
    a. Can be used to directly cover costs, or leveraged to raise external financing
    b. Project dependent
2. **Local and National Government Budgets or Sovereign Loans/Bonds**
    a. Government fiscal support, typically in the form of grants or transfers
    b. Government as a co-financer often increases project's attractiveness to external sources, particular if it is structured as first-loss capital, or similar

   c. Government can also provide investment guarantees, covering other investors to some degree for commercial risks
3. **National Agencies or Funds** (with a relevant mandate)
   a. Typically technical assistance, grant funding, or concessional loans
4. **Project Preparation Facilities**
   a. Funds and facilities set up and supported by multilateral or bilateral development banks and funds, specifically for the purpose of supporting project preparation, and expediting and strengthening project development
   b. Typically provide grant funding and technical assistance, although a small number also provide concessional loans or risk capital
5. **Regional Finance Institutions**
   a. Loans at concessional or commercial rates, equity, guarantees or credit enhancements
6. **Climate Funds (often a subset of bi- or multilateral offerings)**
   a. Typically grant funding, or occasionally concessional loans
   b. Often on "incremental" principle
7. **Multilateral Development Agencies, Banks, and Funds**
   a. Typically grant funding and concessional loans, also guarantee and credit enhancement instruments
   b. A small number offer loans at commercial rates or equity capital
8. **Bilateral Development Agencies, Banks, and Funds**
   a. Typically grant funding and concessional loans
   b. Equity capital and loans at commercial rates are rare
   c. Export credits and trade assistance
9. **Development Finance Institutions and Funds**
   a. Loans at concessional or commercial rates, equity, hybrid instruments, guarantees
   b. Dependent on project having private participation
10. **Foundations and High Net Worth Individuals**
   a. Often proactive and independent in choosing their projects
11. **Private Developers, Investors and Capital Markets**
   a. Commercial loans, equity, hybrid instruments
   b. Clean Development Mechanisms - trading credits (project dependent)

Funding Project Preparation

Project preparation is a vital, first project development phase that ultimately transforms an idea into a feasible and bankable venture ready for external project financing – that the project is viable, risks mitigated, and is ready to receive funds for implementation. Without thorough preparation, it is unlikely that a project will attract sufficient and appropriate financing to allow it to proceed. Conversely, a thorough and well-conducted preparation phase can open access to a wide pool of potential financing and significantly improve a project's chances of success.

Unfortunately, funding and financing to cover activities undertaken in this early phase has typically been a critical constraint to infrastructure development and service provision on the African continent. Projects at this early stage of their development are still inherently risky, and as a result most investors have limited appetite. The funding that is available has often focused on the middle-to-late stage preparation activities, and neglected the foundational importance of early enabling and definition steps. In addition, funding has been squandered due to a lack of clear planning and direction. As a result, many promising and much-needed interventions have failed to get off the ground in a sustainable manner. There is, however, increasing awareness of this gap, and a growing number of initiatives, and project preparation facilities and funds, are attempting to expand and expedite critical project development in Africa.

The sources of project development funding and financing identified in the review process as having potential relevance to this ZSP and the 2027 Priority List, are listed in Table 19 below (categorised by dedicated project preparation, multilateral, and bilateral sources, in alphabetical order).

Table 19: Potential Sources of Funding and Financing (Source: Pegasys Analytics)

Dedicated Project Preparation Sources					
Source	**Eligible Countries**	**P1: Energy**	**P2: Agriculture**	**P3: Water Supply**	**P4: Asset Management**
Africa Climate Change Fund (ACCF) (African Development Bank)	All	✓	✓	✓	✓
African Water Facility (African Development Bank)	All	!	!	✓	✓
Agriculture Fast Track (AfDB)	Malawi, Mozambique, Tanzania	✗	✓	!	✗
DBSA Project Preparation Fund	All	✓	✗	✓	✗
DevCo (Private Infrastructure Development Group)	All except Namibia, Botswana	✓	✓	✓	✗
Global Infrastructure Facility	All (but focus on LI and LMI countries)	✓	✗	✓	✗
InfraCo Africa (Private Infrastructure Development Group)	All (Namibia, Botswana with exceptional application)	✓	✓	✓	✗
NEPAD Infrastructure Project Preparation Facility (African Development Bank)	All	✓	✗	✓	✗
Public-Private Infrastructure Advisory Facility (PPIAF) (World Bank)	All (priority to low-income)	✓	✗	✓	✗
SADC Project Preparation and Development Facility (PPDF)	All	✓	✗	✓	✗
Technical Assistance Facility (Private Infrastructure Development Group)	All	✓	✓	✓	✗

Multilateral Sources					
Source	**Eligible Countries**	**P1: Energy**	**P2: Agriculture**	**P3: Water Supply**	**P4: Asset Management**
Adaptation Fund	All	!	✓	✓	✓
Africa Agriculture Development Company (AgDevCo)	Malawi, Mozambique, Tanzania, Rwanda (but others possible)	✗	✓	!	✗
Africa Enterprise Challenge Fund (AECF)	All except Angola, Botswana, Namibia	✓	✓	!	!
African Development Bank AfDB	Angola, Botswana, Namibia (others have access to AfDB's ADF)	✓	✓	✓	✓
African Development Fund (African Development Bank)	All except Angola, Namibia, Botswana	✓	✓	✓	✓
Climate for Development in Africa (ClimDev) Programme (Global Climate Change Alliance)	All	!	!	!	✓
ClimDev-Africa Special Fund (CDSF) (African Development Bank)	All	!	!	!	✓
Development Bank of Southern Africa (DBSA) (SADC region)	All	✓	!	✓	✗
Emerging Africa Infrastructure Fund (Private Infrastructure Development Group)	All	✓	!	✓	✗
EU-Africa Infrastructure Trust Fund (European Investment Bank)	All	✓	✗	✓	✗
EU-EDFI Private Sector Development Facility (EEDF)	All (under SE4All initiative)	✓	✗	✗	✗
European Development Fund (EuropeAID)	All (Botswana, Namibia priority areas of less relevance to ZSP initiatives)	✓	✓	✓	✓
Global Environment Facility (GEF)	All (restrictions on underlying funds)	✓	✓	✓	✓
Global Partnership on Output-Based Aid (World Bank)	All	✓	✓	✓	✗
Green Climate Fund (GCF)	All	✓	✓	✓	✓

Source	Eligible Countries	P1: Energy	P2: Agriculture	P3: Water Supply	P4: Asset Management
GuarantCo (Private Infrastructure Development Group)	All except Namibia, Botswana	✓	✓	✓	✗
IDA/IBRD (World Bank)	All	✓	✓	✓	✓
International Fund for Agricultural Development IFAD	All except Namibia, Botswana	!	✓	!	!
IRENA/ADFD Project Facility	All	✓	✗	✗	✗
Opec Fund for International Development (OFID)	All	✓	✓	✓	✗
Pilot Program for Climate Resilience (PPCR) (Climate Investment Funds)	Malawi, Mozambique, Zambia	!	✓	✓	✓
Rural Water Supply and Sanitation Initiative Trust Fund (African Development Bank)	All	!	!	✓	✓
Scaling Up Renewable Energy Program (SREP) (Climate Investment Funds)	Malawi, Tanzania, Zambia	✓	✗	✗	✗
Sustainable Energy Fund for Africa African Renewable Energy Fund (African Development Bank)	All	✓	✗	✗	✗

Bilateral Sources					
Source	**Eligible Countries**	**P1: Energy**	**P2: Agriculture**	**P3: Water Supply**	**P4: Asset Management**
Agence Francaise Developpment	Angola, Mozambique, Tanzania, Zambia	✓	✓	✓	✓
Austrian Development Cooperation ADA	Mozambique, SADC	✓	✓	!	!
Belgian Development Agency Enabel	Mozambique, Tanzania	✓	✓	✓	✓
CDC Group (UK)	All	✓	✓	!	!
China ODA (various institutions, on a case-by-case basis)	All	✓	✓	✓	!
Danish International Development Agency DANIDA	Tanzania	✗	✓	!	!
European Investment Bank	All	✓	✓	✓	✓
FMO (Netherlands)	All	✓	✓	✓	✗
Foreign Affairs, Trade and Development Canada Canada International Development Agency CIDA	All except Namibia	✗	✓	!	!
German Federal Ministry for Economic Cooperation and Development BMZ German Federal Enterprise for Int. Cooperation GIZ	Malawi, Mozambique, Namibia, Tanzania, Zambia, Botswana (GIZ - HQ for SADC)	✓	✓	✓	✓
International Finance Corporation (World Bank)	All	✓	✓	✗	✗
Italian Development Cooperation OpenAid	All	!	!	!	✗
Japan Bank for International Cooperation	Angola, Mozambique, Tanzania (others possible)	✓	✗	!	✗
Japan International Cooperation Agency	All except Angola	✓	✓	✓	✓
KfW (Germany) KfW DEG	All except Angola, Botswana, Zimbabwe	✓	✓	✓	!

Based on the trends identified in Chapter 5.2, it is clear that a substantial majority of the total funding and financing for the 2027 Priority List will come from the fiscus of the Riparian States, and from providers of

developmental assistance (both established and emerging). For this reason, the finance review at this stage concentrates in this area. Identifying suitable support from these providers, and beginning to structure/package the projects to suit, should be a priority. In the next phase of developing a detailed financing strategy, additional potential sources of funding and financing outside of these primary pools can be explored. This includes, where relevant to the particular project in hand, appropriate private sector partners/sponsors, if not already in place.

6.1.4 Developing a Comprehensive Funding and Mobilisation Strategy

The finance review is a first significant step in developing a full funding and capital raising strategy for the ZSP and 2027 Priority List. While the shortlisted projects are at varying stages of maturity, engagements with prospective funders and financiers should commence as early as possible. These early engagements are used to assess appetite and wherewithal, which can assist in financially positioning a project or overarching programme.

The strategy must build on the findings of the finance review to consider the funding needs of each project in detail, and begin to narrow down to the most appropriate sources of capital, within viable financing mechanisms. This may include pursuing programme-level funding structures for some, all and/or any newly developed and more focused themes, exclusively or in conjunction with project-level financing where appropriate.

The strategy must also consider the most appropriate phasing of project development, including taking into account the two main development stages (project preparation, and project implementation), as well as operational time horizons and funding needs. This will be influenced (and vice versa) by the timing, nature and quantum of funding and financing expected to be raised directly or indirectly by sponsors and implementing entities.

Finally, the strategy should define universal factors that should be considered in moving the identified projects and programmes forward and optimally positioning them for funding and finance. These include:

- **Alignment with funders objectives and results areas** - many investors and funders have specific funding objectives/criteria, and monitor their success based on specific Results Areas. Projects and programmes need to emphasise their alignment with these funders' objectives and result areas.
- **Local funding and support sources** – even a small amount of financial or technical support from local or national government entities demonstrates will and commitment to the project or programme in question. This can build the confidence of external funders and financiers in a project, and make it more attractive for financing.
- **Sectorial and geographic reach** – projects and programmes should emphasise not just their immediate and explicit sectorial impact, but also cross-over impact and secondary benefits, so as to appeal to as wide a range of financiers as possible. In addition, developmental funders and financiers typically like projects with expansive impact at a regional or national level. Where possible, projects and programmes should also aim to accentuate their regional or national impact so as to appeal to these sources, even if the physical intervention is based sub-nationally in the Basin.
- **Revenue-generating "add-ons"** – a project's ability to generate internal revenue, even if not at self-sustaining levels, significantly increases viability and opens the door to numerous additional financing sources.
- **Private sector participation** – including the private sector to some degree in a project's development and/or operation, where possible, opens access to the substantial pool of developmental

finance aimed at the private sector entities. In addition, the private sector can bring additional capacity and expertise to a project.

- **Leveraging existing relationships** – the riparian states have existing relationships with numerous of the potential financing sources identified in the finance review, in some cases through similar previous projects. These relationships should be leveraged in sourcing financing for new ventures.

In designing the funding strategy and mechanisms, particularly with a programmatic approach, it is imperative to understand the institutional and fiscal linkages amongst the various role-players. This is particularly crucial for the multijurisdictional transboundary projects. This centres around certain policy and governance questions such as: who raises the financing, who manages and deploys the financing, and who repays the financing? Moving forward, it is recommended that a comprehensive diagnostic is undertaken to understand how the proposed entities will link together from a financing perspective, as a part of designing the overall approach to financing implementation of the ZSP.

6.2 Project Structuring and Packaging

The aim of this section is to explore how projects can be structured – both institutionally and financially – to meet investor needs.

The chapter is based on exploring a series of case studies, drawn from the representative projects outlined in Chapter 4, each representing one or more of the programme areas which have been used to structure the Infrastructure Inventory. For each programmatic area, one case study of a complex transboundary project has been developed, looking at institutional and financial options for its delivery. Against this, differences in challenges faced by other projects within the same thematic area, have been highlighted.

The following case studies have been explored:

Programme	Transboundary Joint Case Study	National Case Study
Energy	Batoka Devils Gorge	Cahora Bassa (HES) Extension
Agriculture	Songwe	Chobe - Zambezi Transfer
Water Supply		Bulawayo-Zambezi Transfer

6.2.1 Transnational Hydropower: Batoka Gorge Hydroelectric Scheme

Project Background and Summary

The development of a hydropower scheme on the Zambezi River, 54km downstream of Victoria Falls ("the Project"), has been investigated in various forms since 1904. As shown on Figure 22, the Project is to be located in the central portion of the Zambezi River Basin, situated upstream of the existing Kariba Dam hydroelectric scheme and downstream of the Victoria Falls.

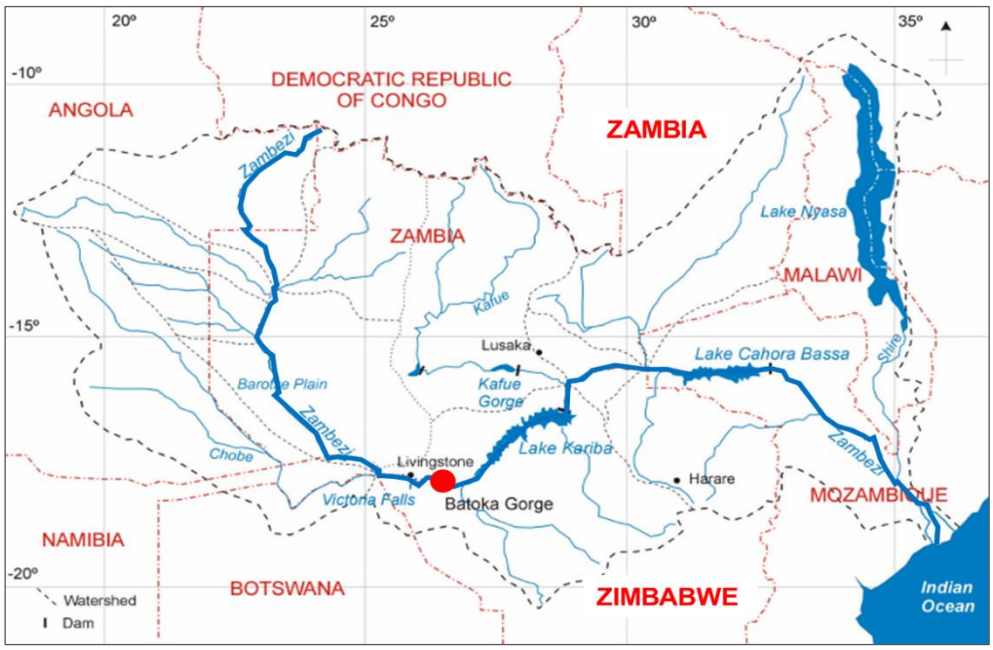


Figure 22: Project Location along Zambezi River

The impetus for implementation of the Project is meeting the future demand of power in Zambia and Zimbabwe, as well as regionally. Zambia's current installed generation capacity is around 2,350 MW, made up of a range of hydropower and diesel generation facilities. Zimbabwe's current installed generation capacity is around 1,960 MW, made up predominantly of coal and hydropower generation. The Project would add a further 1,200 MW of hydropower capacity to each country and make an additional 2,400 MW available to the SAPP.

What specific infrastructure assets would need financing?

Based on the latest engineering studies, there are three main infrastructure components under consideration as part of the Project, comprising:

- Dam (x 1): a 181m high, 720m long roller compacted concrete gravity arch dam, a radial gated crest type spillway, and four intakes in the reservoir which will take the water through 4 tunnels (each ~1km in length) to two surface power plants downstream of the dam;
- Power Plants (x 2): one on either side of the river bank, each having a capacity of 1,200MW (6 x 200MW turbines in each powerhouse); and
- Transmission lines: 330kV in Zambia and 400kV in Zimbabwe[74].

The project costs for the Project's three construction components are set out in Table 20 below and total $3.5 billion, of which $2.9 billion represents construction costs. It is assumed that the SPVs which will own and operate the two power plants will be funded on a 30% equity and 70% debt basis whilst the dam will be wholly debt funded.

It is worth noting that discussions about the vulnerability of Batoka to changing catchment and wetland conditions in the Upper Zambezi River Basin, could result in linking conservation of parts of the forests,

[74] The 400kV lines directed to Zimbabwe will go to the Hwange thermal power station, and in Zambia the outgoing 330kV lines from the Project will go to the future Livingstone station.

woodlands and wetlands with the development of the infrastructure. This highlights the relevance of Programme 4 (Catchment and Aquatic Natural Assets) with the other programmes.

Table 20: Capital Outlay for the Three Project Components

USD'000, 2015 terms	Dam	SPV1/ North bank power co.	SPV2/ South bank power co.	Total
Construction Costs	1,642,076	617,582	617,582	2,877,240
Interest during construction	400,737	64,763	64,763	530,263
Pre-funding of DSRA	-	27,734	27,734	55,468
Arrangement fees	58,818	16,655	16,655	92,128
Commitment fees	36,498	4,956	4,956	46,410
Agency fees	700	325	325	1,350
Total Project Costs	**2,138,829**	**732,015**	**732,015**	**3,602,859**
Equity	-	219,552	219,552	439,104
Senior Debt	2,138,828	512,464	512,464	3,163,756
Total Sources of Funds	**2,138,828**	**732,015**	**732,015**	**3,602,858**

What is the institutional set-up and who are the project sponsors?

In the case of the Batoka Gorge Hydroelectric Scheme, the counterparties involved in the development of the infrastructure are the ZRA, Zambia Electricity Supply Corporation Limited (ZESCO) and Zimbabwe Electricity Supply Authority (ZESA). Each of the three key counterparties are described below:

ZRA is a corporation jointly and equally owned by the governments of Zambia and Zimbabwe, is the implementing agent for the Project and also acts as the Project's sponsor. ZRA was formed by the Zambezi River Authority Act of 1987 and is governed by four Ministers: two in the Republic of Zambia, and two in Zimbabwe.

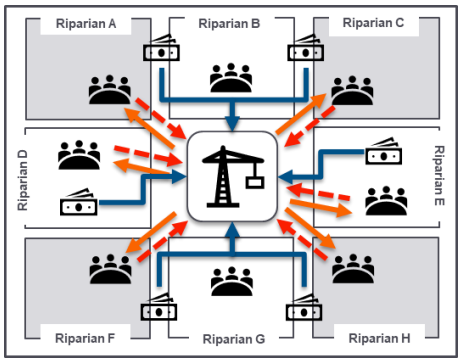
ZESCO Limited is a parastatal, with the main function of producing power in Zambia. ZESCO produces approximately 80 % of the electricity consumed in the country and has historically been the main player in the generation, transmission and distribution of electricity in Zambia.

ZESA, officially called ZESA Holdings (Pvt) LTD., is a state-owned company whose task is to generate, transmit, and distribute electricity in Zimbabwe. It delegates these task to its subsidiaries, the energy generating company Zimbabwe Power Company (ZPC) and the Zimbabwe Electricity Transmission and Distribution Company.

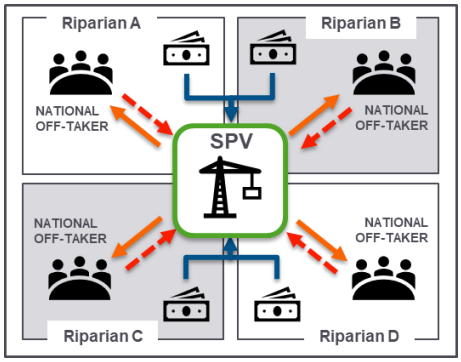
The ZRA has been mandated by the Governments of Zimbabwe and Zambia to develop the Project, whilst the African Development Bank has been chosen as the implementation agent.

What are the possible delivery and financing models?

There are two distinct DMs at play, which correspond with the two main infrastructure components of the Project, namely the dam and power plants. The DMs that best represent the dam and power plants are the "Multi-Lateral, Basin Deployment" and "Multi-Lateral, Joint Deployment", respectively. Each of these is briefly discussed, as follows:



The Dam will be developed by the ZRA, which is governed by both Zimbabwe and Zambia, who share the costs and benefits according to an agreed formula. Through the ZRA, both countries also share responsibility for planning and delivering the project. The dam stores water which has multiple uses. The ZRA is planning to sell water to both national off-takers (power plants) and use this commitment to access concessional finance.



The Power Plants are more complex to construct, commission and operate than the dam. They also have the potential to derive clearer revenue streams through the sale of power. As a result, the use of an SPV which attracts private sector expertise and finance, and in so doing, minimises the risk to the Zambian and Zimbabwe Governments has been selected.

Following approval of the preferred business model by the ZRA, a split commercial structure was adopted whereby the dam would be owned by ZRA, and the power plants would be developed under a project finance structure and owned by SPVs. Under this set up, equity could be provided by the private sector and the relevant country's utility, and debt could be being raised from both the private sector and development finance institutions. The dam will be financed by debt and grants raised by the respective countries, and then on lent to ZRA through subsidiary agreements between the Authority and the governments of Zambia and Zimbabwe. This commercial structure is summarised in Table 21 below.

Table 21: Selected Commercial Structure for Dam and Power Plants

	Ownership	Financing
North Bank Power Plant	North Bank Power Co.	Public / Private
Dam	ZRA	Public
South Bank Power Plant	South Bank Power Co.	Public / Private

The dam will be delivered under an EPC contract and ZRA will select a contractor through a competitive tendering process. ZRA will operate and maintain the dam and will be compensated via water payments made by the SPVs or Power Companies in accordance with the terms of their water supply contracts. The water payments will be structured to comprise both a capacity charge (to cover fixed costs and debt repayments) and a variable charge. The payment mechanism for the water supply agreement assumes that the hydrological risk (in terms of reduced volume of water flow, and hence reduced power supply) will predominantly be taken by the utilities and ultimately power consumers.

Financing for each power plant (i.e. South Bank Power Co. and North Bank Power Co. collectively referred to as the SPVs) will be undertaken based on project finance structure with a combination of equity and debt finance. Each SPV will be responsible for financing and constructing their respective power plants. Operations & maintenance for the power plant will also be the responsibility of the SPVs who will enter into operation and maintenance contracts to deliver these services.

