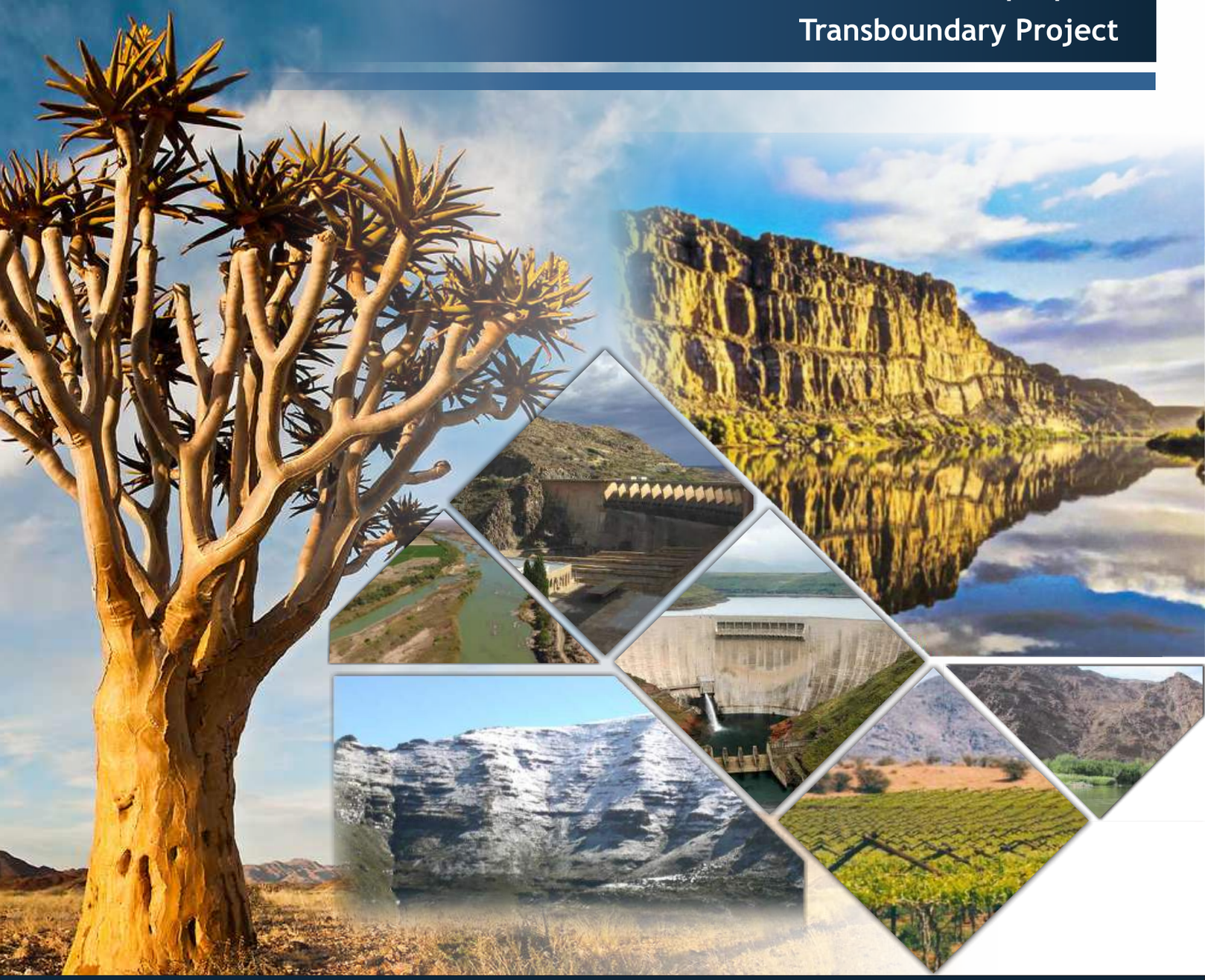
The Orange-Senqu River Commission (ORASECOM)

Sharing the Water Resources of the Orange-Senqu River Basin

Botswana | Lesotho | Namibia | South Africa

Contract No.: P-Z1-EAZ-048/CS/01

Preparation of Climate Resilient Water Resources Investment Strategy & Plan and Lesotho-Botswana Water Transfer Multipurpose Transboundary Project

