FEASIBILITY STUDY (ANNEXURE 2) – FINAL (V1.1)

Provision of Project Preparation Services to the South African National Biodiversity Institute (SANBI) through the GCF Project Preparation Facility (PPF)

17 March 2025

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LIST OF ABBREVIATIONS

Acronym	Definition
AAD	Average Annual Damages
ACDI	African Climate and Development Initiative
AEP	Annual Exceedances Probability
AIDS	Acquired Immunodeficiency Syndrome
ALBATROSS	Advancing Knowledge for Long-Term Benefits and Climate Adaptation Through Holistic Climate Services and NbS
ALTCDD	Longest Period of Consecutive Dry Days
AMS	Annual Maximum Series
CARA	Conservation of Agricultural Resources Act
CBA	Cost-Benefit Analysis
CMA	Catchment Management Agency
CMIP	Coupled Model Intercomparison Project
COGTA	Department of Cooperative Governance and Traditional Affairs
CRVA	Climate Risk and Vulnerability Assessment
CSIR	Council for Scientific and Industrial Research
DALRRD	Department of Agriculture, Land Reform and Rural Development
DMAF	Disaster Management Advisory Forum
DBSA	Development Bank of Southern Africa
DDM	District Development Model
DEMF	District Environmental Management Forum
DFFE	Department of Forestry, Fisheries and the Environment
DFFE: EP	Department of Forestry Fisheries and the Environment: Environmental Programme
DFFE: NRM	Department of Forestry Fisheries and the Environment: Natural Resource Management
DFFE: EPIP	Department of Forestry Fisheries and the Environment : Environmental Protection and Infrastructure Programmes
DFI	Developmental Finance Institution
DHS	Department of Human Settlements
DM	District Municipality
DMAF	Disaster Management Advisory Forum
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSI	Department of Science and Innovation
DWS	Department of Water and Sanitation
EbA	Ecosystem-Based Adaptation
EC: DEDEAT	Eastern Cape Department of Economic Development, Environment and Tourism
Eco-DRR	Ecosystem-Based Disaster Risk Reduction
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
EPWP	Expanded Public Works Programme
EPWPIG	Extended Public Works Programme Integrated Grant
EWS	Early Warning System
FFP	Full Funding Proposal
FOSAD	Forum of South African Directors-General
FPA	Fire Protection Association
GBVC	Green Business Value Chain
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environmental Fund

Acronym	Definition
GESI	Gender, Equality and Social Inclusion
GHG	Greenhouse Gas
GIS	Geographic Information System
GIZ	German Development Cooperation
GVA	Gross Value Added
ha	Hectare
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
HRU	Hydrological Response Units
IAP	Invasive Alien Plant
ICS	Incident Command System
IDP	Integrated Development Plan
IGCCC	Intergovernmental Committee on Climate Change
IMCCC	Inter-Ministerial Committee on Climate Change
IUDG	Integrated Urban Development Grant
JET IP	Just Energy Transition Investment Plan
JSE	Johannesburg Stock Exchange
km^2	Square Kilometres
LM	Local Municipality
LMIC	Low- or Middle-Income Country
LTAS	Long Term Adaptation Scenarios
LSU/ha	Large Stock Units Per Hectare
masl	Meters Above Sea Level
mm	Millimetre
MCA	Multi-criteria Assessment
MDMC	Municipal Disaster Management Centre
MDRG	Municipal Disaster Recovery Grant
MIG	Municipal Infrastructure Grant
MINMEC	Ministers and Members of Executive Councils Meeting
MINTECH	Ministerial Technical Committee
MISA	Municipal Infrastructure Support Agency
MTEF	Medium Term Expenditure Framework
MTPA	Mpumalanga Tourism and Parks Agency
MTSF	Medium-Term Strategic Framework
MWS	Mean Wind Speed
NAFAB	National Adaptation Funds Advisory Body
NBI	National Business Initiative
NBSAP	National Biodiversity Strategic Action Plan
NCCAS	National Climate Change Adaptation Strategy
NCCC	National Committee for Climate Change
NCCRP	National Climate Change Response Policy White Paper
NDC	Nationally Determined Contribution
NDMC	National Disaster Management Centre
NDP	National Development Plan
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NEMPAA	National Environmental Management: Protected Areas Act
NGO	Non-Governmental Organisation
NMBM	Nelson Mandela Bay Municipality
NPV	Net Present Value
NSSD	National Strategy for Sustainable Development
NW: DEDECT	North West Department of Economic Development, Environment Conservation and Tourism

Acronym	Definition
OECD	Organisation for Economic Cooperation and Development
PCC	Presidential Climate Commission
PDMC	Provincial Disaster Management Centre
PDMF	Provincial Disaster Management Framework
PES	Payment for Ecosystem Services
PRCPTOT	Total Annual Rainfall
QC	Quaternary Catchment
QCDB	Quaternary Catchments Database
R99P	Total Heavy Rainfall
RCP	Representative Concentration Pathways
RMF	Regional Maximum Flood
RQO	Resource Quality Objective
RUSLE	Revised Universal Soil Loss Equation
RWU	Regional Water Utility
RX1DAY	Annual Maximum 1-Day Rainfall
SALC	South African Landcover
SALGA	South Africa Local Government Association
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAWS	South African Weather Service
SDR	Social Discount Rate
SMME	Small, Medium and Mico Enterprises
SSP	Shared Socioeconomic Pathways
SST	Sea Surface Temperature
STEM	Science, Technology, Engineering and Mathematics
SWAT	Soil and Water Assessment Tool
TAS	Mean Air Temperature
TCTA	Trans-Caledon Tunnel Authority
TEV	Total Economic Value
TG	Daily Mean Temperature
TN90P	Frequency of Very Hot Nights
ToC	Theory of Change
TS	Time Series
TX90P	Frequency of Very Hot Days
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programmes
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
USDG	Urban Settlements Development Grant
USLE	Universal Soil Loss Equation
WDCS	Waste Discharge Charge System
WMA	Water Management Area
WRC	Water Research Commission
WRMC	Water Resources Management Charge
WSA	Water Service Authority
WSIG	Water Services Infrastructure Grant
WSDI	Warm Spell Duration Index (Heat Waves)
WTP	Willingness To Pay
WUA	Water User Association
WWF	World Wide Fund for Nature
ZAR	South African Rand
°C	Degrees Celsius

Acronym	Definition
%	Percentage

EXECUTIVE SUMMARY

INTRODUCTION

The impacts of climate change have been felt across South Africa with the frequency and severity of droughts, floods and wildfires increasing. Climate projections show that this trend, including changes in intensity and unpredictability, will continue. These hazards are leading to escalating risks of significant impacts on South Africa's wider economy and both the urban and rural livelihoods and its most vulnerable populations. In response, South Africa's National Biodiversity Institute (SANBI) is preparing a full application, with the associated supporting documents, to the Green Climate Fund (GCF) to contribute around USD 40 million of funding to a USD 50 million programme to scale up ecosystem-based approaches to managing climate intensified disaster risks in vulnerable regions of South Africa (the Eco-DRR project). The objectives of this Feasibility Study Report are to provide details of the analysis undertaken for the submission of a full funding proposal (FFP) for the proposed interventions.

SITE SELECTION

The Eco-DRR site selection process commenced with the identification of seven priority district municipalities (DMs). These DMs were: Waterberg DM (Limpopo Province); Garden Route DM (Western Cape Province); Alfred Nzo DM (Eastern Cape Province); Joe Gqabi DM (Eastern Cape Province); Ehlanzeni DM (Mpumalanga Province); Sekhukhune DM (Limpopo Province); and Ngaka Modiri Molema DM (North West Province). A study into future climate drivers of disaster risks across the seven DMs was undertaken by experts from the University of Cape Town's African Climate and Development Initiative (ACDI) which indicated that all seven DMs, across the four climatic hazards considered, *will experience increased climate risk which will be statistically significant* at 2.0 °C of warming, and in many cases, at 1.5 °C of warming, making them suitable candidates for climate change adaptation responses and interventions (New, 2021). These assessments are further supported by municipal level climate fact sheets, based on both Coupled Model Intercomparison Project (CMIP) 6 and CORDEX-CORE data, under development by the Global Change Institute, University of the Witwatersrand. As a statement from the 2021 report of particular importance notes "... *even when total rainfall decreases, heavy rainfall stays the same or increases, indicating that more of the total rainfall falls as heavy rainfall events*" (New, 2021). This significant assertion highlights the importance, especially in the prioritised DMs, that flood hazards are very likely to increase, as a direct result of climate change. This information forced the foundation of the project to be undertaken in the development of the GCF FFP.

The selection of these seven DMs were further refined during the candidate stie selection process to identify potential locations for intervention implementation within the seven DMs. The aim of the candidate site selection process was two-fold – first to identify which of the seven DMs were most vulnerable – resulting in five DMs being identified - and second to identify potential locations *within* the then five DMs that are more vulnerable to climate-induced droughts, floods and wildfires . This two-fold process took into consideration biophysical data, socioeconomic data, climate data and local stakeholder and expert inputs. Of the seven DMs analysed, the Waterberg and Garden Route DMs had the lowest scores (for combined drought, flood and wildfire) when compared to the other DMs and were thus excluded from further analysis. The remaining five DMs that are assessed in this feasibility study are:

1. Alfred Nzo DM
2. Joe Gqabi DM
3. Ehlanzeni DM
4. Ngaka Modiri Molema DM
5. Sekhukhune DM

The figure below presents the top two potential locations / quaternary catchments (QCs) identified in each of the DMs which have been subjected to hydrological modelling (Section 6) and a cost-benefit analysis (CBA) (Section 7) in this feasibility assessment.

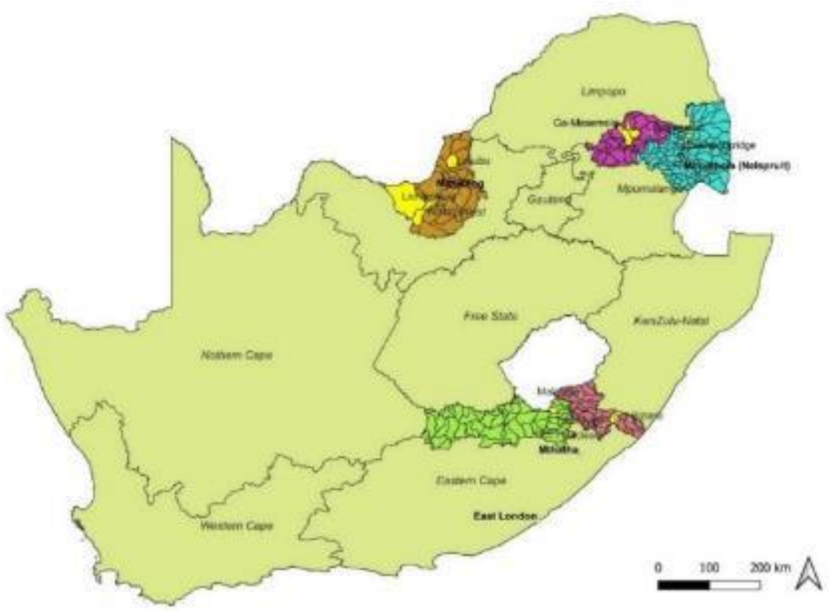

Figure E-1: Map showing the potential locations (candidate sites) for intervention implementation within the five DMs

It is important to note that this feasibility study aims to assess the feasibility of undertaking Eco-DRR interventions within the 5 DMs. As such, this report reviews all 5 DMs – Joe Gqabi, Alfred Nzo, Ngaka Modiri Molema, Sekhukhune and Ehlanzeni – and presents findings for each DM and the reader is asked to bear this in mind. Through the feasibility process and analysis, it was possible to determine which interventions are feasible and in which geographic areas. These results informed the finalisation of the site selection process and resulted in the exclusion of Joe Gqabi DM.

STATUS QUO OF ECO-DRR IN SOUTH AFRICA

As per the Convention on Biological Diversity, ecosystem-based adaptation (EbA) is defined as the use of biodiversity and ecosystem services to help people adapt to the adverse impacts of climate change (Convention on Biological Diversity, 2009). EbA approaches are recognised as an important tool in enhancing climate resilience. The power of EbA lies in its exceptional ability to provide intervention options that modify livelihood and infrastructure approaches in the short-term and at a local-level on a project-by-project case. EbA also has the potential to be widely transformative in the way societies and economies function – namely by ensuring sustainability into the future.

Poor urban and rural communities in South Africa are dependent to a large degree on natural resources and ecosystem services in support of their livelihood stacks (DEA & SANBI, 2018). Where ecosystems thrive, the livelihood stacks are often well-supported and the balance in harvesting of natural and agricultural resources are sustainable whilst Eco-DRR services are then being provided by those ecosystem services. However, where ecosystem services are lacking, in poor condition or under-valued, the DRR elements that may be offered by natural systems do not exist or are not functioning adequately. In this latter scenario, EbA measures are required as a critical intervention to reduce the worst of the impacts, prevent further degradation, and give communities the opportunity to become more resilient (Sack, 2024).

Over the past four decades, South Africa has experienced more than 82 hydro-meteorological hazards(floods, storms, landslides, wildfires, droughts and extreme temperatures) that have resulted in the death of an estimated 1,692 people and affected more than 21 million people (CSIR, n.d.). For drought, applying the lens of EbA to settlement planning for communities located inland can result in the allocation of space that is designated as freshwater recharge zones to offset the impacts of drought (USAID, 2019). EbA can also help to maintain water quality and quantity by recharging aquifers and enhancing water storage (Talberth, et al., 2012; Bertule, et al., 2014). Restoration and revegetation that support forests, wetlands and riparian buffers can help filter runoff, reduce erosion and slow sedimentation. Agroforestry and conservation agriculture can also decrease agricultural water demand and strengthen rural communities' resilience, particularly those that undertake small-scale subsistence farming (Vignola, et al., 2015). Further, EbA measures in response to drought preparedness and drought mitigation can assist in achieving flood adaptation goals due to linkages between drought impacts and flood intensity (Solh. & Ginkel, 2014).

To prevent and/or mitigate the impact that climate change will have on the livelihoods of people living within more rural contexts, it is necessary to focus on measures that would curb the peak and velocity of flood events downstream through attenuation of runoff in the upper catchment areas. In many instances, the effective and efficient functioning and maintenance of stormwater structures, culverts, bridges, and other structures can be supported by effectively managing ecological infrastructure thereby ensuring improved effectiveness in terms of flood prevention. This also increases the lifespan of infrastructure whilst minimising the secondary impacts of built infrastructure on catchments, such as increased erosion, riverine and wetland degradation and so forth.

To reduce the impacts of wildfires on settlements and communities vulnerable to climate change-related wildfires, there is need to implement firebreaks and block burns which helps to protect rangelands, lives and properties. Partnering with local FPAs to coordinate these actions coupled with training of communities to establish and manage firebreaks will further ensure that the impact of wildfires on lives and settlements is reduced. In addition, the removal of invasive alien plants (IAPs) will also reduce the amount of biomass, thus decreasing the amount of fuel load for wildfires.

GOVERNANCE FRAMEWORKS IN SOUTH AFRICA

The enabling environment in South Africa, particularly within the 5 DMs, was assessed to identify the key challenges with regards to adaptation and implementation of EbA / Eco-DRR interventions. In addition, past and current projects in the 5 DMs were reviewed to ensure alignment and identify opportunities for synergies. Some of the primary gaps that were identified include operational challenges and resource constraints in the Department of Forestry, Fisheries and the

Environment (DFFE) and DFFE: Environmental Programmes (DFFE: EP) as well as overlapping mandates between different institutions in the country. Further to this, there is difficulty in ensuring compliance across ministries and departments with regards to climate change and ecological infrastructure. The lack of vertical and horizontal intergovernmental coordination as well as limited financial and technical resources impacts the ability of the country to affect the national vision for climate change at local levels. With regards to disaster risk management (DRM) and DRR, it was noted that there is poor translation of legislation for implementation at local level coupled with inadequate early warning systems (EWS) and monitoring networks. Additionally, entities at a local level lack sufficient capacity and financial resources to effectively implement DRM and DRR. The assessment also revealed poor information management and communication together with limited integration of citizen science and indigenous knowledge into DRR and DRM. Lastly, the issue of language and governance in DRR and DRM needs to be strengthened.

The options analysis for the financing of EbA revealed that, beyond what is funded through the national fiscus, there are multiple alternative finance mechanisms that can be implemented to support the upscaling of Eco-DRR. However, accessing and/or implementing such mechanisms require capacity and technical expertise. As a result, smaller municipalities do not have the necessary resources (financial and technical expertise) to utilise these funding mechanisms, or they are unaware that such mechanisms exist. As such, private sector is more willing to partner with metropolitan municipalities to help finance Eco-DRR and climate change adaptation initiatives. This is compared to smaller and more rural municipalities that do not have major industries present and lack the internal capacity to engage with private sector. Bearing these challenges in mind, the key recommendations for the enabling environment include:

1. Mainstreaming Eco-DRR into legislation, policies and planning instrument;
2. Building capacity at DM and local municipality (LM) Levels to plan, design, implement and monitor Eco-DRR activities; and
3. Undertake comprehensive financial structuring and investment planning

UNDERTAKING FEASIBILITY STUDIES FOR ECO-DRR

The approach to the feasibility studies entailed selecting appropriate sites (see Site Selection) which would be subjected to a hydrological, economic and social evaluations. The two QCs within the 5 DMs were selected based on results from the candidate site selection, climate rationale, stakeholder engagements and site visits.

ECO-DRR INTERVENTIONS

The list of potential technical interventions that were considered for implementation in the proposed QCs in the 5 DMs is presented in the table below.

Table E-1: List of potential technical interventions considered for implementation in the proposed project sites

Intervention	Description
Improved grazing system	Introduce rotational resting for grazing areas. Employ eco-champs / enviro-champs to control livestock movement.
Stone Lines	Use of stone lines placed along contours to reduce runoff velocity and capture sediment.

Intervention	Description
Pathway revets	Used to control erosion on pathways. Poles placed across pathways and secured in place to capture sediment and divert water off the pathway.
Contour brushpacks	Branches from woody aliens are placed and secured along contours in degraded and denuded areas to reduce runoff and capture sediment.
Revegetation / reseeding	Sowing of indigenous grass seed mix on denuded areas, behind contour structures and in rehabilitated gullies.
Gabions	Stones packed into wire baskets as mass-gravity structures to slow runoff and capture sediments.
Dry stone walls	Also known as dry stacking, this involves the construction of interlocking stones similar to brick construction, but without mortar.
Concrete weirs	Concrete walls established in degraded wetlands (gullies and head cuts) to capture and spread water and sediment. Can work better than gabions as there are no opportunities for water ingress and subsequent water flow and erosion around the structure. However, expensive and low levels of community benefit.
Rock packing	The placement of piles of rock in small gullies to capture sediment and reduce runoff. These rocks are stacked in piles, much like building a garden rockery. Unlike dry stone walls this does not require high levels of building skills.
Ecologs	Mesh tubes filled with wood processing fibre and secured along contours to reduce runoff and capture sediment.
Earth works	Manual digging and shaping of donga walls to create shallower, more even slopes for installing ecologs and eco-mattresses.
Eco-mattresses	Mats made of biodegradable, photodegradable material such as coconut fibre, wood fibre and straw. These are placed over bare soil as a blanket to retain moisture and reduce raindrop impact to allow seeds to germinate.
Vetiver lines	The planting of vetiver slips along contours. Once the grass has established it provides a living barrier to runoff and traps sediment.
Broad brushpacking	The spreading of brush, usually from woody alien species, across denuded areas to provide shade and moisture retention for seed germination while also discouraging livestock access.
Ponding	Ponding (also known as pitting) involves constructing a series of shallow ponds over a degraded area and planted with seeds. The ponds capture water to promote germination and growth of grass cover.
Fencing	The establishment of fences to prevent livestock access allowing grasslands to recover or prevent further gully formation
Vetiver lines - agricultural	The establishment of vetiver contours in fields to reduce erosion.
Contours - agriculture	The establishment of earthen contours in agricultural fields.
Conservation agriculture	A cropping system that reduces erosion and improves productivity of cropped lands; based on three principles: (1) limited soil disturbance, (2) retaining a cover over the soil, and (3) crop rotation.
Clearing invasive aliens - manual	The removal of woody alien plants by cutting the stem or trunk and treating with herbicide. For this initiative the removal of aliens is primarily to supply materials for brushpacking and large-scale alien species removal is not considered.
Clearing invasive aliens - biological	The use of biological control to reduce or reverse alien infestation. This could be applied in the conservation areas.

