Integrated Water Resources Management Plan For The Orange-Senqu River Basin

Main Report

December 2014

Report No. ORASECOM 019/2014

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Support to Phase 3 of the ORASECOM Basin-wide integrated Water Resources Management Plan

Main report:
Integrated Water Resource Management Plan for the Orange-Senqu River Basin

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INTEGRATED WATER RESOURCES MANAGEMENT PLAN FOR THE ORANGE-SENQU RIVER BASIN

ABBREVIATIONS AND ACRONYMNS

AA	Action Area
AMD	Acid mine drainage
CEDAW	Convention on the Elimination of all forms of Discrimination Against Women
CTT	Communications Task Team
DWA	Department of Water Affairs
EC	Electrical conductivity
EFR	Environmental Flow requirements
FMH	Female headed households
GDP	Gross Domestic Product
GCM	Global Circulation Model
GEF	Global Environmental Facility
GII	Gender Inequality Index
GIZ	German Agency for International Cooperation
IAPP	International Association for Public Participation
ICP	International cooperating partners
IPCC	International Panel for Climate Change
IWRM	Integrated Water Resources Management
LEWA	Lesotho Water and Electricity Authority
LHDA	Lesotho Highlands Development Authority
mm/a	Millimetres per annum
m^3/s	Cubic metres per second
Mm^3	Millions of cubic metres
MW	Megawatts
NWA	National Water Act
NWP	National Water Policy
NWRS	National Water Resources Strategy
ORASECOM	Orange Senqu River Commission
NAP	National Action Programme
NGO	Non-governmental organisation
NWG	National Working Group
PES	Present ecological state
PWC	Permanent Water Commission
ORP	Orange River Project
RSAP	Regional Strategic Action Plans
RWG	Regional Working Group
RWP	Regional Water Policy
RWS	Regional Water Strategy
SADC	Southern African Development Community
SAP	Strategic Action Programme
SEEAW	System of environmental economic accounting for water
STAR	Statistical Analogue Resampling Scheme
SWCI	Shared Watercourse Institutions
SWOT	Strengths-weaknesses-opportunities-threats

TDA	Transboundary Diagnostic Analysis
TTT	Technical Task Team
UN	United Nations
UNDP	United Nations Development Programme
WAB	Water Apportionment Board
WASCO	Water and Sanitation Company
WASP	Water and Sanitation Policy
WC	Water conservation
WDM	Water demand management
WMA	Water Management Area
WRPM	Water Resources Planning Model

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Foreword

In recent years there has been increased recognition of the risk that water security will place upon the global social economy. The World Economic Forum's Global Risks report 2015 has placed water crises as the most significant risk with regard to societal impacts over the next decade. Notably, in terms of likelihood the top ten risks include extreme weather events, natural catastrophes, failure of climate change adaptation and water crises. This adds an additional layer of complexity when looking to manage water resources to sustain development and compounds the issues when managing trans-boundary river basins.

The Orange-Senqu River Commission (ORASECOM) was established in 2000 to advise the four State Parties of Botswana, Lesotho, Namibia and South Africa with respect to the sustainable management and development of the water resources of the basin. The role of ORASECOM is advisory in nature and the Commission, supported by the State Parties and a number of International Cooperating Partners (ICPs), has played a key role in improving our common understanding of the water resources of the basin through a wide range of studies.

Recognising that a significant portion of the regional economy is generated within this basin, the development of a basin-wide Integrated Water Resource Management (IWRM) Plan has been undertaken through a number of phases that have enabled a common understanding of the resource and its status as a driver of economic growth and by its transboundary nature requiring joint management and sustainable development. This Plan is the first internationally coordinated and supported IWRM plan for the Orange-Senqu river basin.

As with all planning processes, the journey has been as important as the destination itself. The support of stakeholders from all the State Parties has been consistent and dedicated to creating the ownership that is important in ensuring that the Plan is implemented by the State Parties. The interaction of stakeholders from all basin States has enabled the development of a Plan that is robust and rich with insight and detail, but is focused towards advancing pragmatic actions.

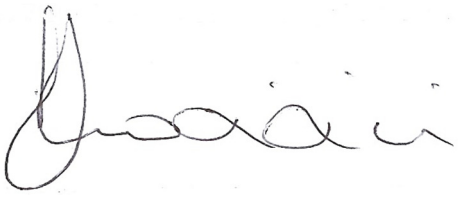
The State Parties recognise that at the core of the IWRM Plan is the need to ensure the optimised and sustainable management of the basin's water resources; to support socio-economic upliftment and eradication of poverty in the basin; to ensure that the adverse effects of catchment degradation are reduced and the sustainability of the resource use is improved; and resilience from water-related disasters, especially flood and drought, is maximised, in the next ten years, namely 2015 to 2024, and beyond.

These central objectives need to be underpinned by strengthened governance structures and, in particular, a strong programme of institutional, technical, organisational, and skills development for sustainable river basin development.

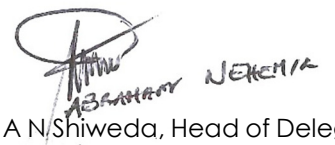
The successful implementation of this Plan will require the commitment of all the State Parties, and a range of stakeholders. The collective action of the public and the private partners will be essential.

On behalf of the ORASECOM Council, we encourage your support to work with us in implementing this Plan.

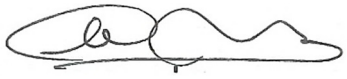
O T Obakeng, Head of Delegation, Botswana



R Mosisili, Head of Delegation, Lesotho



A N Shiweda, Head of Delegation, Namibia



L S Mabuda, Head of Delegation, South Africa

1. Introduction

The purpose of this report is to layout the Commission's (ORASECOM) 10 year basin-wide Integrated Water Resources Management (IWRM) Plan for the Orange-Senqu River Basin covering the period 2015-2024. This represents the end point of a preparatory process that has been built on a wide range of studies, projects and programmes carried out at the regional, basin-wide and national scales. ORASECOM has been responsible for the execution and management of many of these.

It is important to stress that it is focused on defining and prioritizing **only ORASECOM's actions and activities** over the next ten years. However, in order to do this it has been necessary to develop a holistic plan within the spirit of IWRM, even though the majority of actions and activities in the Plan will be planned, prioritized **and carried out** (or are already being carried out) **at the national level by national institutions without any interference from ORASECOM.**

The objectives of ORASECOM (the Council) are provided in Art. 4 of the ORASECOM Agreement where is stated that it "*shall serve as **technical advisor to the Parties** on matters relating to the **development, utilisation and conservation of the water resources** in the River System….*". To this end, the terms of reference for this study stated that "*the Plan is aimed at providing a framework for the management, development and conservation of water resources in the Orange-Senqu River Basin, serving to advise Parties on optimising overall water resource utilisation*".

The aim has been to compile a plan that comprises a convincing and integrated piece of advice where the reasons behind the various proposed actions can be easily understood within the development and management context of the basin and its peoples. A key aspect of the Plan is that it fits within the context of existing regional and national development plans/strategies, as well as into a longer general planning horizon.

An important point that is addressed in this report is the role that **ORASECOM should play with respect to implementation of the Plan**. Like any cross-sectoral and integrated plan, implementation will be carried out by a wide range of institutions at the national, bilateral and transboundary levels. ORASECOM is not an implementation agency but it will be responsible for the management of many transboundary elements of the Plan and that it will play a leading role in monitoring and evaluating progress that is made toward a Vision of the basin in the future. It will also play a role in ensuring that feedback received from stakeholders is heard and taken into account as the Plan is reviewed on a regular basis. The contents of this report have been organised as follows:

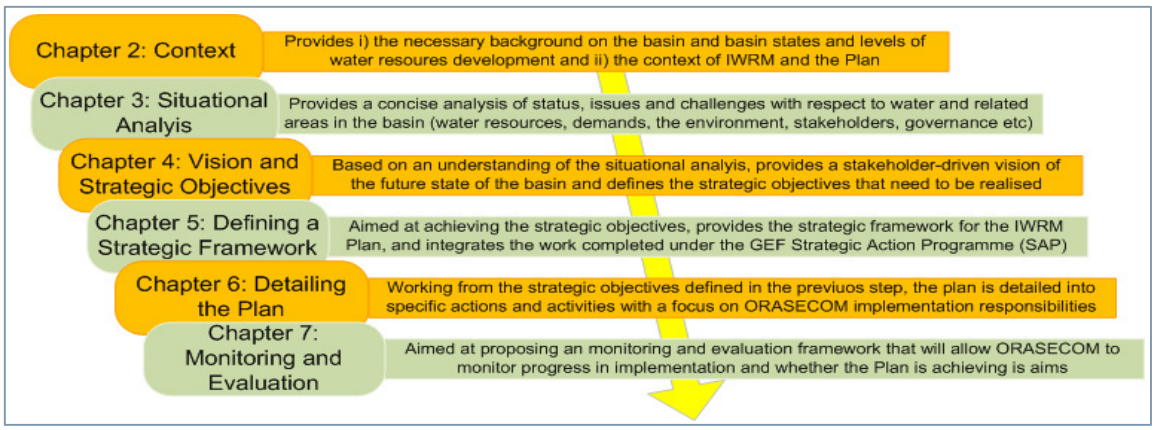


Figure 1-1: Structure of the IWRM Plan Report

The main report exists in two formats. The hard copy formats do not include any annexes. The electronic formats include extensive annexes and hyperlinks to all the relevant supporting documentation. The detail of the actions and activities, with their timelines, milestones and other details have been set out in MS Excel and are most usefully studied in their electronic format. However, a separate hard copy annex has also been developed and can be used in conjunction with either the Executive Summary or the Main Report.

2. Context

2.1 The Basin and the basin states

The Orange - Senqu River originates in the highlands of Lesotho on the slopes of its highest peak, Thabana Ntlenyana, at 3 482m, and it runs for over 2 300km to its mouth on the Atlantic Ocean. The river system is one of the largest river basins in Africa with a total catchment area of 972 783km^2 and encompasses all of the Lesotho, the majority of South Africa and significant portions of Botswana and Namibia. Precipitation decreases sharply from east to west, from source to outflow. Although Lesotho covers only 3% of the total catchment area, it contributes around 40% of the total runoff.

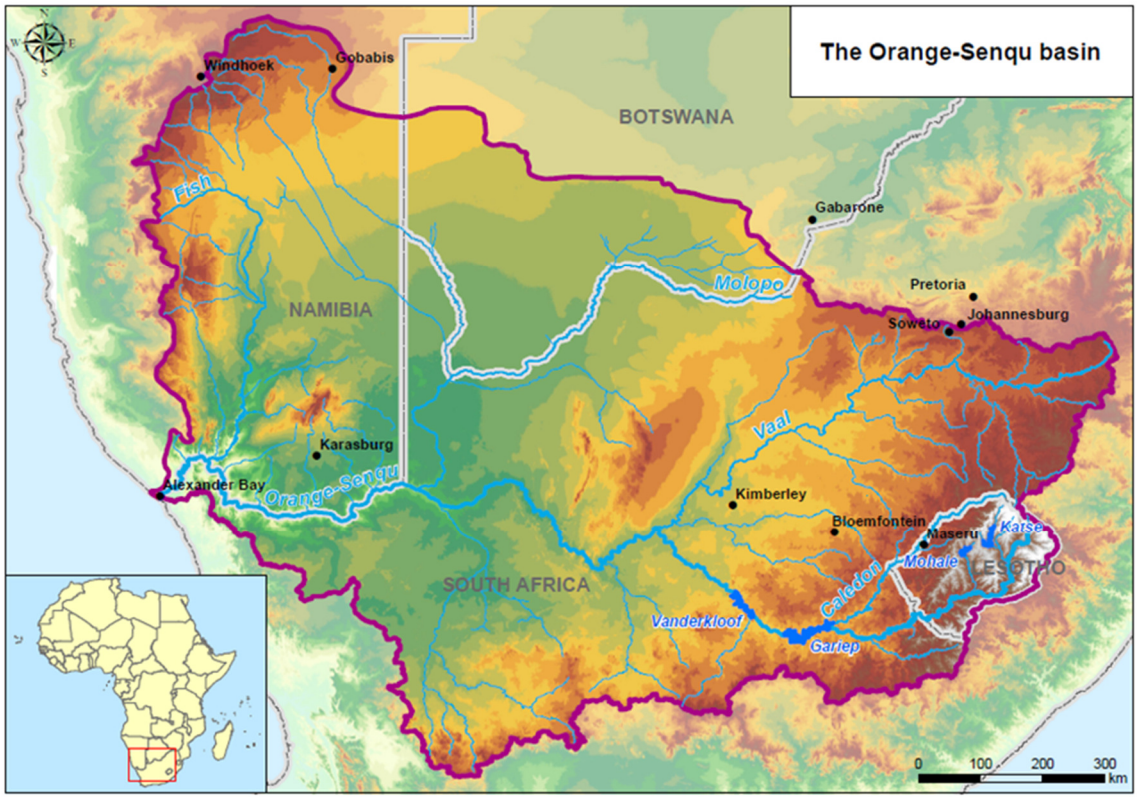


Figure 2-1: The Orange-Senqu basin

While socio-economic activities vary enormously across the basin, water plays a vital role in supporting the livelihoods of more than 14 million people within the system and many others living outside of it.

The basin within Botswana is very sparsely populated with no major urban centres. As a result, water demand is currently low and almost entirely fed by locally developed groundwater sources. Botswana shares two of the four transboundary aquifers.

The vast majority of water resources development in Lesotho has thus far been for export either as raw water via the LHWP or through the generation of hydroelectricity. The contribution of the water sector to national GDP is approximately 8%,with these two exports contributing 3%. Despite the relative abundance of water, very little is used or has been earmarked for development of irrigation, although it is the Government's stated policy to accelerate development of irrigation. If economic development in Lesotho continues to accelerate, it is likely that the Government will start to make much greater

use of its surface water resources in the future, both for domestic and industrial water supply and for productive purposes. Up until now, large dams have been developed largely with the goal of exporting water. This trend has been changed with the recently completed Metolong Dam as part of the Lowlands water Supply project and it is likely that new water resources development projects will follow in the medium and long term.

The Orange-Senqu River basin is of major economic importance to South Africa, supporting both the urban/industrial heartland of Gauteng and large areas of irrigation, producing crops for local consumption and export regionally and internationally. The water resources are also of strategic importance, producing both hydropower and providing water at a high level of assurance for the cooling of thermal power plants. Water is also exported out of the basin to other parts of the country, in particular to the Eastern Cape. These "exports" are to a large extent compensated for through imports from other basins including the Thugela and Usuthu. The complexity of demands and water resource development in the basin in South Africa has presented a major management challenge and has led to the development of specialised water distribution models such as the Water Resources Planning model (WRPM), discussed elsewhere in this report.

The north eastern part of the basin in Namibia is largely given over to stock farming, dependant on rainfall and groundwater. Elsewhere in the basin, irrigation plays an important economic role with several thousand hectares developed downstream of the Hardap and Naute Dams, using artesian ground water in the Stampriet area, and adjacent to the Orange River along the common border with South Africa. A number of mines also depend on the basin's water resources.

Table 2-1 summarises some of the key water resource characteristics of the basin by country.

Table 2-1: Summary of water resource supply and demand by country

Country	Proportion (%) of basin area	Estimated Contribution to natural runoff (%)	Proportion (%) of basin population	Consumptive Water use in 2014 (Mm^3) (%)
Botswana	12.7	0.3	0.3	0.008
Lesotho	3.2	41.5	15.4	0.749
Namibia	24.8	5.2	2.6	2.953
South Africa	59.3	53.0	81.7	96.291

This is presented in more detail in Chapter 3 of this report.

2.2 Management of the Basin's Water Resources

The Orange-Senqu River basin is a highly complex and integrated water resource system characterised by a high degree of regulation and a large number of major inter-basin transfers which allow water to be moved from one part of the basin to another, as well as into and out of neighbouring basins. This, together with the highly variable nature of the rainfall and hence hydrology, makes management of the water resources highly challenging.

Only in the source areas, mainly in Lesotho, are the flows not subject to regulation. The Orange-Senqu system is regulated by 62 significant[1] dams. The large Vanderkloof Dam is the most downstream storage on the Orange-Senqu mainstream, situated around 1 300 km upstream of the river mouth. Since the contributions of tributaries downstream of this

[1] "Significant" has been taken as dams with reservoir storage > $1Mm^3$

dam are either small or highly seasonal, for much of the year the flow regime through to the estuary is largely driven by releases from this dam.

The largest intra-basin transfer is the transfer of water from the Lesotho highlands to the Vaal sub-basin, while the largest inter-basin transfers include the Orange-Fish, Thukela-Vaal and Inkomati Transfer Schemes and the Vaal Eastern sub-system Augmentation Project.

Storage and inter-basin transfers are necessary because of the mismatch between location of abundant water resources and the location of greatest demands. Assuring water to sustain agriculture and other economic activities and domestic needs, necessitates bulk storage and transmission of water to places and at times when it would otherwise not be available. Such development of the river system is also the underlying cause of many of the ensuing transboundary issues.

One of the most significant impacts of the highly altered hydrological regime has been on the environment. As reported in the Transboundary Diagnostic Analysis (TDA), these changes in the hydrological regime impact downstream ecosystems, including the estuary – a Ramsar site – resulting in a moss of ecosystem services. There is increasing recognition of this fact and getting agreement on a consolidated set of environmental flow requirements in the lower part of the system, as well as starting to implement them, are high on the ORASECOM agenda. Linked to the management of the basin's water resources is the issue of catchment management to fight against land degradation. Inadequate land management associated mostly with agriculture and mining in parts of the Orange–Senqu River basin has led to loss of wetland storage and aquifer recharge, increased sediment loads, deteriorating water resources quality, increased distribution and abundance of alien invasive plants, loss of biodiversity and lowered land productivity.

The management and development of the water resources of the basin essentially takes place at three levels:

- **National level**. The basin states have the primary responsibility for the development and management of water resources within their territory. The ORASECOM Agreement (in line with the Revised Protocol on Shared Watercourses in the SADC Region)obliges the parties to :
  - utilise the resources of the River System in an equitable and reasonable manner with a view to attaining optimal and sustainable utilisation thereof, and benefits therefrom, consistent with adequate protection of the River System ;
  - take all appropriate measures to prevent the causing of significant harm to any other Party
  - exchange available information and data regarding the hydrological, hydrogeological, water quality, meteorological and environmental condition of the River System
  - notify the ORASECOM Council and provide all available data and information on any project that may have a significant adverse effect upon any one of the parties.

  Thus while the planning and execution of projects is carried out by the parties, the transboundary obligations are acknowledged.
- **Bilaterals:** A number of bilateral agreements pre-date ORASECOM. Bilateral agreements and institutions have come into existence for a specific reason, essentially to implement or manage a project. They include:
  - The Lesotho Highlands Development Authority (LHDA) in Lesotho and the Trans-Caledon Tunnel Authority (TCTA) in South Africa supervise and coordinate the work on the Lesotho Highlands Project

- The Permanent Water Commission (PWC), formed by Namibia and South Africa in 1992, advises both governments on the development possibilities of the Lower Orange, the section of the river that forms their mutual border

The rights and obligations stipulated in bilateral agreements remain unchanged by the ORASECOM Agreement but there is a formal expectation that the institutions will communicate items that impact other members, as stipulated in the ORASECOM Agreement The ORASECOM Agreement stipulates that agreements that came into force prior to the ORASECOM Agreement remain unaffected by the new agreement (GEF 2008).

- **Transboundary level**: At the regional level, the SADC Water Division has been tasked with creating an enabling environment for the integrated management of shared watercourses. Supporting this integrated approach are the Revised Protocol on Shared Watercourses and the Regional Strategic Action Plans. The ORASECOM Agreement is strongly influenced by the SADC Protocol.

  According to the Agreement, the objective of ORASECOM (the Council) is to serve as a technical advisor to the member countries and perform other functions assigned by the member countries on matters pertaining to the development, utilisation and conservation of water resources in the Orange-Senqu River System.

2.3 AN IWRM PLAN FOR THE ORANGE-SENQU BASIN

2.3.1 Introduction

The Global Water Partnership's definition of IWRM as being ***"a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems"*** is widely accepted.

Integrated Water Resources Management is a cross-sectoral policy approach, designed to replace the traditional, fragmented sectoral approach to water resources and management that has led to poor services and unsustainable resource use. IWRM is based on the understanding that water resources are an integral component of the ecosystem, a natural resource, and a social and economic good.

While this is widely accepted and easily understood, turning what is essentially a philosophy of sustainable development or integrated management into actions that reflect its principles has consistently proved a challenge. In many countries over the last decade, including Botswana and Namibia within the basin, national IWRM Plans have been formulated. However, since IWRM needs to be implemented at the basin level these are essentially strategies for mainstreaming the principles of IWRM into the development and management of water resources. Individual countries are in a position to do this for national-level basins, but by definition, they need to work together and cooperate for it to be achieved for transboundary basins.

Since soon after the establishment of ORASECOM in 2000, the idea of putting in place an IWRM Plan has been on the agenda. Building the Plan has been a long process which started in 2004. Some of the key building blocks have been provided through a number of major ORASECOM-managed studies including:

- Early support from the French Global Environmental Facility (FGEF) resulted in a Council endorsed ORASECOM "Action Plan". This was followed by the implementation of priority actions from the ORASECOM Action Plan between 2004 and 2007.

- Phase I of the GIZ-supported ORASECOM IWRM planning programme was implemented between 2004 and 2007 and focused on collating existing information that described a wide range of areas relating to the management and development of water resources of the Basin.

- Phase II of the GIZ-supported IWRM Planning Programme (2009 to 2011) focused on bridging the planning gaps identified in Phase I. It included major inputs on key areas such as environmental flows, water resources modelling and climate change.

- The European Union provided support between 2009 and 2011 and focussed on institutional and legal aspects as well as communication issues.

- Completed most recently, UNDP-GEF support was aimed at a comprehensive analysis of environmental issues and their resolution. The main outputs were the Transboundary Diagnostic Analysis (2013) and the Strategic (SAP) and National Action Programmes (NAPs).

Other key non-ORASECOM studies or documents include those drawn up at the national levels to guide the process of sustainable water resources development:

- Integrated Water Resource Management Plan for Botswana
- First State of Water Resources Report for the Kingdom of Lesotho and the National Water Resources Policy of 2008.
- Integrated Water Resource Management Plan for Namibia
- National Water Resource Strategy 2 (NWRS 2) for South Africa

While the process of drawing up the IWRM Plan has drawn on other sources, these studies, together with the stakeholder consultation process carried out as part of Phase 3, represent the main building blocks for the Plan.

2.3.2 Scope and Objectives of the Plan

Despite the fact that preparatory work on the IWRM Plan started more than ten years ago, it is only more recently that its objectives and scope have become more clearly defined. The final step in this process was only carried out during the Inception Phase of this study when a structure for the Plan was proposed.

During a so-called "Delphi" workshopping process in 2011, which enjoyed a high level of attendance by ORASECOM representatives and other stakeholders, the overall objective of the ORASECOM basin-wide IWRM Plan was debated at length, refined and agreed as follows:

> ***The objective of the IWRM Plan is*** *"to provide a framework for sustainable development and management of the water resources, taking into account the need for improved distribution and equitable allocation of benefits, in order to contribute towards socio-economic upliftment of communities within the basin, and ensure future water security for the basin States."*

As will be seen in Section 4.2, the overall objective provides a good picture of how a vision for the basin should look, but does not provide any clue or detail in terms of how this framework could be put into place. Further analysis and clarification is required in order to understand the specific actions, especially as they relate to the needs and role of ORASECOM.

As stated in the ORASECOM Agreement, "the Council is a technical advisory body concerned with the sustainable development of the river system's water resources". Although the Council is not a policy maker nor an implementer it is supposed to advise and make recommendations on a wide range of matters including:

- Available yield of the system and the equitable and sustainable use of this yield
- Investigations and studies supporting development of the River System
- Stakeholder consultation and participation
- Collection and sharing of data
- Water quality of the River System
- Disaster management
- Dispute settlement

Clearly the Council needs to be in a position to provide advice on these and other areas, based on an integrated and scientifically sound understanding of how best to manage and develop the basin's water resources, whether this development takes place at the transboundary or national level. The Plan can be seen as a consolidated and integrated summary of advice for the next ten years.

2.3.3 Importance of the Plan for ORASECOM and the Basin

The basin-wide Plan will to provide ORASECOM (and other stakeholders) with a 10 year comprehensive and integrated water resources management (and development) plan for the Orange-Senqu basin. The Plan should:

- Provide ORASECOM (NB Secretariat) with a single tool to plan its activities **within a greater framework** towards agreed goals (short/medium/long-term goals (including IWRM Vision for the basin)
- Provide a clear basis with a transparent logic, but with allowance for review and adaptation
- Enhance and clarify the role of ORASECOM and strengthen its position, for example vis-à-vis bilaterals
- Support efficient development of water resources and optimized management (especially environmental aspects, degradation, EFRs especially)

2.3.4 Characteristics of the Plan

If understood as providing advice and recommendations, the IWRM Plan must take the form of a costed report.

The basin-wide Integrated Water Resources Management (IWRM) Plan will provide a framework for management, development and conservation of water resources in the Orange-Senqu River Basin, serving to advise Parties on optimising overall water resource utilisation. Amongst other things, The IWRM Plan

- will set out the short term and long term actions necessary to achieve the strategic objectives of ORASECOM as well as those of the basin States;
- will signify the transition of ORASECOM from a reactive to a pro-active mode, becoming the technically competent advisor to the Parties as envisaged in the ORASECOM Agreement;

- should be comprehensive AND for the whole basin; i.e. it should cover all water-related thematic areas or sectors and that it should spatially cover the whole basin, i.e. not just areas of transboundary concern;
- will identify activities that will be implemented collectively by all the Parties through ORASECOM and the existing bilateral institutions and those that will be implemented separately by the Parties, with ORASECOM activities developed at a higher level of detail;
- will be forward looking (2015 - 2025) and provide a framework that enables the basin to realise economic and social benefits associated with better water resources management.
- should strive to link the water sector with national economic growth and poverty alleviation strategies based on the fact that IWRM is not an end in itself but rather a means to achieve economic and social development.

2.3.5 Approach and Methodology

The approach used for building the Plan is shown in Figure 2-2. This process was already presented in detail in the Inception Report and in the first briefing note. As can be seen from the flow chart, development of the Plan is built on a Vision of IWRM for the basin and associated themes and strategic objectives.

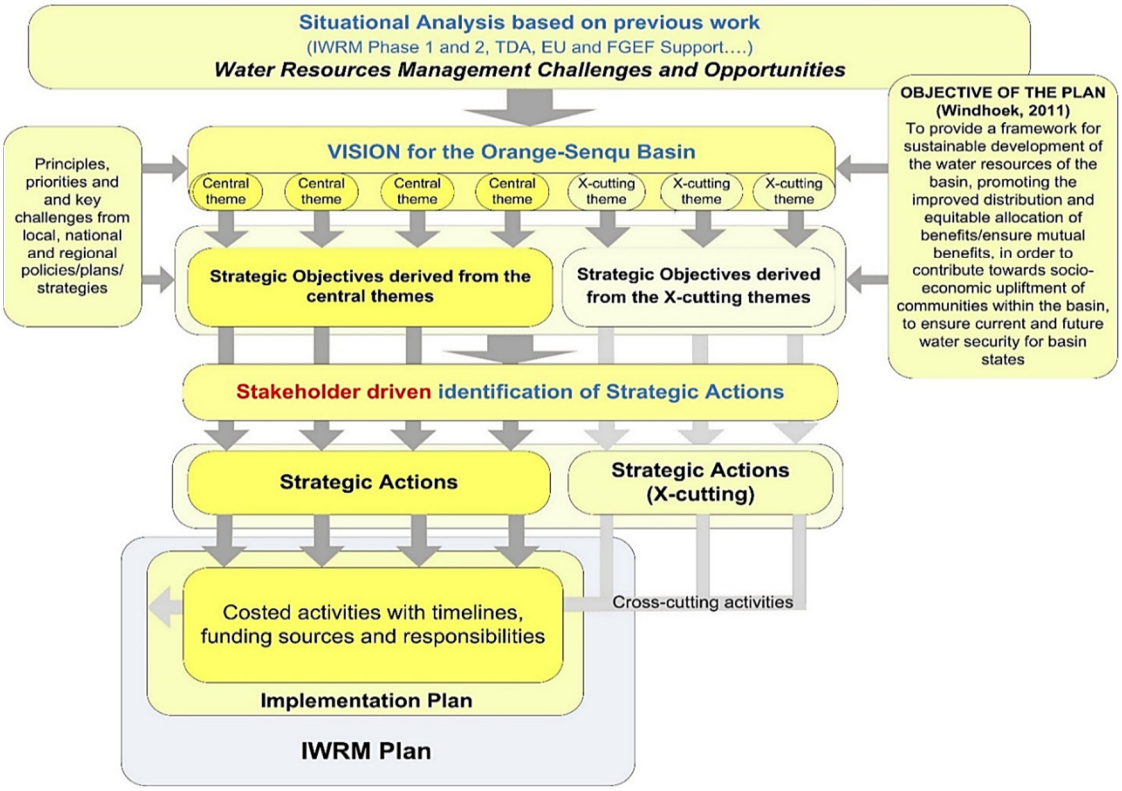


Figure 2-2: Process for building the Plan

3. Situational Analysis

3.1 INTRODUCTION

It is not the objective of this report to provide a detailed situational analysis, rather to provide a brief overview of the diagnostic work that has been done over the past few years and to highlight the key points that inform the Plan. Particular reference is made to the GIZ supported IWRM Plan work of which this report forms a part and to the recently completed TDA and SAP/NAPs,

The preparatory work carried out over the last ten years, both through key ORASECOM-managed studies, and others carried out at the regional and national level, provide an adequate information base for drawing up the Plan. At the same time, a product of this preparatory work has also been to identify areas where understanding could be improved leading to more efficient management and better development choices. The Plan will need to include activities aimed at improving understanding in these areas. One such area worth highlighting relates to climate change where there remains a high degree of uncertainty with respect to the impacts around the basin.

The situational analysis presented in this chapter is very brief. The aim has been to provide only the necessary background for understanding of the issues that the Plan has to tackle. For details, the reader is referred to the documents prepared under the various preparatory studies.

Based on these studies and others which have been reviewed are overviewed:

a) Water resources (climate, surface and groundwater)
b) Water demands
c) Water resources development and management
d) Environment, including environmental flow requirements
e) Economic accounting and economic instruments
f) Stakeholder participation
g) Gender
h) Governance arrangements

Water resources modelling tools such as the Water Resources Planning Model (WRPM), the key tool for the short and medium-term planning of how to ensure that the available developed water resources can best be utilised to meet demand, are dependant an accurate understanding of a) to d).

There is an increasing awareness of the fact that e), the economic aspects will play an increasingly important role in the way that water resources management development decisions are made. This is an area which has not been studied in depth by ORASECOM in the past and as a result is covered in more depth in this report with reference made to the detailed studies that were carried out under the IWRM Plan Development Phase 3 work.

The issue of stakeholder participation has also been re-visited under the Phase 3 work and most recently the issue of gender mainstreaming has received special attention.

3.2 WATER RESOURCES

3.2.1 Climate

OVERVIEW

The climate in the basin varies from relatively temperate in the easterly source areas, to hyper-arid in the west. As shown in Figure 3.1, average annual precipitation decreases from more than 1000mm/a in the source areas of the basin to less than 50mm at the mouth. This varies considerably from year to year. Much of the rainfall occurs as intense storms which can be highly localised. The temporal and spatial distribution of precipitation within any particular year can be considerable. An accurate appreciation of climate at the local level, in particular of rainfall, depends on the collection of data over long periods of time at sufficient points throughout the basin. The identification and quantification of trends depends on these sort of data. Despite the threat of climate change and the need to plan resilience efforts, the collection of precipitation data has declined steadily over recent years. In particular, data on rainfall intensity is not collected at all in many parts of the basin.