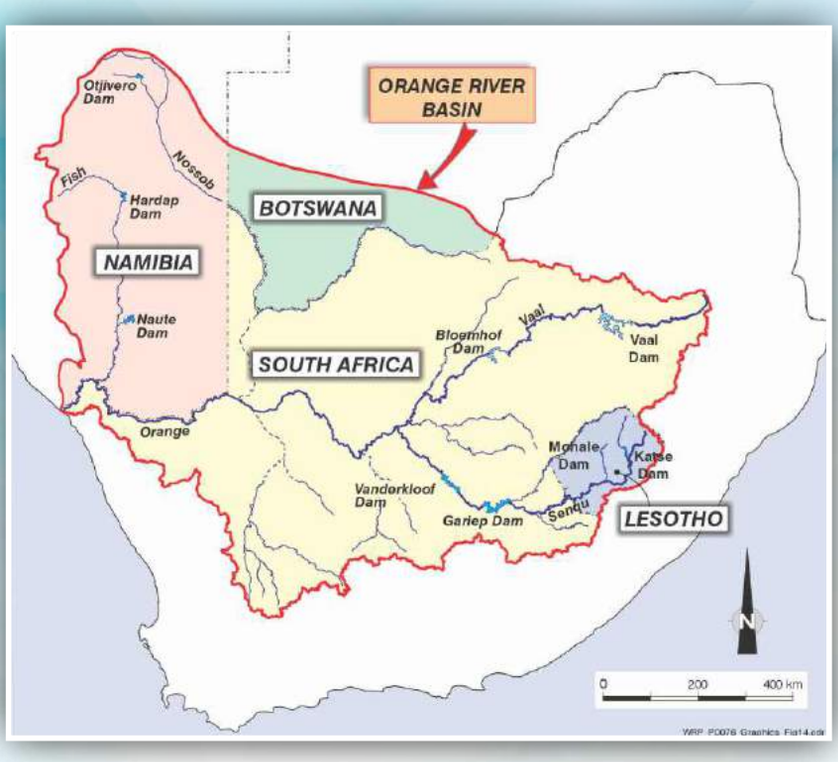


Climate Resilience Investment Plan

Report number: ORASECOM 012D/2019

The Orange-Senqu River Basin

The Orange-Senqu River basin is one of the largest river basins south of the Zambezi with a catchment area of approximately 1 million km^2. It encompasses all of Lesotho as well as a significant portion of South Africa, Botswana and Namibia. The Orange-Senqu River originates in the Highlands of Lesotho and flows in a westerly direction for approximately 2,200 km to the west coast of South Africa and Namibia where it discharges into the Atlantic Ocean.



The runoff values provided highlight the highly variable and uneven distribution of runoff from east to west in the basin and the various water demands have already reduced the actual runoff reaching the river mouth to less than half the natural runoff at approximately 4 000 million m^3/a.

It is important to note that the current demands for water within the basin are basically in balance with the available yields from the many different dams and transfer schemes. In view of the current balanced water resource situation, any new development in the basin may cause a shortage to the downstream consumers. It is therefore important to analyse all possible new dam developments to assess their impacts on the downstream users and to provide additional yield where necessary to rebalance any shortages.

This is an important issue that must not be overlooked or ignored in order to ensure friendly co-operation between the 4 Basin States when addressing further water resource developments in the Orange-Senqu basin.

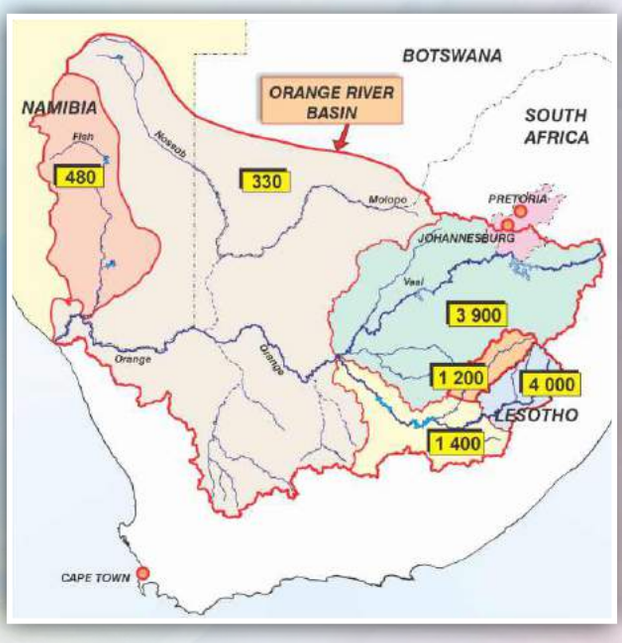
The Yield from a reservoir/dam is the amount of water that can be abstracted each year from the reservoir without failure or at an agreed risk of failure/assurance of supply.