The SPVs will enter into power purchase agreements (PPAs) with ZESCO and ZPC which will be supported by back to back Power Export Agreements between ZESCO/ZPC[75] and other regional utilities. The capital expenditure (capex) costs of constructing the two power plants and the annual operation and maintenance costs of the plants will be passed on to ZESCO and ZPC via the two PPAs. The power purchase agreements between the SPVs and ZESCO/ZPC will have a 'tariff' which is split between:

- An **availability charge** for making their power plant available to provide power and this charge will cover the capital expenditure involved in building the power station, water payment capacity charges as well as its fixed operating expenditure; and
- A **usage charge** for the marginal cost of generating power as and when required and such charge usually covers the cost of the fuel (and in this case, the variable component of water payments) required for the facility to generate power.

Figure 23 below illustrates these ownership and contracting structures.

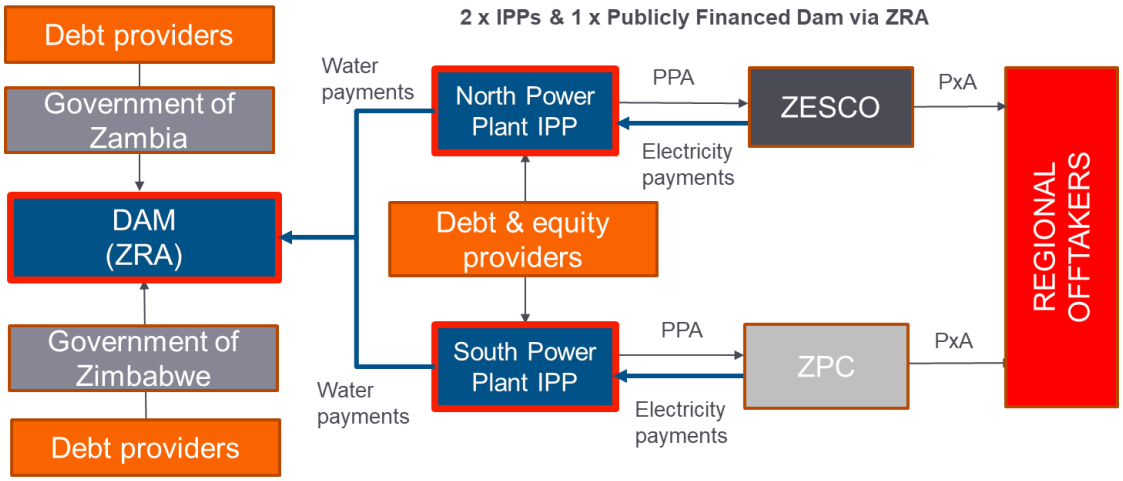


Figure 23: Selected Ownership and Contracting Structures

A financial modelling exercise (shown in Table 22 below) concluded that the SPVs will require a power payment/tariff of US$c 3.2 per kWh to cover its costs, including the water payment, and to ensure returns for shareholders. These were calculated using an assumed Project Internal Rate of Return of around 10.0% (USD real-terms)[76].

[75] An Implementation Agreement is currently being developed which will provide a direct contractual obligation and undertaking between the Government of Zambia and Zimbabwe and each SPV.
[76] Modelled using 6-month LIBOR plus 300bp for the dam and 750bp for the IPPs.

Table 22: Calculated Water and Power Payment Tariffs

COMPONENT	POWER PAYMENT ($C/KWH)	WATER PAYMENT ($C/KWH)
DAM CAPACITY CHARGE	1.19	-
DAM FIXED O&M CHARGE	0.17	-
DAM VARIABLE O&M CHARGE	-	-
WATER PAYMENT TO ZRA	**1.36**	**1.36**
SPV CAPACITY CHARGE	1.59	-
SPV FIXED O&M CHARGE	0.26	-
SPV VARIABLE O&M CHARGE	-	-
POWER PAYMENT/TARIFF (2015 TERMS)	**3.22**	-

In terms of financing options for the dam, given Zimbabwe's debt arears, innovative approaches will need to be considered that will allow development finance institutions to extend concessionary loans to the dam component of the Project as the proposed structure will require both countries to increase their external debt levels by around US$1,069 million or US$2,139 million in total. Climate finance mechanisms, such as the Green Climate Fund (GCF), should be investigated as either providers of subordinated debt to the dam component of the Project or as providers of guarantees to the senior lenders. Both mechanisms would reduce the risk to senior lenders in the event that the proposed water payments are insufficient to cover repayments to all lenders. Grants should also be investigated as a means of reducing the dam's debt requirements, especially in respect of Zimbabwe's portion, but are only likely to cover a portion of the funding requirement.

In order to finance the power plants, an opportunity may exist to finance the two SPVs via project bonds once the power plants have been commissioned and offtake agreements have been put in place with regional off-takers. This funding approach would only make use of concessionary loans during the construction period and commissioning phase, allowing concessionary lenders to recycle their loans earlier. Project bonds may also offer an opportunity to raise funding in local currencies which may be attractive to Zambian and Zimbabwean institutional investors. Using concessionary loans during the construction and commissioning phase would provide ZESCO and ZPC with a grace period to negotiate regional offtake agreements and to strengthen the Project's credit structure.

Once the regional offtake agreements are in place, the two SPVs could appoint a bond arranger to structure project bond(s) that will be secured against the cash flows of the two SPVs. To enhance the bonds' credit quality to a level that will be acceptable to regional institutional investors, guarantees may be required from development finance institutions or the GCF. It is recommended that the proposed funding mechanisms are further investigated and modelled to understand the coupons that the SPVs will be able to offer institutional investors. The outputs from the modelling exercise could also be used to undertake market soundings with development finance institutions and the GCF in respect of the associated concessionary loans and guarantees.

Country Financing Issues

To unlock funding for the dam component of the Project, two key issues will need to be addressed, namely: Zimbabwe's debt arrears; and the potential impact of climate change on the Project[77]. Zambia's overall

[77] The African Development Bank has been mandated to act as lead arranger in respect of the debt required for the Project.

external debt to GDP levels increased at a moderate rate between 2006 and 2013 from 18.6% to 21.6%. However, poor commodity prices, slower growth and the weakening exchange rate saw a steep increase to 39.5% in 2015 and further increases are expected through to 2018. This will put pressure on spending in Zambia, limiting the ability of the economy to raise more debt to fund investment.

Zimbabwe's level of total debt outstanding has increased over the last ten years. However, the rate of increase in debt, since 2006, has been slower than Zambia's, partially due Zimbabwe's already high levels of external debt. As of end-September 2016, Zimbabwe's total arrears to the International Bank for Reconstruction and Development and International Development Association amounted to US$1,156.7 million, and arrears to the African Development Bank amounted to US$632.5 million. Zimbabwe's high levels of external debt is putting stress on government revenue as well as limiting any headroom to increase borrowing.

6.2.2 Transboundary Hydropower: Devils Gorge Hydroelectric Scheme

Project Background and Summary

According to the World Bank[78], the Basin has close to 5,000 MW of installed hydropower generation capacity, with the potential approaching 15,000 MW. Development of the hydropower sector according to the generation plan of the SAPP would include some 53 projects, over more than 15 years. If the full hydropower potential in the Zambezi River Basin was developed this would have the potential to double the production of firm energy from 22,776 to around 43,000 GWh/year. Average energy production would also double from 30,000 to around 60,000 GWh/year due to the extension of existing facilities and the addition of new infrastructure. This is sufficient to meet all or most of the estimated 48,000 GWh/year demand of the Riparian States.

The existing and potential hydro-power sites are illustrated in Figure 24 below, which includes the proposed Devil's Gorge Hydroelectric Scheme.

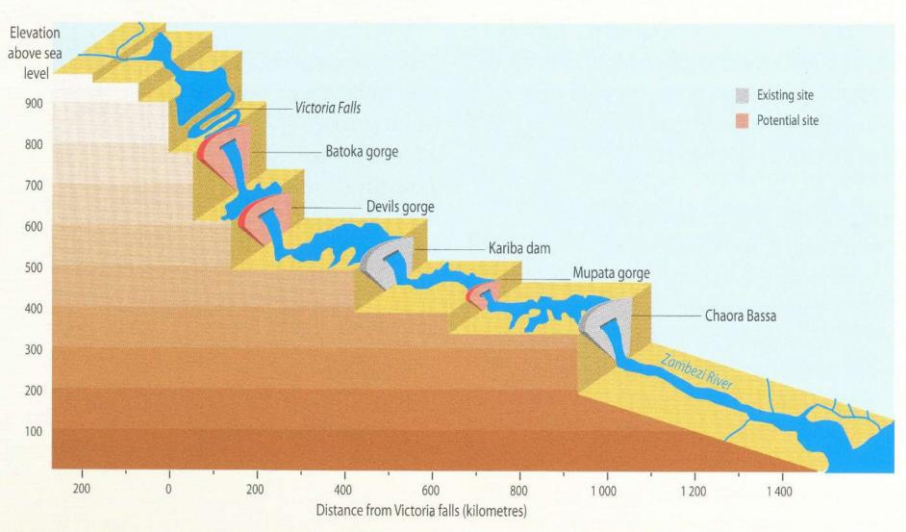


Figure 24: The Devil's Gorge Illustrated as a Potential Site for Development

In order to harness this potential, the governments of Zimbabwe and Zambia are planning to develop a 1,000 MW hydro-power plant at Devil's Gorge along the Zambezi River, in the Victoria Falls region. The

[78] World Bank. 2018. Cahora Bassa North Bank Hydropower Project: Hydropower Sustainability Assessment Protocol.

project is analogous of the Batoka Gorge Hydroelectric Scheme described in the subsection above. The ZRA state that the proposed Devils Gorge Hydroelectric Scheme is located at the tail end of Kariba Dam, downstream of the confluence of the Gwayi and Zambezi Rivers.[79]

What specific infrastructure assets would need financing?

Current efforts to address the power situation by Zimbabwe is driven by rising demand for power and calls from industry for Government to reduce the current power tariff. Chrome smelting companies have been at the forefront, advocating for a sustainable power tariff of around 4 cents per kWh. The proposed Devil's Gorge Hydroelectric Scheme will be a similar run-of-the-river set up to Batoka Gorge, which includes a dam wall and two power plants as its main infrastructure components.

What is the institutional set-up and who are the project sponsors?

Due to the existing intergovernmental agreement between Zimbabwe and Zambia in respect of the shared use of the Zambezi River's water, the ZRA will likely be mandated as project owners and developers. Furthermore, a similar delivery model can be expected to Batoka Gorge, whereby the dam would be owned by ZRA, and the power plants would be developed under a project finance structure and owned by SPVs. Under this set up, equity could be provided by the private sector and the relevant country's utility, and debt could be being raised from both the private sector and development finance institutions. The dam will be financed by debt and grants raised by the respective countries, and then on lent to ZRA through subsidiary agreements between the Authority and the governments of Zambia and Zimbabwe.

What are the possible delivery and financing models?

Identical to the Batoka Gorge Hydroelectric Scheme, the DMs that best represent the dam and power plants are the "Multi-Lateral, Basin Deployment" and "Multi-Lateral, Joint Deployment", respectively.

The financing approach would likely be similar to Batoka Gorge Hydroelectric Scheme. For the dam component, given Zimbabwe's debt arears, innovative approaches will need to be considered that will allow development finance institutions to extend concessionary loans to the dam component of the Project as the proposed structure will require both countries to increase their external debt levels. Likewise, in the case of the power plants, an opportunity may exist to finance the two SPVs via project bonds once the power plants have been commissioned and offtake agreements have been put in place with regional offtakers. This funding approach would only make use of concessionary loans during the construction period and commissioning phase, allowing concessionary lenders to recycle their loans earlier.

6.2.3 National Hydropower: Cahora Bassa Hydroelectric Scheme Extension

Project Background and Summary

The Cahora Bassa Hydroelectric Scheme was built between 1969 and 1974 on the main stem of the Zambezi River in Mozambique. Currently, the dam is a 171-meter-high roller compacted concrete dam, which forms a 55.8 billion cubic meter reservoir. The original construction included provision for two power stations, one on the south bank and a second on the north bank.

The Cahora Bassa South Bank Power Station was built at the time of dam construction and is situated in a 220m long on the south bank of the Zambezi River. The power station includes five 415 MW Francis turbines

[79] According to the ZRA, the earliest detailed studies of the potential of the site for hydro-power development were undertaken by Merz and MacLellan and Sir Alexander Gibb & Partners in 1972; entitled "Power Developments on the Zambezi". Subsequently, the Batoka Joint Venture Consultants, led by Knight Piesold, undertook further studies in 1992/93 entitled "Batoka Gorge Hydroelectric Scheme Feasibility Studies", during which the Devils' Gorge scheme was looked at in greater detail.

providing a total installed capacity of 2,075 MW. The Cahora Bassa North Bank Power Station would be an extension to the existing Cahora Bassa Hydroelectric Scheme, on the north bank of the Zambezi River.

Preparation of the Cahora Bassa North Bank Power Station project resumed between 2011 and 2013 with studies on the hydrological, geotechnical and geological conditions along with social and environmental impact assessments. To date, financial and economic analyses are yet to be carried out[80]

The additional investments associated with sediment and flood management in the Lower Zambezi Basin and Delta, which are also linked to Cahora Bassa, again highlight the cross-cutting role of Programme 4 investments in the other programmes.

What specific infrastructure assets would need financing?

The proposed Cahora Bassa North Bank Power Station would use the dam, reservoir and other facilities of the existing installation, with three additional Francis turbines of 415 MW each. This will see the total installed capacity increase by 1,245 MW from 2,075 MW to a total of 3,320 MW.

In addition, a 140-meter-long bridge would be built downstream of the dam to provide access to the north bank during construction. Access during operation would be through a tunnel from the crest of the dam while transmission lines would pass over the dam wall and connect to the existing Songo substation. No additional roads are required during construction or operations.

What is the institutional set-up and who are the project sponsors?

Operationally, the Cahora Bassa North and South Bank Power plants would be operated jointly, with explicit coordination of power generation, water storage, downstream discharges, and flood control. While Cahora Bassa South will continue to provide base load generation, Cahora Bassa North would be operated as a peaking plant during the high demand periods from 08h00 to 16h00 daily. Most of the power produced by the dam has historically been dispatched to the South African utility ESKOM under long-term Rand-denominated contracts. An increasing proportion of the power is bought back from ESKOM by the national utility in Mozambique, Electricidade de Moçambique, and a small proportion is sold to Zimbabwe (ZESA) and the Southern African Power Pool under short-term contracts.

Hidroeléctrica de Cahora Bassa (HCB) is the designated project developer and operator. HCB was established on June 23, 1975, just two days before Mozambican independence, and is responsible for the operation and maintenance of the Cahora Bassa Hydroelectric Scheme. HCB was originally majority-owned by the government of Portugal until the Mozambican government became the majority shareholder in 2007. HCB is also a joint partner with ESKOM in ownership and management of the closely associated Cahora Bassa Transmission Project. This includes a high-voltage direct current transmission line from Songo in Mozambique to the Apollo Station near Johannesburg.

The commercial arrangements also include Electricidade de Moçambique which takes supply from Cahora Bassa through a wheeling arrangement with ESKOM in the south of the country, primarily for supply to Maputo.

What are the possible delivery and financing models?

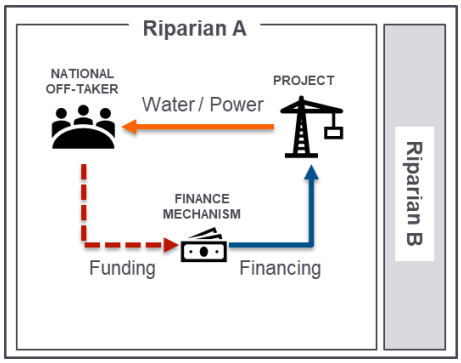
In the wider river basin context, the Cahora Bassa North Bank Power Station would be nationally implemented with regional off-take of power. Therefore, two possible DMs emerge, namely: (1) Unilateral, Sovereign Led or (2) Bilateral, Exporter Led. The key distinct between these two possible DMs is who the ultimate beneficiary will be, which will directly inform the likely business model and corresponding financing options. There are however some common elements of each of these delivery model options, as follows:

[80] World Bank. 2018. Cahora Bassa North Bank Hydropower Project: Hydropower Sustainability Assessment Protocol.

- **Origination:** The Cahora Bassa North Bank Power Station is originated by HCB, which is majority owned by the Mozambican Government;
- **Counterparty:** HCB is an existing SPV that owners, operates and maintains the Cahora Bassa Hydroelectric Scheme, and has already been set up as the project developer and operator;
- **Riparian Coordination:** Regardless of the national or regional use of power, the north bank extension will have a direct hydraulic impact on both upstream and downstream users of the water from the Zambezi; therefore, the existing joint technical committee will oversee the technical elements that directly impact other riparian states, and then present these to the affected riparian states to solicit no-objections; and
- **Implementation:** Requires EPC contracting.
- **Funding:** The national off-taker for water and/or power typically contributes to the funding of the venture through direct tariffs on use, direct taxes, and/or through indirect taxes that contribute to repaying interest on external transfers, for instance, through ODA loans.

The difference between each of these DMs is briefly explained as follows:

A. Unilateral, Sovereign Led

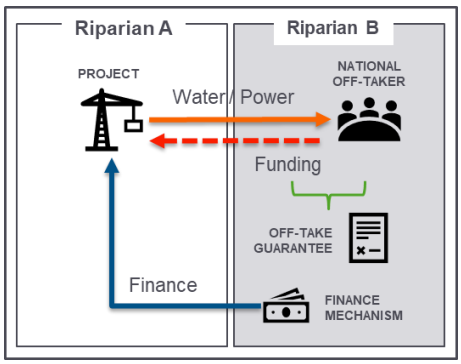


Preparedness and Implementation: This delivery model will likely be preferred in the instance where Mozambique are the largest direct beneficiaries of the power from the Cahora Bassa North Bank Power Station. For project preparation, it will be run as a national Mozambique procurement process, and self-regulated according to national compliance requirements. Furthermore, a national Mozambique procurement and contract administration process, according to national preferential procurement regulation and policies.

Financing Options: Due to HCB's current role as project developer the north bank power plant and minor supporting infrastructure (bridge, tunnel and power lines) would likely be financed through public grants and concessionary loans, during the construction and commissioning periods. After successful commissioning, however, a project bond may be an attractive option to HCB once an offtake agreement has been put in place between HCB and the national utility in Mozambique, Electricidade de Moçambique. This would also allow concessionary lenders to recycle their loans earlier.

Project bonds will also offer an opportunity for HCB to raise funds in the local Mozambican currency, which may be attractive to Mozambican institutional investors. Furthermore, the extension talks to improved catchment and riparian asset management, which may further enhance the attractiveness to institutional investors in Mozambique.

B. Bilateral, Exporter Led



Preparedness and Implementation: This model is typically preferred where the direct beneficiary of power is a regional off-taker from the Cahora Bassa North Bank Power Station. As a result, finance is obtained on securing a commitment (Purchasing of Power or Water), for the export of energy to a riparian state or regional country at an agreed price, e.g. South African power utility, ESKOM.

Financing Options: As in the case of the Unilateral, Sovereign Led model, the north bank power plant and minor supporting infrastructure (bridge, tunnel and power lines) would likely be financed through public grants and concessionary loans to HCB; however, these would be made on the back of commitments from a regional off-taker. Furthermore, after successful commissioning, a project bond may be issued by HCB once an offtake agreement has been put in place between HCB and the regional off-taker.

In consideration of these two likely models, the unilateral, sovereign led model is the most likely due to a gradual increase in Mozambique's energy needs coupled with a gradual decrease in Eskom's power demand.

Country Financing Issues

Mozambique's total public debt stood at approximately US$11.6 billion at the end of 2015, of which around 85% was foreign debt. With disclosure of the hidden loans, the debt-to-GDP ratio is currently sitting at 83%, and expected to break through the 100% barrier later this year due to the falling local currency. This compares to a ratio of only 37.8% in 2011, below the 40% sustainability limit indicated by the civil society organisation Mozambique Debt Group. In May 2016, one of the state-owned companies that had raised hidden debt, missed a repayment of US$178 million, placing Mozambique perilously close to default. Due to these events, all three major credit rating agencies have downgraded the country's credit ratings, from stable B1 and B+ evaluations in 2013, to levels indicating substantial risk and default imminent.

Aside from donations and grants, given its credit ratings, debt metrics, and default risk, it will be very difficult for Mozambique to raise additional financial, both concessional and commercial, at affordable rates in the short term. Most investors are likely to take a "wait and see" approach – even without the hidden debt crisis, many financiers have already been investing elsewhere.

It is possible that certain donors and financiers may see an opportunity to step into the funding breach. China is already a substantial contributor to, and trading partner with, Mozambique. It was estimated that, in 2014, the country's debt to China stood at US$886 million, more than one-and-a-half times more than it was in 201232. It is believed that China has been Mozambique's largest bilateral creditor since 2015, surpassing Portugal. China has long seen the country as an important strategic ally and investment locale - the state-owned newspaper "China Daily" recently called Mozambique a "golden gate into Africa…with boundless natural resources…(and) an enviable geographic location."

6.2.4 Songwe River Basin Development Programme

Project Summary

The Songwe River Basin Development Programme (SRBDP) is a multi-sectoral initiative that aims to support the development of livelihoods and management of climate & water risks in the Songwe river basin, shared between Tanzania and Malawi. There are up to 27 individual projects within the initiative and they vary in their size, complexity and commercial or social impact potential. Interestingly from ZAMCOM's perspective the SRBDP is taking a holistic approach to financing these projects and exploring how the hydropower project could generate surpluses to be re-invested in social projects.

What specific infrastructure assets would need financing?

The programme includes the development of a large multipurpose dam (hydropower, irrigation and flood control), two large irrigation schemes, water supply and other (social) infrastructure. Major projects include:

- Lower Songwe Dam and Hydropower Plant
- Lower Songwe River Malawi Irrigation and Drainage scheme
- Lower Songwe River Tanzania Irrigation and Drainage scheme

- Rural Electrification of 60% of the population in the Songwe River Basin
- Non-structural stabilisation of the course of the Lower Songwe River
- Water supply serving much of the population in the Songwe River Basin
- Economic Development projects (fisheries, tourism, small industry support)
- Community Development projects (health, education, roads and communication)
- Natural Resources and Land Use Management (Soil and water conservation etc.)

Total project costs are estimated to be in the region of $829m of which the majority (66%) is accounted for by the lower Songwe Dam and Hydropower plan and 11% by the cost of irrigation schemes.

What is the institutional set-up and who are the project sponsors?

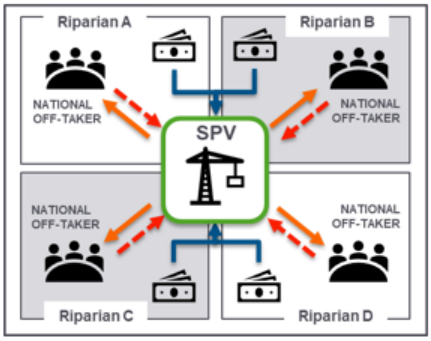
Because the SRBDP is a complex programme, within it specific projects with different cost, impact and spatial footprints have needed to develop their own institutional models.