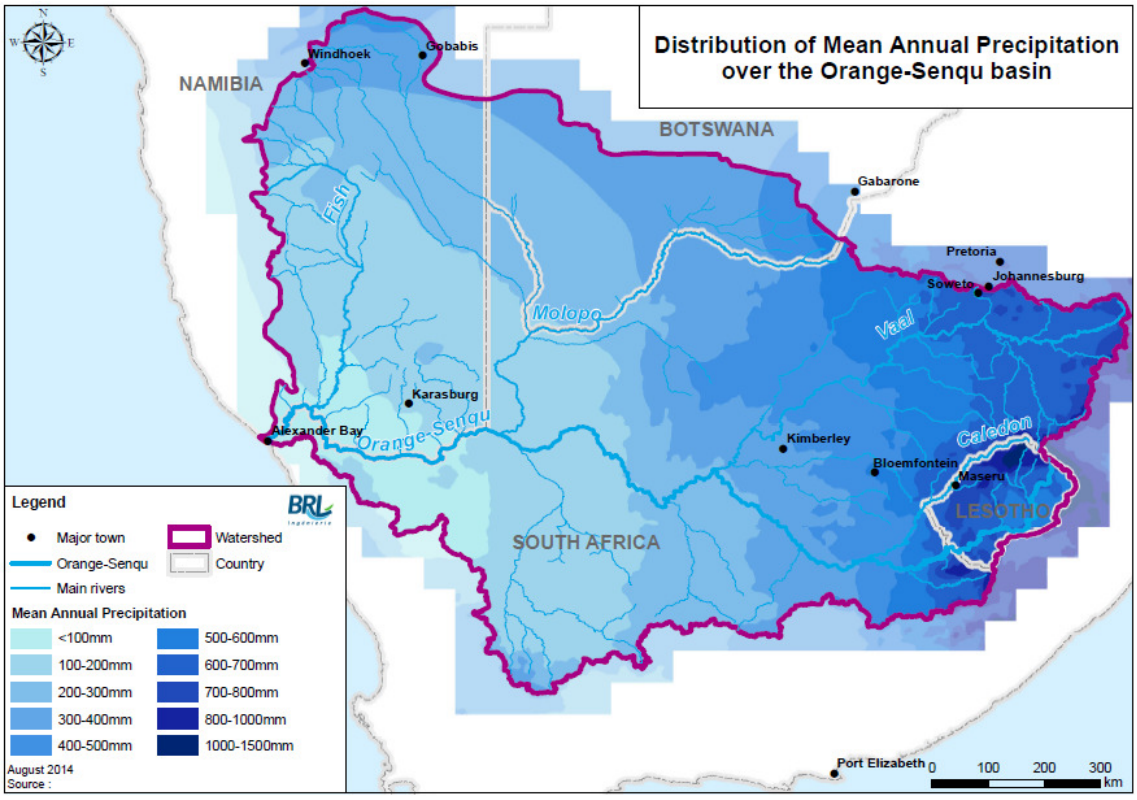


Figure 3-1: Distribution of mean annual precipitation over the Orange-Senqu basin

As can be seen in Figure 3.2, evaporation increases from south-east to north-west reaching a maximum of more than 1,650mm. Even in the cooler and wetter parts of the basin, evapotranspiration exceeds precipitation. Temperature and evapotranspiration follow a similar distribution with coolest temperatures in the Lesotho Highlands and the hottest in western Kalahari.

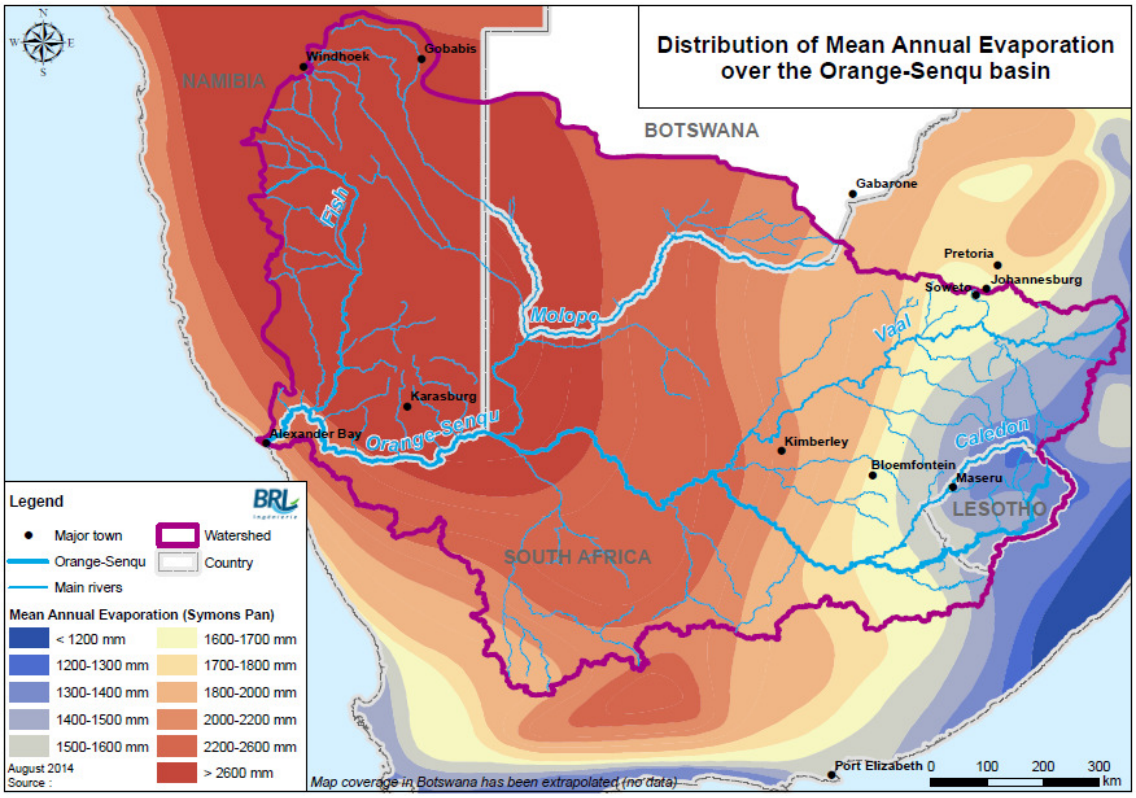
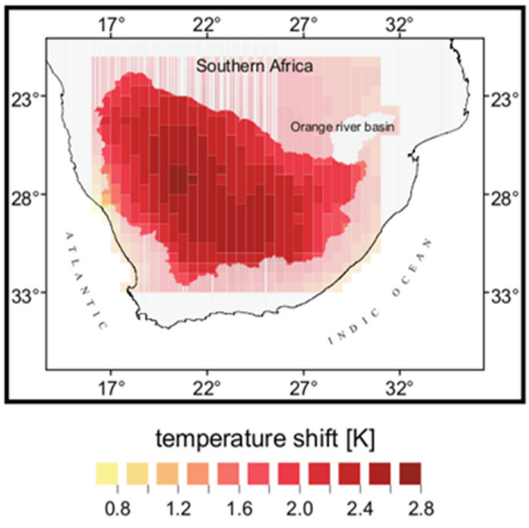


Figure 3-2: Distribution of mean annual evaporation over the Orange-Senqu basin

CLIMATE CHANGE

It is generally accepted that southern Africa will be highly impacted by climate change. As part of the IWRM Plan Phase 2 work a detailed assessment of the occurrence, extent and possible effects of climate change in the Orange-Senqu River basin was carried out. The central part of this work was to carry out statistical and dynamic downscaling to the basin level in order to reveal the nature, extent and spatial coherence of climate change in the basin.



The work concluded that based on climate observations to date there was no clear signal of climate change for either temperature or precipitation but acknowledged that conclusive evidence is hard to obtain due to the high natural variability of the local climate. However, the downscaling exercise provided results showing a high degree of warming comparing the period 2031-2060 with the reference period of 1971-2000. This is illustrated in Figure

Figure 3-3: projected increase in mean temperature (2031-2060 compared to 1971-2000)

While an increase in temperature is to be expected basin-wide, the anticipated change in precipitation is not so clear.

Figure 3-4 shows three equally likely climate realisations as produced by the statistical climate model "STAR"[2]. The change in annual precipitation for the years 2031 to 2060 compared to the average of the years 1971-2000 is plotted. Of the 100 runs generated by "STAR" the results of the "dry" (5-percentile) simulation are shown on the left, of the median (50-percentile) in the middle and of a wet one (95-percetile) on the right. All thee simulations predict a decrease in precipitation for the large majority of the basin. However, and highly significantly, for the source areas, especially of the Senqu River, increased precipitation is projected.

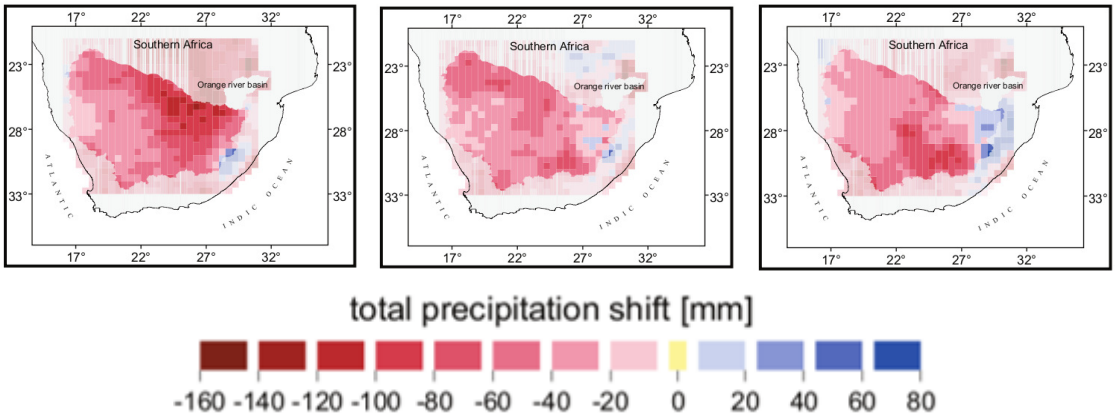


Figure 3-4: Results of downscaling runs as produced by Statistical Climate Model

There were a number of conclusions and recommendations that came out of the climate change work carried out for ORASECOM. It was recognized that there is i) a need to prepare for the impacts of climate change and at the same time ii) to continually improve estimates of the anticipated climate change. Specific conclusions and recommendations included the following:

- It would be useful to do more detailed (higher resolution) regional downscaling for some areas, in particular the source areas such as the Lesotho Highland. At the same time the dynamic downscaling model should be improved, for example to better model convection systems.
- When possible, the results should be updated using the latest IPCC emission scenarios.
- Improved accuracy of GCM downscaling will depend not only on advances in the modelling process but relies on large and good quality climate observation datasets. In view of the importance of having accurate predictions of climate change in the source areas, there is a need to improve the meteorological network in these areas, in particular through the implementation of a dense network of automatic rainfall gauges capable of measuring rainfall intensities.
- It is important to design of a flexible adaptation strategy for the basin as a whole and for the different parts and livelihoods around the basin.

It is clearly important that these are taken forward in the design and implementation of the basin-wide Plan.

[2] STARS (Statistical Analogue Resampling Scheme (Potsdam Institute for Climate Impact Research is based on the assumption that already observed weather situations will very likely recur in the same or similar way in the future.

3.2.2 Water Resources

OVERVIEW

Much of the Orange–Senqu basin is semi-arid to arid, with only the highlands of Lesotho and the eastern escarpment classified as temperate and where annual average precipitation exceeds evaporation. The rainfall deficit increases westwards to such a degree that the climate of the lower Orange is classified as arid and hyper-arid. In these lower reaches of the river, tributaries are ephemeral, flowing only after substantial rainfalls, and contributing relatively little runoff to the main river system.

Groundwater is of major importance not only In the more arid spaces, but throughout the basin, even in the wetter areas. In Lesotho, for example, the majority of rural water supply schemes depend on groundwater or springs. Groundwater is used for rural domestic supplies, livestock watering and to supply many towns and villages.

The importance of groundwater has generally been understated in the past. Since its inception ORASECOM has made efforts to resolve this with but it is only in recent years that the significance of groundwater at the regional level is being given due consideration. This is important for the following reasons:

- Groundwater and surface water are closely linked. This is especially true in the wetter source areas where the strengths of springs and the base flows of perennial streams are closely related to the condition of the water table.
- There are four transboundary aquifers in the basin. Shared management is clearly essential.
- The conjunctive use of groundwater and surface water storage can contribute to improved water conservation.

In the following sub-sections the surface and groundwater resources of the basin are briefly reviewed.

SURFACE WATER HYDROLOGY

The large majority of surface runoff is generated in the wetter eastern part of the basin, in the upper parts of the Senqu and its main tributaries, and the Vaal River. Significant quantities are generated in some of the drier areas but with a high level of inter and intra-annual variability, making their development difficult and costly.

Figure 3-5 shows the quantity of runoff generated on each sub-catchment. This so-called "naturalised runoff" corresponds to the average surface runoff generated in each basin assuming zero abstraction. This explains why, for example, a total of 72.35Mm^3 is generated in the Molopo sub-basin without any apparently flowing into the Orange-Senqu river mainstream. All is effectively consumed or lost to evaporation. These runoff records, disaggregated into more detail to the tertiary and sometimes quaternary level, represent the hydrology inputs for the water distribution modelling discussed in later in this report.

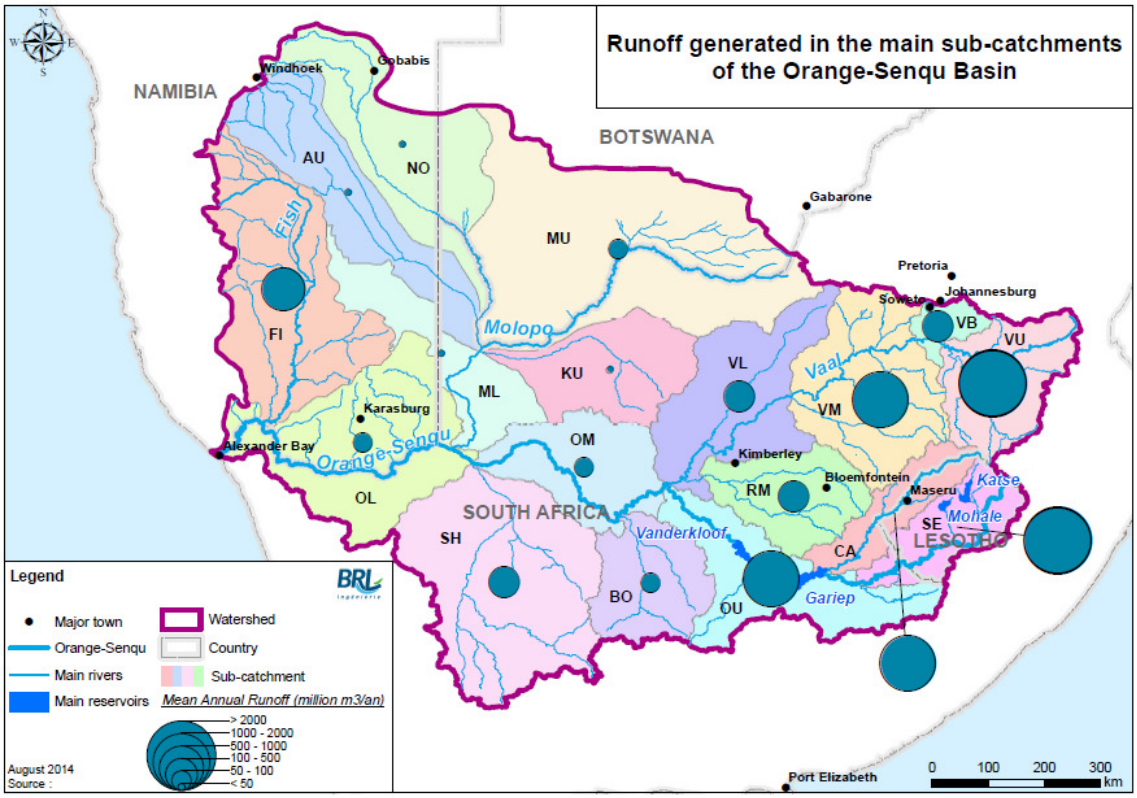


Figure 3-5: Runoff generated in the main sub-catchments of the Orange-Senqu basin

It is important to recognise two key facts with respect to these data:

- They are based on records of stream gauges. While there are many gauges around the basin, there are areas of the basin which are not gauged and for which estimates have had to be made. Knowledge could be improved through improved station maintenance, improved instrumentation and real-time monitoring (of water levels/flows and station condition). Two areas which require particular attention are the more accurate measurement of low flows and the more regular carrying out of discharge measurements to verify and update water stage/discharge ratings.
- An analysis of the current situation or a projection into the future based on the past (historic flow records), doesn't effectively take climate change into account.

Based on the latest hydrology, the best estimate of the naturalised mean annual runoff of the Orange-Senqu Basin is 11,544 Mm^3. It is important to note that this figure may differ from those quoted in other studies and reports. This is because there is no correct figure, only estimates based on an analysis of the past. As longer historic data records become available with time, so estimates based on these records will be continue to be refined.

Groundwater Resources

The occurrence of groundwater is determined largely by geology and its direction and rate of flow by topography. Groundwater is recharged by either rainfall infiltrating downwards or by seepage from rivers and lakes. Recharge also results from leakage from adjacent aquifers and can be enhanced artificially. As indicated in Figure 3-6, recharge rates vary from 25 to 100mm per annum across the basin. In general, the lowest rates of recharge occur in the areas of lower rainfall.

The four transboundary aquifers in the basin are shown in Figure 3-6

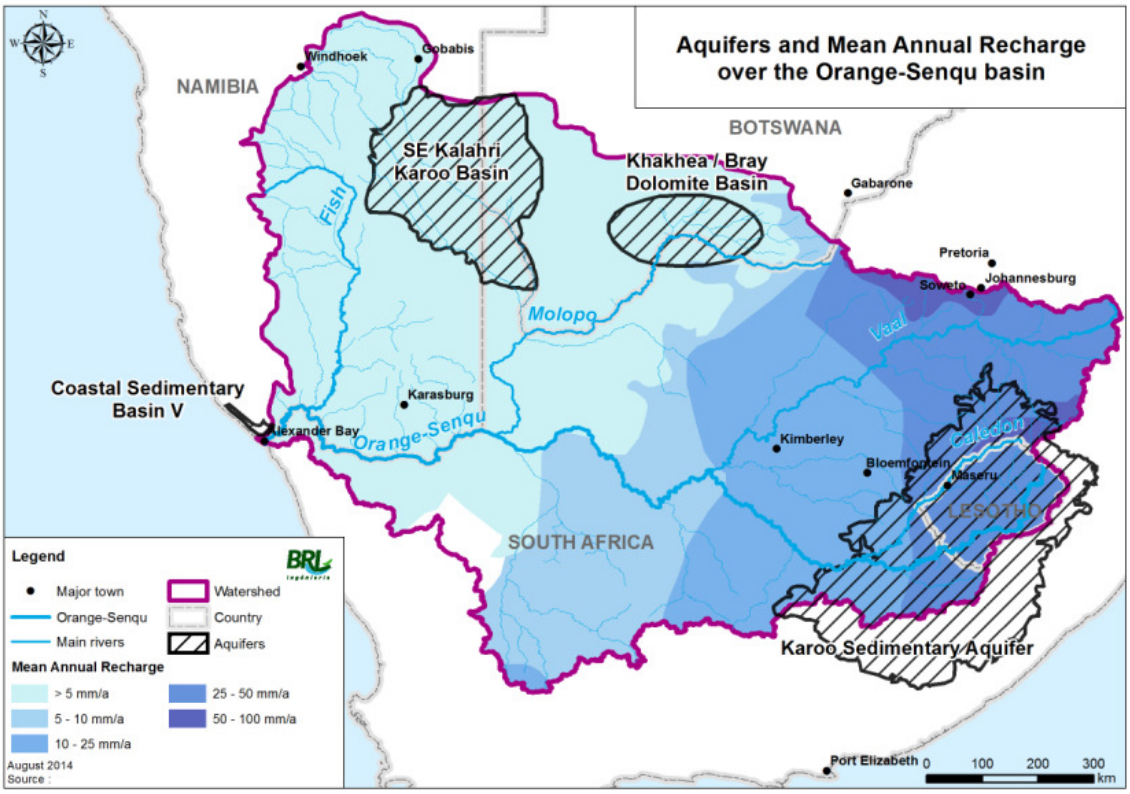


Figure 3-6: Transboundary aquifers and mean annual recharge over the basin

Table 3-1 provides a brief summary of the transboundary aquifers, including an estimate of their areas, where measurable..

Table 3-1: Summary of transboundary aquifers in the basin

Name	Sharing countries	Type	Area (km²)
Karoo Sedimentary Aquifer	Lesotho, South Africa	Fissured; Limited/local	165,900
Coastal Sedimentary Basin V	Namibia, South Africa	Limited/local	undefined
Khakhea / Bray Dolomite	Botswana/South Africa	Intergranular; Fissured	29,700
South Africa	Botswana, Namibia, South Africa	Intergranular1	85,100

3.3 Water Demands

3.3.1 Demands by sub-basin

As part of the Phase 3 work the current and projected water demands were consolidated on a database. The information was based on the most recent measured and estimated demands available. Projections were based on plans and perceptions at the national level as related to the team during country visits. It should be stressed that projections are generally based on identified and planned future projects and on past trends. As discussed in Section 4.3 in this report these projections are far from certain and can be influenced by both internal and external factors. Projections of future demand should therefore be revisited and adjusted on a regular basis. The current (2013) and projected (2030) water demands are summarised by sub-basin in Table 3-2.

Table 3-2: Summary of water resource demand by sub-basin

Sub-basin	Urban, Mining and industrial (Mm^3/a)		Irrigation (Mm^3/a)		Transfers demand (Mm^3/a)		Total (Mm^3/a)	
	2013	2030	2013	2030	2013	2030	2013	2030
Caledon	42.91	61.68	78.63	78.63	0.00	0.00	121.54	140.30
Fish	2.90	2.90	50.25	153.75	0.00	0.00	53.15	156.65
Komati	0.00	0.00	16.57	16.57	0.00	0.00	16.57	16.57
Lower Orange	66.04	91.46	786.74	842.88	0.00	0.00	852.78	934.34
Lower Vaal	62.77	99.53	602.25	602.25	0.00	0.00	665.02	701.78
Makaleng	1.34	2.21	0.00	0.00	0.00	0.00	1.34	2.21
Middle Vaal	171.41	181.97	291.15	290.07	0.00	0.00	462.56	472.03
Molopo	12.03	16.00	1.88	1.88	0.00	0.00	13.91	17.88
Riet/Modder	94.14	154.31	214.39	214.39	5.00	5.00	313.54	373.70
Senqu	3.30	5.27	0.00	0.00	780.19	939.84	783.49	945.11
Thukela	208.01	357.24	0.00	0.00	37.87	0.00	245.88	357.24
Upper Orange	105.21	117.41	1053.10	1129.96	0.00	0.00	1158.30	1247.36
Upper Vaal	1621.92	2067.22	236.46	162.51	303.46	303.46	2161.82	2533.22
Usutu	0.91	1.46	8.53	8.53	0.00	0.00	9.44	9.99
Zaaihoek	0.48	0.83	0.00	0.00	-21.01	-7.87	-20.53	-7.04
Total	**2393.37**	**3159.49**	**3339.94**	**3501.42**	**1105.51**	**1240.43**	**6838.81**	**7901.34**

3.3.2 Demands by country

The current (2013) and projected (2030) water demands are summarised by country in Table 3-3.

Table 3-3: Summary of water demand by country

Country	Urban, Mining and industrial (Mm^3/a)		Irrigation (Mm^3/a)		Transfers demand (Mm^3/a)		Total (Mm^3/a)	
	2013	2030	2013	2030	2013	2030	2013	2030
Botswana	0.54	0.54[a]	0.00	0.00	0.00	0.00	0.54	0.54
Lesotho	31.34	44.82	14.33	14.33	0.00	0.00	45.67	59.15
Namibia	26.81	22.55[b]	92.30	210.80	0.00	0.00	119.11	233.35
South Africa	2334.68	3091.58	3233.31	3276.29	1105.51	1240.43	6673.49	7608.30
Total	**2393.37**	**3159.49**	**3339.94**	**3501.42**	**1105.51**	**1240.43**	**6838.81**	**7901.34**

Notes; a: At the time of publication there was no information on the possible transfer from Lesotho highlands to Botswana. b: Future reduction in demand is due to anticipated mine closures

3.4 Water Resources Development and Management

The Orange-Senqu river basin is a highly complex and integrated water resource system characterised by a high degree of regulation and a large number of major inter-basin transfers which allow water to be moved from one part of the basin to another as well as into and out of neighbouring basins. This, together with the highly variable nature of the rainfall and hence hydrology, makes management of the water resources highly challenging.

Only in the source areas, mainly in Lesotho, are the flows not subject to regulation. The Orange-Senqu system is regulated by more than 30 major dams. The most downstream of these dams, the Vanderkloof Dam is more than 1500 km upstream of the river mouth but since the contributions of tributaries downstream of this dam are either small or highly seasonal, the flow regime for much of the year is largely driven by releases from this dam. All the storage dams with capacities larger than 5Mm^3 are shown in Figure 3-7. The Gariep Dam (5 675 Mm^3) and Vanderkloof Dam (3 237 Mm^3) on the Orange River downstream of Lesotho are the largest reservoirs in the Orange-Senqu river system. Both dams are used to regulate the river flow for irrigation purposes as well as to generate hydro-electricity during the peak demand periods with a combined installed capacity of 600 MW.

The most significant inter-basin transfers include the transfer of water from the Lesotho highlands to the Vaal sub-basin, from the adjacent Tugela basin to the Sterkfontein Dam and from the Gariep Dam on the Orange River to the eastern Cape.

Storage and inter-basin transfers are necessary because of the mismatch between location of abundant water resources and the location of greatest demands. Assuring water to sustain agriculture and other economic activities and domestic needs, necessitates bulk storage and transmission of water to places and at times when it would otherwise not be available. Such development of the river system is also the underlying cause of many of the ensuing transboundary issues

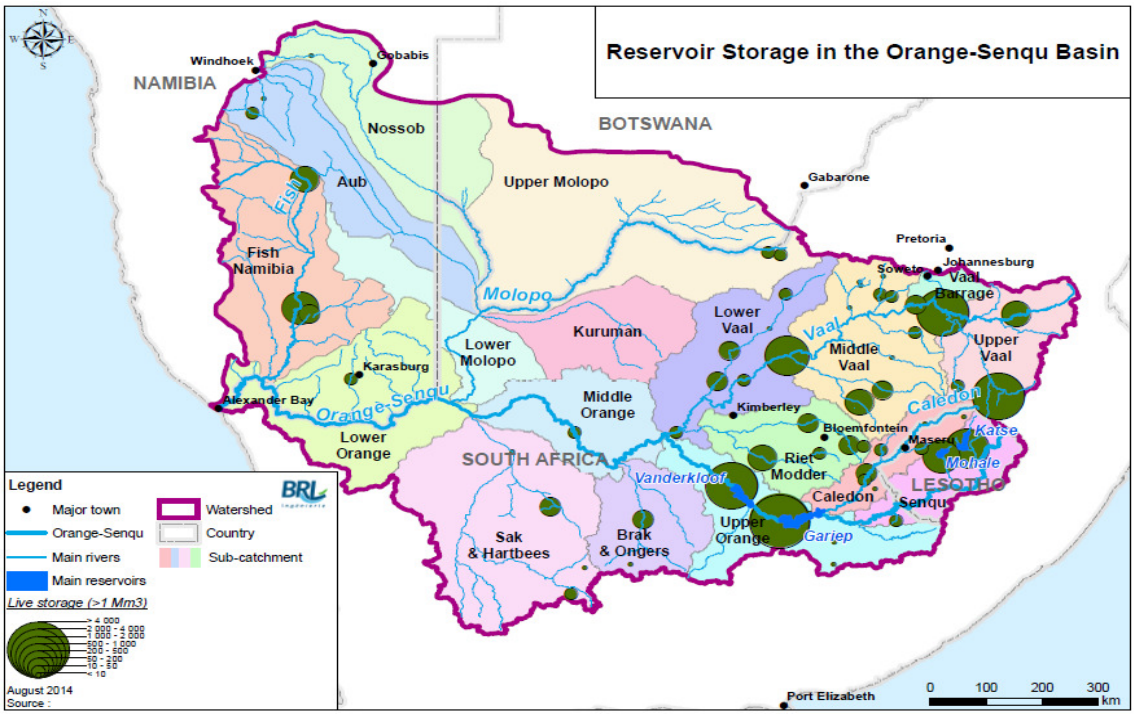


Figure 3-7: Location and size of reservoir storage in the Orange-Senqu Basin

The most highly utilised tributary of the Orange-Senqu system is the Vaal River which supplies water to the industrial heartland of Southern Africa in Gauteng. The Vaal River System also provides a share of water to 12 large thermal power stations producing 90% of South Africa's electricity, as well as water to some of the world's largest gold, platinum and coal mines.

Further downstream, the Fish River sub-basin, entirely located within Namibia accounts for the two (Hardap, Naute Dams) of the seven dams regulating the flows from Namibia into the Orange River.

3.5 THE ENVIRONMENT

3.5.1 Introduction

The *Transboundary Diagnostic Analysis* (TDA) (2013) of the Orange-Senqu river Basin provides the diagnostic analysis of the environment based on a scientific and technical assessment of the priority environmental concerns and shared management issues in the Basin. This document provides a detailed description and analysis of all aspects of the ecosystem under the headings of geographical setting, water resources, terrestrial environment, aquatic environment and climate change. It also includes a governance analysis and an assessment of the key environmental issues with some final analysis and recommendations. In the short summary provided in this report only the issues and recommendations are briefly presented. It is these that have driven the formulation of the *Strategic Action Programme* (2014), which, as already indicated, effectively forms the environmental component of this IWRM Plan.

3.5.2 Priority areas of environmental concern

OVERVIEW

Four areas of environmental priority areas of concern were identified in the TDA as follows:

- Increasing water demand
- Declining water resources quality
- Changes to the hydrological regime and
- Land degradation

Of course, these are areas of concern beyond just the environment. Environmental, socio-economic and technical issues are interlinked. In this section of the report, however, these areas of concern are discussed primarily in terms of the environment.

INCREASING WATER DEMAND

The volume of water currently reaching the mouth of the Orange-Senqu is, on average, approximately 4,200 Mm^3/a or just over a third of the mean annual naturalised runoff. Water is abstracted for irrigation, industry and mining, urban use and livestock farming. These demands will continue to increase and is likely to result in even less water reaching the ocean. Meeting current and future demands, including environmental flows requirements can be achieved through (a combination of) two approaches:

- The **supply-side** option of increasing the usable yield from the system to meet increasing demand requires extensive infrastructure. Moreover, the easy (and less costly) options have generally already been developed.
- **Demand-side** interventions such as water conservation, demand management, re-use of water, desalination, rainwater harvesting, etc. need to be further explored and increasingly implemented through an integrated approach.

DECLINING WATER RESOURCES QUALITY

The key water resources quality issues in the Orange-Senqu River system have been identified as nutrient enrichment, primarily linked to increased phosphorus and nitrogen concentrations; increased salinity from acid mine drainage and irrigation return flows; microbial contamination from urban settlements and poorly operated sewage treatment works; and changes in sediment load. In addition, radionuclides, heavy metals and

persistent organic pollutants, while not currently posing a basin-wide risk, do show high concentrations in certain localised areas. Although a common problem throughout the basin, pollution and declining water quality is most severe in the Vaal sub-basin in South Africa.

CHANGES TO THE HYDROLOGICAL REGIME

As a consequence of upstream development, in particular the construction of many dams and both intra and inter basin transfer schemes, the hydrological regime has changed significantly. Apart from the mean annual runoff being reduced to less than half of the natural flow, the pattern of flow is different to that of the natural river. There is less variability in flow from one year to the next and, within the year, there is a much less distinct seasonal pattern. The frequency of smaller floods has also been reduced, with most being absorbed by upstream abstraction and storage. There is less water in the system to dilute increasing volumes and types of contaminants, reduced and altered patterns of flow and flushing and changes in sediment load and balance and river morphology along its length. These changes in the hydrological regime of the river impact the downstream ecosystems, including the estuary - a Ramsar site - resulting in a loss of ecosystem services.

LAND DEGRADATION

Inadequate land management associated mostly with agriculture and mining in parts of the Orange-Senqu River basin has led to loss of wetland storage and aquifer recharge, increased sediment loads, deteriorating water resources quality, increased distribution and abundance of alien invasive plants, loss of biodiversity and lowered land productivity. While increasing numbers of people are faced with dividing up the land into smaller pieces, they are also faced with land being less productive. In some parts of the basin, livestock production is in decline; opportunities for community-based natural resource management and alternative livelihood options are inadequately considered. Land degradation is generally perceived as a problem in the basin, and Lesotho specifically regards this as a high priority challenge:

CONCLUSIONS

These issues have largely been addressed by the environmental sustainability Strategic and National Action Programmes.

A particular aspect of the environmental situational analysis is the issue of environmental flow requirements. Consideration of the environmental flow requirements cuts across the IWRM Plan in a particularly significant way in that they have to be taken directly into account in the water resources modelling exercise. The current situation with respect to environmental flow requirements is presented in Section 3.5.3.

3.5.3 Environmental Flow Requirements

OVERVIEW

Environmental Flow Requirements (EFR) describe the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (Hirji and Davis 2009).