HYDROLOGICAL EVALUATION

Hydrological models provide a means to simulate and analyse the complex interactions within a watershed, offering insights into the hydrological processes potentially influenced by restoration efforts. Therefore, by incorporating elements such as changes in land use changes and vegetation cover, and maintaining climate conditions and soil properties, hydrological models enable a quantitative evaluation of the impact of restoration practices on the hydrology of a catchment. This data-driven approach allows for a comprehensive understanding of how interventions, such as rangeland rehabilitation (including wetland rehabilitation), IAP clearing, and gully rehabilitation affect the catchment's hydrological dynamics. Moreover, hydrological models facilitate scenario analysis, helping to predict potential outcomes of restoration strategies. The objective of the hydrological modelling exercise was therefore to understand level of impact that can be achieved through the implementation of restoration activities, ultimately to counteract the increases in flooding, drought and wildfire vulnerabilities associated with climate change.

The potential technical interventions considered for implementation in the proposed project sites include improved grazing system, stone lines, pathway revets, contour brushpacks. revegetation / reseeding, gabions. dry stone walls, concrete weirs, rock packing, ecologs, earth works, eco-mattresses, vetiver lines, broad brushpacking, ponding, fencing, vetiver lines – agricultural, contours – agriculture, conservation agriculture, clearing invasive aliens – manual, and clearing invasive aliens – biological. Hydrological modelling was used to determine the level of impact that can be achieved through the implementation of these restoration activities, ultimately to counteract the increases in flooding, drought and wildfire vulnerabilities associated with climate change. The results from the modelling are presented below.

- In the Alfred Nzo DM, where interventions are proposed across **3%** of the catchment, an average reduction of **3%** in the reduction of the annual maximum series (AMS) was realised.
- In the Joe Gqabi DM, where interventions are proposed for **24%** of the catchment area, an average reduction of **6%** of the simulated AMS was realised.
- In the Ehlanzeni DM, where interventions are proposed across **7%** of the catchment, an average reduction of **1%** in the reduction of the AMS was realised.
- In the Ngaka Modiri Molema DM, where interventions are proposed across **18%** of the catchment area, an average reduction of **1.5%** in the simulated AMS was realised.
- In the Sekhukhune DM, where interventions are proposed across **56%** of the catchment, an average reduction of **15%** in the reduction of the AMS was realised.

ECONOMIC EVALUATION

The approach to costing the possible interventions involved a review of the literature and local knowledge specific to South Africa for ecological infrastructure interventions. The total estimated costs for the direct implementation of potential Eco-DRR technical interventions is R518 043 871 and covers a total calculated area of 76 208 ha, as summarised in the table below.

Table E-2: Summary of budgets and areas of interventions per district[1]

	Name of District	Joe Gqabi	Alfred Nzo	Ngaka Modirl Molema	Sekhukhune	Ehlanzeni	TOTALS
IAP Clearing	Area (ha)	156	125	-	111	219	**611**
	Cost	5 935 492	4 757 600	-	4 208 880	8 313 698	**23 215 670**
Bioturbation	Area (ha)	39	-	-	-	-	**39**
	Cost	976 232	-	-	-	-	**976 232**
Revegetation	Area (ha)	309	139	70	984	268	**1 769**
	Cost	9 272 057	4 170 000	2 088 000	29 516 700	8 028 600	**53 075 357**
Gabions	Area (ha)	3	3	4	5	2	**16**
	Cost	41 451 000	34 932 000	46 002 000	59 040 000	20 664 000	**202 089 000**
tional Resting (Ecoran	Area (ha)	33 791	13 313	1 558	12 928	3 342	**64 932**
	Cost	2 027 460	798 780	93 480	775 701	200 520	**3 895 941**
Fencing	Area (ha)	186	45	70	-	-	**300**
	Cost	14 853 600	3 568 000	5 568 000	-	-	**23 989 600**
Firebreaks	Area (ha)	7 439	-	-	-	-	**7 439**
	Cost	13 390 200	-	-	-	-	**13 390 200**
Block Burns	Area (ha)	7 439	-	-	-	-	**7 439**
	Cost	3 347 550	-	-	-	-	**3 347 550**
Brushpacks	Area (ha)	114	45	7	44	26	**236**
	Cost	48 322 500	18 955 000	3 123 750	18 742 500	11 007 500	**100 151 250**
Vetiver	Area (ha)	114	45	7	44	106	**316**
	Cost	25 582 500	10 035 000	1 653 750	9 922 500	23 820 000	**71 013 750**
Concrete Weirs (Wetlands)	Area (ha)	2	-	-	-	-	**2**
	Cost	13 615 200	-	-	-	-	**13 615 200**
Soft interventions (Wetlands)	Area (ha)	172	192	-	-	4	**368**
	Cost	1 720 000	1 920 000	-	-	40 000	**3 680 000**
Pitting (Zai Pits)	Area (ha)	-	-	180	-	-	**180**
	Cost	-	-	5 604 120	-	-	**5 604 120**
TOTALS		**180 493 792**	**79 136 380**	**64 133 100**	**122 206 281**	**72 074 318**	**518 043 871**

An analysis of the economic costs and benefits was undertaken for the proposed interventions in the QCs within each DM, and the economic rates of return associated with proposed project interventions in each of the study areas was determined. It should be noted that, owing to data limitations, the cost and benefit estimates are necessarily high level at this stage and are intended to be indicative only. Further refinements will be required during project implementation.

The CBA showed that the programme (encompassing all five DMs) is strongly cost-beneficial in terms of net present value (NPV), benefit cost ratio and economic internal rate of return (EIRR) in Joe Gqabi, Alfred Nzo and Sekhukhune project sites. Area of grassland rehabilitation underpins many of the benefits and the relatively larger grassland areas in Joe Gqabi, Sekhukhune and particularly Alfred Nzo DMs primarily drive their positive results. In addition, the presence of a high number of bridges and the single dam in Sekhukhune DM compared with other sites strengthens its overall benefits through larger avoided direct and indirect damage costs.

The proposed interventions are not cost-beneficial in Ngaka Modiri Molema and Ehlanzeni DMs. This was due to the DMs having significantly smaller areas of grasslands rehabilitated, resulting in less co-benefits being realised. If rehabilitated grassland area is expanded, especially in Ehlanzeni, results are expected to rise to overall economic viability. In addition,

[1] This costing is based on possible interventions that were proposed for the 2 QCs assessed during this feasibility study. As such, the numbers are indicative and will be revisited during project inception when the types of interventions and locations are finalised.

numbers of households indirectly impacted are relatively lower than in Alfred Nzo, Joe Gqabi and Sekhukhune DMs, resulting in less households receiving avoided indirect damage benefits.

SOCIAL EVALUATION

Recognising gender's pivotal role in climate action, the GCF prioritises women's participation and decision-making in its supported projects. As such all its funded projects are required to promote gender equality, allocate resources to women-led initiatives, and conducting gender-responsive assessments for proposed interventions The focus extends to ensuring that GCF-backed projects aid vulnerable and marginalised communities, enhancing their adaptive capabilities against climate change impacts This involves provisions for clean water access, food security, and sustainable livelihood opportunities, particularly for those disproportionately affected by climate change. The GCF's objective is to foster a more equitable, sustainable future amid climate challenges.

The findings from the social evaluation noted that despite South Africa's adequate legal support for gender empowerment and parity aspirations, the legal provisions have failed to transform gender perspectives on the ground. This includes underrepresentation in science, technology, engineering and mathematics (STEM) fields, gender pay gaps, and alarming levels of gender-based violence and crimes against women. Rural women face exacerbated challenges compared to their urban counterparts, particularly regarding climate change impacts.

At DM and LM level institutions, gender mainstreaming was notably lacking. Insufficient support systems and mechanisms for comprehending and appreciating gender mainstreaming were evident, reflected by absent gender plans or budgets in Integrated Development Plans (IDPs). Gender focal points, predominantly in charge of social services, lacked seniority to influence decisions and lacked action plans guiding their activities. In most of the cases the gender focal points failed to explain their roles and had no idea whether the municipality had a gender strategy or not. Across all DMs, gender focal positions were mere add-ons, lacking clear targets beyond monitoring women's numbers in municipal positions. Another major gap observed at all levels, both nationally and locally, was the dearth of gender-disaggregated data.

Recommendations stemming from these findings spanned national efforts requiring concerted action to address gender-based violence, incentivise girls and women to take up STEM, and ensure equitable remuneration. While these challenges exceed the Eco-DRR project scope, mitigative actions can occur at project sites through awareness, training, and inclusive interventions Training in gender mainstreaming and the development of action plans and tools for gender focal points are crucial and can be integrated into the project. Emphasis is placed on collecting, analysing, and producing gender-disaggregated reports as practically feasible

RECOMMENDATIONS FOR A TRANFORMATIVE APPROACH

There is strong evidence that EbA can be supportive in building climate resilience in communities vulnerable to climate change, within both urban and rural contexts. Many scientific studies support this assertion, and as a result, the policy and strategy instruments of South Africa have introduced EbA and Eco-DRR approaches into the national approach towards the management and development of natural resources. However, there is some uncertainty as to the magnitude of the role ecosystems can play in climate adaptation.

It has become increasingly recognised that the goods and services accrued from ecological infrastructure play an important and increasing role in both adaptation and DRM. Interventions to support the rehabilitation and restoration of ecological infrastructure can serve to increase the resilience of societies to both abrupt and slow-onset climatic and non-climatic hazards, reduce impacts on human health and mortality, and improve overall liveability, wellbeing and sustainability of both urban and rural areas while also promoting biodiversity and environmental quality.

Ecosystem management not only offers an opportunity to strengthen natural infrastructure and human resilience against hazard impacts, but also generates a range of other social, economic and environmental benefits for multiple stakeholders, which in turn feed back into reduced risk. The Eco-DRR project aims to support the sustainable management, conservation and restoration of ecosystems to reduce disaster risk in diverse ecosystems, with the aim to achieve sustainable and resilient development.

1. *Eco-DRR Ecosystem Service Restoration Recommendations*

Site-level implementation interventions are most likely to be scalable and sustainable within 3 of the 5 DMs that were initially identified. These being Alfred Nzo, Joe Gqabi and Ehlanzeni DMs. In these areas, the experienced NGOs are capacitated to support implementation and assist in facilitating private sector engagement. However, with other project support being targeted for Joe Gqabi DM, it is recommended that the Joe Gqabi DM not be included in the Eco-DRR project, noting that the proximity of Joe Gqabi and Alfred Nzo DMs will still be supportive of ongoing knowledge exchange and co-learning between the two projects. This also enables funding to be used to implement at greater scale in the Alfred Nzo and Ehlanzeni DMs.

The enabling environment within 2 of the 5 DMs (namely Ngaka Modiri Molema and Sekhukhune DMs) requires significant capacitation and support to be ready to undertake local-level interventions for Eco-DRR and be able to sustain these into the future. The lack of a foreseeable market to bring finance into Eco-DRR in these districts will also require significant groundwork to prepare the enabling environment. As such, the lessons from the other site-based interventions will be important learning opportunities. It is therefore recommended to run demonstration interventions in these two DMs as part of the learning process.

Building on the planning and capacitation that has be undertaken, the implementation of site -based Eco-DRR interventions will be critical in providing the data, information and knowledge necessary to develop the business cases required to support private sector investment. This implementation is proposed take place in two DMs, namely, Alfred Nzo and Ehlanzeni DM, with the full support of an implementation hub that aims at providing support to the roll out implementation activities at relative scale.

Table E-3: Summary of proposed ecosystem restoration and rangeland management interventions in Alfred Nzo and Ehlanzeni DMs

Type of intervention	DM		Total
	Alfred Nzo (ha)	Ehlanzeni (ha)	
Clearing of IAPs (woody species)	2337.00		2,337.00
Improved landscape management in upper catchment areas		14,517.00	14,517.00

River rehabilitation and wetland restoration (including hard and soft interventions)	234.31	608,40	842.71
Rotational grazing/resting (eco-champs / enviro-champs)	10, 203.18	25,575.70	35,778.88
Total	**12,774.49**	**40,701.10**	**53,475.59**
Total Area of Land Under Improved Management	**12774.49**	**40701.10**	**53475.59**

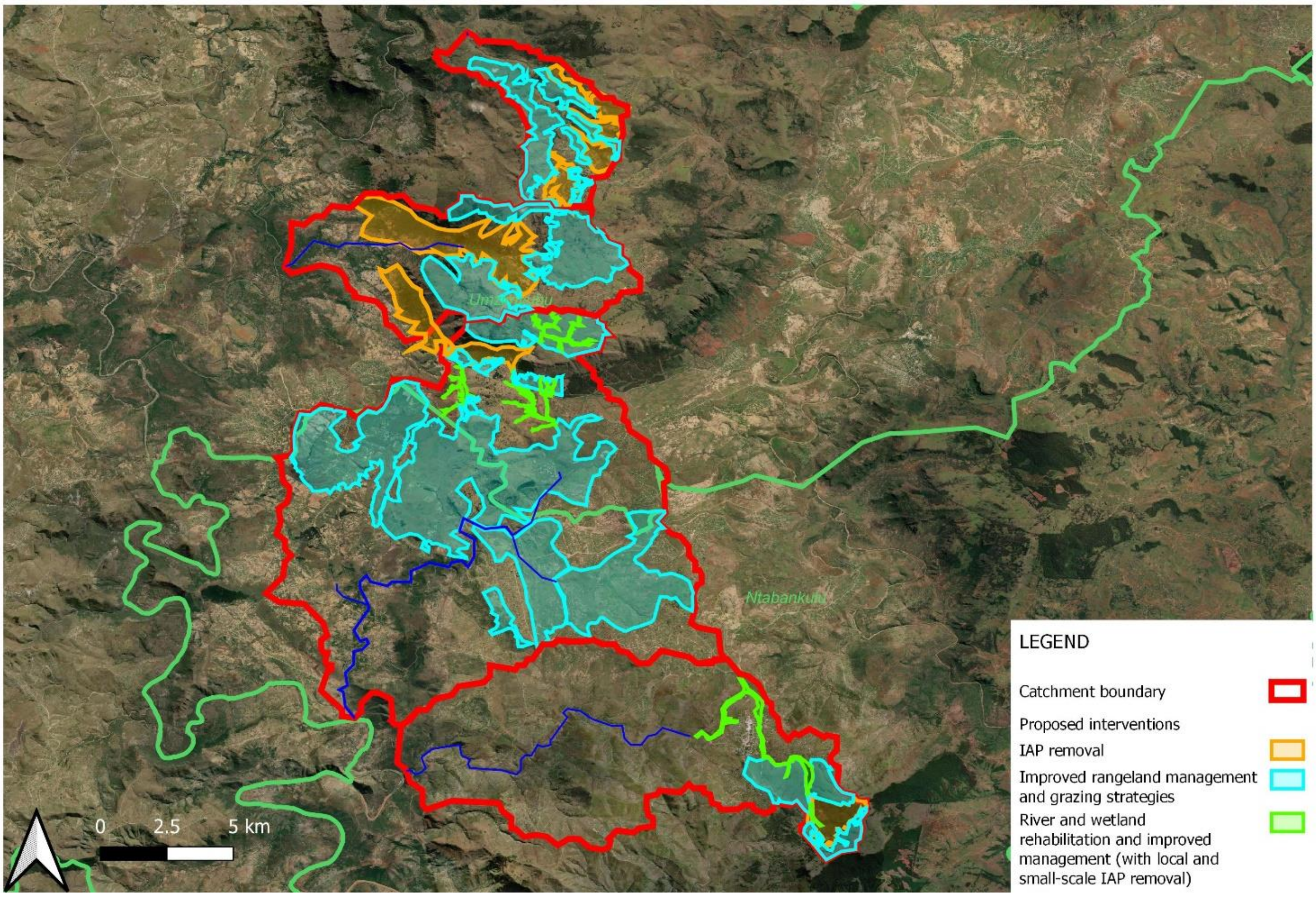

Figure E-2: Recommended and mapped interventions within Alfred Nzo DM

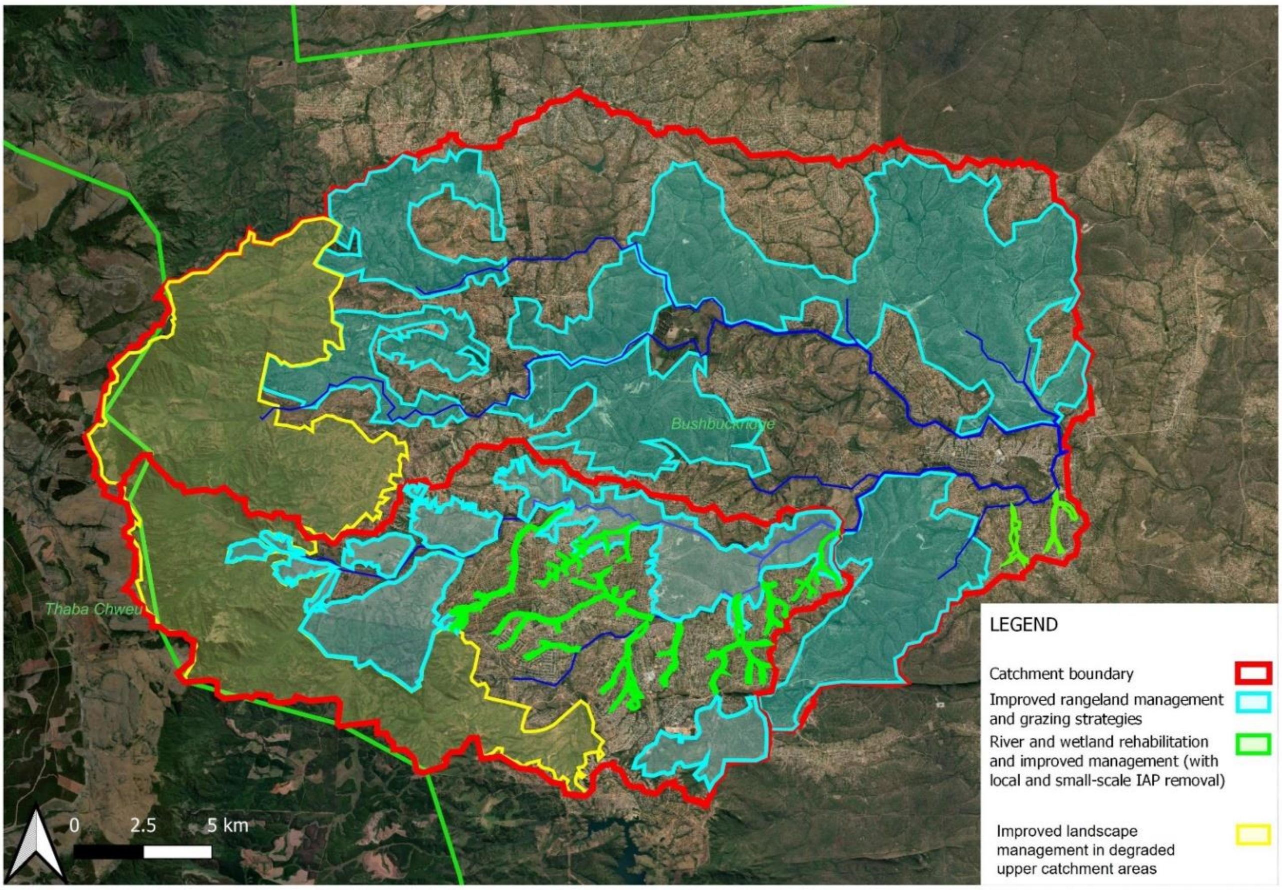

Figure E-3: Recommended and mapped interventions within Ehlanzeni DM

Noting the challenges in the receiving environment within Ngaka Modiri Molema and Sekhukhune DMs, it is recommended that a demonstration approach be utilised while, over the duration of the project, ongoing efforts (supported by the demonstration) assist to build a more receptive and enabling environment for Eco-DRR. In effect, these interventions will then also support efforts to mainstream Eco-DRR and EbA approaches into municipal planning.