The hydropower project has in-principal a relatively clear institutional structure. The Songwe River Basin Commission would act as the key project sponsor and is jointly owned by the governments of Malawi and Tanzania. The Commission would either directly – or via a SPV – appoint contractors to deliver the Lower Songwe Dam and Hydropower Plant project. Based on agreed PPA's with ESCOM and Tanzania Electric Supply Company Limited (TANESCO) the respective national utilities private investment could be secured on a project finance basis.

The irrigation infrastructure programmes are made up of two similar projects in either country the Lower Songwe River Malawi scheme and the Lower Songwe River Tanzania scheme. These it is assumed would be owned and delivered by an appropriate government ministry.

What are the possible delivery and financing models?

Because it is both considerably larger than the other projects and has distinct cash-flows, the hydropower dam is likely to be financed through a project finance structure, which implies that it must be ring-fenced and financed separately. The power station is the first to be developed by the Joint Songwe River Basin Commission, co-owned by the Government of Tanzania and the Government of Malawi. This corresponds well to our proposed joint development financing model in which a separate vehicle is set up to manage the project on behalf of state sponsors.



Multi-Lateral, Joint Deployment developed by a sub-set of the Riparian States who agree to share costs and benefits. Typically requires a SPV to finance the project, and deploys funding under an agreed formula that allocates the proportional contributions made by each party.

In this instance both ESCOM and TANESCO as the respective state utilities are ready buyers for power produced by the project. Financing can then be raised from a combination of public and private sources. Based on initial analysis delivered by CRIDF the funding profile for the project is envisaged to look at a blend of sources as per Figure 25 below.

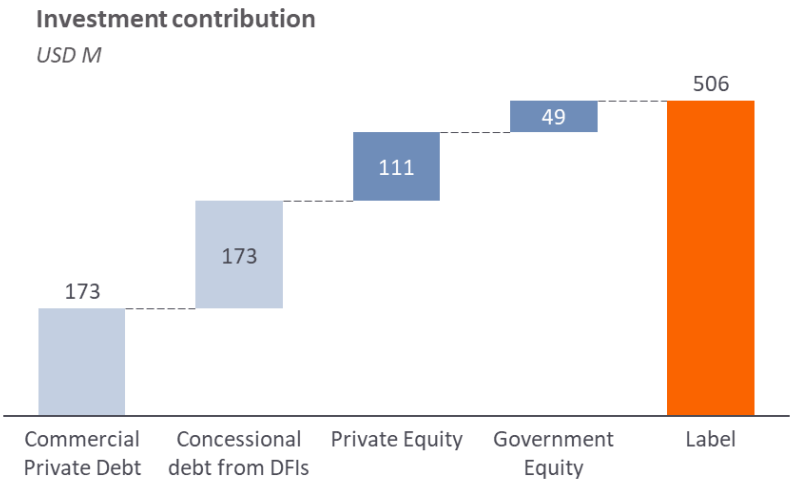


Figure 25: Investment Contribution

Irrigation infrastructure: the irrigation projects are likely to have a different return profile to the Lower Songwe Dam and Hydropower Plant. Analysis conducted by CRIDF suggests that the focus is likely to be on the sustainability of projects, rather than assessing them as commercial investments. Three high-level options to fund the $88 million capital expenditure needed for the two major schemes have been identified by teams working on the project:

1. Fully grant funded;
2. 50% grant funded and 50% SRBC funded;
3. Concessional debt paid back over time through the revenues generated by the schemes primarily through a water usage charge/levy.

6.2.5 Zambezi-Chobe Water Transfer

Project Summary

Botswana is expected to experience sustained water shortages by 2025 unless a major new water supply source is developed. In response the country is exploring different options for importing water from surrounding countries. These include; importing water from the Highlands of Lesotho as well as importing water from the Zambezi.

The proposal to transfer water from the Zambezi has two elements:

- Firstly, water will be transferred from Zambezi to Pandamatenga to support irrigation as part of the Integrated Agro-Commercial Development Project.
- The second phase of the project will transfer water from Pandamatenga to the existing North-South Carrier 1 pipeline. This will then support supply of water to Gaborone and the south of the country.

Botswana submitted a request to the Zambezi Member States of its intention to abstract 495 million cubic meters per annum of water from the Zambezi River at the SADC Ministers of Water Meeting held in Maputo,

Mozambique in July 2009. This has been discussed at various meetings of ZAMCOM, and no objections have been raised by the other member states.

In this mini-case study we explore the issues associated with financing this major transboundary water transfer project and look at what this might imply for other similar projects currently being conceived in the region.

What specific infrastructure assets would need financing?

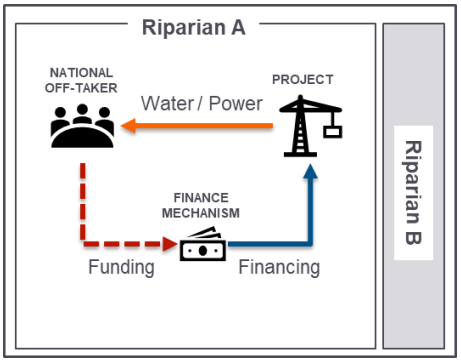
The project will require 581km of pipeline to be laid. The pipeline will have a diameter of 1.9 to 3.5 meters and will convey 150 million cubic meters of water each year. Alongside the pipeline 8 reservoirs will need to be constructed (7x 100ml and 1x 2000ml). Four pump stations will also be constructed along the route.

What is the institutional set-up and who are the project sponsors?

Botswana's Ministry of Minerals Energy and Water Resources is the project proponent and bears responsibility for construction and operations activities of the proposed pipeline and associated infrastructure development. The Ministry will look to appoint a contractor to undertake the construction works.

The Integrated Agro-Commercial Development Project will also be a key project partner in light of their status as a significant off-taker. Once phase 2 has been delivered the city of Gaborone will also become a major player as a consumer of the water supplied by the North-South Carrier. The water utilities corporation a parastatal is also likely to be involved as the current asset owner of the North South Carrier. Their exact role is however not yet entirely clear.

What are the possible delivery and financing models?



As currently conceived the project fits best into our unilateral sovereign lead model. Water will be abstracted from the Zambezi/ Chobe and used within Botswana.

While the abstraction from the Zambezi has the potential to impact shared water resources notification to ZAMCOM was provided as early as 2009. While some suggestions have been received on options for reducing negative environmental impacts no major objections have been raised.

The sources of domestic funding for phase 1 of the project will come primarily from the offtake agreement secured with Integrated Agro-Commercial Development Project at Pandamatenga which is wholly owned by the government. In phase 2 a new pipeline to connect Francistown and Gaborone would be predicated on off-take from urban utilities.

Country Financing Issues

As a state initiated and led project several financing options can be considered.

Direct budget funding: At a policy level Botswana has recognised the importance of investing in national infrastructure. The 10th National Development Plan which ran from 2009/2016 prioritised infrastructure spending. In fact, in 2016 The Ministry of Minerals, Energy and Water Resources received the largest development budget to cater for electricity production through the expansion of power stations and the construction of dams.

Botswana has historically drawn on domestic funding sources for a high proportion of infrastructure investment. Part of this is explained by its reclassification as a Middle Income Country in 1992 which made it ineligible for concessional funding from some multilateral development banks. Since 2009 Botswana's government has also increased the issuance of bonds in the domestic bond market to source financing for its infrastructure investments.

However, Botswana's economy is currently facing some considerable headwinds and although the prospects are forecast to improve (returning to 4% GDP growth in 2018-2019) fiscal space is currently constrained due to reduction in diamond revenues. In light of this Botswana may look to external financing sources in a bid to close the existing infrastructure financing gap.

International Development Finance: Botswana can access support from a range of multilateral development banks several whom have historically been enthusiastic funders of infrastructure (see Figure 26 below). However, Botswana's ability to borrow maybe limited by its debt ceiling of 20% external borrowing (it also has a ceiling of internal borrowing of 20% internal – to a maximum of 40% Debt to GDP overall).

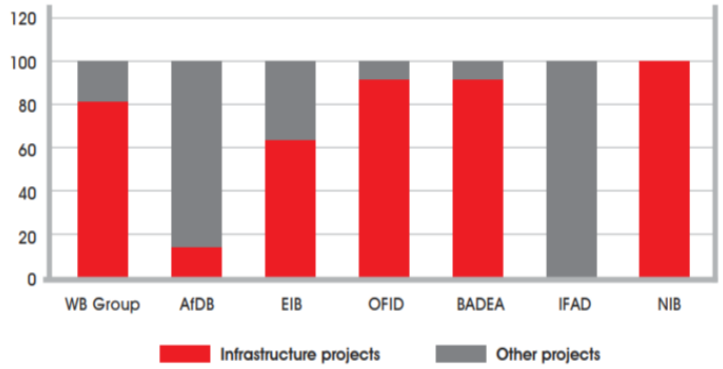


Figure 26: Multilateral Development Bank Cumulative Disbursement Loans to Botswana (Source: GEG, Infrastructure Financing in Botswana, Discussion Paper, 2016)

ODA: Botswana does have access to development aid, but this has also declined since attaining middle income status and ODA's role in funding infrastructure is currently limited. Simultaneously Botswana has increased the number of loans it has taken from China, Japan and Kuwait.

6.2.6 Bulawayo-Zambezi Transfer Scheme

Project Summary

The Bulawayo-Zambezi Water Project would take water from the Zambezi River to Zimbabwe's second largest city Bulawayo, some 400km away. The project has been periodically proposed (since 1912) as a solution to the city's water shortages as the five supply dams built before independence, can no longer adequately support the city's growing population.

What specific infrastructure assets would need financing?

The full project would have three stages and an estimated cost of up to $1billion.

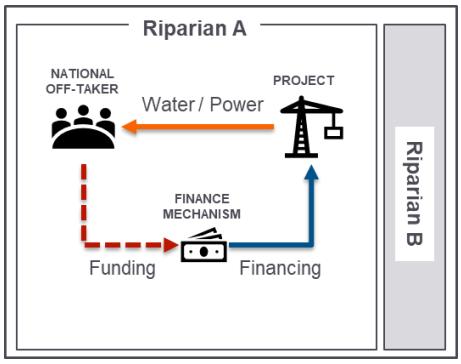
- Phase One: Gwayi-Shangani Dam which would receive water from the Zambezi
- Phase Two: Gwayi-Shangani Dam to Bulawayo Pipeline
- Phase Three: Gwayi-Shangani Dam to Zambezi River Pipeline

A technical feasibility study for the project is reported to have been delivered in 2017 and the project was recently (in 2018) showcased at a Zimbabwe National Water Authority investment forum. The first phase of the project has been estimated to cost in the region of $181.8 million, with $160 million of dam construction cost and $20 million in cost to develop supporting irrigation infrastructure. While evidence of detailed efforts to evaluate the agri-business, potential has been hard to identify it seems this is envisaged to support development of 2,000ha irrigable land under a combination of wheat, tobacco, cotton, maize, sugar beans, tomatoes, onions and cabbage production.

What is the institutional set-up and who are the project sponsors?

Zimbabwe's National Water Authority is expected to play a leading role alongside the department of Industry Commerce and Enterprise Development.

What are the possible delivery and financing models?



Like the Zambezi–Chobe example explored above it seems likely that the project fits best into the unilateral sovereign lead model. Water will be abstracted from the Zambezi and held in Dam's for use within Zimbabwe's territory. However, it's not clear to what extent notification has been addressed and this could be an issue given the potential competition with other regions who depend, at least in part, to access to water from the Zambezi.

Like Zambezi–Chobe it also seems that a major irrigation development is proposed, and this could be at least the initial impetus for constructing the reservoir and provide a potential funding stream to support the financing of the dam through sale of water and the impetus provided to development of new agribusinesses in the region. The degree to which private agribusiness are expected to play a role in this development is unclear but they could play an important role as off-taker.

Unlike Botswana's whose public finances and institutions are supportive of infrastructure investment Zimbabwe faces a challenging financing environment. With the recent change in administration and resurgent appetite from development partners to engage, access to grants and concessional loans as well as potential debt restructuring maybe possible despite limited fiscal space.

However, it's unclear if assurances around off-take from public agencies involved in the project would provide enough confidence to commercial or public finance institutions to extend credit for the project and if direct tariffs could be priced appropriately to support some degree of recovery.

7 Summary and Conclusions

7.1 Summary

This Basin Investment Scenarios Report (D5) was tasked with four core objectives:

Objective 1: Summarize key findings from previously completed reports, including the Situation Analysis and Strategic Directions Report (D2), the Basin Development and Infrastructure Inventory Report (D3) and the Basin Development Scenarios Report (D4).

Objective 2: Define realistic development parameters within the Zambezi Basin, consider financing opportunities, and opportunities for transboundary cooperation.

Objective 3: Develop a framework for the structuring of investment projects and programmes.

Objective 4: Outline finance options for projects with a transboundary dimension.

Chapters 2 and 3 of this report address **Objective 1**, offering an overview of the physical characteristics of the Zambezi Basin, reviewing the mandates of ZAMCOM, summarizing the current investment situation in the Basin and summarizing the key findings presented in the three previously completed reports. These preceding ZSP deliverables focussed on deriving **Strategic Directions** for future development, outlining Riparian States' visions for addressing their **Strategic Issues**. These findings informed the development of a series of **Basin Development Scenarios**, each one describing a single hypothetical version of the Basin's future. Through detailed hydro-economic modelling and stakeholder consultation, three **Recommended Basin Development Scenario** were selected, which serve as a key input to the Basin Investment Framework developed in this report.

Chapter 4 of this report addresses **Objectives 2 and 3**. Previous phases of work demonstrated that there are sufficient water resources in the Basin to support all of the projects currently listed in the Infrastructure Inventory. Thus, one single Basin Development Scenario was selected and developed into a Basin Investment Framework. The Basin Development Scenario chosen was a scenario focused on Inclusive Growth, a priority emphasized in both national and regional development plans. This **Inclusive Growth Scenario** corresponds to the scenario previously described as the **Scenario Resilient to Climate Change**, which strives to maximize economic growth subject to moderate levels of environment and delta/flood protection constraints.

The formulation of the actual Basin Investment Framework was comprised of a multi-stage process. First, projects contained in the Infrastructure Inventory were defined and grouped according to key characteristics, including **maturity** (differentiating between completion horizons of 2018-2027 and 2028-2040), **single versus multipurpose projects and portfolios, transboundary versus national projects, geographic location** and **national prioritization**. Next, investments were grouped into four different programmatic clusters, namely **Energy, Agriculture, Water supply** and **Catchment and riparian asset management**. Finally, suites of projects were then rationalized based on their collective impact/contribution to the future state of the Basin, based on considerations such as **climate resilience, economic welfare gains, improved livelihoods and national priorities**. Some analysis of this Basin Investment Framework was subsequently conducted through preliminary hydro-economic modelling and poverty vulnerability hotspot mapping.

Chapters 5 and 6 of this report address **Objective 4**, providing a basis for ZAMCOM to start thinking about the different approaches to financing projects in the Basin and consider its own role in transboundary projects of varying types and levels of complexity. Chapter 5 first explores the current water infrastructure funding and financing landscape in Africa generally and in the Zambezi Basin specifically. It then offers an overview of a number of cooperative financing concepts applicable to the Basin, before exploring a set of institutional and financial unilateral, bilateral and multi-lateral delivery models, and financier characteristics, important in identifying potential financiers of water-oriented infrastructure assets in Sub-Saharan Africa. Transboundary complexities, coupled with the sheer extent of the Infrastructure Inventory, mean it

is not possible at this stage to match sources of financing to specific projects and portfolios at the scale of the Basin Investment Framework. However, Chapter 6 presents a series of case studies that demonstrate the appropriate questions to be asked in thinking about finance of different projects through the project preparation cycle.

7.2 Conclusions

The goal of this Basin Investment Scenarios Report (D5) was to take the Preferred Basin Development Scenarios produced in the Basin Development Scenarios Report (D4) and guide the reader through the process of developing a Basin Investment Framework from them. To this end, this Basin Investment Scenarios Report characterises and rationalises suites of projects based on their collective impact/contribution to the future state of the Basin and presents a programmatic structure for financing these developments.

Looking to the future, the output of this work serves as an important input to the development of the ZSP. While it is difficult to draw meaningful and high impact conclusions from an intermediate phase of work such as this, the development of this Basin Investment Framework provided a number of important, overarching insights that are worth highlighting and carrying forward into future stages of the ZSP:

- Modelling results suggest that, in average years, **there is enough water to sufficiently meet the demands of the planned energy, agriculture and water supply projects, but anticipated deficiencies in dry years in specific sub-basins will require collective management and decision-making around watershed protection and storage to ensure shared benefits can be maintained.** Regional cooperation, and subsequent peace and security, is therefore a fundamental component of the ZSP and must be driven by ZAMCOM. If there is no cooperation, pursuit of environmental and flood protection risks significant impacts on energy and food production objectives during dry years.
- Despite notable costing gaps in the Infrastructure Inventory, it is evident that **the planned projects will be inadequate to address the socio-economic and environmental development demands of the Basin over the next 20 years**. Acknowledging the preliminary nature of this estimate, the current Basin Investment Framework totals 28 billion USD, which equates to less than 1,000 USD per person in the Basin. This is clearly an underestimate and reflects the lack of preparatory work at all stages (from Master Planning to project identification via feasibility studies, to bankable projects). Hence, **there is a need to both identify new developments that speak to the Inclusive Growth Scenario and mobilise finance to develop the early-stage/conceptual projects into bankable programmes of projects.**
- The first conclusion above described the importance of cooperation on a Basin-scale in safeguarding the joint achievement of development outcomes, environmental protection and climate resilience in the presence of climate change impacts. **Key in this will be the coordinating role of ZAMCOM and SADC not just in facilitating regional cooperation, but also in attracting finance to promote investment preparation.** In some national projects this role may focus on urging and supporting inter-country notification. In others, particularly where complex joint ownership of assets is required, it may extend to providing specific advice on governance, ownership and oversight functions. **Further exploration of ZAMCOM's role in this will be necessary.**

APPENDIX A Infrastructure Inventory

The Infrastructure Inventory contains details of all the existing and planned projects in the Zambezi Basin compiled as part of a previous phase of work on the ZSP. It is available as a separate file.

APPENDIX B Project List

B 1.1. AGRICULTURE - PROJECT NAMES PER PORTFOLIO

Country	Portfolio Name	Node[81]	Projects within Portfolio		Multipurpose elements (if applicable)
Transboundary	**Mid-Zambezi Delta Agricultural Water Management for Food Security Programmes**	KB3	ZM-052	Between Batoka and Kariba (782ha)	
		KB3	ZM-053	Livingstone before Vic Falls (1087ha)	
		KB3	ZW-087	Zimbabwe (1087ha)	
	Bulawayo-Zambezi Transfer Scheme (recently renamed *Matebeleland Zambezi Water Project*)	KB4	ZW-150	Gwayi Umguza Dam (2000ha)	WS (195 Mm^3)
		KB4	ZW-201	Gwayi Dams - Bupi Lupane	WS (40 Mm^3)
		KB4	ZW-202	Gwayi Dams - Gwayi Shangani	WS (635Mm^3)
Malawi	**Irrigation Schemes in Lower Shire (Malawi)**	SL2	MW-017	Chidzimbi Scheme (160ha)	
			MW-053	Mlenza Irrigation Scheme (171ha)	
			MW-061	Mtendere Irrigation Scheme (171ha)	
			MW-031	Kalima Irrigation Scheme (342)	
		SL3	MW-013	Bimbi Irrigation Schemes (1034ha)	
	Irrigation Schemes in Upper Shire (Malawi)	SL5&6	MW-023	Development of New Mini-Scale (578ha)	
		SL5&6	MW-069	Nkhangwa (58ha)	
		SL7	MW-019	Chilumba (340ha)	
		SL8&10	MW-046	Lipimbi (340 ha)	
		SL8&10	MW-065	Nakaleza (340 ha)	
		SL9&11	MW-018	Chigolo (170ha)	
		SL9&11	MW-058	Mpherembe (170ha)	
		SL9&11	MW-074	Pemba (170ha)	
Mozambique	**Phakassa/Goba Luenha Dams**	TT5&6	MZ-044	Phakassa (12ha)	Water supply (0.8Mm^3)
		-	MZ-045	Goba (8ha)	Water supply (0.4Mm^3)
		-	MZ-046	Luenha (12000ha)	Water supply (12Mm^3)
	Sena Sugar Extension Schemes	ZD1&2	MZ-070	Mandua Irrigation Scheme	
		ZD1&2	MZ-071	Inhangoma Irrigation Scheme	
		ZD1&2	MZ-072	Urema-Zangue Irrigation Scheme	
	Rehabilitation of Irrigation Schemes	TT4	MZ-067	Lembane Irrigation Scheme (4600ha)	
		ZD1&2	MZ-068	Thewe 1 Irrigation Scheme (210ha)	
		ZD1&2	MZ-069	Thewe 2 Irrigation Scheme (1900ha)	
	Chinde Irrigation Schemes	ZD1&2	MZ-061	Ilha Salia Chinde Irrigation Scheme (8000ha)	

[81] This Annex includes information on the nodes allocated to the schemes, as projects were largely grouped into portfolio based on proximity (node) and type

Country	Portfolio Name	Node[81]	Projects within Portfolio		Multipurpose elements (if applicable)
		ZD1&2	MZ-063	Luabo Chinde Irrigation Scheme (34000ha)	
	Luenya Irrigation Schemes	TT5&6	MZ-064	Luenya Existing Mozambique (140ha)	
		TT5&6	MZ-065	Luenya Irrigation Scheme (12000ha)	
Tanzania	**Rumakali Irrigation Schemes** *Hectarage for these schemes is estimated at 7249ha – on the basis that 5249ha is accounted for based on inventory data, plus additional estimate of 2000ha assumed for schemes without ha information – to reach MSIOA's estimate	SL5&6	TZ-013	Ipyana (135ha)	
		SL5&6	TZ-016	Kasyabone	
		SL5&6	TZ-017	Katela / Ntaba I	
		SL5&6	TZ-018	Katela / Ntaba Ii	
		SL5&6	TZ-021	Katungila (235ha)	
		SL5&6	TZ-023	Kifunda Ii	
		SL5&6	TZ-025	Kingiri Kanga (300ha)	
		SL5&6	TZ-030	Mabunga (200ha)	
		SL5&6	TZ-033	Makwale 1 (200ha)	
		SL5&6	TZ-034	Makwale 2 (200ha)	
		SL5&6	TZ-036	Mapogoro (112ha)	
		SL5&6	TZ-037	Mbaka	
		SL5&6	TZ-038	Mbambo	
		SL5&6	TZ-042	Mkombozi (2000ha)	
		SL5&6	TZ-043	Mpakani	
		SL5&6	TZ-044	Muungano (23ha)	
		SL5&6	TZ-045	Mwabuke (175ha)	
		SL5&6	TZ-052	Ndola (360ha)	
		SL5&6	TZ-054	Ngana Dam (209ha)	
		SL5&6	TZ-055	Nguvukazi	
		SL5&6	TZ-056	Sasenga (Mbebe) (600ha)	
	Njombe Irrigation Schemes (Tanzania)	SL12	TZ-027	Lifua (450ha)	
		SL12	TZ-029	Luwumbu (170ha)	
		SL12	TZ-035	Manda Dam	
		SL12	TZ-041	Mkiu	
		SL12	TZ-053	Ngaliwipwa	
		SL12	TZ-059	Usungilo	
	Nyasa Irrigation Schemes *Hectarage for these schemes is estimated at 5020ha – on the basis that 3020ha is accounted for based on inventory data, plus additional estimate of 2000ha assumed for schemes without ha information – to reach MSIOA's estimate	-	TZ-009	Azimio Jitegemee (45ha)	
		-	TZ-010	Ikama (600ha)	
		-	TZ-011	Ikombe (Ilulu) (650ha)	
		-	TZ-014	Jikomboe (Ikumbilo - Chitete)	
		-	TZ-015	Kabanga	
		-	TZ-019	Katendo (250ha)	
		-	TZ-022	Kifunda I	
		-	TZ-024	Kilugu (180ha)	
		-	TZ-028	Lusungo	
		-	TZ-031	Magoye	
		-	TZ-032	Makoga	
		-	TZ-039	Mbande (200)	
		-	TZ-040	Mfumbi	
		-	TZ-046	Mwaigoga	
		-	TZ-047	Mwambusi	
		-	TZ-048	Nalwenda (165ha)	
		-	TZ-049	Nambunda	
		-	TZ-050	Nandukutu	
		-	TZ-051	Nasato (130ha)	
		-	TZ-057	Senga (300ha)	
		-	TZ-012	Ikumbilo (200ha)	