Assurance of Supply is the measure of reliability of an abstraction from a particular reservoir/dam. Different user groups tend to be supplied at different assurances of supply - for example irrigators my be supplied at a 95% assurance of supply (1 in 20 year risk of failure) while an industrial centre or municipality may be supplied at a 99% assurance of supply (1 in 100 year risk of failure).

Water Resources of the Orange-Senqu River Basin

It has been estimated that the natural runoff of the Orange-Senqu River basin is in the order of 11,300 million m^3/a, of which approximately 4,000 million m^3/a originates in the Senqu basin in the Lesotho Highlands, 6,500 million m^3/a from the Vaal and Upper Orange, with approximately 800 million m^3/a from the Lower Orange and Fish River (Namibia).

The Natural Runoff refers to the runoff which would have occurred had there been no developments (irrigation and municipal abstractions for example) or impoundments in the catchment.



Climate Change

It is generally accepted that Climate Change is likely to affect the water resources of the basin to some degree. It is agreed that the temperature and thus also the evaporation will increase throughout the basin and rainfall is expected to reduce especially in the lower areas to the west of the catchment. With regard to the higher rainfall areas including Lesotho, there is no clear indication if the annual rainfall will increase or decrease and therefore it is not known if the runoff will increase or decrease since most of the runoff is generated in the high rainfall areas. In light of the uncertainties regarding future runoff, a key element of the study is to develop resilience to climate change through strategic projects and actions, some of which are described in the Integrated Water Resource Development Plan. The proposed Lesotho to Botswana Water Transfer Project is effectively a Water Resilience Project aimed at protecting the water supply to Southern Botswana by providing a reliable alternative water source to augment the existing local water resources as well as the supply from Northern Botswana through the North-South Carrier.

ORASECOM and the Integrated Water Resources Development Plan

Southern Africa has fifteen (15) transboundary watercourse systems of which thirteen exclusively stretch over the Southern African Development Community Member States. The Orange-Senqu is one of these thirteen transboundary watercourse systems.

To enhance the objectives of integrated water resources development and management in the region, the Orange-Senqu River Basin Commission (ORASECOM) was established in November 2000. Through ORASECOM an Integrated Water Resources Management Plan was developed and adopted by the Basin States in February 2015. The Integrated Water Resources Development Plan provides a strategic transboundary water resources management framework and action areas and serves as a guiding and planning tool for achieving the long-term development goals in the basin. The Plan recommends strategies and measures for promoting sustainable management of the water resources of the basin and defines strategic actions that will ensure and enhance water security, considering the long term socio-economic and environmental demands on the water resources of the basin.

Objective of this Study

The objective of this study is to assist ORASECOM and the riparian countries to implement various elements of the Integrated Water Resource Management Plan developed in 2015. The objective will be met through the following three processes:

- A Climate Resilient Investment Plan for the Orange-Senqu River Basin based on the updated Core Scenario.

  The Core Scenario is basically a detailed list of new water resource developments which have been planned by the 4 basin states to ensure that future water demands can be supplied taking possible impacts of Climate Change into account.

- A proposed Implementation Plan for a number (nine separate projects have been identified) of Key Strategic Actions selected from the updated Integrated Water Resource Management Plan.