Table E-2: Summary of proposed ecosystem restoration and rangeland management interventions in Ngaka Modiri Molema and Sekhukhune DMs

Type of intervention	DM		Total (ha)
	Ngaka Modiri Molema (ha)	Sekhukhune (ha)	
Clearing of invasive woody alien plants		110.76	110.76
Improved rangeland management			
- Rotational resting and grazing	1558.00	12928.40	14486.40
- Rotational fencing	69.60		69.60
- Revegetation	69,60	28.19	97.79
- Zai Pits	180.00		180.00
Wetland and riverine rehabilitation			
- Brushpacks	9.16	23.40	32.56
- Vegetative strips	9.16	19.95	29.11
Total Area of Interventions	**1895.52**	**13110.70**	**15006.22**
Total Area of Land under Improved Management	**1558.00**	**12976.70**	**14534.70**

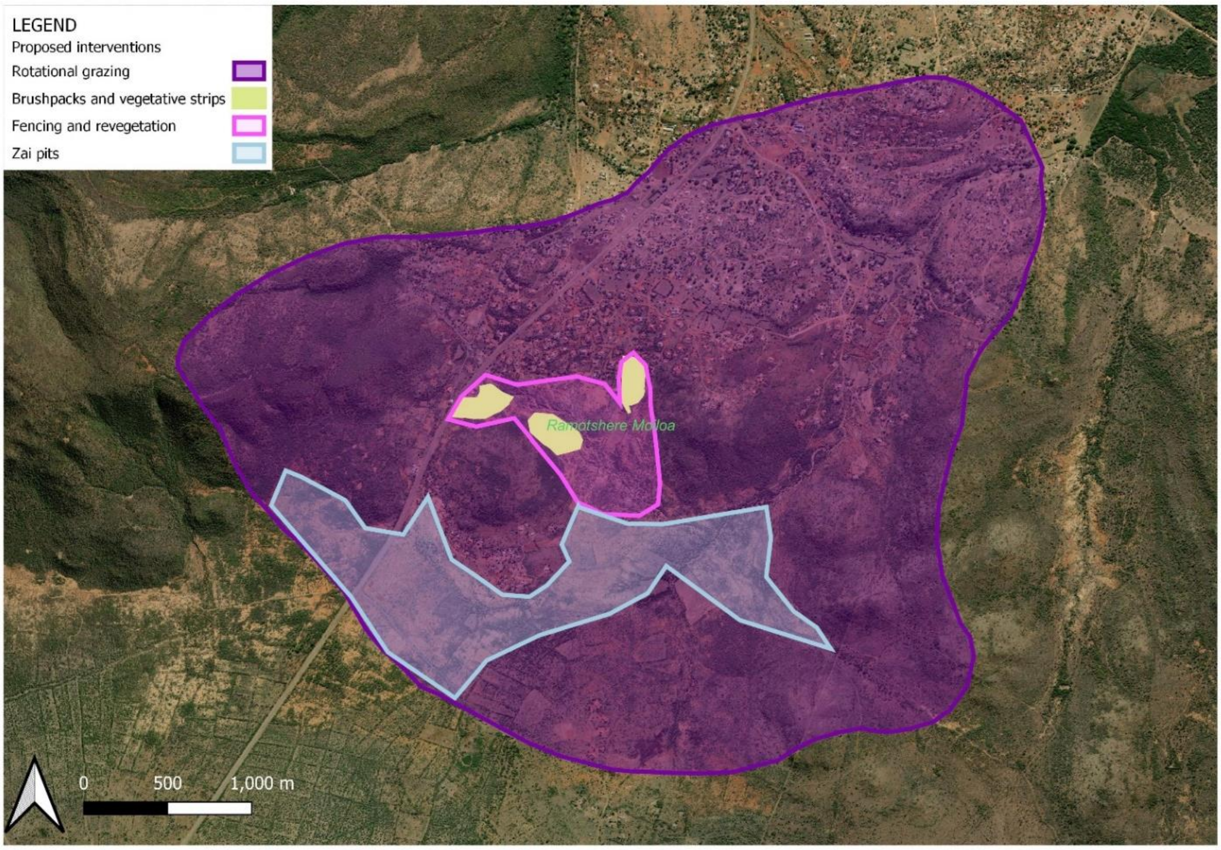

Figure E-4: Recommended and mapped sites for Ngaka Modiri Molema DM

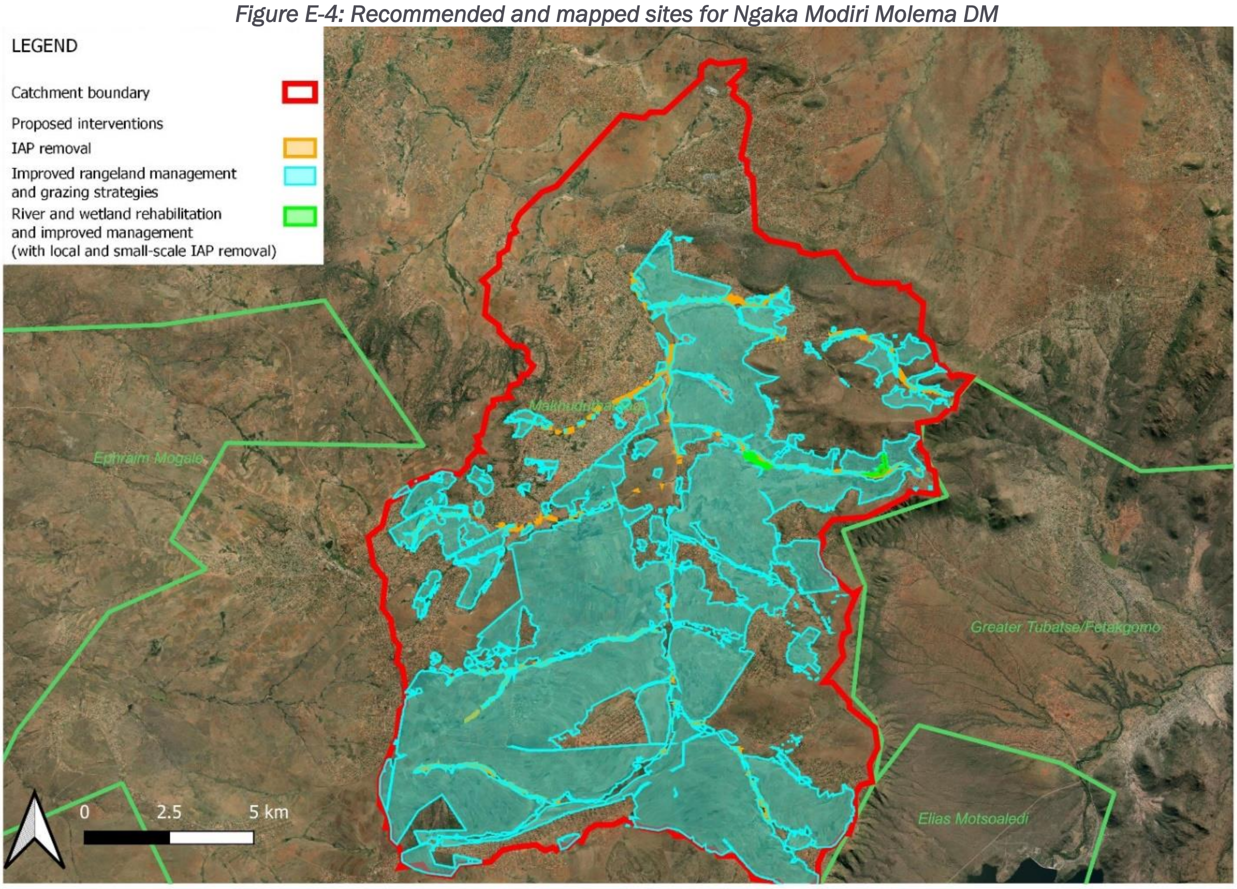

Figure E-5: Recommended and mapped sites for Sekhukhune DM

The number of direct beneficiaries in the 4 DMs are provide in the table below.

Table E-5: Direct beneficiaries from interventions related to ecosystem service restoration

DM	Number of Households	Total Number of People
Ehlanzeni	**62,281**	**249,124**
Female (52.8%)		131,537
Male (47.2%)		117,587
Alfred Nzo	**10,907**	**43,628**
Female (53.1%)		23,166
Male (46.9%)		20,462
Sekhukhune	**17,517**	**70,068**
Female (53.11%)		37,213
Male (46.89%)		32,855
Ngaka Modiri Molema	**817**	**3,268**
Female (51.31%)		1,677
Male (48.69%		816
Total	**91,522**	**366,088**

2. ***Eco-DRR Focused Disaster Preparedness and Planning Interventions Recommendations***

Through the workshops and project design discussions held, it is apparent that the Disaster Management Centres, that function at a district level, are typically under resourced and under capacitated. This presents significant logistical challenges when disasters occur, thereby placing lives and livelihoods at risk. It is therefore imperative that the project provides support to the 4 DMs to strengthen their EWS and the communications so that they are fit for purpose and are timeous to ensure communities vulnerable to climate change can avoid the loss of lives and livelihoods. The development of improved approaches to disaster preparedness provides a useful opportunity to share lessons and knowledge between the various DMs. Noting that the improvement of EWS at DM level will have impacts on all those people who reside within the DM, the number of beneficiaries from these interventions, based on municipal reports (2022-2024), are presented in the table below.

Table E-6: Number of direct beneficiaries across Alfred Nzo, Ehlanzeni, Ngaka Modiri Molema and Sekhukhune DM from improved EWS, communications and hazard avoidance practices

DM	Total Number of People
Ehlanzeni	**2,021,773**
Female (52.8%)	1,064,324
Male (47.2%)	957,449
Alfred Nzo	**892,833**
Female (53.1%)	473,883
Male (46.9%)	418,950
Sekhukhune	**1,266,737**
Female (53.11%)	669,270
Male (46.89%)	597,467
Ngaka Modiri Molema	**934,455**
Female (51.31%)	477,472
Male (48.69%	456,983
Total	**5,115,798**

Climate change and its impact of future hazards as well as the importance of ecosystem services and ecological infrastructure in reducing the impact of these hazards, needs to be mainstreamed into all planning instruments. Working with the DMs and LMs to identify critical built infrastructure where the integration of ecological infrastructure can improve climate resilience is key. Equally, integrating ecological infrastructure into new build plans is also a vital area of the Eco-DRR project to address. Supporting this will also build institutional capacity and will enable the transfer of these skills to other LMs. The varying levels of quality of these planning instruments regarding DRR also requires attention. Undertaking actions to strengthen planning across all 4 DMs will be imperative, with a focus on learning from the LMs where site level interventions will take place.

The Green Book is pivotal in helping South African municipalities understand and mitigate climate risks, contributing to the country's broader developmental goals. The Statistics South Africa National Census 2022 has now been released and the Coupled Model Intercomparison Project Phase 6 (CMIP6) is also now available. Furthermore, there have been improvements in the approach to adaptation and these also need to be updated in the tool. As this tool's primary aim is and remains to aid the public sector in integrating and prioritising climate change considerations within municipal planning for human settlements, providing support to get the Green Book updated and strengthened is important to support resilience building.

3. *Upscaling Pathways for Eco-DRR Recommendations*

Developing a viable business case to support investment in Eco-DRR will need engagement with the South African government regarding a range of policy matters that will require clarification. In this regard, there are various aspects that need to be addressed to facilitate private sector investment. This discourse is complex and politically challenging and project design must recognise that this requires dedicated time and effort. While these policy related matters are being resolved there will be opportunity to meet with a range of private sector investors to alert them to the project and the potential that this holds. This market sounding will also assist in the above-mentioned discussions with the South African Government by providing issues of concern and core elements of risk that financiers will want resolved.

The site level interventions outlined as part of the project design will provide a rich evidence base which will support the development of business cases that can be utilised to garner investment support. It is clear from this feasibility study that there are sites where Eco-DRR related activities are already underway with the potential for upscaling and it is recommended that the project design investigate, during its inception / start-up phase, sites where evidence and experience can be drawn to strengthen the development of these business cases. Once the business cases have been developed, it would be useful to explore further sites where these could be implemented. Noting the Community of Practice that would have been developed, these could be fairly swiftly accessed.

The data, information and knowledge gaps are significant. The data and information needed to support Eco-DRR and EbA will be clarified during the site level interventions, and the lessons from this will need to be shared with the key government departments and agencies in order to develop improved monitoring networks, better information management systems and revised data sharing protocols. This will require attention at national levels to support the development of Natural Capital Accounts, as a key priority for the government in driving towards better-informed decision making.

Based on the feasibility study the recommended project design is presented below, with a more detailed Theory of Change (ToC) being presented in the Funding Proposal.

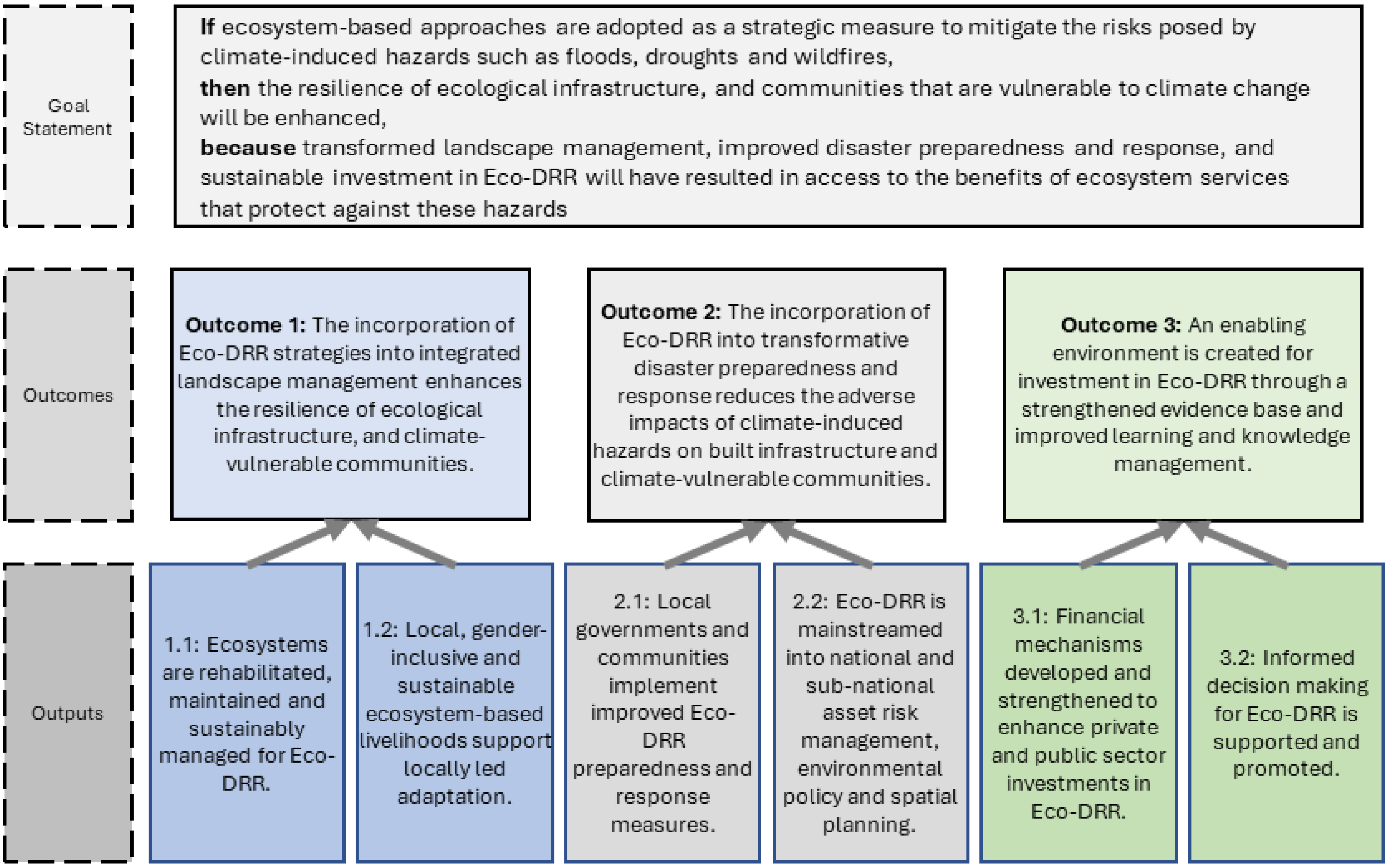

Figure E-6: Eco-DRR project design

1 Introduction

1.1 PROJECT BACKGROUND

The impacts of climate change have been felt across South Africa with the frequency and severity of droughts, floods and wildfires increasing. Climate projections show that this trend, including changes in intensity and unpredictability, will continue. These hazards are leading to escalating risks of significant impacts on South Africa's wider economy and both the urban and rural livelihoods and its most vulnerable populations.

In response, South Africa's National Biodiversity Institute (SANBI) is preparing a full application, with the associated supporting documents, to the Green Climate Fund (GCF) to fund a programme to scale up ecosystem-based approaches to managing climate intensified disaster risks in vulnerable regions of South Africa (the Eco-DRR project). Ecosystem-based approaches are broadly accepted as a cost-effective and sustainable means to promoting resilience in communities vulnerable to climate change intensified droughts, floods and wildfires and this project will utilise ecosystem-based approaches to reduce the impacts of climate change to the benefit of 5 481 886 people. This will be achieved through the rehabilitation of vulnerable catchments, the integration of ecosystem-based approaches into settlement planning and disaster risk reduction (DRR), and the creation of an enabling environment that unlocks private sector finance and scales best practices across South Africa. As part of the GCF full funding proposal (FFP) application process, a concept note was developed for the Eco-DRR project which was initially endorsed in 2019 and subsequently revised.

SANBI followed up the concept note development with a multi-stakeholder consultation and engagement process, examining, together with the National Disaster Management Centre (NDMC) and the Department of Forestry, Fisheries and the Environment (DFFE), the spatial overlap of climate change hazards on drought, flood and wildfire hazards with the additional vulnerability factors relevant to the programme. Through a consensus-driven approach coupled with a Project Site Selection Workshop in 2021, seven priority district municipalities (DMs) were selected within the high-priority at-risk tertiary catchments that also reflected the criteria above. At the outset of FFP development, further analysis was undertaken, focusing on a sub-set of quaternary catchments (QCs) within the seven DMs. As a result of this analysis, the project scope was narrowed to 5 DMs that were subjected to further analysis and feasibility assessments. The results of this analysis together with the initial findings of the feasibility study informed a further adjustment to the project design, and a narrowed focus to only 4 DMs. The final set of DMs that are the focus of the Eco-DRR project proposal are as follows:

1. Alfred Nzo DM – in Eastern Cape Province;
2. Ehlanzeni DM – in Mpumalanga Province;
3. Sekhukhune DM – in Limpopo Province; and
4. Ngaka Modiri DM – in North West Province.

Joe Gqabi District – in Eastern Cape Province is now also excluded.

