Water Production, Use, and Governance in the Pafuri Sengwe node of the Greater Limpopo Transfrontier Conservation Area

SOUTHERN AFRICA
Drought Resilience Initiative
Livelihoods and Food Security

WORLD BANK GROUP
Water

CIWA

Tea plantations outside of Tzaneen, Limpopo, South Africa. @Juergen Bochynek / Gettty Images

Summary Report

Analytical Work to Fill Knowledge Gaps in Water Production, Use, and Governance in the GLTFCA Pafuri-Sengwe Node

04 March 2022

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ABBREVIATIONS

CBNRM	Community Based Natural Resource Management
CSIR	Council for Scientific and Industrial Research
DNAAS	National Directorate Water Supply and Sanitation
DNGRH	National Directorate of Water Resources Management
DWS	Department of Water and Sanitation
EMA	Environmental Management Agency of Zimbabwe
EIS	Ecological Importance and Sensitivity
FCDO	Foreign, Commonwealth and Development Office
GIS	Geographic Information System
GLC	Greater Libombos Conservancy
GLTFCA	Great Limpopo Transfrontier Conservation Area
GLTP	Great Limpopo Transfrontier Park
GNP	Gonarezhou National Park
KNP	Kruger National Park
LEDET	Limpopo Department of Economic Development, Environment and Tourism
LIMCOM	Limpopo Watercourse Commission
LNP/PNL	Limpopo National/*Parque Nacional do Limpopo*
LRB	Limpopo River Basin
MEWC	Ministry of Environment, Water and Climate
MOPHRH	Ministry of Public Works Housing and Water Resources
PCR	Polymerase chain reaction
PES	Present Ecological Status
PPF	Peace Parks Foundation
RESILIM	Resilience in the Limpopo Basin Program
SADC	Southern African Development Community
SADC GMI	SADC Groundwater Management Institute
SADRI	Southern Africa Drought Resilience Initiative
SANBI	South African Biodiversity Institute
SWSA	Strategic Water Source Area
SWSA-gw	Strategic Water Source Area for Ground water
SWSA-sw	Strategic Water Source Area for Surface water
TBA	Transboundary Basin Aquifer
WRC	Water Research Commission
WWTW	Wastewater Treatment Works
ZINWA	Zimbabwe National Water Authority

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Executive Summary

The Great Limpopo Transfrontier Conservation Area (GLTFCA) Pafuri-Sengwe Node has been earmarked as a key socio-economic development focus area in terms of the GLTFCA Integrated Livelihoods Diversification Strategy. Key drivers identified in the Strategy as some of the most significant to be considered, monitored and designed for in all future interventions include: water security governance and resource management; food security and climate change.

Through the SADRI Livelihoods and Food Security pillar, the World Bank provided technical support to the GLTFCA to better understand water governance and water use in the Pafuri-Sengwe Node to inform drought preparation and mitigation measures at a community level. The focus of this analytical work will be on the following water systems: Limpopo River; Mwenezi/Nuanetsi River; Luvuvhu River; and Bubye River.

The objectives for this work included the following:

- Determine the extent of water availability in targeted groundwater aquifers, wetland, and rivers systems;
- Assess current demand and usage of this water, especially among communities in the Parfuri-Sengwe Node;
- Evaluate governance practices in place for managing this water; and
- Based on the above, identify, develop, and recommend near-term and medium-term actions for water management that leads to building community drought resilience.

An important component of this work was the focus on improving the water resources knowledge (*and data management*) of the area, especially important baseline information relating to wetlands, groundwater and the interaction between these surface and groundwater resources.

The key findings of the assignment included the following:

- Conservation of key natural resources (land as well as water-based) and development-focussed trade-offs in the Pafuri-Sengwe Node must be integrated if lasting positive outcomes for sustainable and resilient livelihoods are to be achieved. An example of such an integrated approach would be where community-based and community-led conservation initiatives could be supported by interventions that are focussed on improved water and food security through mechanisms such as payment-for-ecosystem services (PES) or through formal allowances that enable local harvesting of natural resources to be possible within conservation areas. This balanced approach to investments and livelihood resilience in the Node would benefit the intended conservation outcomes, while at the same time directly supporting improved livelihood options, food security and enhanced economic stability for communities living in these very remote areas of the three GLTFCA Partner Countries.
- Initiating effective wetland and aquifer management relies on a solid knowledge base with regard to the number, size, type, and location of the wetlands to be

managed, along with improved aquifer delineation based on accurate in-field monitoring, as well as an understanding of the pressures being exerted on these water resources features and areas. Without this knowledge, wetland and aquifer management is unlikely to be successful. In all the country components of the Pafuri–Sengwe Node, developing a wetland and aquifer inventory is therefore a logical first step to improving wetland and aquifer management, as it provides the data necessary to start including wetland and aquifer management in development planning, spatial planning and decision making. The inventory also needs to be maintained and constantly improved with inputs from various Partner Countries. Whilst a wetland and aquifer inventory would provide an important starting point to inform wetland and aquifer management, this should ideally be enhanced through a prioritisation process that helps to inform decision making and target management interventions in wetland and aquifer areas where they are most needed. In the case of Pafuri-Sengwe Node prioritisation is probably a more significant step following gathering the baseline/inventory data given the mixed-use of the wetland and aquifer resources and largely lacking management plans.

- Managing wetlands and groundwater systems that support livelihood to communities is a complex issue that requires clear thresholds between wise use and sustainable management, especially under the current situation where there is major dependence on wetlands and ground water by communities, as well as an increase in population resulting in high demand for land, climate change effects (including drought and floods), increase in human settlements and demand for services delivery to support communities.
- The increasing extent and intensity of wetland use result in degradation and expansion of encroachment into wetland ecosystems which increasingly compromises wetlands' integrity. The community's major concern is developing alternative livelihoods and not the management and conservation of communal wetlands. This is particularly true in the Mutale-Luvuvhu Catchments and is due to the lack of alternative livelihood options and other socio-economic issues. There is need to utilise wetlands and groundwater sustainably in Pafuri-Sengwe Node. This will in turn support communities to maintain the wetlands capacity and manage groundwater effectively to ensure ecological integrity. There also needs to be a realisation and acceptance of the fact that some livelihood activities are not compatible with conserving and managing the ecological integrity sustainably and that degraded wetlands cannot provide the required ecosystem services.

The table below presents a summary matrix of 11 key Thematic areas for all three Partner Countries, with primary Opportunities and Constraints within each Thematic area. If these opportunities can be harnessed and the associated constraints limited or reduced, sustainable livelihoods and conservation objectives can be achieved in the Node.

Table A: Recommended Livelihood Investment Opportunities

Thematic Area	Mozambique		South Africa		Zimbabwe	
	Opportunity	***Constraint***	***Opportunity***	***Constraint***	***Opportunity***	***Constraint***
1. Governance	Transboundary small business support.	Limited institutional support; distance from service areas.	Increased DWS and local engagement with communities.	Low level of support, especially in more remote locations.	Strengthen local devolution of governance to enable increased local management.	Long distance from central government; low level of regulatory oversight.
2. Water supply	Spare parts – small business opportunities in the Pafuri area.	Boreholes not functioning.	Conjunctive use, potentially deeper Boreholes and use improved pumps that can draw water from deeper, to avoid salinity (however depth is an assumption – not yet proven across the area).	Intermittent (once a week release).	Increase boreholes& rainwater collection. Allow cross border movement of spare parts at new border Create small sand/ earth dams to up supply.	Borehole supplies finish quickly due to high demands. Non-functioning boreholes (long distance from supply and limited supply for parts).
3. Water quality	Potentially deeper boreholes – however uncertain groundwater information restrict confidence in this option. Rainwater collection as non-drinking water supply addition.	High salinity.	Potentially deeper boreholes – however uncertain groundwater information restrict confidence in this option. Rainwater collection as non-drinking water supply addition.	High salinity.	Engage ZINWA and EMA and others to consider improved monitoring.	Poor aquifer information and limited borehole information available.
3. Wetland Data/Information	Develop a detailed wetland inventory.	Poor wetland delineation at local scale, little information available.	RAMSAR site in Makuleke Contractual National Park well demarcated.		Develop a detailed wetland inventory.	Poor wetland delineation at local scale, little information available.
4. Technology	Apply small scale irrigation and potentially solar pumping for water to promote agriculture outside of wetlands.	Wetlands used for agriculture purposes.	Apply borehole technology that can pump water from deeper – e.g. *Bush Pump.*	Shallow wells and boreholes with *AfriDev* pump technology.	Increase commercial scale irrigation and potentially solar pumping for water to promote increased food security.	
5. Mining				Illegal mining threats in Madimbo Corridor threat to management of nature reserve.	Safeguards and a balanced approach to be agreed to and implemented.	Threat to water quality and wetland integrity.

Thematic Area	Mozambique		South Africa		Zimbabwe	
	Opportunity	***Constraint***	***Opportunity***	***Constraint***	***Opportunity***	***Constraint***
6. Crop production	Small scale irrigation to enhance food security, outside wetlands (trade-off); Improve agricultural practices in wetlands – more ecologically sensitive, apply Conservation Agriculture (CA).	Low level of food security, Agriculture in wetlands (compromising wetlands).	Small scale abstraction and irrigation away from floodplains and river banks.	Crop production mainly along rivers for ease of water access.	Promote and support these, and consider CA options.	Viable agricultural irrigation schemes exist.
7. Livestock	Promote alternative energy supply and regenerative grazing. Establish BH's for livestock separate from community water supply.	Deforestation; land degradation, affecting runoff and recharge; behavior change required; Livestock watering from municipal supplies.	Promote alternative energy and regenerative grazing. Establish BH's for livestock separate from community water supply.	Deforestation; land degradation, affecting runoff and recharge; behavior change required; Livestock watering from municipal supplies.	Promote alternative energy and regenerative grazing. Establish BH's for livestock separate from community water supply.	Deforestation; land degradation, affecting runoff and recharge; behavior change required; Livestock watering from municipal supplies.
8. Indigenous and revisited knowledge and practices	Share practices and learnings more widely across the node esp. where BH's have high nitrate/fluoride. Traditionally, water resources management formed a component of local knowledge. However, some knowledge has been lost. Opportunity to re-invigorate the interest and application of this, and strengthen the knowledge and skills of rural extension workers.	Community-based knowledge on safeguarding water quality. Globally, the challenge exist of a lack of awareness of water resource definitely in multiple sectors – this is definitely an important component of future drought resilience work in the Node.	Potential opportunities linked to story-telling and traditional use of the Makuleke wetlands. Community-based monitoring programme of the Makuleke wetlands.		Apply similar management in Mozambique and South Africa Promote traditional drought resistant crops in Mozambique and South Africa (but this require behaviour and food preparation changes).	Water Committee manage each borehole Apply traditional and more drought-resistant crops in small gardens to cope with drought conditions.
9. Economic	Improve access to markets – especially cross-border.	Low levels of income.	Develop alternative income streams; entrepreneurship and small business	Low income and low level of job opportunities.	Improve market facilities including sanitation.	Poor conditions esp. for women at local markets.

Thematic Area	Mozambique		South Africa		Zimbabwe	
	Opportunity	***Constraint***	***Opportunity***	***Constraint***	***Opportunity***	***Constraint***
	Ecotourism in adjacent protected areas.		capacity for transboundary supply.		Ecotourism/controlled hunting potential.	Low levels of income.
10. Transboundary	Harness transboundary community relationships to promote goods supplies across borders (small business opportunities). Establish transboundary monitoring framework for surface and ground water as part of the GLTFCA – LIMCOM collaboration process.. Identify custodian where reports and data can be managed for the Node at a centralised point (before considering establishing a DSS)		Challenges with formal border crossings especially in pandemic closure times and need for PCR testing as well as no easy transport of goods, and water supplies. Poor availability of data, and difficulty to match data and analysis across country boundaries. No central transboundary report- and data repository.			

From a governance perspective, it is necessary to support and promote a decentralised approach to natural resource management where local communities and local authorities, where they are involved and where they have capacity, are empowered (and supported and resourced) to lead decision-making processes relating to sustainable use of the natural resources in their local area. Even though this local approach is promoted, it should be recognised that national regulations and authorisations would have to be acknowledged – therefore, agreements should be established that allows for the decentralisation to take place while rules and regulations are acknowledged. It is also necessary to prioritise investment opportunities and there may have to be a sequence of prioritised steps and activities that require alternatives to be selected.

The selection of such alternatives should still and first and foremost, consider local decisions and local community needs. Prioritisation and trade-offs need to be clearly defined and these should be determined by the community, but in conjunction with the regulators in various countries. This decentralised decision-making of water based natural resources management is already taking place in the Node - especially in Mozambique and Zimbabwe. However there needs to be alignment between the management structures in the Node, across international boundaries, to identify cohesive management opportunities in the Node that allow for pooled resources and harmonisation, as well as aligned investment opportunities. The cross-border community dynamics are inherently strong and should be used to create these opportunities for broader livelihood benefits within the conservation/stewardship areas of the GLTFCA. The exact details on how this can be taken forward, would be part of a future exercise in pre-feasibility and feasibility study and implementation of investment opportunities in which the GLTFCA working groups are key role players.

Wetlands are regarded as sensitive ecosystems, and the prioritisation of wetlands in the Pafuri-Sengwe Node should be considered in the following hierarchical manner, as illustrated in the Figure hereafter:

1. Wetland systems that require absolute conservation and management (set aside areas),
2. Wetland systems that have a potential for restoration through intervention measures,
3. Wetland systems within which wise use (sustainable use) can take place with the appropriate management plan in place, and
4. Wetland systems that have been degraded irreversibly could be considered a lost cause.

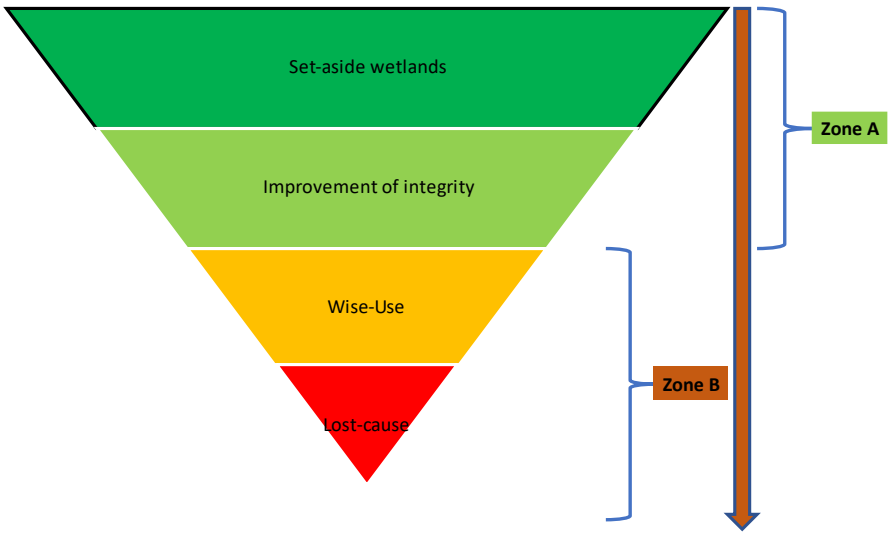

Figure 1: Diagram indicating prioritisation and trade-offs for wetland use

Such a zonation approach would be important and a logical next step for the GLTFCA - this would provide a useful step for any World Bank-further SADRI support in the area.

It is recommended that communities must be assisted by government or development agencies in developing appropriate management plans for sustainable utilisation of the wetlands in their respective areas. The use of wetlands within Zone A areas in the Figure above must not be permitted or must be severely restricted and exclude human-related activities, i.e., wetlands within conservation and protected areas, and in rehabilitation priority catchment areas, must be protected and conserved as it would not make sense to invest in improving wetlands through rehabilitation while simultaneously allowing activities that are known to lead to wetland degradation.

The support of livelihood and provision of other communal-related ecosystem services should rather be encouraged in Zone B areas and the use should be accompanied by appropriate management and monitoring plans/measures aimed at ensuring sustainable use. Sustainable use is critical to ensuring that the wetlands and aquifers can continue providing the resources and ecosystem services that the communities rely upon. Wetlands that become irreparably degraded lose much of their capacity to contribute toward community well-being. Wise-use programs must be developed with clear guidelines to understand threshold requirements. Wetlands considered to be “lost causes” should be used for trade-offs. The above-described hierarchy of prioritisation is proposed for the Pafuri-Sengwe Node.

There exist opportunities and incentives that can be used as entry points for better and sustainable management of wetlands. These include identifying, together with communities, ways of broadening people’s livelihood options. Some apparent opportunities can be seen in the promotion of high-income wetland use like ecotourism, identifying new markets for off-farm income such as brick making, that takes place

around the wetlands, and integrating wetland management into broader rural development programs that are aimed at access to high yielding varieties, improving access to markets, and better extension services (noting that extractive activities could be quite sensitive and requires clear zonation). Management options that include strategies to support alternative income-generating activities to broaden the livelihood options of the poor will reduce pressure on wetland resources.

Groundwater recharge processes largely are episodic in semi-arid areas such as the Pafuri-Sengwe Node – groundwater levels only respond notably after overcoming a certain rainfall threshold. This threshold can be:

- a series of individual rainfall events forming part of a prevailing regional weather system; or
- a single, heavy rainfall event over a short period.

It is important to note that the health of the terrestrial ecosystem and land cover has a direct impact on the ability of the rainfall intensity to recharge aquifers and that degraded landscapes also negatively impact aquifer recharge. The seasonal flows of the river systems influence recharge to the alluvial aquifer system. During the wet season, runoff recharges the alluvial aquifer; surface flows decline during the dry winter stands resulting in dislocated pools during the dry winter months fed by sub-surface flows. Various researchers found that regional groundwater contributions maintain the perennial rivers of the low-land areas at their lower reaches. Limited information is available to calculate discharge to river systems. Groundwater – surface water interaction requires follow-up work, including an improved understanding of Groundwater Dependent Ecosystems (GDEs) in the Node.

Groundwater from several boreholes in the Pafuri-Sengwe Node exceeds recommended water quality standards (i.e. the water quality is worse than what is either generally acceptable or in comparison to various local or international guidelines). The chemical concentration exceedances, such as salinity, nitrate and fluoride, are of health concern to communities. In high salinity waters, as in Pafuri-Sengwe Node, the treatment process must remove the dissolved solids, of which reverse osmosis (RO) is the most common method of desalination. Removing nitrate from water requires treatment processes such as blending, ion exchange, electrodialysis, and RO. Advanced treatment techniques for nitrate removal rely on biological processes to convert nitrate to nitrogen gas, then released into the atmosphere. The treatment options for nitrate removal require operation and maintenance, and sometimes the best option is to abandon the water point and drill a new borehole away from the contamination source – this is not currently necessary in the Pafuri-Sengwe Node. The most common techniques used to remove fluoride from drinking water are precipitation, adsorption, and ion exchange; membrane filtration processes; and distillation. Implementing water treatment solutions and technologies is complex and specific, requiring skilled operators.

Groundwater use is predominantly for domestic water supply and community food gardens. The most common lifting technology is hand pumps in Mozambique and Zimbabwe, whilst in South Africa, there is extensive use of submersible pumps. The hand pump type in Mozambique is the *AfriDev*, and in Zimbabwe, the *Bush Pump*, as

indicated in the figures below. In the absence of lifting devices, the communities use unprotected sources such as dug wells and the river.

Generally, there is a lack of financial resources at government levels in the Node, to allocate sufficient budgets for water infrastructure, and most rural communities, such as in the Pafuri-Sengwe Node, lack the means to pay for the operation and maintenance of groundwater infrastructure. Easy and affordable access to spare parts is crucial in maintaining a groundwater scheme. Through discussions in Mozambique, community members noted that collecting fees to cover maintenance costs is routine. The closure of borders during the COVID-19 pandemic affected the procurement of spare parts, resulting in the inability to repair dysfunctional boreholes.

In Mozambique and Zimbabwe, communities manage the groundwater infrastructure, following a community-based management approach that promotes community involvement. In South Africa, municipalities manage groundwater schemes. The centralised management results in intermittent water supply leading to more affluent households developing self-supply systems. In Zimbabwe and Mozambique, communities on alluvial aquifers dug wells on their properties for self-supply. In a community meeting, a female participant noted that the high-salinity waters affected food taste, requiring water-fetching at a great distance to please the household men. The reliance on women and girls for water collection is common throughout the region. The role of informal institutions and customs in the Node requires recognition within formal management institutions to ensure the promotion and support of gender equality and social inclusion.

Through analysis of the above activities, the assignment developed a set of recommendations and investment needs to achieve tangible drought resilient outcomes for the benefit of society dependent on the region's freshwater resources. Recommendations are be categorised as near, medium, or long-term.

Key transboundary investment needs to support the improved transboundary management of wetland systems include the following:

- Develop wetland inventory, standardise wetland inventory data requirements and enforce basin-wide data sharing protocol.
- Improve technical capacity in planning, managing, and monitoring wetland ecosystems.
- Standardisation of wetland management tools across three countries. South Africa currently has advanced tools in assessing and management of wetlands and these can be workshopped, modified per local conditions, and applied across countries to ensure reporting is similar in all Partner Countries.
- Develop, manage, and monitor spatial data, this includes the development of integrated data management systems across all three Partner Countries.

A summary of the country specific investment needs to support the improved transboundary management of wetland systems is provided in ***Figure i*** below.

Figure i: Country specific investment needs to support the improved transboundary management of wetland system in the Pafuri-Sengwe Node

The key transboundary groundwater investment needs include the following:

- Design a groundwater and surface water monitoring network and programme building on existing monitoring activities under the auspices of the GLTFCA.
- Develop market of water supply system value chain products especially on the South Africa and Mozambican side.
- Develop guidelines for groundwater protection zoning and model regulations to manage groundwater use.
- Encourage the development of community-based monitoring of groundwater levels and rainfall measurements using mobile platforms.
- Develop and set ecological control limits for groundwater at ecological sites.

A summary of the country specific investment needs to support the sustainable groundwater management is provided in ***Figure ii*** below.

Figure ii: Country specific investment needs to support the sustainable groundwater management of wetland system in the Pafuri-Sengwe Node

Key transboundary investment needs to support community livelihoods include the following:

- Development, operationalisation, and maintenance of a Nodal geospatially enabled database.
- Small business development (including supplier development) and support of formal and informal trade.
- Provide improved market access and linkages for agriculture produce from the irrigation schemes in Zimbabwe.

A summary of the country specific investment needs to support the community groundwater livelihoods is provided in ***Figure iii*** below.

Mozambique

- Carry out a detailed inventory of dispersed water sources and water supply systems, characterising their location, capacity, target population, operating status and management model.
- Invest in the development and repair of dispersed water sources (boreholes or wells) based on the recovery of operating costs, in private management models (even if of a local nature).
- Assess opportunities for the development of viable transboundary water supply systems, based on private management but with a participatory community governance model.
- Develop initiatives to improve the regional integration of the water supply logistics chain, ensuring service management, technical assistance for the infrastructure and the availability of parts stocks.
- Promote education for water resources management, drinking water consumption and safe sanitation.

South Africa

- Capacitate DWS to enhance their service delivery to the target area.
- Invest in Market development of the water supply spare parts including investing in small business owners to be able to supply spare parts to the wider area, especially the Mozambican side.
- Invest sustainable management of groundwater in part by informing key policy makers of potential risks and identifying intervention options like installation of deep boreholes that reduce those risks.

Zimbabwe

- Conduct detailed inventory of dysfunctional/under functioning boreholes and irrigation systems taking note of their location, capacity, number of beneficiaries, state of disrepair, management, amount of funds required to fix or upgrade them and management model.
- Train Water Committees in areas which enables them to effectively manage and maintain the boreholes.
- Invest in enhance the water infrastructure of current irrigation schemes so as to provide for enough water to meet the demand in the agriculture schemes.
- Build small dams which will enable for the capturing of river water and directing it into the community where it can be utilised for agriculture and household use.

Figure iii: Country specific investment needs to support the sustainable groundwater management of wetland system in the Pafuri-Sengwe Node

Key recommendations for policymakers have been distilled from the findings of the report. These are presented in Table B below.

Table B: Key Recommendations for Policymakers

Wetland Management			
GLTFCA	**Mozambique**	**South Africa**	**Zimbabwe**
• Develop and implement a transboundary wetland policy and best practice guidelines for the developmental activities (e.g. mining and development infrastructures) impacting wetlands and riparian areas (incl. buffer areas). • Reintegrate indigenous knowledge systems **back** into the management of the pans and wetlands. • Promote transboundary cooperation, capacity building, and knowledge sharing across the Node, to enable harmonisation of wetland management approaches across international boundaries.	• Engage ARA-Sul as an increasingly important role player in the GLTFCA to enhance involvement and support of systems and networks for water supply and infrastructure management, which can indirectly support reduced pressure on wetlands. • Simplify and reform of wetland management governance processes and mechanisms in the local context to promote involvement of local structures and institutions. • Strengthen the knowledge and skills of rural extension workers in the field of water resources management. • Develop training programs focusing on the wise use and protection of wetlands, targeting local communities and the youth, to ensure the protection and sustainable use of the wetland systems. • Support the development of community-based wetland management plans, which include the creation of community conservation areas, identification of wetlands that provide natural resources, development of management strategies, and use and harvesting plans for the local communities to ensure the sustainability of the systems to provide ecosystem services. This could be achieved / facilitated through conservation / biodiversity stewardship agreements linked to small-scale agricultural development support (in areas outside wetland areas).	• Support the development of community-based wetland management plans, which include the creation of community conservation areas, identification of wetlands that provide natural resources, development of management strategies, and use and harvesting plans for the local communities to ensure the sustainability of the systems to provide ecosystem services. This could be achieved / facilitated through conservation / biodiversity stewardship agreements linked to small-scale agricultural development support (in areas outside wetland areas). • Provide continuous financial support for labour intensive wetland rehabilitation programs to ensure healthy wetlands, enhanced biodiversity, wise of wetlands and financial and technical skills to the beneficiaries involved in the implementation of the projects. • Develop training programs focusing on the wise use, multiple use options for selected wetlands, and protection of wetlands targeting local communities, especially the youth.	• Support roll-out training and information sharing of the existing wetland policy and wetland management guidelines published by the Zimbabwe EMA. This should filter down to local communities who are custodians and users of the wetland systems. • Simplify and reform of wetlands governance processes and mechanisms in the local context. Identification of the roles and responsibilities of the local institutions and structures in the legislation requirements • Provide continuous financial support for labour intensive wetland rehabilitation programs to ensure healthy wetlands, enhanced biodiversity, wise of wetlands and financial and technical skills to the beneficiaries involved in the implementation of the projects. • Strengthen the knowledge and skills of rural extension workers in the field of issues of water resources management. • Develop training programs focusing on the wise use, multiple use options for selected wetlands, and protection of wetlands. These training programs should target local communities, especially the youth, to support effective and applicable future use and sustainability of the wetland systems. • Develop and implement best practice guidelines for the developmental activities (e.g., mining and development infrastructures) impacting wetlands and riparian areas (including riparian and wetland buffer areas). • Support the development of community-based wetland management plans, which include the creation of community conservation areas, identification of wetlands that provide natural resources, development of management strategies, and use and harvesting plans for the local communities to ensure the sustainability

			of the systems to provide ecosystem services. This could be achieved / facilitated through conservation / biodiversity stewardship agreements linked to small-scale agricultural development support (in areas outside wetland areas).
Groundwater Management			
GLTFCA	**Mozambique**	**South Africa**	**Zimbabwe**
• Formalise the relationship between the GLTFCA and LIMCOM to ensure an integrated approach to the management and sustainable use of groundwater resources. • Develop guidelines for groundwater protection zoning and model regulations to manage groundwater use. • Encourage the development of community-based monitoring of groundwater levels and rainfall measurements using mobile platforms. • Contribute to the sustainable management of groundwater and ecosystem resilience, in part by informing key policy makers of potential risks and identifying intervention options that reduce those risks. This would require cross-policy and cross-sectoral reporting so that departments e.g. environmental, ecological, agricultural and water resources for example, align. • Safeguard alluvial aquifers from mining activities. This would require definitive policy and regulatory elements, guidelines for use and safeguarding, and practical protection of areas of particular importance in terms of the recharge and utilisation.	• Assess opportunities for the development of viable transboundary water supply systems, based on private management but with a participatory community governance model. • Secure groundwater resources and promoting water demand management, conservation and recycling techniques amongst end users (e.g., crop production and household use) as well as in commercial farming.	• Capacitate DWS to enhance their service delivery to the target area, especially in the short term before small business development in the area enable a localised and SMME-based approach. • Invest in market development of the water supply spare parts, including transboundary markets. • Invest in sustainable management of groundwater by informing key policy makers of potential risks and challenges.	• Train Water Committees in areas such as effective fund raising, financial management and fixing boreholes which enables them to effectively manage and maintain the boreholes. • Invest in sustainable management of groundwater by informing key policy makers of potential risks and challenges.
Community Livelihoods			
GLTFCA	**Mozambique**	**South Africa**	**Zimbabwe**
• Standardise water resources management data and develop and promote a basin-wide data-sharing protocol in order to improve	• Ensure improved access to water for livestock. In this context it is important to ensure awareness of potential artificial water provision impacts on natural	• Support the implementation of climate smart agriculture to increase productivity, where more and better food is produced to improve nutrition, and subsequently enhance resilience.	• Link the production of crops from the irrigation schemes to markets in the Sengwe-Tshipise Corridor through value chain and market development strategies.

coordinated transboundary management of basin water resources. • Create access for locals to the value chain especially in supplier sector. This should also focus on the circular economy with the GLTFCA tourism operators included.	ecosystem dynamics where systems are integrated. • Develop pilot projects of a commercial nature, involving communities and their leaders, but having the private sector as a pillar, that promote the abandonment of rainfed agriculture in flooded areas, diversification of production aimed at subsistence but also for the market, small-scale irrigation agriculture involving community families.	• Create access for local communities to the value chain especially in supplier sector. This should also focus on the circular economy with the GLTFCA tourism operators included.	• Inform traditional authorities and community members on the social and environmental impact (including impact on groundwater) of mining activities. This will enable the traditional authorities and community members to make informed decisions about the type of mining that they will allow in their community.

