

# Policy, Legal and Institutional Development for Groundwater Management in the SADC Member States (GMI-PLI)



Gap Analysis and Action Plan – Scoping Report (Final)  
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This report emanates from the project Policy, Legal and Institutional Development for Groundwater Management in the SADC Member States (GMI-PLI) commissioned by the Southern African Development Community Groundwater Management Institute (SADC-GMI), and executed by Pegasys.

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## FOREWORD

The Southern African Development Community (SADC) Member States, through the support of International Cooperating Partners have gone through a series of Water Sector Reforms which varied in terms of policy, legal and institutional development. The focus of the water sector reforms has been on Integrated Water Resources Management and aimed at achieving sustainable and equitable distribution of water resources in the respective Member States. To a large extent, the water sector reforms did not comprehensively address the sustainable management of groundwater resources, yet 70% of the population in the SADC region depend on it. Climate change continues to negatively affect the availability of surface water, placing significance reliance on the use of groundwater for both urban and rural supply throughout the region. Human wellbeing, livelihoods, food security, ecosystems, natural habitats, industries and urban centres growth throughout the SADC Region are increasingly becoming more reliant on groundwater. The SADC region in general has an abundance of groundwater resources. However, due to several factors which include the lack of an enabling policy, legal and institutional environment, only an estimated 1.5% of the available renewable groundwater resources are currently being utilised.

It is estimated that there are about 30 Transboundary Aquifers (TBAs) and 15 transboundary river systems and that these systems are central to the water security of the region. There is therefore a need for Members States to establish and strengthen existing policy, legal and institutional frameworks to achieve equitable and sustainable access to water resources through joint management of the transboundary resources. It is in view of the above and in response to the need to strengthen the sustainable use of groundwater resources conjunctively with surface water at both the national and regional level, that the Southern African Development Community – Groundwater Management Institute (SADC-GMI) was established by the SADC Secretariat, on behalf of the Member States.

The vision of the SADC-GMI is, “to be a Centre of Excellence in promoting equitable and sustainable groundwater management in the SADC region”. The key focus areas of SADC-GMI are to 1) advocate, raise awareness and provide technical support in SADC around sustainable management through the dissemination of information and knowledge; 2) create an enabling environment for groundwater management through policy, legal and regulatory frameworks; 3) promote action-oriented research; 4) promote impact-oriented capacity building and training for groundwater management in the region; 5) lead and promote regional coordination for groundwater management; and 6) support infrastructure development for groundwater management.

In pursuance of the focus area of creating an enabling environment, SADC-GMI implemented the project entitled “Policy, Legal and Institutional Development for Groundwater Management in the SADC Member States, (GMI-PLI)”. The methodology for said project included the development of the Desired Future State, conducting a baseline study of best practices, and description of policy, legal and institutional frameworks which promote sustainable groundwater management. Using an in-Country Experts model, a systematic analysis of the existing policy, legal and Institutional frameworks in comparison with the Desired Future State was conducted to identify gaps that required to be addressed in order to fulfil the SADC-GMI mandate – to achieve sustainable groundwater management in all 16 SADC Member States. The analytical assessment of the gaps identified at national level culminated in the production of 16 National Gap Analysis & Action Plan Reports and the higher-level Regional Gap Analysis Report. The latter summarises the findings across the SADC region.

This National Gap Analysis for Seychelles provides an overview of the existing gaps in policy, legislation, strategy, guidelines and the institutional frameworks and further suggests enablers required to unlock the identified gaps/challenges. The report provides a clear guidance for Seychelles to develop an implementation roadmap through a process of prioritising the Strategic Actions in close liaison and in consultations with all relevant stakeholders. It is hoped that these National/Regional Gap Analysis and Action Plan Reports will aid Seychelles to develop their own Roadmap which will ultimately advance the groundwater narrative and bring it at par with surface water in terms of policy, legal and institutional frameworks which will no doubt enhance sustainable groundwater management at a national and regional level in the SADC Region.

James Sauramba  
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## DOCUMENT INDEX

Presented in the table below is a list of products developed during the GMI-PLI Project:

Phase	Document	Report No.
<b>Country Reports</b>	Gap Analysis and Action Plan – Scoping Report: Angola	1.1
	Gap Analysis and Action Plan – Scoping Report: Botswana	1.2
	Gap Analysis and Action Plan – Scoping Report: Democratic Republic of Congo	1.3
	Gap Analysis and Action Plan – Scoping Report: Kingdom of Eswatini	1.4
	Gap Analysis and Action Plan – Scoping Report: Lesotho	1.5
	Gap Analysis and Action Plan – Scoping Report: Madagascar	1.6
	Gap Analysis and Action Plan – Scoping Report: Malawi	1.7
	Gap Analysis and Action Plan – Scoping Report: Mauritius	1.8
	Gap Analysis and Action Plan – Scoping Report: Mozambique	1.9
	Gap Analysis and Action Plan – Scoping Report: Namibia	1.10
	<b>Gap Analysis and Action Plan – Scoping Report: Seychelles</b>	<b>1.11</b>
	Gap Analysis and Action Plan – Scoping Report: South Africa	1.12
	Gap Analysis and Action Plan – Scoping Report: Tanzania	1.13
	Gap Analysis and Action Plan – Scoping Report: Zambia	1.14
	Gap Analysis and Action Plan – Scoping Report: Zimbabwe	1.15
	Gap Analysis and Action Plan – Scoping Report: Comoros	1.16
	Tanzania GW-PLI Roadmap	1.17
	Kingdom of Eswatini GW-PLI Roadmap	1.18
<b>Regional Reports</b>	Regional Gap Analysis and Action Plan	2
<b>Groundwater Management Guidance Documents</b>	Development of a Groundwater Policy, Legal and Institutional Roadmap	3.1
	Operation and Maintenance of Groundwater Schemes	3.2
	Building Groundwater Resilience	3.3.
	Institutionalisation of Groundwater Management	3.4
	Strategic Approach to Financing Groundwater Management	3.5

## CONTENTS

<b>FOREWORD.....</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>iv</b>
<b>DOCUMENT INDEX .....</b>	<b>v</b>
<b>LIST OF FIGURES .....</b>	<b>viii</b>
<b>LIST OF TABLES.....</b>	<b>viii</b>
<b>LIST OF ACRONYMS .....</b>	<b>ix</b>
<b>1. INTRODUCTION .....</b>	<b>1</b>
1.1 Background to the GMI-PLI Project.....	1
1.2 Socio-economic drivers for Seychelles.....	1
1.3 Water resources .....	2
1.3.1 Status of water resources (surface water, groundwater and transboundary) .....	2
1.3.2 Groundwater environment and ecology .....	5
1.3.3 Status of groundwater infrastructure .....	6
1.3.4 Groundwater supply and demand .....	8
<b>2. METHODOLOGY .....</b>	<b>9</b>
2.1. Overview.....	9
<b>3. POLICY.....</b>	<b>13</b>
3.1 Evolution.....	13
3.2 Policies to support groundwater management .....	13
3.3 Gaps and challenges identified .....	14
3.4 Enablers required to unlock these gaps/challenges .....	16
<b>4. LEGISLATION.....</b>	<b>18</b>
4.1 Evolution.....	18
4.2 Legislation to support groundwater management .....	18
4.3 Gaps and challenges identified .....	19
4.4 Enablers required to unlock these gaps/challenges .....	22
<b>5. STRATEGY AND GUIDELINES .....</b>	<b>24</b>
5.1 Evolution.....	24
5.2 Strategies and guidelines to support groundwater management .....	24
5.3 Gaps and challenges identified .....	25
5.4 Enablers required to unlock these gaps/challenges .....	26



<b>6. INSTITUTIONAL FRAMEWORK .....</b>	<b>27</b>
6.1 Evolution.....	27
6.2 Institutional arrangements to support groundwater management .....	28
6.3 Gaps and challenges identified .....	28
6.4 Enablers required to unlock these gaps/challenges .....	31
<b>7. CHALLENGES TO IMPLEMENTATION .....</b>	<b>32</b>
<b>8. ACTION PLAN .....</b>	<b>33</b>
<b>9. REFERENCES.....</b>	<b>35</b>
<b>Appendix A: Literature Inventory List.....</b>	<b>36</b>
<b>Appendix B: Stakeholder List .....</b>	<b>41</b>
<b>Appendix C: Desired Future State Summary .....</b>	<b>46</b>



## LIST OF FIGURES

<b>Figure 1:</b> Methodology Outline .....	9
<b>Figure 2:</b> WMIs that have relevance to groundwater management .....	27

## LIST OF TABLES

<b>Table 1:</b> Enablers required to unlock the policy gaps and challenges .....	16
<b>Table 2:</b> Sectoral legislation and implications for groundwater management and overview of proposed Water Act .....	18
<b>Table 3:</b> Sectoral legislation and implications for groundwater management.....	22
<b>Table 4:</b> Strategic themes and actions .....	24
<b>Table 5:</b> Enablers required to support strategy and guidelines implementation.....	26
<b>Table 6:</b> Current and Proposed Functions of Agencies and institutions in groundwater resource management .....	28
<b>Table 7:</b> Enablers required to unlock the institutional gaps and challenges .....	31
<b>Table 8:</b> Action Plan “Must Haves” .....	33
<b>Table 9:</b> Action Plan “Should Haves” .....	33
<b>Table 10:</b> Action Plan “Could Haves” .....	34
<b>Table 11:</b> Action Plan “Won’t Haves” .....	34

## LIST OF ACRONYMS

ACRONYM	DEFINITION
<b>AG</b>	Attorney General
<b>CAMS</b>	Climate Adaptation and Management Section
<b>CIWA</b>	Cooperation in International Waters in Africa
<b>EAPS</b>	Environment Appraisal and Permits Section
<b>EBA</b>	Ecosystem Based Adaptation
<b>EEZ</b>	Exclusive Economic Zone
<b>EPA</b>	Environment Protection Act
<b>GCCA+</b>	Seychelles Global Climate Change Alliance + Climate Change
<b>GDP</b>	Gross Domestic Product
<b>GEF</b>	Global Environment Facility
<b>GESI</b>	Gender, equity and social inclusion
<b>GMI-PLI</b>	Groundwater Management Institute – Policy, Legal and Institutional
<b>GoS</b>	Government of Seychelles
<b>GW</b>	Groundwater
<b>IAEA</b>	International Atomic Energy Agency
<b>ICSMPS</b>	Integrated and Comprehensive Sanitation Master Plan for Seychelles
<b>IMF</b>	International Monetary Fund
<b>IPCC</b>	The Intergovernmental Panel on Climate Change
<b>IWRM</b>	Integrated Water Resources Management
<b>LDN</b>	Land Degradation Neutrality
<b>LDN-TSP</b>	Land Degradation Neutrality – Target Setting Programme
<b>MAR</b>	Managed Aquifer Recharge
<b>MDGs</b>	The Millennium Development Goals
<b>MEECC</b>	Ministry of Environment, Energy and Climate Change
<b>MILHT</b>	Ministry of Habitat, Lands, Infrastructure and Land Transport

ACRONYM	DEFINITION
<b>MoA</b>	Memorandum of Agreement
<b>MoF</b>	Ministry of Finance
<b>MoFA</b>	Ministry of Fisheries and Agriculture
<b>MOH</b>	Ministry of Health
<b>NGO</b>	Non-Governmental Organisation
<b>NISTI</b>	National Institute for Science, Technology and Innovation
<b>NP</b>	National Parks
<b>NRW</b>	Non-Revenue Water
<b>PHA</b>	Public Health Authority
<b>PLI</b>	Policy, Legal and Institutional
<b>PUC</b>	Public Utilities Corporation
<b>S4S</b>	Sustainability for Seychelles
<b>SAA</b>	Seychelles Agricultural Agency
<b>SADC</b>	Southern African Development Community
<b>SADC-GMI</b>	Southern African Development Community – Groundwater Management Institute
<b>SBS</b>	Seychelles Bureau of Standards
<b>SDB</b>	Supply Demand Balances
<b>SDGs</b>	The Sustainable Development Goals
<b>SEC</b>	Seychelles Energy Commission
<b>SIB</b>	Seychelles Investment Board
<b>SIDS</b>	Small Island Developing States
<b>SWSDP</b>	Seychelles Water Supply Development Plan
<b>SNAIP</b>	The Seychelles National Agricultural Investment Plan
<b>SNCCS</b>	Seychelles National Climate Change Strategy
<b>SSDS</b>	The Seychelles Sustainable Development Strategy
<b>TSE</b>	Treated Sewage Effluent
<b>UNCCD</b>	The United Nations Convention to Combat Desertification

ACRONYM	DEFINITION
<b>UNDP</b>	United Nations Development Programme
<b>UNEP</b>	United Nations Environment Programme
<b>UniSey</b>	University of Seychelles
<b>UNOPS</b>	United Nations Office for Project Services
<b>US</b>	United States
<b>WB</b>	World Bank
<b>WHO</b>	World Health Organisation
<b>WIO</b>	West Indian Ocean
<b>WIO-Lab</b>	Project “Addressing Land-based Activities in de Western Indian Ocean”
<b>WMA</b>	Water Management Areas
<b>WMI</b>	Water Management Institutions

## **1. INTRODUCTION**

### **1.1 Background to the GMI-PLI Project**

The critical role of groundwater in building the region's resilience to climate change and improving water security is reflected by the World Bank in their June 2017 online article: *People in Southern Africa are largely dependent on groundwater shared between countries and communities for health and well-being, food production, and economic growth.* As climate variability alters the amount of surface water that is available, people in the region are increasingly turning to groundwater, a resource that is already challenged by threats of depletion and pollution.