It is important to note that the feasibility study aims to assess the feasibility of undertaking Eco-DRR interventions within the 5 DMs. As such, this report reviews all 5 DMs – Joe Gqabi, Alfred Nzo, Ngaka Modiri Molema, Sekhukhune and Ehlanzeni

– and presents findings for each DM and the reader is asked to bear this in mind. Through the feasibility process and analysis, it was possible to determine which interventions are feasible and in which geographic areas. These results informed the finalisation of the site selection process and resulted in the exclusion of Joe Gqabi DM..

1.2 PURPOSE OF THE REPORT

The objectives of this Feasibility Study Report are to provide details of the analysis undertaken for the submission of a FFP for the proposed interventions. This includes providing details on the following:

- Analysis of spatial and non-spatial data, specifically related to the five selected DMs, that enabled the final selection of implementation sites and identification of interventions at these locations.
- Analysis of the enabling environment and the opportunities that exist to strengthen this to support the mainstreaming of Eco-DRR interventions into policy, planning and practice.
- The transformative evidence base to justify the Theory of Change (ToC) and alignment of the ToC with a logical framework for the implementation of selected Eco-DRR interventions in each of the identified project areas.
- Financial and economic appraisals of the identified Eco-DRR interventions.
- Gender, environmental and social plans applicable to the proposed interventions.

1.3 STRUCTURE OF THE REPORT

The structure of the report is as follows:

1. **Introduction:** presents the project background and the purpose.
2. **Status quo of Eco-DRR in South Africa:** describes the status of Eco-DRR in the country including ecosystem-based adaptation (EbA) and Eco-DRR implementation; benefits of investment in Eco-DRR, and the role of EbA and Eco-DRR in response to and droughts, floods and wildfires.
3. **Governance frameworks in South Africa:** details the policy, legal and institutional frameworks for climate change, DRR and EbA in South Africa as well as the assessment of the enabling environment for Eco-DRR.
4. **Undertaking feasibility studies for Eco-DRR:** outlines the climate rationale and the process used to select the sites assessed in this report.
5. **Eco-DRR interventions:** presents an overview of the types of Eco-DRR interventions proposed for sites being assessed in the feasibility study.
6. **Hydrological evaluation:** details the methodology used for the hydrological modelling and the findings from the analysis for the 5 DMs.
7. **Economic evaluation:** describes the approach used for the cost-benefit analysis (CBA) as well as the costs of the proposed interventions in the 5 DMs and benefits of the proposed interventions.
8. **Social evaluation:** outlines the results from the social evaluation for the five DMs.
9. **Recommendations for a transformative approach:** presents the recommendations for the Eco-DRR project based on the findings from the feasibility study.

2 Status Quo of Eco-DRR in South Africa

2.1 EBA AND ECO-DRR IMPLEMENTATION

According to Climate Adapt, EbA refers to ecosystem restoration and enhancement of ecosystem services to protect society against negative impacts of climate change (Climate Adapt, n.d.). As per the Convention on Biological Diversity, EbA is defined as the use of biodiversity and ecosystem services to help people adapt to the adverse impacts of climate change (Convention on Biological Diversity, 2009). DFFE defines EbA in line with the Convention on Biological Diversity's definition of the term and this is noted in the National Climate Change Adaptation Strategy (2019). "Ecosystem-based *adaptation*" was originally a concept introduced in the non-governmental organisation (NGO) and intergovernmental spaces as a natural approach to combat the impacts of climate change and extreme weather events. The term "Ecosystem-based Adaptation" was coined in 2008 by the International Union for Conservation of Nature and its member institutions at the United Nations Framework Convention on Climate Change (UNFCCC) that same year.

EbA approaches are recognised as an important tool in enhancing climate resilience. These approaches are highlighted in several national instruments as a key feature that supports the country's strategy to address climate change impacts. The power of EbA lies in its exceptional ability to provide intervention options that modify livelihood and infrastructure approaches in the short-term and at a local-level on a project-by-project case. EbA also has the potential to be widely transformative in the way societies and economies function – namely by ensuring sustainability into the future. Ultimately societal and economic vulnerabilities are reduced, while resilience within communities and at livelihood-scales improve. The logical implications from the application of these EbA approaches are apparent. However the practical implications when the impacts of these approaches are measured, monitored and reported on, are more subtle. Section 9.1 explores these subtleties towards a transformative approach which the Eco-DRR project aims to achieve.

EbA integrates the sustainable use of biodiversity and ecosystem services into an overall adaptation strategy (Baig, et al., 2016; UNEP, n.d.). The concept of ecosystem services considers the usefulness of nature for human society - with the meaning of the term referring inadvertently to the benefits that the natural environment and healthy ecosystems provide to societies and to economies. While the discussion related to ecosystem services was implicit for decades (being first brought to light by (Marsh, 1864)), the Millennium Ecosystem Assessment in the early 2000s popularised the concept, and ushered in the concept of financial benefits and economic valuation associated with these services. In this context, ecosystems include, for example, agroecosystems, forest ecosystem, grassland ecosystems, and aquatic ecosystems. These ecosystems, functioning in healthy relationships with each other and with the communities within and around which they exist, offer important services such as:

- Pollination of crops,
- Clean air,
- Cooling through high albedo effects,
- Water filtering,

- Infiltration of surface water to replenish groundwater resources,
- Curbing soil erosion and runoff,
- Carbon sequestration, and
- Contributing to human mental and physical wellbeing.

Collectively, these benefits are known as ecosystem services, and are often integral to, among others, provisioning of clean drinking water, management of stormwater / flood protection, decomposition of waste, and the resilience and productivity of food ecosystems.

Within the current context of EbA, ecosystem services can be grouped into four broad categories: *provisioning*, such as fertile soil, support to rangeland livelihoods, crop production, and water provision; *regulating*, such as air temperature regulation and flood control; *supporting*, for example nutrient cycles and oxygen production; and *cultural*, which relates to livelihood approaches where the ecosystem in many traditional settings drive local community beliefs and practices, and present spiritual and recreational benefits. An approach to ecosystem services enactment invariably led to what is now commonly referred to as EbA.

Poor urban and rural communities in South Africa are dependent to a large degree on natural resources and ecosystem services in support of their livelihood stacks (DEA & SANBI, 2018). Livelihood stacks refer to the combination of livelihood options which individuals or households, or groups of individuals or households in communities, apply toward achieving basic access to food, water, finance and the like. These "stacks" may change over time, or even be seasonal and can include the following:

- Dependence on access to areas where wood for fuel or charcoal is available,
- Transportation options that may depend on accessibility during rainy seasons,
- The availability of feed and rangeland vegetation for livestock, or
- Seasonal production of different crops.

Where ecosystems thrive, the livelihood stacks are often well-supported and the balance in harvesting of natural and agricultural resources are sustainable whilst Eco-DRR services are then being provided by those ecosystem services. In such settings, EbA can play a role to enhance the resilience further and build economic and societal strength. However, where ecosystem services are lacking, in poor condition or under-valued, the DRR elements that may be offered by natural systems – whether in the form of buffer zones or barriers to hazards – do not exist or are not functioning adequately. In this latter scenario, EbA measures are required as a critical intervention to reduce the worst of the impacts, prevent further degradation, and give communities the opportunity to become more resilient. This also allows for communities to adapt both their behaviour and their living environment to further increase the positive impacts of EbA interventions (Sack, 2024).

Given that vulnerable and peri-urban or rural communities in South Africa are more directly dependent on natural resources and ecosystem services for their livelihoods, the use of carefully designed EbA initiatives that restore, protect or enhance ecosystems and ecosystem services can make a substantial contribution towards building the resilience of these communities (Sack, 2024). Additionally, existing efforts (such as the work undertaken by DFFE's Environmental Programme (DFFE:EP) including the "Working For" programme) that would support the effective implementation and community-level uptake of initiatives such as those proposed in this study, have already set the scene to ensure that the proposed interventions would be long-lasting and promote (in measurable and immeasurable ways) community resilience in the proposed districts.

EbA can encompass community-based adaptation projects, community-based natural resource management projects and climate change integrated conservation projects. By focusing on community-based efforts, this presents opportunities for addressing specific gender needs identified in the different areas. The integration of gender into EbA can significantly enhance the effectiveness and sustainability of all interventions. By recognising and addressing gender-specific roles, responsibilities, and knowledge of the recipient communities, related to natural resource management, these approaches can better account for the diverse needs, preferences, and contributions of different genders within communities. This integration fosters more inclusive decision-making processes and ensures that interventions are tailored to the specific contexts and priorities of both men and women and other marginalised communities. Moreover, empowering women and marginalised communities, and promoting gender equality can lead to more equitable distribution of benefits derived from ecosystem services, enhance social cohesion, and strengthen the resilience of ecosystems and communities in the long term.

2.1.1 Mainstreaming of EbA and Eco-DRR in South Africa

The mainstreaming of Eco-DRR as an aligned focus on EbA has been the focus of many an endeavour in the South African strategy and planning environment. Examples include, at a national sphere, the development of climate change adaptation and response strategies for sectors including but not limited to water (DWS, 2023), human settlements (DHS, 2024), health (Department of Health, 2024; DFFE and Department of Health, 2023) and others – all of which are being directed through the overarching alignment and integration that DFEE provides. From these initiatives, spin-offs are created that support practical implementation of climate-focussed adaptation efforts. This includes various sector-focussed leadership groups that comprise of government representatives, private public partnerships, civil society, private sector, NGO's, and community activists. Examples of such groups are the Water and Sanitation Sector Leadership Group (led by the Director General of the DWS); and the National Climate Change and Health Steering Committee (established by the Department of Health and includes a wide range of role players such as South African Weather Service (SAWS) and the South African Medical Research Council). Mainstreaming processes at the national sphere all provide the necessary national framework for the positioning of Eco-DRR and EbA projects and programmes at local levels.

The mainstreaming of EbA flows through to the provincial sphere as well. There are numerous examples of the integration of EbA in provincial directives and frameworks. For example, the Gauteng Province embarked on investigations into the mainstreaming of DRR and climate change adaptation (COGTA, 2017), while the Western Cape Province consistently presents efforts on integration of EbA across their operations (WCPDMC, 2023; Western Cape Government, 2018; Western Cape Government , n.d.). With this overarching setting, the situation allows for strong local action that can draw on support from government actors and promote buy-in across government departments. Such positive support ensures that localised action has a basis from which to achieve significant success.

Drawing on the national and provincial impetus, there are examples in the local government sphere that showcase efforts to mainstream EbA into their processes and systems – especially through localised public participation – thus fostering a sustainable and just transition to a lower carbon economy under a changing climate (Mugari & Nethengwe, 2022). In their research reporting on development planning processes, Mugari and Nethengwe (2022) found high-level drives towards Eco-DRR mainstreaming, across the country. However, they highlighted the concern that there is still little evidence regarding how the Eco-DRR approach is applied at the local level. Even though integration is taking place at municipal level through selected initiatives – such as the integration of pandemic responses as a climate-related influence into DRR Planning (City of uMhlatuze and GIZ, 2021) - to date, the recognition of the emergence of EbA remains limited.

Mugari and Nethengwe (2022) further notes that it remains unclear as to the exact extent that Eco-DRR approaches are integrated into local development planning (through, for example, integrated development plan (IDP) processes) and that opportunities exist for further integration – especially in rural areas. This gap is largely due to the consideration that projects and IDP activities do not classify as, or include, ecosystem-based terminology as a specific feature of its narrative. Through deeper investigation, they did find that IDPs from 'mostly rural' local municipalities (LMs) did integrate aspects such as localised climate trends, hydroclimatic risks, risk and vulnerability assessments, DRR actions, early-warning systems, financing mechanisms, integration of traditional and technical knowledge, stakeholder engagement, and alignment with district, provincial, and national priorities. Mugari and Nethengwe's (2022) findings include that although all plans address DRR, the explicit reflection on Eco-DRR, despite having actions that relate to Eco-DRR, does not come to the fore.

2.2 BENEFITS OF INVESTMENTS IN ECO-DRR

In this section, the potential benefits arising from investment in EbA considering flood, drought and wildfires is considered, as well as other co-benefits associated with restoration and rehabilitation. It is important to acknowledge that restoration at scale involves landscape-level processes that are complicated by a range of biophysical and socioeconomic factors (FAO, 2019; Hughes *et al.* 2016). Few studies have attempted to quantify exact or quantitative values for EbA benefits (Holden, et al., 2022; Rasmussen, et al., 2021; O'Farrell, et al., 2019), particularly in lower to middle income countries (LMICs), which is why the vast majority of published research on the subject has chosen to model the phenomenon (e.g. Bester *et al.* 2019; Hughes 2018; Mander *et al.* 2017; Blignaut *et al.* 2010). Furthermore, there is a time lag between the implementation of the interventions and the impact (Annandale *et al.* 2016). This section provides a summary of studies that attempt to estimate or quantify the benefits of investment in ecological infrastructure. A number of the studies referenced below focus on sediment reduction associated with dams. These have been included here for two reasons. Firstly, sediment yield can be used as a proxy for flooding (higher sediment yields are associated with higher runoff volumes and velocities) and secondly, in the case of Joe Gqabi DM, the study area is located in the Mount Fletcher Dam catchment and consequently, ecological infrastructure investments will contribute to sediment reduction associated with the dam.

2.2.1 Considerations When Measuring the Quantitative Benefits of Investments in Ecological Infrastructure

There is general agreement that field-derived quantitative data in the impact of restoration interventions is limited. DEA (Undated) acknowledges that in enabling the restoration of grasslands, many key elements for implementation at a local scale are not well understood, including costs of implementation, broader business plans or the socioeconomic benefits of different implementation models and that research and development through stages of early implementation is required. In particular, the required capacity and cost elements are not well understood.

In addition, several authors note that few studies in South Africa have gathered quantitative (*in situ*) data on soil erosion, flooding and drought benefits associated with ecological infrastructure and highlight the need for long-term field monitoring to inform modelling (e.g. Le Roux *et al*., 2007, Dlamini *et al*., 2011; Gyamfi *et al*., 2016), with scarce human resources, site remoteness, cost and logistical challenges considered to be major constraints. Further, the interlinked social, ecological and economic benefits are not well documented or quantified in South Africa (Hughes, 2018).

While there is extensive information on costs and benefits of built infrastructure, the same cannot be said for investments in ecological infrastructure, leading to higher perceived risks and uncertainty associated with ecological infrastructure investments (UNEP, 2014; Mander *et al*., 2017). Furthermore, the current knowledge base on catchment processes is not sufficient enough to allow prediction of the impact of different restoration and management techniques on sediment delivery (Palmieri *et al*., 2003). While the science of watershed management is still evolving, at this stage, many of the activities are still experimental; and organisations for watershed management are most likely to be effective only if their structure matches the scale of the problem (Palmieri *et al*., 2003).

Catchment management, when done correctly, has been effective in reducing flooding and soil erosion; however, it should be recognised that it requires investment in catchment restoration over a number of decades (Palmieri *et al*., 2003). Pretorius (2016) notes that preventing soil erosion upstream of dams can deliver substantial benefits to dam lifespans, with increases of up to 25 years.

Valentin *et al*. (2006) studied the impacts of soil erosion control practices in 27 catchments in Southeast Asia, including improved agricultural systems and fodder crops. The major findings of the study were as follows:

- In Lao, the introduction of improved fallow systems and conservation agriculture produced 0.1 t/ha/yr and 0.7 t/ha/yr, respectively, compared with sediment yields of 11.3 t/ha/yr for the current practices of maize and rice production;
- In Vietnam, soil loss recorded as bedload decreased from 7 t/ha/yr with the existing system of cassava to 1 t/ha/yr with indigenous fodder species and 0.7 t/ha/yr under tree plantations;
- In Indonesia, the introduction of fodder crops (*Brachiaria ruziziensis* [a tropical African grass] and *Panicum maximum* [indigenous to South Africa]) to fallow lands (old lands) resulted in a reduction of sediment yield from 10.8 to 2.7 t/ha/yr;
- In Thailand, the introduction of maize as a replacement crop for soya and mung bean resulted in an increase of sediment yield from 4.9 to 11.7 t/ha/yr, highlighting the potential negative impacts of land use change on erosion and sediment yield.

The same study noted that in Thailand in 2004, an extreme rainfall event of 218 mm in six hours resulted in sediment yields of 20 times the average for the previous three years, however, the study catchments which had gauging weirs had sediment yields 10 times lower than the sediment yields from catchments that were not part of the study (control). Conservation practices (improved fallow, conservation agriculture and vegetation strips) in combination with a regular fallow were found to have significant effects in reducing sediment (Valentin *et al*. 2006).

This suggests that there is general recognition of the benefits of investment in ecological infrastructure, but much more research and monitoring is required to validate the benefits. To investigate what potential sediment reduction benefits are associated with investment in ecological infrastructure, a comprehensive literature search found that studies applying field-based measurements are limited. However, a number of published modelling exercises do provide information on the potential benefits.

2.2.2 Considerations When Measuring Qualitative Benefits Associated with EbA

When evaluating EbA, evidence is limited on the actual monitoring and reporting processes while the development of targets and indicators are, in many cases, is still in its infancy. However, when considering EbA in the context of its overlap with Eco-DRR, there is much to be gained from considering the benefits of DRR – specifically the risks reduced or avoided – rather than something "gained" (as many traditional benefits assessments are couched). EbA works from the premise of "win-win" outcomes where communities vulnerable to climate change are progressively protected from extreme weather into the future while simultaneously providing a variety of ecological benefits, such as clean water and food.

Measuring the positive impact of EbA and Eco-DRR interventions has been and remains contentious. When quantitatively measuring the impact of transformative interventions that integrate the interface between the human-natural environment, there is a disjuncture between the timing of the ecosystem-based interventions and the tangible outcome within society at a demographic and socioeconomic level. As a result, there are a variety of monitoring, evaluating and reporting measures that seek to recognise the benefits of a specific intervention. Reporting has to balance the immediate nature of physical interventions[2], with the long-term nature of livelihood stack changes, household income improvements, and tracking of improvements in the general health and wellbeing of a community. The measurement and monitoring of these latter indicators are much more challenging to measure as well as being difficult to attribute to one specific intervention. Quantitative measurements and reporting may reflect on indicators such as "*number of individuals employed (temporary or permanently)*", "*number of households living in x km of the adaptation intervention*", or "*income from sales of charcoal produced from invasive alien plant (IAP) removal*". However, these measurements do not reflect the less tangible positive outcomes that EbA interventions have on society, including the following examples:

- Influences such as reduction in soil erosion on land or sedimentation avoided in water reservoirs;
- Flood damage avoided;
- Incidences of visitations to medical clinics avoided;
- Children able to attend school after heavy rains as opposed to in the past when roads washed away;
- Reduction in solid waste entering rivers and ultimately, the ocean; or
- The mere positive effect that an improvement in their living environment has on communities finding pride in their surroundings.

[2] E.g. ha of land restored, number of trees planted, tonnes of invasive alien species removed - noting that IAP removal is a recurring process, so the tonnages would have to be tracked over time as it reduces and less re-growth of unwanted species occur.

In addition to the positive influences listed above, there are also positive benefits associated with livelihood stacking that needs to be measured. The livelihood stacking shifts may support an improved economic outcome[3] as well as support a balanced approach towards the components that make up livelihood stacks of individuals and communities. This reduces the pressure on natural ecosystems which enables higher-value ecosystem services to emerge. The measurement and monitoring of these types of long-term benefits may not be easy to attribute effectively to the EbA intervention – if at all. It is, however, the ultimate transformation of entire societies and their living habitats that remain the goal of ecosystem-based and Eco-DRR approaches.