1. INTRODUCTION

1.1. Project Background and Objectives

The purpose of this assignment is to better understand water governance and water use in the Pafuri-Sengwe Node of the Great Limpopo Transfrontier Conservation Area (TFCA) in order to inform drought preparation and mitigation measures at the community level. This analytical work was conducted on the following water systems in the Node: Limpopo River; Mwenezi (name in Zimbabwe)//Nuanetsi (name in Mozambique) River; Luvuvhu River; and Bubye River. The project aimed at supporting improved governance of these systems within the GLTFCA. This report presents the key findings from the project and presents the short, medium- and long- term recommendations and investment needs for each country in the GLTFCA. This Final Summary Report benefits from three other pieces of analytical work requested by the World Bank as part of the project, these include:

Situational Analysis Report

This task included two desktop reviews on the ecological and socio-economic context and governance structures in place in the project area to manage water resources. The situational analysis report was also informed by a detailed review of literature as well as meetings with partner countries and key stakeholders.

Wetland Systems and Aquifer Maps

This deliverable includes the assessment of wetlands, compilation of data for wetlands across the Node, and development of a wetland systems and aquifer maps in GIS shapefiles and .pdf format for the Node. The .pdf map is a "layered .pdf" that enables users to switch layers, digitally, "on" or "off" and depicts the project area linked to the Limpopo, Luvuvhu, Mwenezi/Nuanetsi, and Bubye River systems. The shapefiles and maps were validated through consultation with local stakeholders.

Hydrocensus Report

Through site visits, leveraging existing stakeholder structures and aligned with current processes, the consulting team undertook a participatory stakeholder consultation process to understand current groundwater use through a hydrocensus in the project area. This was augmented with an in-depth assessment of all available data and information – based on raw data as well as reports – to develop a hydrocensus for the Node. As part of this process, information on indigenous knowledge systems was also gathered and synthesised. The hydrocensus focuses on the Limpopo, Luvuvhu, Mwenezi/Nuanetsi, and Bubye River systems to identify the extent of water use and governance practices.

The specific objectives of the project are to:

- Determine the extent of water availability in targeted aquifer, wetland, and river systems;

- Assess current demand and usage of this water, especially among communities in the Pafuri-Sengwe Node;
- Evaluate the governance practices in place for managing this water; and
- Based on the above, identify, develop, and recommend short to long term actions for water management that lead to building community drought resilience.

Through meeting the objectives above, the assignment meets the GLTFCA treaty objectives (GLTP Treaty, 2002), which are, in brief, to:

- Foster trans-national collaboration and co-operation among the Parties which will facilitate effective ecosystem management in the area comprising the Transfrontier Conservation Area;
- Promote alliances in the management of biological natural resources by encouraging social, economic and other partnerships among the Parties, including the private sector, local communities and non-governmental organizations;
- Enhance ecosystem integrity and natural ecological processes by harmonizing environmental management procedures across international boundaries and striving to remove artificial barriers impeding the natural movement of wildlife;
- Facilitate the establishment and maintenance of a sustainable sub-regional economic base through appropriate development frameworks, strategies and work plans;
- Develop trans-border eco-tourism as a means of fostering regional socioeconomic development; and
- Establish mechanisms to facilitate the exchange of technical, scientific and legal information for the joint management of the ecosystem.

This work also supports the GLTFCA's broader regional strategic objectives (as reflected in the GLTFCA Integrated Livelihoods Diversification Strategy of 2016).[1]

GLTFCA Pafuri-Sengwe Node Context

The governments of Mozambique, South Africa and Zimbabwe signed the GLTP Treaty (2002) to collaborate in the establishment of the GLTFCA. The project study area, the Pafuri-Sengwe Node, is located within the Limpopo River Basin (LRB) and the GLTFCA (Figure 1).

[1] These strategic objectives are (1) Protect and Restore Natural Resource on which Livelihoods are Based; (2) Support Local Communities Capture and Maximise Benefits from Existing or New Livelihood Activities; (3) Support Access to Alternative Livelihood Options Through Enhancing Other Capitals, thus Reducing Resource Dependency; (4) Establish Effective Partnerships and Institutions; and (5) Strategic Objective 5: Accountable Governance and Sufficient Capacity.

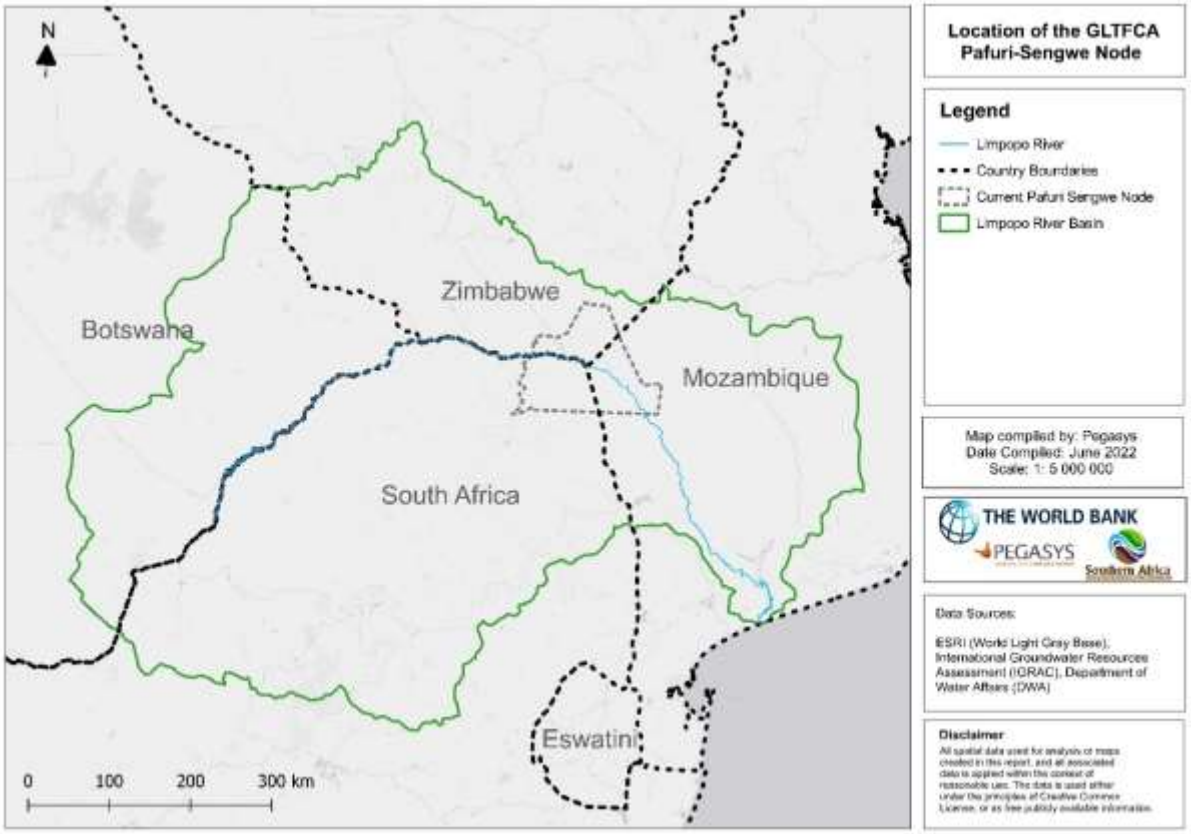

Figure 2: Location of the Pafuri-Sengwe Node within the Limpopo River Basin

The Pafuri-Sengwe Node includes the following areas (GLTFCA, 2016) (GLTP, 2002):

- **Mozambique**: Gaza Province, Chicualacuala and Mapai Districts including Pafuri and Vila Eduardo Mondlane administrative posts and localities. The area includes Salane, the host community into which two villages in *Parque Nacional do Limpopo* (PNL) (Portuguese), referred to in English as Limpopo National Park (LNP), are in the process of being resettled in the northern area;
- **South Africa**: Vhembe District Municipality's Mutale and Thulamela local municipalities; and
- **Zimbabwe**: Masvingo Province, Chiredzi and Mwenezi Districts, including Sengwe and Matabeleland South Province, Beitbridge District including Tshipise.

Most communities in the Node reside in remote areas of the GLTFCA and are generally isolated from main transportation routes, major economic hubs, and markets. Even formal transboundary movement of goods and services are restricted due to fact that there is only one border post present in the node that provides access between Mozambique and South Africa. The national boundary and border closures during the COVID-19 pandemic in early 2020 until late 2021 had a particularly negative impact on the communities within the Node that rely on the transboundary movement of goods to support their livelihoods.

Communities in this node reside predominantly in rural villages, often located in close proximity to a variety of formally protected areas. The Figure below shows the location of villages in the Pafuri-Sengwe Node, together with the rivers in the vicinity.

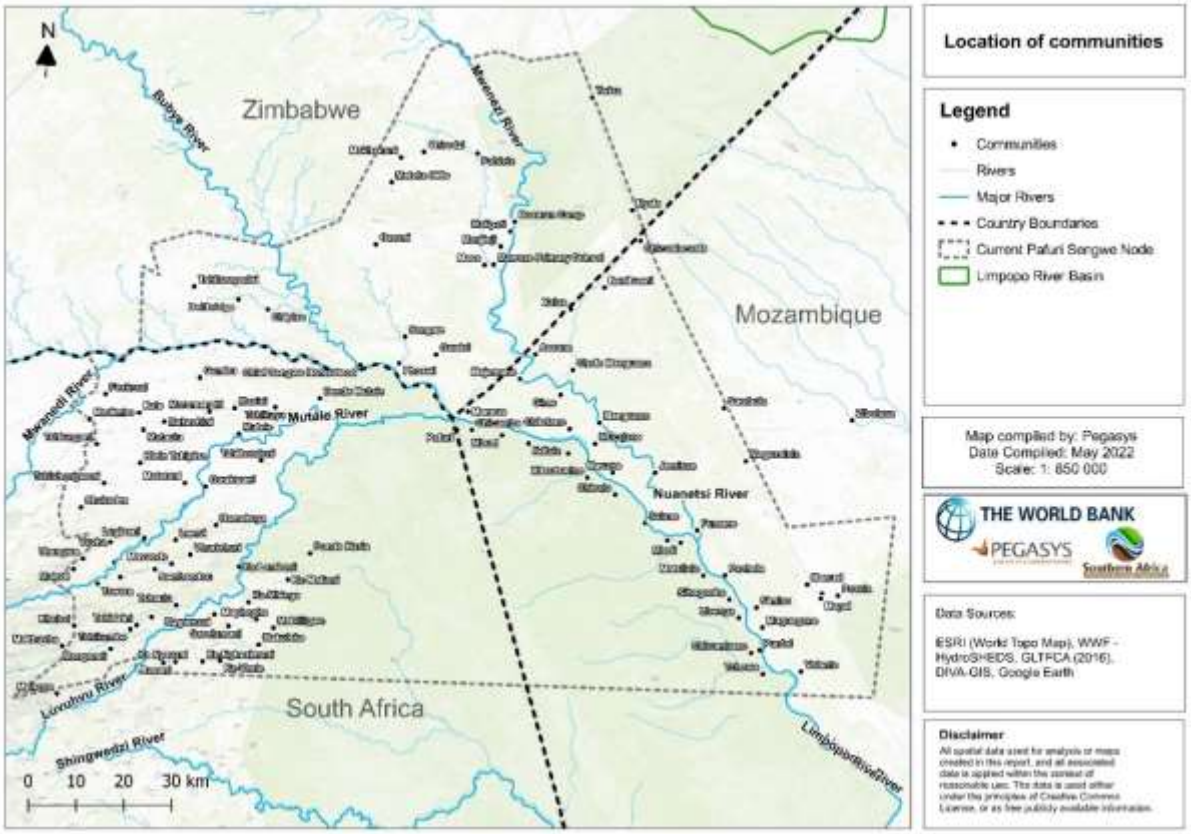

Figure 3: Location of communities in the Pafuri-Sengwe Node

Village locations as indicated in geospatial data was originally received from governance institutions. Village details in the Support Zone of LNP in Mozambique, before the Nuanetsi converges with the Limpopo River, were found to be incorrect based on community indications during in-field consultations. This was corrected after community-based workshops and through data received from Peace Parks Foundation (PPF), indicating an updated geospatial data layer. It is recommended that this new layer be used in future maps that indicate village locations for the Node – especially as it pertains to Mozambique.

1.2. Structure of the Report

This report is structured as follows: **Chapter 2** discusses the stakeholder mapping and engagement processes conducted during the study and the findings collected from these engagements. **Chapter 3** presents the wetland systems in the area with a focus on wetlands that require conservation and consideration for community-water management of wetlands. **Chapter 4** presents the groundwater systems in the area and the Hydrocensus findings regarding aquifer mapping, water quality, boreholes and water use in the study area. **Chapter 5** presents the key recommendations for the node, including proposed repositioning of the Pafuri-Sengwe Node boundary, and proposed wetland management strategies. **Chapter 6** highlights investment needs in the GLTFCA. **Appendix A** presents the project stakeholder database. **Appendix B** presents the GIS metadatabase. **Appendix C** summarizes the governance arrangements for the Node.

2. STAKEHOLDER ENGAGEMENT AND IN-FIELD FINDINGS

2.1. Stakeholder Mapping and Engagement

The stakeholder landscape in the Pafuri-Sengwe Node is varied and vibrant with stakeholders ranging from regional to national, sub-national and community level. Stakeholder engagement was thus a crucial and principal component of the project.

Stakeholders were engaged through the following approaches to reach as many stakeholders as possible (in no particular order):

- Site visits within the Node in all three countries;
- Stakeholder workshops (conducted virtual workshops with wider GLTFCA stakeholders, a wetland map validation workshop, and workshops with communities in the Node's surrounding area and relevant local authorities and organisations);
- Targeted follow-up emails to project stakeholders; and
- Focused interviews and discussions.

The stakeholders represent the public, private, development cooperation, civil society, non-governmental organisations, academia, and national park management authorities. Appendix A contains the stakeholder database for the project.

In-Field Findings

This section provides the in-field findings from two missions[2] - one into the Pafuri-Sengwe Node across the Mozambique border, and one into Zimbabwe with the Sengwe community Workshops held during the missions aimed to:

- Understand current water needs, water uses, water management and storage, and water sources at village and household level, as well as ways in which communities practically address their water quality and quantity challenges.
- Gain insight into the differences between intended governance policies and practices and practical implementation on the ground, especially in cross-border areas that are removed from good transportation systems/routes, large urban areas and supply zones/markets, and central governance functions;
- Better understand water resource and livelihood initiatives, requirements, needs and opportunities in the project area at village- and community-level in order to inform the identification of potential short, medium and long term interventions

[2] Mission participants included members of the Pegasys consulting team, the World Bank, representatives from PPF, South African National Parks /Kruger National Park and Makuleke Contractual National Park, National Administration for the Conservation Areas (ANAC) / Limpopo National Park, Gonarezhou Conservation Trust, and Zimbabwe National Park and Wildlife Management Authority.

and investment opportunities that directly support local improvements and support;

- Gather information through visual observation and through engaging with traditional authorities and access their knowledge regarding community-level water availability, abstraction/water sources, land management alongside rivers and wetland utilisation, livestock and agriculture practices and nuances at village-level, and gain insights into ground water quality especially in areas where groundwater monitoring is not frequently done or where wetland delineation and information on wetlands based on existing studies and reports, is weak.
- First-hand experience the practicalities related to water resources needs, use and management, and economic influences and livelihood strategies. This pertain to community-based resilience in regard to water scarcity challenges and coping mechanisms – especially cross-border linkages between communities;
- Identify and recommend potential investment options indicated in the short, medium and long term for integrated water resource management that will support, or lead to building community drought resilience in the Node; and
- In addition, the in-field visits provided deep insight into the use and importance of floodplains, and the nature and usage of wetlands, as well as ground water situations along the Limpopo River, Luvuvhu River, Mutale and Mwenezi/Nuanetsi River in particular.

2.1.1. Mozambique – South Africa

An in-field mission to the Mozambican-South African area of the Node was conducted from 21 to 26 February 2022. Information gathered during the mission significantly augmented the information gathered during the situational assessment. In addition, the literature review information that was gathered, assessed and reported on in the Situation Assessment was confirmed – especially since some of the documents that were reviewed for purposes of the Situation Assessment was historical. Confirmation of the situation on the ground, and noting either no or little change, or indicative changes between the literature review and the on-the-ground situation was an important part of the in-field missions.

One of the examples of validation that took place in-field is where reference was made in the situation assessment to the International Water Management Institute (IWMI) livelihood report of 2010: this report is already more than a decade old, and the in-field assessment confirmed that indeed there was no change in the situation since 2010. The reported increase in the numbers of resource-poor households without access to water infrastructure, to utilise wetlands for food production (especially in Mozambique and Zimbabwe) was confirmed. This consistent situation that has not changed over time confirms the need for important intervention if wetlands are to be conserved at all; as well as for the need to focus on wetland restoration and the integration of wetland-conscious crop production. The situation was exceptionally noted in the five villages

that were engaged with on the Mozambique side of the border with South Africa. Where the Limpopo River is the source of livelihoods for all these communities, and the situation has seemingly not changed since 2010, it is clear that intervention is needed lest the situation worsen and the last remaining wetlands are potentially lost altogether.

Figure 4: Left: A borehole at Ndlala, situated 2km away from the river, provide good quality ground water in Mozambique. Right: View of the Limpopo River from the Mozambique side, near one of the villages visited during the in-field component of the project

Community members pointed out that they are aware of climate challenges and their expectations are that drought conditions are likely to prevail, even if interim wet spells seem to release the grip of prolonged droughts. This practical experience and perceptions on the ground reflect that not only are local communities in general aware of climate change challenges, but also that their interpretation of the formal predictions are in line with the more academic future climate change projections, which suggest that rainfall across the Pafuri-Sengwe Node may likely decrease over time, with the magnitude of the decrease being greater in the early part of the wet season (November and December) than in the latter wet months (January through April). The decrease in rainfall as it has implications for surface water and groundwater availability and runoff in the catchment in the area, is being understood by the communities living in the area.

Field visits took place along the community resource use zone of the Limpopo National Park, located along the western Limpopo River floodplain. In the Pafuri-Sengwe Node, especially where the river crosses from South Africa into Mozambique, the Limpopo River is present as a wide expanse with significant sand banks along both sides. Upstream and until where the river flows into the Indian Ocean near Xai Xai in Mozambique, it has a channel width of approximately 300 meters, partly obstructed by sandbanks and exhibiting a range of flows varying spatially along the river and varying temporally between dry and wet periods. The floodplain of the river in the Pafuri area and into Mozambique are in some areas as wide as 3km. This reflect the relatively flat topography which was seen first-hand, to promote agricultural development within the floodplain and also within the numerous wetlands in the catchment.

Since the Limpopo River is highly seasonal, often running dry in the dry season, while high flows and occasional flooding can occur following heavy rains in the middle/upper

catchment (including in the Pafuri-Sengwe Node), communities face uncertainty in water supply. They are keenly aware of the need to consider groundwater as a potential water source, however, they do not have means to access the mechanisms through which aquifer access can be gained, other than through relatively shallow, or hand-dug wells. Dry spells associated with El Niño events have significant drought-related impacts in the Pafuri-Sengwe Node, with subsequent downstream water resources challenges in Mozambique in particular – although the communities are not aware of the origin of the drought conditions and they have little forewarning of drought conditions in this very remote area – even when regional forecasts may predict such conditions months in advance.

The following insights were gained and observations made during community-based stakeholder engagements in Mozambique, along with community-based mapping of water resources in the area:

- Communities living close to the Limpopo river rely on surface water and wetlands but in communities further away from the river there is reliance on groundwater sources using the *AfriDev* Hand Pump (which enables abstraction from maximum 30 meters – often shallower).
- Flood events modify the river channels. When normal flow returns, the river channels then sometimes become inaccessible, and since villages are then located further away from the riverbanks, easy access by communities becomes challenging.
- During drought periods, very low and often no river flow occurs, resulting in communities relying on groundwater resources only. Frequently the reliance is on unprotected wells dug in the alluvial aquifer and not protected from flooding.
- Communities from Mugwambane South use untreated water straight from the Limpopo River and are especially exposed to the risk of crocodile attacks.
- There is limited formal institutional support for the operation and maintenance of groundwater infrastructure.
- Communities use informal by-laws set by traditional authorities to manage the boreholes (e.g., agreement to wash clothes away from boreholes.
- Some communities rely on untreated water and brackish groundwater, and in Chicumba, for example, they extract water from a shallow well (as opposed to slightly deeper boreholes in other areas).
- There are several non-functional boreholes in the communities mainly due to the unavailability of spare parts resulting from the closure of the international borders at Pafuri Border Post during the COVID pandemic and the lack of operation and maintenance (O&M) support from the Local Government in Mozambique.
- The drilling of boreholes and installation of water pumps are sometimes financed by humanitarian aid providers, churches or NGOs without significant, if any, consultation with geohydrological experts, nor consultation and

consideration by the communities receiving the aid. In addition, these boreholes often come with little water quality testing before and after the installation, and without provisions for maintenance – whether short or long term. As a result, numerous challenges arise with such quick installations that have good intentions, but little long-lasting or sustainable outcome: Some of the boreholes are ineffective - for example the type or technology applied may not be suitable to the aquifer or groundwater recharge regime, resulting in the depth or pumping mechanism not being able to provide water at times when groundwater levels drop. An inability for communities to access finance to purchase spares, or where the specific spares for the type of borehole type is not locally available, cause some to be not used and non-functional. In other instances, the water quality is unsuitable – either due to boreholes being too shallow, or testing procedures during construction not being effectively applied.

- In some communities, community members agree to pay per family about 10MZN (US$0.16) per month for O&M of boreholes, however, as mentioned above, it remains difficult to get spare parts for the boreholes. The spare parts, even when available, may not be installed effectively, or installed at all, due to lack of technical knowledge at village level. A lack of outreach support from the public (especially governance and parastatal) and private sectors alike, on the Mozambican side of the border was identified by the communities as a significant hurdle to achieving fresh water supply.
- Access to sufficient and acceptable quality water is a historical challenge in most communities in the area.

Figure 5: Source of water for households at Chicumba, Mozambique (left) and non-functional boreholes at Mbuzi Community, Mozambique (right)

The site visits in South Africa (N'Wambi, Mambvumbvanyi, Mapimbana, Jachacha, Mapimbi, Makwadzi and Banyini wetlands inside the Makuleke Contractual National Park. In addition, the team visited the Mutale River area, and observed some community initiatives related to food (maize, citrus, and vegetables) gardening for household consumption. These were managed by women around the Bende Mutale area. The following are the observations that were gained from interactions with community representatives around the South African Pafuri area, collected through the

in-field observations and during a stakeholder engagement meeting at Awelani Lodge (located approximately 10km to the west of the Makuleke Contractual Park):

- In 1969, approximately 3,000 people belonging to the Makuleke clan were removed from a 26,500 ha area between the Luvuvhu and Limpopo Rivers so that the boundaries of the KNP could be expanded to the Limpopo River. In part exchange for this land, 24,000 ha on the north-western boundary of the KNP was de-proclaimed and settled by communities. The Makuleke community did not however receive the whole area and had to share it with other communities.
- Prior to being forcibly removed from the Makuleke Area in 1969, communities residing in the Makuleke area (since 1803) used traditional water resource management practices including collecting water from river sources and storing it in traditional clay pots; they also utilised wetlands in support of livestock grazing and to some extent, agriculture. Wetlands within the area were also important sources of fish protein. Communities relied upon traditional authorities to govern water usage, including rotating fishing, agriculture and livestock grazing to avoid overuse.
- Since the inclusion of the Makuleke Area as part of KNP, utilisation has changed towards the conservation-approach applied in the Makuleke Contractual National Park, where only operational utilisation of water resources are applied;
- Water sources include community boreholes, taps and reservoirs;
- The South African DWS operates the scheme in most of the communities;
- Water supply through the municipal piped water system is intermittent (the municipality generally only release water once a week);
- Piped water is mainly used for domestic use and livestock;
- Cattle drinking pens are opened once a week for livestock watering;
- Farming occurs along the rivers for ease of watering community gardens and this contributes to riverbank erosion and degradation;
- Subsistence hunting in the area (apart from the Contractual National Park) is practiced using dogs, with the use of traps and, reportedly, spears to hunt Reedbucks, small antelope and Impala;
- There are formal institutions in the area that support community-based structures (such as LEDET – however, the depth of involvement of local government is not entirely agreed to between communities and official governance structures);
- Saline ground water is a long-term historically recognised challenge problem in most boreholes; and
- A new dam (the Musina Dam) is proposed upstream of the Pafuri-Sengwe Node to meet the long-term water demands of the Musina Makhado Special Economic

Zone. The proposed dam (located south-east of Musina) will be constructed in the Sand River.

2.1.2. Zimbabwe

A field visit to the Zimbabwe component of the Node' was conducted from 9 to 13 May 2022. This component includes the southern part of Gonarezhou National Park and the adjacent Sengwe Communal Area.

The visit included engagement and consultations with local communities and other key stakeholders. Local community members included traditional leaders, and representative from local community structures and community-based organisations. Other key stakeholders included representatives from national government ministries, provincial government, district rural council, Zimbabwe Parks and Wildlife Management Agency, Gonarezhou Conservation Trust, and NGOs.

The findings from the field visit and the engagement with local community members and key stakeholders revealed that, as in neighbouring Mozambique in particular, many resource-poor households (without access to water infrastructure) use wetlands, particularly floodplains, for subsistence agricultural activities and water supply. Most households have settled very close to water sources such as the Mwenezi River, as water is scarce further away from the rivers and groundwater has high salinity in the basement aquifer. Their settlement close to the water sources in turn, expose them to flood events.

The engagement with community members and key stakeholders also revealed that many community members using wetlands for crop production of livestock grazing purposes do not have much knowledge on the long-term consequences of unsustainable use of wetlands, but only reflect on the short-term livelihood gains. The field visit confirmed the literature review conducted during the situation assessment, in revealing that communities in the Sengwe Communal Area in Zimbabwe utilise the Mwenezi River for water supply, ecotourism activities(e.g. Safari and Rest camps in Gonarezhou National Park), and they keenly understand the importance of the wetlands as biodiversity and wildlife support areas, where some of the fishing breeding habitats were mentioned. Although the communities generally do not live in wetlands (since it poses a flood hazard to their dwellings), the wetlands has cultural significance for them and are especially important in enabling subsistence agricultural activities that provide food – often to entire villages and even further afield.