Country	Portfolio Name	Node[81]	Projects within Portfolio		Multipurpose elements (if applicable)
		-	TZ-020	Katumba – Songwe (300ha)	
Zambia	**Irrigation Schemes in Barotse Catchment**	BT	ZM-038	Katima Mulilo (1400ha)	
		BT	ZM-051	Manto (1400ha)	
		BT	ZM-061	Ngamwe (1400ha)	
		BT	ZM-078	Sioma (1400ha)	
		BT	ZM-081	Zambezi Floodplain (3000ha)	
		BT	ZM-059	Nakatoya[82] (11ha)	
		BT	ZM-038	Katima Mulilo (1400ha)	
	Irrigation Schemes in Upper Zambezi Catchment	KB	ZM-028	Kabompo (4169ha)	
		KB	ZM-057	Mwinilunga (3196ha)	
		KB	ZM-058	Mwombes (1391ha)	
	Dam Rehabilitation	BT	ZM-063	Mahilo Dam	
		BT	ZM-065	Kabombwa Dam	
		BT	ZM-066	Kalumwange Dam	
		KB3	ZM-069	Lifalali Dam	
		KB3	ZM-073	Sianankanga Dam	
		KB3	ZM-074	Siazwela Dam	
		KF2	ZM-072	Siamaambo Dam	
		LW1	ZM-064	Amose Dam	
		LW1	ZM-067	Kanyanda Dam	
		LW1	ZM-068	Kanyanja Dam	
		LW1	ZM-070	Lutwazi Dam	
		LW1	ZM-071	Sanyinga Dam	
	Luangwa Commercial Agriculture Development Projects	LW1	ZM-024	Mukushi (3670ha)	
		LW1	ZM-025	Mwomboshi (4750ha)	
Zimbabwe	**Mazowe/Luenha Dams**	TT5&6	ZW-199	Bindura Dam	WS (87Mm$^{3)}$
		TT5&6	ZW-204	Luenha 1	
		TT5&6	ZW-205	Luenha 2	
		TT5&6	ZW-149	Chitse Dam (1000ha)	WS (273Mm^3)
		TT5&6	ZW-206	Silverstroom (2000ha)	WS (273Mm^3) & mini-hydro
	Irrigation Scheme Extensions in Mazoe	TT1	ZW-081	Mazvikadei (1387ha)	
		TT1	ZW-097	Mushumbi Pools Arda (1387ha)	
	Rehabilitation/Optimization of the use of Reservoirs (concerning 20% of the equipped area)	KB4	ZW-114	Gwayi (total: 466ha)	
		KB5	ZW-118	Sanyati (total: 5829ha)	
		MP	ZW-117	Mupata (total: 4578ha)	
		TT5&6	ZW-115	Luenya (total: 4387ha)	
		TT5&6	ZW-116	Manyane (total: 7661ha)	

[82] Not explicitly run-of-river but small scale and part of BT node

B 1.2. WATER SUPPLY - PROJECT NAMES PER PORTFOLIO

Country	Portfolio Name	Projects within Portfolio		Multipurpose elements (if applicable)
Angola	**Cuando WS Schemes**	AO-018	Camanongue	
		AO-019	Cangamba	
		AO-020	Cazombo 2	
		AO-021	Leúa	
		AO-022	Luacano	
		AO-023	Luau	
		AO-024	Lumbala	
		AO-025	Lumeje	
Mozam	**Revubue Condezi Dams & Irrigation Schemes**	MZ-083	Revubue Dam (23.4Mm^3)	Small-scale irrigation (no data) & flood management
		MZ-066	M'Condezi-Revubue Irrigation Scheme (32.8Mm^3)	
Tanzania	**Town Water Supply Improvement Schemes in Shire Catchment**	TZ-066	Vwawa Town	
		TZ-064	Mbinga Town	
		TZ-062	Kasumulu Town	
		TZ-063	Kyela Town	
		TZ-065	Tunduma Town[83]	
Zambia	**Water Supply and Sanitation Improvement for Cities and Towns**	ZM-105	Munyumbwe	
		ZM-098	Kazungula	
		ZM-087	Livingstone	
		ZM-088	Batoka	
		ZM-094	Gwembe	
		ZM-096	Kalomo	
		ZM-099	Maamba	
		ZM-110	Siavonga	
		ZM-111	Sinazeze	
		ZM-112	Sinazongwe	
		ZM-113	Zimba	
		ZM-089	Chibombo	
		ZM-090	Chisamba	
		ZM-091	Chisekesi	
		ZM-093	Choma	
		ZM-100	Mazabuka	
		ZM-101	Mbabala	
		ZM-103	Monze	
		ZM-104	Mumbwa	
		ZM-106	Namwala	
		ZM-107	Neganega	
		ZM-108	Pemba	
		ZM-086	Chipata	
		ZM-095	Kabwe	
		ZM-097	Kapiri Mposhi	
		ZM-102	Mkushi	

[83] National Priority Project

Country	Portfolio Name	Projects within Portfolio		Multipurpose elements (if applicable)
		ZM-109	Serenje[84]	
	Dams in Kafue	ZM-021	Chitwi Dam	
		ZM-040	Kibwene Dam	
		ZM-043	Luansobe Dam	
		ZM-048	Machesa Dam	
		ZM-050	Maheba Dam Scheme	
		ZM-054	Mitukutuku Dam	
		ZM-019	Chibwe Dam	
		ZM-072	Rehabilitation of Siamaambo Dam	
Zim-babwe	**Sanyati Dams**	ZW-153	Muda-Nyatsime (173Mm^3)	Mini-hydro (0.27MW)
		ZW-192	Sanyati Dams (160Mm^3)	

[84] National Priority Project

B 1.3. CATCHMENT & RIPARIAN ASSET MANAGEMENT - PROJECT NAMES PER PORTFOLIO

Country	Portfolio Name	Projects within Portfolio	
Angola	**Hydrometric Stations**	AO-001	Cazombo 1
		AO-002	Luanguinga 1
		AO-003	Luiana
		AO-004	Muanga
		AO-005	Neriquinha
		AO-006	Tchafinda 1
Mozambique	**Cahora Bassa Reservoir - Structural Flood Protection Interventions**	MZ-048	Cahora Bassa Reservoir - Structural Flood Protection - Construction of Higher Areas For Refuge
		MZ-049	Cahora Bassa Reservoir - Structural Flood Protection - Diversion of Flood Waters
		MZ-050	Cahora Bassa Reservoir - Structural Flood Protection - Dykes
		MZ-051	Cahora Bassa Reservoir - Structural Flood Protection - Elevated Schools/Public Buildings
		MZ-048	Cahora Bassa Reservoir - Structural Flood Protection - Construction of Higher Areas For Refuge

B 1.4. PROJECTS AND PORTFOLIOS EXCLUDED FROM 2027-PRIORITY LISTS

Programme	Country	Project/portfolio	Reason for exclusion
Hydropower	Malawi	Upgrading Kazumu Barrage	No information on capacity Upgrading existing scheme with anticipated completion date 2018 Not a country priority
	Zambia	Rehabilitation of Mayuwayukwa Hep Plant	No information on capacity or cost (even though stage is stated as feasibility) Not a country priority
Irrigation	Zambia	Dam Rehabilitation Portfolio	No hectarage data or costing (even though stage is stated as feasibility) Not a country priority
Water Supply	Angola, Botswana, DRC, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe	Water Supply and Sanitation To 12 Locations	No capacity or costing data Sourced from SADC RIDMP – completion date is 2020; likely already under implementation.
	Zambia	Dams in Kafue Portfolio	No capacity or costing data (even though stage is stated as feasibility)

APPENDIX C Livelihoods

C 1.1. AIM OF REVIEW

Poverty vulnerability hotspot mapping assists RBOs with the identification of 'hotspots', where compounding socio-economic, environmental, political and climatic challenges affect the ability of communities to adapt or respond to shocks (both natural and man-made). In an effort to foster inclusive, sustainable growth in the Zambezi Basin, it is critical to understand the predominant (and varying) causes behind these high levels of vulnerability – with a view to ensuring appropriate livelihood infrastructure interventions are identified, designed and implemented in response to specific, localised issues. This Annex therefore presents insight into key identified hotspots in the Zambezi Basin using localised spatial data as a basis. The review considers availability of spatial data and presents a method which aims to enable effective localised hotspot characterisation, as well as options for potential intervention based on intervention typologies.

Poverty and socio-economic challenges riddle the Zambezi Basin. The only areas that are relatively better off or not severely economically deprived are those in and around the cities of Lusaka, Harare, Lilongwe and Blantyre, and select pockets where large infrastructure investment or economic incentives are present, for example the Copperbelt. The rest of the Basin is largely characterised by extreme poverty and high vulnerability to climate related hazards. Thus, the aim of this hotspot mapping analysis was to identify areas that are the worst off/most at risk in terms of extreme poverty.

Given the extensive poverty situation, community reliance on natural resources (such as soil, vegetation, hydrology, weather patterns, climate and rainfall) is high. This typically means where rainfall is low, rivers are seasonal and vegetation sparse, livelihood vulnerability is high and resilience to system shocks such as climate change, is low. The northern part of the Basin predominantly displays a wetter (higher rainfall, more lush vegetation) climate, with lower, more variable rainfall to the south. The northern areas are therefore exposed to higher pervasiveness of deforestation, whilst the southern parts display higher prevalence of food insecurity. The typologies identified to address hotspots take these differences into consideration.

The geography across the Basin (land cover, climate, weather etc), and infrastructure (for example transport, energy and water supply) differs significantly, which complicates the process of identifying hotspots across the basin in a single overview, using the same variables. To overcome this challenge, the basin was sub-divided into seven vulnerability zones[85] that reflect similarities in environmental and socio-economic characteristics. Although total standardisation with regard to characteristics is not possible, and in some areas, there may still be significant differences between local community physiognomies, the units reflect similarities in terms of the type of interventions that may be suitable to reduce livelihood vulnerabilities. Within each of these zones (numbered A to G in Figure 27 below), hotspots are indicated as areas where interventions are critically needed (from both a socio-economic and ecological sustainability perspective) and where interventions could have significant impact, given the location characteristics and typology of intervention(s) proposed.

[85] CRIDF has conducted a detailed analysis of each zone, drawing on socio-economic, population, settlement, infrastructure and environmental data.

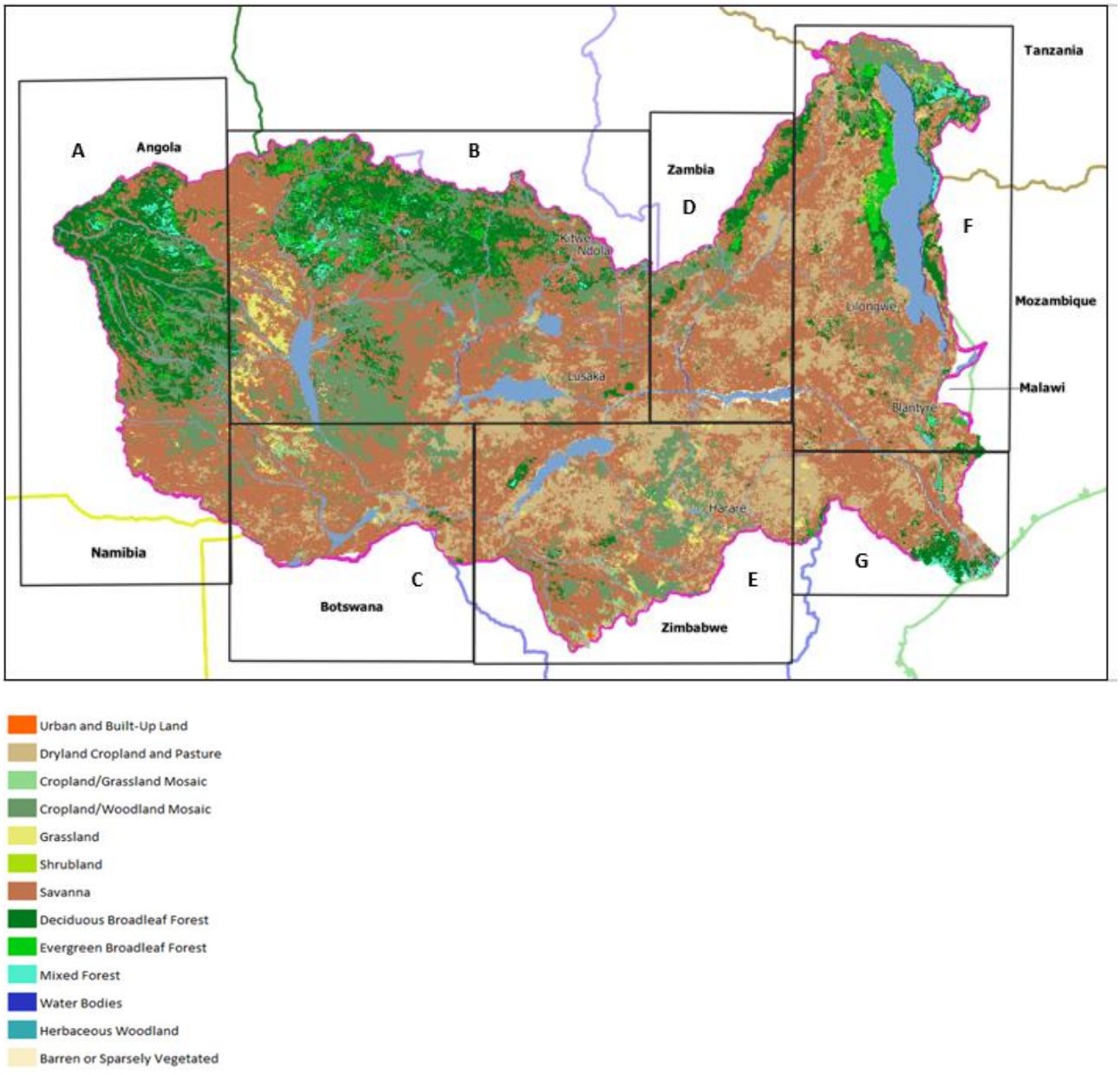


Figure 27: Zambezi Basin Sub-divided into Zones of Vulnerability, Indicating Land Cover Data as Base Layer

C 1.2. METHOD

The hotspot identification process included the following activities:

1) Data layer identification and download/collation in a geographic information system (GIS).
2) Vulnerability zone analysis: The identification of hotspots emanated from first achieving a regional overview of the Zambezi basin pertaining to livelihood vulnerabilities. It enabled the development of large-scale vulnerability zonation and the description of associated narratives across the basin, based on recent and accessible publicly reported data which is available for each member state in the basin.
3) Data layer selection: Including overlay testing based on criteria such as availability, usability, applicability and recency (based on the discussion of Data layer selection in Section B1.3 hereafter).
4) Hotspot mapping overlay (using the final selected layers).
5) Qualitatively describing the characteristics of identified hotspots, noting that the drivers of poverty may differ between vulnerability zones.
6) Characterisation of livelihood typologies, including a matrix of hotspots vs options for intervention.

The details hereafter present the outcomes of the method followed above, excluding activities 1 and 2 which were preparatory to activities 3 to 6.

C 1.3. SPATIAL DATA LAYER SELECTION

Hotspot mapping (also referred to as 'site selection') is a commonly applied approach to development intervention strategies worldwide and can be done in a number of ways – there is no single approach or standardised method nor international or standardised agreement on which data sets or spatial data layers should be used to develop the layer overlays. Many of the non-standard approaches that are applied relate to the differences in raw data, which enables (or in some cases hampers) hotspot identification. In essence, the hotspot mapping process relies on spatial data factors in order to be accurate and reflective of real life and when these items are easily accessible, and the resultant data are of high quality, a suitable and effective hotspot mapping method results:

Data completeness over the study area: Over large geographic areas and especially when considering cross-boundary spatial data, there may be gaps in data sets, where some areas or countries' data is not collected or not available. For example, there is detailed spatial data available for poverty in Malawi and Tanzania, but not for other member states. Thus, this detailed data has to be considered separately for the areas where it is available and cannot be used as a basin-wide layer.

Data recency/age and timeliness or frequency of update: Although geological and topographical data does not alter significantly over time, other data sets such as demographics, health statistics and environmental baseline information may change reasonably often over the course of five to ten years. There is then a decision to be made as to whether to include or exclude a particular spatial data layer when developing hotspots – usually based on the perceived change that may have taken place over time since the data was captured.

Aggregation/averaging of data over geographic areas: Some data sets, such as GDP, Total Population, or Human Development Index, are excellent to identify large-scale regional differences between member states. However, these data sets do not lend themselves to small-scale hotspot mapping or identification.

Representativeness that enables the use of data that may be locally applicable, as proxy data for non-available or non-usable data layers. An example is where data related to health or schools may be used as proxy for non-locally available human development index data.

Cross-boundary alignment: Often, good and small-scale data may be available at local level, however when working across country borders, the collection parameters for data may not be the same. This brings misalignment of data sets at borders of countries or regions even when data is available across the entire basin area – an example being malaria incidence, which differs in collection method and accuracy between countries, thus creating artificial 'lines' in the data viewed in maps. In this instance, the inclusion or exclusion of the data layer may be decided based on the severity of the difference, or the ability to 'rubbersheet' or generalise the data so that it is applicable to the purpose of the study.

Format and physical size: Formatting of data has become easier as cross-software/cross-platform integration has improved. However, the time it takes to download data from original sources, reformat or transform the data to make it usable needs to be considered. For example: Bare soils data is known to be available for the Zambezi Basin, however with the raw data consisting of over 74 individual satellite image base files that have to be downloaded, merged and interpolated, the time it requires reduces the opportunity to include the data in the hotspot analysis.

Projection and datums: When working across RBOs, especially when it spans multiple latitudes (time zones), a decision has to be made as to which projection to use. The projection that is used has impacts on for example area (size of measured polygons) and length, since different projections distort area and length in different manners. In this study for example, geographic data is presented (i.e. no projection applies), however that tends to impact the boundaries of areas that may be delineated on in the GIS as 'boxes' with 90 degree corners, to display 'uneven' boxed areas in map representations.

Examples of available data that is not applicable (see Figure 28) and applicable (see Figures 29 to 33) to use for this project purpose are provided below.

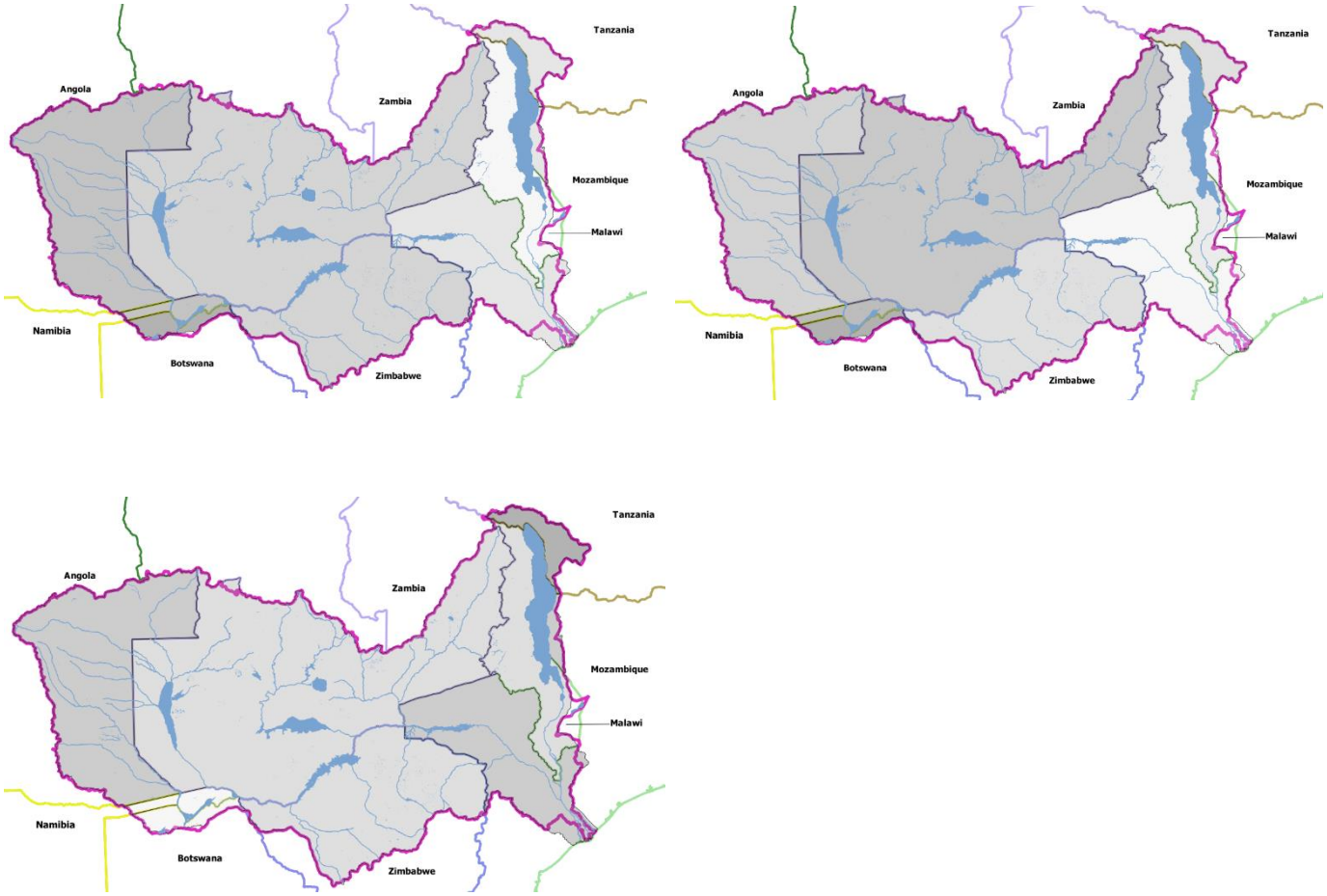


Figure 28: GDP 2013 (Top Left), HDI 2013 (Top Right), Total Population 2013 (Bottom Left)

Figure 27 provides examples of national averaged data sets that are not suitable to use in localised hotspot identification.