The sustainable management of groundwater is a key part of the broader water security for the region, especially in understanding transboundary aquifers. The Southern African Development Community (SADC) has established the Groundwater Management Institute (GMI) to better understand the region's needs and improve their groundwater management capabilities.

The SADC Groundwater Management Institute (SADC-GMI) is the implementing agency of the World Bank funded Sustainable Groundwater Management in SADC Member States Project. This funding is secured through the Global Environment Facility (GEF) and the Cooperation in International Waters in Africa (CIWA) trust. Part of this funding has been dedicated by the SADC-GMI to respond to gaps in the existing policy, legal and institutional (PLI) frameworks for groundwater management in the region towards fulfilling one of four main components of the project –“Enhancing institutional capacity of governments in SADC Member states and transboundary organisations”. The objective is to be met through a series of organised steps which broadly included the development of a benchmark document called the Desired Future State Document, a Gap Analysis and high-level Action plan for all SADC Member States and for the region, development of a suite of guidelines to strengthen groundwater management regionally. To inform the guideline on the development of a groundwater PLI Roadmap, Tanzania was selected as a pilot from which to draw lessons and develop the process.

This report presents the outcomes of the gap analysis for Seychelles.

### **1.2 Socio-economic drivers for Seychelles**

Seychelles is a small, service-based country with a middle-income archipelago of 115 islands scattered over 1.3 million square kilometres of sea, in the middle of the Western Indian Ocean, north of Madagascar. The group of islands comprises of 41 granitic islands and 74 coralline islands. The total land area is approximately 455 square kilometres and an exclusive economic zone (EEZ) of almost 1.4 million km<sup>2</sup> in one of the world's major tuna fishing grounds. The country had a gross national income per capita of US\$13,990 by 2014 according to the World Bank (WB) and growth was at 2.8% GDP in 2014 compared to 3.5 % in 2013.

The population of Seychelles is about 91,000 according to the 2010 census. Mahé is the most populated of the islands with a population of about 79,000 people, followed by Praslin with about 8,600 people and



La Digue with about 2,800 people. The annual population growth rate in the Seychelles is approximately 1.2%. Visitor arrivals in 2016 and 2017 was around 303,000 and 350,000, respectively.

Compared to other countries in the African region, the engine for economic development in Seychelles is the tourism sector which accounts for 70% of the foreign exchange earnings and 25% of GDP followed by fisheries, accounting for 5% of GDP, 7% of employment and 35% of total exports. The government has introduced various activities and incentives to attract local and foreign investors to develop other industries in the Seychelles.

### **1.3 Water resources**

#### **1.3.1 Status of water resources (surface water, groundwater and transboundary)**

The Seychelles has a temperate climate. The hottest months are March and April (32 degrees Celsius), the coolest being July and August (23 degrees Celsius). Rainfall varies considerably from island to island and from month to month. December and January are the wettest months and June and July the driest. The rate of humidity is uniformly high, at an average of 80% and the mean temperature ranges from a minimum of 24 degrees Celsius to a maximum of 32 degrees Celsius.

Seychelles is often thought to be a water abundant nation. However, out of the 2,300mm of rainfall that it receives each year, over 97% flows directly to the sea due to the topography and poor soil absorption in the majority of the catchment areas. Since the mid-1990's the Public Utilities Corporation (PUC) declared that the country was experiencing a deficit of raw water and that additional storage and water management measures was required to minimise the economic, social, and environmental impact on Seychelles.

The latest supply demand balances (SDB) estimates for Mahé, Praslin and La Digue demonstrate that, on an island wide basis through to 2030, there is a surplus on Mahé (when the desalination plants are taken into account), but with deficits on Praslin and La Digue. As for rainwater harvesting initiative, the recent intervention by the Ministry of Health in schools demonstrates that although there has been some progress with respect to the implementation of such schemes, there is a need for clear policy direction from the GoS regarding health risks and agreed end use of collected water.

The expansion of greywater reuse is unlikely for the foreseeable future. Exploration of the use of treated sewage effluent (TSE) as a source of irrigation water for agriculture requires further significant exploration, covering policy and regulatory issues, engineering and risk assessment as well as addressing public acceptability concerns with respect to consumption of fruits and vegetables irrigated by such a source.

The implementation of the proposed Managed Aquifer Recharge (MAR) on Mahé, Praslin and La Digue offers another potential use of TSE as does the use of stormwater runoff. However, further significant investigations are required before the feasibility of any MAR schemes can be confirmed due to a considerable gap in data since the early 90's to the present period of time.

The PUC recommended that feasibility studies for MAR on Praslin and La Digue should be taken forward in order to further assess surface water storage options and the potential for MAR. In addition to this, for Mahé, collaboration is recommended with the SAA and the Ecosystem Based Adaptation project to explore options for MAR in the Anse Royale area.

The majority of water supply in the Seychelles is derived from impoundments and surface water intakes. The contribution to potable water supply from groundwater is minimal and is estimated at less than 2% of total water supply. However, there is hope that this can be between 5% and 10% if more investigative studies are carried out at the right locations.

PUC (a parastatal company formed in 1986) is responsible for providing electricity, water and sewerage services on the three main islands. The current PUC operational groundwater sources are found on Mahé at La Misère, Praslin at Amitie and La Digue. The groundwater is extracted from unconsolidated soils and gravels on plateaus.

The Seychelles National Climate Change Strategy (SNCCS) Report summarizes the likely impact of climate change on water resources by the decrease in rainfall, increase in surface temperature and evapotranspiration, and increases in rainfall intensity which leads to higher surface runoff and reduced soil water absorption. The IMF's policy change policy assessment noted that sea level rise is already affecting Seychelles, such as in May 2007 when very high tides resulted in flooding up to 50m inland causing damage to roads, public infrastructure; and sea level rise is expected to lead to coastal erosion, impacting infrastructure especially tourism and roads whilst increasing salination of the soil and aquifers impacting food and water supply. In response, the Seychelles National Climate Change Strategy provides an overarching framework and direction for climate change adaptation in Seychelles (Climate Change Strategy, 2016). These plans called for the mainstreaming of climate change adaptation into all sectoral plans and this has progressed in several sectors including tourism, health, finance, agriculture, biodiversity, fisheries, disaster management, and land-use planning (ibid).

PUC has been driving a water conservation campaign that has been given a big boost by the Project Neptune, which is a multi-year programme to revitalise and expand Seychelles' water supply and sewage systems on all three major islands.

### **The Project Neptune Rationale**

Project Neptune is the revitalisation programme that emerged out of the SWSDP, and this is being co-financed by the government of Seychelles, the European Investment Bank, Agence Française de Développement, the European Development Fund and the African Water Facility. The programme also includes improvements to the technical capacity of PUC staff and upgrading of tools to help ensure efficient operation of water and sanitation facilities. The following provides a brief overview of Project Neptune:

- A water demand management programme, including promoting rain water harvesting and household water storage, the water conservation awareness campaign, and promotion of by-laws and water saving devices;
- Upgrading and increasing by 50% the production capacity of the existing six desalination plants located on Mahé, Praslin, and La Digue islands with a total output of 24,050m<sup>3</sup> a day;
- Reduction of the non-revenue water (NRW) in the water supply network of Mahé, including replacement of old pipes, analysis and replacement of bulk and customer meters, the purchasing of several software, hardware, leak detection and pressure management equipment;
- Optimising and increasing the efficiency and adapting key components of the water supply system in Mahé, namely the Hermitage and Cascade water treatment plants and trunk mains;
- An energy audit and equipment for reduction of energy consumption;
- Technical assistance and project management support, and also capacity building for the operation of the water and sanitation systems, including design and implementation of environmental, water resources and disaster mitigation and management systems; and,
- Other management programmes related to environmental, water resources, and risk mitigation.

Project Neptune is the first water project in Africa that is supported by the European Investment Bank that specifically focuses on preparing the country to face the long-term threat and effect of climate change. The waste water component of the project involves better management of waste water in an attempt to reduce the risks of water contamination. Though there is no specific mention of ground water, it is expected that the threats of contamination of ground water by septic tank and soakaway systems could be avoided by centralised sewerage systems, re-use of the treated effluent in agricultural areas and hence allow water bodies (surface and ground) to be less impacted by untreated or insufficiently treated sewage. A separate feasibility study entitled “Integrated and Comprehensive Sanitation Master Plan for Seychelles, 2017” (ICSMPs) that was funded by the African Water Facility also draws upon similar conclusions.

### **The Agricultural Sector**

The total arable land in Seychelles is estimated at 500 hectares of which 50% is exploited for agriculture. The agriculture sector consumes close to 3 million cubic meters of water per year.

### **The Seychelles National Agricultural Investment Plan (SNAIP)**

The SNAIP defines agricultural priorities, goals and outcomes which should bring agriculture to providing desired volumes of production to ensure food is available from local sources in quantities that have significant impact on the resilience of the country to sustain food availability even in the face of challenges which may impinge getting food supplies from the global markets.

The SNAIP is a programme-based investment framework. The most relevant area related to groundwater is the area “Protection and Sustainable use of Agricultural Land and Water. Provision has been made for

promoting, establishing and strengthening 12 Water Users Association linked to small-scale irrigation schemes (one per irrigation scheme).

### **Water policy and water management for the Agricultural Sector**

PUC remains the manager and regulator of water resources. This creates a conflict whereby priority is given to usage of surface waters for consumption and agriculture and other industries are given a lower priority. The SNAIP report recognises that in order to increase local food production, water has to be made more readily available in a more systematic manner particularly to the 700 registered farmers. Some of the initiatives include rain water harvesting and increasing water storage. One of the programmes in the SNAIP is entitled “Protection and Sustainable Use of Agricultural Land and Water” which will help ensure that the factors of production such as land and water are secured and sustainably used. The sub-programmes are aimed at: Protecting agriculture land resources; Reducing degradation of agricultural land through effective land and water management from 100 hectares to 180 hectares; and increasing irrigation of agriculture land from 50 hectares to 100 hectares. Reaching these SNAIP targets by 2010, would mean adopting best practices including increasing the land area that can be irrigated as well as increasing the number of Water Users Association from 0 to 12.

Other than agriculture, the other industries do not make use of groundwater. The Seychelles Breweries company commissioned boreholes with the intention of reducing their dependence on costly treated water. However, the boreholes were found to be contaminated, presumably by housing estates uphill of the boreholes.

#### **1.3.2 Groundwater environment and ecology**

Minor aquifers are found within the weathered granite fractures and fracture zones which receive rainfall recent recharge. The main aquifers are in unconsolidated Shoiya soils on the coastal plateaus a few meters above sea level. The water in the fissures are soft whereas in the sandy plateau the water tends to be brackishness. Many of the studies have been investigative and estimating yield except for the study by the International Atomic Energy Agency (IAEA) on La Digue in 2007, where isotopic determinations of  $\delta^2\text{H}$ ,  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  were carried out, no other research has been done on groundwater.

Groundwater is seen as being an essential part of the hydrological cycle. It acts as a storage for water and is either feeds surface waters at higher elevations and is recharged through wetlands and marshes in the coastal plateau areas. The water that evaporates across the soil or is transpired by plants increase air moisture that when condenses and precipitates eventually enters the solid by percolation or is carried downstream via surface waters or as surface runoff. As the water is taken up by the plant it leads to growth and increase of biomass and carbon retention, which is critical in climate change. The increase of salinity leads to accumulation of salt in the soil and this affects soil fertility and eventual loss of plant species.

### 1.3.3 Status of groundwater infrastructure

PUC commissioned eight boreholes on Mahé in the early 90's. Presently only one of them are in operation. The drilling was undertaken by Gondwana Water Drilling Company. Presently only the boreholes at Rochon and Les Cannelles are still in operation. It is to be noted that the borehole of Les Cannelles had a yield of 3 litres per second when it was being commissioned and a few others were producing yields of 2 litres per second. The preliminary data suggested that there is the potential and with an average of 4 persons per household in the country, a borehole can supply up to 24 to 50 homes in a day. It is to be noted that some boreholes were made at around 400m elevation and had depths of over 50m. These were made in rock fissures and there were reports that they were basically tapping from the base flow that could eventually be abstracted from a nearby stream.