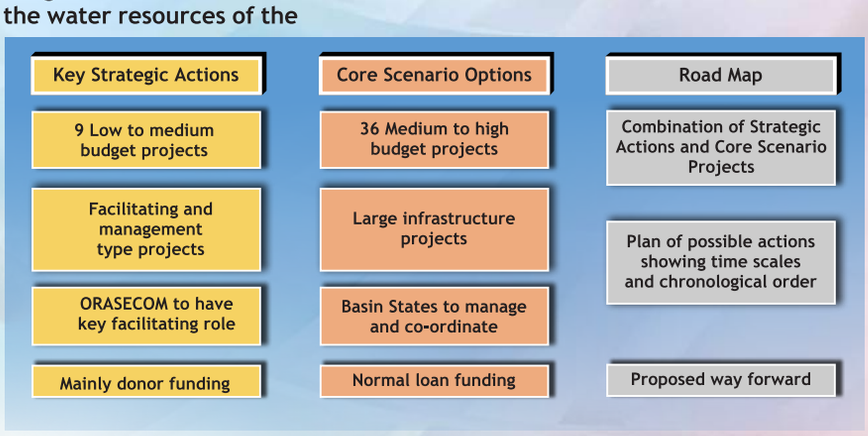
- A Pre-feasibility level report for the Lesotho to Botswana Water Transfer Project, and a feasibility level report for a new dam on the Makhaleng River in Lesotho.

Future Water Resource Developments

As a result of the potential impacts of Climate Change and growing economies, the Governments of Botswana, Lesotho, Namibia and South Africa recently agreed to undertake a Pre-feasibility study on the Lesotho to Botswana Water Transfer Project (L-BWT) aimed at developing a new Dam in Lesotho and a pipeline across South Africa to convey water from Lesotho to Botswana. It was envisaged that up to 156 million m^3/a could eventually be pumped to Botswana with additional supplies for consumers along the route in Lesotho and South Africa (186 million m^3/a total gross transfer).

In addition to the evaluation of the Lesotho to Botswana Water Transfer Project the study also evaluated many other projects. These projects are summarized in the Roadmap Report and include:

- 9 low to medium budget Key Strategic Actions
- 36 medium to high budget Core Scenario Infrastructure Projects



Key Strategic Actions

The nine Key Strategic Actions are as follows:

	Description	Capital Cost ($m)	Running Cost ($m/annum)
1	Agreement and implementation of Environmental Water Requirements	$1m to $5m	$1m per annum
2	Improvement and Implementation of Monitoring and Information Management	$5m	$1m per annum
3	Development and Implementation of Guidelines for sharing	$1m	
4	Synchronisation and preparation of Future and Planned Developments	$1m	
5	Implementation and monitoring of WDM activities	$1m	
6	Assurance of Supply and Economic Value of water	$1m	
7	Water Disaster Management - Climate Adaption	$2m to $3m	
8	Capacity Building		$2m in 3 years
9	Hydrology Update and WQ Model Calibration	$3m	

Strategic Actions are potential projects which will support and facilitate the larger infrastructure Core Scenario Projects where ORASECOM will play a key role in the management and funding of the work.

Strategic Action 1: Environmental Streamflow Requirements
- Design and implement eFlow Monitoring Programme
- Develop Management Plan for the Orange River Mouth

Strategic Action 2: Improvement of Monitoring and Management Information Systems
- Assess and improve hydrological monitoring networks basinwide
- Establish water balances for various river sections
- Set up and calibrate real-time hydraulic river model of Orange River downstream of Vanderkloof Dam
- Test different operating rules for releases from Vanderkloof Dam.

Strategic Action 3: Guidelines for Sharing
- Evaluate existing legislation for water sharing between Basin States
- Workshop the water sharing issues between Basin States
- Formulate agreements on future water sharing between Basin States

Strategic Action 4: Synchronisation of Planned Water Developments
- Establish and agree on net and gross yields for all proposed future water developments
- Establish and evaluate all key operating rules
- Establish and evaluate water related legal agreements between Basin States
- Workshop the key issues and agree on way forward
- Undertake Annual Operating Analyses with all Basin States

Strategic Action 5: Monitoring of Water Demand Management (WDM) Activities
- Identify and evaluate key case studies basinwide
- Create frameworks for WDM projects in Municipal, Industrial and Agricultural sectors
- Assess impacts of future Climate Change on WDM interventions
- Create monitoring and evaluation dashboard for WDM activities basinwide

Strategic Action 6: Assurance of Supply and Economic Value of Water
- Discuss and agree on use of Assurance of Supply basinwide
- Assess economic impact of Assurance of Supply
- Agree on how restrictions will be applied during droughts basinwide

Strategic Action 7: Disaster Management and Climate Adaptation
- Assess economic and social impacts of water supply failure
- Co-ordinate actions needed between Basin States during drought events
- Develop a Drought Management Plan for the basin