Different components of the flow regime maintain different parts of aquatic ecosystems. Thus, loss of one component of the flow regime will affect a system differently than will loss of some other component. Ecosystems can be held at different conditions by ensuring that the flows required to maintain that condition are available. In general, the

closer to natural that the desired condition of the aquatic system is, the greater the volume of the original flow regime that will be required as an EFR. The most important characteristics of a natural flow regime are usually:

- degree of perenniality;
- magnitude of the low flows in the dry and wet season;
- small and medium floods that occur every year and
- large floods that occur over longer intervals.

Identifying these flow components and understanding the ecosystem consequences of their loss or modification is central to an EFR assessment, which should aim to predict how ecosystem condition will change with changes in the flow regime as a result of water-resource development or some other changes in the basin

Making provision for environmental flows; improving monitoring and land and water management practices; increasing awareness; enforcing regulation; and integrating these with current operational systems are likely to improve the condition of the river basin as a whole.

CURRENT SITUATION

As described in the Consolidation of Environmental Flow Requirements Report (2014) under this study, there have been at least 12 full EFR studies undertaken for different parts of the Orange-Senqu Basin plus several smaller, desktop studies. These studies were carried out over a period of around 16 years, and used different methods, or different levels of development of the same methods, for both the assessment of present ecological state (PES) and for the evaluation of ecological flow requirements to maintain these PES or alternative better or worse (less or more degraded) states.

Since it is not realistic to evaluate (and subsequently monitor) EFRs on a continuous basis along every watercourse, sites considered to be representative of relatively homogenous reaches are selected. The sites are shown in Figure 3-8.

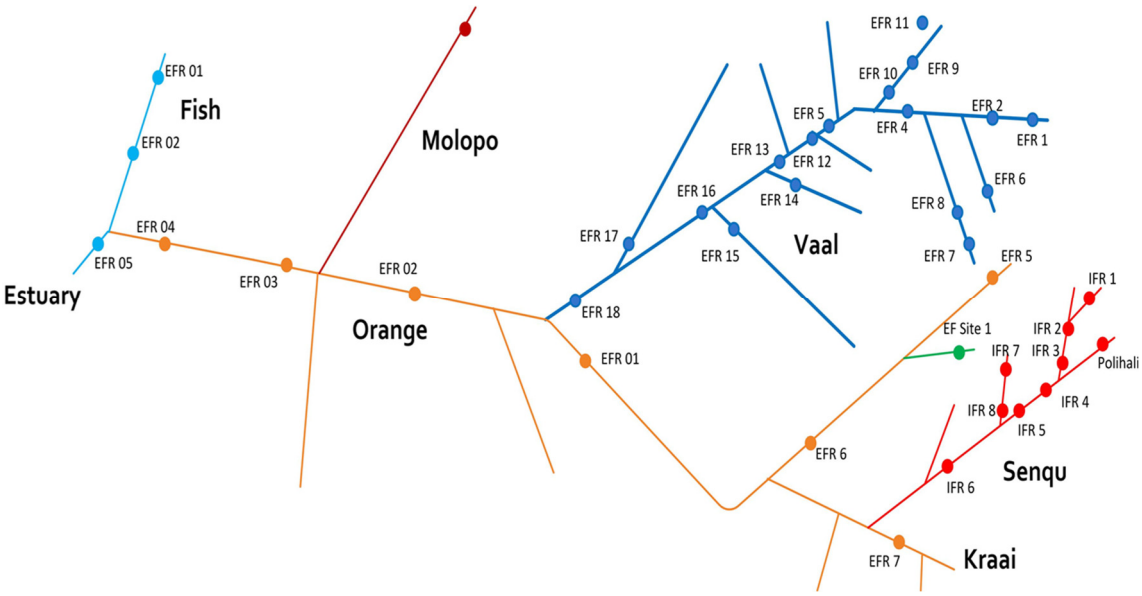


Figure 3-8: EFR Evaluation and monitoring sites around the Orange-Senqu Basin

The steps followed in the EFR evaluation process can be summarised as follows:

- Selection of critical sites to represent the river reach
- Evaluation of present ecological state PES) (defined by a range of parameters)
- Evaluation of environmental flow requirements to maintain the PES or to attain an improved (or more degraded) state

It is important to note that there is always a significant degree of uncertainty in the proposed EFRs and a monitoring programme is required to evaluate whether the proposed EFRs are achieving the desired effects and adjust accordingly through a process of adaptive management. In many cases the monitoring and evaluation of impacts, followed by the adjustment of EFRs will therefore be an ongoing process.

At this moment a set of EFRs are used in the management of water resources around the basin and in particular for defining reservoir operating rules and associated releases.

The Consolidation (Phase 3) study, using findings especially from UNOPS/GEF/TDA and IWRM Phase 2 work, as well as the testing for different flow scenarios based on existing infrastructure and demands) has shown that the present set of EFR definitions will maintain the PES but that it will be complicated to achieve the ecological targets which require improvement in the Lower Orange River and Estuary.

REQUIREMENTS FOR SUSTAINING OR IMPROVING THE PES

The latest work proposes a new set of EFRs both for maintaining the PES and improving it, in particular for the Lower Orange. To improve the situation, more water is required during the wet season, however, less water that is currently being supplied under the current operating rule is required for improvement

The implications of these new EFRs have been investigated and are discussed in the section on scenarios in this report. It is clear that their implementation would significantly reduce the available yield of the system and would require a combination of infrastructure and management measures to be implemented. At the same time, both the Consolidation Report and the SAP have identified a number of measures that could be implemented without delay to improve the situation at the estuary. These include:

- Restorative measures implemented to improve condition of floodplain function including removal of a remnant causeway and old earth-moving equipment and a number of soft measures;
- Design and implementation of a joint zonation scheme to manage activities within the Ramsar sites and/or protected area(s) reviewed and developed,

These measures, together with a proposed phased implementation of revised preliminary EFR values together with the infrastructure and management actions to support them, are discussed in the scenario analysis.

3.6 ECONOMIC ACCOUNTING AND ECONOMIC INSTRUMENTS

3.6.1 Economic Accounting

3.6.1.1 Introduction

Basin Integrated Water Resource Management (IWRM) planning in highly developed basins, like the Orange-Senqu basin, usually requires trade-offs between allocation and development of the water resources in the basin. This is especially essential for basins that are shared between countries as these decisions affect the different sectors and each country. By improving the understanding of the supply of water, use of water, value of water allocated to different users, the efficiency of water use, and the broader social and economic benefit to the basin and the country, the countries can make informed, efficient and equitable decisions.

The System of Economic Accounting of Water (SEEAW) as well as Water Footprint methodologies help to inform the manner in which water is used within a basin and can be used as the conceptual framework for organising water information in order to study the interaction between the economy and the environment. In this chapter, water accounts are of particular focus, while water footprinting is covered at a later stage.

The indicators resulting from the water accounts cover many aspects of water management under Integrated Water Management (IWRM) such as:

- Water resource availability: the water accounts depict the status of water resources and the pressure exerted on the stocks of water.
- Water use for human activities: the water accounts provides details of how water is used in the economy, what pressure is on the water resources as well as opportunities to increase water use efficiency,
- Opportunities to increase effective water supply by managing return flows, reuse and system flows:
- Water cost, pricing and incentives for conservation: The hybrid accounts in water accounting assess the costs of supplying water compared to revenues generated by water tariffs.

The different flows of water can be classified into the following categories:

- *Flows of Water within the environment:* This relates to the natural flow of water between surface, soil and ground water;
- *Flows of Water from the environment to the economy:* This relates to the abstraction of water from the environment for production and consumption purposes in the economy.
- *Flows of Water within the economy:* This relates to the flow of water in physical and monetary terms, from water supply agencies (water utilities) to agriculture, industry, mining, manufacturing, and households
- *Flows from the economy back to the environment:* After using water, the economy discharges wastewater back to the environment (return flows), either into rivers and lakes, or directly into the ocean.

These flows of water can be seen in the figure below:

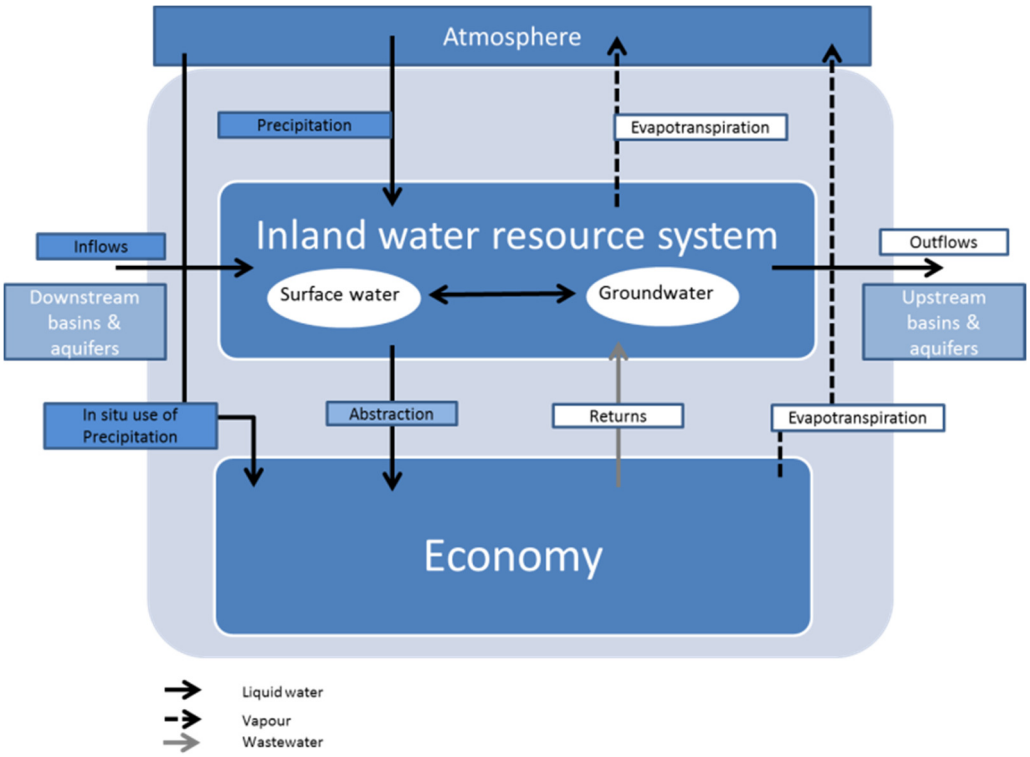
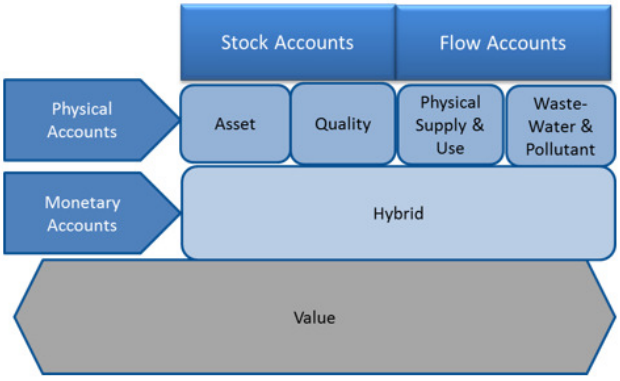


Figure 3-9: Flows between the Economy and the Environment captured by the water accounts

3.6.1.2 *Water Accounts Analysis*

INTRODUCTION

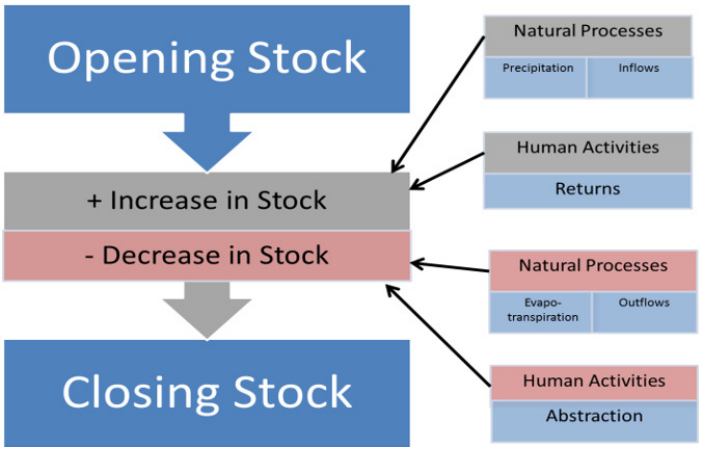
The water accounts for the Orange Senqu River Basin have been split into five geographical areas; namely Namibia, Botswana, Lesotho, Vaal Water Management Area (WMA) and the Orange WMA. The data has been collected from various sources and input into the conceptual model for Water Accounting. The Water Accounts is a live model subject to change based on results from the hydrological modelling.



The analysis carried out is based on the System of Environmental-Economic Accounting for Water (SEEA Water) framework (UN, 2012). The SEEA-water has been recommended as the International standard for water statistics. It has been designed to link economic information with hydrological information for integrated analysis. The framework comprises the main categories as per the figure above. SEEA-Water functions in support of IWRM as it assists policymakers in making informed decisions on subjects such as allocating water resources efficiently, improving water efficiency, understanding the impacts of water management on all users and getting the most value for money from investing in infrastructure etc.

The collection of these different forms of data is helpful in studying the interaction between the economy and the environment, so that resources can be managed appropriately.

ASSET ACCOUNTS



Water asset accounts describe the stocks of water resources and their changes during a particular period of time. The water resources found in the basin can be split between groundwater and surface water.

Table 3-4 gives an overview of the total (ground and surface) water stocks for the region. The opening stock represents the water stored in dams and rivers within the respective catchments. The estimation of surface water stocks is made easier by monitoring of rivers and dams while the estimation of groundwater stocks is more complicated.

The Orange River Catchment represents the largest opening stock, followed by the Vaal River Catchment. In terms of abstraction, the largest use of water stems from the Vaal River Catchment, followed by the Orange.

Table 3-4: Overview of Orange-Senqu Basin Asset Account

Asset Accounts (Mm³)	Vaal WMA (RSA)	Orange WMA (RSA)	Namibia	Botswana	Lesotho
Opening Stock	**38 641**	**28 955**	**4 002**	**5 925**	**11 543**
Increase in stock					
Precipitation	87 825	103 942	12 255	15 800	34 038
Inflows	7 302	13 476	1 713	614	7 475
Transfers in	1 034	2	54	-	-
Return flows	755	181	15	9	18
Decrease in stock					
Abstraction	3 557	2 554	163	188	108
Evaporation/ Actual evapotranspiration	85 634	100 744	11 846	16 186	36 221
Transfers out/Outflows	7 726	14 303	2 028	48	5 202
Closing stock	**38 641**	**28 955**	**4 002**	**5 925**	**11 543**

PHYSICAL WATER SUPPLY AND USE TABLES

The objective here is to provide an overview of the water flows in physical units within the economy and between the environment and the economy. This helps in assessing and monitoring the pressure on water quantities by the different users who are responsible for the abstraction and discharge of water into the environment.

- The flow from the environment to the economy refers to the water abstracted from groundwater and surface water (rivers and dams) by the different economic units (agriculture, mining, industrial, power generation and urban wastewater).

- The flows within the economy refer to water flowing between the different economic units. This includes wastewater supplied to treatment facilities before being discharged into the environment.
- The flows to the environment refers to returns or losses in distribution e.g. evaporation, leakages and illegal tapping. If these losses return back to the environment to be used again, these losses are referred to as return flows.
- The difference between the water use and water supply is the *water consumption* and results from water used (and not returned) in products, plants, evaporation and general consumption of water by households or livestock.

A summary of the total regional demand and supply per sector is given in Table 3-5.

Table 3-5: Overview of Orange-Senqu River Basin water abstraction

Total Abstraction (Mm^3/annum)	Botswana	Lesotho	Namibia	Vaal	Orange
Urban	-	49	11	1 201	79
Industrial	-	17	4	398	6
Mining	34	-	7	115	58
Power Stations	-	-	-	246	-
Strategic industries	-	-	-	134	-
Irrigation	32	35	119	1 318	2 353
Rural domestic	70	7	0	34	13
Livestock	47	0	21	112	45
Tourism	-	-	1	-	-
Other	6	-	-	-	-
Total	188	108	163	3 557	2 554

QUALITY ACCOUNTS

Quality accounts describe the quality of the stock of water resources based on certain characteristics analysed. The structure is similar to the Asset Accounts above. The analysis of the quality of water is essential as this affects the usability of the water. The analysis below takes into account the following indicators of quality:

- Electrical Conductivity (EC): indicates levels of salinization of water resources
- Sulphate (SO_4): provides an indication of mining impacts
- Chloride (CL): provides an indication of agricultural impacts, sewage effluent discharges and industrial impacts;
- Ortho-Phosphate (PO_4-P): provides an indication of the nutrient levels in water resources
- Ammonia (NH_3-N): provides an indication of toxicity
- pH: provides an indication of mining impacts

The volumes of water in the Asset Accounts above are split into quality areas from ideal to unacceptable per indicator above. Results have been generated for all of these indicators in the form of tables and graphs. These can be examined in detail in the thematic report. A typical graphics is shown in Figure 3-10.

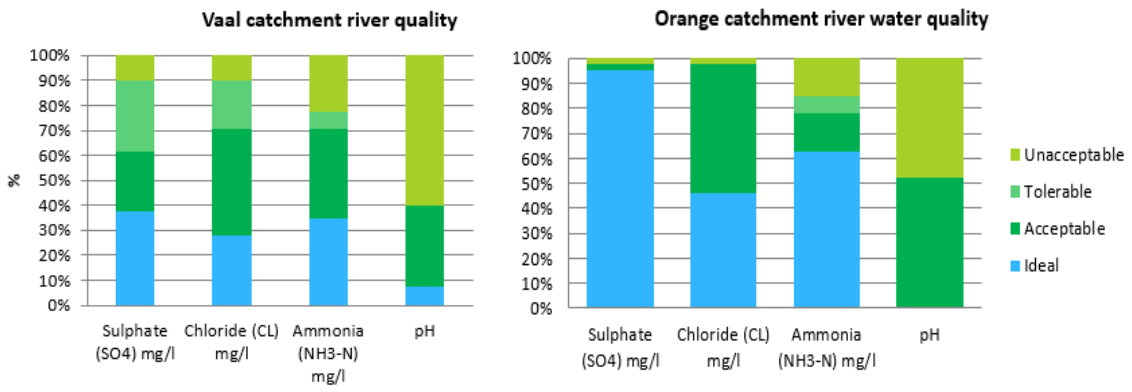


Figure 3-10 : Orange and Vaal river water quality

EMISSION ACCOUNTS

Emissions are separated by water user. Urban, industrial, mining, power stations, strategic industries, irrigation, rural domestic, livestock, tourism and other are all considered according to where runoff or wastewater discharge is emitted to. Direct emissions to water can take place following treatment on site or without treatment. Wastewater which is not directly discharged into water is first sent to sewerage.

The majority of data regarding emissions stem from the Vaal catchment (755 Mm³/annum). The majority of the emissions are urban (353 Mm³/annum), of which 84% are emitted to sewerage, while the remaining 15.7% are discharged directly into surface water. This is followed by irrigation (134 Mm³/annum) and then industrial (117 Mm³/annum).

On the Orange River, the majority of the emissions are irrigation (167 Mm³/annum) of 181 (Mm³/annum). The same is true for Namibia (10 Mm³/annum) or 15 (Mm³/annum). In Botswana the emissions from mining are double that or irrigation 6 Mm³/annum vs. 3 Mm³/annum.

HYBRID AND ECONOMIC ACCOUNTS

The hybrid account includes information from a number of sources and measurement units. The accounts consist of costs associated with water and supply, revenue generated for wastewater treatment, infrastructure costs, their associated maintenance costs, and financing of these costs.

Besides GDP, in ORASECOM, there is only information on the cost of water supply, infrastructure assets and investment in future infrastructure for the Vaal and Orange catchments in South Africa.

The GDP contribution per sector at a high level is as shown in Figure 3-11. The high level indication of sectors helps to identify the overall nature of the economy in each country. Resource dependent economies, especially water-dependant, have significantly different development pathways to others.

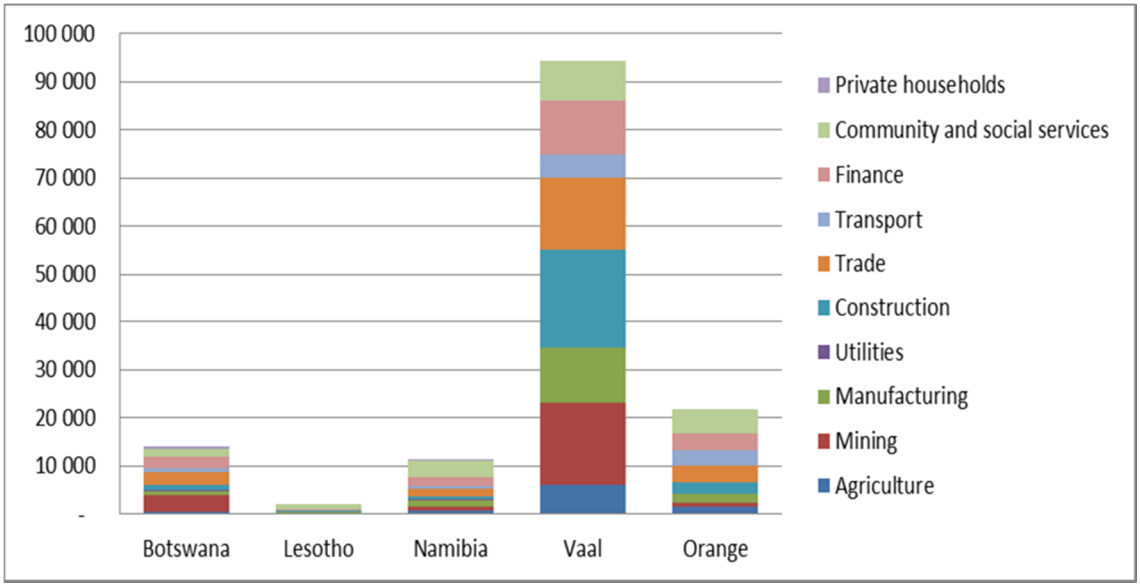


Figure 3-11: Orange-Senqu River Basin GDP per sector

3.6.1.3 Water Footprinting

INTRODUCTION

A water footprint is a measure of freshwater used to make a product, measured throughout the entire supply chain. This includes the upstream processes for manufacturing raw materials, direct operations, and downstream consumer use of a product. The concept of a "water footprint" was proposed as an alternative indicator of water use. A water footprint is different from traditional water statistics in that it looks at consumptive water use instead of water withdrawals (Hoekstra, 2003). It has been argued that examining consumptive, or in other words evaporative, water use is more relevant because parts of water withdrawals return to the water bodies from which they were taken and these parts can be reused.

The water footprint of a product is similar to what has been called alternatively the 'virtual-water content' of the product or the product's embedded, embodied, exogenous or shadow water (Hoekstra and Chapagain, 2008). The terms virtual-water content and embedded water, however, refer to the water volume embodied in the product alone, while the term 'water footprint' refers not only to the volume, but also to the sort of water that was used (green, blue, grey) and to when and where the water was used:

- A blue water footprint refers to the volume of surface and ground water required for the production of a good or service. For the purpose of this assessment, blue water is also the most relevant given that it refers to the Orange-Senqu water abstracted and not returned to the water system.
- A green water footprint refers to the volume of rainwater used to produce a product which does not run off or recharge groundwater, but is stored in or temporarily on top of the soil. Green water can be considered from the perspective of opportunity costs as most of the featured green water is on range land which would otherwise not likely be used for agricultural production.
- A grey water footprint addresses pollution, and represents the volume of freshwater that is required to dilute or assimilate the load of pollutants based on existing ambient water quality standards.

NATIONAL WATER FOOTPRINTS OF PRODUCTION

Typically the most significant contributor to a country's national water footprint of production is water use in agriculture. This is true for all four basin states.

Green and blue water use for crop production (excluding animal grazing and water supply) in South Africa forms almost 80% of the country's total green and blue water footprint. If animal grazing and water supply is added to this, South Africa's total blue and green agricultural footprint increases to approximately 99% of the total green and blue water footprint of national production. In Lesotho and Namibia the equivalent crop production water footprint ratios are approximately 63% and 53% respectively. However, in Botswana, given the relative aridity of the country and thus the preference for rangeland over cropland, water use connected to animal grazing and water supply forms a much greater percentage of the total green and blue water footprint (at approximately 77%) than does water use in crop production. This is mostly made up of green water (rainfall) inherent in grazing land. Figure 3-12 provides the water footprint of production, split by sector for each of the countries. Here the magnitude of water use in agricultural production (particularly in South Africa) is clearly evident (noting that water use in this context refers to water that is not returned to the system).

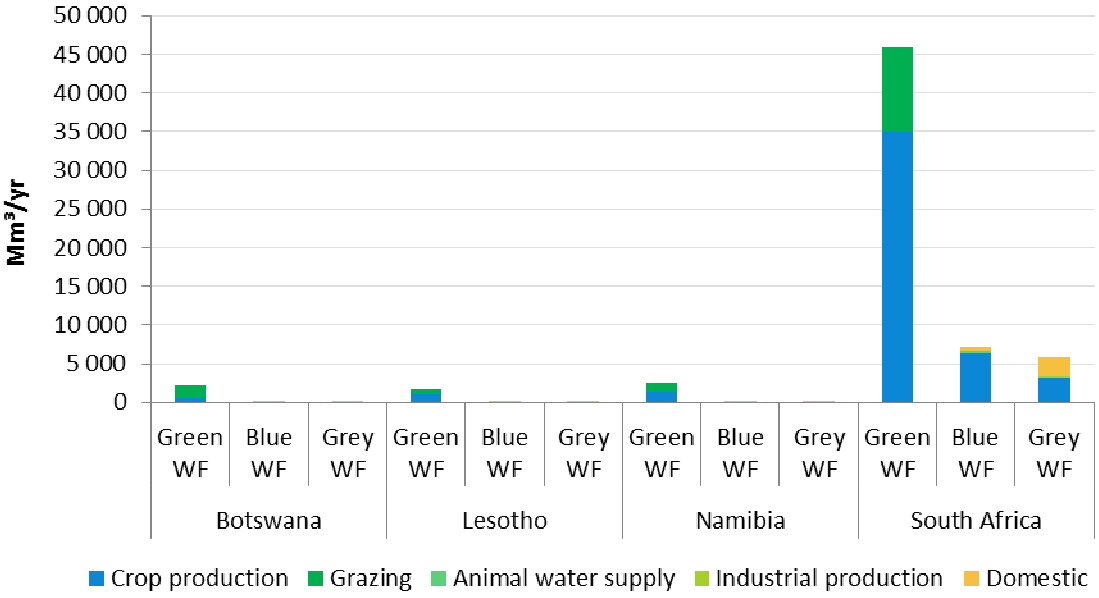


Figure 3-12:Water footprint of production by country

3.6.1.4 National virtual water export

Of the water used in the production of goods and services in each country, a portion is exported in the form of "virtual water" or water inherent in the product's production process. Virtual water flow can be very useful for both water abundant and water scarce countries. For the former, for instance, water intensive crops can be grown and exported to water scarce regions, thereby generating foreign exchange through comparative advantage which can then be channelled into other purposes. For the latter, by importing water intensive crops, so can these countries save their limited resources and reallocate them to other uses including the preservation of environmental flows.

Each of the Orange-Senqu countries' total export water footprints for crop and animal products (split into blue and green water) have been estimated.

Virtual water export for crop products and animal production are shown in Figure 3-13.

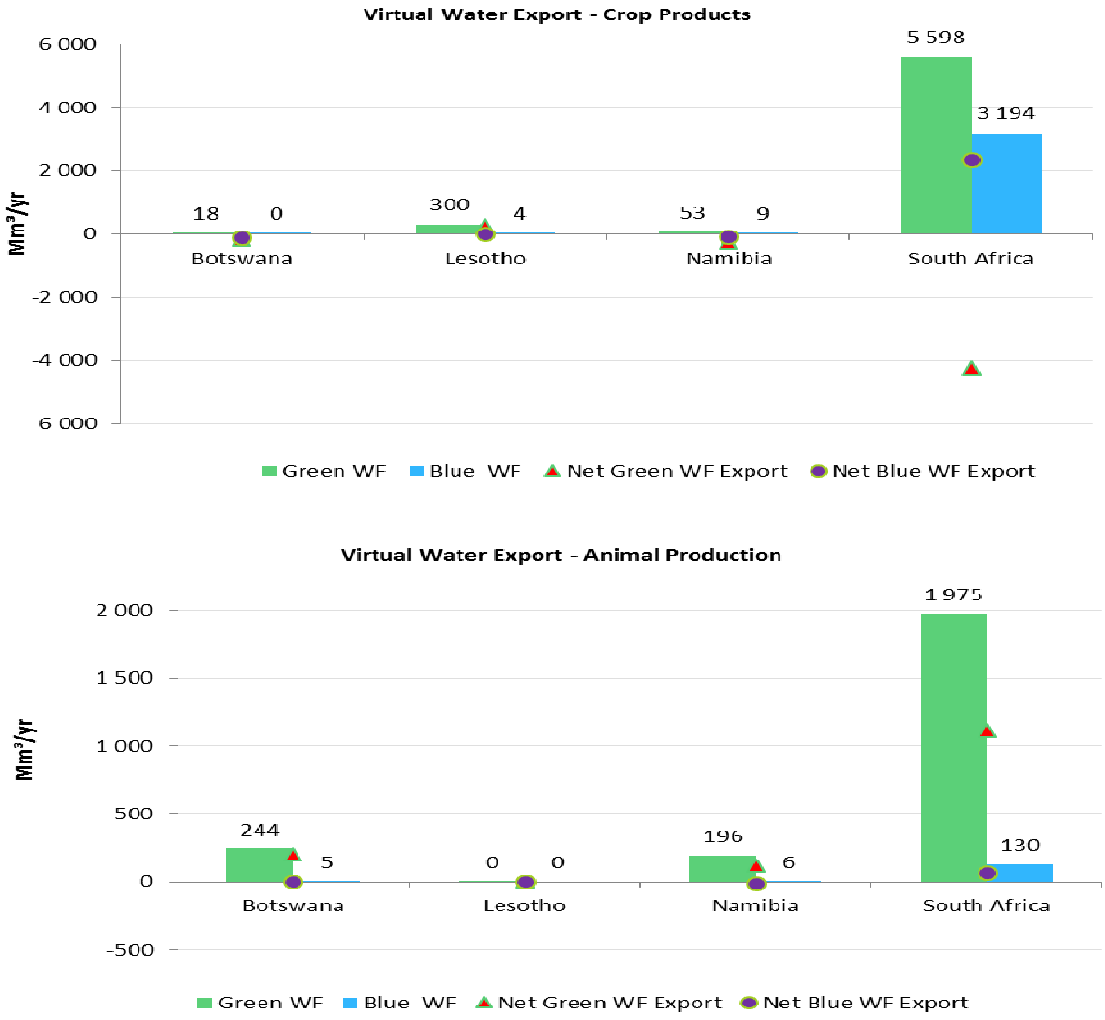


Figure 3-13 : Virtual Water export from the basin

3.6.2 Economic Instruments

INTRODUCTION

Economic Instruments (EIs) are approaches that are intended to modify individuals and corporations' behaviours in a favourable manner, such as reducing water consumption, reducing pollution, or adoption of water efficient techniques such as modern irrigation systems. There is therefore a need to increase the use of economic instruments, through enforcement or voluntary measures, and to share the knowledge and experiences in order to improve the effectiveness of the systems. The use of economic instruments has a number of advantages, such as:

- Avoiding the cost of extensive infrastructure investment and making use of low-cost, non-technical measures;
- Generating revenue to finance water management, monitoring and other water-related infrastructure;
- Aligning incentives and strengthening policy coherence across the different interrelated sectors, such as water, energy, food or land-use; and

- Providing relevant information on the cost of current systems, the benefits of system improvements, and the distribution of associated costs and benefits.

Particular economic instruments are especially suites to specific water resource situations. For example, when water supply far outweighs water demand, investment in infrastructure is a more suitable response than investing in economic instruments to force efficiency. However, as water demand grows, there begins a need for institutions to manage and allocate water appropriately. Finally, as water becomes increasingly stressed, as demand outstrips supply, economic instruments such as trading or water pricing may become more suited to ensure adequate water resources management.

There are a range of tools and instruments to promote water use efficiency as water resources become stressed. These include:

- Water charges & Tariffs
  - Raw water
  - Water supply systems
- Taxes & Transfers
  - National government support
  - Development Assistance
- Trading & Markets
  - Local informal trading
  - Conditions for more permanent trading

Depending on the nature of institutional structures and legislation in particular countries, these instruments may or may not be appropriate. A brief summary of the current state of economic instruments in the riparian states is provided below.