The most prominent borehole is in an aquifer on the coastal plateau of La Digue Island and until around 2005 the community was dependent on it until a desalination was commissioned early this century in order to address the water deficit and quality (in terms of brackishness) that was being experienced since the 1990's. The water that is supplied to the consumers is a blend of surface, ground and desalinated water with the desalinated water becoming more important during prolonged dry weather.

The main well was in an aquifer made up of quartz sands and gravels and covered by calcareous sands and gravels. It was constructed around 1975 and 1976 and it can provide 600 m<sup>3</sup>/day, but this is reduced to around 200 m<sup>3</sup>/day once the conductivity reaches around 1,000µS, when it can recharge. Presently the capacity of the three modules of the desalination plants has a total capacity of 1,400 cubic meter per day (2 Nos. of 450 cubic meter per day and a third with a capacity of 500 cubic meter per day). The present demand of water on La Digue is currently 1,600 cubic meter per day.

There is a high risk of contamination from septic tanks hence the reason why a sewerage project is being implemented. There is scope to undertake more research to establish the present state of the ground water prior to the commissioning of the sewerage system.

La Digue was chosen as the project site for studies in 2007 that was led by the IAEA in association with the PUC. The studies were aimed at estimating the total extent of the La Digue aquifer and the potential for abstraction of fresh water and recharge was studied by the use of isotopic signature and other parameters. The studies suggested that the sandy plateau ground water table is barely 1 to 2m above the sea level and groundwater is brackish even in inland areas (at the foot of the mountains) and where there are freshwater marshes. The study identified two sites that met three criteria, namely: For a considerable amount of groundwater to be of good quality; Recharge potential by fresh water (and not by saline water from the sea); possibility to connect the wells to the existing water supply system on the islands.

More recently, in 2016 and 2017, the Water Harvesting Company, which is part of the EcoPartner Group AS, and the Swedish Geological Survey from Sweden, conducted a feasibility and geophysical investigation on the islands of Mahé, Praslin and La Digue. A total of 10 boreholes were drilled on these three islands and resistivity profiling were undertaken as well as relatively short water test pumping. The studies



concluded that there is potential to abstract ground water from all three islands, but the boreholes had to be further tested and a number of issues, such as authorisation and procedure to drill on private lands. There had been suggestions by the local partners that the studies could have been better planned and more ideal locations could have been selected. Based on the studies in the 1990s, PUC is confident that boreholes could potentially produce better yield that could have benefitted the community and some farming communities.

With the high possibility of implementing the ICSMPS and the IWRM Plan and recycling of treated wastewater the prospect of further studying the ground water resources in the South and West of Mahé and on the islands of Praslin and La Digue should be a priority. The information could provide water managers and decision makers an alternative to the energy demanding desalination plants that the country relies on during the droughts.

### **Inter-Connectedness of Groundwater Across Different Sector Departments**

Ground water is not used in quarrying whereby granite is extracted and converted into aggregates. There are no mining activities except for offshore sand abstraction from the sea bed. On the main island, Mahé, more precisely in the Anse Royale district, there are two major farms that utilise groundwater from open pits in the sandy coastal plateau on their farmland. In the upper parts of the same district, PUC has an operational borehole, but these are in a valley and presumably in a rock fissure. In principle there is limited connectivity between the farming and PUC operations.

Groundwater abstraction also takes place Marie Jeanne Estate on Praslin Island during dry periods. PUC is not abstracting water from that location.

Groundwater abstraction by PUC is more extensive on La Digue Island. Whilst there are three other locations where abstraction is taking place on the same coastal plateau and from presumably from the same aquifer, the PUC Operations Manager does not expect that these operators are affecting the output or quality of the PUC borehole.

### **The Seychelles Global Climate Change Alliance + Climate Change (GCCA+)**

Other than infrastructure projects, environmental projects are implemented with the participation of mainly the UNDP, government agencies and NGOs. One of the most relevant studies on groundwater is the Seychelles Global Climate Change Alliance + Climate Change (GCCA+). The project aims at supporting adaptation to climate change to increase coastal and flood protection in the vulnerable areas of La Digue Island, through integrated shoreline management in place, enhanced stream channel and wetland productivity and flood buffering capacity, enhanced shoreline protection, and mitigation of saltwater contamination. This will be achieved mainly through the formulation and adaptation of an integrated shoreline management plan and works to enhance hydrological dynamics and productivity of stream channels and wetlands and increased flood buffering capacity. The study is still at an early stage and the Project Manager (Mr. Rodney Quatre) for the project has mentioned that a status report is in the making.

#### 1.3.4 Groundwater supply and demand

The development of the Seychelles Water Supply Development Plan (SWSDP) 2008-2030 Study started in February 2010 and ended in May 2011. During its presentation in a donor conference in 2014, it was highlighted that the average daily demand stood at 38,000m<sup>3</sup> per day, and the water deficit during the dry season, which is usually from May to October, is 2.1 million m<sup>3</sup>, or approximately 15,000 m<sup>3</sup> per day. A project cost of 1,162,900 Euros was required for the implementation of the plan. It is worth noting that it is estimated that ground water abstraction is around 5 to 10% of national demand, or an estimated maximum of 3,800m<sup>3</sup> per day or 1.4 million m<sup>3</sup> per annum.

## 2. METHODOLOGY

### 2.1. Overview

The methodology for the gap analysis included conducting a desktop review of available literature. This was coupled with the development of a desired future state to provide a baseline for groundwater management and is discussed in more detail below. Key stakeholders were also identified during the early stages of the gap analysis and multiple engagements were held whereby a questionnaire was administered to evaluate the current state of groundwater management in the country. Based on the desktop review, stakeholder engagements and results from the questionnaire, a draft gap analysis report and action plan was developed which was then validated at Validation Workshops. These workshops involved key groundwater actors from the Member State and provided an opportunity to obtain buy-in and support for the gap analysis reports as well as obtaining further inputs. The draft report was also circulated to broader stakeholders i.e. Water User Associations, Water Service Providers etc. whereby written comment was received. The draft gap analysis report was then finalised based on the comments received from the Validation Workshops and broader stakeholders. The methodology outline is illustrated in the figure below.



**Figure 1: Methodology Outline**

The documents that were referred to are listed in the Literature Inventory List presented in **Appendix A**. The stakeholders engaged with are also presented in **Appendix B**.

The structured questionnaire is based on the Desired Future State and is elaborated on below.

The desired future state has been contextualised for the SADC region, taking into account:

- The high levels of groundwater dependency in many SADC countries, in rural areas in particular;
- The variety of geohydrological contexts;
- High levels of poverty, gender disparities, social exclusion and pollution; and

- Relatively low levels of state capacity – skills, infrastructure and finance.

It sets out the **minimum** requirements that support the delivery of national, regional and international developmental goals, including the Sustainable Development Goals, meeting basic human needs to water, energy and food (the WEF nexus), and the protection of ecosystems that are dependent on groundwater.

The sections below describe, at a high level, what is considered to be the minimum best practice for policy, legislation and subsidiary legislation, regulations and standards for effective groundwater management. For a more detailed description of the desired future state, see **Appendix C**.

The **minimum policy requirements** that should be in place are:

- A long-term policy to protect groundwater by preventing pollution and overuse.
- The social, economic and environmental values of groundwater are all recognised.
- The human right to water is recognized and a rights-based approach to groundwater management is taken.
- Groundwater is recognised as a highly important source of domestic and agricultural water supply and a key resource for poverty alleviation, food security, and the sustainable economic development of rural areas.
- The biophysical and ecological linkages between ground and surface water for their use, protection and management are recognised, including land use zoning for groundwater protection and recharge (conjunctive use).
- The importance of the maintenance of the ecological integrity of wetlands in groundwater management is recognised (recharge zones).
- Intersectoral collaboration is promoted and facilitated.
- The need for adaptive management is recognised.
- The roles of various stakeholders and water users in groundwater management is recognised and participation of stakeholders is promoted and facilitated.
- An apex body that is responsible explicitly for GW management and playing the role of custodian/trustee on the part of the state is clearly defined.
- Effective institutional arrangements are coordinated at transboundary, national and local levels.
- Public access to geohydrological data held by the state is promoted and facilitated.
- Additional environmental principles necessary to protect and sustain groundwater are mandated, including: the precautionary principle, the principle of gender equity and social inclusion (GESI), the principle of subsidiarity, and the principle of intergenerational equity.

The **minimum legislative requirements** that should be in place are those that explicitly addresses the use, management, and protection of groundwater and provides the necessary tools for the state to regulate, manage, control, protect and develop groundwater resources in conjunction with surface water resources. At a minimum, legislation and/or subsidiary regulations should:

- Provide the status of groundwater noting that all water has a consistent status in law, irrespective of where it occurs, and there is explicit reference to groundwater and conjunctive use

management; and recognise the human right to water recognized in groundwater legislation, facilitating prioritization of drinking water and basic human needs, as well as small-scale users.

- Regulate groundwater quantity by providing conditions for accessing groundwater through water use authorisations system that does not discriminate (especially against the rural poor), is not tied exclusively to land tenure and enables effective compliance monitoring and enforcement.
- Provide groundwater protection mechanisms that includes regulating pollution (point source and non-point source), regulates depletion, regulates abstraction and recharge (usually via permitting) and provides for the sustaining wetlands;
- Enables integrated planning through specifying the need for long term plans (at catchment or basin level) to ensure the sustainable use of groundwater, including drought management plans and cross-sectoral coordination.
- Make provision for institutional arrangements including the mandate, competence and power of the relevant authorities, enabling the integrated management of groundwater and surface water resources, engaging in the arbitration of competing demands and diverging interests regarding groundwater abstraction and use, and support the collaborative engagement with other sector authorities, competent for public health, land-use planning, soils management, and waste management.
- Support effective stakeholder engagement through specifying when and how stakeholders, the public and/or other water users are to be engaged in the development of laws and regulations, planning, decision making and self-management regarding groundwater and should specifically address the issue of the involvement of women and youth in decision-making and the implementation of groundwater supply schemes.
- Provide for Monitoring and data collection to support regulation including protocols for data collection, management, exchange and dissemination, including standardization and harmonization of data, as well as national monitoring and information systems for the management of data and information.
- Regulate to ensure water conservation and efficiency of use.
- Support compliance and enforcement through clear mechanisms for promoting compliance with groundwater regulations through enforcement provisions that enable inspections, the imposition of fines and/or additional administrative penalties and other instruments to address failure to comply with the law.
- Conflict resolution mechanisms and/or the right to appeal.
- Enable the development of regulations on any relevant matter in the legislation to regularise aspects of groundwater management and incentivise appropriate use of groundwater resources.

The actual **requirements for subsidiary regulation** will differ from country to country, according to their own National Legislation. However, it is important to understand the extent to which critical issues around groundwater management have been translated into regulations. Below are some examples of how this could look.

- Subsidiary legislation or regulations pertaining to use, protection including on-site sanitation, borehole drilling, and appropriate financial and economic regulatory tools e.g. water pricing.
- Clear protocols and standards on data collection and storage.



- Templates for municipal by-laws.
- Community management of groundwater and community participation in groundwater management.

From an **institutional perspective**, it is critical that countries have as a minimum, a dedicated Ministry for water resource management, which is also the custodian for ground water management. Noting that the groundwater is a localised resource, decentralised institutions at trans-boundary, catchment and local government level are crucial, where groundwater management fits into overall mandate for water resource management

### **3. POLICY**

#### **3.1 Evolution**

Prior to the establishment of the Rivers' Committee around 1985, there was no formal regulatory body for water resources. The committee is chaired by the Water and Sewerage Division of the PUC is responsible for managing requests made for abstraction. The committee operate under the Water Supply (Abstraction License) Regulations, 1984 and the Public Utilities Corporation (Miscellaneous) (Amendment) Regulations, 1999, which are regulations specifically for the abstraction of surface, ground and seawater for private use.

Following the approval of the Water Policy in 2017, an Apex body is expected to be established once the legislations are in place. This might take up to three years to be in place and fully functional. The Apex body will act as an independent regulatory body and replace the existing Rivers' Committee whose Secretary is an employee of PUC. It is expected that water quality will be assigned to the body. However, a thorough review of water management, including quality aspects, needs to be undertaken.

#### **3.2 Policies to support groundwater management**

The Seychelles does not have a policy document specifically for groundwater. It only has a policy that has been influenced by several local and international policies and strategy documents, namely: The National Climate Change Strategy (2009); The Intergovernmental Panel on Climate Change (IPCC); The Dublin Principles on Integrated Water Resources Management (IWRM); SADC Regional Water Policy (2005); The SADC Regional Water Strategy (2006); The Seychelles Sustainable Development Strategy (SSDS) 2012 – 2020; The Development Goals (The Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs); The United Nations Convention to Combat Desertification (UNCCD) and the UNCCD Land Degradation Neutrality (LDN) Target Setting Programme (LDN-TSP); The Ecosystem Based Adaptation (EBA) to Climate Change Project; The Nairobi Conventions (The WIO-LaB project); The Integrated & Comprehensive Sanitation Master Plan (ICSMP) for Seychelles, August 2017), and the WHO Drinking Water Guidelines, 2017.