Figure 6: Women-run Irrigation system in the Sengwe Communal Area, Zimbabwe.

Field visits in this area focussed on the Sengwe Communal Area. Travel into the area is challenging, with limited access and long distances and time delays to reach the area, due to land-border crossing challenges (the Beitbridge Border Post is a distance away and takes a long time to execute). The following observations were made and information gained from community-based stakeholder engagements and community-based mapping of water sources in the area:

- The main water source (for household and livestock) for the community living in the Sengwe Communal Area (alongside the Gonarezhou National Park) is community boreholes (bush pumps – which can draw water from deeper levels than the hand pumps often used in South Africa and Mozambique).
- Each borehole in the Sengwe Communal Area is managed by a Water Committee (constituted of community members). Water Committees gather resources from community members to finance borehole maintain but there is not always sufficient funds due to the relative poverty in the area. There are therefore a number of non-functional boreholes in the Sengwe Communal Area – for example in the Malipati village;
- The water committees have a pump minder who focuses on the maintenance of each borehole.
- Women do most of the water collection;
- Water from “bush pumps”/boreholes gets finished/used up early in the day due to high demand. This results in long queues. Some women reported queueing for hours for water collection;
- Some of the boreholes (including the one at Chief Sengwe’s homestead) have salty water;
- There are viable and successful small agricultural irrigation schemes (food gardens) which were established by NGOs including World Vision and Plan as well as with support from UN agencies. These irrigation schemes utilize solar water pumps. The community members and key stakeholders however mentioned that the water in the irrigation schemes is inadequate as the water infrastructure does not produce enough water to meet the demand.

- Women provide the labour in the irrigation schemes in the Sengwe Communal Area as (according to the culture and practice of the area) they are responsible for horticulture plant production while men are responsible for livestock farming;
- The irrigation schemes do benefit women. Those engaged reported producing sufficient food for home consumption and sale at local markets. However, despite having surplus to sell, selling at the market is not always profitable as the Rural District Council (RDC) requires the purchase of stand at a price of ZAR60 or approximately US$4.
- During the workshop in Sengwe Communal Area, stakeholders requested assistance with small dams or any other means of capturing the river water and directing it into the community. According to them, this will help them move away from dry land farming to irrigation as the rain is erratic in the South-eastern Lowveld of Zimbabwe – or geographic region number 5 -- where the Sengwe Communal Area is located. This is one of five national geographic regions in Zimbabwe which demarcate rainfall patterns throughout the country. (Region 1 which is in the Eastern side Zimbabwe has the highest rainfall while Region 5 is the driest with the lowest rainfall across the country);
- In terms of resilience to drought, the community members in the workshops said that they adapt to droughts by farming smaller gardens, going back to growing traditional crops such as drought tolerant sorghum, and relying on food assistance from donors and NGOs. The drought-resistant crops remain “cash crops” which they may sell locally, as it is more robust to varying rainfall and reduced as well as hotter germination times, as well as reduced rainfall. However, it is recognised that this may lead to additional challenges such as lengthier processing times and potentially lower market values than what corn, for example, may fetch; and
- Mining prospecting occurs outside the Gonarezhou National Park in the Mwenezi/Nuanetsi river floodplain. A major issue of contention, within the same communities and even within the same households, is the presence and increase in mining activities along the river and especially in the floodplains. From an environmental perspective, and for farmers who rely on water quality and quantity especially for crop production, the prospecting and potential for mining to commence is considered as a negative impact on the health of wetlands. Others, however, especially those in traditional authority positions such as Chief and headmen), support mining as it provides job opportunities and enhances the local economy – being viewed as options to diversify livelihood stacks. The opposing viewpoints where the need for jobs and income is set against conservation- and sustainable natural resource management-based approaches indicate the need to keenly explore alternative livelihood stacking and income options, where job creation can be attained through Eco-based solutions, rather than through affecting the natural resource base and water quality & quantity that is so important to resilient and sustainable livelihoods both locally and downstream.

Figure 7: Source of water for households in Sengwe Communal Area, Zimbabwe (left) and The Community mapping exercise also in Zimbabwe (right)

2.1.3. Fragmented Geospatial Data

. For example, in South Africa, spatial data provided by DWS excludes the Langwe River, which supplies water to the Luvuhvu River. The Langwe River features prominently through Samandou, Mayunde, Vhurivhuri, and Hamakaya communities on its way to the Luvuhvu river.

Village locations and village names were also missing from the national geospatial databases. For example, Lamvi is part of Hamakuya, and there are 22 communities in Hamakuya village. Geospatial datasets provided by the Mozambican government were missing at least five (5) communities in the Pafuri-Sengwe Node, namely: Chicumba, Mbuzi, Ndlala, Mugwambane North, and Mugwambane South.

This location data was identified by participants during a workshop that included community members, local authorities and the Wildlife and Protection Technical Advisor from PPF (the Figure below), and the maps were changed subsequently.

Figure 8: Community mapping exercise (left) and resultant map indicating edits to village locations (right) in Mozambique

2.1.4. Cross-border Cohesion and Movements

There are strong cross border networks and cultural linkages including cross-border trade and movement of people. Historically, the use and management of natural resources by communities living across the rivers in the Pafuri-Sengwe Node has taken place rather seamlessly and without engagement in formal cross-border processes. Community-level access to water and natural terrestrial-based resources as well as economically-sourced goods, occurred in the past and still take place, across borders, via river. In addition, Community-level access to water is complemented by rainwater harvesting where traditional use of locally available water containers is used for rainwater storage.

Communities in Mozambique and South Africa have a long tradition of cultural and transboundary community cohesion with family ties across the international border remaining strong. In addition to informal crossings, communities along the river and even further afield, use the Pafuri Border Post regularly to access commodities and goods for household use. This also means that, in addition to the informal community cohesion, business opportunities tend to emerge near to the border.

Similar to the Mozambique-South Africa example – where there is the formal Pafuri Border Post in place - transboundary cohesion between communities on the Zimbabwean side of the Node with South Africa, as well as between Zimbabwe and Mozambique exist. However, this is almost entirely informal, since there are no border posts between Zimbabwe and its neighbouring countries in the Node. With Zimbabwe citizens facing challenges in terms of access to goods and services in general but specifically in the far South-Eastern corner of the country, transboundary linkages between communities are an important part of their survival. For example, there is a community from the Gonarezhou National Park (Zimbabwe) whose residents cross into Mozambique to collect safe drinking water from boreholes on a daily basis during dry seasons. This happens without conflict between the two communities as the families are related, of the same culture, and speak the same language (Shangaan).

During the time that COVID-related border crossing closures were in place, as well as once borders re-opened but with the need to present negative test results or proof of vaccination for crossing, business along the border suffered and so did the communities dependent upon that economic activity. Goods that were usually brought across the border from both sides to sustain day to day living needs, were no longer available.

This practice of crossing rivers, regardless of international boundaries and regulations, reflects practices elsewhere in SADC, where communities across from rivers are dependent on each other in a very real manner, and where border crossing formalities do not really exist, or at most are rather informal in nature. There are currently activities under way involving the relevant authorities from South Africa and Zimbabwe to investigate the feasibility of a formal border crossing over the Limpopo River in the Node.

2.1.5. Summary of Key Issues

The following is a summary of key issues and challenges identified within the project area. Many of these issues are directly linked and cut across themes.

Table1: Summary of key issues

Theme	Key Issue
1. Governance	⇒ There is limited formal institutional support for the operation and maintenance of groundwater infrastructure. ⇒ Communities use informal by-laws set by traditional authorities to manage the boreholes. ⇒ Historically, communities residing in the area used traditional transboundary water resource management practices to meet human and livelihoods needs. ⇒ Wetlands within the area were also important sources of fish protein. Communities relied upon traditional authorities to govern water usage, including rotating fishing, agriculture and livestock grazing to avoid overuse. ⇒ Although there are formal institutions in the area that support community-based structures, the level of involvement of local government in supporting water supply and services is not entirely agreed to between communities and official governance structures. ⇒ Water infrastructure is often managed by a community-based institution / structure (e.g. Water Committee), which is constituted of community members. Water Committees gather resources from community members to finance borehole maintain but there is not always sufficient funds due to the relative poverty in the area. ⇒ During workshops with the communities and local stakeholders in Mozambique, South Africa, and Zimbabwe, the fragmentation in the available spatial data was identified as a key challenge in supporting improved and integrated water management in the Node.
2. Water Services and Supply	⇒ Communities living close to the Limpopo River rely on surface water and wetlands but in communities further away from the river there is reliance on groundwater source. ⇒ During drought periods, very low and often no river flow occurs, resulting in communities relying on groundwater resources only. Frequently the reliance is on unprotected wells dug in the alluvial aquifer. ⇒ Water sources include community boreholes, taps and reservoirs; ⇒ Water supply through the municipal piped water system is intermittent and often unreliable. ⇒ Water from “bush pumps”/boreholes gets finished/used up early in the day due to the high demand. This often results in long queues. ⇒ The construction of small dams /sand dams (or any other means of capturing the river water and directing it into the community) is viewed a viable intervention to assist local communities to move away from dry land farming to irrigation as the rain is erratic in the Node.
3. Water Infrastructure and Access	⇒ Flood events modify the river channels. When normal flow returns, the river channels then sometimes become inaccessible, and since villages are then located further away from the riverbanks, easy access by communities becomes challenging. ⇒ Communities use untreated water straight from the Limpopo River and are especially exposed to the risk of crocodile attacks. ⇒ There are several non-functional boreholes in the communities mainly due to the unavailability of spare parts resulting from the closure of the international borders at Pafuri Border Post during the COVID pandemic and the lack of operation and maintenance (O&M) support from the Local Government. ⇒ The drilling of boreholes and installation of water pumps are sometimes financed by churches or NGOs without consultation or consideration by the communities, and without provisions for long-term maintenance. As a result, some of these are not used and non-functional.

Theme	Key Issue
	⇒ In some communities, community members agree to pay per family to support the operation and maintenance of boreholes. However, it is difficult to get spare parts for the boreholes. The spare parts are also not available due to lack of technical support and knowledge, as well as a lack of outreach support from the public (governance) and private sectors alike. ⇒ Piped water is mainly used for domestic use and livestock. Cattle drinking pens are opened once a week for livestock watering. ⇒ Women do most of the water collection.
4. Community Livelihoods	⇒ Farming occurs along the rivers for ease of watering community gardens and this contributes to riverbank erosion and degradation;. ⇒ There are viable and successful small agricultural irrigation schemes (food gardens) established with support from NGOs. However, some of the irrigation schemes are not operating at their full potential as the water infrastructure does not produce enough water to meet the demand. ⇒ Community members adapt to droughts by farming small gardens, going back to growing native crops such as drought tolerant sorghum, and relying on food assistance from donors and NGOs. ⇒ Women provide the labour in the irrigation schemes and they are responsible for horticulture plant production while men are responsible for livestock farming. ⇒ A major issue of contention is presence and increase in mining activities along the river and especially in the floodplains, negatively impacts the health of wetlands. Some of the key stakeholders, such as traditional authorities (, support mining as it enhances the local economy and diversify livelihood options, whilst other more conservation and sustainable natural resource management-based stakeholders are of the view that mining damages the environment, including water sources. ⇒ There is a need to explore, alternative livelihood and income options, where job creation can be attained while at the same time not negatively affecting the natural resource base and water quality that is so important to resilient and sustainable livelihoods both locally and downstream.
5. Water Quality	⇒ Some communities rely on untreated water and brackish groundwater, often extracted from shallow wells. ⇒ Access to sufficient and acceptable quality water is a historical challenge in most communities in the area. ⇒ Saline ground water is a long-term historically recognised challenge problem in most boreholes.
6. Market Access	⇒ Irrigation schemes provide benefits to women, including producing sufficient food for home consumption and sale at local markets. However, despite having surplus to sell, selling at the market is not always profitable due to limited support to access local markets.

3. WETLAND SYSTEMS

3.1. Wetland Delineation and Prioritisation

Existing wetland datasets were used and additional desktop delineation of wetlands was undertaken to produce a combined, integrated wetland layer for the Pafuri-Sengwe Node. The existing datasets included:

- WWF Global Lakes and Wetland Systems;
- European Space Agency Landcover Datasets[3];
- South Africa's National Wetland Map 5 (2018); and
- Zimbabwe National Wetland Map (2021)[4].

The additional desktop mapping was done using available aerial imagery and following the procedure outlined by (Thompson, et al., 2002) and (Job, et al., 2018). This includes the use of high-resolution satellite imagery (Google Earth™). The updated desktop delineation was supplemented by existing wetland information gleaned from the literature review and included wetland areas that were not covered within the existing datasets. This integrated map forms the baseline wetland layer to be further assessed and prioritised for various planning purposes within the Pafuri-Sengwe Node.

The wetlands within the Pafuri-Sengwe Node cover an aerial extent of approximately 148,000ha, excluding riparian areas. The delineated wetlands were classified using all available spatial data and reports, and were delineated in terms of regional setting, landscape and hydrogeomorphic unit. This classification was conducted during the desktop mapping exercise and throughout the duration of the project, as and when new data became available, and during which the use of latest available imagery on Google Earth™ was instrumental. Four types of wetlands have been mapped within the Pafuri-Sengwe Node and these include:
(1) Depressions (Pans);
(2) Floodplains;
(3) Seeps; and
(4) Valley Bottom wetlands.

The Figure hereafter illustrates the extent of the different types of wetlands delineated within the Pafuri-Sengwe Node at a desktop level, using remote sensing data, available digital spatial data, and delineations indicated at community-level, which were then validated through remote sensing data.

[3] Spatial resolution of 20m, recorded between December 2015 and December 2016.
[4] http://wetlands.ema.co.zw:8099/emawetlands/

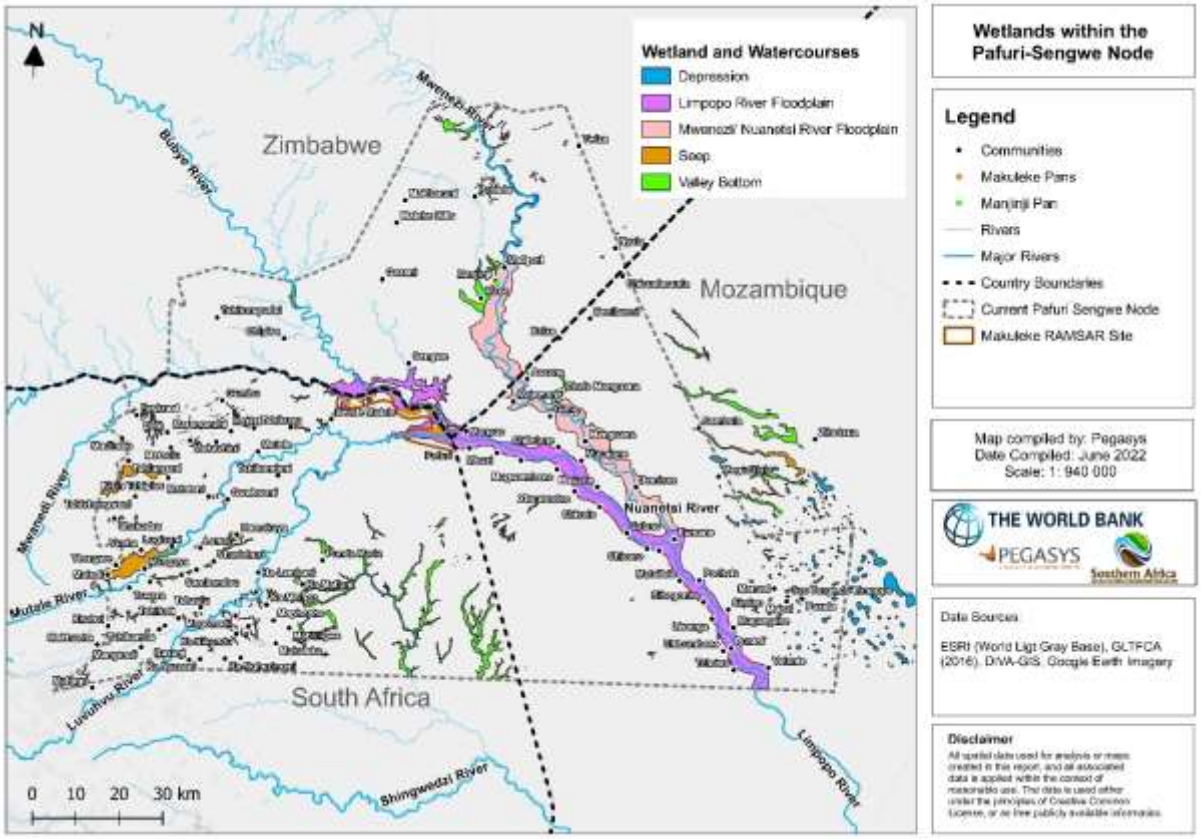

Figure 9: The extent of wetlands delineated at desktop level within the Pafuri-Sengwe Node

3.2. Demarcation of Wetlands that Require Conservation Focus

Protected- and conservation areas are important as one of the criteria for prioritisation of wetlands. This was regarded as the primary criteria and others follow on the original prioritisation that was done, however, the current revised prioritisation recognises the overlapping and provides a weighting score for both ecological and regulatory functions provided by wetlands. The wetlands that have the potential to be successfully protected and conserved are the systems within existing protected areas where management plans of natural resources are already likely to exist. These wetlands should continuously be ensured this protection status into the future and therefore is of significant importance. The categorisation of wetlands that require conservation focus within the Pafuri-Sengwe Node integrates both ecological and regulatory functions provided by wetlands. The wetlands within the conservation and protected areas are most important for safeguarding and provision of ecological functions and the same wetlands may also be important for the provision of regulatory functions. Many of these functions attributed to wetlands are wetland type-specific and can be linked to the local biodiversity and position of wetlands in the landscape as well as to how water enters and flows through the wetland. Thus not all wetlands can be expected to perform all functions and/or to perform these functions with the same efficiency. A weighted scoring system of various functional criteria has been applied in this project.

For the purpose of this project, the criteria used to prioritise wetlands are based on the following:

Ecological Functions Criteria:

Wetlands within conservation and protected areas: these are important systems for conservation and biodiversity. This includes all wetlands and pans within the Limpopo National Park (Mozambique), the Makuleke Ramsar site in the Makuleke Contractual National Park (South Africa), and Manjinj Pan and wetlands and pans within the Gonarezhou National Park.

Regulatory Functions Criteria:

1. Wetlands within strategic water source areas;
2. Wetlands for climate change resilience; and
3. Wetlands for rehabilitation aimed to improve functioning and ecological integrity:

as follows:

1. Wetlands associated with strategic water source[5] and supply areas (floodplains) are important for water production, including flow regulation.
2. Wetlands of importance to both climate change resilience and climate mitigation: Peatlands are important wetlands that support carbon sequestration, under anaerobic conditions.
3. Wetlands already prioritised for rehabilitation and where investment has been made for the implementation of rehabilitation activities are important due to their potential contribution toward improved functioning and ecological integrity of wetlands in the landscapes.

Finally, there are wetland systems present in the Node where no information is available. Although some may be of high conservation value, without supporting data any scoring will be subjective. These information gaps need to be addressed prior to further assessments.

Some wetland systems may meet more than one criterion. Given this, the following priority ratings were applied to provide the first order of prioritisation for the systems. The weighting is not fixed and can be amended in future for similar analytical outputs where ratings and importance weightings may be further refined. The rating of each criterion noted above is shown in the following tables:

Table 2: Rating table for wetland within the conservation and protected areas

Protection of wetland Habitat	Ratings
Wetland within conservation and protected areas	5
Wetland outside conservation and protected areas	0

Table 3: Rating table for wetland within Strategic Water Source areas

Water supply	Ratings
Wetlands within SWSAs	5
Wetland outside SWSAs	0

[5] Strategic water source areas have only been delineated within the South African portion of the node.

Table 4: Rating table for wetland with confirmed peat substrates (Peatlands)

Climate change mitigation	Ratings
Wetlands with peat substrate (peatlands)	5
Wetland without peat substrate	0

Table 5: Rating table for the confirmed rehabilitated wetlands for ecological integrity and ecosystem services

Ecological integrity and ecoservices improvements	Ratings
Confirmed rehabilitation activities within the wetlands	5
No rehabilitation activities	0

Wetlands with no available information are not rated. To combine all criteria into one prioritisation ranking, scores were area-weighted, as indicated in Table 6, based on the importance weighting of each selection criteria. Table 7 indicates the final categories used to determine the final prioritisation class of wetland areas. Below is the area weighting used for the prioritisation of the targeted wetlands as well as the final rating. These can be summarised as follows:

- Area-weighting used for the combined scoring of selection final rating categories of wetlands targeted for rehabilitation (Table 6); and
- Final rating categories of wetlands targeted for (Table 7).

Table 6: Area-weighting used for the combined scoring of selection final rating categories of wetlands

Criteria	Importance Weighting
WC&PAs	5
SWSAs	4
Peatlands	4
Rehabilitated wetlands	3
Other wetlands	1

Table 7: Final rating categories of wetlands

Priority List	Scoring Category Ranges
Very High	≥20
High	10 – 20
Medium	5 – 10
Low	0 – 5

The Figure hereafter, which is linked to Table 7, illustrates the locations and extents of the priority wetlands based on the above criteria. It is not practically feasible and in some instances may not be not possible to safeguard all wetlands to the same extent.

Therefore, the prioritisation of the wetlands are necessary in support of achieving the best possible ecosystem services outcome.

The analysis done during the project delineated wetlands and classified them based on remote sensing and limited in-field observation. Based on the analysis, it is recommended that wetlands of very high and high priority, as visible in red and orange in the Figure below, be safeguarded as best possible from any overexploitation and unsustainable use. These wetlands should, wherever possible, receive formal protection, and where local use of such wetlands resources occur, the use should be managed in a sustainable and wetland-conscious manner. For example, specific agricultural practices may apply and specific crops could potentially be cultivated within such wetlands, whilst it may then still serve the intended wetland function as part of its ecosystem service. Other wetlands may be able to absorb additional compromise and in some cases, may even be lost in totality, where such wetlands do not form part of the critical and key ecosystem services in the catchment. In natural habitats where wetlands are not compromised, total conservation and safeguarding may be possible – however, in a situation such as that which the Pafuri-Sengwe Node exist, many of the very high and high priority wetlands areas have already been compromised – thus necessitating this alternative approach. All non-compatible land uses to the functioning of these systems should be avoided as far as possible and management plans should be developed and implemented so that these systems may function optimally and support sustainable and continuous functioning.

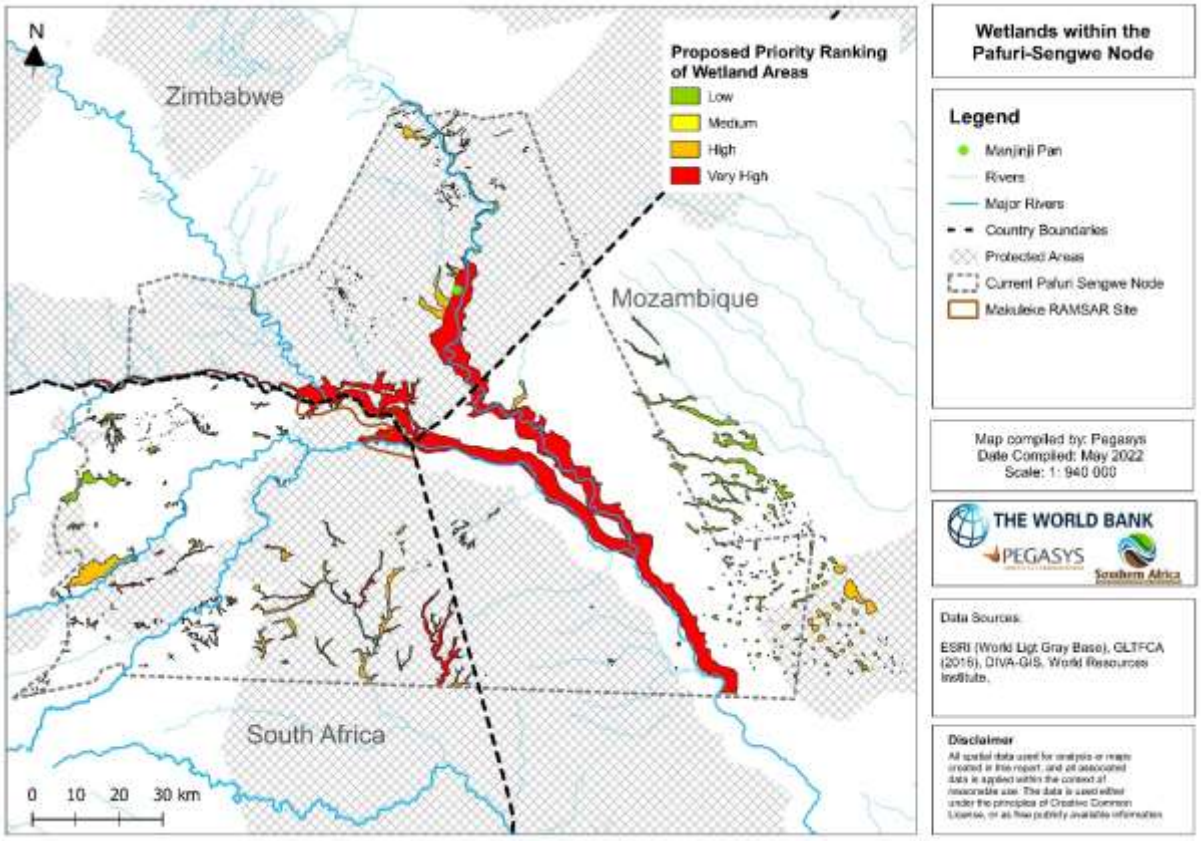

Figure 10: Priority wetlands in the Pafuri-Sengwe Node based on the adopted criteria

3.3. Wetland Multi-Use Considerations and Community-Based Resource Management

3.3.1. Wetland Use and Sustainable Wetland Management

In rapidly urbanising areas with a high proportion of low-income residents, high levels of poverty, and a general lack of appropriate water and sanitation infrastructure, reliance on ecosystem services can be relatively high. Degradation of those services hurts the communities and acts as a barrier to socio-economic development (Edwards, et al., 2018). Intact and functional ecosystems and their services also contribute to the increased resilience of societies in the face of the effects of global warming and climate change (Edwards, et al., 2018).

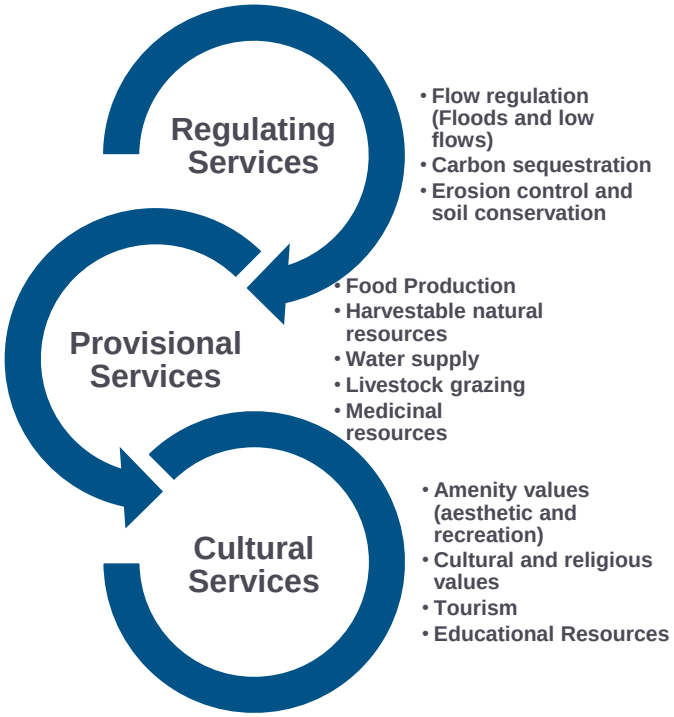

Figure 11: Summary of the typical ecosystem services provided by natural ecosystems

Wetland ecosystems provide a wide range of ecosystem services (Figure 11). The Pafuri-Sengwe Node largely consists of rural, conservation and protected areas, agricultural areas (livestock and crop production) and urbanised areas (particularly on the South African side, and Upper reaches of the Mutale and Luvuhvu Catchments). The dependence on natural resources, particularly among rural communities, is high with the focus on provisional and cultural services. Conservation and protected areas are important for the maintenance of biodiversity, including aquatic ecosystems, terrestrial fauna and flora, preservation of natural capital, and building climate resilience. The floodplains traversing the node are important for basic human needs and livelihoods (particularly in Mozambique and Zimbabwe) as well as biodiversity support. The Makuleke Ramsar site, which is at the confluence of the Luvuhvu and Limpopo Rivers, provides various habitats for the local biodiversity.