COUNTRY BRIEFS ON ECONOMIC INSTRUMENTS

Botswana does not have a formal policy or legislation that explicitly stipulates a framework for funding water resources management. However, the Water Utilities Corporation Act, National Water Master Plan Review (NWMPR), National Development Plans (NDPs) and other government documents mention Botswana's water tariffs and their implementation. The Water Act specifies that self-providers have to develop, operate and finance their own water supply sources after water abstraction rights have been obtained from the Water Apportionment Board (WAB).

Lesotho has three water management institutions that have the ability to make use of or affect the available economic tools in the country's water sector. These institutions are the LHDA, WASCO and LEWA. The LHDA determine the appropriate costs associated with the projects it overseas, which ultimately influence the charges to be paid by the users who benefit from the water transfer schemes in South Africa. The Water and Sewerage Company (WASCO) has the power and authority to set charges on urban water use and LEWA plays the regulatory function over the charges set by WASCO. The other institutions are funded by government or donors and do not have tariff setting authority of any form.

Namibia has strong natural resources management policies and strategies in place or under development. Block tariffs have been used effectively to penalise heavy water users and reduce demand in urban settlements for several decades. However, the country has had some challenges in setting and recovering full cost charges for operations and management in the recent past. In some cases, the Local Authorities have needed financial assistance from the Ministry of Regional, Local Government, Housing and Rural Development.

South Africa has fairly robust charge determination structures and processes. The challenge that South Africa faces is that of full and proper implementation of policy. For many years now the country (through DWA) has been attempting to achieve full cost recovery from those users who can afford to pay the full cost of supplying water to them. However, the irrigation sector (the biggest water user in the country) and the forestry sector continue to use highly subsidised water. To a large degree, the failure to follow through on attempts to put in place the envisioned transition to full cost recovery is the high level of stakeholder participation in the charge determination processes. There also needs to exist stronger political will to move towards full cost recovery in South Africa.

Although there is uncertainty over which economic instrument or approach is more effective, and as illustrated in the synoptic country briefs, there is agreement of which economic approaches that have been deemed more favourable.

The issue of equitable utilisation and 'benefit sharing' of the basin's water resources can be effectively supported by the use of economic approaches.

3.6.3 Implications for the IWRM Plan

The IWRM Plan has 4 central and 3 cross-cutting water resources management and development themes as indicated by the figure below. The tools described previously contribute towards the development of these themes.

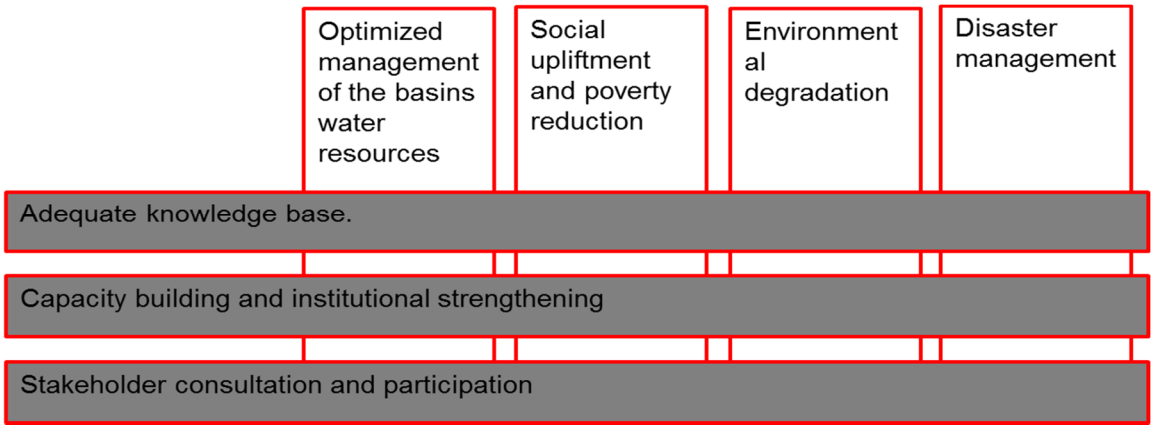


Figure 3-14: Structure of the IWRM Plan

Taking cognisance of the preceding information regarding water accounts, water footprints and economic instruments for managing water, there are a number of observations which are of relevance for the IWRM Plan. These are captured in a selection of the strategic action areas.

Economic considerations of water use are likely to play an increasingly prominent role in the planning of how best to use what will become an increasingly scarce and expensive resource. Projections of water demand into the future and the infrastructure implied will most likely be misleading of the economic realities of future development are not fully taken into consideration. Of course these realities are by no means certain and the need of looking more closely at uncertainty and plausible futures is critical. This is discussed later in this report.

Optimising the efficient utilisation, development, adaptive management of water resources is an area of importance for ORASECOM and the basins states which can benefit from the use of economic accounting and water footprinting.

The effective use of economic approaches will require better water use and demand data and information, which of particular relevance for these tools so this should be reflected in the IWRM Plan.

Optimising the efficient utilisation, development, adaptive management of water resources is a strategic area which may benefit from the use of economic accounting and water footprinting.

Agreeing on the equitable utilisation of (the basin's) water resources and benefit sharing may be supported through the use of economic instruments to manage water resources equitably. This may be through subsidies to cross-subsidise water and ensure an equitable distribution. Alternatively, the setting up of instruments and institutions to manage water resources is helpful in agreeing on definition and guidelines for water resource 'benefit sharing'.

Inter/Intra-sectoral planning and coordination (Horizontal and vertical alignment) can be supported through the use of the hybrid accounts and water footprinting to develop the concept of water 'in' the economy rather than purely 'for' the economy. Water resources play a significant role in catalysing development. The use of such tools can support the promotion of transboundary inter-sectoral planning and coordination in order to support cost-effective and sustainable development of water and associated natural resources

Finally, economic instruments indicated in this report are useful in ensuring that adequate financing mechanisms and funding are supported through the adequate utilisation of tools for building economic efficiency and effective water resources management, which takes cognisance of the full value of water.

There are a range of other strategic action areas that may not be directly, but rather indirectly supported through the use of the System of Environmental-Economic Accounts for Water, Water Footprinting and economic instruments such as pricing or trading. In essence, the value of using these tools, lies in the exploration of data availability and conceptualising the entire economy supported through water, rather than the absolute volume or quality passing through the river or taps.

3.7 STAKEHOLDER PARTICIPATION

3.7.1 The ORASECOM Agreement and Stakeholder participation

The legal mandate for ORASECOM to engage in stakeholder participation derives from Article 5.2.4 of the ORASECOM Agreement which states that "*Council shall recommend or advise Parties on extent to which inhabitants (stakeholders) in each territory shall participate in planning, development, utilisation, protection and conservation of the river system*". Deriving from these stakeholder participation imperatives in the Agreement, a meeting of the Ministers of Water from each of the Parties in 2002 therefore mandated ORASECOM to develop a strategy for stakeholder participation in the Basin in accordance with international trends, guidelines and any other relevant considerations.

3.7.2 Roadmap Towards Stakeholder Participation

Although the ORASECOM 'Roadmap towards Stakeholder Participation' developed in 2007 process is recognised as the approved guideline document for stakeholder participation in the Orange-Senqu Basin, it has not been actively rolled out. However,

recent work has focussed attention on the practicalities of, and need for, implementing some of the recommendations.

The Roadmap highlights the following important considerations relevant to directing the stakeholder participation process:

- The participation process should tie in with the overall ORASECOM vision and strategy, which has been developed as part of this Plan.
- The Roadmap proposes a progressive approach to the development of stakeholder participation, but clearly indicates the end goal as being co-management of the water resources in the Basin with effective input from stakeholders.
- The Roadmap proposes participation of stakeholder at National level (via National Basin Forums) as well as Basin level (via Basin Wide Forum).
- A self-funded (through each Member State) observer or expert groups, should be established to represent Basin wide interests and should sit in on Task Team and/or Council meetings.

3.7.3 Stakeholder Participation rollout and way forward

There are several documents available on investigations undertaken and recommendations made in terms of stakeholder participation and integrated water resource management within the basin. These documents/reports have been widely referred to in initiatives to develop the ORASECOM stakeholder participation process, and numerous reviews have been undertaken through ORASECOM to explore stakeholder participation for the Orange-Senqu Basin. These documents include:

- Roadmap for Stakeholder Participation (2007)
- Draft Proposal for Stakeholder Participation in ORASECOM: Discussion Document (2010)
- Proposed Rules for Granting Observer Status to ORASECOM (2010)
- Considerations and options for an ORASECOM stakeholder participation platform, Pros and Cons of Basin Wide and National Stakeholder Participation Forums (2011)

The conclusions drawn in the latter study are worth noting and have relevance as to how stakeholder participation should be viewed for future projects and indeed the implementation of the IWRM plan. The key recommendations include:

- Stakeholder participation is not consistent across all aspects of ORASECOM business and projects.
- Stakeholder participation in national and basin wide projects will vary from project to project, as projects would have specific and possibly differing requirements for stakeholder input. Participation processes would therefore be structured and implemented at a project specific level.
- Council resolved (Decision 13 of 26th Ordinary Meeting) that participation of stakeholders be at national level while modalities of participation at basin-wide scale are still being considered. Frameworks and guidelines to strengthen and ensure effective stakeholder participation at national level should be developed.
- Noting the various challenges, a Basin wide forum for stakeholder participation can be advantageous but is not essential. Stakeholder engagement at national levels needs to be representative and effective, such that stakeholders' interests at the national level are represented at the basin level by the Parties' representatives.

- ORASECOM does not **need** a basin wide stakeholder platform in order to facilitate stakeholder participation in ORASECOM's core business. ORASECOM, in the absence of a Basin level platform, will have a critical contribution to make in ensuring meaningful and adequate representation of stakeholders' issues at a Basin level.

Noting the challenges, ORASECOM opted to make use of National Working Groups (NWG) and Regional Working Groups (RWG) on specific projects in the basin. The NWGs comprise groups of up 15 to 30 stakeholders at the national level, with a more limited (7 to 10) stakeholders from each country represented on the RWGs. These engagement bodies were put in place for the ORASECOM TDA/SAP process and for the purpose of continuity this approach was carried through in the development of the IWRM Plan. Some modification in representation required, but nonetheless the approach proved valuable in gaining national and regional insights. . Therefore, instead of updating and implementing a revised "Roadmap" the approach has been rather to work towards developing an engagement framework that articulates through the plan how stakeholders will be engaged as the Plan is implemented across the basin. Principles that will form the basis of this include:

- Accessibility: where information is made easily accessible to the targeted stakeholders
- Inclusivity: where engagement with all identified stakeholders, including vulnerable and disadvantaged groups are included. Attention should be given to the different groups in society such as men, women, youth, elderly and the disabled. Where certain groups are marginalised, devise strategies to ensure their inclusion.
- Transparency: where the relevant stakeholders are kept abreast of the Plan and developments.

3.8 GENDER MAINSTREAMING

3.8.1 Introduction

Gender mainstreaming is one of the key principles of IWRM. However, information on gender roles and the differential access of men and women to water resources management and related services is often lacking in many water strategies and policies. National statistics that relate to natural resource use and water resources management are not disaggregated by gender. In the absence of such statistics, gender based indicators will be used to provide an overview of gender (in) equalities in water resources management in the basin. These indicators are important in tracking and upholding commitments in gender equality in the water sector and in sustainable development. They could measure structural inequalities such as men and women's access to water in the basin, gender participation in water related decision making structures at all relevant levels, access to water resources water management information and training participation in education and employment in the water sector, to name a few. A gender disaggregated data collection and reporting system is essential to achieve this.

Gender-based inequalities are measured using the Gender Inequality Index (GII). This index is based on three critical elements that reflect gender inequalities- i.e. reproductive health, empowerment and participation in the labour force market. The GII ranges from 0 to 1 with the higher figure indicating higher levels of gender inequality.

The findings of the most recent Gender Inequality Index Score, (Human Development Report 2013) the four countries in the basin show similar results of the GII but more diversity in the criteria, which were used to calculate the GII (see Table 3-6).

Table 3-6: Gender-based indicators in the riparian states

Country	Seats in Parliament by women (%)	Population with secondary education (%)	Economic decision making Women (%)	Labour force participation (%)		Unemployment (%)		GII
				Women	Men	Women	Men	
Botswana	8	52	43	72	82	20	15	0.485
Lesotho	26	57	21	55	73	25	21	0.534
Namibia	25	53	25	63	69	32	23	0.455
South Africa	42	55	23	49	62	28	23	0.462

3.8.2 Policy and Legal framework

All the riparian states have signed the 'Convention on the Elimination of all Forms of Discrimination against Women' (CEDAW). At a regional level, governments of the riparian states, with the exception of Botswana, have signed and ratified the SADC Protocol on Gender and Development and the Charter of Fundamental Social Rights in SADC in 2008 and 2003 respectively. To varying degrees, all countries have aligned their national policies and legislation with regional and international obligations on gender equity and equality and have all developed policies on gender and development, and these are binding in the water sector and all the sectors.

The riparian states are also in the process of developing gender mainstreaming strategies to systematically address gender inequality in their development planning. Enabling conditions to implement and monitor gender equality have been created in all the riparian states through the creation of National Gender Machineries (NGM) such as Gender Ministries and Gender Commissions that lobby and advocate for the implementation of rights and gender based approaches in development. In the water sector in the riparian states so far, only South Africa has developed a gender mainstreaming strategy which sets out a comprehensive approach to address rights and gender in the water sector.

3.8.3 Challenges of gender and water resources management in the Orange-Senqu Basin

The following is a brief summary of the common challenges for gender mainstreaming as it relates to water resources management in the Orange-Senqu River Basin. These challenges were identified during consultative meetings with ORASECOM member states that took place in July and August 2014.

- Gender and access to water. In the Orange-Senqu River Basin, levels of access to potable water vary considerably across the basin. Lack of access to water to meet the multi-faceted basic human needs is intrinsic to poverty (Schreiner and Van Koppen, 2002). Basic human needs including health and income mostly require water to be realized. Furthermore, poor people often are unable to meet the costs associated with accessing water, even when water resources are abundant. According to interviews carried out in Lesotho, Botswana and South Africa, women and Female Headed Households (FHH) within the Orange-Senqu Basin generally form a significant proportion of poor people that lack access to water in the basin. Reasons for lack of access to safe water by poor and marginalized people were attributed to the inadequate infrastructure, high initial water connection fees and high water tariffs which are a deterrent for many poor households within the basin.

- Gender and disaggregated data: Information and data on water resources in various documents (policies, strategies and national statistical documents) lacks gender related evidence in the water sector. All the riparian states of the Orange Senqu River Basin do not have gender disaggregated data on water resources management, for example household water connections, access to safe and appropriate sanitation services, water use and priorities and participation of women and men in formal and informal institutions in water resources management. This information would enable water planners and decision makers to comprehend gendered differences in water use, demands and management. Such data is crucial in understanding the demands for different groups, informs policy alternatives and program planning, as well gender monitoring of progress. This would then enable decision makers to device appropriate strategies of increasing water access to all its citizens.
- Gender and participation: A rapid review of the different governance structures for water resources management at national and local levels reveals that men play a much greater role than women for a variety of reasons. While there is a fair amount of women represented in higher decision making structures within ORASECOM (40% women ORASECOM Commissioners), the equal participation and the involvement of women at the grassroots level is often inadequate and at times lacking. As a result, there is inequitable participation of poor woman and men resulting in their local knowledge in water resources management often being ignored and therefore untapped.
- Coordination between gender and water departments: Consultations have revealed that in all the member states, little or no coordination exists between the water sector and the gender machinery. South Africa has developed a gender mainstreaming strategy for the water sector to strengthen the linkages with the gender machinery and also to institutionalize gender. Other countries within the basin however are still exploring best approaches to strengthen those linkages with the gender ministries.

The sections above provide an overview of the commitments and the challenges of the riparian states to gender equity and equality. The realities on the ground point to the fact that there are still challenges with regards to the implementation of human rights and gender based approaches in water resources management. As a response to these challenges, a preliminary strategy for mainstreaming gender in the basin has been developed with the participation of the Departments of Water in each country and other stakeholders in the basin states

3.9 Governance Arrangements

3.9.1 Legal and policy aspects

Regional water policy and strategy

The Regional Water Policy (RWP) and the Regional Water Strategy (RWS) lay down the regionally agreed policy guidelines concerning water resources management, covering a wide range of topics from infrastructure development, information exchange, capacity building to gender aspects and stakeholder involvement. The RWP provides the broad statements of intent as to how water resources will be managed and developed. The RWS gives effect to the RWP and this is done primarily through the SADC Regional Strategic Action Plans (RSAP), as well as through the implementation of national IWRM plans.

The RSAP has gone through a number of stages of development with the most recent being RSAP III. RSAP I was focused upon creating an enabling environment for water

resource management whilst RSAP II placed its emphasis upon the development of infrastructure. RSAP III is based upon interventions in three strategic areas namely water governance, infrastructure development and water management. In addition the RSAP III focuses upon three strategic objectives namely, capacity development, climate change adaptation and social development. These then provide the basis for a strategic framework that provides nine operational objectives.

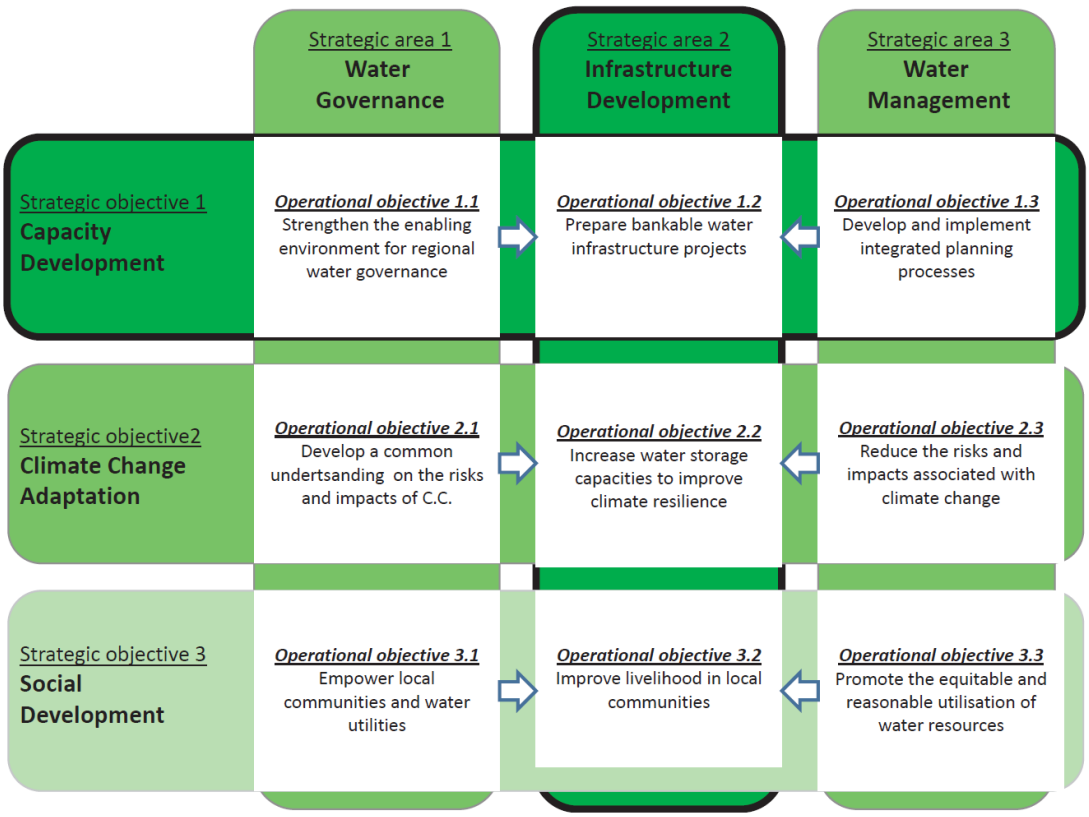


Figure 3-15 : RSAP III Strategic framework providing operational objectives (SADC, 2011)

The RWP and RWS are founded upon the philosophy IWRM and recognise the importance of regional cooperation over water resources and the need to manage water resources in an integrated manner (Malzbender & Earle, 2007), specifically highlighting the need for regional integration (Policy 3.1) as well cooperation between all affected (water use) sectors (Policy 3.3) (SADC, 2005).

The RWP promotes the establishment and development of institutions that engage with stakeholders in water resource management decision-making. The establishment of Shared Watercourse Institutions (SWCI) on each shared watercourse (Policy 9.2.2) is aligned with the provisions of the Revised SADC Protocol, and requires that these SWCI promote stakeholder participation in decision-making (Policy 9.2.8) (Malzbender & Earle, 2007). Stakeholder participation and capacity building are specifically addressed in chapter 10 of the RWP, noting that water resources management and development at all levels shall be based on a participatory approach (Policy 10.1) and that stakeholders need to be supported and empowered to ensure effective participation in such decision-making (10.1.2) (Malzbender & Earle, 2007).

The Revised SADC Protocol on Shared Water Courses

The Revised SADC Protocol provides the basis for transboundary water management in the SADC region. Whereas the RWP and RWS are important guideline documents, the

Revised SADC Protocol is the framework agreement for transboundary water management in the region and does so by providing a suite of generic rules for managing these shared rivers.

The Revised SADC Protocol thus, as a framework agreement provides the general direction and principles for any future watercourse agreements concluded in the SADC region, and importantly allows for a basin to reflect key aspects and characteristics that are pertinent within their own agreement (Ashton et. al., 2006; Beekman and Pietersen, 2008).

The generic provisions of the Revised SADC Protocol are aligned with the provisions of the 1997 UN Convention on Non-navigable Uses of International Watercourses and as such does reflect contemporary international water law. Thus the principles of "equitable and reasonable utilisation" (Article 3 (7)) and the "duty to prevent significant harm" (Article 3 (8)) are aligned to international water law.

In support of the above, an important dimension of the Revised SADC Protocol are the provisions dealing with notification and consultation requirements regarding planned measures and rules on pollution prevention, reduction and control.

THE ORASECOM AGREEMENT OF 2000

This agreement was concluded in November 2000 and was ratified by Botswana, Lesotho, Namibia and South Africa during the same year. However, the Agreement is not expressly based on the Revised SADC Protocol (signed in August of the same year) but reflects in the preamble the original protocol on shared watercourse systems. Interestingly, however, within the agreement there are specific references to the Revised SADC Protocol such as in Articles 7.2 and 7.3 that discuss the terms "equitable and reasonable" and "significant harm".

It is important to note that the objective of the Council is provided as "technical advisor to the Parties on matters relating to the development, utilisation and conservation of the water resources in the River System…" (ORASECOM, 2000). This is further explored in Article 5 of the agreement which then details the matters upon which the Council make recommendations. These are specifically relevant to the Council and it is critical to note that the international legal rules that outline water management in the Orange Senqu basin and the framework within which the Commission needs to provide its advice are contained within the SADC Revised Protocol and the bilateral agreements, and not within the ORASECOM agreement.

NATIONAL WATER POLICIES AND LEGISLATION

Botswana - The 1968 Water Act currently controls the access to and use of water in the country and provides an institutional framework for water allocation and control. However, the on-going water sector reform project will implement far reaching institutional reforms, and prepare new water legislation and tariffs. The Department of Water Affairs has developed a draft National Water and Wastewater Policy for the country in 2010 which is now awaiting approval. The policy is largely based on IWRM principles and therefore will influence IWRM implementation at national level. Botswana is going through lengthy policy revisions and changes which are yet to be approved.

The draft Botswana National Water Conservation (WC) Policy (2004) has implications for water allocation. The Policy provides a prioritisation of different water uses, where water for human consumption, urban and domestic use has top priority followed by water for production, environment, agriculture and livestock. According to the same Policy other uses may be met based on availability of water of a suitable quality after all the above

uses have been met. These uses will be based on cost recovery, efficiency, pollution risk, water requirement, IWRM, cost-benefit ratio and the impact on social equity.

Lesotho – Water Resources Management in Lesotho is governed by the Water Act of 2008. The Act provides for the management, protection, conservation development and sustainable utilisation of water resources. The Water Act is complimented by the Water and Sanitation Policy of 2007. The Water and Sanitation Policy provides strategic guidelines for: sustainable water resources management based on IWRM principles; effective delivery of water supply and sanitation services; measures for protection and conservation of water resources and associated ecosystems; management and use of transboundary water resources with downstream countries in shared watercourses; coordination among all sectors and stakeholders for IWRM; and institutional and regulatory framework of the water sector for implementation of IWRM. Lesotho's legal and policy issues for the water sector have been stable although implementation remains the biggest challenge.

Namibia – Water Resources Management in Namibia is governed by the Water Resources Management Act of 2004. The Act classifies water resources as national assets, and intends to promote the equitable and beneficial use of international watercourses based on general accepted principles and practices of international law among others. The Water Sector is guided by a number of policies developed within the Ministry of Agriculture, Water and Forestry. The existing key water policies include the 2000 National Water Policy (NWP) and the 2008 Water Supply and Sanitation Sector Policy (WSASP), which are in congruence with the IWRM principles. However, some aspects of the policies have not yet been completely implemented. And continued efforts are underway towards the full implementation of the act in a progressive manner. Moreover, new policies that are most urgently required must address the issues of bulk water and end user tariffs, water tariff subsidies and the reduction of bush encroachment to enhance groundwater recharge. Namibia's water sector, policies and legislation have been stable, however there are some challenges in implementing.

South Africa - Water Resources Management in South Africa is primarily governed by the National Water Act (36 of 1998). In terms of Sec 3 of the Act the national government is the public trustee of the nations' water resources and the responsibility for the protection, use, development, conservation and management of water resources vests with the Minister (of Water and Sanitation). The NWA makes provision for only one right to water, the Reserve. This represents the water required for basic human needs and the water required to maintain ecosystem functioning. The NWA provides for the development of a National Water Resource Strategy which provides the implementation roadmap for the NWA towards the protection, use, development, conservation, management and control of water resources for the country as a whole. Furthermore, the Act provides for the development of Catchment Management Strategies, at water management area level, in alignment with the National Water Resource Strategy.

Section 21 of the Act defines eleven types of water uses, including abstraction, storage, stream flow reductions, recreational use, discharge of waste, diverting and impeding flow, controlled activities and altering the bed, banks or characteristics of a water course. All other water use is subject to a four-tiered use authorization/ licensing system defined in Section 22 of the Act as: Schedule One use; General Authorisations; Existing Lawful Use; and Licensed Water Use.

The legislative and policy environment in the water sector in South Africa, like elsewhere in the basin, is stable, but noting the complexity of policy and legislation, implementation remains the biggest challenge.

3.9.2 Institutional aspects

ORASECOM ORGANIZATIONAL STRUCTURE

The highest body of the Commission is the Council which is supported by various Task Teams who manage the projects and a Secretariat. The Council consists of the participating countries, delegations, each having three members. Delegations of the respective member states are from:

- Ministry of Minerals, Energy and Water Resources – Botswana
- Ministry of Natural Resources – Kingdom of Lesotho
- Ministry of Agriculture, Water and Forestry, Namibia, and
- Department of Water and Sanitation (formerly DWA) - South Africa

A Permanent Secretariat has been established with its offices in South Africa. The Commission mostly works through a subcommittees system of legal and technical Task Teams in which the members are technical experts or advisors nominated by each delegation. Their work is facilitated by the Secretariat.

FUNCTIONS AND MANDATE

ORASECOM, through the Council, serves as technical adviser to the riparian countries on the development, utilization, and conservation of the water resources of the basin. The Council serves as the technical advisor to the Parties. It has both "functions" and "powers". The former are about advice and recommendations to the Parties; the latter about appointment of technical experts, ensuring the implementation of the functions and regulating costs. The Commission is mandated to develop a comprehensive perspective of the Basin, study the present and planned future uses of the river system, and determine the requirements for flow monitoring and flood management (Dikobe (Ed), 2013). The main objective is the realization of the principle of equitable and reasonable utilization, as well as the principle of sustainable development with regards to the River System.

It is critical to note that the executive functions remain with the relevant Water Authorities of the four member states.

The following functions were assigned to ORASECOM (Hollingworth, 2007; Dikobe (Ed), 2013):

- A secretariat function related to administration, financial control and technical back stopping to the Commission in order to facilitate its functions;
- A management function related to the provision of support to the joint management of those projects in the basin that are under the auspices of the Commission;
- A coordination function related to harmonizing development activities in the basin and facilitating the participation of all stakeholders in the activities of ORASECOM;
- A communication function related to the maintenance of a comprehensive Database on the basin, with a view to enabling transparent dialogue between the Commission, the scientific community, NGOs and other stakeholders; and
- A screening function related to ensuring the execution of decisions made by the Commission and the assessment of proposals for new activities submitted by a variety of outside interests.

NATIONAL AND LOCAL LEVEL INSTITUTIONS

As noted above the lead national authorities play a critical role in ensuring implementation of policy, legislation and national IWRM plans within their soveriegn borders. Whilst each member state looks to an array of intergovernmental relations with sister departments to give effect to water resource management and development, all in support of social economic development, the key lead departments are:

- Ministry of Minerals, Energy and Water Resources – Botswana
- Ministry of Natural Resources – Lesotho
- Ministry of Agriculture, Water and Forestry, Namibia, and
- Department of Water and Sanitation (formerly DWA) - South Africa

These national departments broadly establish the policy, strategic and regulatory intent of water resource management and development within their respective countries.

Aligned to the philosophy of IWRM and the recognised importance of engagement of stakeholders, the member states are all looking to some form of decentralisation that will see stakeholders increasingly capacitated and involved in the implementation of IWRM. These more localised structures which could be either statutory (as with Basin Management Committees in Namibia or Catchment Management Agencies and Water User Associations in South Africa, for example) or be non-statutory such as stakeholder forums. These more localised structures need to support the implementation of national imperatives, but in so doing should support the implementation of this basin plan.

4. IWRM for the Orange-Senqu River basin – a vision and strategic objectives

4.1 Introduction

As can be seen from the flow chart presented in Chapter 2, development of the Plan is built on a Vision of IWRM for the basin and associated themes and strategic objectives. In this chapter the Vision and strategic objectives are presented together with an overview of how they have been derived through the participation of key stakeholders at the regional and national levels.

4.2 Goals and an IWRM Vision for the Basin

4.2.1 The Vision

Preliminary work by the Consultant, based on an extensive literature review, derived seven key water resources management and development themes, four considered as "central" and three as "cross-cutting.

The four central themes were presented as follows:

- Optimized management of the basins water resources
- Social upliftment and poverty reduction
- Environmental degradation (aquatic and terrestrial environments)
- Disaster management (especially flood and drought, climate change)

The three cross-cutting themes were presented as follows:

- Adequate knowledge base.
- Capacity building and institutional strengthening
- Stakeholder consultation and participation

During October 2013 – January 2014 work was focused on trying to consolidate these themes and to ensure that they reflect an agreed and accepted Vision for the Orange-Senqu Basin. A meeting[3] of the Regional Working Group was held on 16 October 2013 with the main aim being to make progress towards consensus on the Vision and strategic objections that are required to guide further development of the Plan.

Despite the fact that an IWRM Plan for the basin has been on ORASECOM's agenda for many years, a vision of IWRM for the basin remains absent. Such a vision is necessary to provide direction for the IWRM Plan. It is generally agreed that the overall objective for the IWRM Plan; agreed at high-level stakeholder workshop (Windhoek, "Delphi process") in 2011 provides a good point of departure for the visioning process. This, the seven provisional themes already introduced above and an overview of various initiatives,

[3] For all references to RWG and NWG workshops, cross-references and hyperlinks to the workshop documents/minutes will be provided

plans; strategies, agreements and treaties were used by the Regional Working Group to carry out a visioning exercise in Pretoria in October 2013. The details of this process are provided in a comprehensive click here to open full workshop report.

Participants in the workshop first critically examined the seven provisional themes and came up with suggestions for both revisions and additions (see Section 4.2.2). They then developed the goals on which the Vision statement could be based. After some debate and bearing in mind that the Vision (statement) is a vision of the future after the achievement of the goals, a Vision of the Orange-Senqu Basin was agreed as follows:

ORASECOM's Vision for the Orange-Senqu River basin:

A well-managed water secure basin with prosperous inhabitants living in harmony in a healthy environment

There was discussion as to whether there was a need to explore possible amendments or rewording to provide a stronger emphasis on sustainability and development. This could still be considered but it can be argued that "well-managed', "secure" and "prosperous" adequately capture the ideas of sustainability and development.

It should be stressed that the Vision statement does not aim to state how or what has to be done for the envisioned future state to be achieved. The identification of those mechanisms will be achieved through consideration of what actions are required to realise the goals. The above Vision Statement was presented to the ORASECOM Communications and Technical Task Teams in Maseru in November 2013.

Details of the Vision, including justification, targets and potential indicators are detailed in the electronic annexes. It should be stressed that while the IWRM Plan aims to set out actions and activities over the next 10 years only, the timeline behind the Vision is much longer, in the order of 30 to 50 years.