2.2.3 Measuring Benefits of EbA

The monitoring, evaluation and reporting of the effectiveness of EbA interventions, to date, has focused predominantly on the assessment of design options and operational indicators (i.e. number of people reached / directly involved; number of ha achieved, number of tonnages delivered, etc.). Using data that can support the assessment of human-nature interactions becomes more challenging since there may be little tangible difference that a community / household survey may reveal - especially in the short-term after an intervention was implemented. Additionally, the longer the time of measurement and monitoring is after the initial intervention is completed, the more difficult it is to directly attribute the benefits to the specific intervention – since there are so many other external influences that may have a positive or negative influence on the area and community involved in the intervention. Regional and global benefits are also seldom measured since the further the positive influences extend away from the initial local geography where the intervention was implemented, the weaker the direct attribution of benefits become.

Measurements can be done through remote sensing applications – such as “% hectares restored” and “% of ha maintained over time” (e.g. tree cover re-generation over one decade) – which do provide options for benefits assessments. However, the timeframe of such impacts can only be determined over a very long period of time – much longer than what international development partners, funding agencies, and government reporting cycles allow for to prove absolute beneficial outcomes and impacts. This creates complexities in trying to qualify and quantity impacts.

CBAs have also been applied in the EbA context (Baig, et al., 2016) with varying levels of success. Direct quantifiable project-based inputs into the approach can be achieved. However it is the long term, more qualitative benefits across social-economic and cultural outcomes that are more challenging to measure. Riera-Speigelhalder, et al. (2023) notes that socioeconomic assessments of EbA is gaining importance due to potential multiple benefits, including social and environmental benefits. Potential co-benefits of EbA include livelihood diversification and biodiversity conservation (Riera-Speigelhalder, et al., 2023) and the measurement of these concepts may lend itself to a more qualitative assessment and recording / reporting of benefits, rather than quantitative.

The challenge faced by researchers worldwide is the ability to reflect on the tangible outcomes of and evidence-based support toward EbA. This evidence base for this is not readily available and the Eco-DRR project will significantly contribute

[3] Improved economic outcomes cannot always be linked to the formal economy.

to this body of knowledge by supporting the development of practical methods and indicators, and approaches to measure impact.

2.3 ROLE OF EBA AND ECO-DRR IN RESPONSE TO DROUGHTS, FLOODS AND WILDFIRES

Over the past four decades, South Africa has experienced more than 82 hydro-meteorological hazards (floods, storms, landslides, wildfires, droughts and extreme temperatures) that have resulted in the death of an estimated 1,692 people and affected more than 21 million people (CSIR, n.d.). The intensity and frequency of meteorological hazards, in particular droughts, floods and wildfires, have increased in South Africa over the past four decades and will likely continue to be more damaging to people, property, and both natural and manmade systems in the future, due to climate change.

2.3.1 Droughts

The frequency and intensity of drought in South Africa has increased due to climate change with drought being one of the major constraints affecting food security and livelihoods in rural communities (Gajjar, et al., 2021). Coping with drought and water scarcity are critical to address major developmental challenges in dry areas, namely poverty, hunger, environmental degradation and social conflict. Drought is a climatic event that cannot be prevented, but interventions and preparedness to drought can help to: (i) be better prepared to cope with drought; (ii) develop more resilient ecosystems; (iii) improve resilience to recover from drought; and (iv) mitigate the impacts of droughts. Preparedness strategies to drought include: (a) geographical shifts of agricultural systems; (b) ensuring rainfall-based systems have more resilient practices; (c) ensuring that rangeland and catchment management practices ensure healthy soils and runoff retention that supports and groundwater recharge; (de)rehabilitating wetlands to store water and support groundwater recharge and (d) removing IAPs that use more water than indigenous species (Gajjar, et al., 2021).

Droughts are a natural component of the South African climate (Ballard, 1986) with major drought periods in the past few decades including 1982–1984, 1991–1992, 1994–1995, 2004–2005, 2008–2009, 2015–2016, and the most recent in 2018–2020 (Mahlalela, et al., 2020; SASSCAL, 2020; Walz, et al., 2020; Unganai & F.N., 1998). Future climate projections and downscaling show that an increasing trend in intensity and magnitude of hydrometeorological hazards (such as periods of high temperatures and prolonged and more intense drought conditions as well as more intense precipitation that often result in floods) is expected under all analysed scenarios.

EbA can reduce the impacts of drought on vulnerable communities. Applying the lens of EbA to settlement planning for communities located inland can result in the allocation of space that is designated as freshwater recharge zones to offset the impacts of drought (USAID, 2019). EbA can also help to maintain water quality and quantity by recharging aquifers and enhancing water storage (Talberth, et al., 2012; Bertule, et al., 2014). Restoration and revegetation that support forests, wetlands and riparian buffers can help filter runoff, reduce erosion and slow sedimentation. Agroforestry and conservation agriculture can also decrease agricultural water demand and strengthen rural communities' resilience, particularly those that undertake small-scale subsistence farming (Vignola, et al., 2015). Further, EbA measures in response to drought preparedness and drought mitigation can assist in achieving flood adaptation goals due to linkages between drought impacts and flood intensity (Solh. & Ginkel, 2014).

2.3.2 Floods

The eastern half of South Africa, especially the coastal and inland regions along the escarpment east of Lesotho, as well as southern Mpumalanga, is expected to see a slight increase in precipitation, while the western half of the country, and in particularly the southwest regions (generally referred to as the 'Karoo') is expected to experience drying. The severity of single rainfall events is expected to intensify, while dry periods in-between the rainfall events, especially towards the south-east and south of Lesotho, is expected to increase dramatically. Maximum one-day rainfall depth and rainfall intensity will increase across almost all the country. The scenario suggests an increased risk of flooding (both fluvial and pluvial), particularly in the eastern half of South Africa. Of particular interest are extreme events due to variable rainfall and flash-flood hydrological regimes as being important characteristics in the semi-arid regions of the country.

These more frequent and intense rainfall events will lead to rapid run-off and increased erosion in catchment areas, reducing infiltration into groundwater, worsening water quality in rivers and decreasing storage capacity of dams through siltation. In systems where dams help to regulate systems and manage these climatic extremes, the reduced functioning of these impoundments can contribute to increased flood risk.

Damages from floods and storms in South Africa between 1968 and 2017 amounted to USD 5.5 billion (EM-DAT, n.d.), while the flood events between 1980 and 2013 impacted upon an estimated 480,000 people (DFFE, 2020). Several floods have been reported across the country including floods in Alfred Nzo DM (2023, 2019, 2017, 2014, 2011 and 2000), Joe Gqabi DM (2018, 2011, and 2001), Ehlanzeni DM (2023, 2018, 2012, and 2000), Ngaka Modiri Molema DM (2023, 2017, and 2014) and Sekhukhune DM (2021 and 2014). These floods caused significant damage to infrastructure including roads, bridges, schools, hospitals and dwellings resulting in billions of rands in damages. The floods also led to loss of life, mainly in rural areas, as well as displacing thousands of people (Davies, 2023; Reliefweb, 2023).

To prevent and/or mitigate the impact that climate change will have on the livelihoods of people living within more rural contexts, it is necessary to focus on measures that would curb the peak and velocity of flood events downstream through attenuation of runoff in the upper catchment areas. Such interventions would ideally support improved infiltration and interception of rainfall and moderate the progression of flood events. Undertaking actions within the upper reaches of catchments can assist with reducing downstream fluvial flooding, whilst land management practices across catchments can reduce the severity of localised pluvial flooding events. In many instances, the effective and efficient functioning and maintenance of stormwater structures, culverts, bridges, and other structures can be supported by effectively managing ecological infrastructure thereby ensuring improved effectiveness in terms of flood prevention. This also increases the lifespan of infrastructure whilst minimising the secondary impacts of built infrastructure on catchments, such as increased erosion, riverine and wetland degradation and so forth.

2.3.3 Wildfires

Wildfires are a natural phenomenon in many of South Africa's ecosystems, including those found in the country's former homelands (Strydom & Savage, 2016), however in future climates it is expected that fire regimes would change. In addition, rising population numbers in these homeland areas, are linked to an increased vulnerability of communities to fires. Moreover, high household densities in these rural areas increase the risk of wildfires spreading rapidly between households, leading to greater losses in property or human life.

Fire management in grassland and savanna biomes is complex due to the presence of fire-adapted/dependent vegetation that often relies on fires with specific characteristics to complete their life cycles (Maurin, et al., 2014). A change in incidence and types of fires can disrupt the natural ecosystems and impact associated economic activities, especially those supporting local livelihoods and businesses. Roughly 84% of human settlements in South Africa are located within ecosystems that rely on regular fire patterns and ecosystem-supporting fire regimes (Le Maitre, et al., 2019). For example, 35,000 fires were reported across the country in 2008 alone, resulting in 380 fatalities and more than ~US$121 million (R2.3 billion) in losses, while 40,000 fires in 2009 led to 376 fatalities and ~US$210 million (R4 billion) in financial losses (Strydom & Savage, 2016).

The majority of settlements in the country reside in fire ecology types that naturally require fires that burn regularly. Bearing in mind the impact of climate change on wildfire severity and frequency in the future, there is need to minimise the risk and impact of wildfires on settlements. Different spheres of government are responsible for implementing DRR processes and measures to prevent wildfire as far as possible through limiting the impacts of wildfire and preparing for wildfire events (e.g. EWS). National government is responsible for creating an enabling environment and guiding local level planning to ensure effective responses to wildfires. In addition, communities also play an important role in managing and responding to wildfires at a local-level, noting their vulnerability to these hazards and the need to improve their resilience through community-based adaptation and preparedness. Furthermore, legislation has been adopted that promotes the formation of fire protection associations (FPAs) - partnerships between fire management authorities and landowners or lessees - to better manage and prevent wildfires (and veldfires). Local government, FPAs and communities need to be adequately prepared to deal with wildfires, including establishing procedures to ensure that their level of preparedness to respond increases in line with increasing fire danger ratings (CSIR, n.d.).

To reduce the impacts of wildfires on settlements and communities vulnerable to climate change-related wildfires, there is need to implement firebreaks and block burns which helps to protect rangelands, lives and properties. Partnering with local FPAs to coordinate these actions coupled with training of communities to establish and manage firebreaks will further ensure that the impact of wildfires on lives and settlements is reduced. In addition, the removal of IAPs will also reduce the amount of biomass, thus decreasing the amount of fuel load for wildfires.

2.3.4 Localised Knowledge Systems and DRR Benefits

Considering the DRR challenges faced in South Africa, there is need to explore opportunities whereby localised and indigenous knowledge systems can be used to improve climate resilience, improve the economic productivity of savannas and grasslands and ensure financial sustainability of the GCF interventions.

The more traditional way of managing cattle and wildlife by rural communities across southern Africa ensured that the vigour of palatable grass species was maximised, the cover of trees and shrubs was kept to a minimum and the livestock productivity of the landscape was maximised. The tight herding ensured that the cattle did not overgraze the palatable grass species. It also resulted in a long rest period for the grazed grass because the tightly-packed herd naturally moved on to new areas after an area had been intensely grazed. Indigenous practices also promoted certain species of wildlife, such as greater kudu (tragelaphus strepsiceros), common duiker (cephalophinae) and giraffe (giraffa camelopardalis), as a means of preventing trees and shrubs from dominating the savanna and grassland ecosystems to the detriment of cattle.

The net effect of this tight herding and long rest periods was an extremely vigorous grass sward, comprised predominantly of highly palatable grass species. The vigour of this grass sward provided the rural communities with maximal resilience to droughts, floods and wildfires because the livestock productivity of the landscape and retention of water in soils was maximised. The effects of the grass sward on woody plant cover, clay dispersion and soil organic matter were of particular importance. First, there was minimal recruitment of trees and shrubs into the ecosystem because of the highly competitive grass sward, particularly that of IAPs (DEA, 2019; Vadigi, 2013; Wakeling, et al., 2015). This ensured that woody plants did not dominate the system to the detriment of the grasses and the cattle. Second, the grass sward covered a large percentage of the soil surface, which protected the soil from raindrop impact (Mills & Fey, 2003; Du Preez & Van Huyssteen, 2020). The loss of topsoils greatly reduces the livestock productivity of the landscape because there is less water and smaller amounts of nutrients available to the grass. The vigorous grass layer ensured topsoils were not lost. And third, a vigorous grass sward maintains a relatively large amount of soil organic matter because of the rapid growth of grass roots, which ultimately die off and get incorporated into the soil (Mills & Fey, 2003; Du Preez & Van Huyssteen, 2020; Stoner, et al., 2021). The livestock productivity of the landscape is strongly associated with its capacity to hold large amounts of water and its capacity to recycle nutrients for further grass growth.

Over the past century, these local practices and associated indigenous knowledge has been lost with the net effect of an increase in the vulnerability of rural communities to droughts, floods and wildfires. Bearing in mind how the encroachment of trees and shrubs into South African savannas and grasslands have greatly reduced the livestock productivity over millions of hectares (DEA, 2019; Vadigi, 2013; Wakeling, et al., 2015; Anedón, et al., 2014; Belayneh & Tessema, 2017).

By reintroducing these practices the project can, over thousands of hectares reinvigorate the quality of rangelands thereby reducing the potential for flooding, reducing the impacts of drought and reduce the prevalence of wildfires having significant impact on the climate resilience of rural communities.

Links Between Climate Change and Soil Health in South African Savannas and Grasslands

Soil health ultimately underpins resilience to droughts, floods and wildfires. This is because healthy soils: i) store more water; ii) produce more healthy and indigenous plant biomass (and therefore economic outputs); and iii) erode less easily.

South African savannas and grasslands have soils that are particularly prone to erosion if not managed well. This is because the clay component in South African sandstone-derived, shale-derived and basalt-derived soils are usually highly dispersive. When the clay component in South African soils disperses, a clay seal forms on the surface of the soil, and water runs off the surface rather than penetrating into the soil profile and moving into aquifers. This water runoff causes erosion, loss of productivity of the landscape, siltation of dam and greater flooding.

Climate change increases the dispersion of clay in our savannas and grasslands for the following reasons:

- Increased temperatures and rapid drying of soils results in loss of soil organic matter in the soil surface (Singh, et al., 2023; Lado-Monserrat, et al., 2014). It is the soil organic matter that binds onto the clays and prevents dispersion.
- A greater intensity of rainfall results in greater raindrop impact on the soil surface. This extra energy on the soil surface results in greater clay dispersion (Mill & Fey, 2004; Vaezi, et al., 2017).
- Greater temperatures result in more frequent burning and more intense fires. This change in fire regime results in a disproportionate loss of calcium and magnesium relative to sodium from the soil surface. The reason for this is that the ash from the fire has a relatively high concentration of calcium and magnesium compared with sodium, and ash is often washed away or blown away. The net effect of these more frequent and intense fires is a soil with less calcium and magnesium relative to sodium (Mills & Fey, 2004).

2.4 THE NEED FOR A NEW APPROACH TO EBA AND ECO-DRR

The status quo of EbA and Eco-DRR in the country highlights the need for a project such as this to usher in a clear and unambiguous directive on natural resource management that is inclusive of climate change adaptation which will inform a new national, provincial and local approach. This new approach would address the need to ensure alignment with hydroclimatic risks, localised climate trends and vulnerability assessments that indicate the severity of hazards and identify populations and areas at most risk (Mugari & Nethengwe, 2022).

However, it is important to recognise that while EbA and Eco-DRR interventions need to be upscaled to build climate resilience, there are also limits to what can be achieved. These are contextual and need to be understood on a case-by-case basis. It is apparent that as ecosystems become degraded, their ability to provide the needed ecosystem services is diminished. Hence, the importance of undertaking rehabilitation actions, together with those that strengthen the capacity to sustainably manage these ecosystems into the future.

In this regard, Eco-DRR provides for interventions that focus upon the sustainable management, conservation and restoration of ecosystems in order to reduce disaster risk to communities (Doswald & Estrella, 2015).

There are clear linkages between EbA and Eco-DRR in that they include the use of nature-based solutions, they both assess vulnerability to design appropriate responses, and they both require the engagement of local communities in designing the necessary plans and actions. However, for every EbA / Eco-DRR intervention, it is important to recognise that each receiving environment (i.e. each DM) involved in the Eco-DRR project has to be considered in its own unique context, with each DM having a significantly different demographic, socio-cultural, economic and environmental setting. In this regard, when assessing the receiving environment in each district, it will be necessary to request stakeholders' input on the following:

- What are the current and proposed land uses in the areas surrounding the Eco-DRR project sites?
- Do the surrounding land uses pose any direct, indirect or cumulative impacts on the Eco-DRR project?
- Are these impacts positive or negative impacts?
- Are these impacts of an environmental, social or economic nature?

3 Governance Frameworks in South Africa

3.1 POLICY AND LEGAL FRAMEWORKS

Managing the impacts of droughts, floods and wildfires on communities is a high priority for the Government of South Africa. This priority is evident in its preparation of several national legislation, policies and strategic plans for climate change adaptation. Climate change adaptation is highlighted as critical in many of South Africa's laws, plans, programmes and strategies, emphasising the importance of drought, flood and wildfire impacts. In addition, these laws, strategies and plans acknowledge the importance of ecosystems and ecosystem services and their role in community resilience.

The implementation of EbA requires a conducive legislative framework that clearly identifies roles, responsibilities and scope across the different spheres of government. In this regard, it is critical to understand the primary policy and legal instruments that are used in South Africa to determine how best to implement EbA that is compliant within the existing framework while also identifying possible gaps that can be addressed through the Eco-DRR project.

South Africa's Constitution provides the overarching legal framework within which all laws, policies and strategies are based upon. Section 24 of the Constitution protects the right to an environment that is not harmful to health and wellbeing while also balancing the right to have the environment protected with rights to social and economic development. The Constitution allocates environmental functions to a wide range of government entities across all spheres of government and requires cooperation between government entities and spheres of government. In this regard, the Constitution provides a framework for intergovernmental and inter-sectoral coordination required for effective implementation of EbA (DEA and SANBI, 2016).

South Africa's Third National Communication to the UNFCCC recognises that climate change effects will lead to increasingly severe and frequent droughts, floods and wildfires, which will significantly impact infrastructure and communities. In response to these hazards, the Communication highlights the need for a comprehensive approach to adaptation measures, including improved infrastructure, land-use practices and water-conservation measures. The interventions under the proposed Eco-DRR project will align with the approach outlined by the Communication (DEA, 2018).

South Africa's National Climate Change Adaptation Strategy (NCCAS) also highlights the increased frequency of floods and an increase in the risk of slow-onset events such as drought in the country prompting the need for climate change adaptation interventions. Under the NCCAS, improving water management and conservation and reducing risk through flood risk management and upgraded infrastructure are emphasised as strategies for climate change adaptation. The strategy also calls for enhancing land-use practices to reduce the risk of floods, including protecting and restoring ecosystems (DFFE, 2020).

In the water sector, the National Water Resources Strategy Third Edition prioritised climate change mitigation and adaptation for the water and sanitation sector. The strategy places emphasis on the importance of ecological infrastructure the need to invest in them, specifically strategic water source areas to promote long-term adaptation to the impacts of climate change. The document goes on to note the need to develop adaptation measures that maximise water security and resource protection under changing climate conditions as well as improving the resilience of societies and economies in the region, including mechanisms to reduce the risks associated with extreme events such as droughts, floods and wildfires (DWS, 2023). The National Water and Sanitation Master Plan (2019) prioritises the protection and restoration of ecological infrastructure in response to degradation and climate change (DWS, 2019). The Master Plan is currently in the process of being updated as well asl the regional water reconciliation strategies, all of which guide climate change interventions in the water sector.

The National Development Plan (NDP) further advocates for strategies that include improved management, infrastructure and ecosystem protections (National Planning Commission, 2014). Overall, the NDP, and NCCAS prioritise the need for an integrated approach to managing the impacts of droughts, floods and wildfires in South Africa. The proposed project will align with these priorities by implementing DRR measures underpinned by integration with established management strategies.