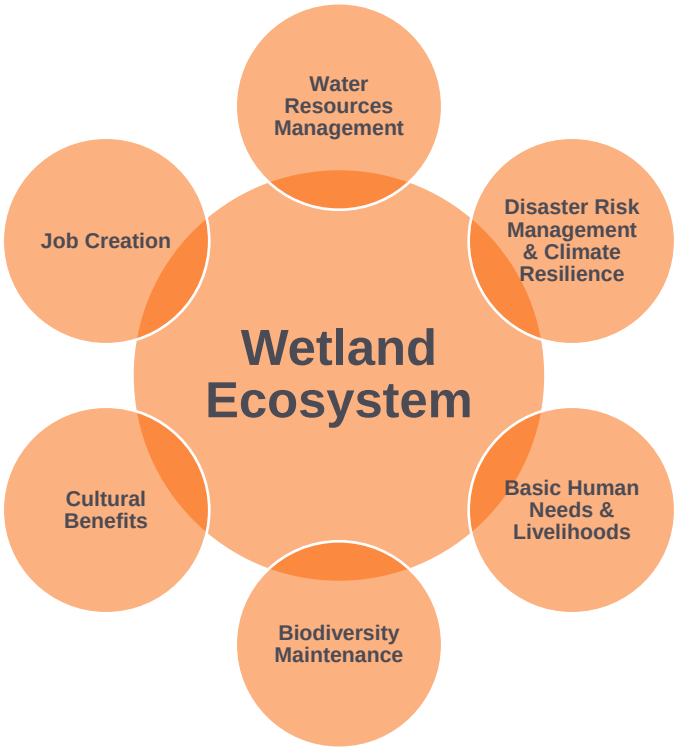

Figure 12: Services that wetland ecosystems management can contribute to

(Source: (Edwards, et al., 2018))

Wetlands (in or out of floodplains) has the ability to store water during the wet season and release it during the dry season, in the same way that a sponge functions in absorbing and releasing water. This release function provides farmers who plant crops downstream – whether in or alongside wetlands or in floodplains downstream, opportunities to grow crops all year-round , thereby improving their food security and incomes. The classification and delineation of wetlands outside and within floodplains is therefore very necessary – so as to protect the "sponges" effectively and enabling subsequent downstream out-of-wetland floodplain farming to be possible.

Wetlands also support livestock grazing and watering, water supply, fishing, and natural product harvesting.

Altering the wetland environment through conversion to cropland and other uses can degrade wetlands and undermine their capacity to provide the necessary ecosystem services to all water and land users downstream, and into the future.

In the context of Pafuri-Sengwe Node, provisioning services provided by wetlands are perhaps the most significant in terms of sustaining fundamental human needs, reducing poverty, and supporting people's livelihoods (Figure 12 Adapted from (Edwards, et al., 2018). Even the smallest wetland can be a vital resource for people living nearby, providing water for domestic use, crops and livestock, or a source of food, including fish. These can be lifesaving 'safety nets' in arid and semi-arid regions, often being the only source of water and food in the dry season.(Edwards, et al., 2018)).

Figure 13: Key provisioning services supplied by wetlands that support meeting basic human needs and sustaining livelihoods

As discussed earlier, resource-poor households without access to water infrastructure often utilise water in wetlands for food production and as a source of domestic water (e.g. Mozambique and Zimbabwe (IWMI, 2010) confirmed during in-field investigations to still be very much the case). At a local level, the value derived from wetland farming and the harvesting of other wetland products remain significant. This value forms a significant part of households' income or livelihood ((IWMI, 2010), confirmed to still be the case during the 2022 in-field investigations). It is often very difficult to balance all the ecosystem services with maintaining a healthy functioning system due to population growth, an increase in dependence on natural resources, and in the absence of oversight. This leads to overexploitation of services and resources. Altering the wetland environment through cultivation has potential impacts, not just within the wetland, but also in downstream areas.

In a context of escalating unemployment and unreliable rainfall, it appears difficult to prevent further development of wetlands for agriculture. The thresholds of individual services within the concept of *multi-use* are not well understood. Some activities are not compatible with each other, for example, crop production may be at odds with the maintenance of biodiversity and hydrological processes driving the integrity and sustainability of the wetland. The hydrological functioning of the individual wetlands creates conditions that support livelihoods, for example through supporting agriculture. The agricultural use of these wetlands has an impact on water supply at the wetland level and the capacity of the wetland to provide water for such use. Wetland users may attempt to create conditions suitable for desired crops, such as through draining of the wetland, rather than finding crops suitable for the wetland condition. The maintenance of a shallow water table in the wetland aquifers is essential for crop production. Therefore, water management interventions for agriculture should focus on managing the water table and water distribution across the landscape rather than drainage as a way of minimizing trade-offs between crop production and water supply.

Sustainable management of wetlands cannot be achieved without the active participation of all stakeholders, including local communities (Morardet & Koukou-Tchamba, 2015). It is often easier to manage wetlands within protected areas, however, the majority of the problems are within wetlands outside of protected areas, within communal lands, and it is, therefore, essential to place more focus on managing wetlands and wetland use within the context of these highly utilised landscapes.
The type and intensity of wetland uses have potential impacts on wetland functions. Increasing population, partly due to resettlement imposed by political regulation or spontaneous immigration of population attracted by better natural resources, has put high pressure on wetlands' ecological processes. In some cases, this scenario is worsened by the fact that access to other surrounding natural areas is now denied to local communities due to their incorporation into conservancies.

The protection and sustainable management of wetlands contribute to enhancing food security and improving the livelihoods of wetland-dependent communities by increasing the productivity of land and water and optimizing, while maintaining, wetland ecosystem services.

The following sections address the current wetland uses and nature of use within specific areas, as well as any management measures or plans at a local level.

3.3.2. Mutale-Luvuvhu Catchment

Peatlands within the Mutale and Luvuvhu Catchments provide important water production and climate resilience areas. Rehabilitation within these catchments and the Kruger National Park (Shingwedzi Catchment) aim to improve the functioning of the wetlands, as well providing jobs and household income through Expanded Public Works Programmes (EPWP). In urbanised areas of the Mutale and Luvuhvu catchments, wetlands are considered by government actors and communities alike, as important ecological infrastructure, supporting water resource management. The management of surface water resources through stream flow regulation (attenuation of flows from developed areas), nutrient and toxicant removal (agricultural activities and discharge from wastewater treatment works (WWTW)) and sediment trapping as a result of changes in land use surrounding the wetlands, support the broader ecosystem services functioning in the environment, and thus provide buffer mechanisms to drought conditions. Where stream flow regulation is effective, the release may act in the same manner as a natural wetland system would act (i.e. as if the “sponge” release water over a period of time and even well into drought conditions). The removal of nutrients and pollutants supports improved water quality, thus ensuring that the water remain usable well into times of drought: noting that in drought conditions due to less water being available, water often become unusable due to the mere concentration of pollutants and nutrients rather than simply the reduced of flow. Where rivers and canals have high sediment loads, the water often become unusable earlier on during drought conditions, when less water is available and the water become muddy, than when the sediment load is low.

A quantitative assessment (household survey) of wetlands within the Thulamela Local municipality indicated that 73.6% of the households are aware of the wetlands in their

areas (Mukhuwana, 2019). The communities in the survey mostly used wetlands for water supply, medicinal plants, woods and reeds harvesting and agriculture. The agricultural activities within the wetlands in the study include growing vegetables and crops (such as maize), livestock rearing, cutting reeds and fishing. Vegetables and crops production accounts for 60% of the agricultural use of wetlands (*ibid*).

The methods used for farming in and around flood plains include hand/hoe, tractors, irrigation systems, animal-drawn and water pumps – across the Pafuri-Sengwe Node and even in wetlands in the Node. , the use of technology and motorisation such as the use of tractors and irrigation systems are more prevalent in the South African area. The areas worked with hand/hoe were the largest proportion at 45%, followed by the use of tractors (33%), irrigation systems (12.7%), animal-drawn method (8.5%) and water pumps which were the smallest proportion at 0.5% (*ibid*). The extent of cultivation in wetlands, as seen on aerial reconnaissance images, shows a loss of mostly seepage wetlands and extensive cultivation of valley bottom wetland and riparian areas – however, due to the lack of ground-truthed wetland delineation data in the Zimbabwe and Mozambique areas, the exact percentage of this loss can only be quantified through a detailed study.

A pilot project (Wise Use Project) undertaken by the Association for Water & Rural Development (AWARD) on behalf of the Working for Wetlands (WfWet) in the Mutale Catchment "*noted that accelerated degradation is often typical in areas where surrounding communities depend heavily on wetlands for grazing, food crop production and thatching material"* (DFFE, 2022). The program sought to address the root causes of the degradation through focussing on local-level custodianship in communities. This approach was implemented through community researchers and monitors (CRMs) who were trained to facilitate and mediate communication between, the community and Working for Wetlands. The Wise Use project grew from initially working through volunteers to formally employing CRMs with remuneration. The CRMs approach goes a long way in creating a platform for engagements and promoting the wise use of wetlands at a community level.

Although the stakeholder engagements undertaken as part of this project did not directly include the WfWet team, engagements included representatives from AWARD and the South African Department of Forestry, Fisheries & the Environment (DFFE) from whom lessons from WfWet can be gleaned. The WfWet programme team have engaged with local communities in areas where they work, and in future can be a key point of entry to share information and build networks with the community structures and other role players in wetland use. Another key stakeholder is the Limpopo Wetland Forum which includes South African government departments at national and provincial levels with mandates to protect wetlands. The Forum also includes academics, Non-Governmental Organisations (NGOs) and community members that have an interest in wetlands and wetland management. Forums such as these should be incorporated in the Node to maximize community engagements and the sustainability of interventions. This is especially important when engaging with communal level decision-making bodies responsible for decision making around

wetland issues, including wise-use programmes and community-based management plans.

3.3.3. Makuleke Ramsar site and surrounding areas

Historically, wetlands in and around the Makuleke Ramsar site were used for multiple purposes – including livestock grazing and agriculture. Controls put in place when the Makuleke site was changed into a conservation area in 1969 excluded crop production within the boundaries of the Kruger National Park and Ramsar Site. This removed the potential for wetlands to be used for multiple purposes. Other control measures include that no livestock are allowed in the contractual national park area.

Prior to the forced removal of the Makuleke community in 1969, the area was used and sustainable managed as a transboundary natural resource. Cattle were currently often being raised in Zimbabwe (by South African farmers), with hunting and reeds harvesting (mainly for thatching) also taking place in a rather seamless transboundary approach between communities on both sides of the river. The crossing of the river took place mainly in the dry season, when there are large exposed sand banks, and crossing on foot is possible. Traditional resource management controls that were implemented also included control of fishing methods within the pans in the site by Chiefs and Indunas, who monitored the pans and permitted the timing of fish harvesting. This also included rotation harvesting between the pans.

Based on in-field observations, **outside** the Makuleke Contractual National Park and RAMSAR site, communities practice subsistence farming especially south of the Madimbo corridor and on the western edge of the Pafuri area. These play a very important role in sustaining livelihoods in the area (Midgley, et al., 2013). Additional crops produced in the South African part of the Node, also outside of the RAMSAR site, include tomatoes, oranges bananas and mangoes. Although a large part of these crops are produced through commercial farming and through irrigated measures, the local use of the non-market-offset produce provide a valuable food security base, while small-scale and subsistence farmers produce these crops for household and local use as well as gaining farming and produce skills and knowledge from the commercial production processes. This enable a technical knowledge base as well as a nutrient base in support of human health, that broadens the staple diet of maize and sorghum, which may support extended wellbeing into times of drought. Even though it is possible, there is minimal beef cattle farming outside the Makuleke Contractual National Park, with goats and small-scale poultry farming (producing eggs and meat for local use) being the primary focus.

Inside of the protected area, water supply in the Makuleke Contractual National Park area is primarily gained through boreholes, which are managed by the lodge tourism operators and monitored by Kruger National Park authorities. The maintenance of biodiversity and wildlife support within the site complements other users and the impact of livelihoods in the National Park, on wetland integrity, is low. With no cultivation, structural and morphological changes are taking place within the wetland and with the assistance of the Kruger National Park (KNP), the site's management plans are being implemented.

Stakeholders recalled the historical multi-uses of wetlands and pans, with a transboundary approach to livelihood efficiencies in the Makuleke Ramsar site before its proclamation as a conservation area. Communities still consider the wetland and water resources as an asset that could be utilised sustainably – even when under conservation status. International boundary crossing, primarily from Zimbabwe into South Africa, is still being practiced – although not formally recognised from a governance level between the countries. This situation needs reflection, especially considering ministerial policy on transboundary movement and natural resource utilisation in this "flexible" zone. Although the consideration of international and transboundary matters are outside of the scope of this project to consider in more detail, it is necessary that this feature of the Pafuri-Sengwe Node be considered in all future planning and implementation of programmes and projects in and across the Node.

3.3.4. Manjini Pan and Mwenezi River Floodplain

The Mwenezi River (in Zimbabwe it is the Mwenezi River; in Mozambique it is the Nuanetsi River) forms a boundary between the Gonarezhou National Park and the Malipati Safari Area and has formed the Manjinji Pan (a sanctuary under the Parks and Wildlife Act) from an old oxbow lake. The pan is located at 22°07'S 31°24'E and is in the Sengwe communal land. Manjinji Pan is surrounded by thick woodland, dominated by fever-tree *Acacia*. There are many palms (*Hyphaene)* in the area (Bird Life International, 2022). The local people practise subsistence agriculture and pastoralism with cattle and goats. They regard Manjinji Pan as a sacred area. Manjinji pan is an Important Birding Area and National Parks Sanctuary with a rich diversity of species recorded. The Limpopo-Mwenezi Floodplain and pans are also classified internationally as a Key Biodiversity Area (KBA) in Zimbabwe.

There is some agricultural development on the floodplain downstream from the pan. Towards Chikwarakwara, to the north of the Limpopo River, are more flood-plain areas. The natural vegetation of the area is mopane woodland and *Terminalia* woodland.
(Bird Life International, 2022)The Mwenezi floodplain is important for water supply for domestic and irrigation purposes through various dams and schemes in the river networks. The river supports a diverse range of wildlife – both inside and out of the water. The wetland areas in particular floodplains are important for water supply, ecotourism (presence of Safaris and Rest camps), biodiversity (especially avifauna) and wildlife support, cultural services and subsistence agricultural activities. The percentage of arable land suitable for crop production is generally small. The crops produced include cereals and cotton, there is a relatively lively cross-border exchange of goods and currency.

3.3.5. Limpopo Floodplain and Pans

The Nuanetsi and Limpopo Rivers' floodplains converge within the Mozambique side of the Pafuri-Sengwe Node. Both floodplains are within communal lands outside protected areas. The Limpopo River floodplain in Mozambique forms the northern and

eastern boundary of Limpopo National Park. However, the western part of the Limpopo River floodplain has been zoned as a community resource use zone.

The mosaic pans on the Mozambique side provide water and fertile soil for agricultural activities. Agricultural activities are concentrated in and around these pan systems. The biodiversity support of these pans is however not known, and this gap provides opportunities for education and research work. The floodplains of the river are used for cashew nut and rice cultivation. Other crops produced outside the park are mainly maize, sorghum, millet, vegetables and melons (Midgley, et al., 2013). Fish farming is also practised in the area. The natural resource which is most harvested is the mopane worm for both household consumption and market.

The river is currently on a gradual decrease in its flow due to dry conditions at its source, excessive extraction in some locations upstream, evaporation, and consumption by riparian vegetation (including alien invasive plant species). Trade-offs appear to be dominant, and these are amongst crop production, water demand/supply and wetland support services including biodiversity support. The economic situation favours crop production and water supply over maintaining wetland ecosystem services. Based on available information from stakeholder engagements, it does not appear that there are systems or management measures in place at a communal level, especially outside protected areas, to encourage the sustainable use of natural resources with emphasis on the wetland ecosystem.

As indicated earlier, floodplains and pans on the Mozambique side of the Node are extensively used for subsistence agriculture, and water supply for both domestic and agricultural use. Communities indicated that there are no structures in place for discussion on wetland management issues. However, there is a system in place regarding fishing in watercourses, the control being that no one fishes without authorisation from the head of the community. The extent of the powers of the head of the community is not known particularly concerning cultivation, water supply and water abstraction within wetlands.

In 2017, the Mozambican government introduced a new Conservation law with accompanying regulations that provide for a category of Community Conservation Area as part of the formal protected area system (Resource Africa, 2020). "*According to the Conservation Law 5/2017, a Community Conservation Area (CCA) is an area of conservation of sustainable use in the Community public domain, under the management of one or more local communities where they have the right to use and benefit from land, for the conservation of fauna and flora and sustainable use of natural resources"* (Resource Africa, 2020). This option does not appear to have been fully explored within the Node and could potentially provide platforms to formulate community-based management plans and measures at a communal level that could be understood and easily implemented at a community level.

3.3.6. Ecosystem Services opportunities

The wetlands within the Pafuri-Sengwe Node provide a variety of ecosystem services (Table 8).

Table 8: Summary of ecosystem services provided by wetlands

Ecosystem Services	Mozambique	South Africa	Zimbabwe	Notes
Flood attenuation	✓	✓	✓	Limited to floodplain and valley bottom wetlands
Streamflow regulation	✓	✓	✓	Limited to floodplain and valley bottom wetlands
Sediment trapping	✓	✓	✓	Limited to floodplain and valley bottom wetlands
Phosphate trapping		✓	✓	Limited to commercialised agricultural areas where there is the use of fertilisers or similar
Nitrate removal		✓	✓	Limited to commercialised agricultural areas where there is the use of fertilisers or similar
Toxicant removal		✓		Limited to the urbanised environment (industrial, stormwater and wastewater discharges)
Erosion control		✓		Limited to the urbanised environment (changes in the catchment land uses, elevated flows)
Carbon storage		✓	✓	Limited to peatlands and un-channelled valley bottom wetlands
Maintenance of biodiversity	✓	✓	✓	Across all wetlands
Water supply for human use	✓	✓	✓	Across all wetlands
Natural resources	✓	✓	✓	Across all wetlands
Cultivated foods	✓	✓	✓	Across all wetlands
Cultural significance	✓	✓	✓	Across all wetlands
Tourism and recreation	✓	✓	✓	Floodplains, Ramsar site, Majinji pan, Malipati Safari Area
Education and research	✓	✓	✓	Floodplains, Ramsar site, Majinji pan, and possible mosaic pans in Mozambique

The following points highlight many options for entry points for wetland management activities in any community. These are:

1. Baseline information inform a sound understanding of the wetland ecology and socio-economic situation of the local communities in the area. There is currently inadequate delineation and classification of wetlands in the Node and therefore effective management plans cannot be developed yet – only once the necessary information is available, can effective wetland management result.
2. A clear understanding of the capacity of a given wetland system to provide various ecosystem functions, how the local communities use (or could potentially use) the wetland, and identification of which functions need to be prioritised for management to support (at a local, regional and/or national level) human needs, strategic biodiversity planning and management, and persistence of important landscapes or landscape features.

3. Management interventions that balance maintaining ecosystem functionality and human needs. This strategy approach would explore community trade-offs such as conserving important wetlands in exchange for food security support through development of small-scale agricultural schemes, for example. This could be achieved through conservation / stewardship agreements between the park and communities living in the buffer / resource use zones, including the restoration of degraded areas through the creation of 'green jobs'.
4. Incentives that encourage sustainable use of the wetlands and the maintenance of ecosystem services. This relate to the previous point of balancing ecosystem and human needs, but explore the adaptable use of certain wetlands where multiple use options and conservation-based wetland use is possible.
5. Legal frameworks and approaches between different economic sectors, even within Countries, does not always align. To support a coherent vision where eco-based adaptation, wetland safeguarding, integrated water resource management, income generation through mining, effective agricultural food production, hunting, and eco-tourism-based economic growth can align. When alignment and integration takes place across the sectors, sustainable livelihoods, economic opportunity and environmental protection may all be enabled at the same time. To achieve this it is necessary for the governance actors involved to find common ground and develop integrated developmental plan(s) where sectors can function together even within the same geographical space, and the potential for multiple use options exist.
6. Negotiated local rules and by-laws which discourage unsustainable use of wetlands.
7. Agreed-upon and functional institutional arrangements which facilitate and regulate sustainable wetland utilisation and conservation.
8. Facilitation of land users/communities that ensures an inclusive, consensus-based planning and management process.
9. Implementation of a community-based monitoring and evaluation system that enables managers to learn and adapt from action/intervention successes and failures.

A clear order of the planning and implementation of wetland management within these communities is the key towards successful management of the natural landscape, ecosystem services it provides, and subsequent livelihood support.

4. GROUNDWATER SYSTEMS

4.1. General geology and aquifer types

The nature of the rock, degree of consolidation and fracturing play an important role in the presence and the type of groundwater system. Understanding the type of aquifers and productivity of the aquifer requires considering all available geological and hydrogeological material. The productivity indicates the borehole yields expected in different aquifer types.

The main rock-type groupings in the Pafuri-Sengwe Node are:
(i) Archaean basement rocks (4 000 – 2 500 million years);
(ii) Paleozoic/Mesozoic age rocks (550-50 million years), including Karoo Supergroup sedimentary deposits with associated intrusions (i.e., dyke and basalt flows);
(iii) Cretaceous (150 -50 million years) and younger age consolidated and unconsolidated sedimentary sequences mainly in Mozambique; and
(iv) recent deposits associated with watercourses.

The SADC hydrogeology map (SADC-HGM) formed the basis of aquifer delineation and productivity in the Figure below. The Limpopo Basin Transboundary Aquifer (TBA) underlies part of the Pafuri-Sengwe Node. The extent of the Limpopo TBA is poorly defined and has not formed the basis of prior investigations. The rock-types form low-permeability formations; fissured aquifers and unconsolidated intergranular aquifers, as shown in the aquifer productivity map. There are upper cretaceous formations that can be potentially classified as Karst aquifers but are relatively low-yielding and can be considered low permeability formations.

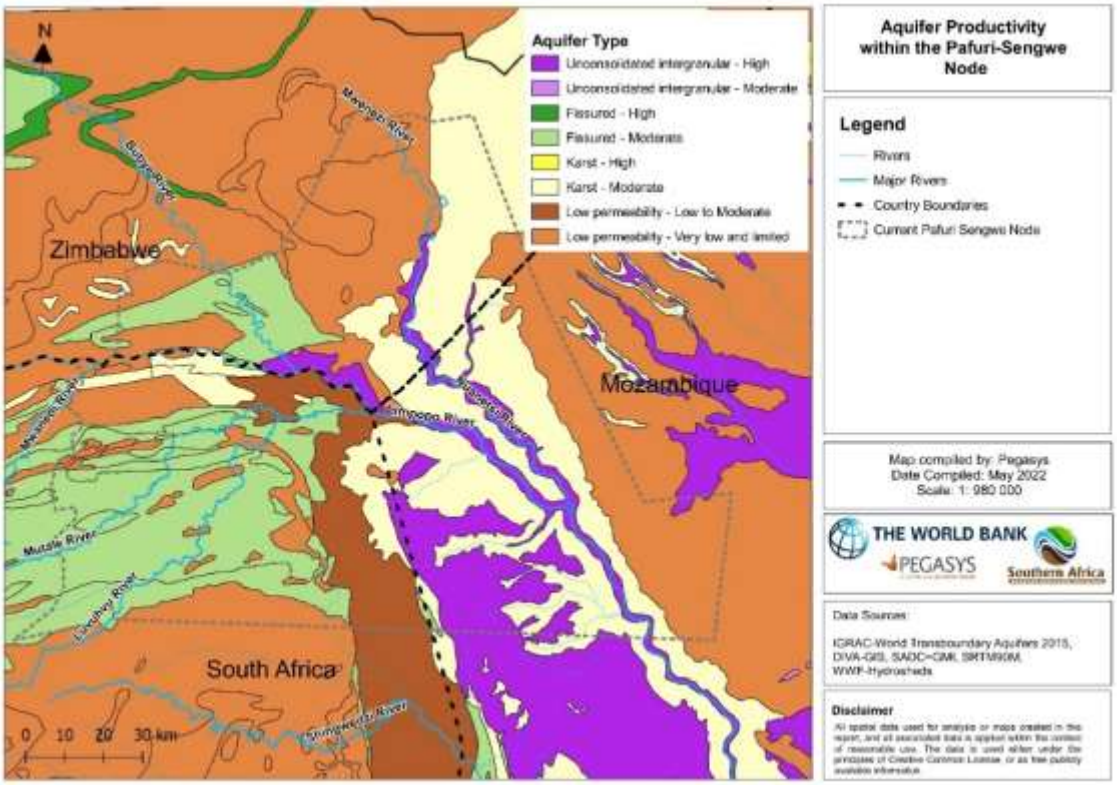

Figure 14: Aquifer productivity in and around the Pafuri-Sengwe Node

Low permeability formations predominate the study area and are associated with crystalline basement, volcanic formations (basalt) and compacted sediments. The poor connectivity of the low permeability formations results in significant local variations in yield and response to abstractions (Pietersen et al., 2010). The expected water strikes vary between 10-50 metres (m) with yields lower than 1 litre per second (L/s). In the crystalline basement aquifers, boreholes often have high initial yields, and if pumped continuously, yields drop off markedly.

The severely faulted Soutpansberg Group and sandstone of the upper Karoo sediments formed fissured aquifers in the Pafuri-Sengwe Node. Higher yields in the Soutpansberg rocks greater than 3 L/s occur along fault and fracture zones. Away from the fault and fracture zones, the Soutpansberg rocks have low potential. A thin basal sequence of Upper Karoo sandstone overlain by basalts and rhyolites occurs in the Pafuri-Sengwe Node, with yields generally ranging from 0.5-1.5 L/s.

The unconsolidated intergranular aquifers are associated with the alluvial deposits (forming alluvial aquifers) of the Limpopo River and its major tributaries, the Bubye from Zimbabwe, Luvuvhu from South Africa and Mwenezi from Zimbabwe Nuanetsi in Mozambique). The alluvial aquifers usually have good storage (5% to 20% of aquifer volume) and mainly recharge from river flow. Up to 20 L/s per borehole during the rainy season can be abstracted. The alluvial aquifers are by far the most productive.

4.2. Groundwater recharge and discharge

In a pristine groundwater system, the natural recharge equals the discharge, and a dynamic equilibrium exists between wet and dry years. The groundwater levels recede during dry periods and recover during wet periods in response to changes in recharge from precipitation and surface water bodies. Measuring the groundwater level changes over time within an aquifer is a good proxy for groundwater volume changes within an aquifer system.

The Figure hereafter shows the groundwater levels (orange line) and the groundwater level status (blue line) of a groundwater monitoring borehole in the Pafuri-Sengwe Node (South Africa)[6].

It is recognised that the years indicated in the graph – i.e., 12 years in the case of the Figure, is not adequate to provide an overview of the long-term behaviour and climate-related response of ground water levels to recharge and acclimating variability. However, there are challenges to access long term records for boreholes in the region. This issue is included in the investment recommendations (Chapter 6) to enable longer term monitoring and data collection across the Node.

The groundwater level status approach compares the shallowest and deepest groundwater levels measured at a borehole. During the first part of the hydrograph 2010 – 2011, the groundwater levels are constant, starting to rise from 2012 to the middle of 2013, from which the groundwater level recedes for several years. The long-term recession of groundwater levels is a feature of groundwater in semi-arid areas continuing for some instances up to 20 years. During prolonged and above-average rainfall, the groundwater levels, in many cases, recover to the original reference levels. Understanding the fluctuations of groundwater levels and having long-term monitoring records leads to a deeper understanding of the groundwater system and making possible to make management recommendations.