Strategic Action 8: Capacity Building
- Agree between Basin States on training needs
- Develop standard video training templates
- Develop training videos for each issue identified by the Basin States
- Set up web site for dissemination of training materials

Strategic Action 9: Hydrology Update and Water Quality Model Calibration
- Agree on hydrological data sets to be updated
- Update the data sets and Water Quality Model calibrations
- Check and test updated hydrological data sets with Stochastic Models
- Incorporate El Nino and La Nina in Stochastic Models where possible
- Assess impacts of Climate Change and verify existing Climate Change Models for preservation of variability
- Update Groundwater Maps for consistency

Core Scenario Projects

The Orange Senqu River basin is one of the most complicated and integrated water resource systems in the world. It covers an area of over 1 million km^2 and includes:

- Over 80 large Dams/Reservoirs
- Over 270 small Dams/Reservoirs
- Over 1200 demand centres (cities, irrigation schemes, power stations etc)
- A system network of over 4 000 links (pipelines, tunnels, river sections etc)
- Over 300 individual naturalised streamflow sequences (monthly records for 90 years)
- Over 300 monthly rainfall records(monthly for 90 years)

In order to effectively manage such a large and complicated water resource system, it is necessary to continually monitor and update the various water demands as well as to plan and commission new water related infrastructure in the form of new dams, pipelines, tunnels etc. The proposed future schemes are discussed by the 4 basin states (Botswana, Lesotho, Namibia and South Africa) on a regular basis and the process is managed and facilitated through ORASECOM which has been created to ensure that all new developments are first discussed and agreed in principle to avoid possible problems in future.

Core Scenario Projects are likely future water resource development projects proposed by one or more of the 4 basin states and comprise 36 individual projects that have been grouped into 9 clusters.

The most likely future development scenario is referred to as the "Core Scenario" and it includes the current and likely future demands for all existing demand centres, as well as all existing water related infrastructure and possible future developments. The future developments include the projected water demands and possible new infrastructure as provided by each of the 4 basin states. Only projects that have been investigated to at least a pre-feasibility level, in that a basic costing has been done, have been included in the "Core Scenario". When considering the detail provided for each possible future project, it is important to note the following:

- All cost estimates provided are estimated based on 2018 price levels unless otherwise stated.
- The cost estimates were all taken from various reports prepared by others.
- Some of these reports were only at a pre-feasibility level of detail while others were at a feasibility level with the result that some cost estimates are more accurate than others.
- The cost estimates quoted in the various reports were escalated to the 2018 price levels, using published government inflation figures.

Furthermore, in future, cost estimates and project viability would need to be verified through detailed feasibility and design level planning studies.

The 36 Core Scenario Projects have been presented in 9 clusters which are each discussed in this report. The nine clusters and related costs and yields are provided in the table below:

	Cluster Name	Capital Cost ($million)	Operational Cost ($million)	Yield Impact (million m^3/a)
1	Orange River Project + Noordoewer/Vioolsdrift options	2 096	6.9	724
2	Lesotho Botswana Water Transfer Scheme	2 856	45.3	162/334*
3	Lesotho Lowlands developments	73	0.3	65
4	Integrated Vaal River System intervention options	1 723	84.4	552
5	Caledon to Greater Bloemfontein internal resource improvements	15	0.6	11
6	Greater Bloemfontein internal resource improvements	82	8.8	31
7	Gariep to Greater Bloemfontein transfer	226	12.1	43
8	Neckartal Scheme in Namibia	26	0.7	90
9	Integrated Water Management Options	337	67.2	308

*Note: * 162 million m^3/a refers to the net transfer volume (186 million m^3/a gross transfer) and 334 million m^3/a to the local yield of the dam which reduced to 308 million m^3/a in feasibility phase due to repositioning of the dam.*

Cluster 1: Orange River Project + Noordoewer/ Vioolsdrift options

The Orange River Project refers to Gariep and Vanderkloof dams and their total supply area. The yield available from this system is currently fully utilised and therefore no new demands can be supplied without adding some additional yield to the system through the construction of new dams/reservoirs or through the reduction of existing demands in some manner.