The table below provides a summary that establishes linkages to legislation and policies relevant to climate change and EbA. This table does not serve as a legal due diligence exercise and the primary aim of the table is to showcase alignment to key policies and legislation.

Table 3-1: Relevant national legislation and policy for climate change and EbA

Legislation / Regulation / Policy	Description
National Environmental Management Act 107 of 1998 (NEMA)	• The act provides for cooperative and environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance and procedures for coordinating environmental functions exercised by organs of state. • Environmental Impacts Assessment Regulations and Listing Notices have been published under NEMA to regulate development activities • All project actions will need to ensure coherence with legal and regulatory requirements of NEMA and associated regulations.
Climate Change Act 22 of 2024	• The act seeks to enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development. • The act focuses on alignment of policies and institutional arrangements (including the establishment of the Presidential Climate Commission (PCC)), and sets out adaptation objectives nationally and sectorally, as well as sectoral emission targets and carbon budgets. • Lastly it lays out other general matters such as regulations, consultation, and appeals, etc. • The act has provisions for the development of adaptation scenarios, the development and publication of the National Adaptation Strategy and Plan (which must be reviewed every 5 years); the development and implementation of a Sector Adaptation Strategy and Plan. • The act requires existing premier intergovernmental forums to also serve as Provincial Forums on Climate Change. It also provides for district intergovernmental forums to serve as Municipal Forums on Climate Change. • It also requires climate change needs and response assessments to be undertaken for provinces, metropolitan municipalities or DMs. This must be accompanied by an implementation plan. • Project interventions and outcomes will need to be communicated through municipal climate change forums.

Legislation / Regulation / Policy	Description
Carbon Tax Act 15 of 2019	• The Carbon Tax Act imposes taxes on carbon dioxide emissions. • The Carbon Tax Act provides for the polluter-pays-principle to support the country in achieving its greenhouse gas (GHG) emission targets and Nationally Determined Contributions (NDCs) commitments. • Businesses that engage in activities that produce direct GHG emissions are required to report under the 2017 National GHG Emission Reporting Regulations of DFFE. • The Act also allows for carbon offsets to enable industry to invest in mitigation projects at a lower cost to what would be achieved in their own operations (thereby lowering their tax liability). The offset component also seeks to incentivise mitigation in sectors that are not directly covered by the tax and/or benefiting from other government incentives (National Treasury, 2020). • As of 2024, the carbon tax rate was ZAR 190 per tonne of CO_2, up from ZAR 159 per tonne of CO_2 in the previous year. National Treasury is in the process of consulting to implement the carbon tax penalty of ZAR 640 per tonne of CO_2 for emissions exceeding carbon budgets (Wright, 2024). • Financing mechanisms developed under the project will need to be coherent with this act.
National GHG Emissions Reporting Regulations (2017)	• This document seeks to present a singular national reporting system for GHG emissions, which can be used to maintain the national GHG inventory. • These regulations will need to be considered when looking at the impact of activities linked to carbon sequestration
Spatial Planning and Land Use Management Act 16 of 2013	• The act provides a framework for spatial planning and land use management in the country. • It specifies the relationship between the spatial planning and the land use management system and other kinds of planning; and provides for the inclusive, developmental, equitable and efficient spatial planning at the different spheres of government. • It also provides a framework for the monitoring, coordination and review of the spatial planning and land use management system, as well as a framework for policies, principles, norms and standards for spatial development planning and land use management. • The act seeks to address past spatial and regulatory imbalance and promote greater consistency and uniformity in the application procedures and decision-making by authorities responsible for land use decisions and development applications. • Additionally, the act provides for the establishment, functions and operations of Municipal Planning Tribunals as well as providing for the facilitation and enforcement of land use and development measures. • The act is important for the Eco-DRR project noting that some communities in the target DMs are more adversely impacted by disasters than other communities, as a result of environmental degradation.
Environmental Impact Assessment Regulations, 2014 as amended	• Environmental Impact Assessment Regulations regulates environmental impact assessments which need to be undertaken to obtain an environmental authorisation. • All project actions will need to ensure coherence with legal and regulatory requirements of NEMA and associated regulations.
Environmental Impact Assessment Regulations - Listing Notice 1	• Listing Notice 1 sets out activities that require a basic assessment before an environmental authorisation may be granted. • All project actions will need to ensure coherence with legal and regulatory requirements of NEMA and associated regulations.
Environmental Impact Assessment Regulations - Listing Notice 2	• Listing Notice 2 sets out activities that require a scoping and environmental impact reporting process before an environmental authorisation may be granted.

Legislation / Regulation / Policy	Description
	• All project actions will need to ensure coherence with legal and regulatory requirements of NEMA and associated regulations.
Environmental Impact Assessment Regulations - Listing Notice 3	• Listing Notice 3 sets out activities which, in certain geographical areas, require a basic assessment before an environmental authorisation may be granted. • All project actions will need to ensure coherence with legal and regulatory requirements of NEMA and associated regulations.
The National Environmental Management: Waste Act 59 of 2008	• The act seeks to reform the law regulating waste management to protect health and the environment. • All project actions will need to ensure coherence with legal and regulatory requirements of this act, for example the biomass generated from Alien Invasive Plant removal.
The National Environmental Management: Air Quality Act 34 of 2004	• The act regulates air quality and protects the environment. • It provides the overarching legislation under which the GHG reporting regulations and pollution prevention plans were developed. This links to the project activities that support carbon sequestration.
National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA)	• The NEMBA provides for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998. • It provides for the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; and the establishment and functions of SANBI. • Catchment based activities will need to consider any implications on biodiversity.
The National Environmental Management: Protected Areas Act 57 of 2003 (Amended in 2004 and 2009) (NEMPAA)	• The act provides for the protection and conservation of ecologically viable areas, the establishment of a national register of protected areas, as well as the proclamation and management of these areas. • It provides for a national system of protected areas in South Africa as part of a strategy to manage and conserve the country's biodiversity. • The act also provides for the assignment of national parks, special parks and heritage sites to South African National Parks (SANParks). • Catchment based activities will need to consider any implications on protected areas and heritage sites.
National Disaster Management Framework Act 57 2005 (amended in 2015)	• The document highlights the need for consistency in DRR approaches across multiple interest groups and seeks to provide a coherent, transparent and inclusive policy on appropriate disaster management in South Africa by all sector players. • It also provides for the creation of appropriate institutional arrangements for disaster management by providing guidance on key performance areas, supportive enablers and key performance indicators and for unified DRR interventions. • The amendments to the Act in 2015 introduced several updates and change with the aim of enhancing the country's approach to disaster risk management (DRM). These changes include: ○ Clarifying the policy focus on the rehabilitation and efficient functioning of disaster management centres; ○ Aligning the functions of the National Disaster Management Advisory Forum to support the South African National Platform for DRR; ○ Enabling the South African National Defence Force, South African Police Service and other organs of state to assist disaster management structures, enhancing response capabilities; ○ Introducing an extended reporting system for state organs on occurrences leading to disaster declarations, response and recovery expenditures, risk reduction actions and challenges encountered;

Legislation / Regulation / Policy	Description
	○ Strengthening reporting on the implementation of policy and legislation related to DRR, including the management of allocated funding to municipal and provincial intergovernmental forums; ○ Requiring disaster management plans to include disaster risk assessments for functional areas, risk mapping, and identification of vulnerable areas and communities; ○ Mandating measures for DRR through climate change adaptation and the development of EWS; and ○ Providing regulations for disaster management education, training and research to build capacity and knowledge in DRR. • Project support to municipalities regarding the improvement of DRR approaches will need to align with this framework.
Disaster Management Act 57 of 2002 (DMA)	• The Act is the primary legislation that provides guidance on disaster management in South Africa with a strong emphasis on prevention and its comprehensive approach to DRR. • The Act provides for; an integrated and coordinated DRM policy and institutional governance structures that focus on preventing or reducing the risk of disasters, mitigating the severity of disasters, preparedness, rapid and effective response to disasters, and post-disaster recovery. • The Act also delegates disaster management to various stakeholders including all spheres of government as well as the establishment of national, provincial and municipal disaster management centres; other disaster management players such as private sector, civil society, traditional leaders and volunteers. • Project support to municipalities regarding the improvement of DRR approaches will need to work within the precepts of this legislation.
Local Government: Municipal Systems Act 32 of 2000	• The act provides for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities and ensure universal access to essential services that are affordable to all. • It defines the legal nature of a municipality as including the local community within the municipal area, working in partnership with the municipality's political and administrative structures and provides the way municipal powers and functions are exercised and performed. • The act provides a framework for local public administration and human resource development and empowers the poor by ensuring that municipalities put in place service tariffs and credit control policies that take their needs into account by providing a framework for the provision of services, service delivery agreements and municipal service districts. • The act requires all municipalities (metropolitans, DMs and LMs) to have spatial development frameworks as core components of their IDPs. • Project activities to strengthen municipal capacity will need to consider the roles and responsibilities of DMs and LMs as set out in this legislation.
National Water Act 36 of 1998	• The act recognises that water is a scarce and unevenly distributed national resource which belongs to all people. • The act acknowledges national government's overall responsibility for and authority over the nation's water resources and their use. • The aim promotes water resource management that achieves the sustainable use of water for the benefit of all, noting that protection of the quality of water resources is necessary to ensure sustainability. • The act also promotes integrated management of all aspects of water resources and the delegation of management functions to a regional or catchment level so as to enable everyone to participate. • All project activities linked to catchments and watercourses will need to work with the precepts of this act and its associated regulations.

Legislation / Regulation / Policy	Description
Conservation of Agricultural Resources Act (CARA) (Act 43 of 1983)	• The Act allows for the Minister responsible for agriculture to determine control measures, and establish schemes, which may pertain to various forms of DRR and management. • Control measures are applicable to land users and may relate to inter alia the prevention and control of veld fires and the restoration or reclamation of eroded land. (sections 6(2)(j) and (m) of CARA). • Schemes (section 8 of CARA) are established to provide financial assistance out of funding appropriated by Parliament to land users who undertake disaster management or DRR measures. Examples of these measures include repairing natural agricultural resources damaged by flooding or any other natural disaster, or for restoring or reclaiming eroded land. Such schemes have been established to assist land owners (generally farmers) specifically for cold spell relief (under GN 274 GG 26080 of 3 March 2004.), flood relief (under GN 272 GG 26080 of 3 March 2004) and assistance during drought (under GN R20 GG 27157 of 14 January 2005 and GN R21 GG 27157 of 14 January 2005). • All project activities linked to catchments and watercourses will need to work with the precepts of this act and its associated regulations.
Water and Sanitation Sector Policy on Climate Change (2017)	• The policy seeks to advocate sector specific policy positions on water and sanitation adaptation to climate change, the role of water and sanitation in mitigation, mainstreaming climate change into the sector and the cost and subsidies. • All project activities linked to catchments and watercourses will need to align with this policy.
National Climate Change Response Policy White Paper (NCCRP) (2011)	• The NCCRP comprehensively outlines South Africa's strategies in both adaptation and mitigation up to 2050 in the following areas: carbon pricing, water, agriculture and commercial forestry, health, biodiversity and ecosystems, human settlements and DRR and DRM. • The policy recognises the importance of integrating gender considerations into climate change responses to ensure equitable and inclusive outcomes. • The project will, and must, align with and support implementation of this white paper
National Policy on Gender and Climate Change (2015)	• The Policy aims to address the differential impacts of climate change on women and men. By incorporating gender perspectives into climate change policies, strategies , programmes and actions. • It aims to ensure that climate change adaptation and mitigation strategies are gender-responsive and promote the active participation of women in decision-making processes related to climate change. • Project activities will and must align with this policy
Promotion of Equality and Prevention of Unfair Discrimination Act (2000)	• The act aims to promote equality and prohibits discrimination based on various grounds, including gender. • Project implementation and procedures will need to ensure adherence to this legal requirement.
National Policy Framework for Women's Empowerment and Gender Equality (2000)	• It provides guidelines and strategies for promoting gender equality and women's empowerment across various sectors, including education, health, and economic empowerment. • It aims to prevent and respond to violence against women, promote women's economic empowerment, and advance gender equality in various sectors. • Project implementation and procedures will need to ensure adherence to this policy.

3.2 STRATEGIC PLANNING INSTRUMENTS AND TOOLS

South Africa's NDP is the primary plan for the country and sets out South Africa's 30-year vision and roadmap to address key priorities with regards to sustainable socioeconomic development. The plan aims to eliminate poverty and reduce inequality by 2030 with one of the priorities being to ensure a transition to an environmentally sustainable, climate change resilient, low carbon economy and just society. The NDP recognises the threat that climate poses to the country's development and that it needs to be considered when planning the country's development future and which investments in sectors should be prioritised. Further to the above, the NDP makes specific mention of the need to "*actively support the development of plans that cross municipal, and even provincial boundaries that would promote collaborative action in fields such as biodiversity protection, climate-change adaptation, tourism and transportation*" (DEA and SANBI, 2016).

Other key strategies and plans related to climate change and EbA are presented in the table below:

Table 3-2: Relevant strategies and plans for climate change and EbA

Strategy / Plan	Description
Medium Term Strategic Framework (MTSF) 2019-2024	• The MTSF is a prioritised framework that focuses government efforts. • Under the Environmental Management and Climate Change Programme, several priority areas are highlighted: GHG emission reduction; municipalities prepared to deal with climate change; just transition to low-carbon economy; and state of ecological infrastructure improved. • The framework identifies ecosystem protection as critical with the implementation plan including activities to improve ecological infrastructure. This includes rehabilitating and restoring land and wetlands; mapping ecologically sensitive areas, amongst others.
Draft National Biodiversity Economy Strategy (2024)	• At the time of writing this report, the draft strategy was published for public comment. • The strategy has been broadened to respond to the White Paper on Conservation and Sustainable Use of South Africa's Biodiversity, the Kunming-Montreal Global Biodiversity Framework, and the National Operation Phakisa Oceans and Biodiversity Labs. • The strategy guides the biodiversity economy including ecotourism. • The strategy aims to leverage the biodiversity economy to promote conservation and species and ecosystem management, thereby ensuring a positive feedback loop. • The strategy also seeks to promote growth and transformation of the biodiversity economy.
National Water Resources Strategy Third Edition (2023)	• The strategy sets out how South Africa will achieve its goals related to the protection, use, development, conservation and management of water resources in a controlled, sustainable and equitable manner. • Emphasis on climate change is highlighted throughout the strategy and actions are included that address the impacts of climate change.
Just Energy Transition Investment Plan (JET IP) (2022)	• The plan outlines South Africa's plan to tackle climate change for the period 2023-2027. • The vision and objectives are to establish an ambitious long-term partnership to support South Africa's pathway to low emissions and climate resilient development, to accelerate the just transition and the decarbonisation of the electricity system, and to develop new economic opportunities such as green hydrogen and electric vehicles amongst other interventions to support South Africa's shift towards a low carbon future.
NDCs to the UNFCCC (2020)	• South Africa submitted its first NDC in 2015 and subsequently updated the NDC in 2021. • South Africa's revised mitigation target range for 2021-2025 is 510-398 Mt CO_2e and for the period 2026-2030 its annual GHG emissions range will be 420-350 Mt CO_2e.
South Africa's Low Emission Development Strategy 2050 (2020)	• This strategy is informed by the NDP, the Climate Change Act, and the NCCRP. • The strategy provides an overview of current measures undertaken by the government in the areas of energy, industry, agriculture, forestry, and other land use and waste.

Strategy / Plan	Description
NCCAS (2019)	• The NCCAS builds on the NDP, the NCCRP, adaptation commitments from the NDCs and other adaptation plans. • The NCCAS provides a consolidated vision for adaptation to climate change and increasing climate resilience.
South Africa's Low Emission Development Strategy 2050 (2020)	• The strategy provides for the achievement of a low-carbon growth path and for the commitment to ultimately moving towards a goal of net zero carbon emissions by 2050, while making a fair contribution to the global effort to limit the average temperature increase and ensuring a just transition and building of the country's resilience to climate change.
National Energy Efficiency Strategy (2019)	• This strategy builds upon the White Paper on Energy Policy (1998) and focuses on how to further promote energy efficiency improvements through financial incentives and enabling measures.
National Water and Sanitation Master Plan (2019)	• The plan presents the top priority issues confronting the water and sanitation sector and seeks to rally all water sector stakeholders in South Africa to work together to ensure that the country gets ahead of the curve in relation to both current and future challenges. • Once of the challenges, as noted in the plan, is climate change and the need to implement coordinated and integrated adaptation and mitigation responses.
National Action Programme to Combat Land Degradation and Alleviate Rural Poverty (2018-2030)	• The purpose of the programme is to identify factors contributing to desertification, land degradation and drought as well as to implement practical measures necessary to combat desertification and to mitigate the effects of drought.
Third National Communication to the UNFCCC (2017)	• The Third National Communication to the UNFCCC follows on from the second communication of 2011, and the second biennial report of 2017 and sets out an updated GHG inventory, climate trends over the period and mitigation and adaptation measures.
Strategic Framework and Overarching Implementation for EbA in South Africa (2016-2021)	• The framework seeks to take forward EbA as a central component of the country's programme of work on biodiversity and climate change. • The vision of the framework is for EbA to be implemented as part of South Africa's overall climate change adaptation strategy in support of a long-term just transition to a climate resilient economy and society.
National Protected Area Expansion Strategy (2016)	• The document presents a 20-year strategy for the expansion of protected areas in South Africa. • The strategy seeks to achieve cost effective protected area expansion for improved ecosystem representation, ecological sustainability and resilience to climate change.
National Biodiversity Strategy and Action Plan (NBSAP) (2015-2025)	• The document puts forward a strategy and plan for contracting parties to fulfil the objectives of the Convention on Biological Diversity. • It identifies the priorities for biodiversity management in South Africa for this period, aligning these with the priorities and targets in the global agenda, as well as national development imperatives (DEA and SANBI, 2016). • It emphasises the need for gender-responsive approaches to biodiversity conservation and ecosystem management
Climate Change Adaptation Plans for South African Biomes (2015)	• The plans reviews literature on climate threats to South African biomes and details the adaptive actions that can be taken to reduce the effects of climate change at a biome level. • The plan highlights EbA is one of four categories of adaptive actions to reduce climate change threat (DEA and SANBI, 2016).
Long Term Adaptation Scenarios (LTAS)	• The report, produced by DFFE, presents the projected impacts of climate change on South Africa's major sectors based on scientific research and modelling. The assessments in the LTAS report are used as a basis for informing climate change adaptation in the country.
Biodiversity Sector Climate Change Response Strategy (2014)	• The strategy recognises the opportunity for climate change responses to contribute towards sustainable livelihoods by ensuring that livelihoods are able to cope with and recover from stress and shocks, maintain or enhance capabilities and assets and provide for next generations.

Strategy / Plan	Description

	• The strategy has two priorities: 1) Ensuring biodiversity is able to adapt to climate change, through expanding protected areas and protecting critical biodiversity areas; and 2) Focussing on EbA, with the following priorities:
	  ◦ Identifying and maintaining in good condition landscape features and ecosystems important for EbA.
	  ◦ Improving resilience of degraded or fragmented ecosystems through restoration and effective land-use planning and enforcement.
	  ◦ Reducing climate risk of communities.
	  ◦ Vulnerability assessments that inform local level planning.
	  ◦ Avoiding actions that will compromise ecosystems important for EbA (DEA and SANBI, 2016).