[66] The longer the time series data available the better the confidence to reflect drought conditions in the analysis. Unfortunately, limited time-series data are available throughout the Pafuri-Sengwe Node, which means that the boreholes' limited monitoring periods reduce the analyses' confidence. Data from this borehole represents the best available time series data. The borehole is representative of most of the boreholes in the Node.

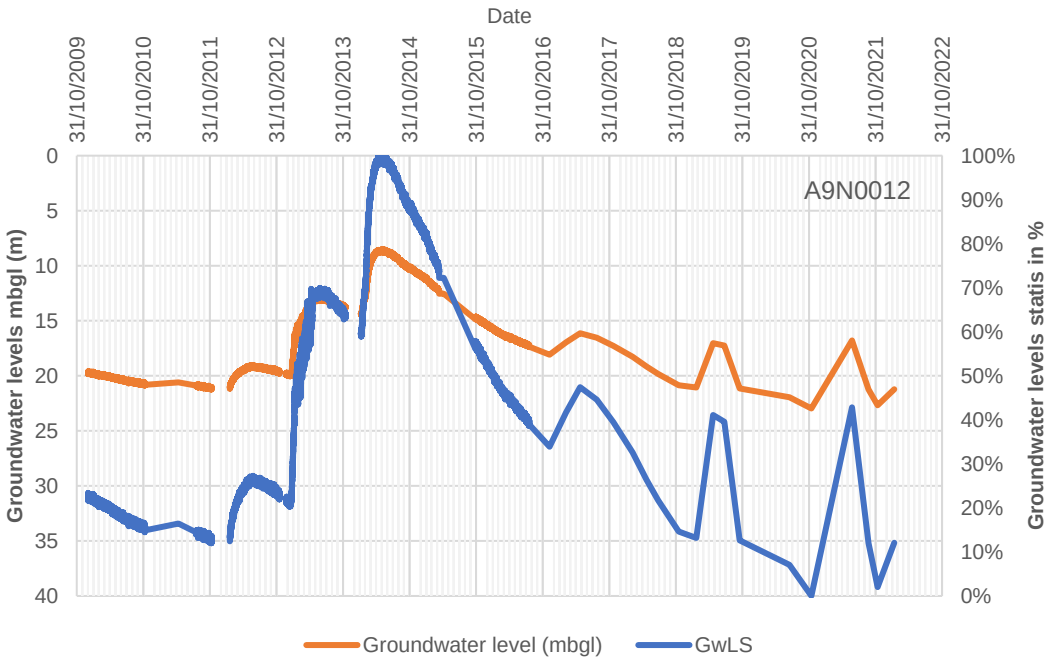

Figure 15: Groundwater Level (meters below ground level (m) – orange line) and Groundwater Level Status (% - blue line) borehole A9N0012 located in South Africa

In the Figure above, the interrogated borehole record span (n = 41 409) ranges from January 2010 to February 2021. The maximum groundwater level recorded during this period was 23m, and the minimum groundwater level was 8.5m. The maximum-minimum fluctuation was about 14m. The measurement frequency from the datalogger was hourly until August 2016. After that, the frequency of monitoring becomes tens to hundreds of days. The Figure below shows the groundwater level severity using percentiles of the historical groundwater levels. As alluded to above, the borehole responded to recharge events in 2011, 2013, 2016, 2018 and 2021 but has been in general recession since 2013. The severity illustrated in the Figure below gives a graphical demonstration of drought conditions for the same borehole as above, i.e. from the same location in the Node as discussed above. In this example, reaching a groundwater level status of P10-P25 requires implementing restrictions on groundwater abstraction from high-volume users. This is a reflection of the situation of many boreholes (for which data is available) across the Node.

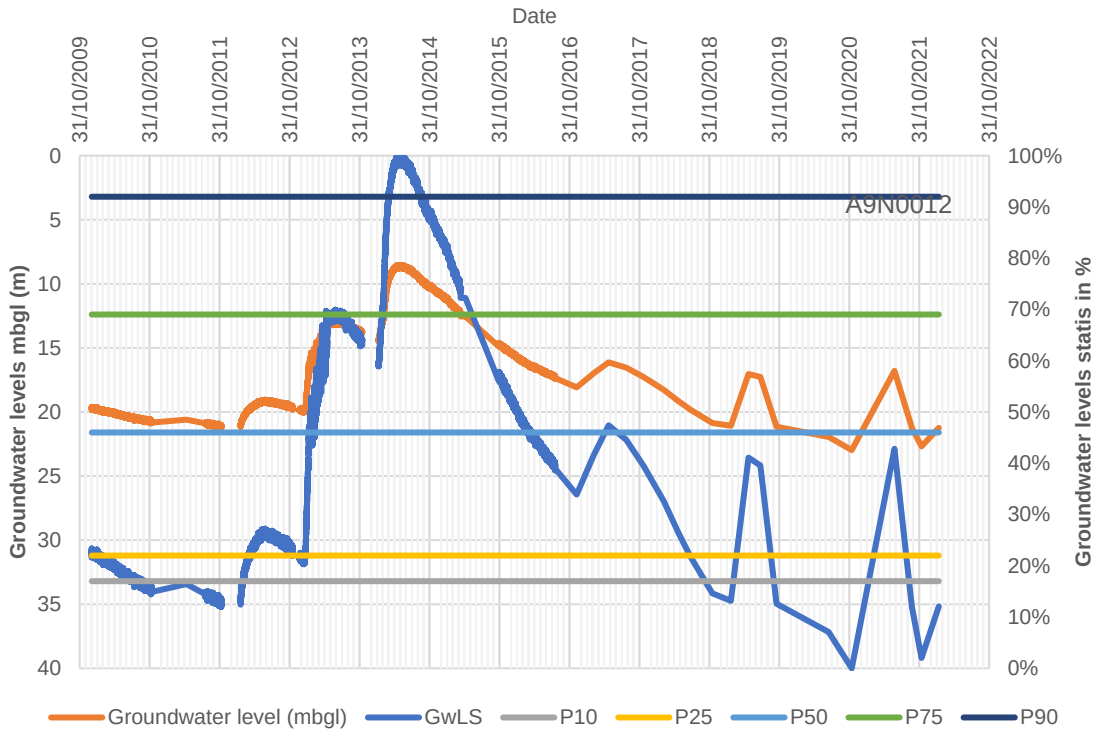

Figure 16: Groundwater level status with the groundwater level severity for borehole A9N0012 located in South Africa

Groundwater recharge processes are episodic in semi-arid areas such as the Pafuri-Sengwe Node – groundwater levels only respond after overcoming a certain rainfall threshold. This threshold can be:

(i) a series of individual rainfall events forming part of a prevailing regional weather system; or

(ii) a single, heavy rainfall event over a short period.

In the Kruger National Park (KNP) (South Africa), researchers found that if rainfall of intensity 100mm/24 hours does not happen, direct recharge to the aquifer does not occur, and the water evaporates from the soil matrix. It is important to note that the health of the terrestrial ecosystem and land cover has a direct impact on the ability of the rainfall intensity to recharge aquifers and that degraded landscapes also negatively impact aquifer recharge.

The seasonal flows of the river systems influence recharge to the alluvial aquifer system. During the wet season, runoff recharges the alluvial aquifer; surface flows decline during the dry winter stands resulting in dislocated pools during the dry winter months fed by sub-surface flows. Various researchers found that regional groundwater contributions maintain the perennial rivers of the low-land areas at their lower reaches. Limited information is available to calculate discharge to river systems. Groundwater – surface water interaction requires follow-up work, including an improved understanding of Groundwater Dependent Ecosystems (GDEs) in the Node.

4.3. Groundwater quality[7]

Groundwater from several boreholes in the Pafuri-Sengwe Node exceeds recommended water quality standards (i.e. the water quality is worse than what is either generally acceptable or in comparison to various local or international guidelines). The chemical concentration exceedances, such as salinity, nitrate and fluoride, are of health concern to communities. The communities reported cases of brackish groundwater, which is an issue for drinking water and food preparation. There are frequent cases of diarrhoea, and the focal group discussion highlighted cholera outbreaks in the past.

4.3.1. Salinity

Salinity indicates concentrations of salts in the groundwater obtained through measuring electrical conductivity (EC). The World Health Organisation (WHO) does not set limits for EC as it is not of health concern. However, high salinity causes water to have a very salty taste, making it undesirable for humans and animals to consume.

The maximum EC measured during field visits for this report was 14 600 micro siemens per centimetre (µS/cm) and 44 µS/cm minimum. The average EC was 1189 µS/cm. However, Mozambique's water quality permissible limits are set at 2000 microsiemens per centimetre (µS/cm) and 1700 µS/cm for South Africa. Zimbabwe follows the WHO standards. The figures below indicate the latest EC measurement at a particular borehole in the Pafuri-Sengwe Node against the exceedance of selected water quality guidelines. In general, the higher salinity groundwater result from water-rock interactions and the dissolution processes of rocks as found in the Limpopo National Park (Barbieri, et al., 2019). This means groundwater associated with the older geological formations has a higher salinity than recent formations such as the alluvial aquifers. Based on the South African and Mozambiquan guidelines, selected boreholes across the area reflect higher salinity than what is nationally acceptable (indicated in red dots) – however, there are no particular "hotspots" in this regard since the distribution is scattered and not seemingly following any particular pattern.

[7] The data in the figures hereafter is a combination of observations/mapping in the field and data derived from databases provided by governance authorities.

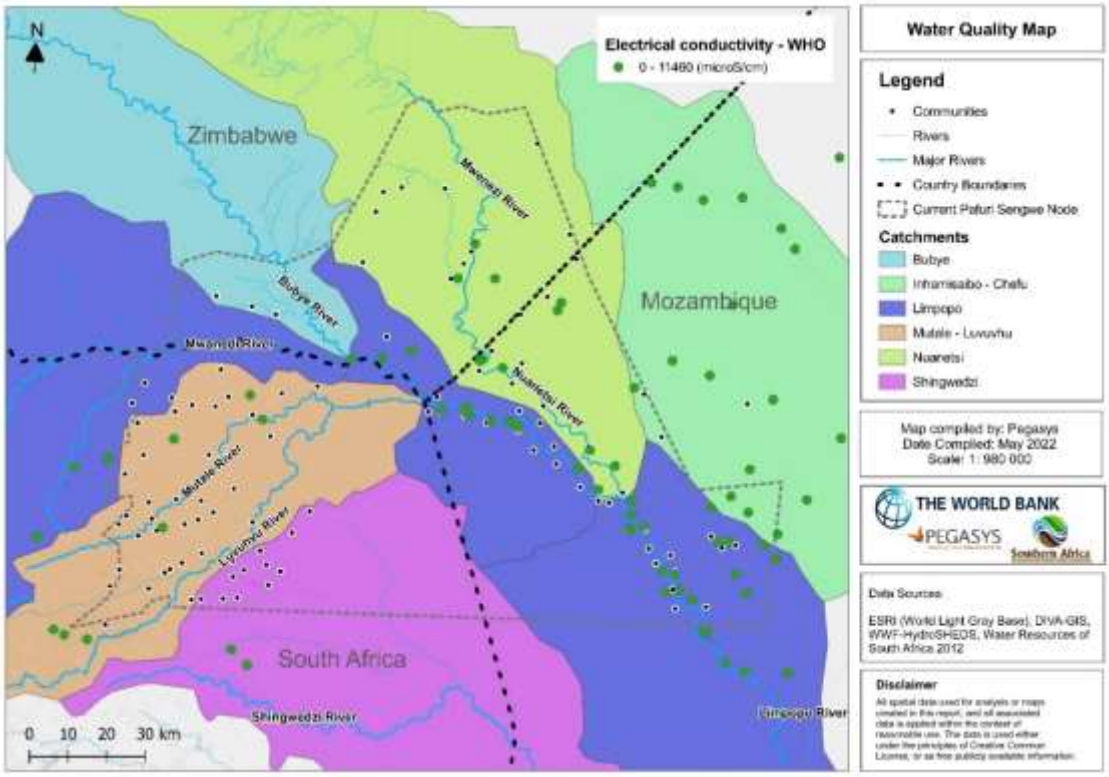

Figure 17: Water quality - electrical conductivity – against WHO guidelines

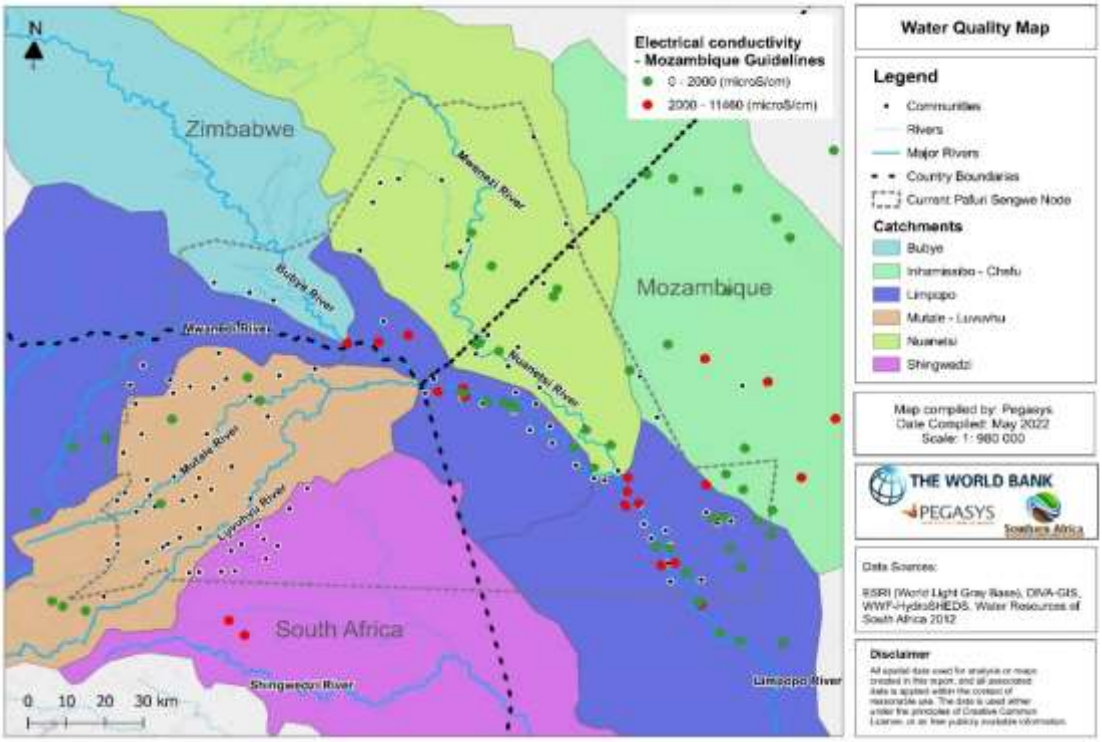

Figure 18: Water quality – electrical conductivity – against Mozambique guidelines

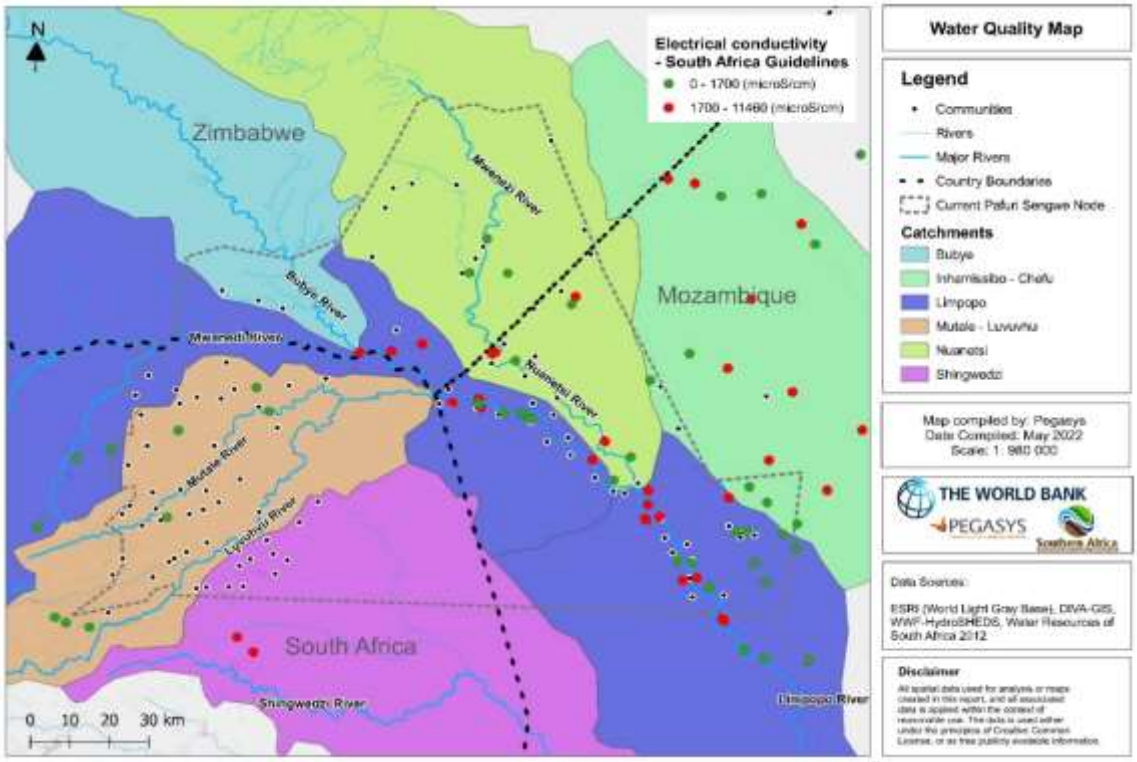

Figure 19: Water quality – electrical conductivity – against South African guidelines

4.3.2. Nitrates

Nitrate in groundwater concerns as concentrations greater than 3mg/L generally indicates contamination. The source of contamination in rural areas mainly relates to poor sanitation and animal waste (Netshiendeulu & Motebe, 2012). It is important to note that poorly constructed boreholes are a pathway for nitrate contamination.

Excessive levels of nitrates in groundwater and prolonged exposure are dangerous to humans, especially among infants and livestock. Anecdotal information indicates that ingesting polluted water with a nitrate (N) level exceeding 50mg/L is fatal for infants with pathogens, generally increasing the morbidity at lower nitrate levels (Tredoux, 2004). It is also highly likely that spontaneous abortion of foetuses may be linked to the ingestion of high nitrate water (Tredoux, 2004). Nitrates are a serious health concern which is consistently underreported.

The figures hereafter provide an overview of the latest nitrate concentration levels in the Pafuri-Sengwe Node against the exceedance of water quality guidelines. No measurements exceed the WHO guidelines of 50mg/L. Mozambique and Zimbabwe use the WHO water quality standard. However, several boreholes exceed, in this case, the South African water quality permissible limits for nitrate concentration levels of 11mg/L. This limit is set in South Africa due to the risks involved as methaemoglobinaemia may occur in infants - this condition leads to abnormal levels of oxygen in the blood. The are several boreholes that exceed this guideline. Unfortunately, there are no measurements of nitrates available in Mozambique and

Zimbabwe; however, it is expected that nitrate contamination is likely in these countries due to the reliance on unimproved sanitation systems.

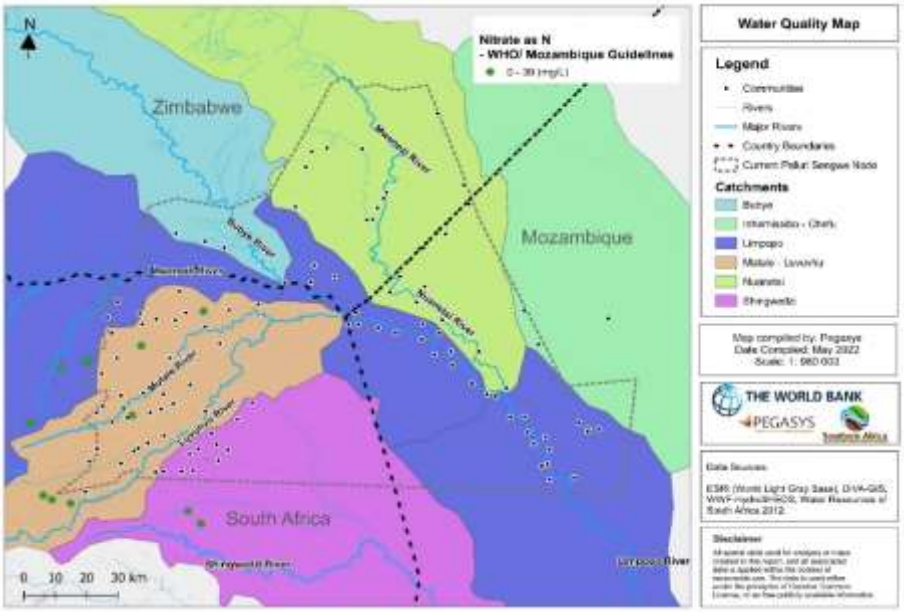

Figure 20: Water quality – nitrate – against WHO guidelines

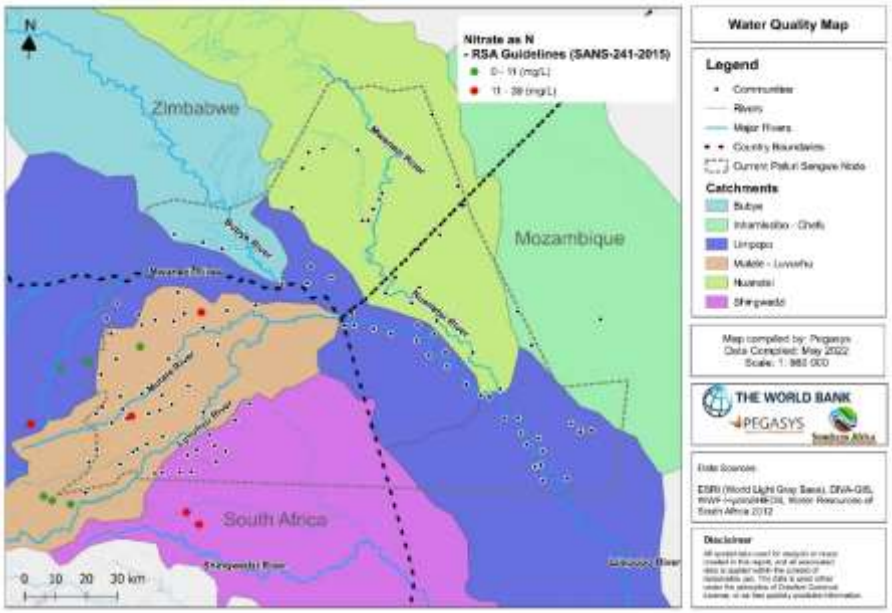

Figure 21: Water quality – nitrates against South African guidelines

Although the measurements are not precisely in the study area, the graph below shows the dynamic nature of nitrate pollution at a borehole in South Africa. The graph reveals an extreme pollution event in 2010, with nitrate concentration levels exceeding the WHO guidelines, likely from unimproved sanitation systems. The high nitrate concentration levels meant that communities were exposed to drinking water that was harmful to their health. The graph illustrates the need for continual measurements of water quality parameters such as nitrate.

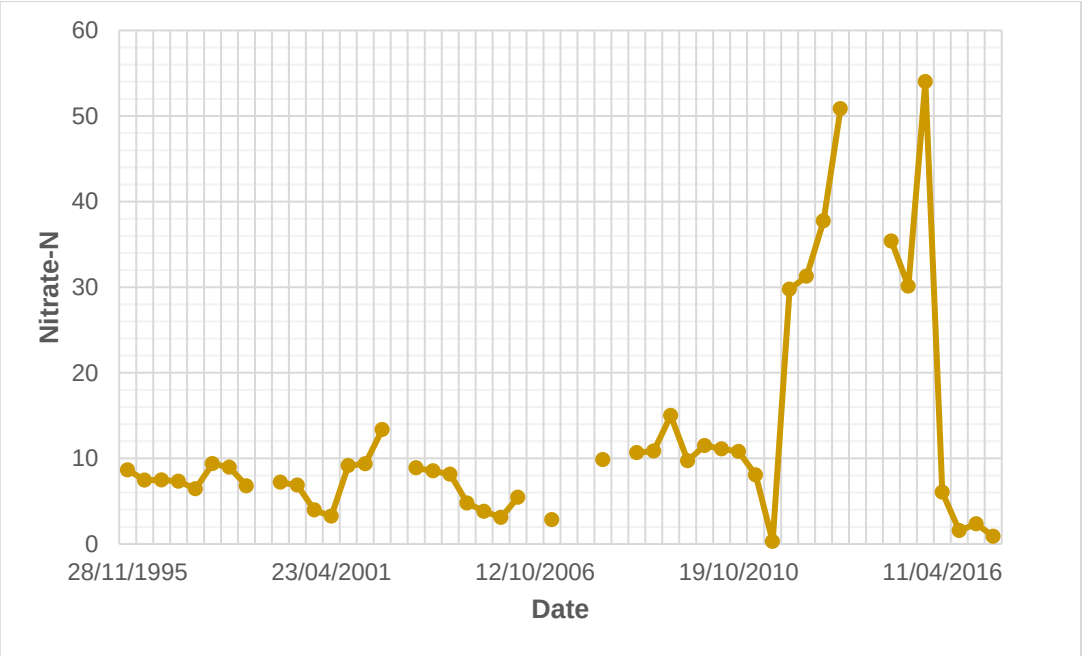

Figure 22: Nitrate contamination of groundwater at a borehole outside the Pafuri-Sengwe Node

The maximum nitrate measured was 54mg/L and 0mg/L minimum. The average nitrate concentration level was 7mg/L.

4.3.3. Fluoride

In drinking water, at higher concentrations, fluoride harms human health, causing fluorosis, ranging in severity from mild dental mottling to a crippling skeletal form. The Figure below provides an overview of the fluoride concentration levels in the Pafuri-Sengwe Node against the exceedance of water quality guidelines. No measurements in the Pafuri-Sengwe Node were found to exceed the WHO permissible limits for levels above 1.5mg/L for fluoride. Mozambique, South Africa and Zimbabwe have the same standard. Outside the study area, some cases exceed the water quality guidelines. The highest fluoride measure was 5.5mg/L with an average of 0.7mg/L.

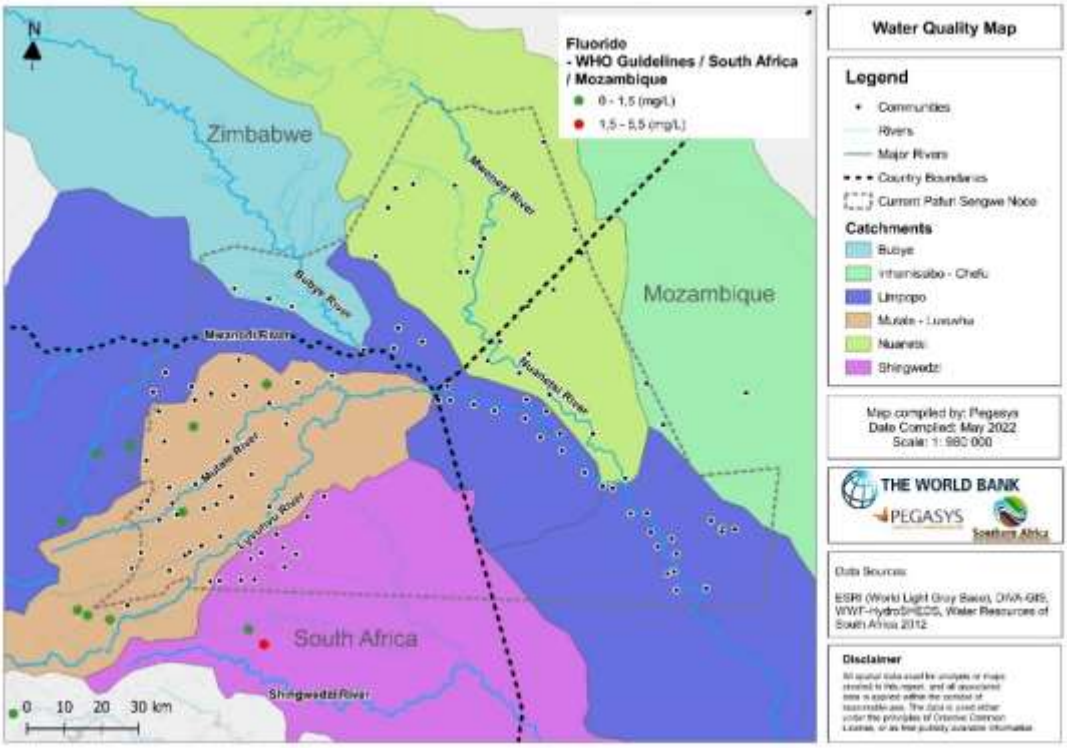

Figure 23: Water quality – fluoride – against WHO and country guidelines

4.4. Treatment options

In high salinity waters, as in Pafuri-Sengwe Node, the treatment process must remove the dissolved solids, of which reverse osmosis (RO) is the most common method of desalination. Removing nitrate from water requires treatment processes such as blending, ion exchange, electrodialysis, and RO. Advanced treatment techniques for nitrate removal rely on biological processes to convert nitrate to nitrogen gas, then released into the atmosphere. The treatment options for nitrate removal require operation and maintenance, and sometimes the best option is to abandon the water point and drill a new borehole away from the contamination source – this is not currently necessary in the Pafuri-Sengwe Node. The most common techniques used to remove fluoride from drinking water are precipitation, adsorption and ion exchange; membrane filtration processes; and distillation. Implementing water treatment solutions and technologies is complex and specific, requiring skilled operators.