As shown in Figure 28 below, this study uses global 2005 population estimates for the hotspot identification process. More recent data is not yet available for use in the analysis, at a localised level.

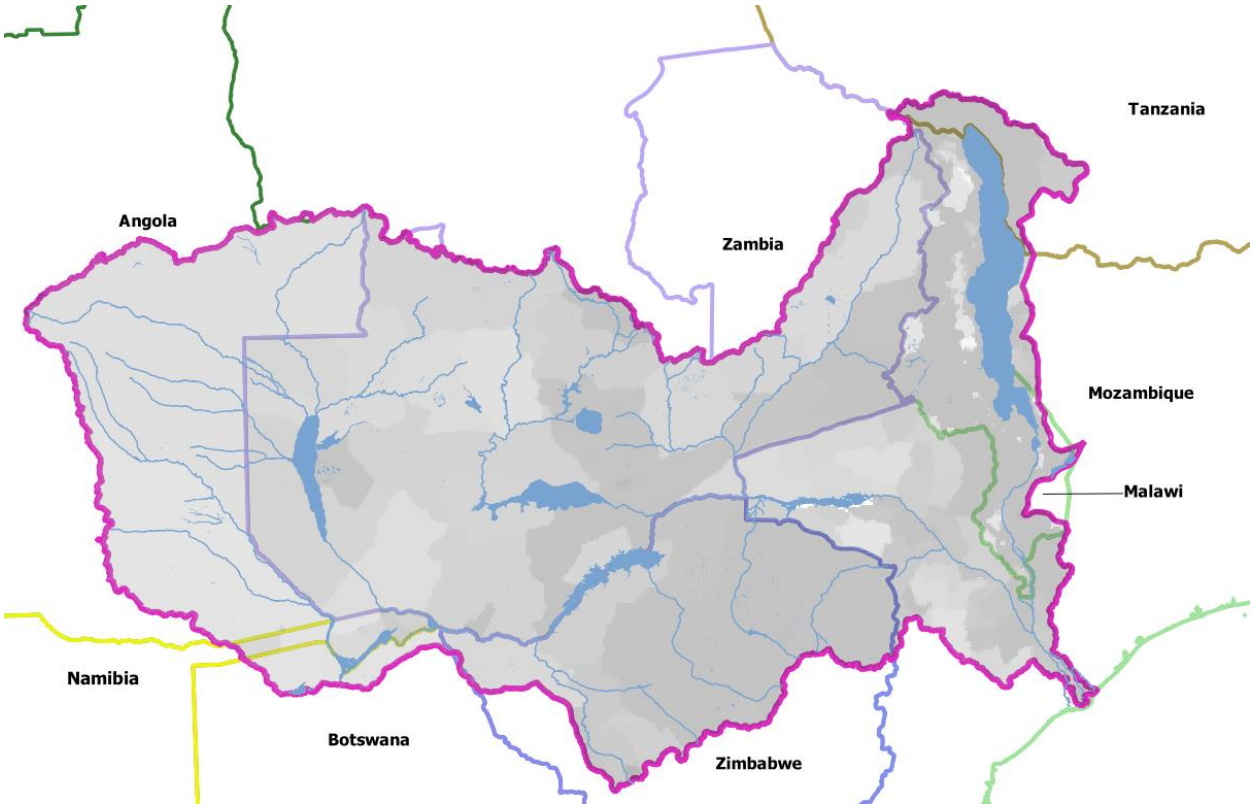


Figure 29: Population Density (2005)

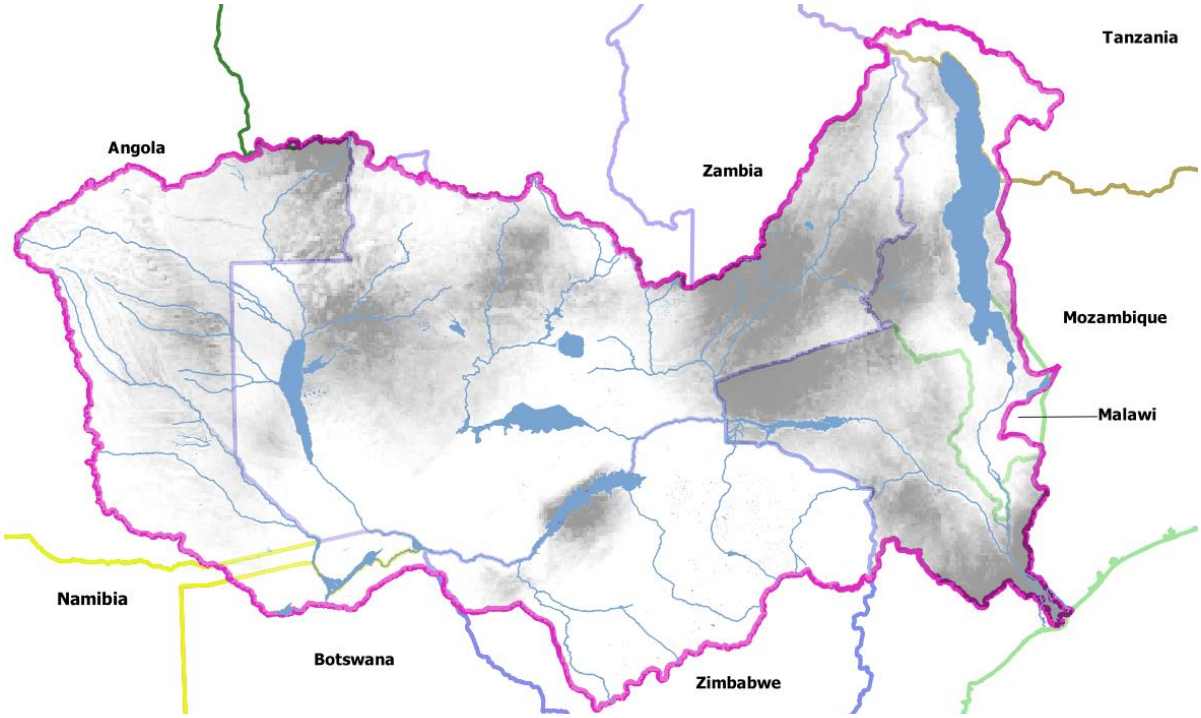


Figure 30: Malaria Incidence (2015), showing Differences in Data Collection and Resultant Views between Member States (Source: The Malaria Atlas Project (2015))

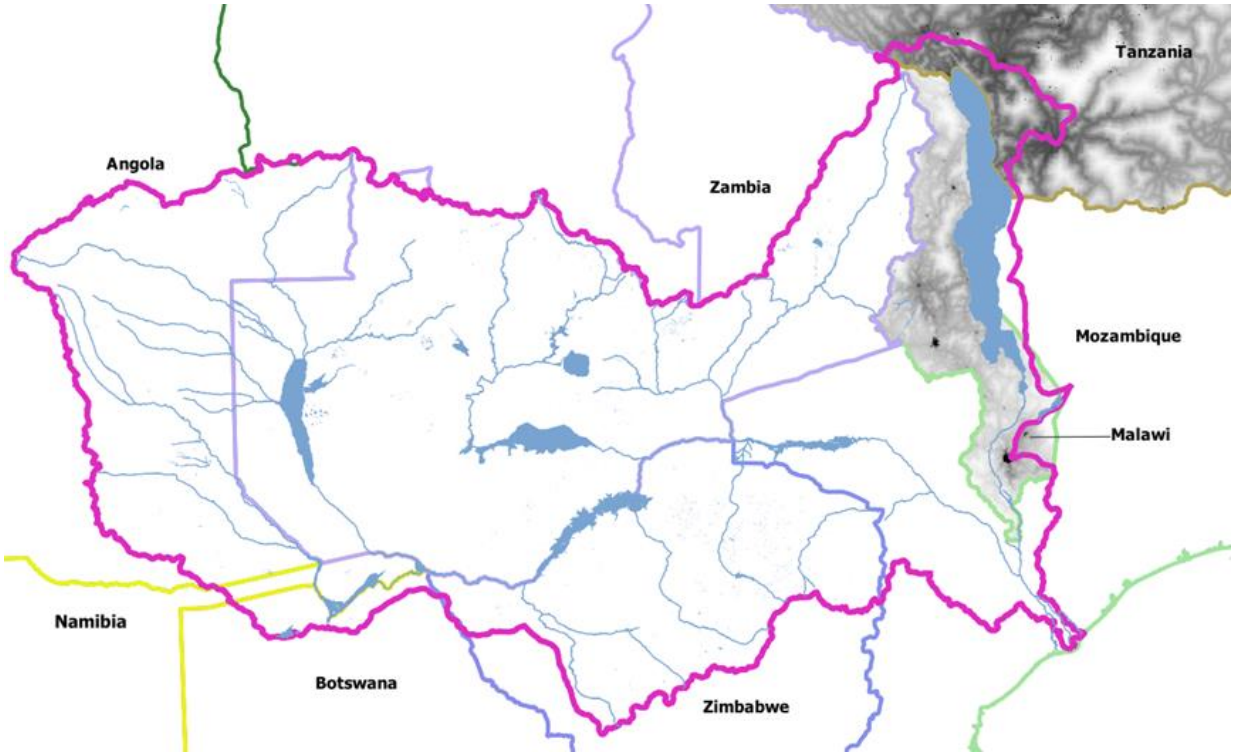


Figure 31: 1km scale Poverty data – only available for Malawi and Tanzania (Source: http://www.af-ripop.org (2013))

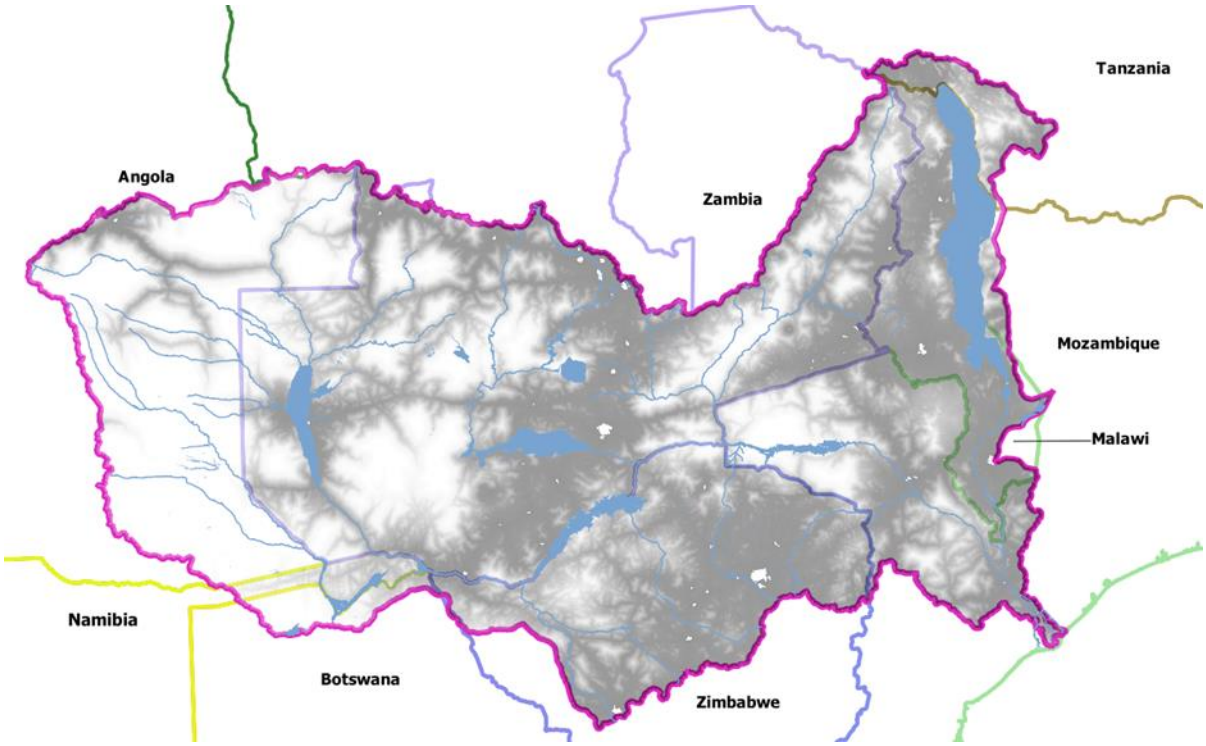


Figure 32: An Indication of Poverty (by lack of other available data): Market access (low access to markets meaning these areas are hotspots) (Source: The Malaria Atlas project (2015))

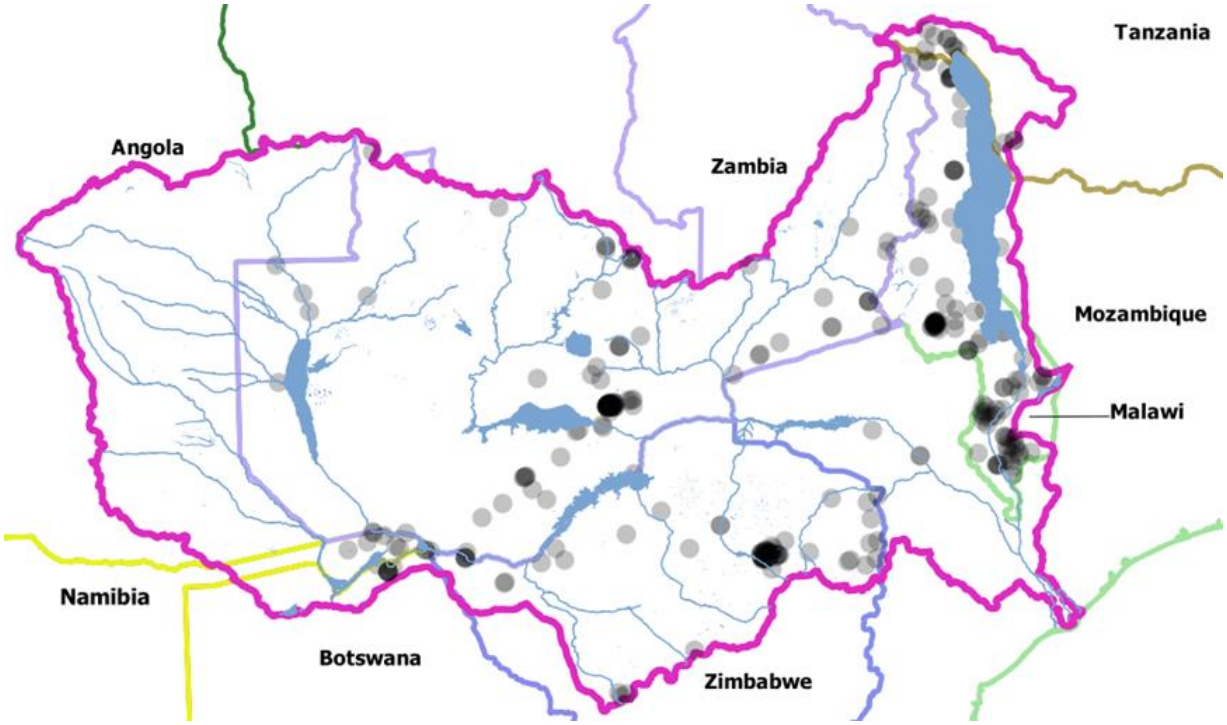


Figure 33: An Indication of Poverty (by lack of other available data): Clinic and Hospital locations (areas far away from these locations are hotspots)

C 1.4. HOTSPOT MAPPING OVERLAY

The Hotspot identification was done based on integration of the following available, applicable and usable spatial data layers:

- Population density (2005)
- Proxy for Human Development Index (HDI): Health (malaria prevalence areas as hotspots)
- Proxy for Poverty and HDI: access to clinics (where there are no hospitals or clinics, the areas can be considered hotspots)
- Proxy for Poverty: Market access (low access meaning these areas are hotspots)
- Proxy for HDI: Public violence (areas of high violence incidences are hotspots)
- For Malawi and Tanzania: Poverty (with high poverty/low income as hotspots)
- Forest loss (2000 – 2016)

C 1.5. HOTSPOT CHARACTERISTICS

The hotpots are indicated in Figure 34 below based on investigation of each vulnerability zone, with the explanation of characteristics that define the drivers that prioritise a given location or area as a hotspot, presented.

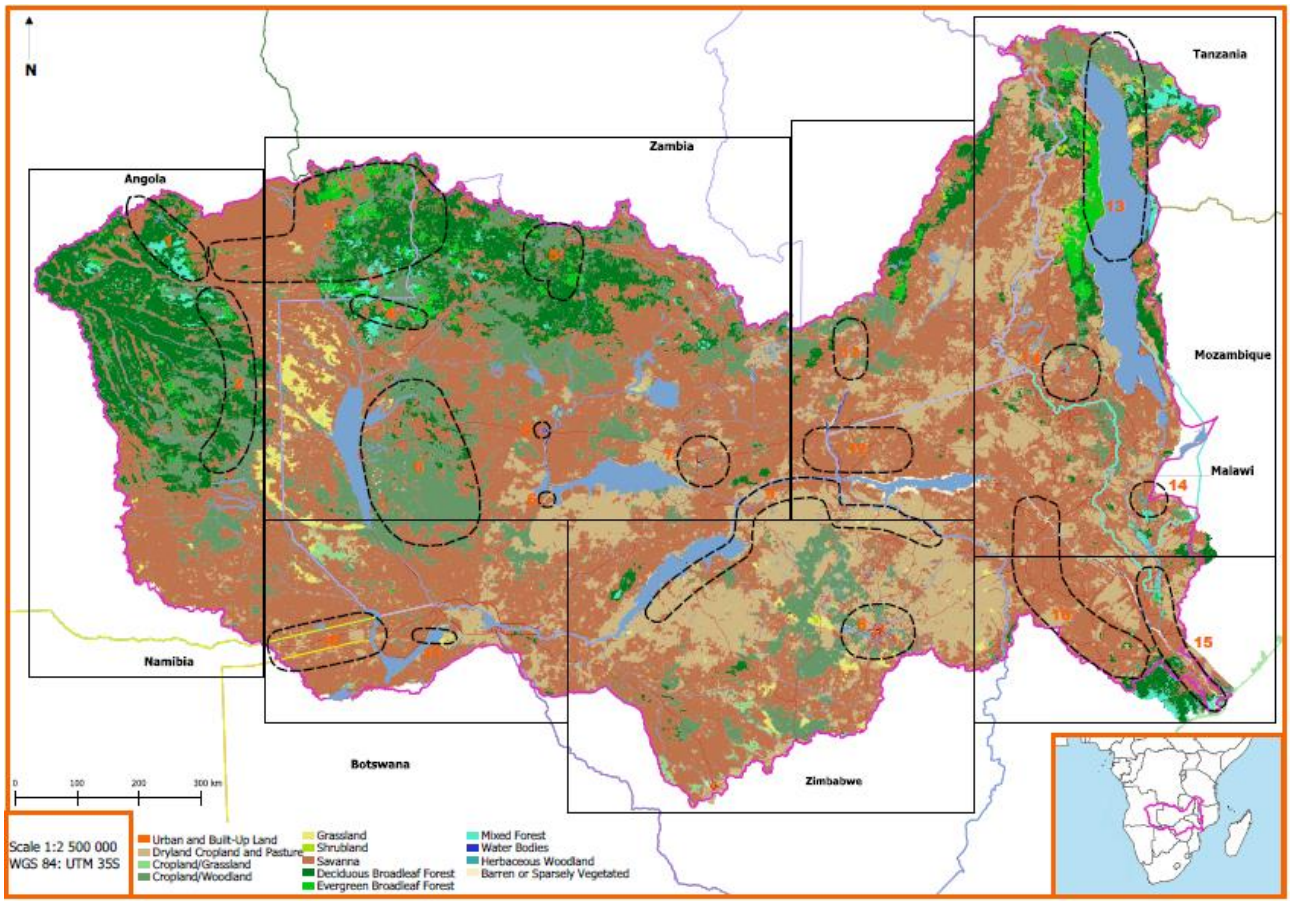


Figure 34: Vulnerability Zone Delineations, with Hotspots Indicated

Vulnerability Zone A

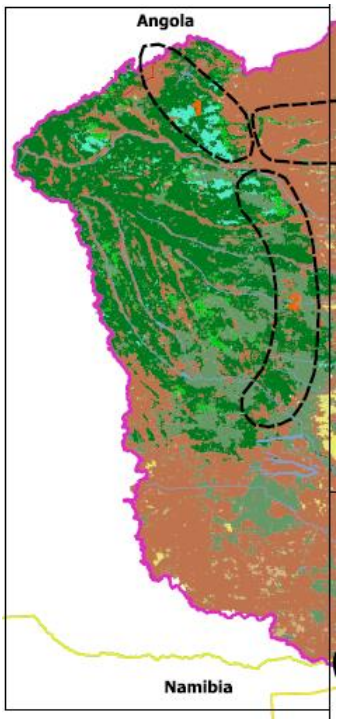


Figure 35: Vulnerability Zone A, Hotspots 1 and 2

Hotspot 1:

The hotspot runs from the settlement of Luena south along the main road, where most villages and populations are located. The region is exposed to natural and man-made hazards and presents high level of social, economic and environmental vulnerability. Specifically, this hotspot area is subject to floods; floods can be destructive and make can increase the levels of isolation of villages, as there is no infrastructure such as bridges to connect villages to services/market access. In the region, ravines present another hazard to the population.

The hotspot includes forested areas where the sustainability of the deciduous broad leaf, evergreen and mixed tree species is of key concern. Deforestation, practiced to supply wood as cooking fuel, is a significant concern. The loss of vegetation also increases sedimentation downstream. The relatively steep slopes in the area indicate potential increase in erosion along with the deforestation trend. In addition, in the north-east part of the hotspot (east of Luena), poaching presents a challenge to biodiversity. This impacts tourism and tourism-related economic activities. Rainfed agriculture is a livelihood activity in the region. In order to protect natural resources, there is a need to balance forested areas with agricultural land and soil-preserving low till, low-fertilisation agriculture.

Hotspot 2:

Hotspot 2 is another relatively isolated area of Angola. The environmental characteristics of this hotspot are similar to that of Hotspot 1, with the forest edge rapidly retracting towards the West, and rivers overflowing regularly. As with Hotspot 1, the area follows the linear road infrastructure. In this hotspot, water-related health concerns are more prevalent than in Hotspot 1; currently, malaria prevalence rates are relatively low, but future risk of cholera and malaria prevalence is likely to be high (especially where standing water is present). It would therefore be opportune to consider interventions that maintain (or improve) these levels, to avoid the severity of outbreaks experienced towards the eastern area of the basin.