The SSDS mentions the principle of sustainable use of resources and ensuring that they are not exploited beyond their capacity to recover. Indirectly this refers to groundwater extraction and the detrimental effects that can arise if not managed properly. The draft Coastal Management Plan for Seychelles for 2019-2025 re-emphasizes on the threats of sea level rise, costal erosion, tidal surges and flooding on the coastal areas. Stormy weather have the tendency of increasing the potential for tidal surges which causes seawater intrusion into the costal sandy plateau and the ground water, mainly through water outlets, and increases the salinity of ground water. Despite the fact that Seychelles Islands lies outside the cyclonic belt, a few islands in the south (e.g. Farquhar Atoll) which on 16<sup>th</sup> April 2016 Farquhar Atoll was affected by Tropical Cyclone Fantala, which is recorded as being the strongest tropical cyclone in the south-west Indian. Tropical cyclones are related to the rainy season, which is essentially when the surface water flows increase and the ground water and water reservoirs are replenished absence the rainfall patterns. With

the change in rainfall patterns, whereby rainfall intensity has increased but is shorter in duration, surface water flows have dried out more rapidly and flooding events are more common, and recharge of groundwater is less consistent.

The two main documents are the Seychelles IWRM Plan and the Water Policy, which are summarized below.

### **The Seychelles Water Policy (2017)**

The national water policy of Seychelles, namely The MEECC (2017) National Water Policy Ministry of Environment, Energy and Climate Change, Seychelles, was also approved by the Cabinet of Ministers on the 12th July 2017. The policy document does not specially address ground water management despite the fact that it recognises that upstream activities in the catchment areas have an effect on the plateau and the coastal areas. The Policy states that “the pollution of groundwater and surface water, or high sedimentation loads from erosion in catchments, can result in marine (reef) pollution”. Point and non-point pollution of ground water and surface waters that have been found to be originating from sewage disposal systems and from agricultural and industrial activities are suspected of affecting the limited water resources. These main two items basically suggest that the Policy is concerned about issues related to pollution of groundwater, though there is no mention of a statement to specifically address this issue.

### **The Seychelles IWRM Plan (2017)**

The National Integrated Water Resources Management (IWRM) Plan builds upon and reinforces the weaknesses and gap that have been identified during the formulation of the Water Policy. The plan was approved by the Cabinet of Ministers on 12th July 2017.

The IWRM suggests that the low level of connections to the sewer system and poor maintenance of existing treatment systems is seen as a major threat to the ecosystem and the services that it provides. Detrimental effects due to social and economic development is also seen as being harmful to the environmental quality. A collaborative approach is necessary to better monitor the quality of surface waters, ground water and coastal waters. A more coordinated approach would also allow the sharing of resources, such as laboratory equipment, and a framework for information to be shared. With the introduction of the proposed Apex body.

## **3.3 Gaps and challenges identified**

The Water Policy was developed to be futuristic and to resolve stakeholder concerns and conflicts and to address the other challenges and opportunities in the area of water resources management. However, the stakeholders were not in possession of the final and printed version of the Water Policy. This led to delays in the interviews and questioning on certain issues related to groundwater. The key policy gaps and challenges include:

- Inadequate sharing of data and information - Based on data that were forwarded on hydrology by PUC, it can be assumed that the data for yield or water quality of groundwater is lacking. There

was only brief mention of the historical data on yield (in litres per second) for the boreholes on the main island, Mahé. The methodology or log book is missing hence it was not possible to understand how long the test has been sustained or how long it took for the borehole to recharge.

- Lack of enforcement capacity - The other major issue is enforcement capacity or reluctance to enforce, which in the case of Seychelles, with its small population leads to a situation whereby everyone is almost familiar with one and hence there is a hesitation to enforce in case of reprisals. The policy document suggests that key capacity gaps are identified in a systematic manner and addressed through a capacity building exercise.
- Lack of prioritisation and overreliance on desalination - at national level, the water supply demand is met by an overdependence on desalination plants that require unsustainable power requirements. The Water Policy does not mention how priority will be given to groundwater over desalination in order to reduce spending made on electricity though it mentions that energy consumption of water management will need to be considered. Otherwise, the present scenario will remain as it is assumed that sea water is limitless and has less management issues compared to groundwater.
- The policy does not recognise the need for catchment management boundaries to be shaped to address cross catchment nature of aquifers.
- The policy does not address the need for a targeted approach to groundwater management that allows different approaches to be used in different contexts in the country.
- The Policy does not make mention of customary water law. It only states that within the context of IWRM, traditional technical water management skills are supplemented in order to allow for a more comprehensive set of skills.

There is fresh input from stakeholders and the public for the authority to consider ground water, along with water conservation methods (e.g. rain water harvesting). MAR is believed to be the only realistic option for the main islands, namely Praslin and La Digue. However, there is limited or almost non-existent trial on this technique. The Water Policy makes brief mention that guidelines for recharge during dry period shall be developed.

Under Policy Statement C1.5, the water policy gives scope for prospectors of ground water to venture into the exploitation of ground water and sharing the resource with those who wish to be involved in such activities so that one stakeholder does not overshadow or discourage the ones with less resources or financial means. In the past, PUC could intervene and ensure that abstraction rights are controlled in such a way, especially in catchment areas where water quality was guaranteed, so that PUC could benefit either during the abstraction of boreholes or there was sufficient water for the consumers depending on treated water supply by PUC. The general rule was for abstraction by private individuals to be undertaken downstream of the PUC water barrage.

The regulator of the water resource falls under PUC, a parastatal company that treats and supplies water, collects and treats waste water and generates and supplies electricity. The Rivers' Committee is also

chaired by the Hydrologist, who is presently retired, who was an employee of the PUC. In general, the present water resources governance and legal framework centers around the PUC Act which provides PUC with the mandate to act as Regulator, Resources Manager and Service Provider. PUC is presently capable of controlling who could be issued abstractions permits and could provide an abstraction fee that compares the volume of water being abstracted with the cost of PUC supplying treated water to the premises. In other words, PUC can collect (substantial) revenue from a private person or entity abstracting (substantial amounts of) surface or groundwater despite not being dependent on the community treated water network. Notwithstanding some challenges like all other institutions, the PUC is one of the leading institutions in Seychelles in terms of operational and functional efficiency, effectiveness and governance.

The principle of subsidiarity/decentralised groundwater management is not captured in the policy. However, the policy mentions makes provision for the delineation and establishment of water management areas that cover the entire land area of catchments, and that will allow the consideration for improved integration of the management of water and land.

The Water Policy states that during the improvement of stakeholder participation and capacity building, women shall be included and empowered to fully participate in decision making at all levels of water resource development, management and safeguarding. The question then becomes, is gender addressed in relation to the need for women to have equitable access to groundwater, and to the resources needed to harness groundwater? In response, the policy states that that the GoS shall strive to maintain and further advance access to safe water for its citizens. It also states that the GoS will ensure an equitable use of water resources.

### 3.4 Enablers required to unlock these gaps/challenges

The table below reflects the enablers required to unlock the identified gaps and challenges being experienced.

**Table 1: Enablers required to unlock the policy gaps and challenges**

Groundwater gap/challenges	Enablers
<b>Dissemination of Water Policy document and proposals for Strategy formulation</b>	<ul style="list-style-type: none"> <li>▪ Increase knowledge of key officials (e.g. Sanitary Health Engineers and officers) on Policy document</li> <li>▪ Ensure that a working group is formed other than the current Rivers' Committee to ensure that the proposed framework is discussed and trialled despite the fact that the New Water Act is being drafted</li> </ul>
<b>Lack of Strategy for Groundwater Management and a National Groundwater Management Policy</b>	<ul style="list-style-type: none"> <li>▪ Discuss the merits of having a separate Groundwater Policy</li> </ul>



Groundwater gap/challenges	Enablers
	<ul style="list-style-type: none"> <li>Propose Strategies and Action Plan for Groundwater Management</li> <li>Identify key players in government Agencies, civil society and in Regional Councils</li> </ul>
<b>Lack of data</b>	<ul style="list-style-type: none"> <li>Initiate research on existing boreholes</li> </ul>

## 4. LEGISLATION

### 4.1 Evolution

In one of its earliest Law, the Seychelles State Land and River Reserves Act, 1903, it was recognized that during development of a site, consideration should be made to the stream and any underground water sources. In the subsequent laws and regulations that were passed little or no specific mention was made on groundwater despite the fact that it is estimated that 5 to 10% of the water demand could be satisfied by groundwater alone. During a recent feasibility study that was commissioned in August 2017 Integrated & Comprehensive Sanitation Master Plan for Seychelles, the issue of ground and surface water protection was highlighted which consolidated the need for the extension of the sewerage network in some parts of the main island, Mahé, and its introduction on the second and third most populated islands, namely Praslin and La Digue. The focus on groundwater shows the shift from an era where ground water was neglected and to one where ground water is recognised as being a natural resource that requires protection and preservation.

The development of the Water Policy, which is seen as an IWRM-based legal framework for water management, was found to be necessary while formulating the new central National Water Act. This was initiated following the approval of the National Water Policy and the National IWRM Plan. The development of the proposed Act was also approved by the Cabinet of Ministers and subsequently commissioned through the GEF funded UNDP/UNEP/ UNOPS Atlantic and Indian Ocean SIDS project.

### 4.2 Legislation to support groundwater management

The laws and regulations that have been reviewed are as follows; The Seychelles' State Land and Rivers Act, 1903; The National Parks and Nature Conservancy Act (Act 19, 1969); The Town & Country Planning Act (Act 14, 1970); The Water Supply (Abstraction License) Regulations, 1984 and the Public Utilities Corporation (Miscellaneous) (Amendment) Regulations, 1999;; Public Health Act, Chapter 189, 1991 Edition; Public Health Authority Act, 2013 (Act 7 of 2013) and the Environmental Protection Act, 2016 (Act 18 of 2016). All of these pieces of legislations are not prescribing specific measures to protect and conserve groundwater despite making provisions to limit the level of pollution.

**Table 2: Sectoral legislation and implications for groundwater management and overview of proposed Water Act**

Legislation	Implications for groundwater management
<b>PUC Act and Regulations</b>	<ul style="list-style-type: none"> <li>Water Supply (Abstraction License) Regulations of 29th Oct 1984 to be repealed - licensing system will be included in the Water Act</li> <li>Ownership of waterworks to be stipulated in Act - currently owned by PUC - to continue</li> <li>Regulations under PUC Act to become Regulations under the Water Act - some revision and strengthening of Regulations (e.g. with respect to property access rights) needed</li> </ul>

Legislation	Implications for groundwater management
<b>Environment Protection Act</b>	<ul style="list-style-type: none"> <li>EPA provisions too limited, need to be expanded (e.g. power to establish 'protection zones' also for catchments not currently used for abstractions; 'uses' to include environmental uses Two options: a) repeal of relevant section in EPA and inclusion in Water Act, or b) additional provisions in Water Act and otherwise cross-reference to EPA.</li> </ul>
<b>State Land and River Reserves Act</b>	<ul style="list-style-type: none"> <li>Sec 5 to be maintained, or integrated into revised Planning Law in case SLRRA gets repealed; Part III &amp; IV to be repealed; Content of Sec 36 to be included in Regulations to EPA)</li> </ul>
<b>Town and Country Planning Act</b>	<ul style="list-style-type: none"> <li>WMA water management plans need to be aligned with land use plans</li> </ul>
<b>Forestry Reserves Act</b>	<ul style="list-style-type: none"> <li>n/a, but Forest Reserves Act redundant since entry into force of EPA?</li> </ul>
<b>National Parks and Nature Conservations Act</b>	<ul style="list-style-type: none"> <li>Definition of NPs, Special reserves, Strict natural reserves - align with definition of 'protection zones' in the EPA; Rights/ conditions for water abstraction in NPs, Special reserves and strict natural reserves to be clarified</li> </ul>
<b>Energy Act</b>	<ul style="list-style-type: none"> <li>If SEC becomes regulator, powers and functions of SEC with regards to water need to be defined in the Water Act; the composition of the SEC board should probably be amended to reflect water specific expertise; this likely would require an amendment to the Energy Act - most suitable legal mechanism to be discussed with AG's office</li> </ul>
<b>Public Health Act</b>	<ul style="list-style-type: none"> <li>If water resources monitoring responsibilities are concentrated under the new regulator (see 4.3.4 above, Part 3 of the Act might have to be amended and Regulations repealed - exact legal mechanism to be discussed with AG's office</li> </ul>

### 4.3 Gaps and challenges identified

Presently there is no specific legislation for groundwater. The draft Water Act provides an opportunity for that to be done. A thorough analysis for groundwater has not been carried out as extensively as it has been done for surface waters. This could be presumably because there is a lack of research in that area that could be used to guide managers and decision makers.