The table below describes the most common treatment processes used to remove substances commonly found in groundwater and classifies the treatment process based on the treatment type and the relative cost of the treatment process. Conventional treatment includes flocculation, sedimentation, filtration, and disinfection conventionally used in municipal water treatment works. Advanced treatment describes the processes used to desalinate water and remove nitrates and fluoride. Water treatment is complex and specific, and appropriate treatment processes should always be designed with specialist knowledge. Conventional and advanced treatment processes require skilled operators, but more operator expertise is required for other processes involving chemical dosing and advanced treatment (SADC-GMI, 2020). The

communities in the Pafuri-Sengwe Node will be unable to recover the treatment costs, which may require government financial support.[8]

Table 9: Commonly used municipal treatment processes and associated relative cost and complexity

Determinant	Units	Most Common Municipal Treatment Processes	Treatment type	Treatment Cost
Electrical Conductivity	µS/m	Reverse osmosis or ion exchange, or electrodialysis	Advanced	High cost
Fluoride as F	mg/L	Activated Alumina	Additional to Conventional	Medium cost
Nitrate and nitrite as N	mg/L	Reverse osmosis or ion exchange, or electrodialysis	Advanced	High cost
Sodium as Na	mg/L	Reverse osmosis or ion exchange, or electrodialysis	Advanced	High cost
Sulphate as SO_4	mg/L	Precipitation with salts of Calcium, settlement and filtration Reverse Osmosis or ion exchange or electrodialysis	Additional to Conventional or Advanced	Medium cost OR high cost (depending on the treatment type)
Arsenic as As	mg/L	Flocculation, settlement and filtration	Conventional	Medium cost
Calcium as Ca	mg/L	Chemical precipitation and sedimentation	Additional to Conventional	Medium cost
Iron as Fe	mg/L	Oxidation, precipitation and filtration	Additional to Conventional	Medium cost
Magnesium as Mg	mg/L	Lime softening & re-carbonisation	Additional to Conventional	Medium cost

(Source: (SADC-GMI, 2020)).

There were no examples of water treatment taking place within the three areas of the Node. This is understandable because implementing the above treatment options is difficult at point sources such as hand pumps distributed throughout the Pafuri-Sengwe Node. The above water treatment processes must be done at a centralised point by skilled operators and reticulated to the water users. There are options at the household level to deal with microbiological and some chemical water quality parameters. Blending poorer water with better quality water is an option but can only be done in small amounts and is seasonal. Besides chlorination, solar disinfection options can be operated at the household level. Ultraviolet radiation from the sun destroys most pathogens and increasing the water's temperature enhances the radiation's effectiveness. Desalination by distillation produces water without chemical salts, which can be used at the household level. The method can be expensive because of the capital investment needed, and fuel/charcoal is used to heat the water. The volume of water produced is also low. Ultimately dealing with nitrates and fluoride must be done on a centralised level, requiring institutional support.

[8] Due to transportation, installation, production, maintenance and operating cost fluctuations, as well as exchange rate fluctuations, exact values cannot be quoted – however, basic internet and sector-wire searches for costs of these options are easily obtainable at the time that it would be considered.

4.5. Borehole Inventory

Groundwater use is predominantly for domestic water supply and community food gardens. The most common lifting technology is hand pumps in Mozambique and Zimbabwe, whilst in South Africa, there is extensive use of submersible pumps. The hand pump type in Mozambique is the *AfriDev*, and in Zimbabwe, the *Bush Pump*, as indicated in the figures below. In the absence of lifting devices, the communities use unprotected sources such as dug wells and the river.

The unprotected wells are only possible in areas with shallow groundwater (usually less than 5m below groundwater level) and are primarily dug in the alluvium of river water courses. The wells are typically equipped with ropes and buckets. The motivation for installing unprotected wells at household level is often due to the unreliability of the public water supply, distance from supply or water scarcity in times of surface water droughts but it can also be an economic decision where the cost of public water supply is high (SADC-GMI, 2020). The shallow wells are sometimes lined with brick or stone masonry, reinforced concrete rings, or mostly left unlined. The wells are susceptible to pollution, and due precautions such as construction of an apron around the well must be exercised. Shallow wells are relatively cheap to construct and maintain and should thus be considered an option where groundwater levels are shallow and sparsely populated areas (SADC-GMI, 2020). Risks to existing unprotected hand-dug wells can be mitigated by using proper construction measures. A hand pump is safer to lift groundwater instead of the traditional use of a rope and bucket (SADC-GMI-2020).

Government agencies or relief agencies tend to install the hand pumps in Mozambique and Zimbabwe, whilst in South Africa, municipalities perform water supply functions. In all three countries, there are examples of community food gardens that are watered with water from these pumps as well as through rain-fed practices, established with the support of cooperating partners.

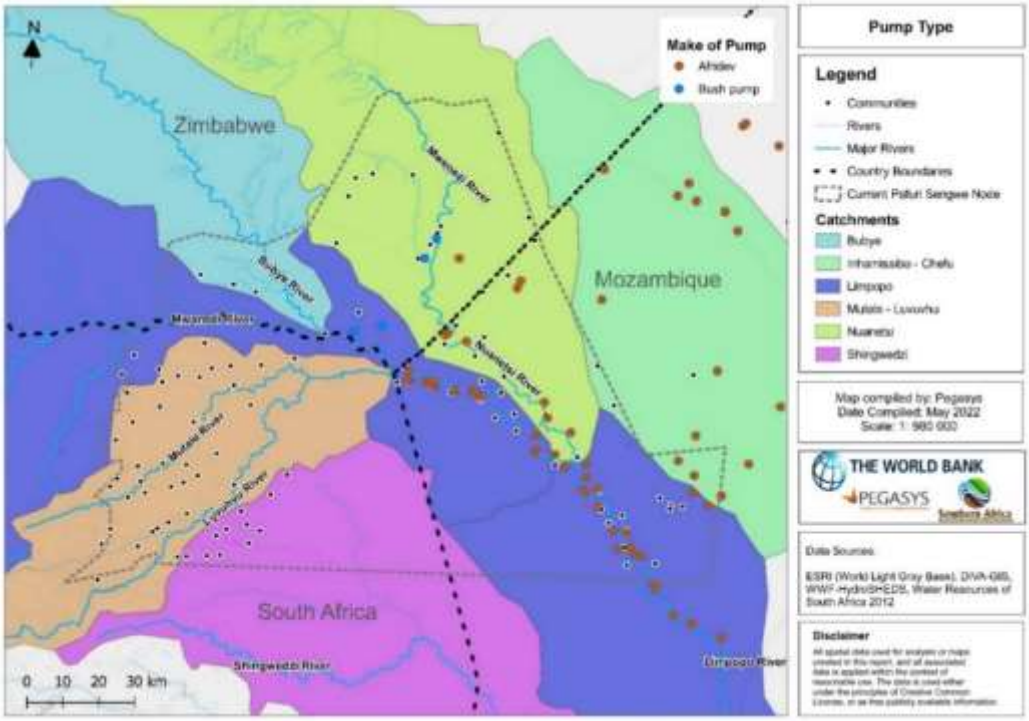

Figure 24: Pump types in and around the Pafuri-Sengwe Node

Figure 25: Borehole types and groundwater use (a) AfriDev hand pump used for community water supply in Mozambique (b) Zimbabwe Bush hand pump (c) dysfunctional hand pump in the vicinity of Malipati village (d) unprotected well used for domestic water supply in Mozambique (d) unprotected abstraction directly from the Limpopo River in Mozambique

Abstraction of groundwater through unprotected wells occurs where hand pumps are absent, distant or not operational. The risks associated with such unsafe sources are

pathogens and nitrate contamination above permissible limits. Cholera outbreaks are a common occurrence where untreated water is consumed causing acute diarrhoea and, left untreated, death. Mitigation of groundwater contamination begins with proper construction to minimize pollution and disinfection of any water meant for consumption.

The *AfriDev* (Hand) Pump is most common throughout Southern Africa. This pump lifts water from depths ranging from only 15–45m, which might be the reason why some boreholes produce more saline water (whereas the Zimbabwe Bush Pump can lift water from a depth of up to 80m, where water may potentially be less saline in nature). The status of the boreholes is given in the Figure below. Groundwater use is predominantly for domestic water supply and community gardens.

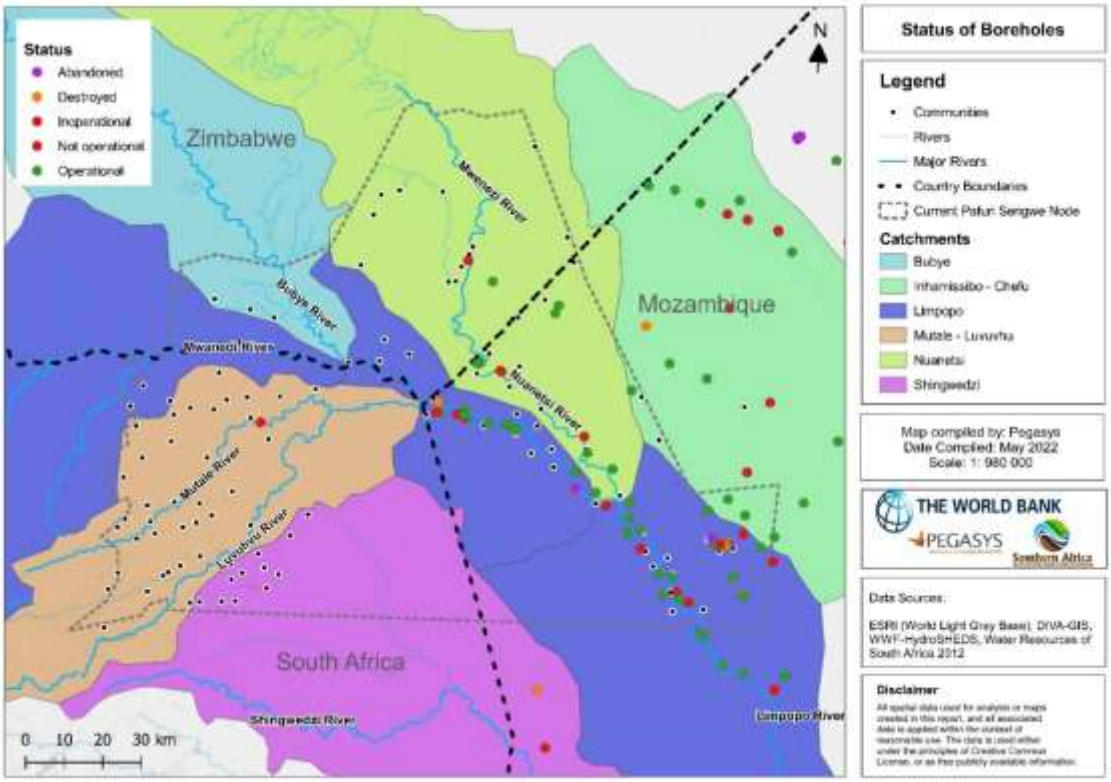

Figure 26: Status of boreholes in and around the Pafuri-Sengwe Node

Generally, there is a lack of financial resources at government levels in the Node, to allocate sufficient budgets for water infrastructure, and most rural communities, such as in the Pafuri-Sengwe Node, lack the means to pay for the operation and maintenance of groundwater infrastructure. Easy and affordable access to spare parts is crucial in maintaining a groundwater scheme. Through discussions in Mozambique, community members noted that collecting fees to cover maintenance costs is routine. The closure of borders during the COVID-19 pandemic affected the procurement of spare parts, resulting in the inability to repair dysfunctional boreholes.

In Mozambique and Zimbabwe, communities manage the groundwater infrastructure, following a community-based management approach that promotes community involvement. In South Africa, municipalities manage groundwater schemes. The centralised management results in intermittent water supply leading to more affluent

households developing self-supply systems. In Zimbabwe and Mozambique, communities on alluvial aquifers dug wells on their properties for self-supply. In a community meeting, a female participant noted that the high-salinity waters affected food taste, requiring water-fetching at a great distance to please the household men. The reliance on women and girls for water collection is common throughout the region. The role of informal institutions and customs in the Node requires recognition within formal management institutions to ensure the promotion and support of gender equality and social inclusion.

5. DROUGHT PREPAREDNESS AND DROUGHT MITIGATION

5.1. Overview

Droughts are one of the main constraints affecting food security and livelihoods in southern Africa. It is estimated that approximately one-third of the people in the Southern African Development Community (SADC) region live in drought prone areas, causing substantial impacts on local livelihoods, public health, land degradation, loss in biodiversity, and ecosystem degradation. Drought is one of the main constraints to crop and livestock production in the region, threatens agriculture-based communities. Over the past 30 years, rainfall has been declining in Sub-Saharan and southern African drylands (60% of the total land area of Africa), with the frequency of drought increasing because of climate change. The region has seen the rise of mega-droughts, which are prolonged and particularly severe droughts lasting two decades or longer[9].

Several southern African countries lack an objective forecast-based early warning and response mechanism that enables drought preparedness and response capacity. This result in support to water and food insecure households being late and insufficient. Ex-post reactive responses, coupled with the lack of drought readiness and preparedness, often ends up with measures prioritizing saving lives over protecting livelihoods and building resilience at the household and local community level[10].

Mozambique. Mozambique is one of the countries in the SADC region most affected by natural hazards including drought, which tend to occur every 3 to 4 years. The country is also vulnerable to other natural hazards such as floods, cyclones, coastal erosion, and rising sea levels. El Niño conditions in 2015–2016 caused the worst drought in 35 years, impacting severely on food availability. The situation worsened in 2017 with Cyclone Dineo making a landfall near Inhambane, Southern Mozambique. Cyclone Dineo damaged crops and destroyed infrastructure, especially in Gaza and Inhambane provinces where about 137,784 people were affected and exposed to intense food insecurity. The Chicualacua district was one of the districts most affected by drought in Gaza province[11].

South Africa. South Africa is a water-scarce country and one of the 30 driest countries in the world, experiencing a growing frequency of droughts partly triggered by El Niño Southern Oscillation (ENSO). This had a direct impact on agriculture and food production, including on food prices such staple food items. Lower agricultural

[9] World Bank (2021). Southern Africa Drought Resilience Initiative (SADRI): Zimbabwe Drought Profile. Washington, DC.
[10] Ditto.
[11] World Bank (2021). Southern Africa Drought Resilience Initiative (SADRI): Mozambique Drought Profile. Washington, DC.

production also affected food supplies, which in turn increased food prices and food insecurity[12].

Zimbabwe. Zimbabwe is one of the world's most drought-prone countries, experiencing frequent and severe droughts. The country also faces numerous development challenges that exacerbate its vulnerability to drought, including high levels of food insecurity and competition over scarce resources. The poor rainfall season in 2019-2020 resulted in a delayed harvest, and reduced water availability for livestock and households. High prices of food items and other basic commodities resulted in many rural household's not being able to purchase food, relying on external assistance and social networks for food supply. This has also impacted on labour opportunities, resulting in an increase in labour migration to South Africa and other SADC countries. Zimbabwe is also prone to mid-season droughts, even in a rainy season (non-drought years). This is one of the most critical challenges for smallholder farmers who practise and rely on rain-fed agriculture[13].

5.2. Drought Interventions and Preparedness

Droughts are a climatic events that occur in cycles and cannot be prevented. However, drought preparedness and drought mitigation interventions can help local communities prepare to better cope with droughts. These include the following[14]:

(i) Improve preparedness to cope with drought;
(ii) Improve ecosystems functionality and resilience;
(iii) Improve resilience to recover from drought;
(iv) Mitigate the negative impacts of drought.

Preparedness strategies to drought include the following[15]:

(i) Geographical shifts of agricultural systems;
(ii) Climate-proofing rainfall-based systems;
(iii) Making irrigated systems for efficient;
(iv) Expanding the role of intermediate rain-fed systems.

A proactive approach is needed to prepare for drought events, as droughts will continue to hit vulnerable populations. The collective way in which society lives, trades, travels, uses resources and generates waste has consequences for biodiversity, ecosystems, and the services these provide to support human wellbeing and livelihoods. Increases in human population, unsustainable economic growth, and unsustainable resource management practices are placing additional stress on the natural resource base, resulting in water depletion, deforestation, erosion, land degradation and desertification. Climate change compounds these and adds its own

[12] World Bank (2021). Southern Africa Drought Resilience Initiative (SADRI): South Africa Drought Profile. Washington, DC.
[13] World Bank (2021). Southern Africa Drought Resilience Initiative (SADRI): Zimbabwe Drought Profile. Washington, DC.
[14] M. Solhn, M van Ginkel (2014). Drought preparedness and drought mitigation in the developing world's drylands.
[15] Ditto.

unique impact, including through its contribution to more frequent and extreme droughts and floods, increase in the frequency and extremes of high temperatures and changes in rainfall patterns. The following table presents the main approached to drought management.

Table 10: Approaches to drought management[16]

Approaches	What	Costs
Reactive Drought Response ⇒ **Relief** ⇒ Reduction of vulnerability*	Assistance to vulnerable populations: water, food, health care Water infrastructure: wells, aqueducts, dams, irrigation, water distribution	During droughts Triggered during droughts
Proactive drought policies and planning: ⇒ Readiness and relief ⇒ Reduction of vulnerability* ⇒ Sustainable development	Preparedness or contingency plans, programmes; drought policy institutions Hydraulic infrastructure: wells, aqueducts, dams, irrigation, water and sanitation systems Proactive drought policies as part of sustainable development planning: integrated water resources management; environmental policy; drought and environment as part of sectoral and regional policies; institutional development and capacity building; participation and civil society role	Continuing Continuing, especially in non-drought years Continuing

*** Even** reactive responses to drought include some measures that may result in less (or greater) future vulnerability. Many dam constructions have been undertaken in response to specific drought episodes. Proactive drought management also includes actions taken during drought.

5.3. Interventions to Support Drought Preparedness and Drought Mitigation in the Pafuri-Sengwe Node

Potential interventions to improved drought preparedness and drought mitigation in the Pafuri-Sengwe Node could include the following:

- **Strengthening transboundary governance, including policy harmonisation, data and information management, and learning and knowledge sharing.** This include the strengthening current institutional arrangements for the Node, development of data sharing agreements, and sharing information on approaches for management of ecosystem services, water resources, terrestrial resources, and land-use.
- **Improve the management of Protected Areas through the inclusion of climate change adaptation strategies** in protected area management plans, including an understanding of the management and operational costs implications of managing these areas under the three climate change scenarios.
- **Implementing a natural resource management approach in range land restoration** to build partnerships in support of ecosystems and socio-economic resilience, improved range land management, job creation, sustainable financing, and Ecosystems-based Adaptation. This also the

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development and implementation of biodiversity stewardship / conservation agreements with communal and private sector land-owners, and development of framework to support investment in conservation.

- **Support investment in natural capital and nature-based solutions** as a cost-effective approach to ecosystems management, disaster risk reduction, and climate change mitigation.
- **Improving disaster and risk management preparedness and coordination** between disaster management offices, protected area management entities, businesses and host communities. There should also be improved provision of climate information to the agricultural and tourism sectors through cooperation with national meteorological services to facilitate climate-response preparedness.
- **Building more resilient and diverse biodiversity economies** through the development and implementation of partnerships to support more diverse and resilient biodiversity economies in rural landscapes adjoining protected areas, providing for a range nature-based financing and income generating opportunities.
- **Mainstream climate change adaptation and sustainable development in the agriculture and nature-based tourism industries** through implementation of climate mitigation actions, which include but are not limited to sustainable land management and restoration, water-wise agricultural practices, implementation of agro-ecological practices, reducing carbon footprint of tourism-related transportation, facilities and services; climate-friendly design and building guidelines for tourism accommodation, park recreation and other tourism-related facilities and services.
- **Support the implementation of a systematic / systemic approach to biodiversity baseline and eco-system inventories** to monitor, assess and respond effectively to existing anthropogenic pressures together with the additional pressures that climate change presents.
- **Support the development and implementation of a sustainable innovative finance framework** to support investment to build climate resilience and adaptation. This should include Financing sustainable tourism and climate adaptation is a critical component of implementation. A first step would be to identify potential funding sources for climate change adaptation for the tourism sector.

6. RECOMMENDATIONS

6.1. Proposed repositioning of the Pafuri-Sengwe Node boundary

The original Nodal boundary was delineated during the GLTFCA Integrated Livelihoods Diversification Strategy (GLTFCA, 2016) process. This boundary partly follows ecological delineations such as catchment boundaries, and partly applies existing infrastructure such as railway lines to define some of the boundary lines. Following the completion of this project and the in-field missions conducted, it is recommended that the boundary be reconsidered to follow natural catchment boundaries. The reason for this is due to the location of villages and wetlands in that region of the Node. The wetlands, in particular, extend significantly outside of the existing linear boundary and it will be best suited if a large component of the wetlands in that area is included in the Node boundary in order to support effective natural resources management and Ecological Goods and Services (EG&S) provision across the Node.

Effectively managing and protecting wetlands requires management of the land uses both within and around the wetlands, as well as the water which feeds them and maintains their essential character (Dickens, et al., 2003). Without water, wetlands would not exist and without healthy, functional wetlands, the flow patterns and quality of water in a catchment can be greatly affected. Therefore, for effective wetland management to occur, the drivers of the wetland must be managed and protected. The way to achieve this is to manage the catchments that feed into the focal wetlands. In this context, it is proposed that the boundary of the Pafuri-Sengwe Node should be adjusted to rather focus on the entirety of the catchments of the focal wetlands, rather than the current approach of following existing infrastructure, for example, a railway line which cuts through the wetland's catchment. The Figure below indicates the proposed additional catchment areas to be included in Mozambique and Zimbabwe, as well as proposed Node boundary adjustments for discussion purposes. Following the above, it is proposed that the repositioning the Pafuri-Sengwe Node boundary be presented to the GLTFCA Pafuri-Sengwe Joint Park Management Committee for further discussions and approval.

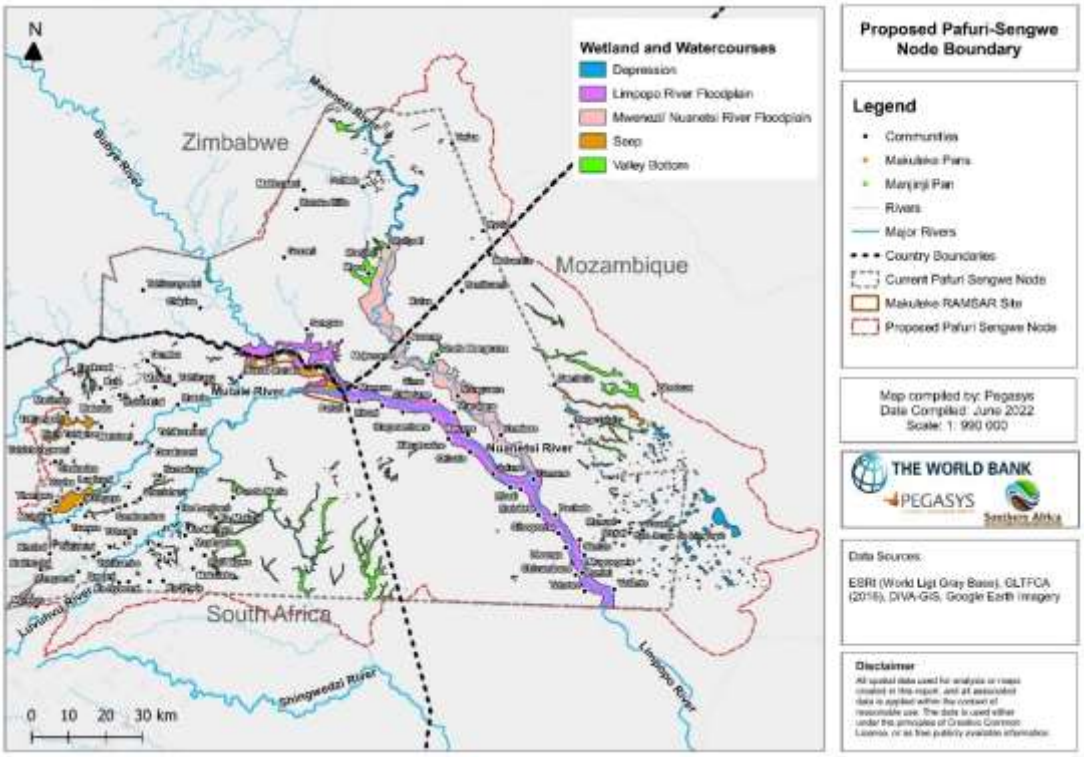

Figure 27: Proposed amendment of the Pafuri-Sengwe Node Boundary

6.2. Proposed Wetland Management Strategies

Managing wetlands such that both wetland conservation and human needs are serviced requires strategies that target drivers of wetland degradation. The following focus areas are key to consider when developing an effective and sustainable wetland management programme tailored to the local environment.

Figure 28: Framework indicating strategies and actions for sustainable wetland management

The recommendations on specific interventions and investment needs are elaborated on in Chapter 6, where specific strategy elements are indicated per country, per recommended intervention.

Policy and legislation: Despite the regulations at a national level in Mozambique, South Africa, and Zimbabwe, wetland management occurs at a local level. The local level is therefore the most logical entry point for effective and sustainable wetland management. At present, the policy and legislative environment and the penalties for cultivating in wetlands are not sufficiently deterrent, and this results in the continued use of wetlands in prohibited ways. This may be attributed to a general lack of awareness and education, on a community-level, about the stipulations and implications of key relevant policies and legislation on livelihoods activities.

Facilitation of climate-smart agricultural use around wetlands: Agriculture in and around wetlands can lead to degradation, including wetland drainage, soil depletion and soil erosion. Crop selection and consideration of drought-resistant varieties is very important. Zimbabwe, in particular, acknowledges through its policies and guidelines that not all crops are compatible with wetlands. Cultivating dryland crops in wetlands requires that the wetlands be drained. In South Africa most wetland loss is due to current and legacy agricultural activities that are incompatible with a healthy wetland. If wetlands are properly managed, cultivation and crop production are excluded within wetlands, degraded wetlands are rehabilitated to improve their functionality, appropriate buffers are maintained between wetland and crop production fields, the sustainability of these systems will be maintained and, at the same time, those systems will be able to provide water for the community for drinking and irrigating crops for a longer time ensuring greater resilience during drought.

Agricultural extension services can play an important role in guiding farmers on suitable crops to use in proximity of wetlands, including farming techniques to maximise return on investment while limiting unnecessary environmental damage. Awareness raising is also an important part of sustainable wetland management. Educating communities on the risks of degradation from unsustainable agriculture bett4er positions them to play an active role in sustainable landscape management.

Livelihood diversification: Where a household or community is wholly dependent upon natural resources (subsistence farming and fishing, water sourced from a river, pan or borehole) they are especially vulnerable during a drought. When income reduces, for example during drought conditions, households are likely to take costly decisions to cope (i.e., taking children out of school; selling productive farm assets, etc.). These coping strategies have compounding costs: when reducing education opportunities, future learning trajectories and employment may be curbed. When selling productive assets to farm, future farming operations are hampered and production potential is reduced. The likelihood of falling into poverty increases.