4.2.2 Strategic Objectives

4.2.2.1 Introduction

A number of strategic objectives, the realisation of which should lead to the attainment of the Vision, were developed through a stakeholder-driven process. The details of this process are summarised in the electronic annexes and detailed in a RWG workshop document. Three types of strategic objectives were identified, central, enabling and cross-cutting strategic objectives. They are summarised in Table 4-1.

Table 4-1: Summary of strategic objectives

Central strategic Objectives (CO 1 to 4)	Enabling strategic objectives (EO 1 to 5)	Cross-cutting strategic objectives (X0 1 and 2)
1. Ensure the optimized sustainable management of the basins water resources 2. Support socioeconomic upliftment and eradication of poverty in the basin 3. Ensure that the adverse effects of catchment degradation are reduced and the sustainability of resource use is improved **4.** Maximize security from water-related disasters (especially flood and drought)	1. Put an adequate knowledge base in place 2. Build sufficient capacity and institutional strength 3. Promote high level of stakeholder engagement 4. Ensure appropriate financing mechanisms are in place 5. Promote adaptive management and effective monitoring and evaluation systems.	6. Promote the mainstreaming of adaptation to potential impacts of climate change into planned actions 7. Ensure the mainstreaming of gender considerations into planned actions

4.2.2.2 Towards realising the Strategic Objectives

These strategic objectives represent the core of the Plan and will provide a reference point for the monitoring and evaluation of the Plan's success. It is not possible at this stage to clearly define a complete set of indicators of progress towards realisation of the central strategic objectives, since some of the groundwork for doing this will only be done as part of some of the Plan early actions, In the remainder of this sub-section each of the central strategic objectives is briefly discussed with respect to the areas of progress that will be required in order for these objectives to be achieved. This provides the context for the success indicators that will have to be developed as part of the monitoring and evaluation programme that will be introduced in Chapter 7 of this report. This is only done for the central strategic objectives since it is the realisation of these objectives that will ultimately result in the vision become a reality. However, progress towards the achievement of cross-cutting and enabling strategic objectives is also critical and as indicated in Chapter 7 will form a central part of the monitoring and evaluation programme.

CENTRAL STRATEGIC OBJECTIVE 1: 1. ENSURE THE OPTIMISED SUSTAINABLE MANAGEMENT OF THE BASINS WATER RESOURCES

In many parts of the basin the water resources of the Orange-Senqu are both highly developed and heavily utilized. The development of new infrastructure to meet increasing demand, even if technically and environmentally feasible is both expensive and complex. As a result, it is clear from all standpoints, economic, environmental and for ensuring a high level of reliability (user satisfaction), that the management of the basin's water resources has to be optimized. Indeed the resources and intensive efforts that have been put into the development of the WRYM and WRPM water resources models by the South African DWA, are an indication of how important the issue of optimization is.

The optimized management of the basin's water resources can be supported by:

- An accurate understanding of the available surface and ground water resources under historic, present and future (taking into account climate change) climatic and land use conditions

- The fullest and most informed possible application of water resources and economic modelling tools, including the incorporation of adaptive management approaches applied at the basin-wide and sub-basin levels
- A high level of inter and intra sectoral planning and coordination and the application of IWRM principles at all the appropriate levels

The assessment of progress towards the attainment of this strategic objective will therefore have to take into account progress in these areas. Potential associated indicators are discussed in n Chapter 7 will form a central part of the monitoring and evaluation programme.

CENTRAL STRATEGIC OBJECTIVE 2: SUPPORT SOCIO-ECONOMIC UPLIFTMENT AND ERADICATION OF POVERTY IN THE BASIN

Realisation of this strategic objective could be supported by a wide range of water resources development interventions. The development of water resources can range from something very simple to complex and expensive infrastructure. The common point is that an investment is made to develop or manage the available water resources in order that they can be used to satisfy a development need thus supporting socio-economic upliftment and the eradication of poverty.

While recognising the fact that the waters of the basin are already extensively developed and that further large-scale development would require expensive new infrastructure or changes to the existing, it is nevertheless clear that there is a major need to develop the water resources in some parts of the basin in order to support economic growth and alleviate poverty through the provision of employment and the improvement of services, especially those related to water.

It is important to stress that levels of development around the basin are highly heterogeneous and that the sort of developments that are required in the basin to bring socio-economic benefits and to contribute to poverty eradication will also be very different from one part of the basin to another. In some rural areas and poorer urban areas, access to an improved water supply will be critical, while in others, where these are already a given, the availability of water for irrigation may be the critical action. The sort of water-focussed areas that can contribute to socio-economic upliftment and poverty reduction include the following:

- abstraction and treatment of water for potable water supply for both urban and rural communities (in the basin or close to the basin);
- treatment of waste water for both urban and rural basin's communities;
- improvement/extension of existing potable water supply networks;
- abstraction and distribution of water (water control) for irrigation resulting in improved food security, commercial and employment opportunities in agriculture and agro-processing;
- development of hydropower (benefits extend beyond the basin limits;
- development or conservation of water resources can also lead or support the tourism and recreation activities and create employment opportunities;

Indicators of progress towards the realisation of the strategic objective should reflect progress in these areas. Potential indicators are presented and discussed in Chapter 7 on monitoring and evaluation

CENTRAL STRATEGIC OBJECTIVE 3: ENSURE THAT THE ADVERSE EFFECTS OF CATCHMENT DEGRADATION ARE REDUCED AND THE SUSTAINABILITY OF RESOURCE USE IS IMPROVED

The areas of concern relating to this strategic objective have been addressed by the strategic action programme. Key areas are deteriorating water quality, catchment degradation and Environmental flow requirements. Indicators relating to the realisation of these strategic areas are required.

With respect to water quality, work needs to be done before indicators can be firmly established and this should be carried out early in the Plan to allow these M and E indicators to be further developed. For example, levels of concentration for key water quality variables. Similarly the findings of a follow up on the basin-wide POPs survey will allow the establishment of monitoring guidelines and the identification of what and where for the monitoring of trends of key POPs at the identified high risk areas.

With respect to the problem of land degradation, as highlighted in the TDA and SAP, it is driven by a number of underlying factors lack of integrated planning, insufficient understanding of ecosystems, inadequate policy harmonisation, limited alternative livelihood options, population pressures, land tenure, contradictory statutory and traditional rules and poor rehabilitation practices in construction and mining industries. A conflict of interest between interventions aimed at poverty eradication and ecosystem health is a common issue in all four basin countries, as well as issues around tenure systems and dual grazing rights. Key transboundary elements to this problem include:

- loss of land and infrastructure due to erosion
- decreased wetland storage potential
- reduced groundwater recharge
- reduced water quality in rivers and reservoirs
- increased abundance of alien invasive plants
- decreased potential for land productivity
- poor coordination and lack of integration between development, and water and environmental sectors there are a number of key areas.

In some of the critically degraded areas of the basin, much of the population is rural with many people making a living from subsistence activities coupled with the sale of some excess produce when possible. There is a very close relationship between these activities and the status of the watershed and vice versa. A degraded watershed notably means reduced agriculture productivity and subsequently higher levels of poverty which in turn results in more pressure on the natural resources of the watershed. Stopping and reversing land degradation is therefore critical in both poverty reduction where it's happening and in the reduction of adverse localised and transboundary environmental impacts.. Integrated catchment practices can result in reduced loss of top soil, better soil moisture retention and increased crop yields at the farm level while better water quality, reduced silt load and an improved hydrological regime can be witnessed further downstream. Progress in the implementation and success of these policies will form part of the monitoring and evaluation programme outlined in Chapter 7 of this report.

CENTRAL STRATEGIC OBJECTIVE 4: MAXIMISE SECURITY FROM WATER-RELATED DISASTERS (ESPECIALLY FLOOD AND DROUGHT)

Given high degree of natural climatic variability This issue of drought within the basin has always been present and providing security against drought has been the main priority of water planners. While the impacts of climate change on precipitation over the source areas of the basin are not yet clear, a basin-wide general increase in temperature and

decrease in precipitation over the rest of the basin are inarguable. An increase in rainfall variability is also highly likely. These factors, combined with an increased demand will mean that the risk of drought will continue to be present and that providing security against it will remain the key challenge for water resources planners.

While drought and water shortage are the predominant challenges, the risk of localised flooding is also likely to increase with climate change. Flooding problems in the lower reaches of the range-Senqu River have been a regular occurrence although their magnitude has been mitigated by the large reservoirs upstream. More extreme rainfall events may increase this challenge as well.

With respect to maximising security from especially drought, there are two main areas of concern.

- rural areas where much of the population are rainfed (commercial and subsistence) farmers. Here the effects of drought and flood can be devastating since in most cases farmers have little to fall back on in the event of crop failure, damage or livestock losses. Providing security has to come in the form of a range of water and non-water related adaptation and resilience measures.
- users who are dependent on the regulated surface water resources of the Orange-Senqu River system. The availability of water for urban water supply, industry, mining, the energy sector and irrigation is largely dependent on how much water is stored in the many reservoirs around the basin. Providing security against drought can be achieved through the provision of adequate reservoir storage and the optimised management of this storage.

Measuring progress towards the achievement of this strategic objective will require looking at indicators that deal with these two areas. A set of preliminary indicators is included in Chapter 7 of this report

4.3 Scenarios, Uncertainty Analysis and Plausible Futures

Ultimately, basin planning has to understand the current water resource management context, identify issues and challenges that may emerge into the future and then provide a range of management initiatives to ensure that the resources are effectively and efficiently managed into this uncertain future.

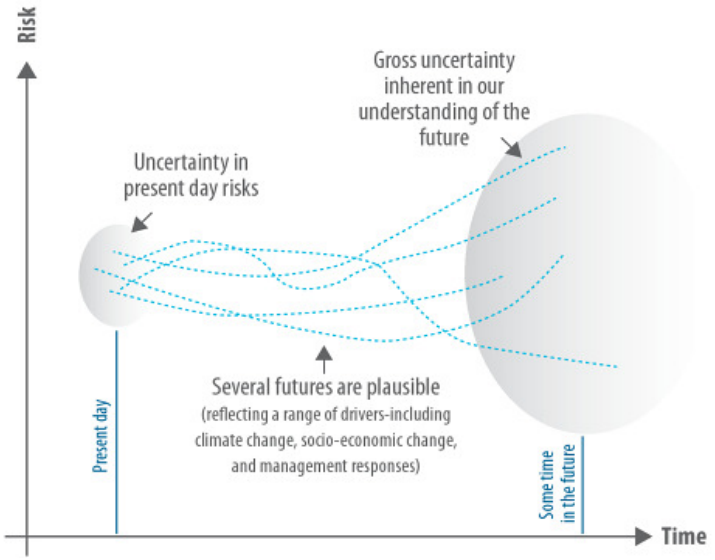
The social economy has become increasingly complex and globalised, and there is an increasing level of uncertainty in terms of predicting the future. Our ability to forecast the future with any degree of certainty, and therefore to make appropriate planning decisions (new infrastructure etc) has become more and more difficult. As a result, basin planning needs to consider the various uncertainties and develop a range of possible management responses that can underpin the effective management of water resources under a range of different futures (Pahl-Wostl, Sendzimir, Jeffry, Aerts, Berkamp and Cross, 2007; Pegram, Li, Le Quesne, Speed, Li and Shen, 2013).

The importance of water resource management in the broader social economy is being better understood across the globe. Water can constrain or catalyse development. Climate variability is already a key element of the management regime within the basin but the rapid growth that is being experienced in many parts of the world creates a level of complexity that requires more flexibility in our management regimes.

Within the Southern African region there are a range of longer term uncertainties that need to be considered when considering the management of the Orange Senqu basin. These include:

- Climate: The impacts of climate change on rainfall, temperature and the potential for more variability in terms of extreme events.
- Agricultural production: Due to shifts in climate the nature of agricultural production in parts of the basin may shift.
- Energy: The rate at which the global economy shifts towards decarbonising will have impacts upon the mix of coal based energy and those based upon renewable energy forms. This could impact upon water demands.
- Settlement patterns: The rate of urbanisation is placing significant challenges on resources and infrastructure and this can only be expected to continue. The need to ensure rural development and improve livelihoods is a key consideration.
- Regional integration: The degree to which we move towards regional integration will influence trade, agriculture, energy production, and migration patterns.

This requires planners to recognise that there are unknown futures that may have a range of change implications, and hence the risks associated with these changes need to be outlined. In developing content, it is necessary to work with a developing suite of goals, objectives and outcomes that are contextualised against a longer term vision. From a process perspective there needs to be a suite of initiatives that allow for ongoing alignment in planning, programmes and implementation actions. These, importantly, all take place at various levels, but need to fit in with the overall strategic intent (Pegram et al, 2013).



Noting the longer term nature of uncertainties, it is therefore imperative to have a longer term vision for the management of water resources within the basin. Towards this vision, planning for the nearer future is required on a five year cycle that is supported by annual business plans that are monitored and refined. (Pegram et al., 2013).

Figure 4-1: The nature of uncertainty over time

This adaptive management regime enables the flexibility to make changes as conditions (environmentally, economically, socially, financially, politically) change and to respond appropriately to unforeseen events. This is underpinned by monitoring and importantly by social learning.

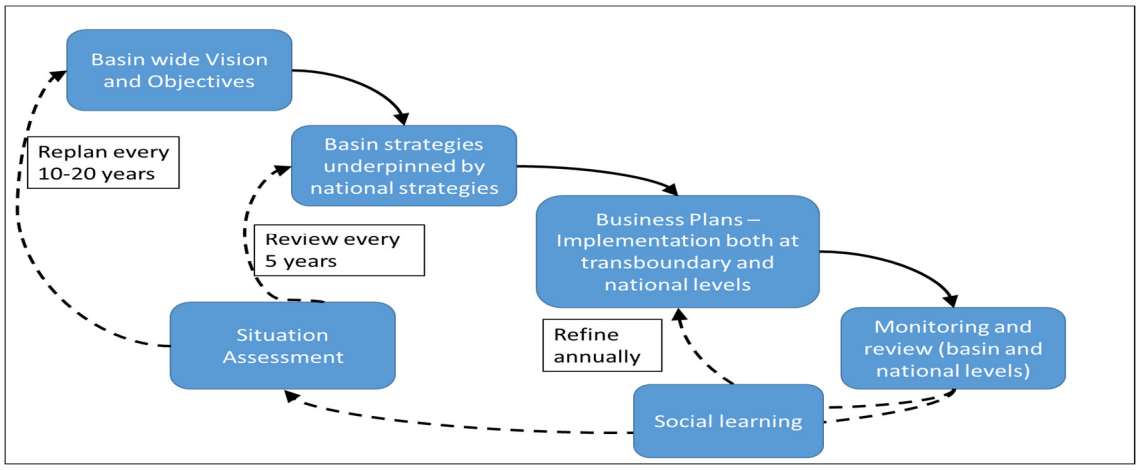


Figure 4-2: Adaptive planning process (adapted from Pegram et al., 2013)

With the aforementioned complexities in mind. It is important to recognise the value of highlighting a range of potential future scenarios regarding climate, agriculture, energy, settlement patterns and regional integration in the Orange-Senqu. Without being able to decide on a particular future with certainty, understanding the economic, social and environmental impacts of each future will help in the development of a strategy to fulfil or avoid particular futures.

The use of scenarios is particularly useful when looking at water demands into the future. By exploring different futures under a range of water use and demand scenarios, potential effects on the sectors using the water resources may be anticipated. It is of adequate water quality and quantity are recognised when carrying out these scenarios.

The use of scenarios to explore different supply and demand options is supportive of an adaptive management process. It is critical that water resources management are managed in an adaptive manner, as the level of uncertainty regarding a range of factors such as climate, economic development or regional integration may change the status quo, making the management framework outdated. Principles of adaptive management include:

- use responses that do not foreclose on future options or unnecessarily constrain future choice
- use responses that are effective under a range of possible futures
- monitor sufficiently to assess change and its impacts on the future scenarios
- modify policy, strategy and planning structures to adequately deal with the changing future

The Orange-Senqu is now within a phase whereby decisions need to be cognisant of the competing water users and what potentially decreasing particular sectors' water availability may result in.

5. The IWRM Plan – the strategic framework

5.1 Introduction

Up to this point the development of the IWRM Plan has been entirely strategic in nature. In this chapter the process moves from the theoretical and strategic to action. The aim is to develop first the broad action areas and then the strategic actions required to meet the strategic objectives of the Plan.

In this chapter the process of Plan development moves from the theoretical and strategic to action. The aim is to develop first the broad action areas and then the strategic actions required to meet the strategic objectives of the Plan. The various targets and interventions as proposed in the environmental sustainability Strategic Action Programme (SAP) and country level National Action programmes (NAPs) are also discussed and integrated into the IWRM Plan. The aim is to have a single plan, which includes an environmental component largely defined by the UNDP/GEF SAP and NAPs.

5.2 Identifying the Strategic Actions

5.2.1 Introduction

As with the identification of the strategic objectives, the process followed in identifying action areas, strategic measures and strategic actions and first ideas on specific actions was stakeholder-driven and used SWOT (strengths-weaknesses-opportunities-threats) analyses carried out at regional and national level workshops between October 2013 and early February 2014. The full details of the SWOT analyses carried out are presented in the respective workshop reports.

5.2.2 Action areas and strategic actions

An analysis of the outputs of each of the workshops resulted in a preliminary identification of more than 30 strategic actions under the three central strategic objectives. These were discussed at regional and national working group workshops in March/April 2014 where it was agreed that they should be consolidated and streamlined. The Consultant team then worked further on this. After considering several options and also taking into account the need to integrate the targets and implementation areas (and projects) proposed un the UNDP/GEF SAP and NAPs, it was concluded that it was better to identify a comprehensive but limited number of "**action areas**" and then to organise the strategic actions under these.

Table 5-1 summarises the 12 main action areas and the strategic actions that fall under each action area. The action areas are organised under the strategic objectives that they most strongly relate to.

Table 5-1: Main action areas, strategic actions and relationship to strategic objectives

Strategic Objective (see Section 4.2.2)	Main Action Areas	Strategic Actions
1. Ensure the optimised sustainable management of the basins water resources	1.1: Surface and groundwater assessments	1.1.1: Update hydrology for catchments as required
		1.1.2: Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields and other characteristics)
	1.2: Optimising efficient utilisation, development, adaptive management of water resources	1.2.1: Utilisation of an adaptive management approach including application and continuous/regular use of surface and groundwater resources planning/allocation tools (e.g. WRPM), including proactive, transparent and coordinated approach with empowered regional participation
		1.2.2: Planning (reconnaissance, Investigation, feasibility study, design of water resources development and management infrastructure)
		1.2.3: Implement water demand management (WDM) and water conservation (WC) in agriculture and wildlife management
		1.2.4: Implement water demand management (WDM) and water conservation (WC) in domestic, industrial and mining water supply
	1.3: Inter/Intra-sectoral planning and coordination (Horizontal and vertical alignment)	1.3.1: : Promote transboundary inter-sectoral planning and coordination in order to support cost-effective and sustainable development of water and associated natural resources
		1.3.2: Promote (facilitate development of) intra-sectoral (water sector) planning and coordination in order to support cost-effective and sustainable development of water resources
2. Support socio-economic upliftment and eradication of poverty in the basin	2.1: Equitable utilisation of (the basin's) water resources	2.1.1: Review and agree on definitions in the context of the Orange-Senqu Basin and set out guidelines and procedures to improve equitable utilisation and benefit sharing at the basin level
		2.1.2: Implement procedures to improve equitable utilisation and benefit sharing at transboundary and national levels
	2.2: Water resources development	2.2.1: Improve sustainable access to improved water supply and sanitation in urban and rural environments
		2.2.2: Develop water resources for supply to economic development sectors, especially those supporting employment opportunities
		2.2.3: Ensure optimised availability of water for strategic use areas (power, industry, etc)
3. Ensure that the adverse effects of catchment degradation are reduced and the sustainability of resource use is improved	3.1: Improving water resources quality	3.1.1: Set and agree on basin-wide water resources quality objectives
		3.1.2: Management of the increasing salinity of the system
		3.1.3: Management of Eutrophication
		3.1.4: Understand the extent and impacts of persistent organic pollutants (POPs)
	3.2: Catchment degradation, watershed management, settlement and land-use planning	3.2.1: Planning, prioritizing and promotion of multipurpose watershed management interventions around the basin
		3.2.2: Implementation of sustainable livelihood-based integrated catchment management programmes in degraded parts of the catchment based on the taking to scale of pilot demonstration projects
		3.2.3: Management and control of alien species
	3.3: Environmental water requirements	3.3.1: Basin-wide implementation and monitoring and evaluation programme for agreed preliminary EFRs according to chosen water resources management and development scenario
		3.3.2: Management of the Orange-Senqu Mouth
		3.3.3: Improve knowledge of EFRs, including capacity building, updating of EFRs, and basin-wide implementation
4. Maximise security from water-related disasters	4.1: Flood and drought mitigation, extreme events, climate proofing	4.1.1: Improve knowledge, understanding and communication of extreme events
		4.1.2: Mainstreaming of climate-adaptation into the design of development activities
		4.1.3: Mainstreaming of climate-adaptation into drought and flood mitigation Mainstreaming of climate-proofing into drought and flood mitigation

Strategic Objective (see Section 4.2.2)	Main Action Areas	Strategic Actions
5. Put an adequate knowledge base in place	5.1: Water resources and associated environmental data and information	5.1.1: Improve reliability, usefulness, trans-boundary confidence and areal coverage of surface water monitoring networks at the transboundary and national (sub-catchment) levels
		5.1.2: Improve water resource focused climate (change) monitoring
		5.1.3: Improve reliability, usefulness, transboundary confidence and areal coverage of groundwater monitoring networks at the transboundary and national (sub-catchment) levels
		5.1.4: Improve reliability, usefulness, transboundary confidence and areal coverage of water quality monitoring networks at the transboundary and national (sub-catchment) levels
		5.1.5: Integration of water resources and related environmental data through development of Water Information System (WIS)
	5.2: Water use and demand data and information	5.2.1: Improve monitoring and reporting of water usage and return flows at national and transboundary levels
		5.2.2: Increase permit/licence coverage, reduce illegal abstraction and other losses, improve monitoring, control and enforcement
		5.2.3: Update projected demands and consideration of possible plausible futures
6. Build sufficient capacity and institutional strength	6.1-11.1: Promotion/ maximising mainstreaming of key cross-cutting and enabling actions	6.1.1: Ensure effective capacity building at various levels in all appropriate action areas 6.1-6.3
		6.1.2: Ensure effective policy, legal and institutional arrangements
		6.1.3: Sharing of research and knowledge in areas to support sustainable water resources development and management
7. Promote high level of stakeholder engagement		7.1.1: Ensure appropriate and effective stakeholder participation for implementation of all areas of the Plan.
		7.1.2: Mainstream the promotion of transboundary cooperation into all appropriate actions
8. Ensure appropriate financing mechanisms are in place		8.1.1: Ensure adequate financing mechanisms and funding
9. Promote adaptive management and effective monitoring and evaluation systems		9.1.1: Ensure that effective and appropriate monitoring and evaluation systems are in place
10. Promote the mainstreaming of adaptation to potential impacts of climate change into planned actions		10.1.1: Promote the mainstreaming of adaptation to climate change into all areas
11. Ensure the mainstreaming of gender considerations into planned actions		11.1.1: Ensure appropriate and effective mainstreaming of gender considerations into planned and ongoing actions

5.2.3 Integration of UNOPS/GEF Strategic and National Action Programmes

5.2.3.1 Overview

Work on development of the Orange-Senqu Environmental Sustainability Strategic Action Programme (SAP) and associated National Action Programmes (NAPs) came to an end in early 2014. They represented the end point in the work that started with the compilation of a preliminary transboundary diagnostic analysis (TDA) and a full TDA, completed in 2013.

The SAP and NAPs (covering actions at the national, Botswana, Lesotho, Namibia, South Africa levels), like the IWRM Plan, are developed for a 10-year planning time span with targets set for that period. While the IWRM Plan is a comprehensive plan dealing with a wide range of water resources management and development issues pertinent to the basin, "*the SAP and NAPs primarily concentrate on priority environmental issues and combined they form the environmental core component of the IWRM Plan*".

The SAP, as well as the NAPs in each country, are structured around the four environmental priority areas of concern identified in the TDA:

- Declining water resources quality
- Changes to the hydrological regime
- Land degradation.
- Increasing water demand

The first three of these will fall clearly under the environmental component of the IWRM Plan, although there are implications on wider development concerns as well. While the issue of increasing water demand has major environmental implications, it also has implications across all development sectors and will cut across several components of the IWRM Plan. The challenge will largely be met through the water resource modelling work, water demand management and other interventions, which will be handled under specific strategic action areas of the IWRM Plan.

The SAP defines technical and management interventions to address the TDA's four areas of concern, with a focus on transboundary and/or common environmental concerns, i.e. those that can only be addressed through collective action of more than one, or even all, basin states. The SAP is aligned with the NAPs of the four basin states. The NAPs prioritise the environmental concerns identified by the TDA from a national perspective and identify suitable responses that can be implemented at national level only. **Together, the SAP and the four NAPs provide a comprehensive programme to address the identified priority areas of environmental concerns at basin and national levels.**

In compiling the IWRM Plan an effort has been made to integrate the SAP and NAPs as seamlessly as possible and to preserve the integrity of the actions specified in the SAP (and NAP) documentation. This is important since many of these actions, drawn up as they are in a specific "GEF format", are aimed at obtaining funding support from the GEF and/or other ICPs. They already form part of an endorsed SAP document to be taken forward as a key document in the search for funding. The aim therefore has been to:

- Ensure that the SAP and NAP actions have a logical place in the overall IWRM Plan
- Preserve the integrity of the way in which the various actions (especially in the SAP/NAP "concept notes") are presented in order not to complicate potential ongoing GEF support.

In most cases this has been possible. Where adjustments have been made, this has be highlighted and explained.

For each of the four priority areas In the SAP and NAPs there is an associated objective and a number of targets (up to 5). For each target a number of interventions are proposed. Some of these interventions are then detailed in the form of "concept notes" at the transboundary and/or national levels. These concept notes are effectively ***scopes of work*** with associated budgets. It is these concept notes and the actions/activities defined within them, that have been integrated in the detail of the IWRM Plan as presented in Chapter 6.

In the following sub-section the **targets** and **associated interventions** for each of the SAP/NAP **priority areas** are briefly discussed in terms of how they best fit into the overall structure of the IWRM Plan. The aim is to indicate under which action area they fall and with which strategic action they should be associated, bearing in mind that the strategic actions have in any case been defined with due consideration of the SAP.

5.2.3.2 Integration of SAP/NAP interventions into the IWRM Plan

SAP/NAP Priority Area 1 : Increasing Water Demand

The objective under this area is that "***the basin-wide understanding of available resources is further enhanced and water-use efficiency improved".*** The five targets and associated interventions are summarised in Table 5-2 together with how they are integrated into the IWRM Plan.

Table 5-2: Integration of targets and interventions under SAP/NAP Priority Area 1: Increasing water demand

SAP/NAP Targets and proposed Interventions	NAP/SAP Project Concept Note (PCN)
Target 1: Improved basin-wide hydrometeorological and geohydrological monitoring systems are established and data shared by the member states **Proposed Interventions: Water monitoring (quantity and quality) networks of rainfall, flow, groundwater levels and water metering improved; data captured, analysed, modelled and findings distributed**	**SAP PCN 1: ORASECOM information and knowledge Management:** ***Outcome 1****: Basin -wide environmental monitoring networks established and maintained;* ***Outcome 2****: Technical guidelines for data exchange and sharing developed* ***Outcome 3****: ORASECOM WIS enlarged and maintained* ***Outcome 5****: Capacity development for water resources practitioners*
These outcomes are integrated under **Action Area 1** of the IWRM Plan**, *Water (and natural) resources data and information*** and ***Action Area 12, Ensure effective capacity building at various levels in all appropriate action areas***	
Target 2: Recommendations for transboundary environmental assessments are developed, reviewed, refined and adopted by the basin (member) states *Basin-wide transboundary environmental assessment guidelines developed*	**SAP PCN 1: ORASECOM information and knowledge management** ***Outcome 4****: ORASECOM recommendations for transboundary environmental assessment applied by basin states and* ***Outcome 5*** *Capacity development for water resources practitioners*
These outcomes are integrated under **Action Area 7** of the IWRM Plan**, *Environmental water requirements***	
Target 3: Pilot initiatives for improving on-farm water efficiency are upscaled and implemented in priority areas *Establish appropriate technology to measure water abstraction effectively and accurately* *Develop appropriate incentives to motivate irrigators to improve water-use efficiencies* *Develop awareness-raising and training programmes on irrigation water demand management and water-use efficiency approaches*	**Namibia NAP PCN 3:** Water conservation and demand management in the irrigation sector **South Africa NAP PCN 4**: Water conservation and demand management in the irrigation sector
These outcomes are integrated under **Action Area *5*** of the IWRM Plan***; Optimising efficient utilisation, development, adaptive management of water resources***	

SAP/NAP Targets and proposed Interventions	NAP/SAP Project Concept Note (PCN)
Target 4: Potential for alternative options to meet water demand (increased storage, demand management, expanded wastewater treatment, conjunctive re-use or surface and groundwater, etc.) in the basin have been defined *Integrate the management and use of groundwater and surface water resources*	**SAP PCN 2: Groundwater management and use** ***Outcome 1**: Understanding of groundwater resources in the basin enhanced* **Botswana NAP PCN 2**: Improved fresh water availability and knowledge of groundwater potential **Lesotho NAP PCN 4**: Improvement of groundwater management in selected aquifers within the Central Mohokare sub-catchment **Namibia NAP PCN 1**: Improving groundwater resources management to enhance water supply in the Nossob–Auob sub-basin **Namibia NAP PCN 2**: Improving water-use efficiency and demand management in local authorities
These outcomes are integrated under **Action Area 1, *Water (and natural) resources data and information;* Action Area 5 *Optimising efficient utilisation, development, adaptive management of water resources*** and **Action Area 3, *Surface and groundwater assessments* of the IWRM Plan**	
Target 5: Understanding of groundwater use potential enhanced and efficiency of use improved *Identify the threats and issues to groundwater resources that need to be alleviated by basin-wide management* *Identify and agree on a uniform groundwater resources management system* *Establish shared governance of the groundwater resources within the basin*	**SAP PCN 2: Groundwater management and use** ***Outcome 2**: Groundwater governance and management in the basin improved* **Botswana NAP PCN 2**: See above **Lesotho NAP PCN 4**: See above **Namibia NAP PCN 1**: See above
These outcomes are integrated under **Action Area 5 of the IWRM Plan, *Optimising efficient utilisation, development, adaptive management of water resources***	

SAP/NAP Priority Area 2 : Declining Water resources Quality

The objective under this area is that ***"the water resources quality within the basin is improved".*** The three targets and associated interventions are summarised in Table 5-3 together with how they are integrated into the IWRM Plan.

Table 5-3: Integration of targets and interventions under SAP/NAP Priority Area 2: Declining water resources quality

SAP/NAP Targets and proposed Interventions	NAP/SAP Project Concept Note (PCN)
Target 1 Basin-wide water resources quality objectives defined and monitoring system established *Basin-wide water resources quality guidelines developed Basin-wide water resources quality monitoring regime refined, agreed and implemented*	**SAP PCN 1: ORASECOM information and knowledge Management:** ***Outcome 1**: Basin -wide environmental monitoring networks established and maintained* ***Outcome 2**: Technical guidelines for data exchange and sharing developed* ***Outcome 3**: ORASECOM WIS enlarged and maintained* ***Outcome 5**: Capacity development for water resources practitioners* **South Africa NAP PCN 1**: Monitoring priority chemical pollutants
These outcomes are integrated under **Action Area 1 of the IWRM Plan, *Water (and natural) resources data and information*** **and Action Area 11, *Improving water quality*** and **Action Area 12, *Promotion/ maximising mainstreaming of key cross-cutting and enabling actions* of the IWRM Plan**	
Target 2: Tools/incentives for reduced agrochemical application in the agriculture sector developed and implemented in pilot areas	**South Africa NAP PCN 2:** Mitigation of impact of agricultural sector on water quality
These outcomes are integrated under **Action Area 11 of the IWRM Plan, *Improving water quality***	
Target 3: Innovative methods for water quality improvements identified and implemented in pilot sites	**Botswana NAP PCN 4**: Treatment and re-use of wastewater **Lesotho NAP PCN 2:** Management of water resources quality in Central Mohokare sub-catchment **Namibia NAP PCN 4:** Improvement of water quality management and pollution control **South Africa NAP PCN 3**: Support for wastewater treatment upgrade

SAP/NAP Targets and proposed Interventions	NAP/SAP Project Concept Note (PCN)
These outcomes are integrated under **Action Area10, *Water resources development*** and **Action Area 11, *Improving water quality*,** of the IWRM Plan	

SAP/NAP Priority Area 3 : Changes to Hydrological Regime

The objective under this area is that *"the adverse effects of the changed hydrological regime are mitigated"*. The two targets and associated interventions are summarised in Table 5-4 together with how they are integrated into the IWRM Plan.