Any intervention in this hotspot must consider the safety risks associated with operating in the southern (specifically southwest) area of the hotspot, where landmines are a significant concern, reducing access and infrastructure development.

Vulnerability Zone B

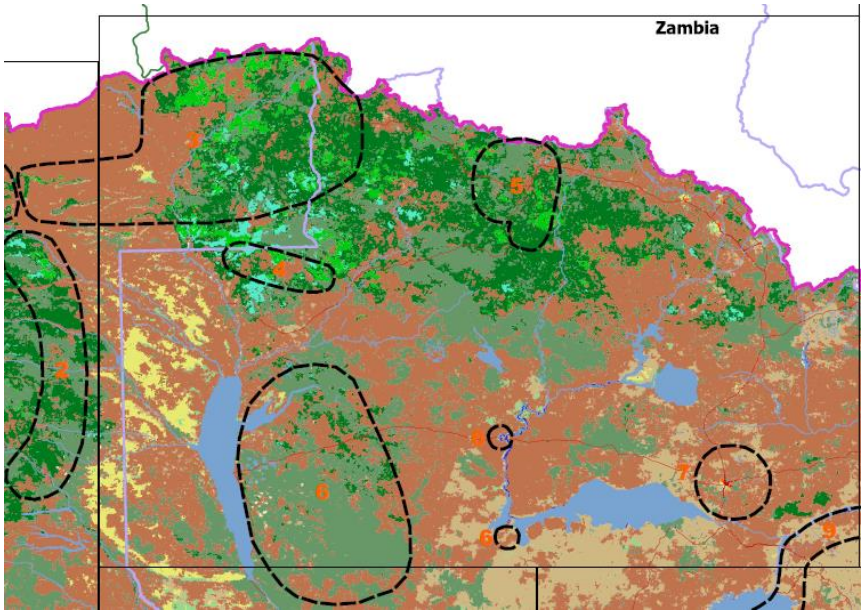


Figure 36: Vulnerability Zone B, Hotspots 3, 4, 5, 6 and 7

Hotspot 3:

This area, situated between the cross-border settlements of Cazombu and Mwinilunga, is difficult to access, with relatively poor electricity and transport infrastructure, leading to long travel times to markets. Just to its North, is a prominent hydropower facility. While the facility creates limited employment opportunities,

the energy produced does not reach the Hotspot area, as it is off the electricity grid. Therefore, the local communities do not benefit from the infrastructure.

Waterborne health challenges are prevalent in the region, mainly due to poor water supply infrastructure and traditional means of sanitation (despite the relatively proximity to bulk water supply infrastructure). As a result, communities are reliant on the natural resources, and depend on the sustainability of the nature conservation areas towards the southeast of the hotspot. With relatively higher rainfall (compared to southern areas of the vulnerability zone), improved rainfed agricultural activities (along with improved market access) stand to improve communities' adaptive capacity and also strengthen the natural resource – provided climate smart practices are employed to maintain the integrity of the soils.

In the North-East of Angola's Zambezi region, floods occur regularly; this natural hazard is coupled with social, economic and environmental vulnerability, heightened by man-made impact on natural ecosystems, through deforestation and poaching. The region also lacks infrastructure and is difficult of access.

Hotspot 4:

This hotspot is a cross-border area between Cavuma and Manyinga; the primary reason for its identification being poor sanitation infrastructure and a high prevalence of waterborne disease, which is related to the low levels of water and electricity supply, and poor, if any, health care services. Improved fresh produce availability could support the general health and wellbeing of the subsistence communities and would support food security in the area.

Hotspot 5:

Deforestation at this hotspot is becoming a critical issue. This hotspot is an emerging hotspot requiring preventative action to mitigate increased risk of vulnerability. There is significant opportunity for reforestation and a restoration of forest around the settlement of Solwezi, through agricultural and wood harvesting practices that promote sustainable forest management. This needs to be coordinated with pollution control measures from the mines to minimise contamination of water sources and the environment. The area is relatively close to the Copperbelt, making it attractive for households to migrate to; however, the natural resource base may not be able to sustain the growing communities unless forest management practices and improved agricultural production are promoted.

Hotspot 6:

The hotspot south of Kaoma is characterised by particularly poor services availability in rural villages (including particularly vulnerable road infrastructure) – with virtually no electrical power, poor water and sanitation, and no formalised health care services. Communities are almost entirely reliant on subsistence farming and significantly exposed to changes in rainfall regime given this area receives on average less rainfall than the northern area of the zone. There is also poaching within the hotspot especially around the Sioma, Liuwa and Ngwezi areas.

Hotspot 7:

Ground water contamination leading to water borne diseases such as cholera, was noted as a significant issue in Lusaka and surrounding peri-urban settlements. The area is characterised by very poor services (especially in peri-urban areas) whose supply is largely dependent on groundwater, which has led to the mushrooming of boreholes, often poorly equipped and maintained. The challenges here are similar to those indicated and identified in the hotspots covering Harare, Lilongwe and Blantyre where urban flooding, water contamination, and waste discharge (owing to untreated sewer intrusion and other contaminants from industries) are prevalent. This is further compounded by poor service delivery in water supply and sanitation.

Vulnerability Zone C

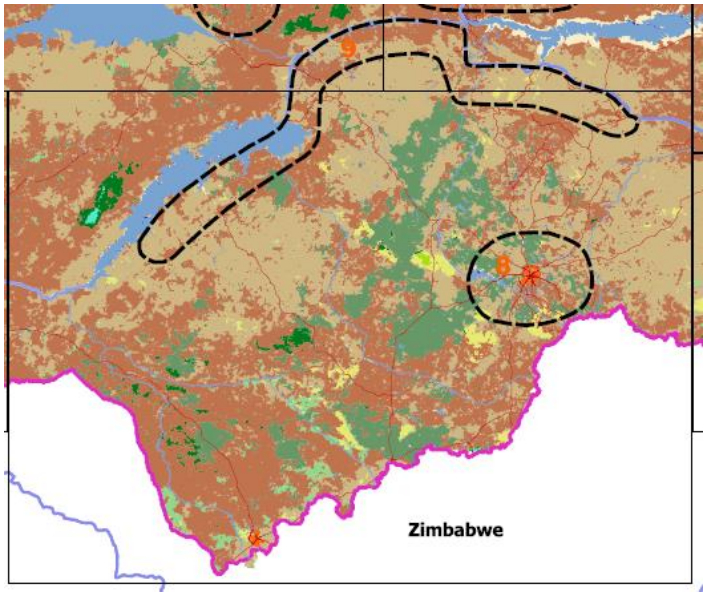


Figure 37: Vulnerability Zone E, Hotspot 8 and 9

Hotspot 8:

Harare's polluted water sources are due to poor waste water management disposal and mines as well as illegal gold panners. The water pollution from Harare is traced along one of the major rivers through Chinhoyi town all the way to the Zambezi Valley rural areas (see hotspot 9) and finally into the Zambezi River. Along the way, the water has been so polluted that it is no longer suitable for irrigating tobacco and other crops, leading to investments in groundwater by the farmers. Similar to hotspot 7, this hotspot suffers from substandard water supply and sanitation service delivery and infrastructure, which has resulted is characterised by urban flooding and waterborne disease outbreak.

Hotspot 9:

This hotspot is a large band widely spaced between the nature reserves towards Zimbabwe's northern border. Settlements in the hotspot experience high levels of poverty and food insecurity, which is further exacerbated by the polluted water sources from Harare (see hotspot 8). The water has been so polluted that it is no longer suitable for irrigating tobacco and other crops, leading to investments in groundwater by the farmers.

Subsistence agriculture is insufficient to feed communities year-round especially along the valley areas of Muzarabani, Mbire, Chitsungo, Kanyemba, resulting in a high reliance on food imports from other areas. The border stretches from Mukumbura in the East, Mbire in the North, Makuti, and Siyabuwa along the Zambezi Valley and the border with Mozambique; it is characterised by vulnerable, degraded ecosystems exposed to tsetsefly and malaria as well as flooding and drought. The cost of the imported food makes households with limited income (and in some cases, no income) highly vulnerable. With rainfall being variable, droughts frequent, water pollution along the Manyame and Mazoe rivers endemic, soils leached and evapotranspiration high, the potential for land being agriculturally viable is reducing rapidly. Critical interventions in this hotspot include agricultural interventions that not only maintain but improve the degraded nature of both the land and water bodies.

Vulnerability Zone D

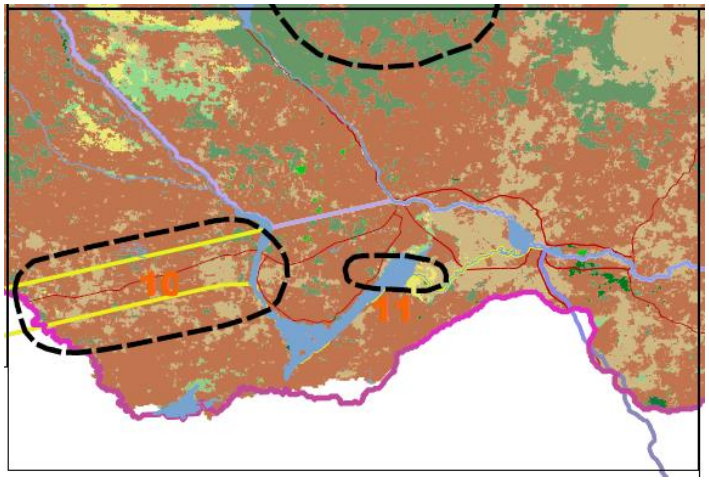


Figure 38: Vulnerability Zone C, Hotspots 10 and 11

Hotspot 10:

The Caprivi strip has notoriously low service delivery levels, being a somewhat 'disregarded area' far away from Namibia and Botswana's primary service delivery areas. Given the relative remoteness of these communities, they largely subsist off the natural resources in the area - typically following the availability of water resources (i.e. with permanent settlements situated away from wildlife dispersal zones during the wet season, and seasonal homes near the river during the dry season).
Using wood for cooking and heating, the bush for sanitation, and natural water sources for water supply make them highly vulnerable to external shocks. Droughts and veld fires across all areas (close to as well as away from rivers) and flooding along the river courses – especially downstream and towards hotspot 11), is a major concern for human and livestock safety.
There is also very little formal schooling and healthcare available: severe poverty and in some cases illiteracy within entire villages is of great concern. Malaria is also reported as a major cause of illness (and thus reduced productivity) and death in the area.
A dual economy exists in the hotspot that presents opportunities to improve livelihoods and support localised development. Currently, thriving tourism hubs operate alongside these vulnerable communities, where benefits are largely limited to employment opportunities and conservancy concessions. Opportunities for local communities to intercept the tourism value chain through more impactful, formal mechanisms should be explored. Previously this was readily covered through the participation of community trusts under the rubric of CBNRM, where they shared income from proceeds of trophy hunting. The dilemma is that trophy hunting was banned in Botswana, especially elephant trophies which were the main source of income for the local communities. Although Namibia's hunting regulations differ, the challenge should be considered a shared one across international borders between Botswana and Namibia.
Tourism in the hotspot has taken a step backwards, with many facilities (other than internationally-supported/run concessions) being unable to maintain a high standard of service to its customers. That is, locally run investments have seen declining numbers and a decline in service delivery, with quality of especially restaurant/food services potentially contributing to a large extent to the situation. Such decline has an overall negative effect in returning customers and may cause ever-escalating localised economic downturn. Localised interventions focussed on improved quality and quantity of local produce for the tourism industry, as well as the provision of hospitality training for local communities, would contribute to improved socio-economic growth in the hotspot.

Hotspot 11:

This hotspot around Kasane is characterised by intense and frequent flooding. It is expected that the flood risk for communities in this area will increase as climate variations in the basin increase. Although the population density is relatively low, the close proximity of villages to each other and high numbers of child-headed households enables the potential for interventions to have high and potentially long-lasting impacts. Kasane is also a key regional tourism hub, with a substantial wildlife population (including functioning elephant corridors in the hotspot). The banning of ivory trade has largely impacted on community trusts that relied on proceeds from safari hunting. This has led to the increase in poaching in both hotspots 10

and 11 and is a clear need for interventions that address high levels of poverty in this region. The communities in this area therefore face similar challenges to those in Hotspot 10, and opportunities to support local communities enter into, and benefit from, formal markets must be explored. As a primary and niche tourism hub for Botswana where poverty and human wildlife conflict persist, the whole Kasane and Chobe enclave is dotted with inter-connected vulnerable areas requiring intervention.
The construction of a new major bridge near Kasane to link Zambia with the region south of the border, holds potential for hotspots 10 and 11 to achieve improved road/transport connection which will enable accessibility to share regional improvements in economic opportunities.
Interventions for hotspot 10 and 11 must be of a cross-border nature given the land-use and human-wildlife-conflict (HWC) issues concentrated along and across the Chobe River affect both countries.

Vulnerability Zone E

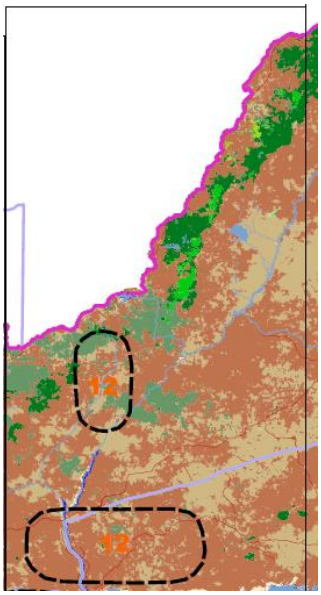


Figure 39: Vulnerability Zone D, Hotspot 12

Hotspot 12:

This cross-boundary hotspot, although indicated in two separate areas (to the north in Zambia, and towards the south in Mozambique), have the same characteristics. In many ways, the hotspot has similar characteristics in terms of community and subsistence agriculture vulnerability as hotspot 9 (Zimbabwe), although with a lesser water resources contamination character. There two distinct areas within the hotspot houses significantly vulnerable communities who have little or no water supply and sanitation, and very poor transport routing, in addition to the same low-income levels, land degradation and related challenges as discussed in hotspot 9. As in hotspot 9, communities rely to some degree on harvesting of natural wildlife resources that migrate in the area.
The hotspot reflects a much drier savannah landscape than towards the west of the region, where higher levels of vegetation cover and lower levels of evapotranspiration provide a buffer against systemic shocks which villages face. The hotspot is characterised by higher than average potential for crop failure in drought years or when excessive heat days are experienced. The high dependence of communities on natural resources and a lack of access to basic services are what identified this hotspot as one of the priority areas for intervention.

Vulnerability Zone F

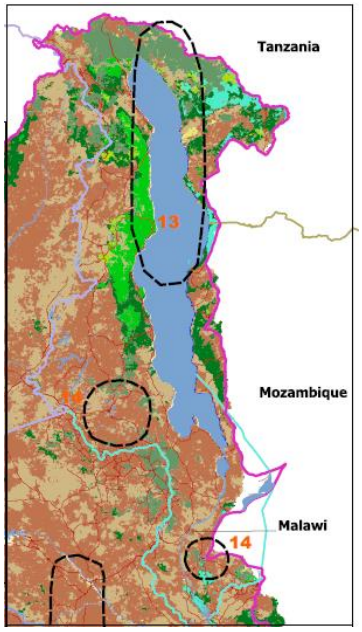


Figure 40: Vulnerability Zone F, Hotspots 13 and 14

Hotspot 13:

The area indicated by the hotspot runs along the banks of the lake (the name and boundary/ownership of which is contested between Tanzania and Malawi). This hotspot is indicated as only slightly lower population density than that of Hotspot 14, but settlements are of a more rural, remote nature. The density of population alone asks for critical intervention, given the associated levels of poverty and high prevalence of waterborne disease outbreak that communities in this hotspot face.

With poor road accessibility and a lack of reliable energy sources, communities have limited adaptive capacity to respond to the impacts of hazards such as floods and earthquakes. At a household level, reliance on poor farming practices outside large commercial crop planting areas puts significant strain on communities to be self-reliant. Improved agriculture, even hydroponics, as well as a focus on sustainable fisheries would enhance the ability of the natural resources in the hotspot to support the livelihood needs of communities. Capacity building around improved community-based natural resource management and monitoring should accompany these interventions to avoid catchment degradation and preserve the integrity of soils.

Given the transboundary nature of this hotspot, similar interventions in both Malawi and Tanzania will be required to ensure socio-economic development occurs equitably – avoiding cross-border conflict or illegal migration. However, the uncertainty about rights to the Lake's water resources is contentious and the area may benefit if clarity can be found at a governance level, especially with regard to investment in aquaculture.

Hotspot 14:

The cities of Lilongwe and Blantyre draw significant numbers of migrants, creating almost seamless urban edges from north to south along the hotspot. This hotspot has the highest population density in the basin, and with urban capacities and poverty rates growing rapidly (especially in the peri-urban areas surrounding the cities), existing infrastructure and services are unable to support the population as they face issues of urban flooding, increasingly strong winds, and waterborne disease outbreak. Interventions in this area could focus on improved, climate resilient water and sanitation services (a lack of which puts pressure on the health care services), sustainable urban drainage systems, and urban agriculture (including vertical agriculture), to support food security., If the identified issues in these vulnerable areas are not addressed, there is a high risk of secondary impacts (linked to poverty and disease outbreak) spreading more widely both within Malawi and across the Mozambican border.

The proposed interventions are also applicable to other regional hubs in the Zambezi, where similar socio-economic and physical issues persist. The proposed approaches to improved sanitation, waterworks and food security in this dense (peri-)urban hotspot will therefore serve as demonstration pilots, with the aim of motivating for wider investment and replication elsewhere in the basin.

Vulnerability Zone G

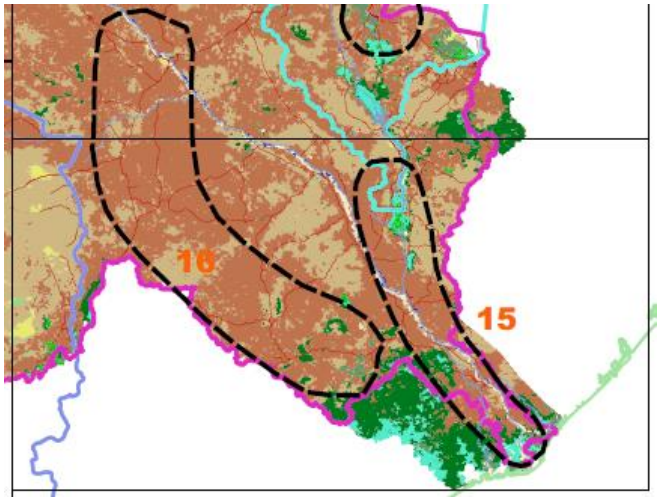


Figure 41: Vulnerability Zone G, Hotspots 15 and 16

Hotspot 15:

Settlements[86] located along the Shire River in Malawi and Mozambique are exposed to severe, and increasingly prevalent, floods – requiring significant support from the governments' disaster response ministries. People have died, fields damaged, property lost, and in some cases, infrastructure has been destroyed. Siltation issues (resulting from severe deforestation and erosion in hotspot 16) have further affected ecosystem services (including flood mitigation) and increased the region's environmental vulnerability to flooding. The region is also affected by strong winds, and at times storms. With accessibility to some of these areas also posing a major challenge, services and links to markets are limited – which exacerbates widespread poverty and risk of disease outbreak.

Given groundwater in many parts of this area is saline, communities remain reliant on the river as source for domestic and livelihood needs. However, they currently lack the infrastructure to pump and reticulate water to areas of land above the flood line. Priority interventions in the area should therefore focus on improved, climate resilient run-off-river supply schemes – including suitable water storage facilities to account for extended / unexpected drought period.

Given the intrinsic links between challenges in hotspots 15 and 16, it must be noted that the issues in these hotspots cannot be tackled in isolation; that is, interventions to address deforestation and restore the integrity of soils and catchments in hotspot 16 are a critical starting point toward addressing risk of flooding in hotspot 15.

Hotspot 16:

This hotspot covers dry lands, where local communities are affected by droughts. Without proper irrigation facilities, this vulnerability to droughts makes agriculture an unreliable practice, affecting food security. Further, there is a lack of economic opportunities in the region. An important livelihood activity is wood cutting, wood being used for fuel and as construction material. As a result, deforestation and erosion in the hotspot is at a critical level. This increases the prevalence and intensity of floods in downstream areas. In a vicious cycle, food insecurity and poverty trigger migration flow towards riverbeds where the population is vulnerable to floods (*see Hotspot 15*).

C 1.6. TYPOLOGIES

These narratives present a high-level overview of the severity and breadth of challenges faced by vulnerable communities throughout the Zambezi Basin. Given the differing contexts, characteristics and climate change projections of each hotspot, tailored and targeted responses are required to adequately address the localised socio-economic and environmental issues. Potential livelihood responses/types are therefore differentially important to different areas in the basin.

Identifying and defining resilient, appropriate interventions within each hotspot requires significant ground-truthing and stakeholder engagement; however, the following generic livelihood project typologies (Table

[86] Such as Murraca and Caia (Mozambique) and Bangula (Malawi)

23) can be used as a starting point to guide the process. These typologies represent the range of potential projects discussed during NASC consultations in each Riparian State.

It is also important to recognise that livelihood projects should not sit in isolation of the larger-scale projects within the ZSP's programmatic structure. Opportunities to expand the wider socio-economic benefits of these larger developments through related livelihoods interventions should be considered both by the Member States and potential funders. The typologies have therefore been linked to the four programmes. In addition, as this livelihoods piece is unpacked through more detailed analysis and engagement, it will be important to remain cognisant of how livelihood interventions link with other programmes of intervention that sit outside the immediate ambit of water resources – but which still contribute to poverty reduction, sanitation, improved human health, food security, etc.