Increasing off-farm income and employment opportunities has a double dividend effect of simultaneously improving the economic well-being of households and enhancing wetland conservation through the reduced intensity of use. The investment opportunity is indeed more nuanced than this: the motivation is based on the need to support communities toward increasing resilience and by extension their economic well-being – at its root it is not merely focussed on enhancing wetland conservation. Especially in

Mozambique there is a need to reduce and, if possible, cease subsistence farming in wetlands. To do so, it is necessary to diversify people's livelihoods away from dependence on the wetland. Identifying new markets for off-farm income (such as brick-making), investing in ecotourism (in wetlands with high biodiversity levels), and integrating wetland management into broader rural development programs are opportunities. The hierarchy of available opportunities for wetland use is presented in Chapter 6. the conclusion, and identifies various areas where opportunities exist for conservation, and wise use of wetlands.

Livelihood diversification can be supported through increased investment in rural infrastructure, downstream value chains, health and education, especially on the value of in-tact wetlands and alternative livelihood options. Wetland protection, conservation and management are a collective responsibility guided by country-based legislation, policies and guidelines for their protection, management and sustainable use. These initiatives are often implemented through partnerships between government, local communities, the private sector, and donors / funders. In support of livelihood diversification, the emphasis should be on assisting countries/communities with the following:

- Identification of viable and feasible livelihood options that do not impinge on the sustainable use of wetland areas;
- Demarcating appropriate land outside wetland areas for cultivation or other feasible and sustainable livelihoods activities;
- Awareness raising, capacity building and skills development, and where appropriate resourcing of key development needs such as infrastructure; and
- Providing technical support for better and more climate-friendly agriculture options, such as soil assessments, identification of suitable crops based on land capability, and crop rotations.

There is a significant role to be played by the private sector – especially SMMEs. There are opportunities for small-scale transboundary and local support to farmers and communities to enhance their ability to maintain their water resources infrastructure locally, while also enabling the economic growth in the area to shift away from purely livelihood and subsistence-based modes. The need in this regard is to fill skills gaps in entrepreneurship and business development, use and application of water and agriculture infrastructure and technologies, as well as building capacity at community-level to act on these options and have a good baseline understanding of the opportunities related to a change in focus and adoption of potential external (private sector) offerings as well as new technologies.

There are various courses offered for different audiences in Southern Africa, for example, Provincial wetland forums in South Africa run wetland basics courses which include NGOs who are involved in environmental education (e.g. WESSA, and the South African Weather Services (SAWS)). Technical courses run by tertiary institutions deal more with sciences i.e., sustainable utilisation of wetlands, assessment tools, rehabilitation tools, planning. These institutions include, for example, the University of Free State, University of Pretoria, Rhodes University and other CETA registered consultants (in the case of South Africa). Bursaries are available for scholars and it is advisable that secondary school youngsters are made aware of these opportunities –

which could both enable them to enhance their skills, but at the same time enable local communities in the Pafuri-Sengwe Node to benefit from the offerings that do exist outside of direct government-funded and donor-enabled support.

It is recognised that government investment is not always feasible as envisaged, and that the allocation of resources from partners and donors (other than the government) often seem to reduce the impetus for government to engage. This practice of constant external enabling mechanisms provides short-term relief and may enable some private sector growth, but reduces the focus on the mandated role of government to provide basic services and infrastructure. Without It remains critical that rural infrastructure that would make a real difference (e.g. roads to better connect communities and markets) are supported through governmental developmental programmes and civil works. In addition, the development and maintenance of the value chain that enables rural communities to have an improved offset market of locally produced goods is important to support from a governmental perspective.

In addition to the infrastructure and value chain support, it would be necessary for ministerial-level consideration of the need to enhance ease and efficiency of border crossings between all three countries. Enabling formal crossings (over illegal informal crossings) and promoting service and goods offerings and market access across borders would enable significant opportunity for local economic growth, stability and diversification of livelihoods.

Reducing wetland dependence: Strategies that reduce dependence on wetlands, such as investment in water harvesting and storage, efficient irrigation methods, promoting the use of drought-tolerant crops and diversifying out of agriculture should be promoted.

Capacity building: At a wetland management level, capacity development for the management of natural resources remains an issue in Southern Africa. It is recommended that a capacity-building program focuses more specifically on the practicalities of assessing and monitoring wetlands across the Limpopo basin with an emphasis on approaches that can be readily undertaken and provide early warning of possible adverse change. This program could include training and awareness-raising components based on user needs related to inventory, assessment and monitoring and how to consider wetland issues at multiple scales from local site to basin-wide.

In summary, efforts to improve wetland management should integrate awareness, capacity building and programs aimed at supporting alternative livelihood avenues to enable the poor to diversify into non-resource-based livelihood activities. This should be linked with broader rural development programs such as the introduction of improved agricultural technologies, investment in irrigation infrastructure.

7. INVESTMENT NEEDS

7.1. Principles underpinning the recommendations

This chapter provides interventions identified in close collaboration with communities and stakeholders from the Pafuri-Sengwe Node to minimize the negative impact of drought on livelihoods.

Recommendations are presented as short- (current to 1 year), medium- (years 2-5), and long-term (years 5-15) and focus on the most prominent investments options that can be practically implemented in the Node. The time frames for short, medium and long term align with that of the GLTFCA Livelihoods Strategy (GLTFCA, 2016). Recommended investment interventions support the strengthening of wetland and aquifer conservation and their improved sustainable utilisation, as well as utilisation in support of drought resilience at community level. They furthermore support SADRI's strategic initiative, which aim to foster integrated drought risk management across the energy-water-food-environment nexus and help lay the foundations for increased resilience in Southern African countries to the multi-sectoral impacts of drought.

The recommendations include those that related to Member State policy and regulatory approaches, that to a large extent would be directed or at least guided and determined through international agreements at Member State governance level, as well as through internal amendment of Member State policies and approaches.

When projects are planned and implemented over short term cycles, it is often difficult to align them with long term aims where lasting change and sustainability is sought. Some opportunities presented below may require governance and institutional arrangements that take longer to either put in place formally, or to develop efficient institutional alignment to ensure sustainability and recognition of the investments into the medium and long term.

In addition, when livelihood pressures are exacerbated by recurring and multiple occurring impacts of hazards such as drought, fire and/or floods, the cycle of livelihood vulnerability is especially difficult to break. It is therefore important that short, medium and long-term investments are identified that align with each other and build on each other, and that can be drawn on when humanitarian support is made available - even during short term response times and times of crises

7.2. Recommendations on a framework guiding investment approaches[17]

The Figure below showcases a Framework within which the investments that are detailed in the tabulated section below that, is situated. This follows the GLTFCA ILDS, where the sustainable provision of ecosystem services were viewed as the foundation

[17] It is beyond the scope of this report to define how exactly recommendations could or should be financed and implemented. However, to attract financing, and investment framework that identifies potential funding mechanisms and clarifies the roles of institutions, would be useful.

for local community livelihoods. The investments are presented as “pillars”, which are based on the understanding that key foundational elements are either already in place or would be addressed during the implementation of any activity that falls within the wetland, groundwater or livelihood intervention spheres. Although these “pillars” appear as separate elements in the framework, they are interlinked and therefore interventions in either element need to consider the ecosystem services and their fundamental role in sustaining local community livelihoods. This linkage is recognised in the GLTFCA Integrated Livelihoods Diversification Strategy which noted the water security, woodland and grassland management initiatives while support the development of local economies (GLTFCA, 2016).

The basis of the framework consists of the critically important transboundary nature of investments that form the basis of wetland and aquifer management, surface and ground water utilisation, and governance interventions. Along with this the base also include alignment across all the programmes, projects and interventions, so as to **schedule it effectively to improve impact as well as reduce stakeholder fatigue**– especially on the ground within villages. **Awareness, capacity development and training would of course need to be part and parcel of all interventions**.

The basis of the structure – i.e. awareness, capacity, alignment and cooperative approaches - is consolidated to ultimately building Livelihood resilience. Finally, all the **data, information and knowledge that is generated within and through programmes, as well as copies of all knowledge products and reports, would need to be collated and maintained in a suitable geospatially enabled datab**ase – that in turn again serve the structures below it.

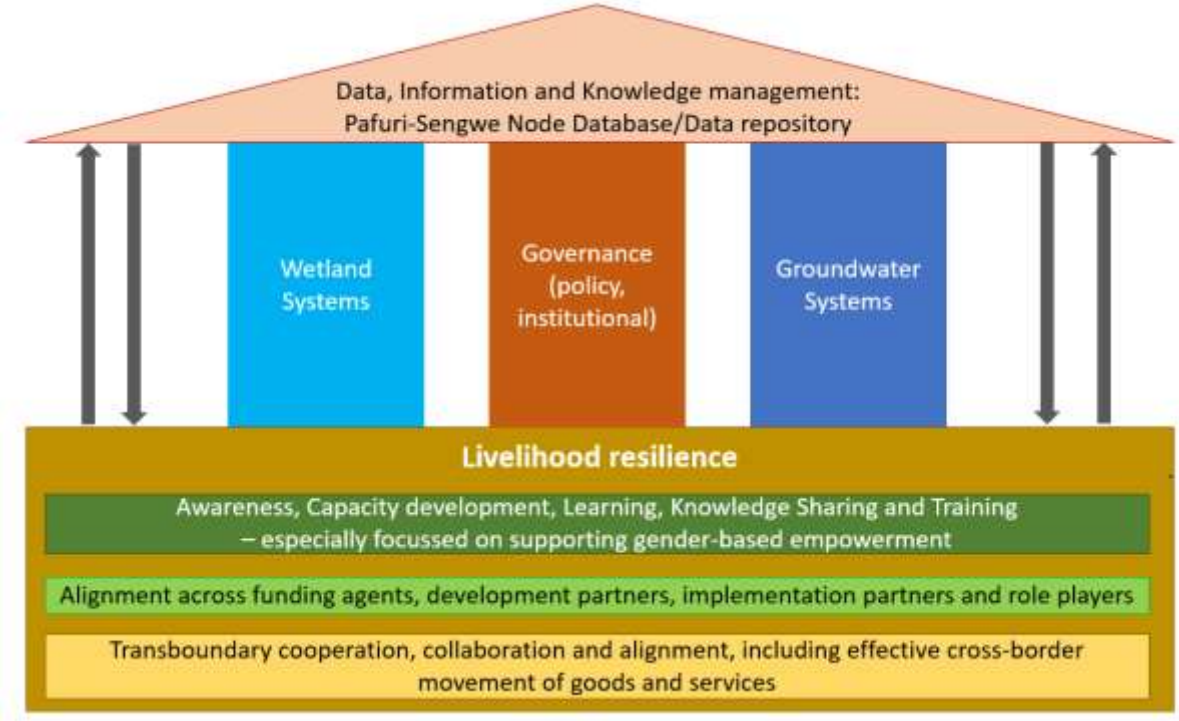

Figure 29: Pafuri-Sengwe Node Investments needs Framework

7.3. Approach to the implementation of investments

Interventions should be facilitated by the GLTFCA, lead departments / ministries in the Partner Countries, in consultation with the other relevant national departments / ministries and governance structures as necessary. The three GLTFCA Partner Countries have confirmed the GLTFCA's mandate to support and facilitate the process of transboundary management in the Pafuri-Sengwe Node through GLTFCA Joint Management Board, the Pafuri-Sengwe Joint Park Management Committee, and the respective Implementing Agencies, and the lead ministries / departments in each of the Partner Countries. The implementation of key related investments and initiatives are usually facilitated through collaboration between the GLTFCA and its key partners such as Development Finance Institutions (DFIs), NGOs, Community-Based Organisations (CBOs), and the like. The GLTFCA has also established a Funding Partners Forum to further facilitate these types of discussions.

Ensure alignment among implementing actors to reduce stakeholder fatigue. Across the Pafuri-Sengwe Node including Zimbabwe and South Africa, but especially in Mozambique, development often happens at local level within the ambit of local administrative mechanisms. It is therefore important that projects that have different implementing agents and follow different governance and institutional structures prioritize alignment in their work, and especially in their engagement of stakeholders. This includes alignment with projects that are not Pafuri-Sengwe Node specific, for example projects driven through, for example, ARA-Sul, ZINWA or the Limpopo Economic Development, Environment and Tourism (LEDET). Ultimately, it is necessary to approach projects differently to break the cycle of being locked into short-term and piece-meal interventions that have no linkage onto longer term and sustainable projects and programmes. The GLTFCA can play a key coordinating and convening role, taking the lead on these processes and guiding their implementation.

A balance is needed between on-the-ground investments to address current urgent needs, and medium to long term interventions. Livelihoods is a cross-cutting intervention element. Support for livelihoods are directly linked to the need for strong leadership and effective collaboration and cooperation across the geographical extent of the Pafuri-Sengwe Node and beyond. To enact this, it is recommended that a Node co-ordinator role be established, which would enable a single point of contact through which programmes and projects can be aligned and coordinated.

7.4. Data, Information and Knowledge Systems

Dedicated data sharing agreements should be in place. In the short term, data, information and knowledge management can be improved with informal data sharing agreements. In the longer term, a digital geo-spatially enabled decision support system (DSS) is needed. It should be supported by a management entity and dedicated data sharing agreements.

A public information management system, database or portal is required. Such a system would capture all interventions in the Pafuri-Sengwe Node. Such a system should also capture raw data (e.g. water quality, attribute data) and geospatial data,

that is maintained and updated. The database would serve not only to provide the latest updated data and information in and for the Node, but also support reduction in duplication and improvement in integration, alignment and co-operation between partners, projects, stakeholders, and communities. In reality this needs to run in parallel with on the ground investments to address current critical needs while building up the database of knowledge that future projects can draw on.

Funding for such an investment and the management thereof should ideally be channelled through an existing platform or organisation with existing capacity to support its maintenance into the future. There are options in this regard, and recent discussions with stakeholders indicate that there may be an opportunity to align the data management and data sharing with the LIMCOM and PPF work that has been done to date. There is also the existing database related to the Makuleke Management Plan, which may serve as the basis for such a DSS. The way forward in this regard, however, remains to be further explored in the future, after completion of this project. The importance – regardless of which decision is agreed to in this regard in the end, is that this should be coordinated through the proposed Nodal coordinating position/office, to support transboundary and transparent sharing of data and information across and for the Node.

Share information on approaches for management of ecosystem services, water resources, terrestrial resources, and land-use. Opportunities related to information sharing stem particularly from extensive work undertaken in South Africa on wetlands and freshwater ecosystems – however, it is not limited to these biodiversity focus areas nor the geographical extent of the work done to date. As an example, the RESILIM Investment Strategy identifies key opportunities that are relevant to wetland ecosystems, which include, amongst others, investments in ecological infrastructure as opposed to only hard infrastructure . Here readily available data can help determine the positioning and placement of biological or ecologically sensitive flood attenuation structures, as opposed to concrete/brick-and-mortar structures to mitigate riverine floods.

Standardise water resources management data and develop and promote a basin-wide data-sharing protocol in order to improve coordinated transboundary management of basin water resources. Specific focus areas should include wetlands, the promotion of equitable access to and sustainable use of wetlands, and conjunctive ground water use. This needs to be done at all levels – Member State governance structures and operations should support the collection and sharing of harmonised data across the Node, while role players and stakeholders engaged outside of the governance sphere also has to confirm that the data that they may collect and share could easily be harmonised into the data sharing process. LIMCOM, as RBO, also has an important role to play in this regard, since at RBO level there are usually already data sharing processes and agreements in place between Partner Countries of the RBO – thus enabling the ease of harmonisation between countries.

7.5. Wetland Investments

The section below provides recommendations for wetland investments to build community drought resilience while at the same time supporting wetland integrity and conservation. The objectives of the investment to wetland related projects can be categorised as follows (Table 10):

Table 11: Objectives of investing in wetland management related projects

Country	Objectives
Transboundary	Improve and strengthen transboundary management of wetland ecosystems, including protection of, avoidance of, and ecologically sensitive utilisation of wetlands for agricultural and livestock feeding purposes.
Country-level: • Mozambique • South Africa • Zimbabwe	Wise use and protection of wetlands in a manner that maximises employment creation (job creation and poverty alleviation), supports small businesses and cooperatives and transfers relevant and marketable skills to local communities. These can be summaries as follow: • Wetland Protection, Wise Use and Rehabilitation, • Skills and Capacity Development, • Knowledge Sharing, and • Communication, Education and Public Awareness. Benefits accruing from healthy and well-managed wetlands: • Improved livelihoods, • Protection of agricultural resources, • Enhanced biodiversity, • Cleaner water, • Reduced impacts from flooding, and • Sustained base flows in rivers.

The table hereafter provides the recommendations categorised as short, medium, long term to support wetland investments that lead to building community drought resilience:

Table 12: Recommended Wetland Investment Opportunities

Country	Short Term	Medium Term	Long Term
Transboundary	**Recommendations:**		
	• Develop wetland inventory, standardise wetland inventory data requirements and enforce basin-wide data sharing protocol. • Sharing information and creating awareness, as well as building awareness in communities on ecologically sensitive and sustainable use of wetlands. • Dedicated data sharing agreements should be in place. In the short term, data, information and knowledge management can be improved with informal data sharing agreements. • Assess the impact of the proposed Musina Dam on the integrity and functionality of the Limpopo River wetland systems, including the Makuleke RAMSAR site.	• Improve technical capacity in planning, managing, and monitoring wetland ecosystems. This can be done by implementing a template similar to Ramsar reporting for the Makuleke site (which is currently being revised by DFFE and to be implemented in 2022-2023). • Standardisation of wetland management tools across three countries. South Africa currently has advanced tools in assessing and management of wetlands and these can be workshopped, modified per local conditions, and applied across countries to ensure reporting is similar in all Partner Countries.	• Promote the integrated management of water resources in the transboundary area, involving the three countries and centered in the communities.
	Investment Opportunities:		
	⇒ Communication and capacity building program for various institutions tasked with wetland management.	• Supporting development of food gardens outside of wetlands and flood plains through support of irrigation infrastructure. This require the development of a land capability assessment at Nodal scale to identify areas suitable for small-scale agriculture. This would support food security as well as SMME-based commercial activity and circular economy enablement at local community level.	• Develop, manage, and monitor spatial data, this includes the development of integrated data management systems across all Partner Countries, including a "dashboard": ▪ User-friendly spatial data viewing tool ▪ Some data is already available* while others has to be collated, e.g.: ○ *Wetland extent (maps) ○ Present ecological state ○ Ecological sensitivity (habitat and species) ○ Wetland functional assessment

Country	Short Term	Medium Term	Long Term
			• *Threat assessment and categorisation based on threat.
Mozambique	**Recommendations:**		
	The integrity of some of the wetlands are threatened by encroachment of agricultural activities. A process should be set in motion to protect or rehabilitate the ones deemed as very high or high priority wetlands. The following initiatives are possible: • Engage ARA-Sul, as an increasingly important role player in the GLTFCA as a whole. This would be an important growth area and an interesting institutional capacity transfer approach - although ARA-Sul does not carry a direct mandate for wetland management, their involvement in support of systems and networks of water supply and infrastructure management can indirectly support reduced pressure on wetlands. • In order to support the protection, and ecologically sustainable use of wetlands, LNP should engage communities to identify feasible options to move from poor agriculture practices to sustainable wetland-utilisation, supported through a partnership between LNP and suitable entities in Mozambique. • Communication, capacity building and awareness building on importance of wetlands, sustainable use of wetlands, and wetland rehabilitation, including identification of training needs for the local communities and implementation of training programs at a local level. • Improvement on the baseline wetland information (through a Wetland Inventory). • Development of detailed mapping and characterisation of wetlands in the node region, including their ecological state and use. • Simplification and reform of wetland management governance processes and mechanisms in the local context, involvements of local structures and institutions.	• Strengthen the knowledge and skills of rural extension workers in the field of issues of water resources management. A global challenge which emerge in Mozambique in particular, is the lack of awareness of water resource management in many sectors. This would be an important component of future World Bank/SADRI work in the Node (this is also highlighted as a key recommendation in Chapter 7). • Development of training programs focusing on the wise use and protection of wetlands targeting local communities, especially youth for future use and sustainability of the wetland systems. • Development and implementation of a transboundary wetland policy and best practice guidelines for the developmental activities (e.g. mining and development infrastructures) impacting wetlands and riparian areas (incl. buffer areas). In this regard it would be useful for the GLTFCA to identify how to align this approach given that it operates across three sovereign policy domains. The Ramsar guidelines would be the most appropriate entry point.	• • Development of community-based enterprises to implement wetland rehabilitation works. • Development of technical and financial skills as part of wetland rehabilitation. projects in local communities.
	Investment Opportunities:		
	• Establishment of food gardens with small-scale irrigation infrastructure (and potential co-implementation of small-scale solar pumping options to support water abstraction from the river, to areas further away from flood plains). This goes along with the assessment of land capability, where the approach	• Development of Community based wetland management plans, which include the creation of community conservation areas, identification of wetlands that provide valuable natural	• Wetland rehabilitation planning, identification, and prioritisation of wetland rehabilitation projects. Identification and

Country	Short Term	Medium Term	Long Term
	should include broader ecosystem services beneficiation to communities. In this regard the value chain for marketing of goods and services has to be considered from start to end, with SMME development along the value chain including for example climate smart agriculture, horticulture, installation of renewable energy sources (e.g. solar), agro-processing, refrigeration, utilization of excess energy for community benefit, etc. In the Pafuri-Sengwe Node this advantage for electrification of communal areas (especially e.g. clinics, schools) would be hugely beneficial. This would require a cost-benefit analysis and specific action plan with timeline and schedule, to enact implementation. • Support opportunities to improve the sustainable utilisation of wetlands, by training and building capacity where smallholder farmers may learn how to manage wetland agriculture and livestock grazing in and around wetlands that have been identified to accommodate such practices. One of the primary manners in which this is implemented in other TFCA's and river basins across Africa as well as internationally, is by mobilising finance to secure the training, capacity building and monitoring and evaluation of wetlands and farmers that utilise wetlands - especially through grant funding, but also via project funds and investment-earmarked funds such as is the case with the "Nature 4 Water" initiative. In this space, international development partners would be urged to provide financial support toward the development of SMME's where the SMME's can produce food from in and/or around wetlands (depending on the wetland classification) that would enable them to deliver marketable produce, –and where the SMME's are trained and capacitated to become self-sustaining from an economic perspective and thus release their reliance from financial and other resource support, once it is established. In such cases, the fund mobilisation would for example include business set-up and may include equipment such as that which is needed for packaging, printing of labels, invoicing and the like.	resources at the local level, and development of management strategies, including use and harvesting plans for the local communities to ensure the sustainability of the systems to provide ecosystem services. It may require trade-offs between conservation and development initiatives. This could be achieved / facilitated through conservation / biodiversity stewardship agreements linked to small-scale agricultural development support (in areas outside wetland areas). These do exist in some form already on the Mozambique side of the border with South Africa, with semi-permanent allotments and a good governance system in place - on the surface and at present scale appears to be sustainable – however, there are considerable pressures such as damage causing animals (DCAs) especially during dry periods - elephant primarily.	implementation of labour-intensive programs to provide jobs and reduce poverty in the surrounding communities.
South Africa: Makuleke Ramsar Site - Contractual National Park	**Recommendations:**		
	• SA National Wetland map version 5 covers some of the wetlands within the KNP and this include the Ramsar site. DFFE through SANBI, CSIR and other partners are in a process of updating Wetland Map 5 and there is therefore an	• Ramsar Convention required each member state to compile wetland management plans for all the listed Ramsar sites. KNP must ensure that all	• Continuous implementation and monitoring of the wetland management aspects of the KNP

Country	Short Term	Medium Term	Long Term
and wetlands in the KNP	intension to produce Wetland Map 6 for South Africa. KNP Management are already involved with SANBI and CSIR to align the wetland integration into the updates for Wetland Map 6, particular with conditions assessments as well inclusion of some of the local issues that should be considered in relating to the wetlands in the KNP.	the management activities are implemented within the Ramsar site in particular the KNP in general is implemented as existing KNP Management Plan. These should be implemented jointly with local structures (refer to Section 3.3.3 of this report for some of the management site interventions within the Contractual Park). One of the main aspects is how to reintegrate indigenous knowledge systems **back** into the management of the pans and wetlands – as an example, this has been decoupled in the case of the Makuleke site, but there is a need to re-couple the knowledge with the practices that are being applied – this can be facilitated through the knowledge management system/database that is proposed, Section 6.3.	Management Plan including already existing communal wetland management activities within the contractual park.
	Investment Opportunities:		
	• Working for Wetland is current doing various wetland rehabilitation projects within the KNP, these included rehabilitation of the Malahlaphanga Peatland. With an improve wetland Map 6, further prioritisation should be undertaken to extend these projects to both KNP and the Contractual National Park, to provide employment to communities around and within both Contractual National Park. This is happening in the Node already e.g. at Makwadzi as an example, for further roll-out: WfW is effective in this example, however WfW processes do need to be improved to gain heightened benefits from these interventions.	• Existing communal wetland management plan particular within the Contractual National Park including Ramsar site must be supported and monitored by KNP with the support of community members.	
South Africa: Communal wetlands outside the	**Recommendations:**		

Country	Short Term	Medium Term	Long Term
Park/Ramsar site	• Communication and capacity building at a local level (training needs), includes engagements of the government institutions tasked with wetland management with the communities to provide training, skills and information transfer on legislation requirements and compliance levels. • Continuous Improvement on the baseline Wetland information (Wetland Inventory). The existing National Wetland Map 5 datasets are done at a National Level, and on a course scale and omit some of the local small systems which may be important at a communal level. • There are various Expanded Public Works projects already existing in South Africa (i.e., Working for Water (WfW) responsible for the removal of alien invasive vegetation and Working for Wetlands (WfWet) for rehabilitation and wise use of wetlands amongst others). These programs cover wetland rehabilitation projects and alien vegetation removal projects. Continuous financial support for these programs is crucial to ensure healthy wetlands, enhanced biodiversity, wise of wetlands and financial and technical skills to the beneficiaries involved in the implementation of the projects. There is currently no direct linkage between the rehabilitation of wetlands, and small business skills and job opportunities – the primary focus of these wetland rehabilitation programmes focus on government-subsidised job creation. There may, however, be opportunity in future to develop SMME opportunities in this sector, that may support poverty alleviation – however, it would require a detailed feasibility assessment and strategy, based on the aptitudes of individuals who may be involved in such endeavours as, well as the identification of funding streams and development of funding mechanisms for these opportunities at community level – the base information is currently insufficient to recommend more details on the private sector and SMME component of this intervention.	○ Development of Community based wetland management plans, which include the creation of community conservation areas, identification of wetlands that provide natural resources, development of management strategies, and use and harvesting plans for the local communities to ensure the sustainability of the systems to provide ecosystem services. This could be achieved / facilitated through conservation / biodiversity stewardship agreements linked to small-scale agricultural development support (in areas outside wetland areas). • ICLEI (Local Government for Sustainability) has developed wetland management guidelines for use by the local government. The extent of use of these is not known particular by small under-resourced municipalities. Rolling out of these and training to the local authorities is required. Funding and support (financial and resources) to assist struggling small municipality is required.	• Extension of the Wise Use projects, starting from extending the first program that was launched by WfWet, WESSA, MWP and AWARD in communally owned land in the Mutale River Catchment in Limpopo Province (?). this includes rolling out this initiative to other catchments within the Pafuri-Sengwe Node.
	Investment Opportunities:		
	• Continuation of wetland rehabilitation projects (providing technical and business skills, enhancement of biodiversity, and poverty alleviation). The implementation of rehabilitation measures includes intensive labour practices done by local communities, the results of the implementation are employment creation for local people, creation emerging contractor and companies and skills development which can be used inside	• Invest in ecological infrastructure projects within Strategic Water Source Areas. Both Groundwater and Surface water Strategic Water Source Areas have been identified within the Mutale-Livuhvu catchments. Identified ecological infrastructure projects by	• Financing of the Wise Use projects. starting from extending the first program that was launched by WfWet, WESSA, MWP and AWARD in communally owned land in the Mutale

Country	Short Term	Medium Term	Long Term
	and outside the programme. The programme provides necessary training needs for the individuals and emerging companies, and these focus on technical skills for example tendering and project costing and business skills including cash flow management and use of technology, computers, and essential bookkeeping. The results of these initiatives of various training offering had resulted in various emerging contractors being registered with CIDB. The skills obtained from the programme assist beneficiaries in advancing their careers outside the programme. Majority of the skills are CETA accredited skills development training programme.	SANBI should be extended in these areas to ensure their sustainability.	River Catchment in Limpopo Province (?). this includes rolling out this initiative to other catchments within the Pafuri-Sengwe Node.
Zimbabwe	**Recommendations:**		
	• Communication and capacity building at a local level including identification of training needs for the local communities and implementation of training programs at a local level. • Wetlands basics courses are critical for local communities. In South Africa for example, annual courses are run by Provincial wetland forums assisted by various institutions including South African Wetland Society (SAWS) about wetlands in general tailored for non- technical persons, including communities. Lessons learned in South Africa through engaging with WESSA, SANBI, SAWS and Provincial Wetland Forums can be used to tailor the courses for local communities, Government personnel as regulators and consultants in the wetlands sector. Transboundary cooperation and capacity building sharing across South Africa and Zimbabwe is highly recommended, to support skill-sharing as well as enable harmonisation of approaches across boundaries. • Technical courses: These courses are targeted to government employees as regulators, consultants assisting in development applications and also working in the space of wetland consulting. Again, it is recommended that transboundary sharing of capacity, skills and knowledge between Partner Countries be shared. • Roll-out training and information sharing of the existing wetland policy and wetland management guidelines published by the Zimbabwe EMA. This should filter down to local communities who are custodians and users of the wetland systems. • Improvement on the baseline Wetland information (Wetland Inventory). • The existing Zimbabwe Wetland Master Plan (published 2021) should be continuously improved and aligned with other	• Strengthen the knowledge and skills of rural extension workers in the field of issues of water resources management. • Development of training programs focusing on the wise use, multiple use options for selected wetlands, and protection of wetlands is necessary to be developed and implemented. These training programs should target local communities, especially the youth, to support effective and applicable future use and sustainability of the wetland systems especially in the Zimbabwe area of the Node. • Development and enforcement of best practice guidelines for the developmental activities (e.g., mining and development infrastructures) impacting wetlands and riparian areas (including riparian and wetland buffer areas). As mentioned, Zimbabwe has published national policy and wetland management guidelines. The purpose of these documents is to provide guidance toward sustainable wetland management as well as the requirements of various developments within and around wetlands. There are specific guidelines for wetland management in rural areas including	• Continuous implementation and monitoring of the existing policy and management guidelines by the Zimbabwean Environmental Agency • Development of technical and financial Skills as part of wetland rehabilitation projects in local communities.