Table 5-4: Integration of targets and interventions under SAP/NAP Priority Area 3: Changes to hydrological regime

SAP/NAP Targets and proposed Interventions	NAP/SAP Project Concept Note (PCN)
Target 1 Basin-wide environmental flows regime agreed and implementation ongoing *Synchronise existing environmental flows studies* *Refine and agree on basin-wide environmental flows scenarios* *Agreed scenarios implemented and monitored on ongoing basis*	**SAP PCN 3: Basin-wide environmental flows regime:** ***Outcome 1**: Existing E-flows work harmonised and integrated.* ***Outcome 2**: Basin-wide E-flows regime agreed through consultative process* ***Outcome 3**: Setting up, implementation and compliance monitoring of basin-wide flows regime supported* **South Africa NAP PCN 1**: Monitoring priority chemical pollutants
These outcomes are integrated under **Action Area 7, *Environmental water requirements*, Action Area 11, *Improving water quality* and Action Area 12, *Promotion/ maximising mainstreaming of key cross-cutting and enabling actions*** of the IWRM Plan	
Target 2: Integrated management plan for the river mouth (Ramsar site) developed and implementation ongoing *Remove man-made structures in the floodplain and mouth area of Orange–Senqu River* *Align fishing legislation and compliance initiatives on both South African and Namibian sides of the estuary* *Verify the origin of the elevated nutrients below Vioolsdrift/Noordoewer and implementing agricultural best practice to reduce input*	**SAP PCN 4: Orange-Senqu River mouth management:** ***Outcome 1**: Natural floodplain function and marked improvement in estuarine habitat condition restored* ***Outcome 2**: Status of over-exploited/collapsed estuary species improved* ***Outcome 3**: Nutrient input from agricultural area(s) below Vioolsdrift reduced*
These outcomes are integrated under Action Area 7, *Environmental water requirements*, Action Area 11, *Improving water quality* and Action Area 12, *Promotion/ maximising mainstreaming of key cross-cutting and enabling actions* of the IWRM Plan	

SAP/NAP Priority Area 4 : Land Degradation

The objective under this area is that *"the adverse effects of catchment degradation are reduced and the sustainability of land use is improved"*. The four targets and associated interventions are summarised in Table 5-5 together with how they are integrated into the IWRM Plan.

Table 5-5: Integration of targets and interventions under SAP/NAP Priority Area 4: Land degradation

SAP/NAP Targets and proposed Interventions	NAP/SAP Project Concept Note (PCN)
Target 1 Local level monitoring systems for rangeland conditions (including alien invasive species) developed and implemented *Development of rangeland monitoring indicators* *Establishment of rangeland monitoring system*	**SAP PCN 1: ORASECOM information and knowledge Management:** ***Outcome 1**: Basin -wide environmental monitoring networks established and maintained* ***Outcome 2**: Technical guidelines for data exchange and sharing developed* ***Outcome 3**: ORASECOM WIS enlarged and maintained* ***Outcome 5**: Capacity development for water resources practitioners)*
These outcomes are integrated under Action Area 1 of the IWRM Plan, *Water (and natural) resources data and information,* Action Area 4*, Catchment degradation, watershed management, settlement and land-use planning* and Action Area 12*, Promotion/ maximising mainstreaming of key cross-cutting and enabling actions* of the IWRM Plan	
Target 2: Catchment protection initiatives upscaled and implemented in priority areas across the basin *Strengthening of institutional frameworks for effective catchment management* *Rehabilitation of degraded rangelands and wetlands* *Improvement of ecosystem services functioning of catchments*	**SAP PCN 4: Orange-Senqu River mouth management** ***Outcome 2**: Status of over-exploited/collapsed estuary species improved* **SAP PCN 5: Control of alien invasive species** ***Outcome 1**: Priority areas identified and selected* ***Outcome 2**: Alien vegetation cleared in prioritised areas* **Botswana NAP PCN 3**: Conservation and sustainable land Addressing: Sustainable natural resources use practices for livelihoods improvements **Botswana NAP PCN 5**: Integrated community-based natural resources management for Kgalagadi District (OSB) **Lesotho NAP PCN 1**: Integrated catchment management in the lower Mohokare sub-catchment **Lesotho NAP PCN 3**: Upscaling of the ORASECOM demonstration rangeland management project for sustainable management of Letšeng-la-Letsie (Ramsar site) **Namibia NAP PCN 5:** Control of invasive species through integrated management in a pilot area in the Orange–Fish River basin, Namibia **Namibia NAP PCN 6**: Alternative land-use options for improved rangeland conditions and sustainable livelihoods **South Africa NAP PCN 5**: Complementary support for LandCare Programme
These outcomes are integrated under **Action Area 4*, Catchment degradation, watershed management, settlement and land-use planning*** and **Action Area 12*, Promotion/ maximising mainstreaming of key cross-cutting and enabling actions*** of the IWRM Plan	

5.3 DEVELOPMENT AND MANAGEMENT SCENARIOS

5.3.1 Introduction

The final part of the strategic framework for the IWRM Plan is the choice of a development and management scenario that will be at the core of the plan.

There is sometimes confusion around the use of the word "**scenarios**". In the remainder of this section the term is used to refer to **different combinations of water resources development and management options** that may be proposed to best cater for future needs. This is quite different from the concept introduced in the presentation on scenarios and uncertainty analysis. This concept is important and provides a context against which the development and management scenarios should be developed.

Several studies recently conducted by DWAs of RSA, Namibia and Lesotho provided key information to be used as basis for the definition of the selected or core scenario that represents the most likely developments within the Orange-Senqu system over the next 10 to 15 years.

These included the following studies:

- Vaal River System Large Bulk Water Supply Reconciliation Strategy Study (RSA).
- The implementation of the Reconciliation Strategy for the Vaal River System (RSA)
- Development of Reconciliation Strategies for Large Bulk Water Supply Systems: Orange River Study (RSA)
- Water Reconciliation Strategy Study for the large bulk water supply systems: Greater Bloemfontein Area (RSA)
- The implementation of the Reconciliation Strategy for the large bulk water supply systems: Greater Bloemfontein Area (RSA)
- Metolong Dam development related reports (Lesotho).
- Neckartal Dam development related reports (Namibia).

Results from these studies showed that most of the large schemes will soon be in deficit and some were already were. The reconciliation strategy studies specifically focused on the identification and development of the most viable intervention options to maintain a positive water balance in these water supply schemes over the next 20 to 30 years.

As a first step in the process to develop and define realistic scenarios for modelling purposes in support of the IWRMP, the available study reports were scrutinised and all the proposed development and management actions forming part of the individual reconciliation strategies of the main sub-systems, were obtained and listed. For each of these options brief descriptions were included in summary tables along with a description of the purpose of these options and the possible impacts of each option on the system. These proposed development and management options are the most likely ones to be implemented in future, as they are driven by the respective departments of water affairs from the different basin states.

The respective reconciliation strategies were presented at the ORASECOM Regional Working Group in Botswana on 5 and 6 March 2014. This information was then work shopped in group sessions to derive at realistic trial scenarios for modelling purposes in support of the IWRMP and to form the basis for the development of a selected core scenario. The core scenario needs to represent the most likely developments expected to occur in the basin over the next 10 to 15 years. These trial scenarios and related results

were discussed in follow up RWG and NWF workshops/meetings which finally resulted in the formulation of the core scenario. The core scenario will form the basis for WRPM setup that includes these expected developments and can then be used to evaluate the future developments as well as possible deviations from that and the related impacts of them on the Orange-Senqu Basin over the next 10 years.

5.3.2 Most likely future development options

INTRODUCTION

Several actions within the Integrated Vaal and Integrated Orange/Senqu systems were already put in place to maintain an assured supply to the associated users. These actions or intervention options all originated from the Reconciliation Strategy studies as mentioned in Section 5.3.1 and represent the initial intervention options that were already activated or will very soon be in activated.

These actions or intervention options include the following:

- Removal of unlawful irrigation in the Upper Vaal.
- The neutralising of mine water outflows relating to the acid mine drainage (AMD) problem in the Vaal River.
- Water conservation and water demand management activities mainly focussed on urban/industrial sector within the Integrated Vaal system.
- Water conservation and water demand management activities focussed on urban/industrial and irrigation sectors within the Integrated Orange Senqu system.
- Water conservation and water demand management activities mainly focussed on urban/industrial sector within the Greater Bloemfontein system.
- The initial increase in the Tienfontein pumping capacity to 3.87 m^3/s and the Novo Transfer scheme capacity to 2.2 m^3/s as recommended in the Greater Bloemfontein Reconciliation Strategy study. This sub-system is used to supply water to Bloemfontein, Mangaung, Botshabelo, Thaba Nchu and several other small towns in the Free State.

Several other intervention options were identified to be developed and or activated in the medium to long-term future.

5.3.3 Selected Core Scenario

5.3.3.1 Overview

The baseline scenario that reflects the current system with only the existing water resource and water supply related infrastructure in place, was used as the basis or point of departure for the development of the selected core scenario. A detail description of the baseline scenario as used for system analyses purposes, is provided in the electronic annexes.

The following intervention options were already captured in the baseline scenario.

- The removal of the unlawful irrigation was one of the urgent matters included in the Final Strategy prepared for the Integrated Vaal System. The process has already been put into action and currently (2013) 66% of the unlawful irrigation has been removed. For the purpose of the baseline scenario it was accepted that these irrigation areas in the Vaal will be at lawful plus 34% at the start of the analyses. It was assumed that further eradication takes place according to the latest information from the "Maintenance of the Vaal River Reconciliation Strategy" study, which is currently in process.
- Current and planned neutralising of mine water outflows was included. This is the first step in the intervention option to address the acid mine drainage (AMD) problem. The timing of the planned neutralising is according to latest information from the "Implementation of the Vaal River Reconciliation Strategy" study.
- The initial increase in the Tienfontein pumping capacity to 3.87 m^3/s and the Novo Transfer scheme capacity to 2.2 m^3/s as recommended in the Greater Bloemfontein Reconciliation Strategy study and refined as part of Greater Bloemfontein Reconciliation Strategy Implementation study.
- Water conservation and water demand management activities mainly focussed on urban/industrial sector in the Integrated Vaal, the Orange and Greater Bloemfontein supply systems.

The selected Core Scenario includes all the components already defined for the baseline scenario plus the following:

- Metolong Dam start to store water from May 2014 and deliver water to users in May 2015.
- Neckartal Dam start impounding water in May 2016. The first water is delivered to irrigation in May 2017 with the full irrigation development in place and supplied from 2024 onwards. The EFR just downstream of Neckartal Dam is supplied from Neckartal from May 2016.
- Re-use and desalination of mine water effluent to address the AMD in the Upper/Middle Vaal area. This was modelled to start in July 2018 reaching its full capacity of 43.2 million m^3/a by May 2019.
- Real Time flow modelling and monitoring in the Lower Vaal downstream of Bloemhof Dam and in the Orange River downstream of Vanderkloof Dam to the Orange River mouth. In the Core Scenario this intervention option was activated from May 2016 and results in reducing the operating losses by 80 million m^3/a.
- Botswana water supply through Vaal Gamagara Scheme. Transfer 5 million m^3/a to Botswana villages located close to the South African border from 2022/23 onwards.
- Utilise the lower level storage in Vanderkloof Dam from May 2021 onwards. This will increase the yield available from Gariep and Vanderkloof dams by 137 million m^3/a.
- Polihali Dam (Lesotho Highland Water project (LHWP) Phase II and connecting tunnel to Katse Dam. Polihali Dam start to store water from May 2022 and deliver the first water to the Vaal from May 2023. The increased volume transferred to the Vaal from Polihali is based on the expected deficit in the Vaal system at the time, and is only a small portion of the yield available from Polihali Dam.
- Polihali Dam is used to also support Gariep Dam from May 2023 onwards. The operating rule used, gave priority to the transfer in support of the Vaal system and limit the volume used to support Gariep Dam to the Polihali yield minus that transferred to the Vaal from Polihali Dam. The volume transferred from Polihali to the Vaal is calculated as the full volume transferred to the Vaal in a specific year, minus the LHWP Phase I transfer volume of 780 million m^3/a.

- Vioolsdrift Dam start to store water in May 2025. Vioolsdrift Dam is used for reregulating purposes as well as to increase the Orange system yield. Using Vioolsdrift Dam for reregulation purposes will reduce the operating losses by approximately 120 million m^3/a. Vioolsdrift Dam has a gross storage of 510 million m^3 and produces a yield of 192 million m^3/a.
- The preferred EFRs as determined by the ORASECOM study "Orange-Senqu strategic Action Programme: Environmental flows Project" was included on the Lower Orange and Fish River in Namibia. The EFR for site 5 just downstream of Orange Fish confluence was adjusted to produce acceptable flows at the river mouth and only the summer EFR flows at the Augrabies site were included in the core scenario to avoid too high flows at the river mouth during the winter months. The EFR releases in support of the estuary, can only be accurately controlled by means of releases from Vioolsdrift Dam, as Vanderkloof Dam is located too far upstream. The adjusted preferred EFRs were only supplied from May 2026 onwards. The inclusion of the preferred EFRs result in a significant reduction in the system yield, to such an extent that large deficits in water supply to the current users will be experienced.
  - Yield increase intervention: To overcome these deficits and to accommodate future demand growth in the system an increase in the Orange system yield is required. This can be obtained by the raising of Gariep Dam or the building of the Verbeeldingskraal Dam upstream of Gariep Dam. A feasibility study is recommended to be able to determine the most preferable option. Current information and results shows that it can be any of the two proposed options. The selected core scenario therefore considered both options as briefly described below.
    - Raising the existing Gariep Dam by 10m to increase the system yield by 350 million m^3/a. The raising of the dam needs to be completed by May 2026.
    - Verbeeldingkraal Dam started to store water in May 2026 and was used to support Gariep Dam. Water is however kept in Verbeeldingskraal Dam for as long as possible and will only be released in support of Gariep Dam when Gariep is at low storage levels (below 1 232.78 masl). Using this operating rule results in a significant reduction in evaporation losses from Gariep Dam.
- A pump station at Welbedacht Dam to augment Knellpoort Dam. This includes a pipeline between Knellpoort Dam and Welbedacht WTP to deliver water into Knellpoort Dam, but also to address the turbidity at Welbedacht WTP by supplying clean water from Knellpoort Dam to Welbedacht WTP during periods of high turbidity in the Caledon. This pipeline would therefore be used as a bi-directional pipeline, with a maximum transfer capacity of 2 m^3/s.
- Tienfontein pump station capacity increase to 7m^3/s.
- Planned direct reuse from the Bloem Spruit WWTW (± 11 million m^3/a)
- Pump station and pipeline from Gariep Dam to Knellpoort Dam with a maximum transfer capacity of 20 million m^3/a.

5.3.3.2 Core Scenario analysis Results and Impacts

The water balances for the integrated Vaal System as obtained from the implementation of the Reconciliation Strategy for the Vaal River System are given in Figures 5.1 and 5.2. Figure 5.1 shows the balance without desalination of the AMD and requires high releases from Vaal Dam to dilute the water in the Vaal Barrage, so that the quality of the water is at a reasonable level for downstream users. Due to these releases, the Vaal Dam yield (see drop in Vaal system yield shown by brown line in Figure 5.1) is reduced to such an extent, that not even the yield from Polihali Dam (LHWP Phase II) will be sufficient to obtain a positive water balance within the Integrated Vaal system. Desalination of the AMD

outflows is therefore essential and a very high priority to be implemented successfully (see Figure 5.2).

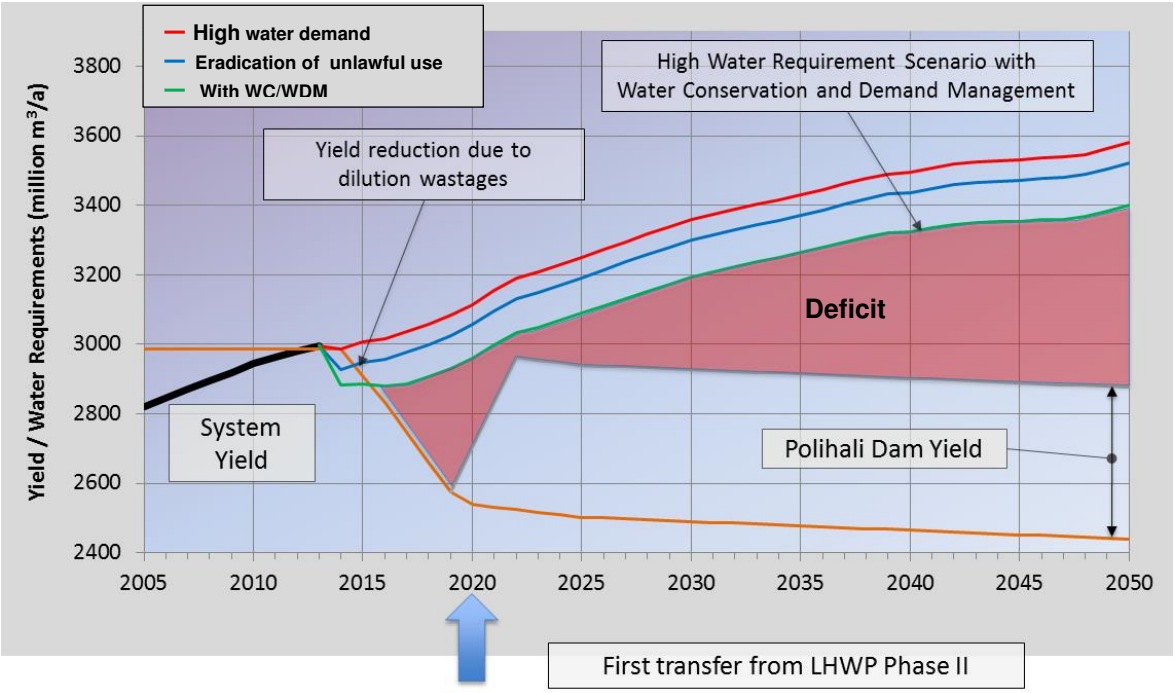


Figure 5-1: The Integrated Vaal system balance using high demand projection with WC/WDM, the removal of unlawful irrigation and neutralisation of the AMD water

With the desalination of AMD in place it is evident that the increased transfers from LHWP Phase II due to the Polihali Dam incremental yield, will enable the Integrated Vaal system to maintain a positive balance until 2050 (see Figure 5.2).

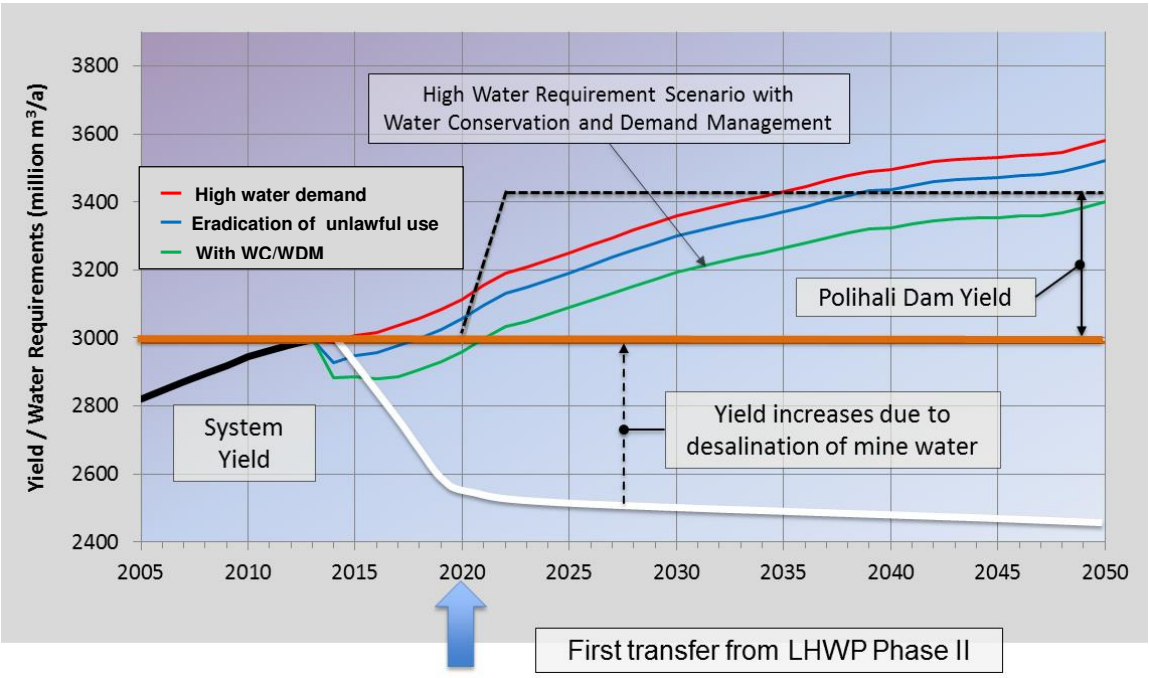


Figure 5-2: The Integrated Vaal system balance using high demand projection with WC/WDM, the removal of unlawful irrigation and desalination of the AMD water

Preliminary analyses showed that the operating rule applied to Polihali Dam and related transfers to the Vaal, significantly impacts on the assurance of supply to users in the Integrated Vaal system, as well as the timing when the next Vaal system intervention option needs to be implemented. Further detailed analyses are required to determine the most beneficial set of operating rules, which also need to be agreed upon by both Lesotho and the RSA.

Similar water balances was prepared for the Reconciliation Strategy study for Large Bulk Water Supply System in the Orange River.

The focus of these water balances is in the Orange River Project (ORP) Gariep and Vanderkloof dams and their entire area of supply). In Figure 5.3 it is evident that due to the expected growth in demands upstream of the ORP as well as the growth in demands supplied from the ORP, deficits are expected to occur from 2017 onwards. When Polihali Dam starts to inundate water from 2024 onwards, a significant drop in the yield available from the ORP is evident.

The Orange Reconciliation Strategy strongly recommended that the yield available from Polihali Dam, after the Integrated Vaal system deficits have been satisfied, should be made available to support the ORP. This remaining yield available in Polihali dam to support the ORP is shown by the purple triangle component in the Figure 5.3 water balance. The red area in Figure 5.3 however clearly shows that the support from Polihali will not be sufficient and additional intervention options will be required to maintain the balance.

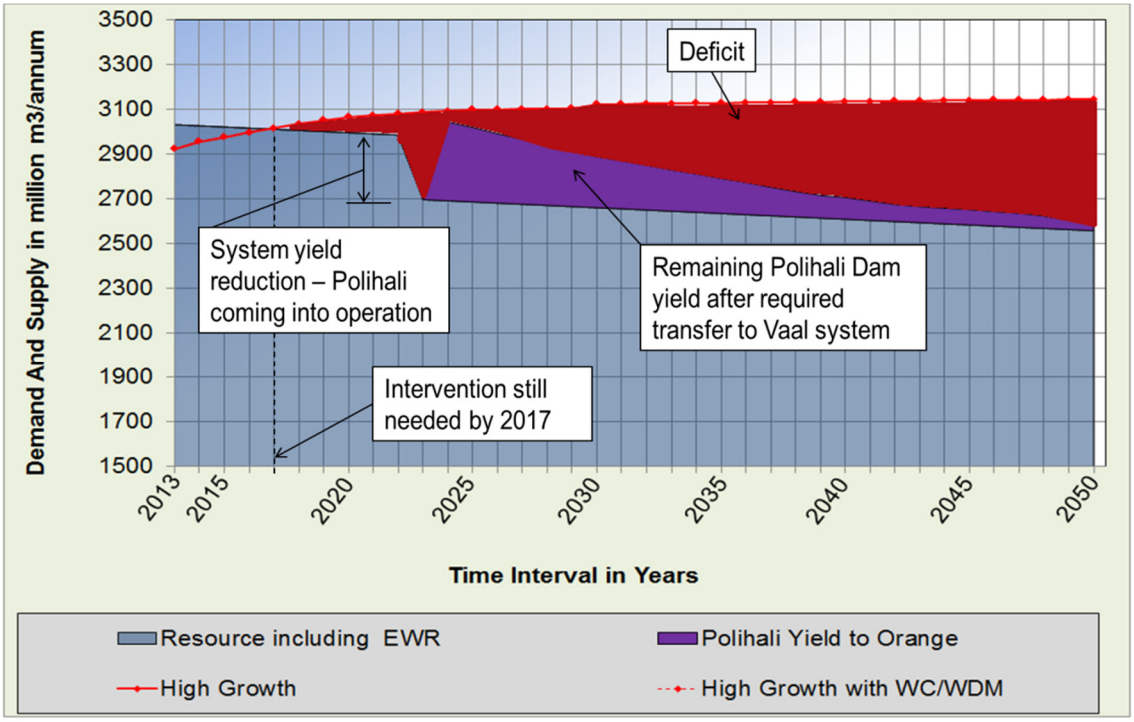


Figure 5-3: Future water balance of ORP with LHWP Phase II and no further interventions

By including the real time flow modelling and monitoring intervention option as well as utilising the lower level storage in Vanderkloof Dam well before Polihali Dam starts to store water, the deficits in the ORP system can be postponed until 2035 (See Figure 5.4). The problem with the balance given in Figure 5.4 is that the preferred EFRs were not addressed as part of the balance and only the current EFR releases were still used, which

is insufficient and is resulting in the continued deterioration of the ecology along the river and more specifically at the river mouth.

When the preferred EFRs are implemented the yield available from the ORP will reduce significantly. To be able to supply the EFR at the estuary in an effective manner, a control structure much closer to the river mouth than Vanderkloof Dam, is required. A dam at Vioolsdrift will be able to provide the required control for these EFR releases and can at the same time be used to significantly reduce operating losses in the ORP system. Vioolsdrift Dam can also be used to increase the ORP yield by capturing spills from the Vaal system and Vanderkloof Dam, as well as utilising local runoff. The Orange Reconciliation Strategy therefore recommended that the implementation of the preferred EFR should only occur once Vioolsdrift Dam is in place. The timing of the preferred EFR implementation is thus flexible, as it can be done at the earliest possible date at which Vioolsdrift Dam can be constructed and put into operation, but also at the latest by 2035, when a next intervention option is required to maintain a positive balance in the ORP (see on Figure 5.4).

For the purpose of the Orange Reconciliation Strategy study, is was assumed that Vioolsdrift Dam will be operational in May 2025, with the preferred EFR supplied from May 2026 onwards.

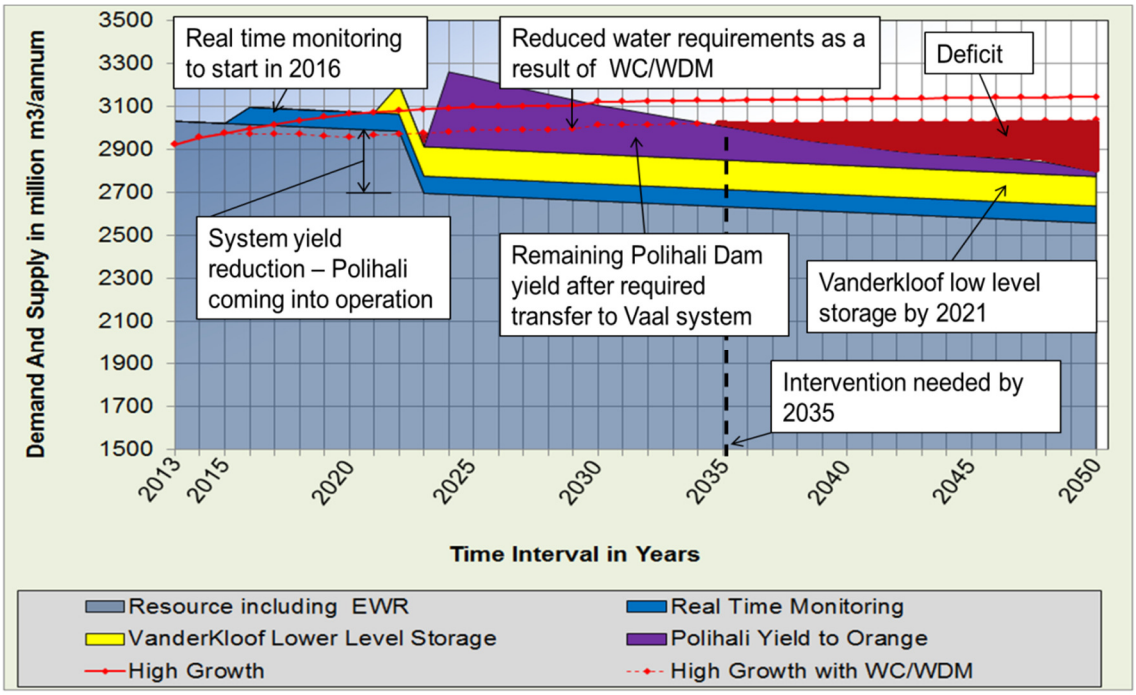


Figure 5-4: Future water balance of ORP with LHWP Phase II and some further interventions

The impacts the preferred EFR, inclusion of Vioolsdrift Dam as well as the other intervention options recommended by the Orange River Water Resources Reconciliation Strategy, is shown in Figure 5.5. To be able to maintain a positive water balance in the ORP, the raising of Gariep Dam is needed by 2026. Due to the large additional storage created by the 10 m raising of Gariep Dam and the related high increase in evaporation losses

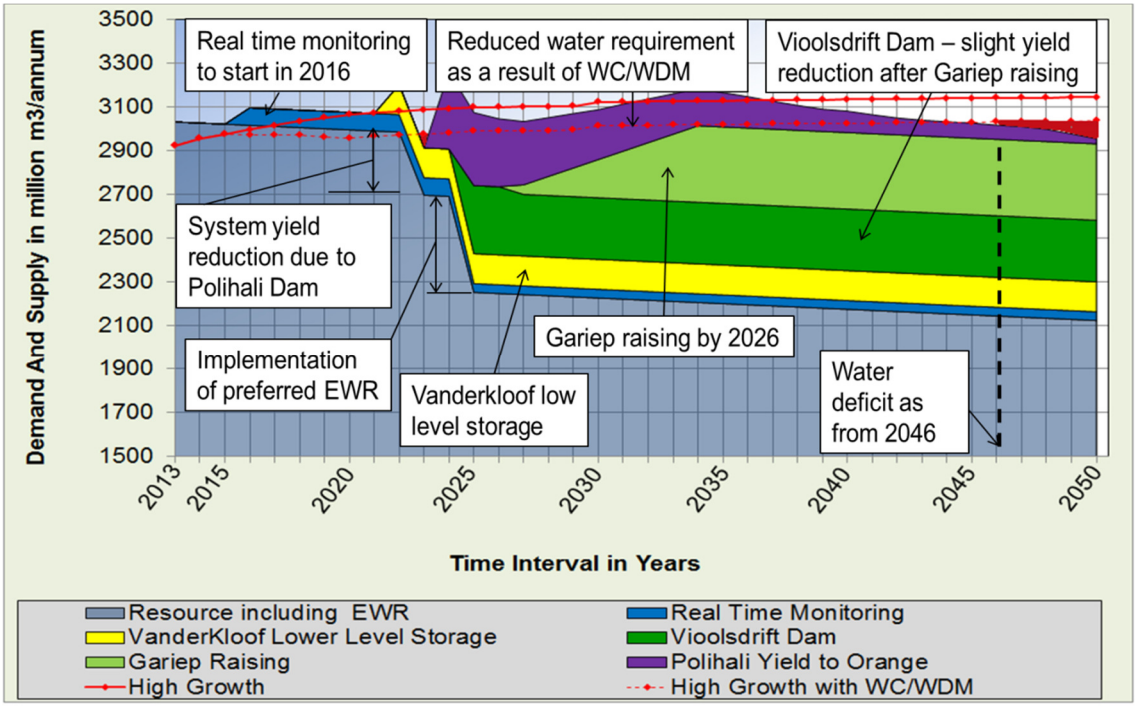


Figure 5-5: Future water balance of ORP with LHWP Phase II, Raised Gariep and recommended intervention options

from the Gariep dam, it will take a number of years (approximately by 2035) before the raised Gariep Dam will be able to deliver its full additional yield. It is thus important to note that both Vioolsdrift Dam and the raising of Gariep Dam are needed when the ecological preferred EFR is operationalised.

An alternative option to the raising of Gariep Dam was also recommended from the Orange River Water Resources Reconciliation Strategy study, which is the Verbeeldingskaal Dam upstream of Gariep Dam, closer to the Lesotho border. The main advantage of Verbeeldingskraal Dam is that it will significantly reduce the evaporation losses from the system in comparison with the raised Gariep option, and will allow more spills from the ORP in support of downstream EFRs.