Several augmentation options have been identified by Department Water and Sanitation South Africa to rebalance the system and allow for some further development along the Orange River. All these augmentation options form part of the Orange River Project Cluster. Due to the significant impact of the new Polihali Dam (under construction) on the Orange River Project it was included as part of this cluster. These options include:

- Utilise the lower-level storage in Vanderkloof Dam yield increase 137 million m^3/a.
- Noordoewer/Vioolsdrift Dam along Namibia RSA border on the Lower Orange with an estimated yield of 280 million m^3/a for a medium size dam. Final size of the dam is still to be determined and agreed on between Namibia and the RSA.
- Polihali Dam and transfer tunnel to Katse Dam forming part of the Lesotho Highlands developments. The local yield of 391 million m^3/a. Construction recently started.
- Verbeeldingskraal Dam upstream of Gariep Dam with an estimated yield of 200 million m^3/a.
- Real time monitoring and modelling, reducing operational requirements by approximately 80 million m^3/a.

Cluster 2: The proposed Lesotho to Botswana Water Transfer Scheme

This project includes a large dam (storage of three times the mean annual runoff) on the Makhaleng River plus a 688 km pipeline (diameter from 2 200mm to 1 100mm) from Lesotho to Gaborone/Lobatse. The pre-feasibility study for this transfer scheme was completed with the Feasibility Study in progress at the time of writing this document (November 2023). This dam has a local yield of 344 million m^3/a of which an annual gross transfer of 186 million m^3/a will be transferred to users in Lesotho and the RSA, with the bulk of that (156 million m^3/a) transferred to Botswana.

Cluster 3: The Lesotho Lowlands Dams

These dams comprise two proposed dams, supplying urban/rural demands and irrigation developments within Lesotho, namely:

- Hlotse Dam; and
- Ngoajane Dam.

The final size and yield from these two dams still need to be determined.

Cluster 4: The Integrated Vaal River System Intervention Options

The Vaal River System Intervention Options include:

- Further phases of the transfer from the Thukela River;
- Utilising the Crocodile River Return Flows in Tshwane (Pretoria) to reduce the demand from the Vaal River via the Rand Water Board supply system; and
- Desalination and re-use of mine water effluent.

The proposed further phases of the Thukela River Water Transfer comprise two new dams at Jana on the main tributary of the Thukela River and the Mielietuin Dam on the Bushmans River (a tributary of the Thukela River) with new pipelines and pump stations linking these dams to the existing Thukela Water Transfer Scheme.

Cluster 5: Caledon to Greater Bloemfontein Transfer

The intervention options to increase the water supply from the Caledon/Mohokare River include the following:

- Increase the total pump capacity at the Tienfontein Pump Station to 3.87 m^3/s.
- Increase the Novo transfer capacity to 2.2 m^3/s.
- Further increase the total pump capacity at Tienfontein pump station to 7 m^3/s by 2040.

Cluster 6: Greater Bloemfontein Internal Resource Improvements

Several components form part of Cluster 6 which include the following:

- Raise Mockes Dam
- Increase the Maselspoort Water Treatment Works capacity to 130 Ml/d
- Indirect re-use of 16 million m^3/a from the Bloemspruit Waste Water Treatment Works
- Direct re-use of 11 million m^3/a to be fed directly into the water supply system at the Maselspoort Water Treatment

Cluster 7: Gariep to Greater Bloemfontein Transfer

The projects covered under Cluster 7 include:

- Phase 1: Transfer from Gariep Dam to Bloemfontein of 32 million m^3/a by means of a pump station and pipeline.
- Phase 2: Inclusion of a booster pump station increasing the transfer capacity by another 11 million m^3/a, to a total transfer capacity of 43 million m^3/a.

Cluster 8: Neckartal Scheme

The Neckartal Dam located in the lower Fish River in Namibia was completed in 2018 and has been storing water since that time. It is not discussed further in this document.

Cluster 9: Integrated Water Management Options

The integrated water management options comprise several components which include the following:

- Removal of unlawful irrigation.
- Water Conservation and Water Demand Management within irrigation schemes.
- Water Conservation and Water Demand Management in the urban and industrial sectors.
- Increasing the area of water use permit/licence coverage.
- Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields, and other characteristics).
- Manage salinity.
- Manage eutrophication.
- Management and control of alien and invasive species and problem pests.
- Set water quality objectives/standards.
- Consolidation of climate data and extreme event data at basin level.