Country	Short Term	Medium Term	Long Term
	inventories, especially transboundary with South Africa, which is well established. This should include standardisation of attribute wetland information across the three countries*. • Simplification and reform of wetlands governance processes and mechanisms in the local context. Identification of the roles and responsibilities of the local institutions and structures in the legislation requirements.** • The same situation in Zimbabwe exist as noted above in South Africa, where the apatite and aptitude for private sector involvement and SMME development has not yet been scoped – a feasibility assessment is possible, however it would likely have a notable impact toward the medium and long term. A transboundary scoping of SMME opportunities across the Node would likely present an improved outcome as to a single-country focussed scoping alone.	processes to follow in authorising such activities, this information needs to be communicated with rural communities in the form of training, and information workshops.	
	Investment Opportunities:		
	• The process for formalisation of formal wetland protection in Zimbabwe require in-depth and direct interaction with the Zimbabwe EMA, as well as Gonarezhou National Park and local authorities. The EMA processes are determined through National Policy in the country and have to be confirmed with the EMA for each wetland that would be considered for protection. Each wetland needs to be assessed based on its own individual criteria and the EMA will guide the process based on their latest regulatory steps and requirements at the time. The development of detailed mapping and characterisation of wetlands in the Node would be a prerequisite to support the application and process - including the ecological state and current use of the wetlands. This first step of mapping out the wetlands would then be followed by discussion, negotiation and agreement on how it can be best protected (if possible) or how multi-use can be applied, and then, finally – and potentially into the medium term only, implement its actual protection if feasible.	• Development of Community based wetland management plans, which include the creation of community conservation areas, identification of wetlands that provide natural resources, development of management strategies, and use and harvesting plans for the local communities to ensure the sustainability of the systems to provide ecosystem services. This could be achieved/facilitated through conservation/ biodiversity stewardship agreements linked to small-scale agricultural development support (in areas outside wetland areas). Although the project team was not able to locate a management plan for the Majinji pan, there are opportunities in and around the Pan for community-based conservation and monitoring initiatives. If or when one exists, it would be possible to replicate the approach to be developed for Makuleke, should the GLTFCA and local stakeholders approve.	• Wetland rehabilitation planning and identification and prioritisation of wetland rehabilitation projects – as elaborated in Section 3.3.7. • Development of community-based enterprises to implement wetland rehabilitation works.

** The inventory gives baseline information that informs the management strategies of wetlands. It also assists with filling the gabs in information, for example there maybe wetland which are important from the local context which are omitted as a results of scale and lack of information. The inventory will also provide ecological state, importance and sensitivity of the individual wetlands including functional assessment (level of provision of various ecosystem services by individual systems, the combination of this information will assist in refining the prioritisation of which then will inform management and interventions to be prioritised. Those interventions may include identification of specific wetland for rehabilitation activities, wetland for local protection and wise use (i.e. springs and local water source areas, etc). The terms of reference for the development of the inventory is therefore critical to ensure that deliverables consider critical information for decision and investment opportunities.*

Formalisation of protection of a system is a regulatory and legislation-based process where Partner Countries have to act within their autonomous state to enact the recommendations and needs within the GLTFCA towards mutually beneficial outcomes. In South Africa as an example: once systems are assessed in detail, DEA, through recommendations from the inventory and stakeholders' engagements, can initiate the process for formal protection and the Minister is responsible to approve and gazette wetland of national or regional importance that requires formal protection.

*** The wetlands that are mapped in Zimbabwe are within the protected areas from available information (refer to the protected areas map and mapped wetlands earlier in this report). The existing guidelines in Zimbabwe do however make provision for the application of the permit for cultivation within wetlands where appropriate crops will need to be approved by relevant state department, how these are integrated in the park management as well as in the communal structures is not clearly delineated at this stage and engagement between actors and role players in this regard is necessary to further the confirmation of sustainably use of wetlands in the Pafuri-Sengwe Node. This would be a key way forward for implementation and to take up further with World Bank-SADRI - given the land capability recommendations reflected on in the table above, while ensuring that the biodiversity and Ecological Goods and Services are maintained.*

7.6. Groundwater Investments

The table below provides the recommendations categorised as short, medium, long term to support Groundwater investments that lead to building community drought resilience:

Table 13: Recommended Groundwater Investment Opportunities

Country	Short Term	Medium Term	Long Term
Trans-boundary	**Recommendations:**		
	• Use the groundwater resources conjunctively, meaning that groundwater storage can be a buffer during periods of extended droughts. Investment options include water harvesting and drought contingency boreholes. Currently, national entities and SADC-Groundwater Management Institute (GMI) have a key role to play here – with LIMCOM potentially being involved in future, should their mandate include groundwater resources.	• Develop guidelines for groundwater protection zoning and model regulations to manage groundwater use. • Encourage the development of community-based monitoring of groundwater levels and rainfall	• Contribute to the sustainable management of groundwater and ecosystem resilience, in part by informing key policy makers of potential risks and identifying intervention options that reduce those risks. This would require cross-policy and cross-sectoral

		measurements using mobile platforms.	reporting so that departments e.g. environmental, ecological, agricultural and water resources for example, align. • Safeguard alluvial aquifers from mining activities – this would require definitive policy and regulatory elements, guidelines for use and safeguarding, and practical protection of areas of particular importance in terms of the recharge and utilisation.
	Investment Opportunities:		
	There is a need to do detailed work on groundwater dependent ecosystems and determine the extent and sustainable use of the transboundary aquifer – with the Joint Management Board being a key actor. There is currently a lack of data which makes management of this resource difficult: the levels of groundwater use are currently relatively low but with mining and expansion of agriculture the issues may become complex in future. This include: • *Step 1:* Design a groundwater and surface water monitoring network and programme building on existing monitoring activities under the auspices of the GLTFCA. • *Step 2:* Develop and set ecological control limits for groundwater at ecological sites to ensure GDE functioning. This recommendation is relevant to the entire Node – in populated and rural community area as well as in protected areas in the Node. It also includes the establishment of a freshwater and groundwater monitoring system (with the KNP already having proposed such an activity inside the Park) (Petersen, 2012) (Riddell, et al., 2020) – and expansion thereof into other areas of the Node e.g. Gonarezhou National Park.	• Develop market of water supply system value chain products especially on the South Africa and Mozambican side. •	• Repeat the hydrocensus every two to three years, and especially focus on the consideration of groundwater dependent ecosystems in this census and its assessment.
Mozambique	**Recommendations:**		
	• Carry out a detailed inventory of dispersed water sources and water supply systems, characterising their location, capacity, target population, operating status and management model. These will include all the current functional and dysfunctional boreholes, unprotected water sources, etc. This would require	• Assess opportunities for the development of viable transboundary water supply systems, based on private management but with a	• Secure groundwater resources and promoting water demand management, conservation and recycling techniques amongst end users (e.g., crop production and

	intensive and lengthy in-field visitations to every village in the Mozambique area of the Node. These highlighted aspects are key World Bank-SADRI implementation interventions to take forward in the transboundary context, where the GLTFCA can facilitate/leverage better cross border management and maintenance of groundwater infrastructure.	participatory community governance model. The underlying logic should not be the country, but the existing population and resources in the node. This cross-border management model will also make it possible to address the serious management weaknesses on the Mozambican side.	household use) as well as in commercial farming.
	Investment Opportunities:		
	• Invest in the development and repair of dispersed water sources (boreholes or wells) based on the recovery of operating costs, in private management models (even if of a local nature) and abandoning the option of community management or public administration management. The water supply service must always be paid for (in cash or in kind), except for demonstrably poor families. • Investment in food gardens and small-scale irrigation infrastructure at household level. • Fix and maintain existing and implement additional hand pumps.	• Develop initiatives to improve the regional integration of the water supply logistics chain, ensuring service management, technical assistance for the infrastructure and the availability of parts stocks. • Promote education for water resources management, drinking water consumption and safe sanitation.	•
South Africa	**Recommendations:**		
	• Capacitate DWS to enhance their service delivery to the target area, especially in the short term before small business development in the area enable a localised and SMME-based approach.	• Invest in Market development of the water supply spare parts	• Invest sustainable management of groundwater in part by informing key policy makers of potential risks
	Investment Opportunities:		
	• Support the development of SMME's in the South African part of the Node, to start by providing services to local communities in the SA side of the Node – and thereafter, to move into the medium term toward transboundary SMME business expansion (see next column). This approach enacts a dual-mode model where the local communities may be able to enact their own livelihoods and businesses, regardless of the ability for DWS to sustain and maintain infrastructure.	• Invest in small business owners to be able to supply spare parts to the wider area, especially the Mozambican side.	
Zimbabwe	**Recommendations:**		
	• Train Water Committees in areas such as effective fund raising, financial management and fixing boreholes which enables them to effectively manage and maintain the boreholes.	• Promote the installation of new boreholes to reduce the current high levels of demand for water that leads to water at the boreholes being finished/used up early. This will result in women not being in	• Build small (sand/earth) dams which will enable for the capturing of river water and directing it to the community where it can be utilised for agriculture and household use. This will help the community to

		queues for hours waiting for water and therefore enabling them to be engaged in other productive activities. There is a particular option to commission NGO's such as World Vision, to establish and maintain boreholes.	depart from dry land farming to irrigation. This can be done in partnership between donors/development agencies, with ZINWA, the RDC, Gonarezhou National Park and other government entities. It is necessary to keep in mind that large scale infrastructure development and the building of large dams are discouraged, due to the impact that it has on E-flows and downstream users. This is underpinned by the land capability assessment that is required, as recommended earlier (under the Wetlands Section 6.4).
	Investment Opportunities:		
	• Conduct detailed inventory of dysfunctional/under functioning boreholes and irrigation systems taking note of their location, capacity, number of beneficiaries, state of disrepair, management, amount of funds required to fix or upgrade them and management model. • Conduct investigation into the types and locations of potential sand dams or small ecologically sensitive structures. • Rainwater harvesting provide an opportunity to enable interim water scarcity challenges.	• Invest in new boreholes to reduce the current high levels of demand for water that leads to water at the boreholes being finished/used up early. • Invest in enhance the water infrastructure of current irrigation schemes so as to provide for enough water to meet the demand in the agriculture schemes. This work can be implemented by NGO's.	• Build small (sand/earth) dams which will enable for the capturing of river water and directing it to the community where it can be utilised for agriculture and household use.

7.7. Livelihood Investments

The table below provides the recommendations categorised as short, medium, long term to support livelihoods that lead to building community drought resilience:

Table 24: Recommended Livelihood Investment Opportunities

Country	Short Term	Medium Term	Long Term
Trans-boundary	**Recommendations:**		
	• Development, operationalisation and maintenance of a Nodal	• Continuing the small business development and growth commenced in the short term: especially education of business owners, and capacity development of suppliers.	• Enable for effective transportation/export of agriculture produce from the irrigation schemes in Zimbabwe

	geospatially enabled database. • Share information on approaches for management of ecosystem services, water resources, terrestrial resources, and land-use. • Standardise water resources management data and develop and promote a basin-wide data-sharing protocol in order to improve coordinated transboundary management of basin water resources.		to Mozambique and South Africa. This can be done through funding that supports implementation by a consulting firm and/or NGOs working with government departments that focus on trade and industry) (For example, in Zimbabwe this would be the Ministry of Industry & Commerce, and Zimtrade).
	Investment Opportunities:		
	• Small business development awareness and establishment processes (including supplier identification and establishing a supplier database) in support of formal and informal trade.	• Supporting small business development and growth commenced in the short term: especially education of business owners, and capacity development of suppliers. This can be funded by development partners and implemented by NGOs and consultancy firms with experience in Small Business Development for communities in nature conservation areas, conservancies, community-managed nature areas, and rural areas.	
Mozambique	**Recommendations:**		
	• Ensure improved access to water for livestock. In this context it is important to ensure awareness of potential artificial water provision impacts on natural ecosystem dynamics where systems are integrated.	• Assess the feasibility study and subsequent implementation of ponds for fish farming, based on private management and market principles focus all Node region and not only the Mozambican side. The location to be selected should take in account floods and flood areas, with critical consideration of the risks associated with alien species introduction. • Develop pilot projects of a commercial nature, involving communities and their leaders, but having the private sector as a pillar, that promote the abandonment of rainfed agriculture in flooded areas, diversification of production aimed at subsistence but also for the market, small-scale irrigation agriculture involving community families. This could include a sustainable intensification approach which may be implemented through World Bank-SADRI as an example.	• Develop human capital including skills and health by promoting access to adult education, education of youth (early childhood development, schooling, vocation and skills training). • Address human health issues (e.g., malaria) and zoonotic diseases, and promote reproductive health.
	Investment Opportunities:		
	• Construction of excavated reservoirs for	• Undertake a feasibility study and subsequent implementation of ponds for fish farming, based on private management and market principles focus all Node region and not only the Mozambican side.	

	access to water for livestock. • Invest in small scale irrigation schemes. • Implementing a natural resource management approach in range land restoration to build partnerships in support of ecosystems and socio-economic resilience, improved range land management, job creation, sustainable financing, and Ecosystems-based Adaptation. This also the development and implementation of biodiversity stewardship / conservation agreements with communal and private sector land-owners, and development of framework to support investment in conservation.		
South Africa	**Recommendations:**		
	• Create access for locals to the value chain especially in supplier sector. This should also focus on the circular economy with the GLTFCA tourism operators included. • Development and support of formal and informal trade to develop small businesses.	• Investment opportunity in addressing and reducing the land use pressure along the rivers by promoting activities which do not degrade the natural resource. This includes food and water security concerns.	• Support the implementation of climate smart agriculture to increase productivity, where more and better food is produced to improve nutrition, and subsequently enhance resilience.
	Investment Opportunities:		
	• Business development and support to support the development of small	• Support for water harvesting and storage. Interventions which seek to support an increase in the productivity of existing subsistence agriculture and livestock activities.	• Invest in climate smart agriculture to increase productivity, including both technologies and practice

	enterprises focussed on tourism value chains. • Implementing a natural resource management approach in range land restoration to build partnerships in support of ecosystems and socio-economic resilience, improved range land management, job creation, sustainable financing, and Ecosystems-based Adaptation. This also the development and implementation of biodiversity stewardship / conservation agreements with communal and private sector land-owners, and development of framework to support investment in conservation.		(i.e. sustainable intensification) which is an important implementation focus of World Bank-SADRI.
Zimbabwe	**Recommendations:**		
	• Conduct a comprehensive livelihood and opportunity assessment – if not already done. If already done, the implementation of interventions can commence earlier (note: information was not adequately available at the time of this report being compiled, to indicate the existence and/or level of detail of such an assessment).	• Linking the produce from the irrigation schemes to markets in the Sengwe Communal Area. Value Chain Development and Market • Adequately inform traditional authorities and community members on the social and environmental impact (including impact on groundwater) of mining in their communities. This will enable the traditional authorities and community members to make informed decisions about the type of mining that they will allow in their community.	• Funding agents, working with the Zimbabwean government, can invest in refurbishing roads and bridges which enable for the easy transportation of agricultural produce (horticulture & livestock) from communities in Sengwe Communal Area to outside markets (roads & bridges are currently in a bad state making transportation difficult).
	Investment Opportunities:		
	• Enhance capacity of Community Trusts that are owning and managing tourism enterprises - this	• Support the Rural District Council (RDC) to build adequate infrastructure that enable the women in the irrigation schemes to comfortably sell their horticulture products at the local markets. This infrastructure can include well-built stalls for selling the horticulture	• Invest in value addition of produce from the irrigation schemes. This will enable the women and families in the

	would ideally continue into the medium term to ensure effective sustainability. • Implementing a natural resource management approach in range land restoration to build partnerships in support of ecosystems and socio-economic resilience, improved range land management, job creation, sustainable financing, and Ecosystems-based Adaptation. This also the development and implementation of biodiversity stewardship / conservation agreements with communal and private sector land-owners, and development of framework to support investment in conservation.	products and adequate water and sanitation facilities such as toilets which are currently non-existent at the local markets. It could further expand into sanitation infrastructure options identification, and provisions that the World Bank-SADRI and other programmes in the Node should take note of for implementation in the medium and into the long term. • Train women (in particular) who work in current irrigation schemes on farming techniques such as climate smart agriculture, Farming as a Business (FaaB) and Financial Management, to enhance their productivity in the irrigation schemes and to effectively change their livelihood circumstances for the better. Investment in this regard could be well-founded in a project that enhances the farming and non-farming skills of women working in the irrigation schemes in the Sengwe Communal Area.	irrigation schemes to realise more profit from their produce.

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APPENDIX A: Stakeholder List

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APPENDIX B: GIS Metadatabase

Layer	Source:	Source URL: (if applicable)	License: (if applicable)	Date Obtained: (if applicable	Date Created: (if applicable)	Citation to use: (if specified)
Limpopo River	WWF - HydroSHEDS	https://www.worldwildlife.org/pages/hydrosheds				
Country Boundary	DIVA-GIS - Spatial datasets downloads	diva-gis.org/gdata				
Current Pafuri Sengwe Node	Generated from Google Earth					
Proposed Pafuri Sengwe Node	Generated from Google Earth					
Limpopo River Basin	WWF - HydroSHEDS	https://www.worldwildlife.org/pages/hydrosheds				
ZAF Settlement	DIVA-GIS - Spatial datasets downloads	diva-gis.org/gdata				
ZM Settlement	DIVA-GIS - Spatial datasets downloads	diva-gis.org/gdata				
MOZ Settlement	DIVA-GIS - Spatial datasets downloads	diva-gis.org/gdata				
Communities	Google Earth Border and labels		-			
Makuleke RAMSAR Site	Ramsar Sites Information Service	https://rsis.ramsar.org/ris/1687	-			
Makuleke Pans	KMZ received from SANPARKS - Eddie Riddell		-			
Majinji Pan (in some references also referred to as Manjinji)	Generated from Google Earth					
Rivers	WWF - HydroSHEDS	https://www.worldwildlife.org/pages/hydrosheds				
Protected areas (World Resources Institute)	Protected Planet	https://www.protectedplanet.net/	https://www.protectedplanet.net/c/terms-and-conditions	May 2022	Updated monthly. Used version	UNEP-WCMC and IUCN (year), Protected Planet: [insert name of component database; The World Database on Protected Areas (WDPA)/The Global Database

					of May 2022	on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [insert month/year of the version downloaded], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.
Major Rivers	WWF - HydroSHEDS	https://www.worldwildlife.org/pages/hydrosheds				
Proposed Priority Ranking of Wetland Areas	DEFF - Working for Wetlands					
Aquifer Type	WHYMAP datasets	https://download.bgr.de/				
Catchments	WWF - HydroSHEDS	https://www.worldwildlife.org/pages/hydrosheds				
Electrical Conductivity	Department of Water and Sanitation / DNGRH					
Nitrate as N	Department of Water and Sanitation					
Fluoride	Department of Water and Sanitation					
Pump Type	DNGRH					
Status of Boreholes	DNGRH					
Wetlands and Water Courses	SANBI-GIS Spatial datasets	metadata.sanbi.org/geonetwork/srv/eng/catalog.search#/home				

Appendix C Governance Context

The GLTFCA was formally established through an International Treaty signed by the Heads of States for Mozambique, South Africa and Zimbabwe in December 2002 (GLTP Treaty, 2002). Its governance structure includes the GLTFCA Joint Management Board, Working Groups and Partners Forum and these have overseen the development of GLTFCA joint frameworks and operational plans, the GLTFCA Institutional Reform Strategy, and the GLTFCA Integrated Livelihoods Diversification Strategy (GLTFCA, 2016) (which forms the basis for this work).

Water resources governance in the GLTFCA is characterised by regional (transboundary), national, sub-national and community level governance structures. SADC as a regional governance institution, acknowledging the importance of water resources for development and regional integration, has adopted a range of regional instruments to support the joint management of shared water resources. This resulted in a framework that supported the establishment of LIMCOM in 2003 by the Republics of Botswana, Mozambique, South Africa and Zimbabwe within the basin-wide signed treaty intended to govern basin management. With the objective of advising the four States and providing recommendations on the uses of the river basin's riverine water resources, LIMCOM has an important role to play in alignment with and support of the Node.

LIMCOM, in coordinating the shared international water issues among its four riparian states, formalized a cooperation mechanism in December 2018 focusing on groundwater resources and management. The mechanism will facilitate and promote the joint management of surface water and groundwater resources in the basin, thereby increasing the attention given to transboundary aquifers. So far, three major transboundary aquifers have been identified, the Ramotswa Aquifer, the Tuli Karoo Aquifer and the Limpopo Basin Transboundary Aquifer (TBA) (GRIPP, 2019). As noted earlier in this document, the Limpopo TBA underlies part of the Pafuri-Sengwe Node.

In **Mozambique**, in accordance with the Constitution of the Republic and the legislation on local government and decentralisation, the governance of the water sector follows two different regimes: one for the management of water resources and the other for the supply of water and sanitation. The management of water resources is a function of national government through the National Directorate of Water Resources Management (DNGRH), included in the Ministry of Public Works, Housing and Water Resources (MOPHRH). In turn, the DNGRH manages water resources through Regional Administrations, with the Pafuri-Sengwe Node being within the scope of ARA-Sul's intervention. Mozambique Regional Administration of Waters in the South (ARA-Sul) is the water agency responsible for the river basins in southern Mozambique, including the trans-boundary flood prone rivers Limpopo and Maputo. ARA-Sul is one of the leading agents in conducting river flow and flood modelling using hydrological models and applications, and as such involved in overseeing water availability, dam operation and flood forecasting.

Created with the mandate to ensure and promote sustainable and equitable development, the Ministry of Land, Environment and Rural Development (MITADER) focuses on reducing socio-economic inequalities with emphasis on the rural environment, by promoting a diversified economy and inclusive. Conservation areas in Mozambique are managed by the National Administration of Conservation Areas (*ANAC*), which is a body supervised by MITADER.

In May 2018, Mozambique adopted constitutional reforms towards decentralization. While elected bodies will be in place at the level of the provinces, districts and municipalities, the actual scope of autonomy of these bodies is in many instances still in the process of being clarified through implementing legislation. The transfer of power (and financial resources) from the central government to subnational authorities would enable local residents to control the selection of their leaders and could lead to the adjustment of policies to local preferences and needs. Moreover, decentralization is increasingly popular as an instrument of accommodating claims of rival factions in conflict-affected settings. Primary responsibility for water supply and sanitation in Mozambique services lies with municipalities and district decentralized governance bodies (OGDD). It is expected that the first elections for the OGDD will take place in 2023. In the meantime, this function is exercised by the central government through the district administration, which is responsible for defining policies, strategies, national programs, directing regulation and investing in the development of infrastructure and water supply and sanitation services to achieve sustainable services and universal coverage. This government function is exercised by the Ministry of Public Works, Housing and Water Resources (MOPHRH: *República de Moçambique Ministério das Obras Publicas*, *Habitação e Recursos Hídricos*) through the National Directorate for Water Supply and Sanitation (DNAAS) which, to date, also has an operational program management intervention in rural water supply and sanitation, in coordination with local authorities. DNAAS is also responsible for the technical regulation of the water supply and sanitation service.

In **South Africa**, the Department of Water and Sanitation (DWS) is responsible for issuing water use licences, as well as overseeing dams with a safety risk, and determining the ecological reserve requirements per catchment. The DWS has the power to issue directive notices for prevention and remedying effects of pollution, for control of emergency incidents and for rectification of contraventions. The enforcement function of the Department is located within the Branch Policy and Regulation, specifically the Directorate of Regulation. The Department of Environment, Forestry & Fisheries (DFFE) is responsible for protecting, conserving and improving the South African environment and natural resources. DFFE is also managing the Working for Wetlands (WfW) Programme, which focusses on the rehabilitation, wise use and protection of wetlands in a manner that maximises employment creation, supports small businesses and transfers relevant and marketable skills to beneficiaries. WfW is a joint initiative of the DFFE & DWS.

The Limpopo Economic Development, Environment and Tourism (LEDET) is also a key government stakeholder in the Node. LEDET provides leadership in economic

development, investment promotion, business development, and promotion of tourism and sustainable use of the environment in Limpopo Province.

In **Zimbabwe**, The Ministry of Environment, Water and Climate (MEWC) is responsible for the water sector. The Zimbabwe National Water Authority (ZINWA) is a state owned enterprise formed in 2000 in terms of the ZINWA Act (Chapter 20:25) falls under the Ministry of Lands, Agriculture, Fisheries, Water and Rural Resettlement. ZINWA acts as an operator and a regulator and is responsible for the following functions at the national level: Water planning and implementation; management of public dams; and supply of bulk water to the agriculture, industrial and mining sectors. ZINWA is key in providing information on current and future water usage in the targeted communities (including information on water to be drawn from rivers). For all potential investments in Zimbabwe, the relevant Rural Development Councils (RDCs) must be notified of a project's intentions in the targeted locations. If this is not done there would be challenges for implementation on the ground, especially in an election season when outsiders who come into local communities are viewed with significant suspicion. RDCs are therefore engaged directly. Traditional authorities are the gatekeepers to the communities. Investment opportunities will not be able to engage community members without their approval and facilitation. They are engaged directly and are normally present at the community engagement meetings – this causes any short-term investment option to potentially need additional mobilisation and preparation time, which may turn it into a medium to long term investment process.
The Environmental Management Agency of Zimbabwe (EMA) is a statutory body responsible for ensuring the sustainable management of natural resources and protection of the environment, the prevention of pollution and environmental degradation, and the preparation of Environmental Plans for the management and protection of the environment. Recently, the EMA shared updated wetland management guidelines for the country, which were considered in the development of this document (Ministry of Environment, Climate, Tourism and Hospitality Industry, 2021).