Table 23: Hotspot Typologies

PROGRAMME	TYPOLOGY
Energy	• **Off-grid small-scale hydropower generation**, for household and productive use in remote locations –negating the need for (and reliance on) grid energy and reducing extensive fuelwood and charcoal production (thus reducing biomass, increase soil erosion, sedimentation and evapotranspiration). • **Solar power generation** for household and productive use. Whilst not directly linked to the hydropower programme, expanding alternative sources of off-grid power increases the capacity of the power pool, and ultimately reduces the dependency on water for power generation.
Agriculture	• **Sustainable rainfed agriculture**, through the provision of accessible and sufficient storage and localised distribution facilities to bridge variations and mitigate risks during periods of low rainfall. • **Small-scale irrigation,** using technology suited to local water availability and climate (e.g. channels, drip irrigation, tunnels, hydroponics, etc.) – with the intention of improving quality, quantity, diversity and consistency of produce to allow farmers to move beyond subsistence horticulture. • **Climate smart agriculture practices,** adopting appropriate cropping schedules/rotations and modern agronomy techniques to optimize water usage and maintain the integrity of the soils. e.g. low/no- till.
Water Supply	• Assured water supply for domestic and small-scale productive use, noting different sources (ground vs. surface water), infrastructure, governance and tariffing/payment mechanisms will be required for urban, peri-urban and rural areas. • **Urban flood management** through implementation of sustainable urban drainage systems (including infrastructure and O&M components)

Catchment and riparian asset management	• **Flood management,** through:
	  ○ **Early warning flood systems** that can be managed, interpreted and communicated by local communities.
	  ○ **Dyke construction** and related flood protection infrastructure, as appropriate[87]
	• **Aquatic ecosystem management/enhancement**, promoting fisheries and related aquaculture activities (including harvesting reeds and herbs for medicinal purposes).
	• **Woodland management and forestry restoration,** protecting, and promoting sustainable use of, woodland resources and forests through the provision of assured, alternative energy sources.
	• **Maintaining and/or recovering wildlife corridors and dispersal areas**, by identifying opportunities for local communities to accrue direct

[87] Noting risk of maladaptation responses must be avoided – i.e. providing infrastructure to communities residing in flood zones, which would essentially encourage them to remain in high-risk areas, which will always require emergency/disaster response.

	benefits from wildlife and surrounding protected/conservation areas through increased participation in formal tourism value chains. Critical to this is improved land use planning (i.e. ensuring irrigation schemes do not encroach on wildlife corridors), which will reduce human wildlife conflicts and maintain the integrity of the ecosystem. • **Catchment restoration and management,** through interventions such as agroforestry, erosion control, terracing and buffer strips. • **Green infrastructure,** such as wetland health restoration, increased green and blue space in urban areas, riparian buffers, etc. • **Urban food security interventions,** through low-water use vertical food gardening in urban areas

These typologies have been matched to the 14 hotspots, with a view to initiating further in-country assessments to both validate the hotspot mapping analysis and inform the conceptualisation, identification and development of specific projects.

The matrix below (Table 24) uses a traffic light system to differentiate between relevant typologies, as follows:

- **GREEN**: Prioritised project typology (targeting key hotspot issues)
- **YELLOW:** Appropriate typology (targeting issues in the hotspot, but not critical to maintaining the system/mitigating a major risk – be it climate, health (human and nature), ecosystem, etc.)
- *Blank*: Not applicable

Table 24: Hotspot-Typology Matrix

HOTSPOT NO.	ENERGY	AGRICULTURE	WATER SUPPLY	CATCHMENT AND RIPARIAN ASSET MANAGEMENT
1	Off-grid small-scale hydropower generation	Rainfed agriculture (low-till, low-fertilisation practices)		Woodland management and forestry restoration
2	Off-grid small-scale hydropower generation		Assured water supply for domestic use	Woodland management and forestry restoration
3		Sustainable rainfed agriculture	Assured water supply for domestic use	Aquatic ecosystem management/enhancement Flood management
4		Climate smart agriculture practices	Assured water supply for domestic use	
5	Off-grid small-scale hydropower generation			Sustainable forest management practices
6	Solar power	Sustainable rainfed agriculture Climate smart agriculture practices	Assured water supply for domestic use	Maintaining wildlife corridors and dispersal areas
7			Sustainable urban drainage systems Improved water supply for domestic use	Green infrastructure
8			Sustainable urban drainage systems	

HOTSPOT NO.	ENERGY	AGRICULTURE	WATER SUPPLY	CATCHMENT AND RIPARIAN ASSET MANAGEMENT
			Improved wastewater management for domestic and industry	
			Improved water supply for domestic use	
9	Solar power	Small-scale irrigation: tunnels (drip/hydroponics)		Catchment restoration & management
				Recovering wildlife corridors and dispersal areas
10	Solar power	Climate smart agriculture practices	Assured water supply for domestic use	Aquatic ecosystem management/enhancement
		Small-scale irrigation: tunnels		Maintaining wildlife corridors and dispersal areas
11		Climate smart agriculture practices		Flood management
		Small-scale irrigation: tunnels		Aquatic ecosystem management/enhancement
				Maintaining wildlife corridors and dispersal areas
12		Small-scale irrigation: water storage facilities for reliable supply	Assured water supply for domestic use	Catchment restoration & management
		Climate smart agriculture practices		
13		Small-scale irrigation: tunnels (drip/hydroponics)		Aquatic ecosystem management/enhancement
				Catchment restoration & management

HOTSPOT NO.	ENERGY	AGRICULTURE	WATER SUPPLY	CATCHMENT AND RIPARIAN ASSET MANAGEMENT
14			Assured water supply for domestic use, and assured water supply for small-scale productive (in peri-urban areas around urban centres) Sustainable urban drainage systems	Green infrastructure
15		Small-scale irrigation: run-off river / pump & storage schemes outside flood lines		Flood management
16	Solar Power			Woodland management and for-estry restoration

APPENDIX D Financial Review Table

The Financial Review Table contains the information used to analyse the sources of financing in Africa, SADC and the Zambezi Basin. It is available as a separate excel file.

APPENDIX E Joint Cooperation

E 1.1. FACETS OF COOPERATION

Planning

The characterisation of projects as transnational / transboundary or national employed in this report does not correspond precisely with the established practice of international water law, which is concerned with any project undertaken on an international watercourse or utilising its water resources, whether national or transboundary in terms of its geographical location or implementation, which has the potential to have a significant adverse impact on the interests of another watercourse State(s) or upon the watercourse itself. Therefore, many projects characterised as 'national' in this report, and particularly those involving the development of large-scale infrastructure, such as hydropower, or significant use of the waters of an international basin, such as mining, will be subject to the requirements of the ZAMCOM Agreement and of international water law more generally.

The most clearly established requirements of international water law demand that a State(s) within whose territory a major project is being planned must provide other watercourse States likely to be affected with meaningful notification thereof. It is now clearly understood that such notification requires that an environmental impact assessment (EIA) of the project corresponding to generally accepted international standards must be carried out, and that the results of the EIA be shared with the affected States as early as possible in the planning process.[88] The State(s) planning the project must afford the notified State(s) reasonable time to study the notification and to respond with any concerns or objections prior to any decision of the planning State's national authorities to permit the project to proceed.

While practical implementation of the requirement to provide adequate notification, and the process for responding in a timely manner to such notification, can become quite complicated procedurally, the ZAMCOM Member States benefit from the formal adoption in February 2017 of the *ZAMCOM Procedures for Notification of Planned Measures*. Though these *Procedures* merely comprise non-binding guidance adopted under the ZAMCOM Agreement, they are intended to provide '[c]lear guidance to Member States on detailed notification requirements, e.g. timelines, format, required supporting information, etc. [which] will ensure faster project development, approval and implementation and significantly reduce the possibility of disputes arising over planned projects.' However, the notification process for any large-scale project impacting an international watercourse nevertheless involves inevitable delay, even where the project is uncontroversial and unlikely to give rise to objections from other watercourse States. For example, the notifying State must normally wait at least six months for notified States to respond. Where objections and disagreements do arise, these delays can be quite substantial, as the States concerned are required to enter into consultations and, where necessary, negotiations in a good faith effort to resolve their differences over the project in question.

Further, the lack of harmonisation among the ZAMCOM Member States of key provisions of national law relating to project planning and approval, as identified by the *Zambezi Legal Equivalence Assessment*, may give rise to further delay and disagreement. Indeed, the

[88] *Case Concerning Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, 20 April 2010.

ZAMCOM Procedures for Notification of Planned Measures expressly acknowledge the relevance of the principle of 'subsidiarity' in their application, under which 'the present Procedures will wherever possible rely on existing provisions of the national law of the ZAMCOM Member States in order to give effect to requirements arising under international water law'.[89] Differences in the legal systems and institutional capacities of the ZAMCOM Member States are traced to a number of deep-rooted factors, including colonial heritage, socio-economic development trajectory and status, and citizens' expectations regarding natural resource use. However, such differences can largely be overcome, and Member State rules incrementally brought into line through the so-called parallel national action approach outlined in the *Zambezi Legal Equivalence Assessment*.[90] The parallel national action approach involves building consensus at the regional institutional level in the case of non-contentious issues and the incorporation of such consensus into all Member States national regulatory frameworks, as well as coordinated notification procedures and harmonised information management arrangements in the case of more divisive issues.

In addition to the notification and consultation / negotiation requirements of international water law, projects funded (or part-funded) by multilateral development banks will inevitably be subject to the more highly elaborated environmental and social appraisal and disclosure requirements set out in the environmental and social safeguard policies to which these institutions adhere. For example, in addition to the policy on Environmental Assessment,[91] projects (part-) funded by the World Bank would be subject to a specific policy on Projects on International Waterways,[92] under which watercourse States must inform affected riparian States of proposed projects on international waterways and, if there are objections, refer the proposal to independent experts.[93] Other multilateral development banks which might fund water-related development projects in Africa, including the African Development Bank, the International Finance Corporation, and the European Investment Bank, all have in place extensive safeguard policies requiring full disclosure of the environmental and social impact assessments required as part of institutional project due diligence.

In the case of joint/transnational development projects States would normally conclude bilateral agreements regarding the construction and operation of joint infrastructure. Such agreements should ideally include detailed provisions on mutual notification and notification of third party States, as well as on the conduct of EIA and a range of matters relevant to project planning.

Legal and Institutional Constraints on Financing

Financing for major infrastructure and development projects might be expected to come from a wide range of sources, many of them foreign investors of one sort or another. These might include, *inter alia,* climate funds, climate bonds, multinational energy and construction companies, multilateral development banks, investment banks, and foreign governments or sovereign wealth funds. Each of these sources of project finance present different governance challenges and opportunities and the sections below outline the environmental and social safe-

[89] *ZAMCOM Procedures for Notification of Planned Measures* (February, 2017), at 8.
[90] *Final Options Paper for Harmonisation of Water Law and Policy across the Zambezi River Basin* (December 2017), at 15-16.
[91] OP/BP 4.01 Environmental Assessment.
[92] OP/BP 7.50 Projects on International Waterways.
[93] See, for example, World Bank, *Environmental Flows in Water Resources Policies, Plans, and Projects: Findings and Recommendations* (2009), at 55-56.

guard requirements associated with multilateral development bank financing, and the potential for conflict between the requirements of international water and environmental law and those of international investment law.

All multilateral development banks are now expected to ensure that the projects they finance adhere to the strict environmental and social requirements set out in comprehensive institutional policies and overseen by independent accountability mechanisms to which project-affected people and/or civil society organisations may bring complaints. For example, in addition to the general World Bank safeguard policy on Environmental Assessment and the specific policy on Projects on International Waterways referred to above, the World Bank also has detailed policies on a range of related issues likely to arise in the development of water-related infrastructure projects in the Zambezi Basin. These include policies on Natural Habitats,[94] Indigenous Peoples,[95] Physical Cultural Resources,[96] Involuntary Resettlement,[97] and Forests.[98] The World Bank even has a specific policy on the Safety of Dams.[99] The normative requirements set out in such safeguard policies tend to mirror the requirements of international environmental, water resources and human rights law, and so they provide an effective alternative means of enforcing such requirements – something often lacking in the formal practice of international law. The implementation and enforcement of the Wold Bank policies is overseen by the Inspection Panel which, like the independent accountability mechanisms established by other multilateral development banks, has found itself investigating the compliance of many water-related projects, especially hydropower dams[100] and large-scale agriculture projects.[101]

In the case of development projects involving foreign private-sector investors, as might often be the case in hydropower or agriculture projects, the requirements of international investment law become highly relevant.[102] Foreign private-sector investors are likely to be covered by bilateral investment treaties or free trade agreements concluded between the State hosting the project the home State of the investor. Over 2,300 such bilateral investment treaties have been concluded to date, of which over 1,700 are currently in force, thereby providing investors with considerable legal protection and restricting the ability of host States to regulate their activities. Investment treaties normally guarantee 'fair and equitable treatment' of investors, incorporating a requirement for host States to provide a stable framework for the investment.[103] In addition, they normally provide for the payment of compensation in the case of direct or indirect (including regulatory) expropriation of the investment, as well as mandatory dispute settlement before a nominated international investment tribunal, such as the International Centre for the Settlement of Investment Disputes (ICSID) or the United Nations Committee on International Trade Law (UNCITRAL). Investment or concession contracts concerning particular development projects and concluded between host States and foreign investors will normally seek to provide a high level of investor protection. They achieve this though the

[94] OP 4.04 Natural Habitats.
[95] OP 4.10 Indigenous Peoples.
[96] OP 4.11 Physical Cultural Resources.
[97] OP 4.12 Involuntary Resettlement.
[98] OP 4.36 Forests.
[99] OP 4.37 Safety of Dams.
[100] See, for example, World Bank, *Uganda – Bujagali Project – Inspection Panel Investigation Report* (2002). For other IAMs, see, for example, IFC Compliance Advisor Ombudsman (CAO), *Assessment Report – Pangue Project* (2003).
[101] See, for example, World Bank, *Armenia – Irrigation System Enhancement Project: Request for Inspection* (2016). For other IAMs, see, for example, IFC Compliance Advisor Ombudsman (CAO) Early Warning System, *Burkina Faso – Smallholder Water Management and Irrigation Project* (2016).
[102] See generally, A. Tanzi, 'International Law and Foreign Investment in Hydroelectric Industry: A Multidimensional Analysis', (2016) 18 *International Community Law Review* 183-222.
[103] See *Enron v. Argentina* (ICSID, 2007).

inclusion of, *inter alia*, 'stabilisation clauses', which limit future changes in the national law or new regulatory measures, and may frustrate efforts aimed at the cooperative sustainable management of shared international water resources. At the same time, investment treaties often include 'umbrella clauses', requiring a host State to respect all commitments to investors and thereby transforming a simple breach of contract into a breach of an international treaty.

The approach of investor-State arbitration tribunals to claims relating to the regulatory activities of host States varies and thus can be difficult to predict. In different cases, tribunals have adopted a range of approaches, ranging from reliance on the 'sole effects' doctrine,[104] which is regarded as very sympathetic to investors' claims, to the more host State-friendly 'police powers' doctrine,[105] as well as compromise 'binary' approach.[106] It is important to note, as regards water-related projects, that international investment arbitration tribunals have recognised that water and sanitation services involve 'complex public and international law questions, including human rights considerations', which suggests that water-related needs might enjoy special priority.[107] However, despite such uncertainty, the spectre of investor-State investment arbitration seeking to establish the liability of host States for extensive damages can have a 'chilling' effect as regards host State regulatory activity and transboundary cooperation to achieve sustainable management of international water resources.

Therefore, host States would be well advised to clarify in investment or concession contracts relating to water-related projects the nature and extent of their *bona fide* right to exercise their regulatory powers, even where such measures might impact on the rights of a foreign investor. It would be prudent to establish, for example, whether changes to rules on the operation or filling of dams, in order to protect the legitimate interests of other watercourse States, amounts to breach of a stabilisation clause. Similarly, in the light of increased climate risk, it would be wise to ensure that legal arrangements for the protection of foreign investors can accommodate regulatory changes, such as modification of dam operating rules, necessitated by greater climate variability and the occurrence of extreme weather events. States should seek to ensure that climate-related risk is equitably shared between investors and States, including both upstream and downstream watercourse States.

Of course, there may exists a wide range of other legal and institutional mechanisms which can function to facilitate the development of water related infrastructure projects, including bilateral inter-State agreements regarding the construction and operation of joint infrastructure projects which are intended to optimise the benefits secured by both States, and cooperative arrangements established amongst operators of water-related infrastructure in order to optimise the benefits derived by each. Such mechanisms may involve the conclusion of specific legal agreements, liability to make side-payments, or sophisticated benefit-sharing and/or cost-sharing arrangements amongst operators. It appears that ZAMCOM can play a central role in assisting and facilitating such cooperative arrangements, as the Commission enjoys a very broad mandate to advise Member States and foster awareness among the inhabitants of the Zambezi Basin and, more generally, to 'promote, support, coordinate and

[104] See *Metalclad v. United Mexican States* (ICSID, 2000).
[105] See *Methanex v. USA* (UNCITRAL, 2005).
[106] See *Tecmed v. United Mexican States* (ICSID, 2005).
[107] See *Aguas Argentinas SA, et al v. Argentina* (ICSID 2005); *Aguas Provinciales de Sante Fe, et al v. Argentina* (ICSID 2006); *Suez, et al v. Argentina* (ICSID 2007); *Biwater Gauff (Tanzania) Ltd v. Tanzania* (ICSID 2007).

harmonise the management and development of the water resources of the Zambezi Watercourse'.[108] At any rate, ZAMCOM may be expressly charged with facilitating such cooperative practices, as Article 5(h) instructs the Commission to 'carry out such other functions and responsibilities as the Member States may assign from time to time', while the Agreement further requires Member States to 'promote partnerships in effective and efficient water management'.[109] Of course, the Member States can do so most effectively making use of the cooperative institutional mechanisms provided by the Commission.

E 1.2. PRINCIPLES FOR TRANS-BOUNDARY PROJECTS

In planning water-related development projects which might have transboundary implications, watercourse States are required to take all reasonable steps to ensure that each State is adhering to the three key rules or principles of international law, as enshrined in the ZAMCOM Agreement:

- The principle of equitable and reasonable utilisation;[110]
- The duty to prevent significant transboundary harm;[111] and
- The general duty to cooperate.[112]

However, the practical application of each of these principles in the context of basin-wide cooperation for project implementation ought to be elaborated further.

Equitable and Reasonable Utilisation:

Practically all States sharing transboundary basins have come to adopt an approach to international water resources management that recognises that both the sovereign utilisation rights of one (upstream) basin State and the right to territorial integrity of another (downstream) basin State are each restricted by a recognition of the equal and correlative rights of the other State. This approach is usually articulated in normative terms as the principle of 'equitable and reasonable utilisation', which entitles each co-basin State to an equitable and reasonable use of transboundary waters flowing through its territory. As it involves recognition the 'equality of right' of both upstream and downstream States, or of States causing and suffering pollution, equitable and reasonable utilisation coheres with the notion of the sovereign equality of States, a fundamental principle of international law authoritatively enshrined in Article 2(1) of the United Nations Charter. However, equality of right does not entitle each State to an equal share in the waters of a shared basin, but only to an equal right *vis-à-vis* its co-riparian neighbours to an equitable share of the uses and benefits of the watercourse having regard to all relevant factors. The principle is also based on the notion that there exists a 'community of interest' among all co-basin States, requiring a fair balancing of State interests which accommodates the needs and uses of each State. To permit flexibility, the concept of 'equitable and reasonable' use is consciously understood as normatively vague and is to be determined in each individual case in the light of all relevant factors including, most significantly, the human, economic and social dependence of each State upon the water resources in question, as well as considerations of environmental protection. In essence, the principle of equitable and reasonable utilisation requires that, in using shared water resources, each co-

[108] ZAMCOM Agreement, Article 5(b). At any rate, ZAMCOM may be expressly charged with facilitating such cooperative practices, as Article 5(h) instructs the Commission to

> 'carry out such other functions and responsibilities as the Member States may assign from time to time'.

[109] Article 14(3)(d).
[110] ZAMCOM Agreement, Articles 12(1)(h), 13 and 14(1).
[111] ZAMCOM Agreement, Articles 12(1)(c) and 14.
[112] ZAMCOM Agreement, Articles 12(1)(g).

basin State must have equitable and reasonable regard for the legitimate needs and interests of other co-basin States. This principle, which unquestionably provides the prevailing normative framework for identifying international watercourse rights and obligations today, has its doctrinal origins in the sovereign equality of States, whereby all States sharing international watercourse have equivalent rights to the use of its waters.

Though equitable and reasonable utilisation is regarded as the pre-eminent substantive rule of international water law, a normative framework requiring the equitable balancing of the legitimate interests of basin States must inevitably involve intense procedural inter-State engagement, which normally can only be facilitated by the establishment of technically competent inter-State institutional machinery. Such institutions can ensure effective inter-State communication which might involve, *inter alia*, prior notification of planned projects potentially impacting upon the watercourse, routine exchange of information regarding the utilisation or condition of the shared waters, or expression of concerns on the part of any basin State. The pivotal role of institutional mechanisms in giving effect to the principle of equitable utilisation has long been recognised by the international community generally,[113] and by the riparian States of the Zambezi. Reliance on such institutional mechanisms to facilitate the inter-State cooperation necessary to achieve equitable and reasonable utilisation is often referred to as the 'common management' approach, which further underlines the existence of a community of interest among co-basin States.

The principle of equitable and reasonable utilisation enjoys very considerable support in the judicial deliberations of international and federal courts and tribunals, as well as in analogous approaches to the allocation of shared water resources adopted by municipal courts. For example, in the *Gabčíkovo-Nagymaros* case before the International Court of Justice, Judge *ad hoc* Skubiszewski, in his dissenting opinion referred to the 'canon of an equitable and reasonable utilization' as an expression of 'general law'.[114] The principle receives almost universal support in treaty law, international codifications, declaratory soft law instruments and the general practice of States, as well as in the writings of leading publicists.[115] On the basis of an extensive expert examination of the position having regard to all indicators of the existence of a customary rules, the International Law Commission concluded unequivocally 'that there is overwhelming support for the doctrine of equitable utilization as a general rule of law for the determination of the rights and obligations of States in this field'.[116]

However, such universal acceptance by States is due in large part to its flexibility and normative indeterminacy, with the principle providing both a somewhat vague aspirational goal to guide transboundary water cooperation and the starting point for a process to investigate, identify and reconcile the needs, interests, entitlements and obligations of interdependent co-basin States. One commentator emphasises the procedural and institutional nature of the principle of equitable and reasonable utilisation, explaining that it involves 'a discursive process in which adversary interests need to be reconciled', and refers to it as a striking example

[113] See, for example, Recommendation 51 of the *Action Plan for the Human Environment* adopted at the 1972 Stockholm Conference, UNCHE, 1972. *Report of the United Nations Conference on the Human Environment.* Stockholm: UN Publication Sales No. E.73.II.A.14. See further, S. Schmeier, *Governing International Watercourses: River Basin Organizations and the sustainable governance of internationally shared rivers and lakes* (Routledge, Abingdon, 2013).
[114] *Case Concerning the Gabčíkovo-Nagymaros Project (Hungary / Slovakia). ICJ Reports* 7, at 235.
[115] See O. McIntyre, *Environmental Protection of International Watercourses under International Law* (Ashgate, Farnham, 2007) 62-76.
[116] International Law Commission, Draft Articles on Non-Navigational Uses of International Watercourses, *Report of the International Law Commission on the Work of its Forty-Sixth Session*, UN Gaor 49th Sess., Suppl. No. 10, UN Doc. A/49/10 (1994).

of certain 'sophist rules' existing in international law, which have a 'multi-layered complexity', by virtue of which they enjoy a degree of elasticity, and 'usually require an effective, credible, institutionalized, and legitimate interpreter of the rule's meaning in various instances' - a process he characterises as 'institutionalized multilaterization'.[117]

In essence, the principle of equitable and reasonable utilisation involves the allocation of rights in the uses and benefits of shared water resources on the basis of a distributive conception of equity having regard to all relevant factors. This suggests that uses and benefits will be shared in proportion to each basin State's needs,[118] where such needs are calculated through consideration of those factors which are accepted by the States concerned as relevant to water allocation. Therefore, the factors considered relevant to understanding each State's dependence on the shared waters, and thus to the calculation of each State's equitable and reasonable allocation of uses and benefits, are absolutely central and codified or conventional formulations of the principle usually include an accompanying indicative list of such relevant factors.[119] Such a list is not intended to be exhaustive and a range of additional factors might be relevant in the particular circumstances of a particular basin, negotiation or dispute, such as any religious, cultural or local customary significance attached to the river in question or to its waters. Similarly, the conduct of the States concerned regarding a contested use or project might be relevant including, for example, excessive delay in raising objections.