Provincial Climate Change Adaptation Strategies	• As per the NCCAS, provinces are required to develop their own climate change adaptation strategies that identify the threats posed by climate change and identifies measures to address these threats. • The strategies include adaptation responses and associated implementation plans to guide climate response in the province. • These strategies and associated implementation plans should be reviewed and updated every five years.
Catchment Management Strategies	• The strategy is a statutory document which provides the vision, and the strategic actions to address integrated water resources management in its water management area (WMA). • It is based on the best available information and is aligned with the National Water Resources Strategy. • The strategy usually includes a water allocation plan and must set forth principles for allocating water to existing and prospective users as well as the protection, use, development, conservation, management and control of water resources.
District Development Model (DDM) One Plans	• The plans are developed for each DM in South Africa with the aim of improving integrated planning and delivery across the three spheres of government. • The plans see district and metropolitan spaces as focal points of government and private sector investment. • Most plans highlight the challenges posed by climate change and identifies priority areas to address this.
Municipal Adaptation Plans (and/or Strategies)	• These plans align with the provincial and national climate change strategies and seeks to support municipalities in identifying priority climate change measures that need to be implemented to mitigate and/or reduce the risks posed by climate change hazards. • LMs and DMs develop these plans and plans have been developed by Amathole DM, Buffalo City LM, Nxuba LM, Emfuleni LM, and Thulamela LM (DEA and SANBI, 2016).
DM and LM Spatial Development Frameworks	• The frameworks guide spatial development and land use management on a district and local level. • These frameworks are legally required to be a core component of their IDPs. • The frameworks aim to guide where and what type of development can or should take place over a 10 to 20 years' planning horizon as well as providing a scenario for future development that forms a basis for this more specialised planning – particularly for the custodians of urban, social, and physical infrastructure (including transport, water, electricity, housing, and education etc. (Wüst, 2022)
DM and LM IDPs	• The document is a comprehensive and inclusive plan that outlines a DM's and/or LM's priorities and strategies for economic and social development. • IDPs aim to promote integrated and coordinated development across the DM and/or LM by ensuring that different departments and sectors work together to achieve common goals, rather than operating in silos. • The plan serves as a blueprint for a municipality's development, in alignment with national and provincial development plans. • Most IDPs cover several development areas, including infrastructure, economic development, social development, and environmental management by setting out specific goals, objectives, and targets for each area, as well as the actions that will be taken to achieve them (Town Planner, 2023).

3.3 INSTITUTIONAL FRAMEWORK

Planning, coordination, implementation and monitoring in the climate change space lies with multiple institutions. An overview of the institutional framework for climate change in South Africa is presented below:

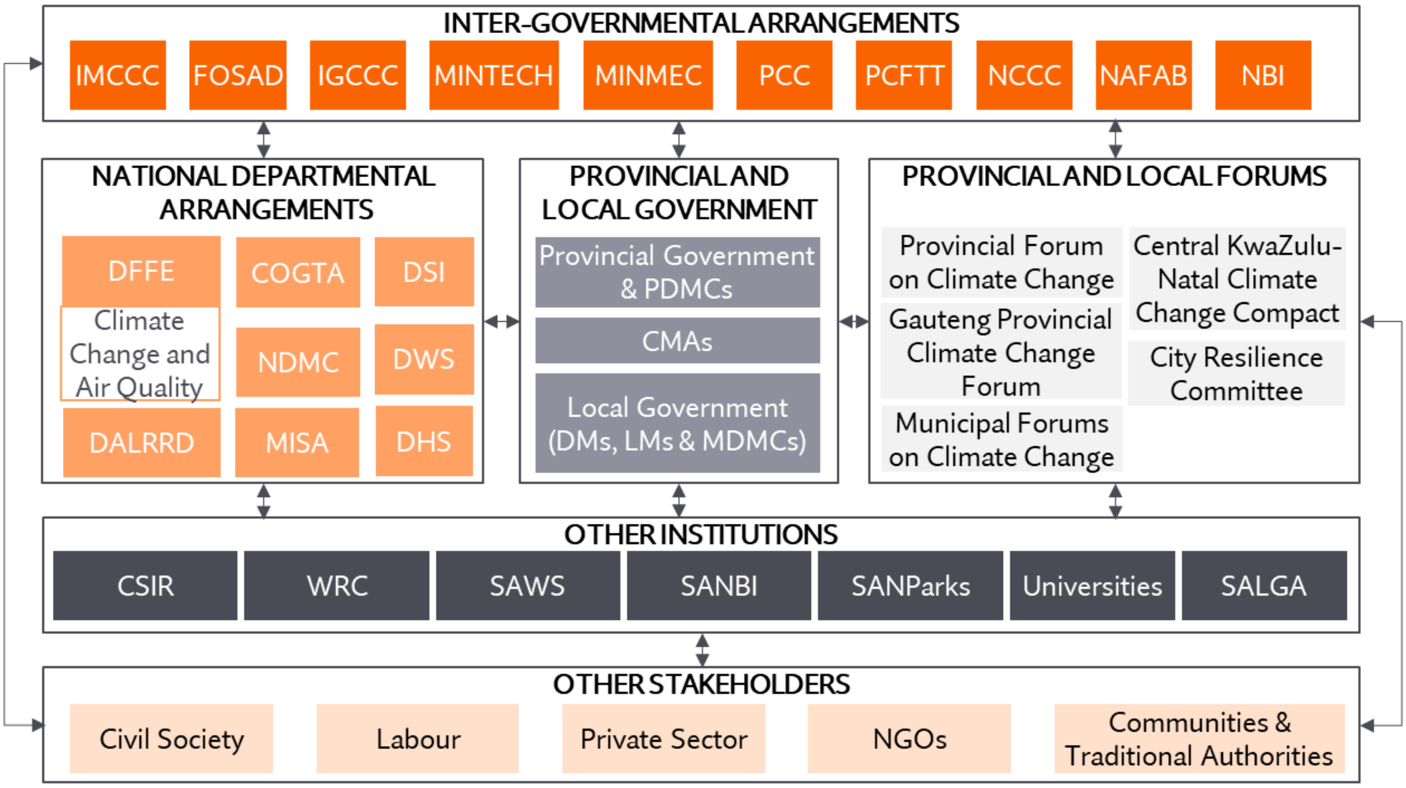

Figure 3-1: Key climate change institutions in South Africa adapted from (Ortega-Cisneros, et al., 2021).

The current roles and responsibilities of the three spheres of government and non-government entities are summarised below, elaborated in more detail in the sections to follow:

- **National Government**: DFFE is the UNFCCC focal point and the lead department responsible for coordinating the implementation of the NCCAS. Other line function national departments are responsible for integrating climate change response into their sectors.
- **Provincial Government**: Each province has an environmental department that is responsible for leading climate change response. Other line function provincial departments are responsible for integrating climate change response into their sectors.
- **Municipalities**: Many critical actions required for climate change responses are the responsibility of municipalities, noting that provision of basic services will be impacted by climate change.
- **Private Sector**: Climate change will affect business in several ways, and businesses need to be more proactive in dealing with climate risk. In addition, their insights, experiences and resources will provide significant opportunities to leverage public sector benefits.

- **Civil society**: Civil society, being directly affected by the risks posed by climate change and the opportunities created by adaptation initiatives, can raise awareness about the need to adapt as well as facilitating debates and supporting and monitoring local implementation.
- **Labour**: Labour groups are directly affected by climate change risks and the opportunities created by adaptation initiatives. They also play a role in redressing past inequities in South Africa and are an influential agent of change and transformation.
- **Academia and research**: Academia is critical to improve the understanding of climate science, vulnerabilities and the effects of climate change. They also ensure a holistic climate change response by focusing on governance, political science, policy, psychology and communication-related aspects.
- **Community leadership**: Community leaders play an important role in the implementation and awareness of climate change initiatives (DFFE, 2020).

3.3.1 Legislative and Executive Competencies

The Three Spheres of Government

The Government of South Africa is divided into three spheres: national, provincial and local whose responsibilities are provided for in the Constitution. The governments of each sphere have a political and administrative arm with different responsibilities – the former is responsible for creating laws and policies while the latter provides services and implements laws and policies (Western Cape Government, 2023).

National Government

National government is tasked with making laws and developing policies for the country as well as providing services that fall under national competencies (Western Cape Government, 2023). National government is divided into three branches:

- **Legislature** (Parliament): makes laws and hold government to account. Includes the National Assembly and the National Council of Provinces which represents the interests of provinces.
- **Executive (**President and Cabinet): governs the country, includes the president, cabinet and government departments.
- **Judiciary** (Courts): upholds the law, includes the Constitutional Court, the Supreme Court of Appeal, High Courts, Magistrate Courts, and specific matters such as child justice courts, labour courts, small claims courts etc (Western Cape Government, 2023).

Provincial Government

As per the Constitution, each province in South Africa has its own legislature that consists of 30 to 80 members. The number of members is determined by a formula that is set out in national legislation and members are elected in terms of proportional representation (Western Cape Government, 2023). The nine provinces support the drafting of the country's national legislation by participating in the National Council of Provinces (Sabinet, 2022). The provincial legislature can make provincial laws and adopt a constitution for its province if two thirds of its members agree. A provincial constitution must align and comply with the Constitution (Western Cape Government, 2023). Provincial legislatures can pass laws with regards to health, housing, education, environment etc. – noting that national parliament retains legal power in these areas and, if necessary, can override provincial legislation (Sabinet, 2022).

Each of the nine provinces has an executive council which includes the provincial Premier and members of the executive council with the Premier being elected by the provincial legislature. The members of the executive council are responsible for various provincial departments (Sabinet, 2022).

The Constitution allows for provinces to have executive and legislative powers over agriculture; cultural affairs; casinos, gambling, racing, and wagering; environment; language policies; education (excluding universities); provincial public media; health services; tourism; public transport; human settlements; welfare services; vehicle licensing; urban and rural development; and trade and industrial promotion. In addition, provinces have exclusive competencies over provincial planning, abattoirs, liquor licences, provincial cultural matters, museums, provincial roads and traffic and ambulance services (Sabinet, 2022).

Local Government

Local government is responsible for providing basic services such as sanitation, water, waste removal etc. as well as promoting community development and a safe and healthy environment (Western Cape Government, 2023). The Constitution provides for 3 categories of municipality:

- **Category A:** A municipality that has exclusive municipal executive and legislative authority in its area.
- **Category B:** A municipality that shares municipal executive and legislative authority in its area with a category C municipality within whose area it falls.
- **Category C:** A municipality that has municipal executive and legislative authority in an area that includes more than one municipality (Government of South Africa, 1996)

Each municipality has a council that is responsible for decision-making while municipal officials and staff implement the work of the municipality. The council comprises of elected members who approve policies and by-laws for their area of jurisdiction. The council is also tasked with passing the municipality's budget on a yearly basis as well as deciding on development plans and service delivery for their area of jurisdiction (Education and Training Unit, n.d.).

Legislative and Executive Competencies Related to Biodiversity and Environmental Management

With regards to legislative and executive competencies that are of wide relevance to biodiversity, these are distributed between the three spheres of government (viz. national, provincial and local government) as follows:

- Exclusive national competences:
    - National parks
    - National botanical gardens
    - Marine resources
- Concurrent national and provincial competences
    - Administration of indigenous forests
    - Environment and nature conservation

    - Regional planning and development
    - Soil conservation
    - Tourism
    - Urban and rural development
    - Municipal planning
- Exclusive provincial competence
    - Provincial planning and provincial cultural matters
    - Beaches
    - Municipal parks
- Local competence
    - Beaches
    - Municipal parks and municipal planning

In the context of protected areas, the administration of national laws usually falls to the Minister responsible for environmental affairs. The Minister, when dispensing their function, may draw on the assistance of its department and two key statutory institutions: 1) SANBI; and 2) SANParks.

Since "environment" and "nature conservation" are concurrent provincial constitutional competences, the ministerial and departmental structures at the national level are duplicated at a provincial level too. This means that provinces have a Member of the Executive Council responsible for environmental affairs as well as a supporting provincial department that is responsible for environmental affairs (including conservation). Some provinces chose to assign its function, either fully or partially, to the conservation authorities. Examples of these conservation authorities include:

- CapeNature
- Eastern Cape Parks and Tourism Agency
- Ezemvelo KwaZulu-Natal (KZN) Wildlife
- Mpumalanga Tourism and Parks Agency (MTPA)
- North West Parks and Tourism

3.3.2 The President and Cabinet

The Executive Authority of the country is vested in the ***President*** who exercises it together with members of the Cabinet. ***Cabinet*** exercises its authority by implementing national legislation, developing and implementing national policy, coordinating functions of state departments and administrations, preparing and initiating legislation, and performing all such duties as may be assigned to it by the Constitution and national legislation (Republic of South Africa, 1996; Mathebula, 2004). ***Parliament portfolio committees*** are responsible for overseeing implementation of national climate change-related policies including the NCCRP as well as reviewing legislation to support the NCCRP i.e. the Climate Change Act (DEFF, 2020).

3.3.3 National Institutions

The overall responsibility for climate change planning and policy making lies with ***DFFE*** with the Deputy-Director General of the Climate Change and Air Quality branch being mandated with climate change functions such as coordination, integration, policy development, mitigation and adaptation responses (Ortega-Cisneros, et al., 2021). Climate change functions are also shared by the environment, risk management and planning directorates in other sector departments with environmental functions (DEA, 2018). It is the responsibility of DFFE to coordinate climate change interventions with other government departments at different levels as well as to ensure integration and alignment with national climate change goals and objectives.

SANBI contributes to South Africa's sustainable development by facilitating access to biodiversity data, generating information and knowledge, building capacity, providing policy advice, showcasing and conserving biodiversity in its national botanical and zoological gardens. The institute seeks to ensure that South Africa's biodiversity is conserved and enhanced to deliver sustainable benefits for all. (SANBI, n.d.).

SANParks is established through NEMPAA and is mandated to conserve, protect, control and manage national parks and other defined protected areas and their biological diversity (biodiversity). SANParks is acutely aware of the impacts of climate change on protected areas and national parks with its Climate Change Preparedness Strategy outlining key areas for SANParks: understanding vulnerability to and opportunities from climate change within SANParks; adapting to the inevitable changes; mitigating or reducing their contribution to climate change; building resilience in those relying on the park's ecosystem services; and communicating the challenges and opportunities that climate change brings, as well as SANParks' responses to it.

The ***Department of Cooperative Governance and Traditional Affairs (COGTA)*** is mandated to 1) develop and monitor the implementation of the national policy and legislation, seeking to transform and strengthen key institutions and mechanisms of governance to fulfil their developmental role; 2) develop, promote and monitor mechanisms, systems and structures to enable integrated service delivery and implementation within government; and 3) promote sustainable development by providing support to and exercising oversight over provincial and local government (COGTA, n.d.).

Within COGTA and established under Section 7(2) Schedule 3 of the Public Service Act of 1994, the ***Municipal Infrastructure Support Agency (MISA)*** is a national government component of COGTA that aims to improve municipal infrastructure provisioning and maintenance for accelerated service delivery. This includes: 1) supporting municipalities to conduct effective infrastructure planning to achieve sustainable service delivery; 2) supporting and assisting municipalities with the implementation of infrastructure projects as determined by the municipal IDPs; 3) support and assisting municipalities with the operation and maintenance of municipal infrastructure; and 4) building the capacity of municipalities to undertake effective planning, delivery, operations and management of municipal infrastructure.

The ***NDMC***, which sits within COGTA, is responsible for ensuring that the National Framework for DRM provides clear guidance across all spheres and sectors of government for managing climate change-related risk. They also ensure that an effective communications strategy is in place for early warnings to communities vulnerable to climate change impacts (DEFF, 2020).

The ***South African Local Government Association (SALGA)*** is another institution that plays an important role with regards to local government. SALGA supports, represents and advises local government action, participates in the intergovernmental system, ensures climate adaptation and mitigation actions are integrated into development plans, and promotes public education, awareness and communication of information on climate change (Ortega-Cisneros, et al., 2021).

The ***Department of Water and Sanitation (DWS)*** is the custodian of South Africa's water resources and is responsible for the formulation and implementation of policy governing the sector. DWS' Climate Change Analysis Directorate develops strategies, plans, guidelines and water resource planning tools to guide effective response to climate change while minimising its adverse impacts on the water and sanitation sector. The functions of the directorate include alignment of climate change analysis strategy with national and international priorities, coordination and informing of policy objectives, conducting of vulnerability assessments and related impacts on water resources due to climate change as well as analysis and development of adaptation and response management measures (DWS, n.d.).

Further to the above are ***Catchment Management Agencies (CMA)*** who are responsible for the management and development of water resources at a catchment-level. The National Water Act (No 36 of 1998) provides for the establishment of CMAs for a specific water management area. CMAs perform the critical role of advising on, and coordinating water resource management, and developing the catchment management strategies for their respective WMAs (DWS, 2016). Six CMAs are planned for the country's nine WMAs with four CMAs - having been established.

The mandate of the ***Department of Agriculture, Land Reform and Rural Development (DALRRD)*** includes developing agricultural value chains, providing agricultural inputs, and monitoring production and consumption in the agriculture sector, as well as facilitating comprehensive rural development. The department has a Climate Change and Disaster Management Directorate which aims to facilitate climate change mitigation and adaptation, risk and disaster management by developing national policy frameworks, ensuring effective planning and implementation of an EWS, coordinating post-disaster recovery and rehabilitation, implement climate change programmes in support of risk and disaster management, ensuring sectoral compliance with the NCCRP and regional and international obligations, and preventing production losses by combating migratory pests and diseases (DALRRD, n.d.)

The ***Department of Human Settlements (DHS)*** is mandated to establish and facilitate a sustainable national housing development process in collaboration with provinces and municipalities. In this regard, DHS determines national policy and norms and standards for the development of housing and human settlements, prescribes national housing delivery goals and oversees provincial and municipal performance outcomes against national targets (South African Government, n.d.). Considering the impacts of climate change on spatial planning, human settlements and land use development, DHS is a critical stakeholder for any climate change project.

The ***Department of Science and Innovation (DSI)*** is a national government department that aims to boost socioeconomic development in the country through research and innovation by providing leadership, an enabling environment and resources for science, technology and innovation (DSI, n.d.). As part of its work, DSI focuses on leading and supporting research development in climate change and environmental sustainability.

SAWS communicates weather information and warnings for the country. SAWS provides useful and innovative weather, climate and related products and services by enhancing observational data and communications networks, effectively developing and managing talent in the sector, enhancing collaborative partnerships and effectively disseminating weather services products to the users, utilising cutting-edge technology to convert data into meaningful products and services for risk mitigation, advancing the science of meteorology, research and relevant applications, and enhancing fiscal discipline and resource mobilisation to ensure sustainability (DFFE, 2023).

3.3.4 Provincial Institutions

At a provincial and local level, government institutions are responsible for integrating climate change into their planning processes. ***Provincial government*** is required to develop a climate response strategy and to coordinate adaptation responses across their departments and between municipalities within the province (Ortega-Cisneros, et al., 2021). Within provincial government are Departments of Environmental Affairs that are responsible for supporting DFFE (national) in managing and protecting the natural environment at a provincial level.

As per the Climate Change Act, a ***Provincial Forum on Climate Change*** is provided for in each province and these forums must coordinate climate change response actions in the relevant province in accordance with the Climate Change Act (Republic of South Africa, 2024).

An example of an existing Provincial Forum on Climate Change is the ***Gauteng Provincial Climate Change Forum*** which aims to create a platform for coordination between different spheres of government and various stakeholders to mainstream climate change. The forum reports to and engages with the IMCCC, IGCCC and the NCCC to ensure effective coordination and alignment with national plans and objectives. At a more local level in the province, the forum relies on the Climate Change Environmental Affairs and Sustainability Working Group (supported by SALGA) for coordination (Gauteng Province, n.d.).