A challenge of the Verbeeldingkraal Dam is that the size of the dam, as currently planned, is limited so as not to inundate any part of Lesotho and that the yield available from this dam is less than that obtained from a raised Gariep Dam. The ORP water balance using Verbeeldingkraal Dam as the future intervention option is shown in Figure 5.6. Due to the lower yield available from Verbeeldingskraal Dam, a positive water balance can only be maintained until 2036, when a next intervention option will be required. This water balance also shows that both Vioolsdrift Dam and Verbeeldingskraal Dams are needed when the ecological preferred EFRs are operationalised.

Management related intervention options such as reducing the assurance of supply to irrigation, the eradication of possible unlawful water users in the Upper and Lower Orange, as well as finding an acceptable EFR to be used for the lower Orange that will not have such a significant impact on the ORP yield, but still be acceptable from an ecological perspective, was not yet included in the water balance, as more detailed work is required in this respect.

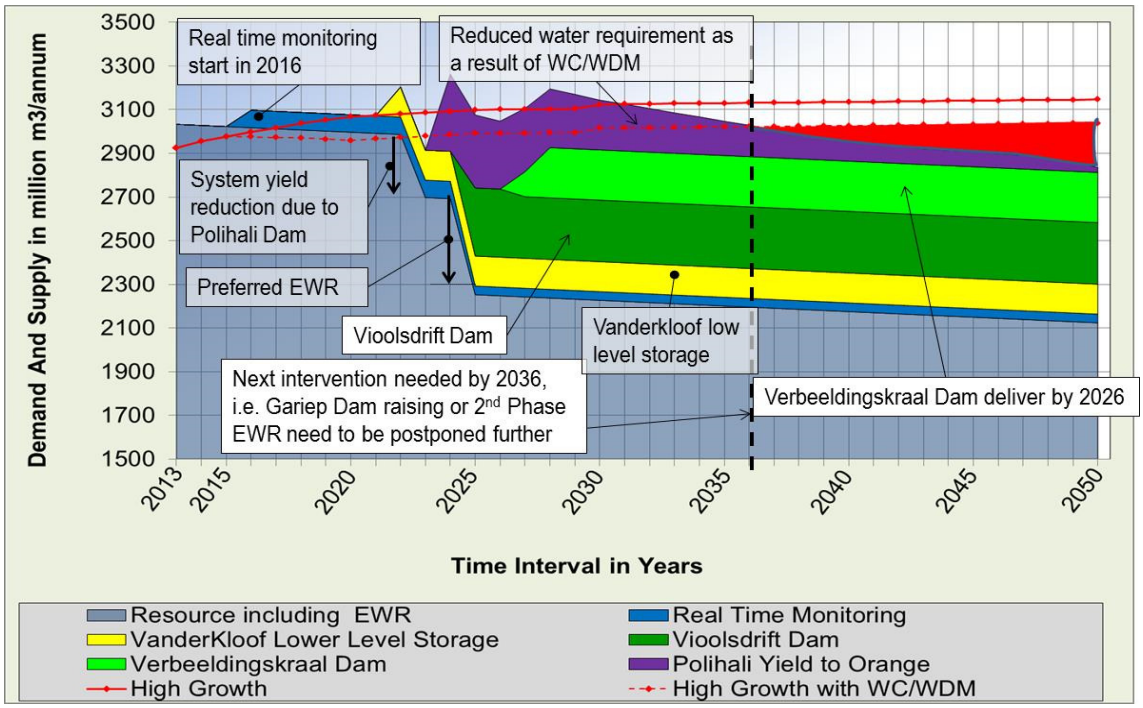


Figure 5-6: Future water balance of ORP with LHWP Phase ll, Verbeeldingskraal Dam and other recommended intervention options

By implementing the management related intervention options it is expected that it should be possible to maintain a positive water balance in the ORP with the Verbeeldingkraal Dam option until 2050 (Figure 5.6 balance). Further work are however required to confirm this.

The Greater Bloemfontein system is also one of the larger water supply systems within the Orange Senqu basin. This system is used to supply water to Bloemfontein, Mangaung, Botshabelo, Thaba Nchu and several other smaller towns in the Free State. A Reconciliation Strategy was prepared for this sub-system and it is currently in the implementation phase.

This sub-system is already in deficit, and restrictions on the water use in this system were imposed in May/June 2014. The yield available from this sub-system is very dependent on pump and transfer capacities, which in turn also impacts on the operating rules between the dams and related transfer systems.

The Novo Transfer capacity will be increased from the current 1.5 m^3/s to 2.2 m^3/s by April 2015 and the Tienfontein pump capacity will increased from the current 2.35 m^3/s to 3.87 m^3/s by June 2016. Due to the improved operation of the Welbedacht Bloemfontein component of this sub-system, the supply capacity of this component will be increased from the current 1.6m^3/s to 1.68 m^3/s from January 2018. This will fully address the first two intervention options as shown in Figure 5.7. The implementation of the strategy intervention options is about 2 to 3 years behind schedule given the original implementation dates from the reconciliation strategy study.

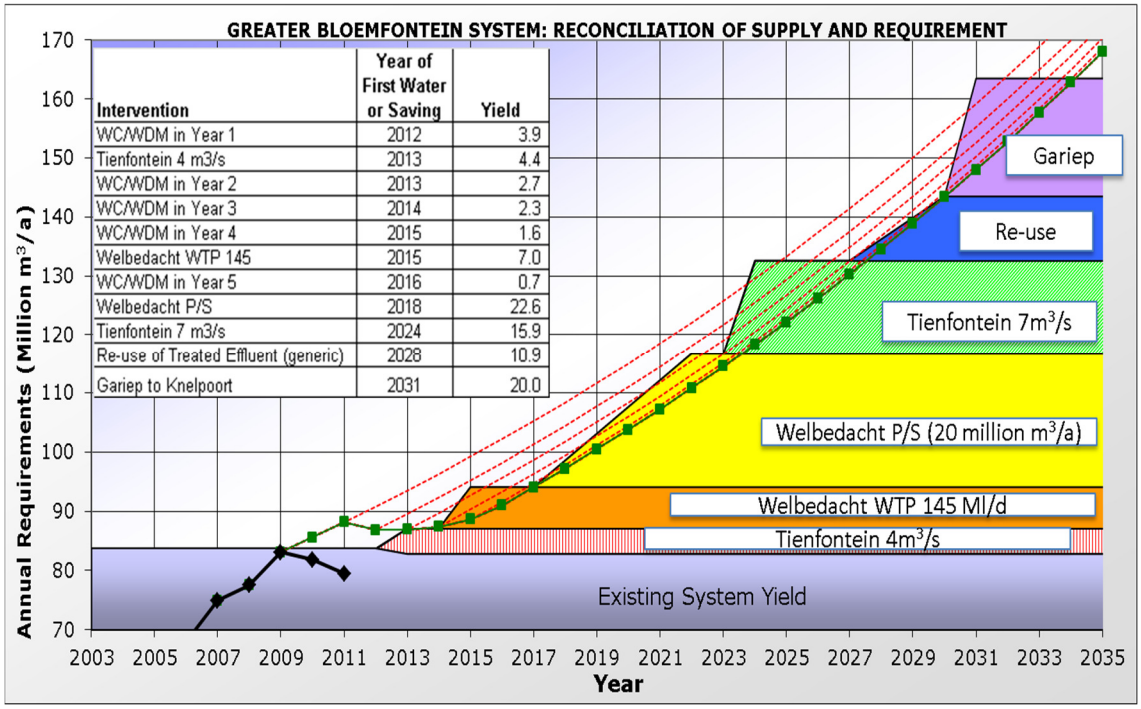


Figure 5-7: Future water balance for the Greater Bloemfontein system showing the related intervention options

There are currently talks that the implementation of the pipeline from Gariep Dam will be moved earlier in the proposed schedule of intervention options. This is still uncertain and investigations are currently underway.

5.3.4 Planning Implications

For the IWRM Plan it is necessary to have a clear picture of the planning implications associated with the Core Scenario. These are summarised in Table 5-6. These have been taken forward to the IWRM Plan detailed in Section 6.

Table 5-6: Planning implications associated with the core scenario

Element	Current Status	Planned implementation date[1]	Actions required (2015 – 2025)
Removal of unlawful irrigation in the Upper Vaal	Currently in process approximately 66% already removed	Completion in 2015	None
Neutralising of AMD	Currently in process	2014/15	None
Metolong Dam and distribution system	Dam construction completed construction of distribution systems underway	Dam 2014	
Distribution system 2018	Construction of distribution system and implementation		
Neckartal Dam and irrigation scheme	Dam construction started Irrigation scheme design	Dam 2016	
First irrigation from Neckartal Dam in 2017	Construction design and implementation of irrigation scheme infrastructure	2017	
Increase Tienfontein pumping capacity to 3.87 m³/s	Design	June 2016	Design and construction
Increase Novo Transfer scheme capacity to 2.2 m³/s	Design	April 2015	Design and construction

Element	Current Status	Planned implementation date[1]	Actions required (2015 – 2025)
Welbedacht pump station pipeline to Knelpoort dam	Preliminary Design?	2018/19	Design and construction
Desalination of AMD	Preliminary Design	2018/19	Design and Construction
Real-time monitoring	Planning for implementation	2016	Implementation
Vanderkloof Lower level storage	Preliminary Design	2021	Design
Botswana Supply via Vaal Gamagara	Design	2022/23	Construction – Final agreement with Botswana
Polihali Dam (LHWP Phase II)	Design	2022	Construction; Finalisation and agreement on the operating rule
Increase Tienfontein pumping capacity to 7 m3/s	Preliminary Design?	2022/23	Design and Construction
Vioolsdrift Dam	Feasibility study	2025	Feasibility, Preliminary design, design, construction
Introduce preferred EFRs on lower Orange	Preliminary analyses were completed	2026	Further study on the level of environmental protection weighed up against the socio-economic implications to establish to fine tune
Gariep Dam raising /Verbeeldingskraal Dam	Recognisance	2018	Pre-feasibility study for choosing between Gariep Dam Raising and Verbeeldingskraal Dam

5.3.5 Impacts of Sedimentation

The potential impacts of sedimentation, as had been suggested at one of the stakeholder workshops, on the yields of some of the key storage reservoirs was investigated. Details of the findings are briefly summarised as follows:

- **Gariep and Vanderkloof Dams**. Recorded catchment sediment yields for Gariep and Vanderkloof dams are reported as 367,9 t/km^2/a and 128 t/km^2/a respectively. Assuming trap efficiencies of 98% it is estimated that the storage in Gariep Dam will reduce by 220 million m^3/a by 2040 and that for Vanderkloof Dam by 40 million m^3. The impact of sedimentation on Vanderkloof Dam is much less as most of the sediment is trapped in Gariep Dam. The reduction in storage capacity at both dams results in a reduction in yield of only 22 million m^3/a. The impact on the yield is thus very small, less than 0.7% of the current yield from the system.
- **Caledon River**. The Caledon River is well known for its high sediment loads and related impacts. Welbedacht Dam is the only major dam located on the mainstream with its current storage of approximately 6 million m^3/a in comparison with its original capacity of 115 million m^3. Measures are currently being put in place to slightly increase the storage capacity. The Welbedacht sub-system yield has been based on the reduced system yield for many years. Although sedimentation in his river is a major concern, further reduction in the Welbedacht sub-system yield is not expected due to siltation. The sediment from the Caledon is now mainly impacting on Gariep Dam.

- **LHWP Storage and sedimentation**. The dead storages of the Katse and Mohali dams are 430 Mm^3 and 90 Mm^3 respectively. Sedimentation generated in these catchments is much lower than that experienced in the Caledon and no significant impact on the LHWP system yield is expected in the foreseeable future, with all sedimentation being absorbed in the dead storage areas.
- **Vaal River System**. Reduction in the integrated Vaal River system (IVRS) yield due to sedimentation is not regarded as a problem in the Vaal system and has not been addressed in any of the recent studies, including the recently completed IVRS water resources reconciliation Strategy study.
- **Neckartal Dam**. The Neckartal Dam design reports stated an expected reduction in storage due to sedimentation over 50 years of 117 M m^3, resulting from a sedimentation rate of 100t/km^2/a and a 100% trap efficiency. For the purposes of the yield analysis the dead storage of 16.2 million m^3 in Neckartal was increased to 130 million m^3 to accommodate the sediment volume after 50 years. The historic firm yield reduced from the 97.5 million m^3/a to 77.5 million m^3/a, representing an almost 21% reduction in yield, which is quite significant.

6. Detailing the Plan

6.1 Introduction

The strategic level framework of the Plan has been presented in the previous chapter. In this chapter the specific actions that are required to turn the strategic framework into an action plan are detailed. The detailing of these actions has been based on three main sources:

- Stakeholder workshops carried out at the regional and national levels under this project
- Conclusions and recommendations from thematic reports compiled under Phase 2 and this phase 3 of the GIZ support to the ORASECOM basin-wide IWRM Plan project and
- The recommendations of the Orange-Senqu environmental sustainability strategic and national action plans as summarised in Section 5.2.3 of this report.

6.2 Disaggregating the Plan

6.2.1 Introduction

As already explained, ORASECOM, whether it be through the Secretariat, Task Teams or other bodies, will be considerably more actively involved in certain of the action areas than in others.

The action areas in which ORASECOM will be most actively involved will be referred to as the primary action areas for ORASECOM, and are the following:

- Action Area 1.2: Optimising efficient development and adaptive management of water resources
- Action Area 2.1: Equitable utilisation of (the basin's) water resources
- Action Area 3.2: Catchment degradation, watershed management, settlement and land-use planning
- Action Area 3.3: Environmental water requirements
- Action Area 4.1: Flood and drought mitigation, extreme events, climate proofing
- Action Area 5.1: Water resources and associated environmental data and information
- Action Area 6.1 – 11: Enabling and cross-cutting action areas and strategic actions

They will also be actively involved in some elements of the following action areas which will be referred to as the secondary action areas for ORASECOM :

- Action Area 5.2: Water use and demand data
- Action Area 3.1: Improving water quality
- Action Area 1.1: Surface and groundwater assessments

For the remaining action areas the role of ORASECOM will be largely restricted to that of an interested observer, providing support where necessary and useful.

In Table 6-13: Action Area 2.2: Water resources developmentTables 6-2 to 6-8, each of ORASECOM's seven primary action areas have been analysed in terms of their strategic actions with the aim of identifying the specific actions that need to be implemented at the regional and national levels. The role of ORASECOM in terms of the implementation of each specific action is also indicated through the use of colours as follows:

Table 6-1: Levels of ORASECOM involvement in implementation of specific actions

Strategic Action X	• High level of ORASECOM involvement. For the majority of activities under the specific action, ORASECOM bodies (Technical Task Team (TTT), Communications Task Team (CTT) etc and Secretariat) will be involved in execution or management during project/programme implementation
	• Significant level of ORASECOM involvement. For some of the activities under the specific action, ORASECOM bodies (Technical Task Team (TTT), Communications Task Team (CTT) etc and Secretariat) will be involved in management, for most in the facilitation role during project/programme implementation
	• For the majority of activities under the specific action ORASECOM bodies (Technical Task Team (TTT), Communications Task Team (CTT) etc and Secretariat) will be involved only in facilitation or support of project/programme implementation
	• ORASECOM involvement limited to review or none in most of the activities under the specific action

6.2.2 Disaggregation of ORASECOM's primary action areas

6.2.2.1 *Introduction*

As might be expected given its transboundary role, ORASECOM will be most involved in the Action Areas that are aimed at satisfying the most transboundary of the strategic objectives. This includes two of the three action areas (3.2 and 4.1) aimed at reducing the adverse effects of catchment degradation and maximising security from water-related disasters. These are detailed in the following paragraphs.

6.2.2.2 *Action Area 1.2: Optimising efficient development and adaptive management of water resources*

This Action Area includes many of the actions that are required to manage and develop the water resources at the transboundary level. ORASECOM has already played a prominent role in ensuring that the water resources and demands of all parts of the basin are integrated into the water resources planning model (WRPM) and in increasing capacity on the use of this model in all the basin states. Efforts will continue to empower technical expertise and decision-makers within Botswana, Lesotho and Namibia in order to create a level playing field when it comes to the transboundary management of the basin water resources.

The importance of the appropriate management of transboundary aquifers is also addressed under this action area as well as moving towards a more integrated approach to the management of surface and groundwater.

Work carried out under this study on the development of economic accounts will lay the groundwork for the increased inclusion of this aspect in optimising the efficient development of water resources in the future.

These are all areas where ORASECOM has an indispensable role to play.

Table 6-2: Action Area 1.2: Optimising efficient development and adaptive management of water resources

Strategic Action	Specific Action
1.2.1: Utilisation of an adaptive management approach including application and continuous/regular use of surface and groundwater resources planning/allocation tools (e.g. WRPM), including proactive, transparent and coordinated approach with empowered regional participation	• Incorporate upgrades and improvements to the model setup
	• Regularly review management options and plans and associated capacity building
	• Implement, continuously update and review chosen water resource management and development scenarios, and associated capacity building
	• Incorporate groundwater resources into the overall planning model starting with transboundary aquifers and (potential) conjunctive use aquifers
	• Consider aspects related to economic accounting of water
1.2.2: Planning (reconnaissance, Investigation, feasibility study, design of water resources development and management infrastructure)	• Real-time monitoring for better management of Vanderkloof etc
	• Vioolsdrift Dam and alternatives
	• Polihali Dam (LHWP Phase 2)
	• Botswana supply via Gamagara
	• Lesotho (via South Africa) - Botswana water transfer
	• Metolong Dam and distribution system
	• Lowlands dam sites in Lesotho
	• Dual/multi-purpose dam sites in Lesotho
	• Neckartal Dam and irrigation scheme
	• Desalination of acid mine drainage (AMD)
	• Welbedacht pump station pipeline to Knelpoort Dam
	• Increase Tienfontein pumping capacity
	• Increase Novo Transfer scheme capacity
	• Vanderkloof Lower level storage
	• Raise of Gariep Dam or construct Verbeeldingskraal Dam /other alternatives
1.2.3: Implement WDM and WC in agriculture and wildlife management	• Implement recommendations on irrigation best practices from Work Package 6 of the IWRM Plan Phase 2
	• Take pilot projects to scale
	• Incorporate economic aspects, water accounting and economic instruments
1.2.4: Implement WDM and WC in domestic, industrial and mining water supply	• Reduce unaccounted for water (UFW) losses in all municipalities/local authorities and industry
	• Replicate/ take to scale lessons learnt from Emfuleni, Mariental, Maseru water demand management and water conservation (WDM & WC) projects, etc
	• Reduce unaccounted for losses in the mining sector
	• Incorporate economic aspects, water accounting and economic instruments

6.2.2.3 Action Area 2.1: Equitable utilisation of (the basin's) water resources

Article 5.2.2 of the ORASECOM Agreement states that Council shall take all measures required to make recommendations, or advise parties on "*the equitable and reasonable utilisation of the water sources in the River System to support sustainable development in*

the territory of each Party". Getting into the detail of what this really means and how it can be achieved has not been satisfactorily stated. It remains a challenge for ORASECOM to make recommendations or provide advice which is acceptable to all parties. During the stakeholder discussion that led to the formulation of this Plan, it was agreed that this is a priority area for ORASECOM to tackle. ORASECOM will manage most of the studies and activities required under this action area.

Table 6-3: Action Area 2.1: Optimising efficient development and adaptive management of water resources

Strategic Action	Specific Action
2.1.1: Review and agree on definitions in the context of the Orange-Senqu Basin and set out guidelines and procedures to improve equitable utilisation and benefit sharing at the basin level	• Review and consolidate existing understanding of the SADC shared waters Protocol and ORASECOM Agreement
	• Develop guidelines and procedures for the definition and implementation of benefit sharing at the transboundary level
2.1.2: Implement procedures to improve equitable utilisation and benefit sharing at transboundary and national levels	• Implement procedures and mechanisms for equitable utilisation and benefit sharing at the basin level

6.2.2.4 Action Area 3.2: Catchment degradation, watershed management, settlement and land-use planning

As shown in Table 6-4, it is anticipated that ORASECOM will play a leading role in the implementation of all of the strategic actions.

Table 6-4: Action Area 3.2: Catchment degradation, watershed management, settlement and land-use planning

Strategic Action	Specific Action
3.2.1: Planning, prioritizing and promotion of multipurpose watershed management interventions around the basin	• Undertake reconnaissance and classification of (especially) upland areas of the basin in terms of levels of degradation, erosion risk.
	• Develop and consolidate best practice guidelines for implementation of sustainable watershed management interventions
	• Phased action plan (priority intervention areas)
3.2.2: Implementation of sustainable livelihood-based integrated catchment management programmes in degraded parts of the catchment based on the taking to scale of pilot demonstration projects	• Implement projects according to implementation plan, including the implementation of already identified projects/programmes, provision of required support and seed-financing.
	• Undertake programme and project review, monitoring and evaluation with respect to overall programme objectives (from pilots to long-term solutions)
3.2.3: Management and control of alien species Improve	• Identify and select priority areas for control of alien weeds and invasive species
	• Clear alien vegetation in prioritised areas
	• Identify and select priority areas for control of problem pests
	• Control problem pests in prioritised areas
	• Design and implement monitoring and evaluation programme for management of alien and migrated species

Addressing catchment degradation is arguably the most pressing of the transboundary challenges facing the basin. At the transboundary level catchment degradation, particularly in the sources areas, results in increased sediment loads and flood peaks, and reduced base flows. At the local level, the livelihoods of farmers are threatened. Similarly the management and control of alien species can free up water for use further

downstream. Without ORASECOM continuing to play a role in expediting progress, these challenges will continue to threaten the water resources of the basin.

6.2.2.5 Action Area 3.3: Environmental Water Requirements

Making progress towards the generalised implementation of environmental flow requirements (EFRs) has been on the ORASECOM agenda for some time. Preparatory studies have contributed to the filling of the remaining gaps around the basin, especially in the lower Orange, the Fish River in Namibia and the estuary. While it is accepted that the fine-tuning of EFRs generally is an ongoing process, it is important to move rapidly towards the implementation of a preliminary set of environmental flow requirements. This has already largely been achieved in most of the upstream part of the basin but remains a challenge for the lower Orange and estuary. Implementation of an improved set of EFRs in this area should be agreed by all basin states, and in particular South Africa and Namibia, and the required associated management and infrastructure actions planned. ORASECOM has a critical role in promoting this work and also in further work to improve the accuracy of environmental flow requirements through further studies.

Table 6-5: Action Area 3.3: Environmental water requirements

Strategic Action	Specific Action
3.3.1: Basin-wide implementation and M and E programme for agreed preliminary EFRs according to chosen water resources management and development scenario	• Formally agree on preliminary EFRs and implementation modalities
	• Implement preliminary EFRs, including M and E programme
3.3.2: Management of the Orange-Senqu Mouth	• Implement measures to improve condition of floodplain function (SAP PCN-4)
	• Improve the status of over-exploited/collapsed species (SAP PCN-4)
3.3.2: Improve knowledge of EFRs, including capacity building, updating of EFRs, and basin-wide implementation	• Further work on harmonisation of existing e-flows (SAP PCN-3-Out1) -
	• Agree on improved basin-wide flows regime through consultative process (SAP PCN-3-Out-2)
	• Ensure Capacity Building at national and trans-boundary level
	• Set up and implement compliance monitoring of basin-wide e-flows regime (SAP PCN-Out-3)

6.2.2.6 Action Area 4.1: Flood and drought mitigation, extreme events, climate proofing

ORASECOM has already taken the lead in commissioning a climate change regional downscaling exercise for the basin, the results of which showed that climate change will pose a real threat to the basin. The study also showed that precipitation was likely to decrease over almost all of the basin. The possible exception was in the Lesotho Highlands and perhaps the headwaters of the Vaal River. However, as with other similar studies carried out in the region, a high degree of uncertainty was underlined. Adding to the uncertainty are the following:

- Whether or not the areas become drier of wetter, there is/will probably be a change in the nature of precipitation with more intense but less frequent rainfall events
- Intra and inter-seasonal variability may increase
- Reduction in snow precipitation

For water resources management, these aspects are as critical as an increase or decrease in mean annual rainfall. Climate monitoring, in particular of precipitation in the key runoff producing areas of the basin, is completely inadequate, especially considering the urgent need to better understand climate change trends. Improving the accuracy of predictions into the future and therefore being better placed to deal with them is critical for the sustainable development and effective management of the basin's water resources. Investment into improving knowledge will result in major savings on infrastructure.

Table 6-6: Action Area 4.1: Flood and drought mitigation, extreme events, climate proofing

Strategic Action	Specific Action
4.1.1: Improve knowledge, understanding and communication of extreme events	• Consolidate relevant climate data at the basin level
	• Update regional downscaling and other CC models
4.1.2: Mainstreaming of climate-adaptation into the design of development activities	• Review existing regional and national guidelines
	• Develop climate change adaptation guidelines for the basin
	• Implement climate-adaptation guidelines for the basin
4.1..3: Mainstreaming of climate-adaptation into drought and flood mitigation	• Review of existing regional and national guidelines
	• Develop climate-proofing guidelines for the basin
	• Implement climate-proofing guidelines

6.2.2.7 Action Area 5.1: Water resources and associated environmental data and information

Table 6-7 shows the envisaged specific activities for the five strategic actions. It is anticipated that ORASECOM will play a leading role in the implementation of many of the strategic actions under this area. Clearly, issues such as transboundary confidence in nationally gathered water resources data and the establishment of basin-wide networks of key stations, increasing efforts on data collection on climate change and the establishment of an ORASECOM-based Water Information System (WIS) are of transboundary importance and ORASECOM is in the ideal position to catalyse progress.

Some of the specific actions are urgent in nature. Other action areas depend on good quality representative data and in particular improving knowledge on climate trends can be regarded as critical.

Table 6-7: Action Area 5.1: Water resources and associated environmental data and information

Strategic Action	Specific Action
5.1.1: Improve reliability, usefulness, trans-boundary confidence and areal coverage of surface water monitoring networks at the transboundary and national (sub-catchment) levels	• Identify and agree on key stations for different purposes – trends, climate change, EFRs, drought, flood, WQ
	• Improve data storage and sharing platforms
	• Improve coverage in selected sub-catchments
	• Design and implement programme of establishment/ upgrades for low flow measurement (drought/EFRs)
	• Improve stage/discharge ratings and confidence therein
	• Upgrade stations to real-time monitoring status
	• Provide on-line access to "real-time" discharge data and historic data series
	• Provide Institutional capacity building in monitoring activities
5.1.2: Improve water resource focused climate (change) monitoring	• Identify and agree on key hydro-meteorological stations for climate change monitoring
	• Implement (in phases) improved climate change (CC)-focussed hydro-meteorological monitoring
5.1.3: Improve reliability, usefulness, transboundary confidence areal coverage of groundwater monitoring networks at the transboundary and national (sub-catchment) levels	• Improve monitoring of transboundary aquifers aimed at better quantification of resource (NB SAP PCN-2)
	• Develop a common platform for the sharing of data on transboundary aquifers
	• Improve monitoring of key national aquifers and sharing of data, including the impacts of fracking
	• Design and implement Institutional capacity building programme in monitoring activities
5.1.4: Improve reliability, usefulness, trans-boundary confidence areal coverage of water quality monitoring networks at the transboundary and national (sub-catchment) levels	• Review and expand basin-wide monitoring network
	• Implement improved and expanded monitoring programme
	• Develop database and internet portal
5.1.5: Integration of water resources and related environmental through development of Water Information System (WIS)	• SAP PCN 1-2: Technical guidelines for data exchange and sharing developed
	• Continue expansion of WIS to accommodate new data and data sharing requirements
	• Carry out regular updating
	• Implement and apply quality control measures

6.2.2.8 Action Area 6.1 – 11.1: Promotion/maximising mainstreaming of key cross-cutting and enabling actions

Action Area concerns the mainstreaming of key cross-cutting and enabling actions. By definition, enabling and cross-cutting activities will already be part of the Action Areas 1 to 5. The main purpose of this action area is to ensure that these cross-cutting and enabling activities really happen effectively. As indicated in Table 6-8, ORASECOM has in important role to play in promoting many of these cross-cutting and enabling actions. This has been recognised in the past already. ORASECOM has played a role in the past looking in depth at communication issues, funding mechanisms and capacity-building needs for example.

Table 6-8: Action Area 6-11: Promotion/maximising mainstreaming of key cross-cutting and enabling actions

Strategic Action	Specific Action
6.1.1: Ensure effective capacity building at various levels in all appropriate action areas	• Revise ORASECOM capacity building plan
6.1.2: Ensure effective policy, legal and institutional arrangements	• Identify gaps or areas of improvement in policy, legal and institutional frameworks
	• Align policy, legal and institutional frameworks
	• Monitor and evaluate of progress with resolution of legal, policy and institutional constraints
6.1.3: Undertake research in areas to support sustainable water resources development and management	• Act as information hub for research and knowledge sharing within the basin
	• Facilitate and/or coordinate key research projects
7.1.1: Ensure appropriate and effective stakeholder participation for implementation of the Plan	• Implement the stakeholder roadmap
	• Revise and implement ORASECOM communication strategy for stakeholder communication and consultation
7.1.2: Mainstream the promotion of transboundary cooperation into all appropriate actions	• Identify IWRM Plan projects and programmes where transboundary cooperation is important
	• Facilitate and support transboundary cooperation in the implementation of the Plan
8.1.1: Ensure adequate financing mechanisms and funding	• Develop strategy for transboundary financing
	• Implement financing strategy
9.1.1: Ensure that effective and appropriate monitoring and evaluation systems are in place	• Monitor and evaluate of progress towards realisation of Strategic Objectives (Vision) of basin plan
	• Monitor and evaluate of implementation of the IWRM plan
10.1.1: Promote the mainstreaming of adaptation to climate change into all areas	Prepare of materials aimed at promoting understanding of climate change impacts and need for adaptation across sectors
11.1.1: Ensure appropriate and effective mainstreaming of gender	• Develop a gender main-streaming strategy for the basin with respect to water resources management and development
	• Implement gender mainstreaming strategy for the basin

6.2.3 Disaggregation of ORASECOM's secondary action areas

While the action areas dealt with in this sub-section or the report, are regarded as secondary action areas for ORASECOM, ORASECOM will be responsible for the management of a certain number of specific actions or at least some activities under certain specific actions.

6.2.3.1 Action Area 1.1: Surface and groundwater assessments

While regular re-assessments of surface water (hydrology) at the sub-catchment level is generally a national responsibility, it is clear that agreement on the contributions of different sub-basins can often be a transboundary issue. This is illustrated, for example, by the extensive bilateral studies that had to be carried out before Lesotho Highland Water project could proceed. The assessment of flows at certain points on the Orange-Senqu mainstream is also of transboundary significance. For some transboundary basins such as the Molopo sub-basin surface water assessments should be coordinated by all concerned countries.

Assessments of aquifers within the basin, especially transboundary aquifers, has lagged behind and ORASECOM has recognised the need to concentrate efforts in rectifying this.

Table 6-9: Action Area 1.1: Surface and groundwater assessments

Strategic Action	Specific Action
1.1.1: Update hydrology for catchments as required	• Implement priorities identified in previous studies (e.g. IWRM Plan Phase 2, Work Package 2)
	• Update other sub-catchment hydrologies
1.1.2: Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields and other characteristics)	• Update assessment of the Khakhea/Bray aquifer
	• Undertake detailed assessment of Stampriet/Matsheng transboundary Aquifer (ISARM)
	• Enhance understanding of groundwater resources in the basin (SAP-PCN2-OUT1)
	• Assess national aquifers; Botswana
	• Assess national aquifers; Lesotho
	• Assess national aquifers; Namibia
	• Assess national aquifers; South Africa

6.2.3.2 Action Area 3.1: Improving water resources quality

ORASECOM was responsible for the first basin-wide water quality survey in 2010. Poor water quality is one of the main transboundary challenges in the basin. It is anticipated that ORASECOM will continue to take the lead in the organising of basin-wide surveys in the immediate future but that these should be largely financed by the countries themselves.

Table 6-10: Action Area 3.1: Improving water quality

Strategic Action	Specific Action
11.1: Set and agree on basin-wide water resources water quality objectives (link to monitoring system)	• Consolidate of existing data to establish current water quality status at key transboundary monitoring points*(*link to AA1)
	• Determine the water resources quality requirements of users
	• Set basin-wide resource water quality objectives (RWQOs)
	• Develop an implementation plan to achieve the RWQOs
11.2: Management of the increasing salinity of the system	• Undertake pilot studies on irrigation schemes to understand the extent of impact of irrigation on water quality
	• Improve the salinity modelling
	• Implement of an action plan
11.3: Management of Eutrophication	• Develop a nutrient balance for the basin
	• Review and update the Phosphorus Model
	• Develop a nutrient management strategy
11.4: Understand the extent and impacts of POPs	• Assess persistent organic pollutants (POPs)
	• Develop mitigation action plan (if necessary)

6.2.3.3 Action Area 5.2: Water use and demand data and information

Water demand and use data have generally been a national prerogative in the past. It is proposed that improving the transboundary transparency of these data and sharing planning projections will useful and that ORASECOM has a role to promote this.