While all key instruments emphasise the lack of a hierarchy among the relevant factors,[120] it is apparent from the practice of States that certain considerations with usually be accorded more significance than others. For example, while Article 6(3) of the UN Watercourses Convention provides that '[t]he weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors', Article 10(2) would appear to prioritise 'vital human needs', a key element in identifying the 'population dependent on the watercourse in each State' as a relevant factor under Article 6(2).[121] Of course, this elevation of vital human needs is 'likely to enhance the "human right dimension" of the use of the waters of international watercourses'.[122] A statement of understanding agreed at the time of the adoption of the Convention advises that 'special attention is to be paid to providing sufficient water to sustain human life, including both drinking water and water required for production of food in order to prevent starvation',[123] a position consistent with the ongoing discourse in international law on the human right to water.[124]

Indeed, it would appear from the practice of States in this field that what matters above all else is the dependence of each watercourse State upon the shared waters in question, in terms of either human, social or economic needs, and that the relevant factors largely function to

[117] T.M. Franck, *Fairness in International Law and Institutions,* (Clarendon Press, Oxford, 1995), 67, 75, 81-82 and 140.
[118] See O. McIntyre, *Environmental Protection of International Watercourses under International Law* (Ashgate, Farnham, 2007) 147-151.
[119] See, inter alia, 1966 Helsinki Rules, Article V(2) and 1997 UN Watercourses Convention, Article 6(1). The ZAMCOM Agreement provides such an indicative list of relevant factors in Article 13(3).
[120] See ZAMCOM Agreement, Article 13(4).
[121] Included as Article 13(3)(c) of the ZAMCOM Agreement.
[122] See A. Tanzi and M. Arcari, *The United Nations Convention on the Law of International Watercourses* (Kluwer Law International The Hague, 2001) at 131; S.R. Tully, 'The Contribution of Human Rights to Freshwater Resource Management', (2003) 14 *Yearbook of International Environmental Law,* 101.
[123] United Nations General Assembly Working Group, *Report of the Working Group to the General Assembly,* UN Doc. A/C.6/51/SR.57 (1997), at 3.
[124] O. McIntyre, 'The UNECE Water Convention and the Human Right to Access to Water: The Protocol on Water and Health', in A. Tanzi, O. McIntyre, A. Kolliopoulos, A. Rieu-Clarke and R. Kinna (eds.), *The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation.* (Brill Nijhoff, Leiden, 2015) 345-366, at 345.

elucidate the true nature and extent of such dependence.[125] For example, though the UN Watercourse Convention suggests that existing and potential uses of a watercourse will in principle be considered equally, it is likely that existing uses will be favoured as they can more easily be scrutinised in terms of their human, social, economic or environmental benefits (or adverse impacts), while the difficulties inherent in reliably considering the beneficial character (or negative impacts) of future uses are manifest. Equally, the examination of factors such as efforts at conservation and economy of use of water resources by a particular State[126] and the availability to a State of alternatives to a planned or existing use of shared waters[127] primarily help to inform that State's true dependence upon the contested waters. Further, though 'natural' factors, including the geography and hydrology of the basin are listed first under the 1997 UN Watercourses Convention, the 1966 Helsinki Rules and the ZAMCOM Agreement,[128] there is general agreement among scholars that such factors are of only marginal significance as these do not relate directly to a State's dependence on the shared water and so could undermine the distributive nature of the equitable allocation envisaged under the principle of equitable and reasonable utilisation.[129] The distributive nature of "equity" as applied in the particular field of international water law is highlighted by the fact that the significance attributed to the physical characteristics of the drainage basin, such as the length of the course of a river situated within each basin State, the extent of the drainage basin area lying in the territories of the basin States, or their relative contribution of water to the flow of a river, is relatively low.[130]

Although the principle of equitable and reasonable utilisation has its origins in inter-State arrangements for allocating co-basin States' quantum share of transboundary waters, it is now largely concerned with environmental requirements and the environmental consequences of incompatible uses. Indeed, as its seeks to balance economic, social and environmental imperatives in the use of water, equitable and reasonable utilisation is now widely understood as the means of operationalising the more nebulous concept of sustainable development in the specific context of transboundary water resources.[131] Thus, it should come as no surprise that environmental protection and sustainability requirements are inherent to authoritative modern formulations of the principle and Article 13(3)(a) of the ZAMCOM Agreement refers to 'ecological' factors, Article 13(3)(d) to the 'effects of the use or uses … on other watercourse States', and Article 13(3)(f) to conservation, protection … and economy of use of the water resources of the watercourse'. This connection is even more apparent in the 1992 UNECE Water Convention, under which the focus is squarely on environmental protection with the parties required, *inter alia*, to ensure 'ecologically sound and rational water management … [and] … conservation of water resources and environmental protection' and 'where necessary,

[125] X. Fuentes, 'The Criteria for the Equitable Utilization of International Rivers', (1996) 67 *British Yearbook of International Law* 337, at 395-408.
[126] ZAMCOM Agreement, Article 13(3)(f).
[127] ZAMCOM Agreement, Article 13(3)(g).
[128] Article 13(3)(a).
[129] See, for example, A. Tanzi and M. Arcari, *The United Nations Convention on the Law of International Watercourses* (Kluwer Law International The Hague, 2001) at 124.
[130] See X. Fuentes, 'The Criteria for the Equitable Utilization of International Rivers', (1996) 67 *British Yearbook of International Law* 337, at 395-408.
[131] P.K. Wouters and A. Rieu-Clarke, 'The Role of International Water Law in Promoting Sustainable Development', (2001) 12 *Water Law*, 281, at 283.

restoration of ecosystems'.[132] The environmental aspects of the principle have tended to enjoy ever increasing emphasis in recent years.[133]

Duty to Prevent Significant Transboundary Harm:

Whereas equitable and reasonable utilisation provides the cardinal, overarching rule of international water law, almost all international water resources agreements and codifications include a closely related obligation on watercourse States not to cause significant harm to other watercourse States. The existence of such a rule in general international law is supported by a wealth of authority in State Practice[134] and it is incorporated into Article 14 of the ZAMCOM Agreement.[135] This rule has been recognised as established customary international law by the arbitral tribunal in the 1941 *Trail Smelter Arbitration* and included among the general principles of international environmental law as Principle 21 of the 1972 Stockholm Declaration on the Human Environment. In the specific context of international water law, very many watercourse agreements contain provisions on the prevention and abatement of water pollution[136] and a survey of watercourse agreements reveals a range of ancillary substantive provisions dealing with, *inter alia,* minimum flow requirements, the prevention of harmful effects, the protection of water quality, and the application of clean technologies.[137]

The requirement to prevent harm is not absolute, however, but is understood as a due diligence obligation relating to the taking of reasonable measures by States in the use and protection of shared water resources, rather than as an absolute prohibition on causing or permitting harm in all circumstances. As the International Law Commission explains, '[i]t is an obligation of conduct, not an obligation of result'.[138] Thus, a State might lawfully fail to prevent significant transboundary harm, provided it had taken all reasonable measures to try to prevent such harm, which occurred despite that State's reasonable efforts. However, despite the principle's inherent flexibility and relativity, lawyers have a reasonably clear understanding of its key elements. For example, as regards the concept of "harm", McCaffrey helpfully explains that, in addition to a diminution in the quantity or quality of water available,

> '"Harm" could also result from, e.g. pollution, obstruction of fish migration, works on one bank of a contiguous watercourse that caused erosion of the opposite bank, increased siltation due to upstream deforestation or unsound grazing practices, interference with the flow regime, channelling of a river resulting in erosion of the riverbed downstream, conduct having negative impacts on the riverine ecosystem, the bursting of a dam, and other actions in one riparian state that have adverse effects in another,

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[132] United Nations Economic Commission for Europe (UNECE), Convention on the Protection of Transboundary Watercourses and International Lakes, (1992) 312 *International Legal Materials* 1312, Article 2(2).
[133] See *Case Concerning Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, 20 April 2010 and *Case Concerning the Gabčíkovo-Nagymaros Project (Hungary / Slovakia). ICJ Reports* 7.
[134] See O. McIntyre, *Environmental Protection of International Watercourses under International Law* (Ashgate, Farnham, 2007), at 198-221.
[135] As well as Article X of the Helsinki Rules, Article 7 of the UN Watercourses Convention and Article 2 of the UNECE Water Convention.
[136] G. Handl, 'Balancing of Interests and International Liability for the Pollution of International Watercourses: Customary Principles of Law Revisited', (1975) 13 *Canadian Yearbook of International Law* 156-194, at 171.
[137] O. McIntyre, *Environmental Protection of International Watercourses under International Law* (Ashgate, Farnham, 2007), at 88.
[138] International Law Commission, Draft Articles on Non-Navigational Uses of International Watercourses, *Report of the International Law Commission on the Work of its Forty-Sixth Session*, UN Gaor 49th Sess., Suppl. No. 10, UN Doc. A/49/10 (1994), at 237.

> where the effects are transmitted by or sustained in relation to the watercourse'.[139] (McCaffrey 2001, p. 348-349).

The concept of harm is understood broadly and the obligation to prevent harm is not confined to one State's direct use of a watercourse that causes harm to another State's use thereof, as 'activities in one state not directly related to a watercourse (e.g. deforestation) may have harmful effects in another state (e.g. flooding)'.[140] Similarly, the International Law Association's commentary to Article X of the Helsinki Rules notes that, for the purposes of the no-harm rule, 'an injury in the territory of a State need not be connected with that State's use of the waters'. The continuing evolution of the so-called "ecosystems approach" to the management of transboundary water resources, endorsed by Articles 20-23 of the UN Watercourses Convention, ought to ensure that Article 7 of the Convention is construed broadly, at least in relation to any ecological or environmental damage.[141] As regards the significance threshold for harm prohibited under Article 7 of the UNWC, the International Law Commission has explained that '[t]here must be a real impairment of use, *i.e.* a detrimental impact of some consequence upon, for example, public health, industry, property, agriculture or the environment in the affected State'.[142] This approach formalises the so-called *de minimus* rule, which derives from the general principle of good neighbourliness and involves 'the duty to overlook small, insignificant inconveniences'.

In describing the nature of the due diligence obligation imposed upon States by Article 7 of the UN Watercourses Convention (or by provisions such as Article 14 of the ZAMCOM Agreement), the International Law Commission's commentary to the 1994 Draft Articles refers approvingly to the definition of due diligence provided in the 1872 *Alabama Claims Arbitration*, which describes the concept as 'a diligence proportioned to the magnitude of the subject and to the dignity and strength of the power which is exercising it' and as 'such care as governments ordinarily employ in their domestic concerns'.[143] In the specific context of international watercourses, the 'magnitude of the subject' might be expected to refer to the nature of the relevant activity and suggests, therefore, that where it is inherently dangerous 'the care required would be so great as to approach strict liability; a virtual guarantee that such a harmful event would not occur'.[144] The 'appropriate measures to prevent the causing of significant harm' required of each watercourse State can be understood to include both substantive and procedural elements, as made clear by the Court in the *Pulp Mills* case.[145] Substantive due diligence might require, for example, that a basin State with the potential to cause transboundary harm should ensure the adoption and enforcement of appropriate domestic legal controls, while procedural due diligence would demand that a State planning a major project likely to impact on the watercourse or on the interests of co-basin States should notify such

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[139] S.C. McCaffrey, *The Law of International Watercourses: Non-Navigational Uses* (OUP, Oxford, 2001), at 348-349.
[140] *Ibid.*
[141] See O. McIntyre, 'The Emergence of an "Ecosystems Approach" to the Protection of International Watercourses under International Law', (2004) 13/1 *Review of European Community and International Environmental Law* 1; O. McIntyre, 'The Protection of Freshwater Ecosystems Revisited: Towards a Common Understanding of the "Ecosystems Approach" to the Protection of Transboundary Water Resources under International Law', (2014) 23/1 *Review of European, Comparative and International Law* 88-95.
[142] International Law Commission (ILC), 1988. The Law of the Non-Navigational Uses of International Watercourses. *Yearbook of the International Law Commission*, 2/2, 22-54.
[143] International Law Commission, Draft Articles on Non-Navigational Uses of International Watercourses, *Report of the International Law Commission on the Work of its Forty-Sixth Session*, UN Gaor 49th Sess., Suppl. No. 10, UN Doc. A/49/10 (1994), at 236-237.
[144] S.C. McCaffrey, *The Law of International Watercourses: Non-Navigational Uses* (OUP, Oxford, 2001), at 373.
[145] *Case Concerning Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, 20 April 2010, para. 77.

States and, where necessary, engage in good faith consultation and negotiation regarding their outstanding concerns.

The relationship between the duty to prevent significant transboundary harm and the overarching cardinal principle of equitable and reasonable utilisation has been a contentious issue. However, on careful examination of the 1997 UN Watercourses Convention it becomes apparent that the no-harm rule, and other substantive rules, such as those relating to environmental and ecosystems protection, are subject to the doctrine of equitable and reasonable utilisation. In other words, the duty to prevent harm has in principle only a limited, though in practice probably profound, effect on the operation of the balancing of interests required under equitable and reasonable utilisation. In certain circumstances, one watercourse State's use of shared waters would have to be tolerated, even if it caused significant harm to another, where the offending use represented the equitable and reasonable allocation of benefits taking account of all relevant considerations. In the *Gabčíkovo-Nagymaros* case the Court strongly endorsed the principle of equitable and reasonable utilisation as the governing rule of international water law and the one on which that dispute should turn.[146]. The subordination of the no-harm rule possibly reflects the fact that, in many international watercourses, lower basin States have tended to develop earlier, and so a strict prohibition on causing harm would effectively serve to protect existing rights and 'would therefore impede opportunities for newly developing upstream States that pursue legitimate interests for the welfare of their societies'.[147]

However, it would be a mistake to imagine that these two key substantive rules of international water law are likely to come into conflict often, if at all, and a leading scholar in the field suggests that 'the *sic utere tuo* [no-harm] principle is not only fully compatible with that of equitable utilization, it essentially merges with the latter principle'.[148] He explains elsewhere that

> 'It is thus the flexibility of the no-harm rule that makes it compatible, even if not entirely identical, with the principle of equitable utilization … rather than prohibiting the causing of harm *per se*, the law takes into account surrounding circumstances. This same process is followed in arriving at an equitable and reasonable allocation of the uses and benefits of shared freshwater resources … There is therefore no need to "reconcile" the no-harm and equitable utilization principles. They are, in reality, two sides of the same coin'.[149]

There can be little doubt that the no harm rule envisages environmental pollution and ecosystems damage as centrally relevant classes of harm to be prevented[150] and the environmental implications of the no-harm rule must be understood in the light of the evolving international legal frameworks for environmental protection:

> 'it must be recognized that much progress has been made on giving content to the notion of due diligence in international environmental law generally, and with regard to shared natural resources, in particular. In these fields, exercising due diligence …

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[146] *Case Concerning the Gabčíkovo-Nagymaros Project (Hungary / Slovakia). ICJ Reports* 7, paras. 78, 85, 147 and 150.
[147] A. Nollkaemper, 'The Contribution of the International Law Commission to International Water Law: Does It Reverse the Flight from Substance?', (1996) 27 *Netherlands Yearbook of International Law* 39, at 57.
[148] S.C. McCaffrey, *The Law of International Watercourses: Non-Navigational Uses* (OUP, Oxford, 2001), at 357.
[149] *Ibid.*, at 370-371.
[150] O. McIntyre, *Environmental Protection of International Watercourses under International Law* (Ashgate, Farnham, 2007), at 116-118.

> generally means adopting and effectively enforcing legislative and administrative measures that protect other states and areas beyond the limits of national jurisdiction. The standard of protection – how stringent the measures should be – may in some cases be determined by reference to internationally agreed minimum standards in the field'.[151]

McCaffrey observes that 'states increasingly treat pollution of international watercourses and degradation of aquatic ecosystems as a special form of harm, subject to a somewhat different regime from that applicable to allocation and utilization in general'.[152]

Finally in relation to the duty to prevent significant harm, it should be noted that, while harm would traditionally have been expected to 'flow downstream', by impacting upon actual or potential economic or social utilisation of the shared water resources in watercourse States located downstream of the source of harm, there is a growing recognition that downstream utilisation of shared waters might effectively 'foreclose' on the options available for future upstream utilisation of the same waters, which suggests that downstream States may also cause significant harm to upstream States.[153]

General Duty of Cooperation:

The general obligation of States to cooperate in the resolution of international problems is widely accepted and receives support from as authoritative a legal source as Article 1(3) of the United Nations Charter.[154] This approach is also evident in the United Nations General Assembly's 1970 Resolution on Friendly Relations and Co-operation Between States.[155] In the field of international water resources, the general obligation to cooperate is given practical effect by means of various associated rules of procedural conduct that are rapidly emerging as contemporary international custom, including the duties to notify, consult, negotiate and warn, as well as duties relating to the ongoing exchange of relevant data and information. Whatever the precise legal status of the general duty to cooperate,[156] it can be said to be more firmly established and highly developed in terms of its application to the protection of the environment and utilization of shared natural resources. For example, Dupuy notes that 'co-operation is the general means by which States will implement the substantive rights and duties regarding the use of transboundary natural resources'.[157] Similarly, Birnie and Boyle describe the obligation to cooperate in mitigating transboundary environmental risk as 'now widely acknowledged' and they refer particularly to the 'requirement of prior consultation based on adequate information' as 'a natural counterpart to the concept of equitable utilization of a shared resource'.[158] In support of this conclusion one needs only to consider the numerous non-binding recommendations and declarations of States, which refer to the obligation to co-operate and define some of its means of implementation,[159] as well as the significant number

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[151] S.C. McCaffrey, *The Law of International Watercourses: Non-Navigational Uses* (OUP, Oxford, 2001), at 374.
[152] *Ibid*., at 364.
[153] See S.M.A. Salman, 'Downstream Riparians Can Also Harm Upstream Riparians: The Concept of Foreclosure of Future Uses', (2010) 35/4 *Water International* 350-364.
[154] Charter of the United Nations, San Francisco, 26 June 1954, in force 24 October 1945, 1 UNTS 16.
[155] G.A. Res. 2625 (XXV), UN GAOR Supp. (No. 28), at 121, UN Doc. A/8028 (1970).
[156] See generally, C. Leb, *Cooperation in the Law of Transboundary Water Resources* (CUP, Cambridge, 2013).
[157] P.-M. Dupuy, 'Overview of the Existing Customary Legal Regime Regarding International Pollution', in D. B. Magraw (ed.), *International Law and Pollution* (University of Pennsylvania Press, Philadelphia, 1991), 61;70.
[158] P. Birnie and A. Boyle, *International Law and the Environment* (2nd ed.) (OUP, Oxford, 2002), at 126.
[159] See, for example, Principle 24 of the Declaration of the United Nations Conference on the Human Environment, Stockholm, 16 June 1972 (1972) 11 ILM 1416 (Stockholm Declaration) and Principle 19 of

of international watercourse agreements which expressly allude to the obligation to cooperate, including the ZAMCOM Agreement.[160]

In 1957 the Arbitral Tribunal in the *Lac Lanoux* arbitration was enequivocal in its recognition of the duty of States to cooperate in the use of the waters of an international watercourse, linking good faith cooperation with the effective conclusion of international agreements as the key means of ensuring the prevention of transboundary harm.[161] In the *Gabčíkovo-Nagymaros* case, the Court's judgment reflects the procedural obligation to cooperate, and even requires the parties to agree to cooperate in the joint management of the project.[162] The duty to co-operate has received similar support from international tribunals in a range of environmental disputes.[163] The most authoritative statement of current general international water law is once again set out in the 1997 UN Watercourses Convention. Indeed, it contains a specific provision on the 'general obligation to cooperate',[164] as well as a Part III, comprising Articles 11-19, which contains detailed procedural rules requiring watercourse States to notify, consult and negotiate in relation to planned measures which may have adverse effects on other watercourse States. Part III may be regarded as the Convention's most important contribution to general international law in this area. Building on the work of the ILC and the UN General Assembly in developing the text of the Convention, the International Law Association's 2004 Berlin Rules include an Article 11 providing that 'Basin States shall cooperate in good faith in the management of waters of an international drainage basin for the mutual benefit of the participating States'. The Commentary to this article asserts that '[t]he duty of cooperation is the most basic principle underlying international water law'.[165] The Berlin Rules also contain a Chapter XI on 'International Cooperation and Administration' setting out detailed rules on, *inter alia*, exchange of information, notification of programmes, plans, projects or activities, and consultation. It is readily apparent that permanent river basin organisations, such as ZAMCOM, can play a key role in facilitating the kind of intense procedural engagement required under the duty to cooperate. The UN Watercourses Convention expressly encourages watercourse States to enter into institutional arrangements to facilitate inter-State cooperation.[166] While States cannot generally be compelled to establish or join such organisations, the *bona fide* participation of States in such common management institutions may help to demonstrate satisfaction of the procedure.

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the Rio Declaration on Environment and Development, Rio de Janeiro, 14 June 1992, (1992) 31 ILM 874 (Rio Declaration).

[160] Articles 12(1)(g), 14(5), 15 and 16.

[161] *Lac Lanoux Arbitration (France v. Spain)* [1957] 25 ILR 101, at 129–30; (1957) 12 RIAA 281; (1959) 53 AJIL 156.

[162] *Case Concerning the Gabčíkovo-Nagymaros Project (Hungary / Slovakia). ICJ Reports* 7, para. 17.

[163] See, for example, the decision of the International Tribunal for the Law of the Sea (ITLOS) of 3 December 2001 in the *MOX Plant Case, Ireland v. United Kingdom (The MOX Plant Case)*, 41 *ILM* [2002] 405 (Order), para. 89.

[164] Article 8(1) provides: 'Watercourse States shall cooperate on the basis of sovereign equality, territorial integrity, mutual benefit and good faith in order to attain optimal utilization and adequate protection of an international watercourse.'

[165] 1966 International Law Association (ILA), Helsinki Rules on the Uses of Waters of International Rivers, Article V, International Law Association, *Report of the Fifty-Second Conference of the International Law Association* (Helsinki, 1966), at 20. The commentary goes on to explain that this obligation: 'ultimately arises because without cooperation between basin States, it is literally impossible for States to fulfil their obligation to share transboundary water resources, to achieve sustainable development, to protect ecological integrity, and to fulfil the many other legal obligations expressed in these Rules.'

[166] Article 8(2).

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