Table 3 provides an overview of the proposed Water Act and its relationship with existing legislations, including expected changes to existing legislation. Some of the suggestions made can be applied to groundwater. A new set of meetings for this activity is expected in the coming months. Presently it has been suggested that the Seychelles Energy Commission (SEC) might expand its role to include Water under its mandate. Subsequently, during the revision of the SEC Act, the draft Water Act will be incorporated within the revised SEC Act. The draft Water Act incorporates water resources in general, which includes

ground water along with watercourses, surface waters, springs, submarine freshwater discharges and water intended for use in desalination. However, it is clear that more emphasis and priority is on surface waters.

It is possible that the proposed Act will be finalized during a funded project.

The main findings that have been highlighted are as follows:

- In general water issues are mentioned in several legislations as mentioned in the table above. It is expected that they are placed under one Law. The other major pieces of legislations are also expected to be reviewed eventually. An example is The Town and Country Act, which is presently under review.
- Public Health Act regulates water pollution, solid and liquid waste disposal and animal keeping.
- There is no mention of raw water from catchment; ground water, river or coastal water in the “Public Health Act (Water Examination) Regulations, 1994”. The Act focuses on treated water and swimming pool water quality. There is, therefore, a need to rely on WHO drinking water guidelines during surveillance of potable water or water intended for drinking.
- The effluent quality standard mentioned in Section 2 of the Environment Protection (Standards) Regulations, 1995 is lacking some parameters that are linked with effluents, e.g. ammonia. The standards are not flexible enough in the sense that it caters for large treatment plants and does not provide flexibility for treatment systems that are smaller or have lower levels of technology. This is mainly evident for phosphorus (or phosphate), whereby the prescribed 5mg/l as Phosphate (or 1.6mg/L as Phosphorus) can only be achieved by tertiary treatment of sewage, dosing with coagulants or regular, if not, daily desludging.
- The Environment Department is also not enforcing these standards given that they lack the necessary capacity. On the other hand, PHA is only enforcing following complaints. This leads to a situation whereby the main two Authorities involved with Environmental Health are not monitoring effluent discharge and the quality of surface and ground water.
- There is almost a non-existent database of establishments that have applied for permits to discharge. The permit makes it obligatory for monthly analyses of effluents by a National Laboratory. The permit is renewed on an annual basis depending on review of the test results and general performance of the treatment system. This weakness does not allow the authorities to determine on the loadings of pollutants and nutrient into the natural environment and especially into the ground water system.
- Despite having well established guidelines for application of organic matter and nutrients on farming land, the SAA presently does not have neither an official or updated guideline nor regulations for; managing and monitoring of wastewater and organic wastes, application of fertilizers or manure on farm. The Agency is, as a result, unable to account or regulate activities

that could be harming groundwater and the environment in general, despite the fact that the Agency could be striving for food security and consumption of local produce.

- Despite being the main regulator for water resources, the Rivers' Committee is only mandated to assess water extraction permission. The committee is chaired by the Water and Sewerage Division of the PUC is responsible for managing requests made for abstraction. The committee operate under the Water Supply (Abstraction License) Regulations, 1984 and the Public Utilities Corporation (Miscellaneous) (Amendment) Regulations, 1999, which are regulations specifically for the abstraction of surface, ground and seawater for private use. The Water Supply (Abstraction License) Regulations, 1984 and the Public Utilities Corporation (Miscellaneous) (Amendment) Regulations, 1999
- The Rivers' Committee does not have the mandate to investigate cases of pollution or malpractice by farmers and the community. It is not clear which Authority, i.e. PUC, Public Health Authority (PHA) or the Environment Department, should be leading during cases of non-compliance. The new Water Act that is being drafted is expected to clarify and resolve this situation.
- Two Sections in the Environment Department, namely the Climate Adaptation and Management Section (CAMS) and Environment Appraisal and Permits Section (EAPS) are also respondents to cases or planning application involving water courses and water bodies. CAMS also provide advisory and monitory services and is involved in projects that involved modification of water bodies, diversion of streams and desilting. However, both sections lack personnel trained in water biochemistry, groundwater management or hydrology.
- There is presently no institute that is leading training and research on groundwater. The SBS is mandated to: The Maintaining a national information center on matters of standardization, industry, science and technology; and collecting and collating information on research and development of relevance to Seychelles and evaluating and disseminating research findings.

The UniSey has started engaging their students in ecological studies and in water resources.

The government agency National Institute for Science, Technology and Innovation (NISTI) is tasked with coordinating government laboratories. Its' mandate lies where science, technology and innovation, have to be used with full optimization for the socioeconomic growth and development of the country. There is a significant opportunity to engage NISTI in innovative research for developing solutions that advance sustainable groundwater exploration, management and utilization to address the country's water needs in the context of competing demands for existing surface water as well as climate change impacts.

It is possible to group these three institutions and the national laboratories to initiate appropriate training research in groundwater in collaboration with an established organisation.

In general, it is evident from the review that most of the regulations are outdated and in need of revision to bring them in line with emerging trends and issues and other policies. The Authorities lack the necessary framework that will allow ground water management and protection to be established.

#### 4.4 Enablers required to unlock these gaps/challenges

Given the fact that most of the legislations were outdated and or impracticable, and given recent and emerging issues, both in a social and institutional context, the reform of the water pertinent legislations was found to be necessary in order to bring it in line with modern management concepts. It is expected that the new National Water Act (summarized further below) during its initial draft, will consolidate water management and service provision legislation in one central Act. As a consequence, some Acts or part of them, may be repealed. The table below reflects the enablers required to unlock the identified gaps and challenges being experienced.

**Table 3: Sectoral legislation and implications for groundwater management**

Groundwater gap/challenges	Enablers
<b>Lack of ground water quality guidelines and standards. Designation of usage class</b>	<ul style="list-style-type: none"> <li>The monitoring of the available water resources, establishment of water quality standards and water use classification. Allocation guidelines shall be referred to during the process of water allocation.</li> </ul>
<b>Weakness in the water resources management framework</b>	<ul style="list-style-type: none"> <li>The re-alignment of the institutional landscape for water resources management, and as a matter of priority, the establishment of a proposed Apex Body that will act as an independent regulatory body that will replace the existing Rivers' Committee.</li> </ul>
<b>Separation of functions and revised institutional framework. PUC presently being an operator and a water user is also the regulatory body. The current scenario requires application to be made through the Secretary of the Rivers' Committee, though bearing in mind the fact that PUC is the major abstractor of raw water and hence the fact that they regulate abstraction is seen as a conflict of interest and against IWRM and general management principle.</b>	<ul style="list-style-type: none"> <li>The separation of regulatory from water resources management and services provision functions, which currently falls mainly under PUC and other government agencies;</li> <li>The establishment of a comprehensive water use authorization regime for surface and groundwater to replace the Rivers' Committee and mode of operation. The law does not have any criteria for abstraction licenses.</li> <li>Establishment of pricing system designed to recover costs</li> </ul>
<b>Replacement of abstraction zones used by PUC to exert some level of management. Use</b>	<ul style="list-style-type: none"> <li>The establishment of hydrologically defined Water Management Areas (WMA, presently mentioned in the EPA) and corresponding local</li> </ul>



Groundwater gap/challenges	Enablers
<p><b>catchment-based approach similarly to IWRM approach.</b></p>	<p>stakeholder participation structures and the setting up of WMA Committees to play a role during water resources management in that WMA. In the case of WMA, the management will include the integrated management of all land and water resources in a particular area.</p>

## 5. STRATEGY AND GUIDELINES

### 5.1 Evolution

Following the approval of the Water Policy, the Seychelles can develop a Groundwater Management Strategy that is in line with international practices modern trends. Compared to surface waters, where there are several illegal or unlicensed users, the numbers of underground abstraction are only a handful and is limited to the agricultural sector by the larger farms which have the financial capability to bear the cost of pumping.

There is currently a revitalised political will by Government and the National Assembly to review outdated legislations, proof being the ongoing debates in the Assembly and the approval of the EPA in 2016 following the election of the new Assembly. The Water Policy and the IWRM Plan are approved by the Cabinet of Ministers and the Water Act is being drafted. However, the way forward needs to be planned carefully to ensure that there is enough representation for all stakeholders bearing in mind that the aquifers could be on private property or even in sensitive (e.g. potential for saline intrusion) or in protected areas (near RAMSAR recognized wetlands).

### 5.2 Strategies and guidelines to support groundwater management

**Table 4: Strategic themes and actions**

Strategic themes	Actions
<b>Improve stakeholder participation</b>	<ul style="list-style-type: none"> <li>▪ Build upon EBA project in which Watershed Committees are being trialled</li> <li>▪ Allow transparent process</li> <li>▪ Government Agencies relinquish leading role to (or share with) newly established Regional Councils that has been initiated in June 2018.</li> </ul>
<b>Establish Leadership Roles</b>	<ul style="list-style-type: none"> <li>▪ Group local experts</li> <li>▪ Capacity building to encourage interest in the groundwater sector and in water resource management in general</li> <li>▪ Make provision for lead agency for water sector</li> </ul>
<b>Revise framework</b>	<ul style="list-style-type: none"> <li>▪ Complete exercise for development of the proposed New Water Act.</li> <li>▪ Initiate revision of Public Health Act and discharge guidelines</li> <li>▪ Accelerate the revision of the Town and Country Act and ensure that groundwater issues are captured</li> <li>▪ Review roles of multiple actors involved in water resource management</li> <li>▪ Improve equity and gender mainstreaming</li> </ul>

Strategic themes	Actions
	<ul style="list-style-type: none"> <li>Empower women and youth and disadvantages groups by ensuring that they are able to participate</li> </ul>
<b>Groundwater resource management</b>	<ul style="list-style-type: none"> <li>Initiate research in groundwater or compilation of all past research in order to provide historical overview</li> <li>Undertake stakeholder consultation, involving retired or personnel no longer involved in water sector</li> <li>Initiate interest in Environment Science programme at University of Seychelles (UniSey)</li> <li>Undertake joint research in the groundwater involving stakeholders</li> <li>Improve on data base</li> </ul>
<b>Awareness programmes</b>	<ul style="list-style-type: none"> <li>Initiate sensitization programmes similarly to other areas such as for wetlands and sea turtles</li> <li>Create awareness of ground water during annual World Water Days (22nd March)</li> <li>Sensitize public on quality issues affecting groundwater in order to reverse growing trend that river mouths need to be left open in order to alleviate fears of flooding on coastal plateaus. The situation contributes to increase in salinity in groundwater</li> </ul>

The strategies and guidelines will bring about better awareness on groundwater and make in line with awareness on sensitive areas such as wetlands and the ocean. It will allow the groundwater to be regarded as a crosscutting issue/item and will hopefully be considered during the evaluation and review of other sectors (e.g. forestry, youth). The engagement with different stakeholders will increase the participation of the community so that they can become custodian for groundwater and take up ownership of its management. The draft Water Act is making provision for the declaration of Water Resource Protection Zones. This declaration can be extended to also enable aquifer protection zoning. The present regulations and framework do not allow for independent enforcement. There is a lack of standard procedures that complicates or reduces the chance for enforcement.

### 5.3 Gaps and challenges identified

The literature review and consultation undertaken indicates that certain difficulties may be identified with regards to the strategy and guidelines state affecting groundwater management:

- Lack of leadership to coordinate inter-governmental strategic planning and implementation
- Insufficient human capacity in government to implement provisions for groundwater management

- Inaccessibility of key areas due to financial resources constraints and poor infrastructure
- Inadequate and insufficient guidelines and standards

#### 5.4 Enablers required to unlock these gaps/challenges

The table below gives the enablers required to support the implementation of the strategy and guidelines implementation.