Funding Options

The proposed Lesotho-Botswana Transfer Project is one of the main elements of the current study and comprises a possible new dam on the Makhaleng River in Lesotho together with a 700km long pipeline from Lesotho to Botswana. The project has an expected cost of approximately $3 billion at 2018 cost levels based on R18/$ exchange rate. Approximately 10% of the overall project cost is associated with the construction of the dam while the remaining 90% is associated with the pipeline and pump stations. The project can include a small hydropower installation which will require a further $60 million should this be included.

The funding requirements of the Lesotho to Botswana Water Transfer Project as well as many of the Core Scenario Projects are so large that they cannot be secured by any single member of the 4 basin states. The Lesotho to Botswana Water Transfer Project, in particular, will require funding from several countries as well as some form of grant funding and Government Guarantees to support the normal loan funding. This means that even with a Public Private Partnership option, the governments will still be required to underwrite the project.

Road Map Report and Way Forward

Each Key Strategic Action and Core Scenario Project is discussed in detail in the "Road Map" report which aims to pull all the proposed projects together into a single coherent plan. Timelines and budgets for each project have been provided to assist possible funding partners to assess the various projects and determine if they wish to participate in them. A key aim of the "Road Map" Report is therefore to summarise the projects through a series of "Concept Notes" (Appendix B and Appendix C) which provide sufficient information for possible Funding Partners to understand the scope of the project and likely funding requirements without having to digest the many lengthy reports which contain the full detail of each project.

The proposed way forward involves the implementation of the various water related projects in a manner in which they can provide additional yield to users in the river basin without damaging the supply to existing demand centres. A proposed action plan has been developed which is presented in a series of figures (Road Map Timeline) which show the proposed commencement dates for each project together with the duration of each project. Where appropriate, the linkages with other projects have been included to highlight where specific projects are linked to each other to ensure that they are implemented in the correct sequence to minimise any water supply problems to existing users. A full description of the various projects and linkages is provided in the main report.

Technical Reports Providing Additional Details and Information

ORASECOM Report	Report No.
Inception Report Components I and II	ORASECOM 010/2018
Inception Report Components III and IV	ORASECOM 011/2018
Preparation of climate resilient water resources investment strategy & plan Component I	
Core Scenario Update Report Component I	ORASECOM 003/2019
Core Scenario Supporting Report: Water Requirements and Return flows Component I	ORASECOM 004/2019
Core Scenario Supporting Report: Water Conservation, Water Demand management and Re-use Report Component I	ORASECOM 005/2019
Core Scenario Supporting Report: Ground Water Report Component I	ORASECOM 006/2019
Climate Change Report Component I	ORASECOM 007/2019
Review and assessment of existing policies, institutional arrangements and structures Component I	ORASECOM 008/2019
Optimized IWRMP Core Scenario economic approach Report Component I	ORASECOM 009/2019
Climate Resilient Water Resources Investment Plan Report Component I	ORASECOM 010/2019
System analysis Report Component I	ORASECOM 011/2019
Preparation of climate resilient water resources investment strategy & plan Component II	
Roadmap for IWRMP Operationalization Report Component II	ORASECOM 012/2019
Roadmap for IWRMP Operationalization Executive Summary	ORASECOM 012A/2019
Roadmap for IWRMP Operationalization: Appendix B Strategic Actions Concept Notes	ORASECOM 012B/2019
Roadmap for IWRMP Operationalization: Appendix C Core Scenario Concept Notes	ORASECOM 012C/2019
Climate Resilience Investment Plan (Brochure)	ORASECOM 012D/2019
Roadmap supporting Report: Strategic actions and TORs (Appendix A to Roadmap Report)	ORASECOM 013/2019
Lesotho-Botswana water transfer multipurpose transboundary project Component III Pre-feasibility Phase	
Pre-feasibility report Phase 1 Report Component III	ORASECOM 014/2019
Pre-feasibility report Phase 2 Report Component III	ORASECOM 015/2019
Report A Phase 2: Dam on the Makhaleng River	ORASECOM 015A/2019
Report B Phase 2: Water Conveyance System	ORASECOM 015B/2019
Report C Phase 2: Environmental and Social Assessment	ORASECOM 015C/2019
Report D Makhaleng River Ecological Water Requirements	ORASECOM 015D/2019
Lesotho-Botswana water transfer multipurpose transboundary project Component IV - Feasibility Phase	
Feasibility Study Interim Report Component IV	ORASECOM 016/2019
Feasibility Study Report Component IV	ORASECOM 017/2019

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