Table 6-11: Action Area 5.2: Water use and demand data

Strategic Action	Specific Action
2.1: Improve monitoring and reporting of water usage and return flows at national and transboundary levels	• Agree on and develop consolidated, transparent basin-wide database for permits/licences with shared access
	• Increase coverage of water use and return flow monitoring according to transboundary and national priorities
2.2: Increase permit/licence coverage, reduce illegal abstraction, improve monitoring, control and enforcement	• Increase coverage of permitting/licensing of water users
	• Reduce illegal abstraction of water in the irrigation sector
	• Reduce illegal abstraction of water in other sectors as well as other losses
2.3: Update projected demands and consideration of possible plausible futures	• Undertake strategic studies on uncertainty analysis and plausible futures, consideration of economic value/accounting of water
	• Update and share of demand projections by sector through transboundary and national studies

6.2.4 Disaggregation of the other action areas

While Action Areas 8 and 10 are not regarded as primary or secondary action areas for ORASECOM, for the socio-economic development of the basin, they are critical. The reason why ORASECOM will be less involved is simply that these action areas will be largely driven at the national level.

6.2.4.1 Action Area 1.3: Inter/Intra-sectoral planning and coordination (Horizontal and vertical alignment)

This area concerns the coordination of planning across sectors, and across sub-catchments. There is a transboundary aspect to this in which ORASECOM would have an interest.

Table 6-12: Action Area 1.3: Inter/Intra-sectoral planning and coordination (Horizontal and vertical alignment)

Strategic Action	Specific Action
8.1: Promote transboundary inter-sectoral planning and coordination in order to support cost-effective and sustainable development of water and associated natural resources	• Coordinate and share sectoral development plans and infrastructure operations at basin level
	• Consolidate and update current demands and projections of demand at the basin level
8.2: Promote (facilitate development of) intra-sectoral (water sector) planning and coordination in order to support cost-effective and sustainable development of water resources	• Ensure coordination and sharing of catchment / sub-catchment water resource management plans (e.g. consider farmers association model)
	• Facilitate consolidation of catchment/ sub-catchment plans into water resource development/management planning
	• Promote intra-sectoral (water sector) planning and coordination

6.2.4.2 Action Area 2.2: Water resources development

This action area is an essential part of the IWRM Plan. While development should be sustainable, it is clear that continuing development is at the top of the priority list of all four countries.

ORASECOM involvement would be limited to certain key transboundary issues.

Table 6-13: Action Area 2.2: Water resources development

Strategic Action	Specific Action
10.1: Improve sustainable access to improved water supply and sanitation in urban and rural environments	• Increase levels of water supply and sanitation coverage
	• Increase affordability (pro-poor/social equity) and economic viability (sustainability) of water supply and sanitation
	• Achieve economic, technical and institutional sustainability of operation, maintenance and required expansion of water supply and sanitation systems
	• Identify, plan for, design and build infrastructure to meet future water supply requirements
10.2: Develop water resources for supply to economic development sectors, especially those supporting employment opportunities	• Identify priority water needs to support economic development at the basin level
	• Develop and apply a decision support tool based upon economic accounts approach
	• Implement of priority water resource development projects
10.3: Ensure optimised availability of water for strategic use areas (power, industry, etc)	• Identify priority water needs to support strategic uses
	• Achieve consensus on strategic basin wide priorities
	• Implement of strategic water resource development projects

6.2.5 Activities

6.2.5.1 Overview

Having established specific actions, the next step is to detail them into activities with timelines and assigned responsibilities. The definition and detailing of activities was carried out as of the consultative process with the Consultant consolidating the discussions from a number of NWG sessions and then circulating for comment.

Activities for each of the specific actions have been compiled on a set of MS Excel spreadsheets. There is one spreadsheet for each of the twelve action areas. An example of one the spreadsheets, for Action Area 6, is shown in Figure 6-1.

For each of the specific actions presented in Table 6-2Table 6-7 to Table 6-13, a series of activities have been developed, detailed enough that the following information can be provided for each activity:

- Activity description; a short description is provided.
- Whether it is a transboundary or national activity (or both). Many activities will be of transboundary significance but implemented in only on country.
- Responsibility in terms of i) whether implementation would be led at the national, sub-national, bilateral, or regional/ORASECOM level and ii) ORASEOM's role with respect to implementation.
- Estimated cost; activities which ORASECOM is responsible for managing or executing have been given a cost, even if these are approximated.
- (Potential) Financing source(s). These are indicative only. Where an ICP or potential source of funding is provided, this may only be that some degree of interest has been given.
- Timeline; This is provided for the ten years of the Plan using a one year time-step.

Figure 6-1: Extract from the detailing of activities spreadsheet for Strategic Action 6.1

Action Area 6: Equitable utilisation of (the basin's) water resources

Strategic Action	Specific Action	Activity	TB	B	L	N	SA
6.1: Review and agree on definitions in the context of the Orange-Senqu Basin and set out guidelines and procedures to improve equitable utilisation and benefit sharing at the basin level	Review and consolidate existing understanding of the SADC Protocol and ORASECOM Agreement	Review the ORASECOM Agreement and define factors relevant to reasonable and equitable utilisation principles					
		Develop mechanisms for implementation of principles of equitable utilization, actual and best practices					
		ESTIMATED COST					
	Develop guidelines and procedures for the definition and implementation of benefit sharing at the transboundary level	Define benefit sharing concepts for the Orange Senqu basin					
		Develop guidelines and procedures for benefit sharing in the Orange-Senqu Basin					
		ESTIMATED COST					
6.2: Implement procedures to improve equitable utilisation and benefit sharing at transboundary and national levels	Implement procedures and mechanisms for equitable utilisation and benefit sharing at the basin level	Obtain political and legal endorsement of guidelines and principles by all four Parties					
		Develop a monitoring and evaluation framework and agreement of role of ORASECOM therein					
		Implement guidelines and principles of equitable utilisation and benefit sharing					
		ESTIMATED COST					

SA	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Responsibility		Cost	Status	Financing
											Lead (IA ?)	ORASECOM	$ 000's	%	identifed
											ORASECOM	Manage		0	None
											ORASECOM	Manage		0	None
	15.25	60.5	0	0	0	0	0	0	0	0			75.75		
											ORASECOM	Manage		0	None
											ORASECOM	Manage		0	None
	0	37.75	37.75	0	0	0	0	0	0	0			75.50		
											ORASECOM	Manage		0	None
											ORASECOM	Manage		0	None
											ORASECOM	Manage		0	None
	0	0	21.5	0	0	0	0	0	0	0			21.50		

6.2.6 Institutional responsibilities and requirements

In effect this Plan is only as good as the various institutions that support its implementation. It is therefore critically important for the various institutions and lead agents to take up full responsibility to see this basin plan implemented. This is not just ORASECOM's Plan.

It is understood that this Plan is in effect a living plan and will develop with time. This can only happen if collectively ORASECOM, the member states and the various stakeholders work towards implementation, and in so doing develop a shared understanding of the challenges, the successes, the lessons learned and the key next steps. Delegation of responsibility to the appropriate institution together with ongoing reporting become a cornerstone of the implementation of the Plan.

- Potential ORASECOM involvement, as indicated in Figure 6.1, is classified as one of the following:
  - **Execute**: There may be some limited instances where the Secretariat or Technical or Communications Task Teams or Council actually carries out some tasks themselves
  - **Manage:** Typically work by consultants under supervision of ORASECOM Secretariat/Task Teams
  - **Facilitate**: Typically playing an active role in coordination across borders, with ICPs etc
  - **Support**: Similar to facilitate but more passive

- **Review**: Typically review relevant studies/projects etc that may be presented to ORASECOM from time to time

It will be important for ORASECOM to maintain and update the Plan on an annual basis and with this process re-affirm with the member states what their responsibilities are in terms of implementation. ORASECOM will maintain the monitoring and evaluation aspects that will inform plan review and amendments

6.2.7 Stakeholder engagement

The ORASECOM stakeholder participation process has been examined in considerable depth since 2007 (Earle et al, 2005; InWEnt-ACWR, 2006; Lewis and Quibell, 2011). Remarkably, the '*ORASECOM Roadmap Towards Stakeholder Participation*' (ORASECOM 2007) is recognized as the officially approved guideline document for the implementation of the stakeholder participation process in the Orange-Senqu River Basin. However, the Roadmap has not been actively rolled out. Transboundary stakeholder participation is somewhat more complex than was initially thought, where best practices from one basin may not be appropriate in another, and local approaches may be influenced by practical constraints or limitations. It would seem that the lack of implementation is largely a result of lack of consensus, or clear decision, on the way forward.

However, recent work (ORASECOM, 2011) has focused attention on the practicalities of, and need for, implementing some of the recommendations therein. Key findings from this study can be distilled into a suite of principles:

- Whilst stakeholder engagement in the business of ORASECOM is not a necessity, it is clear that stakeholder participation in ORASECOM business has benefits that include:
  - Securing support for strategic basin level decisions by facilitating stakeholder input into decision making and planning associated with Basin level issues.
  - Enhanced sense of ownership and buy-in into outcomes.
  - Facilitates the understanding and acceptance of decisions or plans that may initially be unpopular with some sectors of stakeholders.
- There is reticence about stakeholder participating directly in Council or Task Team meetings given the sensitive nature of some of the issues discussed.
- Stakeholder participation in national and basin wide projects will vary from project to project, as projects would have specific requirements for stakeholder input.
- A basin wide forum for stakeholder participation can be advantageous but is not essential. Noting the complexities of arranging such a platform, this should ideally be considered on a project by project basis. If a basin wide structure is utilised (such as the Regional Working Groups deployed for the IWRM Plan development) then power relations need to be carefully considered.
- Stakeholder groups within the Member States need to be adequately represented at the national level. This implies effective stakeholder participation mechanisms and institutions at regional and national levels within Member States. Adequate awareness needs to be created within Member States among stakeholders
- Stakeholders' interests at the national level would be represented at the Basin level (i.e. to Task Teams and Council) by the Parties' representatives. These representatives therefore need to ensure that they adequately represent the opinions, preferences, and real felt needs of their stakeholders as communicated through the national level forums.

Going forward, it is therefore important that any proposed framework on stakeholder participation builds on the work already undertaken, as well as guidelines in international literature. This will provide a platform to identify and define the specific ORASECOM processes and requirements to enable the development of a tailored approach for the ORASECOM context.

Clear roles and responsibilities can be defined as in Table 6-14.

Table 6-14: Responsibilities of ORASECOM and Member States regarding stakeholder engagement

ORASECOM	Member States
Basin-wide stakeholder engagement	
• ORASECOM organises and hosts stakeholder participation workshops/ meetings including logistical arrangements and information sharing • ORASECOM moderates and facilitates balancing of power relations between stakeholders from Member States at Basin wide platform • ORASECOM facilitates agreement between stakeholder from Member states at Basin wide level • ORASECOM facilitates conflict resolution at Basin level • ORASECOM facilitates communication and information sharing and communication between Council, Task Team and Basin wide stakeholder platform	• Establish (build on existing) national level stakeholder forums (resourced by the Parties) • Facilitate nomination of stakeholder representatives from national forums participate in Basin level processes • Fund participation of national representatives on Basin wide stakeholder participation platform
• National level stakeholder engagement	
• ORASECOM recommends to Member States what level of communication is required around certain Basin wide objectives • ORASECOM acts as a monitoring and alignment body to facilitate balance between national level participation processes across Member States • ORASECOM facilitate information sharing and provide material and awareness raising to Member States for their national level processes • ORASECOM moderates and facilitates balancing of power relations between Member States' national processes • ORASECOM *does not* negotiate agreements between stakeholders or sectors at national level processes with Member States	• Establish and resource(fund) national level stakeholder forums and participation processes • Engage with their stakeholders and obtain stakeholder input on national and Basin wide objectives • Facilitate information sharing between stakeholders within their national participation processes • Balance power relations between stakeholders within their national participation processes • Discuss agreements among stakeholders within their national level processes and represent this at the Basin wide level

There are differing ways of viewing participation and different authors have structured these accordingly. Possibly one of the most well-known is the spectrum provided by the International Association for Public Participation (IAPP)[4]. Under the IAPP spectrum five different forms of participation are recognised:

1. Inform
2. Consult
3. Involve
4. Collaborate
5. Empower

[4] http:/www.IAP2.org/spectrum.html

This spectrum is most useful in that it helps to shape the type of participation that is required for the initiative at hand. It recognises that there are differing degrees of engagement and that there is no "one-size fits all" approach.

For the purposes of this Plan the notion of "Empower", in the context of transboundary RBOs, is not really considered a valid option. This is because "Empower" is defined as an autonomous decision making process, which is not catered for in most legislation and, considering the issue of sovereignty in transboundary basins, is unlikely to be achievable or acceptable in the near future. Certainly, even within countries most legislation would not allow for such autonomy.

With this in mind, the revised spectrum of participation is provided in Table 6-15.

Table 6-15: The spectrum of Public Participation (adapted from the IAPP)

Increasing Level of Public Engagement → → → → → → → → →			
INFORM	**CONSULT**	**INVOLVE**	**COLABORATE**
Public participation goal			
• To provide the public with balanced information to assist them in understanding the problem, opportunities, solutions and alternatives	• To obtain public feedback on analysis, alternatives and decisions	• To work directly with the public throughout the process to ensure that public concerns are consistently understood and considered	• To partner with the public in each aspect of the decision-making process including the development of alternatives and the identification of preferred solutions
Commitment			
• We will keep you informed	• We will keep you informed, listen to and acknowledge concerns and aspirations, provide feedback on how public input influenced the decision	• We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how the public input influenced the decisions	• We will look to you for direct advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible
Tools and Techniques			
• Fact Sheets • Newsletters • Newspaper & Radio announcements • Web sites	• Public comment • Focus groups • Surveys • Public meetings	• Workshops • Polling	• Citizen advisory committees • Forums • Consensus building • Participatory decision-making

Whilst each type of participation has its place, processes of more active involvement (or collaboration) with key stakeholder groups provide for more sustainable and more productive projects. By informing and consulting, there are limited opportunities to identify public values and priorities, let alone opportunities to solicit and incorporate stakeholder expertise and local knowledge. When stakeholders are more actively involved they begin to develop ownership over decisions, and are more likely to support and implement final decisions outcomes.

The IAAP spectrum provides a format for progressive development of engagement over time, with developing capacity and improved levels of trust. This structure has been applied as a layer to the strategic actions, detailed in this Plan above, to provide a sense of the types of engagement that are required for each action. These are obviously indicative and provide some form of guidance, however, it is clear that the more

engaged the stakeholders become the more the tendency will be to maintain that relationship with a more collaborative approach. .

It is critically important to note that specific groups will need specific guidance and support and it will, at key junctures, be required that we engage with different groupings of stakeholders. The figure below refers.

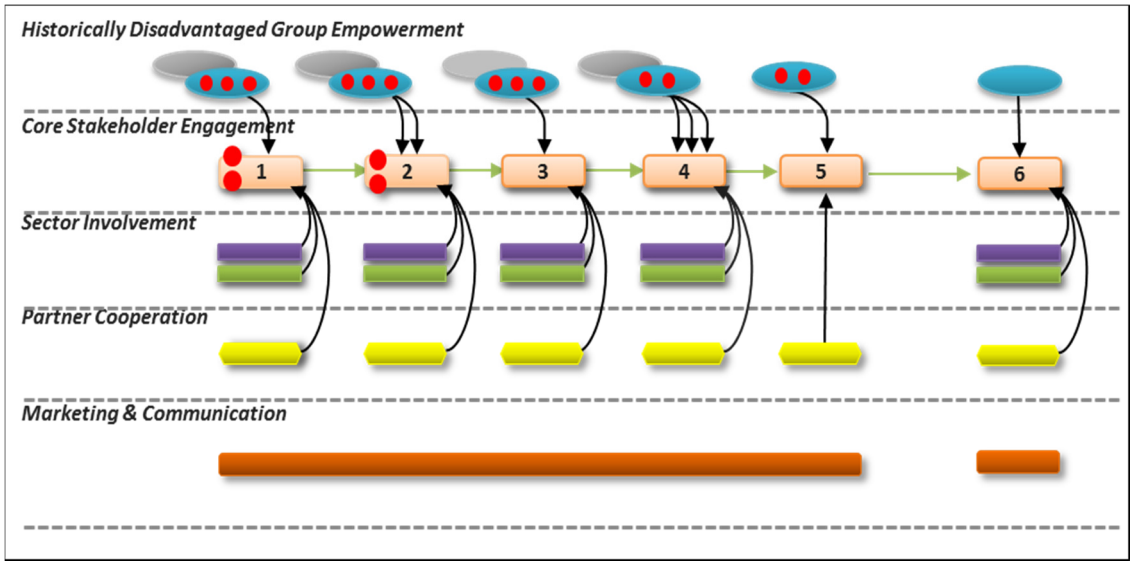


Figure 6-2 : Engagement with different stakeholder groupings

It will often be necessary to provide additional support to some groups in order to help them for prepare for stakeholder meetings, and so these would need to be held in advance of stakeholder engagement sessions. These empowerment sessions would not only take the participants through the subject matter for the meeting that lies ahead, but importantly would expose the participants to the types of issues that will be raised and the level of discussion and debate that will be held.

The core engagement often needs to be supported by sessions with sector partners such as agriculture, industry and mining, as well as similar sessions with partners that could include local government, provincial government and sister departments. Lastly, broader public awareness may be required and this would be supported through marketing and communication.

In implementing this IWRM Plan some elements of the above will be required for certain projects, but by no means not all. It is important to scope out the scope, scale and form of engagement processes in advance of project initiation.

7. Monitoring and Evaluation

7.1 Overview

Monitoring and evaluation is required to ensure that the various components of implementation of the IWRM Plan are **on track** and that they will lead to the **desired outcomes,** essentially progress towards meeting the strategic objectives and realising the Vision. A monitoring and evaluation system is only effective if the understanding of the desired outcomes is clear and measurable in some way, hence the development of indicators is critical. The selection of indicators is facilitated by the work done under the SWOT analyses and a clear understanding of targets over time.

The overall aim of this task can be seen in two distinct parts:

- To develop a monitoring and evaluation framework with suitable indicators to track the progress towards the achievement of the strategic objectives of the IWRM Plan and
- To provide feedback on the implementation process in terms of whether actions are being carried out according to the planned timeline and on budget.

The first of these concerns the monitoring and evaluation of "success" indicators. If application of the monitoring and evaluation framework shows these success indicators are not being met, this would imply

- either that there may be problems with the basic design of some of elements of the IWRM Plan or the implementation strategy **OR**
- that the Plans is not being executed timely or according to specification

The second level of monitoring and evaluation is designed to check the second of these two bullet points. The process is summarised in Figure 7-1.

In the rest of this chapter we distinguish between "success" indicators, which relate to progress towards achievement of the strategic objectives and "process" indicators, which relate to progress with the correct and timeous implementation of planned actions and activities.

It should be noted that the monitoring and evaluation programme is an integral part of the IWRM Plan and not something outside of it. This chapter serves merely to explain how it will operate. The actual monitoring and evaluation activities are included in the Plan already presented in Chapter 5.

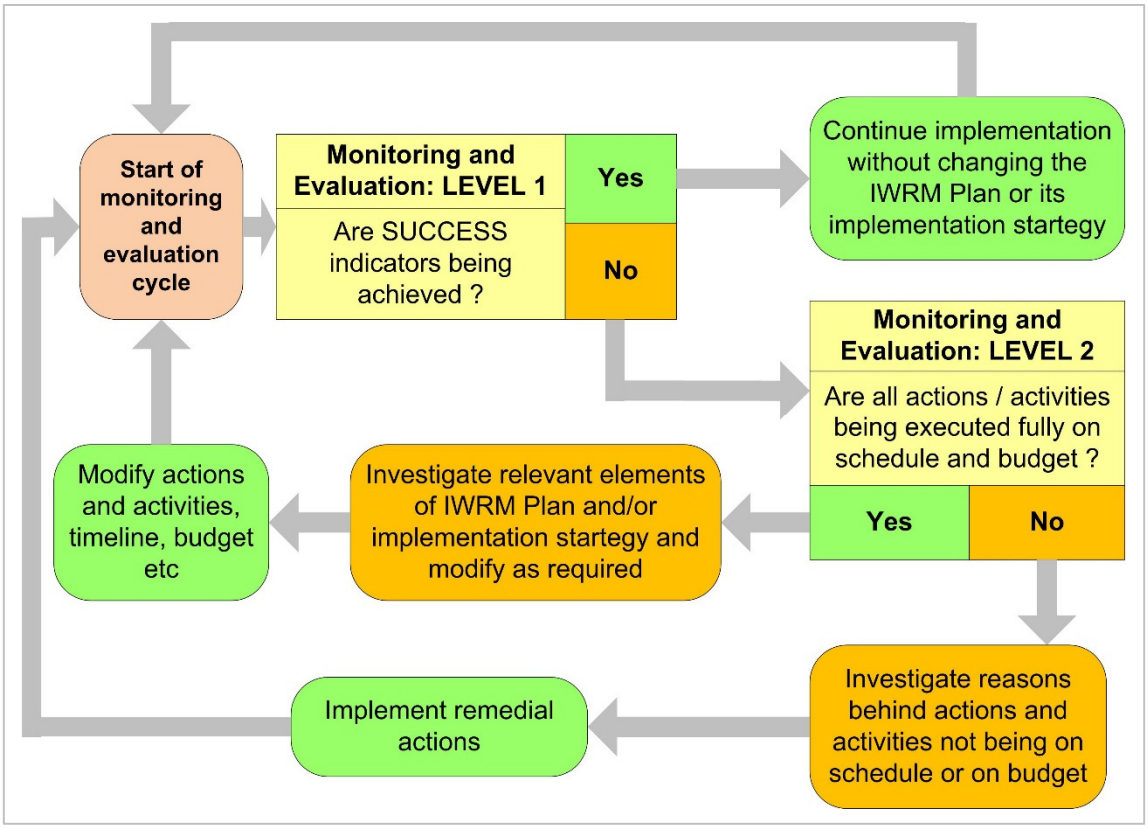


Figure 7-1: Monitoring and evaluation process for the IWRM Plan

7.2 MONITORING AND EVALUATION OF PROGRESS / SUCCESS

7.2.1 Monitoring and evaluation framework

7.2.1.1 Success indicators

This relates directly back to Chapter 4 in which the justification of the strategic objectives have been presented and explanation of what the strategic objectives imply, provided. It is not possible at this stage to clearly define a complete set of indicators of progress towards realization of the central strategic objectives, since some of the groundwork for doing this will only be done as part of some of the Plan's early actions. What follows in the remainder of this section of the report is the identification of a guideline set of indicators. In some cases the proposed indicators could be used immediately, in some cases further work is required to properly define and/or measure them adequately. This will happen as some of the early actions and activities of the Plan are implemented.

The detailing of indicators of progress towards the achievement of strategic objectives (success indicators) takes into account the action areas under each strategic objective. They are summarized in Table 7-1.

Table 7-1: Indicators of progress towards achievement of strategic objectives

1.Ensure the optimized sustainable management of the basins water resources	2.Support socioeconomic upliftment and eradication of poverty in the basin	3.Ensure that the adverse effects of catchment degradation are reduced and the sustainability of resource use is improved	4.Maximize security from water-related disasters (especially flood and drought)
KNOWLEDGE BASE • % of basin for which hydrological assessments < 10 years old **OPTIMISED MANAGEMENT** • Number of schemes using proper scientific operating rules • Assurance of water supply based on economic principles • % of basin (or potential runoff) for which CC has been taken into account **PLANNING/MODELLING TOOLS** • WRYM updated when hydrology or infrastructure updates occur or yields required for special cases • WRPM updated on annual basis part of AOA, updated demands, start storage levels at operating decision dates. • Major updates carried when hydrology is updated • Proportion of the WRPM system that include surface water / groundwater interaction modelling • Number of sub-systems that form part of annual operating analysis and related updates **TRANSBOUNDARY and SECTORAL COOPERATION** • Frequency of transboundary planning meetings involving > ½ of the countries • Level of Involvement of countries and water use sectors in updates for annual operating analysis	**GENERAL OVERALL INDICATORS** • UNDP Human Poverty Index albeit that it may not be possible to distinguish the role of the Plan in improving or reducing the index) • Sustainable yield (m^3/a) available per capita for the basin as a whole and within each country (includes imported water) • Water demand / Consumption m^3/a per capita **SECTORS AND SERVICES** • % of people with access to potable water basin-wide and by country/district; • % of people with access to sanitation basin-wide and by country/district • Number of MW installed capacity and GWh/year generated in the basin, disaggregated by type (HP, thermal etc) • % of people connected to the electricity grid basinwide and in each country/district • Number of ha/ Mm3 delivered to irrigation basinwide and in each country/district; • Number of people employed in the irrigation sector basinwide and in each country/district ; • Annual production of irrigation schemes disaggregated as appropriate;	**WATER QUALITY** • Levels of concentration of a set of key water quality variables at key monitoring sites basin-wide. (To be related to agreed basin-wide water resources water quality objectives). (JBS) • Fuller incorporation of salinity modelling into the water resources modelling system to allow m & e of salinity levels at key locations against those predicted • Based on the work done and planned on POPs, there is a need to monitor trends of ley POPs at the identified high risk areas. **LAND DEGRADATION** • % implementation of basin-wide integrated watershed management "action" plan • Areas of land actively applying integrated watershed management "best" practices; • Average crop yields for selected rainfed areas. • Levels of sediment transport in some selected streams; • Rate of sedimentation in Gariep Dam and other selected dams/reservoirs • Change in base flows in some selected streams in source areas. • Area of wetlands basinwide and by country in good condition; • % land area over to invasive aliens basinwide and by country/zone **ENVIRONMENTAL FLOW REQUIREMENTS** • Degree to which recommendations are being implemented • Indicators of effect – is the EFR regime having the desired effect?	**DIRECT EFFECT OF MEASURES** • Monitoring of peak flood magnitude and minimum discharge at key stations (trends) • Magnitude of seasonal minimum and maximum discharge. **INDIRECT EFFECT OF MEASURES** • Number of people killed by floods per year basinwide and in each country/district • Cost of flood damage per year basinwide and in each country/district • Population (or %) affected with water supply restrictions > 1 month basinwide and by country/district • Number of schemes using curtailment of demands as part of the operating rule. • Are occurrence of curtailments aligned with the required water supply assurance and from when (date) is the curtailment criteria exceeded • % of irrigation water demands supplied • Value of irrigation produce per annum basinwide or by country/district

7.2.1.2 Progress indicators

OVERVIEW

The other side of monitoring and evaluation refers to evaluation of progress of implementation of planned actions and activities, irrespective of whether they are achieving the desired progress towards realization of the strategic objective. These are much more straightforward to design at least in terms of whether activities are being performed according to the programme or not. More complicated is the design of mechanism to react to the delays that monitoring and evaluation system may highlight. It is the ability of programme management to react to an identified problem that will ensure the sustainability of the programme.

BUDGET PLANNING

The complete set of excel spreadsheets describing the activities to be implemented (see Figure 6-1) has been incorporated into the budget planning tab "ORASECOM Monitoring and Evaluation Tool, developed on the MS Excel platform. This ORASECOM Monitoring and Evaluation matrix has been developed by ORASECOM Secretariat between July and December 2014 to monitor the progress and success of programmes of the Integrated Water Resource Management Vision of the Commission from 2015 to 2024. The budget planning tab will provide ORASECOM with the necessary basic budget planning tool for the entire IWRM Plan.

As these spreadsheets are updated as part of the regular review of the IWRM Plan process, so also will they be updated in this matrix.

PROGRESS WITH IMPLEMENTATION

It is envisaged that the ORASECOM Secretariat will play the leading role in coordinating the monitoring and evaluation of progress with implementation of the IWRM Plan. Implementation of the Plan is described using an annual time step (see Figure 6-1). It is anticipated that activities that are planned for the next 12-24 months will be detailed using a quarterly time step and that this will be done by the Secretariat in consultation with the task teams.

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ANNEXES

Annex 1: Water transfers within, into and out of the Orange-Senqu Basin

Transfer scheme	From	To	Purpose; Details	Capacity (m^3/s)
Lesotho Highlands Transfer System	Senqu	Vaal	Urban/industrial water supply in Gauteng; Water is transferred from Katse and Mohale dams in Lesotho Highlands in support of Vaal Dam.	35.7
Thukela-Vaal Transfer Scheme	Upper Thugela	Upper Vaal	In support of Boemhof sub-system yield; Scheme transfers water from Woodstock Dam and Driel Barrage to Sterkfontein Dam.	19.0
Heyshope to Grootdraai Transfer Scheme	Upper Usutu (Inkomati)	Upper Vaal	In support of Boemhof sub-system yield; Transfer from Heyshope in the Upper Usutu catchment (Assegaai River) in support of Grootdraai Dam	3.8
Zaaihoek Transfer Scheme	Upper Thugela	Upper Vaal	1. Majuba Power Station and 2. Support to Grootdraai dam; Water from Zaaihoek (Slang River/larger Buffalo River) in the Tukela basin to the Upper Vaal	2.97
Vaal-Olifants Transfer Scheme	Upper Vaal	Upper Olifants (Limpopo)	Transfer from Grootdraai Dam in support of the Sasol Secunda complex and Eskom Power Stations	6.5
Inkomati Transfer System	Komati West (Inkomati)	Upper Olifants (Limpopo)	Transfer from the Nooitgedacht and Vygeboom Dams in the Komati West catchment to the Upper Olifants catchment for the Eskom Power stations. Used as an alternative, relieving pressure on Vaal	5.67
Vaal Eastern sub-system Augmentation Project	Upper Vaal	Upper Olifants (Limpopo)	Transfer from Vaal Dam to the Sasol Secunda complex as well as the Eskom Power Stations in the Upper Olifants, when the water from Grootdraai Dam in not sufficient for this purpose	5.07
Usutu Transfer System	Upper Usutu (Inkomati)	Upper Olifants (Limpopo)	Transfer from Morgenstond, Jericho and Westoe dams to the Eskom Power Stations in the Upper Olifants. This sub-system, can also receive support from the Heyshope Transfer System and can in turn also support the Komati sub-system	??
Caledon-Modder Transfer	Caledon	Modder	Bloemfontein and surrounding areas pull water from the Caledon system (Welbedacht and Knellpoort dams) when there is insufficient water in the Modder system	1.4 (2.3[1]); 1.68
Orange-Fish (Eastern Cape) Transfer	Orange	Fish and Sundays	The water is mainly used for irrigation purposes, but also supplies several towns with water as well as Port Elizabeth by means of an abstraction at the downstream end of this system; Transfer from Gariep Dam Orange River to Fish and eventually also to the Sundays River in the Eastern Cape	54
Orange-Riet Transfer	Orange	Riet	Primarily used for irrigation purposes, but also supplies urban requirements of Koffiefontein, Ritchie and Jacobsdal; Transfer by means of a canal and pump system from Vanderkloof Dam over the water shed to the Riet River catchment	15.6
Orange-Vaal Transfer	Orange	Vaal	The bulk of the transfers are used for irrigation purposes, with a small portion also supplied to but the town of Douglas; Transfer from Marksdrift Weir Orange River) to Douglas Weir at the downstream end of Vaal River.	6

Annex 2: Detailing of specific actions and activities for each Action Area

Introduction

The strategic actions, specific actions and associated activities are provided in the following pages for the following Action areas:

- 1.1: Surface and groundwater assessments
- 1.2: Optimising efficient utilisation, development, adaptive management of water resources
- 1.3: Inter/Intra-sectoral planning and coordination (Horizontal and vertical alignment)
- 2.1: Equitable utilisation of (the basin's) water resources
- 2.2: Water resources development
- 3.1: Improving water resources quality
- 3.2: Catchment degradation, watershed management, settlement and land-use planning
- 3.3: Environmental water requirements
- 4.1: Flood and drought mitigation, extreme events, climate proofing
- 5.1: Water resources and associated environmental data and information
- 5.2: Water use and demand data and information
- 6.1-11.1: Promotion/ maximising mainstreaming of key cross-cutting and enabling actions

Level of ORASECOM Involvement

- Potential ORASECOM involvement, as indicated in Figure 6.1, is classified as one of the following:
  - **Execute**: There may be some limited instances where the Secretariat or Technical or Communications Task Teams or Council actually carries out some tasks themselves
  - **Manage:** Typically work by consultants under supervision of ORASECOM Secretariat/Task Teams
  - **Facilitate**: Typically playing an active role in coordination across borders, with ICPs etc
  - **Support**: Similar to facilitate but more passive
  - **Review**: Typically review relevant studies/projects etc that may be presented to ORASECOM from time to time

Transboundary and/or nationally implemented activities

Activity with transboundary component(s)

Activity with national component(s)