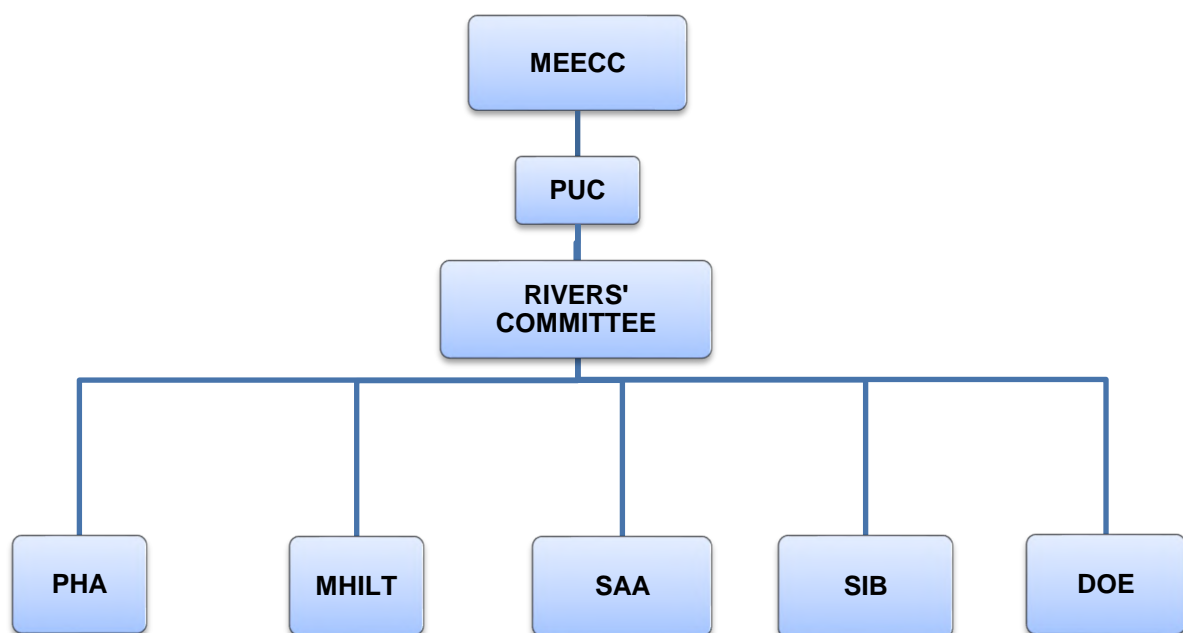
**Table 5: Enablers required to support strategy and guidelines implementation**

Groundwater gap/challenges	Enablers
<b>Increase governance</b>	<ul style="list-style-type: none"> <li>▪ Re-initiate exercise started during development of Water Policy</li> </ul>
<b>Lack of leadership</b>	<ul style="list-style-type: none"> <li>▪ Establish shared responsibility</li> </ul>
<b>Lack of guidelines</b>	<ul style="list-style-type: none"> <li>▪ Initiate process with stakeholders</li> </ul>
<b>Inability to access key areas</b>	<ul style="list-style-type: none"> <li>▪ Ensure public participation and share benefits</li> </ul>

## 6. INSTITUTIONAL FRAMEWORK

### 6.1 Evolution

The Public Utilities Corporation (PUC) is the parastatal company that is given the mandate to collect, treat and supply water to the population on the three main islands. It also acts as the regulator given that the Rivers' Committee is chaired by one of its employees. According to the new water law, it is expected that the regulatory functions of the PUC regarding ground and surface water will be separated. Members of the Rivers' Committee include officials from different government agencies, namely the MEECC, MHILT, PHA, SAA and newly formed Watershed Committees (Refer to Figure 1). Outside of the Rivers Committee, the other government agencies operate independently as stakeholders to the water sector given the obligations under their respective Act under which they operate. An example is the Public Health Act that regulates water pollution and is tasked with monitoring water intended for consumption. They are also involved, along with the Environment Department, in cases of water pollution. NGOs such as the Sustainability for Seychelles (S4S) and the Wildlife Club for Seychelles promote conservation of rivers and wetlands. The UniSeey involves its Environmental Science studies to participate in ecological studies and water analysis. Such NGOs and the UniSeey are expected to be involved in research and monitoring and other stakeholder issues. It is expected that the Seychelles Chamber of Commerce, which groups industries and businesses, will become more active in future given the pressure to reduce the cost of operation and social responsibility among other pertinent issues. There are also three national laboratories, namely the Seychelles Bureau of Standards, the Public Health Laboratory and the PUC Water Laboratory. The Water Management Institutions (WMIs) as it pertains to groundwater is illustrated in Figure 2 and their roles and responsibilities outlined in Figure 2.



**Figure 2: WMIs that have relevance to groundwater management**

## 6.2 Institutional arrangements to support groundwater management

During the review of the existing Acts and legislations the current distribution of the Government Ministries and Agencies within the water management institutional framework of Seychelles of these key functions were found to be as follows (Refer to Table 6). There are plans to further discuss these proposed workable options for re-alignment of the functions of these ministries and agencies so that they are in line with the current Water Policy. It is possible to extend and further discuss these functions so that they enable better groundwater management, which is presently lacking.

**Table 6: Current and Proposed Functions of Agencies and institutions in groundwater resource management**

Function	Current	Under new Water Act
<b>Water resources policy making</b>	MEECC	See options 1a - 1c below
<b>Water resources planning</b>	PUC	See options 2a – 2c below
<b>Water resources monitoring</b>	MEECC; PUC; MoH	See options 3a and 3b below
<b>Water resources regulation</b>	PUC through River Committee	Independent regulator (see options 4a – 4c below)
<b>Water infrastructure operation and management</b>	PUC; MoFA	PUC; MoFA
<b>Water and sanitation services provision</b>	PUC	PUC
<b>Water and sanitation services regulation</b>	MEECC; MoF for tariffs. PUC established by law (PUC Act) as only water services provider in the country	Independent regulator (see options 4a – 4c below)

## 6.3 Gaps and challenges identified

### The Rivers' Committee and the New Water Act

Presently, the Rivers' Committee is the regulator of abstractions for surface and ground water as well as sea water for the island state. This name, however, does emphasize surface water, making the focus on groundwater quite implicit. Under the New Water Act, there is provision to set up a new water board to replace the Rivers' Committee. In the interest of creating awareness around the importance of groundwater as a viable source, the author of this report suggests that the new name of the board replacing the Rivers' Committee be made representative of the range of water resources managed - including groundwater. Currently, the name "Rivers' Committee" implicitly emphasizes surface water management, making it inherently challenging to raise awareness, manage or regulate alternative water sources such as groundwater. Noting that the resource is important for especially the agricultural sector, a name of the board that reflects on the conjunctive approach to managing all available water resources would help promote the regulation and management of groundwater uses towards sustainable water resources management.



## **Water infrastructure operation and management, and water services provision**

It is consensus among stakeholders, that in addition to its functions as a water and sanitation services provider, the PUC shall continue to be mandated to construct, maintain and operate bulk water infrastructure (albeit eventually under an abstraction license issued in accordance with the new licensing system established by the Act). Likewise, in practical terms it makes sense for the MoA to continue providing bulk water to farmers (as is currently the case) – also under an abstraction license in accordance with the new licensing system. For the delineation of the other functions, the following options are proposed<sup>1</sup>:

### **Water Resource Policy Making**

Option 1a: The function remains under one organization, which shall be the ministry responsible for water (MEECC). In exercising the function, stakeholders shall be consulted.

Option 1b: The function remains under one organization, which shall be the independent regulator for water resources management – hereafter WRM regulator (see regulator options below). In exercising the function stakeholders shall be consulted.

Option 1c: The function is jointly exercised by MEECC and the independent regulator. In exercising the function stakeholders shall be consulted.

### **Water Resources Planning**

Option 2a: The planning function would be exercised by the PUC only (within the policy and strategy framework set by the ministry) in consultation with stakeholders, and the water resources management plan approved by the WRM regulator. The water resources management plan would be jointly implemented by the PUC and the WRM regulator (as far as licensing is concerned).

Option 2b: The planning function would be exercised by the WRM regulator only, and the water resources management plan jointly implemented by PUC and the WRM regulator (as far as licensing is concerned).

Option 2c: The planning function would be exercised jointly by the PUC and WRM regulator (within the policy and strategy framework set by the ministry) in consultation with stakeholders. The water resources management plan would be jointly implemented by the PUC and the WRM regulator (as far as licensing is concerned).

### **Water Resources Monitoring**

Option 3a: The current distribution of functions is maintained.

Option 3b: Water resources monitoring functions are concentrated under the WRM regulator. Monitoring of potable water quality to be done by PUC and MoH.

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<sup>1</sup>

## **Water Resources Regulation & Water Services Regulation**

Option 4a: Water resources and water services regulation are concentrated under one regulatory authority. This authority shall be the current Seychelles Energy Commission (SEC).

Option 4b: Water resources and water services regulation are concentrated under one regulatory authority. This authority shall be a newly created body (name to be determined) separate from the SEC.

Option 4c: Regulatory functions for water services provision and water resources management are separated (given the substantially different skills and capacity needed). Water services regulation is exercised by the SEC, which effectively becomes a national utility regulator. Water resources regulation functions (i.e. predominantly water resources monitoring and licensing) are exercised by a newly established WRM regulator (e.g. water resources department; or water resources authority) separate from the SEC.

The proposed Act makes provision for the establishment of hydrologically defined Water Management Areas (WMA, presently mentioned in the EPA) and corresponding local stakeholder participation structures and the setting up of WMA Committees to play a role during water resources management in that WMA. In the case of WMA, the management will include the integrated management of all land and water resources in a particular area. Provision has been made in the SNAIP for promoting, establishing and strengthening 12 Water Users Association linked to small-scale irrigation schemes (one per irrigation scheme).

Being a small country, regulations are in principle national and is not necessarily for a particular region or community.

The law does not recognise the need for catchment management boundaries to be shaped to address the cross-catchment nature of some aquifers. Instead, the proposed Water Act makes provision for establishment of Water Management Areas (WMA). In principle it is expected that migration of ground water will either follow the slope or remain in a confined rock fissure or may extend over an entire coastal sandy plateau found at almost sea level.

The national laws do not recognize customary water law or practices.

The proposed Act does not specifically provide for any regulation for non-point source pollution regulation that impacts aquifers such specifically for aquifer, but it does make provision for the abatement and prevention of pollution of water resources, which included groundwater.

There is no mention of gender issues and equitable access to groundwater in the proposed Water Act. This is only mentioned in the Water Policy but for water resources in general.

## **Local Capacity**

Two noteworthy surveys namely an audit exercise by the National Institute for Science, Technology and Innovation (NISTI) in 2015 and 2018 and a situational analysis by the WHO in 2018, were undertaken. The Gap Analysis by NISTI covered issues such as Equipment Adequacy; The Quality, Availability and Storage of

Reagent and consumables; Regulatory Framework; Data Management and Quality Assurances. The general remarks that were made in the absence of a comprehensive and coordinated monitoring programme, the availability of water quality data has been either non-existent or lacking. The fact that resources and capacity are limited or lacking provides less of an opportunity to effectively map out pollution and water quality and for high level decisions to be taken. However, without a cross sectoral approach and involvement of the citizens and the non-governmental agencies, these data are often believed to be inconclusive and this renders enforcement difficult.

There are presently around five qualified professionals who are active in the field of Water Resources and Hydrology. These include a Civil Engineer, a hydro geologist, a hydrologist, an Environmental Engineer and a Water Resources Manager. However, most of them are undertaking limited, if any, collaborative work that can further development in groundwater.

#### 6.4 Enablers required to unlock these gaps/challenges

The following enablers are required to unlock the institutional gaps and challenges.

**Table 7: Enablers required to unlock the institutional gaps and challenges**

Groundwater gap/challenges	Enablers
<b>Weak groundwater function</b>	<ul style="list-style-type: none"> <li>Establish Governance Unit for coordination of groundwater management</li> <li>Initiate research and awareness programmes</li> </ul>
<b>Delays in groundwater devolution</b>	<ul style="list-style-type: none"> <li>Review and complete the drafting of the proposed Act</li> <li>Implement Watershed Committees in other catchment areas</li> </ul>
<b>Limited participation in local groundwater management</b>	<ul style="list-style-type: none"> <li>Empower the community, District Task Force and the Regional Councils</li> <li>Undertake sensitization programmes</li> </ul>
<b>No capacity for groundwater management at local level</b>	<ul style="list-style-type: none"> <li>Local-level institutions for groundwater management</li> <li>Train technicians in all aspects of management</li> </ul>

## 7. CHALLENGES TO IMPLEMENTATION

- Stasis in enforcing regulations (due to ongoing reforms and mandates)
  - The challenges that arise is whether to proceed with a working model or guideline while the proposed Water Act is being finalised. Given the number of government agencies involved, it is prudent for them not to enforce if the regulations are not in place.
- Institutional complexity and unclear mandates
  - The number of agencies involved suggest that Water related issues should fall under one Agency or one Ministry so that they can be responsible for all water related issues. Otherwise each Agency will focus on their particular domain and information will not be shared or may not be comparable given the different methodology being used or different times of sampling.
- Limited capacity
  - The other major challenge is in the limited manpower resources and the hesitation to place all the necessary powers under one Ministry or Agency and/or sharing responsibility with the civil society leading to hesitation to act or responsibility. Given the small population size, whereby “everyone technically” knows each other and a blind eye is often turned away from the offender.
  - While there is an opportunity, Regional Councillors are currently not engaged in training or governance. There is need to ensure that regional councillors are included in training and governance.
- Limited tools and systems
  - Continuous data collection, due to budget cuts does not allow statistical analysis to be necessary. There are locations where only one sample is collected each year hence preventing the long term and seasonal trends to be observed. Research needs to be initiated so that scientific data can be collected and will permit more informed decisions to be undertaken.

## 8. ACTION PLAN

The MoSCoW method of prioritisation has been used to develop the action plan. This method identifies the *Must have*, *Should have*, *Could have*, and *Won't have* elements for the Groundwater Management Regulatory Framework.

**Table 8: Action Plan “Must Haves”**

Prioritisation	Element	Description
<b>Must have:</b>  <i>those elements of the regulatory framework that are critical</i>	<b>Policy</b>	<ul style="list-style-type: none"> <li>This is currently in place though it may be necessary to make special emphasis on groundwater when the Water Act is formulated. Otherwise in the preamble, ground water must be included and is seen clearly as being part of water bodies and has the same status as the others.</li> </ul>
	<b>Legislative</b>	<ul style="list-style-type: none"> <li>Separate Section on groundwater. Establish a Water Commissioner and Board responsible for all matters linked to the environmental aspects of water</li> </ul>
	<b>Institutional</b>	<ul style="list-style-type: none"> <li>Ensure that Watershed Committees fall under and report to Regional Council rather than directly to Government Agencies.</li> </ul>
	<b>Strategy/ Guidelines</b>	<ul style="list-style-type: none"> <li>Ensure that Water Commissioner shares responsibility with Regional Councils so that there is shared responsibility with a government appointed person (the Commissioner) with the locally elected community non-politically affiliated members (elected by the community).</li> </ul>

**Table 9: Action Plan “Should Haves”**

Prioritisation	Element	Description
<b>Should have</b>	<b>Policy</b>	<ul style="list-style-type: none"> <li>Addendum to existing Water Policy for groundwater</li> <li>Provision for research to be undertaken given that ground water may differ widely in each watershed area compared to surface stream water where the water is low in ionic content and pollution and to allow ground water to be used in community areas and reduce dependence from other watershed areas. This will encourage each community to establish safeguards and control in their respective watersheds.</li> </ul>
	<b>Legislative</b>	<ul style="list-style-type: none"> <li>Implement polluter pays principle</li> </ul>
	<b>Institutional</b>	<ul style="list-style-type: none"> <li>Research institute to support enforcement</li> </ul>
	<b>Strategy/ Guidelines</b>	<ul style="list-style-type: none"> <li>Review Water Act to include groundwater management</li> <li>Implement information sharing and transparency</li> <li>Raise awareness</li> </ul>

**Table 10: Action Plan “Could Haves”**

Prioritisation	Element	Description
<b>Could have</b>	<b>Policy</b>	<ul style="list-style-type: none"> <li>More specific guidelines on how powers will be shared with the community but without affecting decisions taken for national interests or benefit of other regions</li> </ul>
	<b>Legislative</b>	<ul style="list-style-type: none"> <li>Ensure that law is specific and is more powerful than other laws</li> </ul>
	<b>Institutional</b>	<ul style="list-style-type: none"> <li>Ensure that research institute falls under separate government agency to the one that the “Water Agency” falls under.</li> </ul>

**Table 11: Action Plan “Won’t Haves”**

Prioritisation	Element	Description
<b>Won’t have</b>	<b>Policy</b>	<ul style="list-style-type: none"> <li>Sector dominates water usage. Water should be shared by all sectors (domestic, tourism, agriculture) and leaving sufficient amount for ecological purposes/functions</li> </ul>
	<b>Legislative</b>	<ul style="list-style-type: none"> <li>Legislation that is in conflict with existing laws whose review/revision are being delayed</li> </ul>
	<b>Institutional</b>	<ul style="list-style-type: none"> <li>Regulatory body that falls under PUC (sole national Water Operator)</li> </ul>



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## APPENDIX A: LITERATURE INVENTORY LIST

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
<b>2018</b>	Coastal Management Plan Seychelles 2019-2025	van Zanten, Boris, Reguero Borja, Brenden Jongman	Ministry of Environment, Energy and Climate Change, The World Bank	Draft Version (Final Edition expected in February 2019)	
<b>2017</b>	MEECC (2017) National Water Policy Ministry of environment, energy and climate change, Seychelles	Ministry of Environment, Energy and Climate Change	Government of Seychelles	Final, 2017	-
<b>2017</b>	National Integrated Water Resources Management (IWRM) Plan	Ministry of Environment, Energy and Climate Change	Ministry of Environment, Energy and Climate Change	Final Draft, 2017	NA
	Water Act (Draft)	Government of Seychelles		Working Draft	-
<b>2009</b>	Seychelles National Climate Change Strategy	The Seychelles National Climate	Government of Seychelles	Final, November 2009	

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
		Change Committee			
	Seychelles Water Supply Development Plan 2008-2030	PUC	AWF	Draft Report	
<b>2015</b>	(Proposal For) National Food and Nutrition Security (NFNSP) Multi Sector Implementation Plan-Scaling Up Multi-Sectoral Efforts for a Healthy and Competitive Human Capital	Florence Y. Conteh Nutrition Specialist	Specialist Food and Agriculture Organization of the United Nations	Draft, December 2015	
<b>2007</b>	Assessment of groundwater resources on La Digue Island in the Republic of Seychelles: A study proposal (IAEA-CN-151/55), p. 315 H.A. Alcindor, A.E. Taigbenu, L. Araguás-Araguás, L.P. Jayawardena. International Symposium on Advances in Isotope Hydrology and Its Role in Sustainable Water Resources Management (2007 : Vienna, Austria) Advances in isotope	H.A. Alcindor, A.E. Taigbenu, L. Araguás-Araguás, L.P. Jayawardena.		Final, 2007	

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
	hydrology and its role in sustainable water resources management (IHS-2007) : proceedings of an International Symposium on Advances in Isotope Hydrology and its Role in Sustainable Water Resources Management (IHS-2007) / organized by the International Atomic Energy Agency and held in Vienna, 21–25 May 2007. — Vienna, IAEA, 2007. p. ; 24 cm. — (Proceedings series, ISSN 0074-1884) STI/PUB/1310 ISBN 978–92–0–110207–2				
<b>2007</b>	Processes Affecting Groundwater Quality in the La Digue Aquifer, Seychelles, p.319, Alcindor, A., E. Sacchi, A.E. Taigbenu, Isotopes in Hydrology, Marine Ecosystems and Climate Change Studies : Proceedings of the International Symposium held	Alcindor, A., E. Sacchi, A.E. Taigbenu,	International Atomic Energy Agency	Final, 2013	Yes. IAEA

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
	in Monaco, 27 March–1 April 2011 : in two volumes. — Vienna : International Atomic Energy Agency, 2013. p. ;24 cm. — (Proceedings Series, ISSN 0074–1884) STI/PUB/1580 , ISBN 978–92–0– 135610–9				
<b>2017</b>	Seychelles Groundwater Survey (Draft) Mahe, Praslin & La Digue Feasibility & Investigation	Johan Von Garrelts	The Water Harvesting Company, Part of EcoPARTner Group AB,	9th October 2017	
<b>2015</b>	Seychelles Infrastructure Action Plan		African Development Bank	May, 2015	
<b>January 2015</b>	Seychelles National Agricultural Investment Plan (SNAIP) 2015-2020	Ministry of Agriculture and Fisheries	Government of Seychelles		
	The Seychelles Sustainable Development Strategy (SSDS) 2012 to 2020		Government of Seychelles		
<b>September 1978</b>	Institute of Hydrology (1978) Groundwater Investigations of Selected Plateaux in the Republic of	PUC	Ministry of Overseas Development		

Year	Title of Document	Author	Publisher	Report Number	Link (if it is a website document)
	Seychelles. Report prepared for the Ministry of Overseas Development,				
<b>1981</b>	Rooke, E.E. (1981) Hydrogeology of the Anse Royale Coastal Plain	PUC			
<b>November 1992</b>	Meyer, R. (1992) Preliminary report on the ground water resources of Mahé Island, Republic of Seychelles. Report No. EMAPC. Division of Earth, Marine and Atmospheric Science and Technology, Council for Scientific and Industrial Research, Pretoria, November 1992.	PUC	Division of Earth, Marine and Atmospheric Science and Technology, Council for Scientific and Industrial Research, Pretoria	Report No. EMAPC.	



## APPENDIX B: STAKEHOLDER LIST

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Ms	Ginnie	Laurencine	Public Utilities Corporation	Water Resources Manager	Parastatal	(248) 678000 (248) 2817731	<a href="mailto:glaurencine@puc.sc">glaurencine@puc.sc</a>	Yes
Mr	Antoine	Moustache	Ministry of Fisheries and Agriculture, Department of Agriculture	Principal Secretary	National government	(248) 4672300 (248) 2722009	<a href="mailto:antmoust@seychelles.net">antmoust@seychelles.net</a>	Yes
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Title	Name	Surname	Affiliation	Role	Sector Group	Telephone	Email	Priority (yes/no)
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<b>Mr.</b>	Rodney	Quatres	UNDP-PCU- Seychelles Office - GCCCA+ Project	Project Manger		(248) 4225914 (248) 2818506		

Title	Name	Surname	Affiliation	Role	Sector Group	Telephone	Email	Priority (yes/no)
<b>Mr</b>	Antoine	Alcindor	Public Utilities Corporation	Retired-Hydrologist	Parastatal	(248) 2712408		

#### Stakeholders engaged with and who completed the questionnaires

Name	Position	Stakeholder Group
<b>Mr. Franky Duprès</b>	Manager of Sewerage Section - Public Utilities Corporation, SADC Focal Point	Parastatal
<b>Mr. Denis Matatiken</b>	Special Advisor, Ministry of Environment, Energy and Climate Change, Environment Department	Government
<b>Ms Eulalie Sabury</b>	Principal Public Health Officer, Public Health Agency, Public Health Engineering Unit	Government
<b>Mr Guy Morel</b>	Consultant for Seychelles Water Policy	Private (Consultant)
<b>Mr. Jean-Luc Mondon</b>	Hydro Geologist, Petro Seychelles	Parastatal
<b>Mr. Andy Ally</b>	CEO, Seychelles Bureau of Standards	Parastatal

## Validation Workshop

Name	Position	Stakeholder Group
<b>Mr Franky Duprès</b>	Manager of Sewerage Section - Public Utilities Corporation, SADC Focal Point	Government (Validation Workshop)

## APPENDIX C: DESIRED FUTURE STATE SUMMARY

### Reflection of Policy Framework as per the minimum requirement for the Desired Future State

Minimum requirement for desired future	Status	Comment
A long-term policy to protect groundwater by preventing pollution and overuse. This policy is comprehensive, implemented at all appropriate levels, consistent with other water management policies and be duly taken into account in other sectorial policies;	Achieved	<p>The Water Policy makes mention that proper sanitation is key to mitigating pollution of groundwater. Hence the Policy (and the accompanying proposed Water Act) endorses the Sanitation Master Plan that makes provision for sewerage systems or proper abatement of sewage/effluent.</p> <p>The Policy makes mention that all abstractions will be based on sustainable yield calculations made by competent persons or authority. The establishment of a central abstraction register has also been proposed.</p>
The social, economic and environmental values of groundwater are all recognised;	Achieved	The guiding principle of IWRM with respect to economic and social value has been acknowledged. The protection of the country's water resources for the economic, social and environmental benefits is one of the objectives of the National Water Policy
The human right to water is recognized and a rights-based approach to groundwater management is taken, <i>inter alia</i> , through:	Achieved	This is done in order to alleviate poverty.
Prioritization of drinking water/basic human needs in water legislation;	Achieved	For drinking and for domestic requirements.
Ensuring that land-based rights cannot entitle unlimited access/use of freshwater, including groundwater;	Partially	The topic is not mentioned but possibly captured under equitable distribution.
Ensuring groundwater is legally recognized as a public good;	Achieved	Water is considered as a public, economic and social good.
Recognising the role of groundwater in meeting basic human needs for food security;	Achieved	This is mentioned with a view of ensuring water is available for irrigation and promoting reliable food production and to support the National Food and Nutrition Security Policy.



Minimum requirement for desired future	Status	Comment
Legal recognition of customary rights to freshwater, including groundwater;	Partially	The Policy only mentions water use rights for all types of users and user types but no mention as to whether it may customary.
Legal mechanisms to ensure gender equity in access, use and management of freshwater, including groundwater;	Partially	Gender mainstreaming is seen as being important in the Policy and the empowerment of women to fully participate is mentioned but legal mechanisms has not been mentioned.
Provision of pricing mechanisms that incentivize equitable distribution of rights to access and use of groundwater, as well as prioritization of small-scale users' livelihoods and food security needs, especially youth and women.	Partially	Pricing is seen as necessary but requires balancing with social and economic concerns.
Groundwater is recognised as a highly important source of domestic and agricultural water supply and a key resource for poverty alleviation, food security, and the sustainable economic development of rural areas;	Partially	Water is seen as a requirement for irrigation and as a consequence necessary for food security.
The biophysical and ecological linkages between ground and surface water for their use, protection and management are recognised, including land use zoning for groundwater protection and recharge (conjunctive use);	Partially achieved	The ecological integrity is seen as being vulnerable to pollution hence legal framework shall be developed to ensure meaningful enforcement. Water Managers and users will be encouraged to cooperate in adopting an ecosystem and river basin approach to protecting the environment as a resource base.
The importance of the maintenance of the ecological integrity of wetlands in groundwater management is recognised (recharge zones);	Achieved	This is especially seen as necessary in order to maintain hydrological functions including natural water storage.
Intersectoral collaboration is promoted and facilitated so that the needs and impacts of different sectors (e.g., land, agriculture, mining, municipal, and environment) are taken into account in groundwater management and the impacts of developments in those sectors on groundwater are accounted for;	Partially	Integrated planning is a fundamental of the IWRM and to ensure stable economic growth and economic benefits.  Appropriate land use planning is seen as necessary to limit human induced disasters.

Minimum requirement for desired future	Status	Comment
The need for adaptive management is recognised due to the inherent limitations in the nature of scientific information in conjunction with the widely occurring dynamic processes of climate, social and institutional change;	Partially	The Policy states that conditions should be created that can reduce the risk of disasters such as climate change adaptation strategies and clear rules for water allocation in drought situations.
The roles of various stakeholders and water users in groundwater management is recognised and participation of stakeholders in decision-making and groundwater management is promoted and facilitated;	Achieved	There is the commitment to engage with and promote the involvement of users and consumers in water management.
An apex body that is responsible explicitly for GW management and playing the role of custodian/trustee on the part of the state is clearly defined;	Partially	The establishment of an independent regulatory body for water, also referred to as an apex body, has been identified as a priority. However, the structure of the body is yet to be discussed.
Effective institutional arrangements are coordinated at trans boundary, national and local levels;	Achieved	All water institutions shall be encouraged to make efforts to collaborate in developing and sharing the capacity to carry out their mandate efficiently and effectively.
Public access to geo-hydrological data held by the state is promoted and facilitated	Partially	The need for reliable, accurate and accessible information is seen as fundamental to water management. Hence the competent authority shall ensure the sharing of data on hydrological, hydrogeological, water quality, meteorological and environmental condition of water resources.
- Additional environmental principles necessary to protect and sustain groundwater are mandated, including: the precautionary principle, the principle of gender equity and social inclusion (GESI), the principle of subsidiarity, and the principle of intergenerational equity.	Partially	The precautionary principle, social inclusion and intergenerational equity is not mentioned.

## Reflection of Legal Framework as per the minimum requirement for the Desired Future State

Minimum requirement for desired future	Status	Comment
<b>Provide Status of Groundwater</b>		
All water has a consistent status in law, irrespective of where it occurs	Achieved	Water resources in general.
Explicit reference to groundwater and conjunctive use management in catchment/water management and development plans and drought/emergency management plans	Partially Achieved	The proposed Water Act only mentions control of emergency incidents and reserved flow during use of water for firefighting and emergencies during severe water shortage as defined per Regulations or for firefighting.
Human right to water recognized in groundwater legislation, facilitating prioritization of drinking water and basic human needs, as well as small-scale users		The establishing, administering and enforcing a system of regulation for water supply and to ensure the right to basic human needs and basic sanitation is met has been mentioned. However for small scale users, this is not mentioned.
<b>Regulate Groundwater Quantity</b>		
<b><i>Provide conditions for accessing groundwater</i></b>		
i. Water use authorizations:	Partially Achieved	Provision has been made for water to be used and developed in a sustainable and equitable manner.
Legislation must enable the authorisation of groundwater use (with a system that does not discriminate, especially against the rural poor);	Partially Achieved	The equitable management and control of water is seen as necessary for the benefit of all persons.
The permitting of groundwater use should not be tied exclusively to land tenure;	Not achieved	This can be considered and clarified during later stages of the development of the Draft Water Act.
Legislation should allow for the categorisation of water users;	Partially	This is only mentioned in the pricing strategy and for application of abstraction licence.
Groundwater should be declared a public asset and/or authority vested in government to restrict, in the public interest, the rights accruing from its private ownership to prevent over-abstraction or inequitable access/use by landowners;	Achieved	Water is seen as a public good.
New legislation should strive towards changing ownership rights to use (usufruct) rights,		

Minimum requirement for desired future	Status	Comment
subject to a government-controlled, permit system for large scale users with appropriate non-permit systems for addressing the needs of small scale users		
The legislation recognises and legalises affordable, small-scale and indigenous solutions;		Not mentioned in the Draft Act.
The legislation should enable the regulation of borehole drillers, regulation for drilling, control of drillers, information from drillers and standards for borehole drilling;	Partially Achieved	Borehole drilling requires a licence under the proposed Act. The development of an operations manual is not mentioned though.
Legislation should give water inspectors the right to enter land with the offenses and associated penalties noted in the legislation (this includes appropriate fines and jail time that needs to be adjusted annually);	Achieved	Authorised Officer are allowed to enter any premises and to issue penalties.
The legislation should enable the regulation of exploration;	Not Achieved	This is not specifically mentioned under scientific investigations and research.
The legislation should allow for zoning for overused/fragile aquifers;	Not Achieved	Zoning is only mentioned to ensure water resource protection.
Groundwater use organizations should be integrated into existing institutional frameworks (e.g., catchment management, customary institutions)	Partially achieved	This is mentioned in the Policy and needs to be considered in the proposed legislation.
<b>Stakeholder engagement</b>		
The legislation should specify when and how stakeholders, the public and/or other water users are to be engaged in planning, decision making and self-management with regard to groundwater;	Partially Achieved	The engagement of the services of such experts and consultants as necessary to fulfil the functions of the Regulator is mentioned. The mentioning of engagement with stakeholders and the general public is not mentioned.
There should be specific mechanisms for directly involving stakeholders in the development of laws and regulations related to groundwater and decisions that may impact	Not Achieved	Refer to previous point.

Minimum requirement for desired future	Status	Comment
the use or quality of groundwater on which they depend for drinking, livelihoods, food security, economic or cultural well-being; and		
The legislation should specifically address the issue of the involvement of women and youth in decision-making and the implementation of groundwater supply schemes.	Partially Achieved	Gender mainstreaming is mentioned in the Policy but not in the proposed Water Act.
<b>Monitoring and data collection to support regulation</b>		
The legislation should specify the need and parameters for a sustainable system for data collection, management and dissemination, including standardization and harmonization of data. This entails a national monitoring and information system which captures quantity and quality data from key aquifers;	Partially Achieved	The Regulator is expected to undertake research, analysis and the preparation of national inventory, records and databases.
The legislation should specify the need for drought monitoring systems which extend beyond rainfall, surface water and food security indicators to groundwater and groundwater supply status, including the appropriate prediction of future hydrogeological conditions;	Not Achieved	Presently the only warning is from the supplier PUC which alerts the public on reduced surface water flow. The Met Office also occasionally alerts the public when dry weather is persisting.
In transboundary basins, legislation should address the need for standardization and exchange of data as well as the establishment of joint inventories; and		Not Applicable for the Seychelles.
The legislation should enable access by the public to geohydrological data held by the state.	Achieved	It is included in the legislation for Access for Information.
<b>Water conservation and efficiency of use</b>		
Legislation should enable regulation to ensure the efficient use of groundwater, such as the use of economic incentives and imposition of technologies.	Partially Achieved	The increase of efficiency of water use and reduction of wastage of water is mentioned in the Draft Water Act.
<b>Compliance and Enforcement</b>		

Minimum requirement for desired future	Status	Comment
Clear mechanisms for promoting compliance with groundwater regulations should be included in the legislation	Not Achieved	
Enforcement provisions should include, <i>inter alia</i> , inspections authority for groundwater management institutions, the ability to impose fines and/or additional administrative penalties and adjust those as necessary, and enumerate criminal offenses associated with failure to comply with the law.	Achieved	Enforcement Officers are given this power.
<b>i. Conflict resolution mechanisms and/or the right to appeal</b>	Achieved	An appeals process is suggested in the Draft Water Act with a view to resolve a dispute.
<b>Regulatory measures</b>		
The legislation must enable the relevant authority (Minister) to make regulations on any relevant matter in the legislation	Achieved	This is mentioned under the section on Powers and Function of the Minister
Legislation should provide a clear ability for the government to pass regulatory measures, such as abstraction fees and waste disposal charges, to provide revenue to water management institutions and to incentivise appropriate use of groundwater	Achieved	This is mentioned under the Section for Functions of the Regulator.

#### Reflection of Strategy and Guidelines Framework as per the minimum requirement for the Desired Future State

Minimum requirement for desired future	Status	Comment
<b>Provide Status of Groundwater</b>		
<b>Groundwater Protection Mechanisms</b>		
<b><i>Regulating Pollution (Point source and non-point source)</i></b>		
i. Water quality targets; ii. Regulation of emissions/wastewater discharge/waste storage including the impact of mines on groundwater quality: Permits can be used to regulate the	Partially achieved	This is mentioned in the EPA 2016 (e.g. Section 15, 17, 20).



Minimum requirement for desired future	Status	Comment
discharge, disposal and possibly the storage of waste should specifically take into account the vulnerability of the aquifer concerned and the provisions necessary for its protection;		
i. Classification of water bodies; and	Partially achieved	Provision for the classification of waters is mentioned under Section 16 of the existing EPA 2016 legislation.
/. Reducing and regulating abstraction.	Achieved	Provision has been as part of the Functions of the Regulator.
/. Powers of compliance monitoring and enforcement	Achieved	Although included in the EPA 2016 and in the proposed Water Act. However the procedure for monitoring needs to be further clarified or elaborated.
<b>Regulating Depletion</b>		
Regulation of abstraction and recharge (usually via permitting);	Partially Achieved	The existing regulation only cover the abstraction. It has to be updated to include the recharge
Sustaining wetlands;	Partially Achieved	The effective and sustainable use of water resources for water services is mentioned but not specifically for wetlands.
Land use zoning – prohibition of abstraction in certain zones; cropping or irrigation practices; protection zones for recharge areas; no surfacing/drainage requirements; and	Achieved	The Proposed Water Act will make provisions for declaration of protection zones.
Legislation must make it mandatory for installation of monitoring equipment of boreholes especially for large-scale users (the information must then be supplied to the state).	Partially achieved	This is actually recommended in order to effectively bill the consumer especially where there is potential for PUC (the water Supplier) to provide potable water from the mains.
Powers of compliance monitoring and enforcement	Achieved	.
<b>Planning</b>		

Minimum requirement for desired future	Status	Comment
The legislation should specify the need for long term plans to ensure the sustainable use of groundwater, including drought management plans and cross-sectorial coordination;	Not Achieved	
Where water legislation provides for catchment level or basin level planning, groundwater should be integrated into those plans (for example through impact assessment requirements);	Not Achieved	
The legislation should specify that groundwater management planning should take into account and be integrated into land use and environmental planning; and	Partially Achieved	Within the proposed Water Management Areas demography and land use is expected to be taken into account.
Planning should be cyclical and based on continuous learning from data and stakeholder feedback to ensure adaptive management and effective responses to changing climatic, social, political and institutional contexts/drivers.	Not Achieved	The Water Policy is expected to be reviewed every 3 to 5 years. Under the proposed Water Act, tariffs are expected to be reviewed periodically but the reasoning to that is not clear.

#### Reflection of Institutional Framework as per the minimum requirement for the Desired Future State

The gaps and challenges identified are summarized in the table below.

Minimum requirement for desired future	Status	Comment
Legislation should contain provision for its effective implementation, including the mandate, competence and power of the relevant authorities in accordance with uniform governance principles;	Partially achieved	
Water authorities or coordinating bodies should have the competence to integrate all aspects of water management and should be rendered competent to arbitrate among various competing demands, and diverging interests regarding groundwater abstraction and use, both in the short-term and in the long-term;	Partially achieved	The proposed Water Act makes mentioned that the Appeals Board should include 3 persons with knowledge in matters concerning water resources management. The proposed integration can be added to the list under the Section for National Water Resources Master Plan under the proposed Water Act.

Minimum requirement for desired future	Status	Comment
The authority or body should collaborate with other authorities, competent for public health, land-use planning, soils management, waste management;	Partially Achieved	The collaboration can be included under the Section for National Water Resources Master Plan in the proposed Water Act.
Water user associations and other appropriate forums (such as municipalities) should be utilized to strengthen the user advocacy role and achieve new partnerships and a joint management of the common resource.	Partially achieved	This can be included under the Section for National Water Resources Master Plan in the proposed Water Act.



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