Another similar provincial forum is the ***Central KZN Climate Change Compact*** which was formed after the adoption of the Durban Adaptation Charter. The eThekwini Municipality, as the Charter Secretariat, has driven the implementation of the Charter with the Compact enabling collaboration between the three spheres of government in the region. The aims of the Compact are to build technical capacity across the three spheres of government to mainstream climate change; undertake joint research that benefits several cities in the region; access funding to implement climate projects and activities; and increase the visibility of region’s climate action at the international level The local and provincial levels of government collaborate through the Steering Committee that consists of metropolitan (eThekwini), district (iLembe, uGu and uMgungundlovu) and local (Msunduzi) municipalities, as well as provincial offices of the Department of Economic Development, Tourism and Environmental Affairs, the Department of Cooperative Governance, and SALGA. Engagements between the local and national levels occur through direct interactions between Compact KZN and DFFE, notably on initiatives such as the Cities Resilience Forum (see below under District and Local Institutions) (Central KwaZulu-Natal Climate Change Compact, South Africa, 2020).

From a DRR perspective, ***provincial disaster management centres (PDMCs)*** have been established in each province. The PDMCs serve as the interface between local and national government with regards to disaster management and ensure alignment between national objectives and provincial and municipal DRM activities and priorities. The PDMCs are the primary functional unit for DRM in each province. A key responsibility of the PDMC is to provide support to the NDMC and the metropolitan and district disaster management centres in the province. It must provide the link between national objectives and provincial and municipal DRM activities and priorities (Government of South Africa, 2005). The PDMCs are responsible for coordinating and chairing quarterly provincial disaster management advisory forums where all relevant stakeholders are invited to discuss pertinent matters relevant to disaster management. The PDMC must maintain a strategic overview of DRM projects and programmes in each province in South Africa (COGTA, 2017).

All PDMCs across South Africa have a common drive and focus - they aim to play a crucial role in mitigating and responding to disasters within their respective province, with some of its key functions including:

- **Emergency Preparedness and Response**: The centres coordinate emergency responses during natural disasters, accidents, and other crises. This includes mobilising resources, aiding and ensuring effective communication among role players.
- **Risk Assessment and Planning**: Assessing potential risks and vulnerabilities in the region, such as floods, fires, and severe weather events. Based on these assessments, the development of disaster management plans and strategies get driven by the PDMCs.
- **Public Awareness and Education**: The PDMCs conduct awareness campaigns to educate the public about disaster preparedness, safety measures, and evacuation procedures. This helps build resilient communities that can respond effectively during emergencies.
- **Coordination with Stakeholders**: Coordination and collaboration with local government, NGOs, and other organisations is critical to enhance disaster prevention, mitigation and response capabilities. This coordination ensures a unified approach to disaster management across each individual province and nationally.
- **Monitoring and EWS**: The centres work with agencies such as the SAWS on weather warnings and DWS on the monitoring of river levels, and other indicators to provide early warnings. These alerts help communities take preventive measures and evacuate if necessary.
- **Capacity Building**: Training and awareness including those for community leaders and volunteers.
- **Recovery and Rehabilitation**: After a disaster, the centre assists in recovery efforts, including rebuilding infrastructure, providing relief to affected communities, and restoring essential services.

3.3.5 District and Local Institutions

The Climate Change Act provides for district intergovernmental forums i.e. ***Municipal Forums on Climate Change***. These forums must coordinate climate change response actions for those activities within its operational control of the relevant municipality in accordance with the Climate Change Act; and report on such actions to the relevant Provincial Forum on Climate Change (Republic of South Africa, 2024).

The Climate Change Act goes on to elaborate on the role of a Member of the Executive Council and a mayor of ***a metropolitan or DM*** which includes:

- Undertaking and updating their climate change needs and response assessment for the province, metropolitan or DM;
- Assessing the extent to which its constitutionally mandated functions are affected by climate change and formulate steps to address these effects in the performance of its functions; and
- Developing, implementing and updating a climate change response implementation plan as a component of, and in conjunction with, provincial, metropolitan or district municipal planning instruments, policies and programmes (Republic of South Africa, 2024).

In addition to the above, the ***City Resilience Committee*** serves as a forum where city government comes together to discuss climate change issues and how cities need to take the lead in climate action (DEFF, 2020).

While ***LMs*** do not necessarily have a direct mandate regarding climate change, they do have a mandate to provide critical services to people living within their jurisdiction e.g. water provision, access to a clean and healthy environment etc. to name a few. However, the impacts of climate change are becoming more severe, and this affects municipalities' capability to service the day-to-day needs of its citizens. As such, there is a growing recognition of the need for LMs to incorporate climate considerations into their mandates to ensure that they can continue to provide the same level of service delivery whilst at the same time ensuring that each and every citizen within the jurisdiction of a municipality is protected against the impacts of climate change (DEFF, 2019).

In terms of disaster management, ***municipal disaster management centres (MDMCs)*** are located within DMs and/or metropolitans. He centres provide direction for the implementation of DRM policy and legislation and the integration and coordination of municipal DRM activities and priorities to ensure that national and provincial objectives are achieved. In addition, a key function of the MDMCs is to provide support to the NDMC and the relevant PDMC. In the event of a disaster occurring or threatening to occur, the MDMC is required to provide support and guidance to the relevant sub-administrative units in the case of metropolitan municipalities and to LMs in the case of DMs. Furthermore, it must mobilise municipal infrastructure and all other available resources to support local DRM resources (Government of South Africa, 2005).

Water Boards are provided for in the Water Services Act and are mandated to provide bulk industrial and potable water services to municipalities and industries within their gazetted areas of operation. According to the national water resource strategy, the existing water boards are to be consolidated into ***regional water utilities (RWUs)*** which will manage bulk water service infrastructure as well as supply bulk water to water service authorities (WSAs), water service providers and bulk water consumers (South African Government, n.d.). In addition, it is envisioned that RWUs will operate existing regional water resource infrastructure, manage bulk sanitation infrastructure for wastewater treatment, provide support to CMAs and WSAs, and develop new regional water resources infrastructure (DWS, 2023).

WSAs refers to "any municipality that has executive authority for water services within its area of jurisdiction in terms of the Municipal Structures Act or the ministerial authorisations made in terms of the Municipal Structures Act" (Department of Water Affairs and Forestry, 2005) and can include metropolitan municipalities, DMs and LMs. As such, WSAs have the responsibility of regulating, planning, and ensuring access to water services (supply and sanitation) within their areas of jurisdiction (Department of Water Affairs, 2013).

Water Service Providers can include private, public, or mixed entities as well as municipal government who are contracted by the WSA to provide water and/or sanitation services for municipalities (Beck, T.; Rodina, L.; Luker, E.; Harris, L., 2016).

Water user associations (WUAs), according to the National Water Act are "co-operative associations of individual water users who wish to undertake water-related activities for their mutual benefit" (Republic of South Africa, 1998). WUAs can only perform functions that have been assigned or delegated to them with the Minister being responsible for the establishment or disestablishment of WUAs.

3.3.6 Inter-Governmental Arrangements

Considering how climate change crosscuts across sectors and departments, several inter-governmental structures have been put in place to coordinate and support implementation of climate change programmes and interventions. The ***Inter-Ministerial Committee on Climate Change (IMCCC)*** is an executive (Cabinet) level committee that coordinates and aligns climate change response actions with national policies and legislation. The IMCCC oversees all aspects of the implementation of the NCCRP with the Minister of the Environment chairing the committee (DEFF, 2020).

The ***Forum of South African Directors-General (FOSAD)*** cluster consists of Director-Generals from the main departments and is grouped in the Economic Sectors and Employment, Infrastructure Development and International Cooperation, Trade and Security clusters. FOSAD coordinates policy development, ensures cross-departmental alignment of policies, monitors implementation of programmes and provides technical support to ministerial departments (Ortega-Cisneros, et al., 2021).

The ***Intergovernmental Committee on Climate Change (IGCCC)*** operationalises cooperative governance and is the mechanism through which DFFE promotes cross-departmental cooperation and coordination in the area of climate change. The IGCCC consists of the relevant national and provincial departments responsible for environmental management as well as organised local government, science councils, and conservations bodies amongst others. (Ortega-Cisneros, et al., 2021; DEFF, 2020).

There are also ministerial governmental committees such as the ***Ministerial Technical Committee (MINTECH) and Ministers and Members of Executive Councils Meeting (MINMEC)***. Both MINTECH and MINMEC facilitate high level policy and strategy coherence among the three spheres of government and guide climate change work across the three spheres of government (DEFF, 2020).

MINTECH is chaired by the Director-General of DFFE and is a technical intergovernmental forum attended by concurrent provincial heads of departments, chief executive officers of public entities and environmental authorities, and relevant sector departments. MINTECH has several Working Groups which deal with cross-cutting issues and support the MINTECH Implementation Forum in achieving its outcome i.e. developing, maintaining and implementing an effective governance framework in a manner that ensures that the unacceptable past, current and future impacts on the quality of the environment, forestry and fisheries sectors are minimised, mitigated or managed in line with government policy, legislation, goals and strategies. The intended outcomes per working group are to monitor progress against an agreed sector work plan, which is aligned to the 2019-2024 Environment Sector Medium-Term Strategic Framework. The MINTECH working groups report to the Minster of Environmental Affairs regarding progress made (DFFE, 2022)

MINMEC comprises of national Ministers and provincial Members of Executive Council related to the environment as well as key national and sector departments that have related functions on environmental issues. MINMEC provides the interface between the Minister and the Provincial Members of the Executive Councils and MINTECH. MINMEC is advised by MINTECH (DEAT, 2004).

The PCC was formed in December 2020 (initially as the Presidential Climate Change Coordinating Commission) with the purpose of overseeing and facilitating *"a just and equitable transition towards a low-emissions and climate-resilient economy"* (PCC, n.d.). In addition, the ***Presidential Climate Finance Task Team*** was established in February 2022 to give effect to the Just Energy Transition Partnership (The Presidency, Republic of South Africa, 2022). With regards to social partners and consultations with broader stakeholders, the ***National Committee for Climate Change (NCCC)*** consults with stakeholders from key sectors that impact on or are impacted by climate change. The NCCC also advises on matters relating to national responsibilities and on the implementation of climate change-related activities (DEFF, 2020).

The **National Business Initiative (NBI)** is "a voluntary coalition of South African and multinational companies, working towards sustainable growth and development in South Africa and the shaping of a sustainable future through responsible business action, thereby demonstrating business action for sustainable growth" (NBI, n.d.). The NBI does focus on climate change and environmental sustainability with a focus on: 1) providing companies with access to strong science in accessible formats to allow them to adequately and reasonably assess the risk of climate change; 2) building the capacity of business to adequately manage climate change, supporting the reduction of GHG emissions and improving the resilience of business, society and the economy; 3) improving trust between business and government and investors by providing platforms for transparency and technical assistance to government bodies; 4) raising the importance of climate change by establishing the connection between climate change and economic health; 5) expanding businesses' understanding of climate change to include the sustainability of their value chain; and 6) working with domestic and international stakeholders to understand and mitigate against the barriers to an effective transformation to a green economy, focused particularly on trade and finance (NBI, n.d.)

Another important inter-governmental arrangement is the ***National Adaptation Funds Advisory Body (NAFAB)***, (formerly known as the National Implementing Entity Steering Committee) which is an oversight body that provides overall project governance and promotes optimal linkages with the policy environment. NAFAB sought to approve project submissions by Small Grant Recipients to the Adaptation Fund as well as ensuring compliance of the submission. NAFAB was setup by SANBI, noting that oversight extended beyond small grant facilities and included other projects to ensure an aligned and integrated approach to climate change adaptation. DFEE; National Treasury; National Planning Commission; NDMC; DSI; Department of Planning, Monitoring and Evaluation; NBI and the Adaptation Network sits on NAFAB (Conservation South Africa and IIED, 2021).

3.3.7 Research Institutions

The ***Council for Scientific and Industrial Research (CSIR***) is a state-owned enterprise that was established through an Act of Parliament in 1945 with the organisation's executive authority being the Minister of Higher Education, Science and Innovation. CSIR is a leading scientific and technology research organisation that researches, develops, localises and diffuses technologies to accelerate socioeconomic prosperity in South Africa. The organisation's work contributes to industrial development and supports a capable state (CSIR, n.d.).

The ***Water Research Commission (WRC)*** is an organisation that is dedicated to research in the water sector and is the leading funder of water research in South Africa - being funded through the water research levy, as enabled through the Water Research Act (Act 34 of 1971). The WRC has produced several pieces of research related to the climate change and sustainable environmental management with one of its key strategic areas being water resources and ecosystems.

Alongside CSIR and WRC are South Africa's universities that undertake climate change research.

Based on the above, South Africa has very strong guiding frameworks to undertake initiatives to build climate resilience, however, the Chapter below highlights some of the gaps and challenges being faced in the ECO-DRR implementation.

3.4 ECO-DRR ENABLING ENVIRONMENT ASSESSMENT

While South Africa has a strong legislative and policy framework to guide the implementation of EbA in the context of climate change, the enabling environment, both at national and local levels, have challenges that hinder the ability of South Africa to achieve its NDCs and national climate change objectives. These gaps are presented below:

3.4.1 Policy, Legal and Planning Analysis

Policy and Legal Framework

National Analysis

The **Climate Change Act (2024)** is seen as landmark piece of legislation in that it is the first law in the country that targets the impacts of climate change. The Act provides a national consensus on the actions required to address climate change as well as empowering government to enforce climate change-related measures on both private sector and government. It creates an integrated and unified framework for responding to climate change and showcases South Africa's commitment to a coordinated response. The Act has also been commended for detailing adaptation objectives and related planning instruments at a national, provincial and local level with the Minister of Forestry, Fisheries and the Environment being required to develop adaptation scenarios and National Adaptation Strategy and Plan (The African Climate Foundation, 2023).

The Act is also cognisant of the importance of ecological services, with one of its principles being the recognition that a robust and sustainable economy and a healthy society depends on the services that well-functioning ecosystems provide, and that enhancing the sustainability of the economic, social and ecological services is an integral component of an effective and efficient climate change response. Furthermore, the Act goes on to note that a mayor of a DM must identify and spatially map within their areas of jurisdiction risks, vulnerabilities, areas, ecosystems and communities that will arise, or that are vulnerable to the impacts of climate change – something that closely aligns with the Eco-DRR project.

However, the Act has been criticised since the Minister of Forestry, Fisheries and the Environment has yet to define the Act's mechanism to support and finance its implementation as well as how this will translate to provincial and municipal spheres of government (The African Climate Foundation, 2023). This uncertainty regarding funding and resources will negatively impact the implementation of the Act - particularly at a local level. As a result, the mainstreaming of climate change in local level planning, policies and by-laws may face challenges which could affect the Eco-DRR project. Lastly, mention of Eco-DRR or EbA is not observed in the Act.

While the **NCCRP (2011)** was developed over a decade ago, the **NCCAS** builds on the policy and provides for clear and ambitious policy objectives that are centred on a climate-resilient economy and society, development pathways, and innovative solutions across all sectors and levels of government (Khavhagali, et al., 2023). The NCCRP and NCCAS recognises the importance of ecosystem services and the need for EbA with the NCCAS noting the use of climate-smart and EbA to restore ecological integrity of natural resources and improve community resilience to climate change, taking into account gender differences in access to and control over natural resources.

In addition, the **National Water Act** in its current state does not adequately address climate change. While it provides flexibility to develop regulations to contribute to climate change adaptation, there is need for the Act to be reviewed to explicitly integrate measures for climate change resilience (Kong, et al., 2016). The recent proposed amendments to the National Water Act (which was published in 2023 for public comment) does recognise strategic water source areas and the need to safeguard such areas. The bill prohibits certain activities – such as open cast and underground mining, streamflow reduction activities and agricultural activities within a certain distance from the water source area – to protect vulnerable water sources as well as prohibiting the issuing of water use licences for the activities listed above. The amendments also prioritise the water conservation and water demand management and includes this as one of the Act's purposes. Further to this, the amendments do add the management of climate conditions, floods and droughts as a purpose of the Act. Of note is the specific mention of operation and maintenance of ecologic al infrastructure by WUAs in the amended Act. The amendments to the Act does not make specific mention of climate change.

From a DRR and DRM perspective, South Africa adopted legislation in 2002 placing it at the forefront of a global paradigm shift that was taking place at the time, from a predominantly response oriented approach towards disaster management, to a more proactive approach, focussing on DRM across all sectors of the disaster management continuum (i.e. prevention, mitigation, adaptation, early warning, response and recovery) (Van Niekerk, 2014). Since then, DRM across South Africa has involved various role players from all three government spheres i.e. national, provincial and local levels with ever-increasing involvement from the private sector, civil society, academia, NGOs and community-based organisations. The **Disaster Management Act (Act 57 of 2002) and the Amendment Bill (2013)** (Government of South Africa, 2002), along with the **National Disaster Management Framework** (Government of South Africa, 2005)(as revised in 2013), stipulate the regulations and requirements, and provide guidelines and recommendations aimed at helping to achieve more effective disaster prevention, mitigation and preparedness as well as response and recovery, at all spheres of government in the country. The Act makes provision for several structural forms to ensure the effective implementation of DRM strategies and plans (Van Niekerk, 2014; Bushbuckridge LM, 2017).

The Disaster Management Act has been internationally recognised for the emphasis on its comprehensive approach to DRR especially with the focus on prevention (Kunguma, 2020). The Act provides for an integrated and coordinated DRM policy and guides the approach that should be taken by institutional governance structures. The Act also assigns disaster management responsibilities and powers to various stakeholders including; - all spheres of government, which required at the time among others establishment of national, provincial and municipal disaster management centres – these centres have been established, however the capacity of some of these centres especially in rural DMs are often challenging to achieve.

The **National Disaster Management Framework** (Government of South Africa, 2005) **(amended in 2013)** places emphasis on the need for consistency in DRR approaches across the multiple interest groups. It provides a coherent, transparent, and inclusive policy on applying appropriate disaster management in South Africa across all sectors. It also hones in on the creation of appropriate institutional arrangements for disaster management by guiding key performance areas, supportive enablers and key performance indicators for unified DRR interventions (NDMC, 2018). The framework also provides a list of guidelines to support implementation of the framework including guidelines on conducting risk assessments and development and structuring of DRM plans across all government spheres in South Africa (NDMC, 2018).

Although national policies and legislation provide an effective framework for climate change responses in the country, there is misalignment between national and line ministries' policies and strategies (Climate Action Tracker, 2020; Madondo & Nkwana, 2021; eThekwini Municipality, 2018; DTIC, 2020; Zwane & Montmasson-Clair, 2016). This reinforces line ministries operating in siloes and hampers government's attempts to implement a coordinated and integrated approach to climate change across sectors and spheres of government (Climate Action Tracker, 2020). Possible reasons that can be attributed to the lack of alignment is adequate financial resources and human capacity across different government spheres and line ministries / departments (Sibiya, et al., 2023). This is compounded by a lack of understanding amongst different line ministries regarding climate change and how it can be integrated in their plans, processes and systems as well as low prioritisation of climate change in departments' agendas. Going forward, there is need to mainstream climate change across the three spheres of government and line ministries through capacity building, awareness raising and strengthening access to relevant information to inform planning and decision-making processes (Sibiya, et al., 2023; Pieterse, et al., 2021)..

Provincial Analysis

Environmental management and protection at provincial level is done through the passing of legislation by the Provincial Legislature(i.e. through provincial Acts) as well as regulations gazetted by DFFE and other relevant institutions. In particular, DFFE has gazetted multiple environmental regulations to promote sustainable practices that can be sector- and or province-specific. While these regulations vary, it has been noted by Govender (2019) that many of the provincial nature conservation ordinances or biodiversity legislation that were in place before NEMBA have outdated concepts and approaches that remain legally applicable. One example of this is the misalignment of old provincial boundaries with the current provincial boundaries (Govender, 2019). The misalignment of old and current provincial boundaries is also being overcome through the repeal of laws pertaining to the old provinces (viz. Transvaal, Natal, Orange Free State and the Cape). Some provinces will no longer be influenced by ordinances, because under the Constitutional dispensation, these provinces have enacted new provincial legislation to repeal apartheid legislation. An example of a provincial law repealing a number of applicable laws in a province is the Western Cape Biodiversity Act No. 6 of 2021, which repeals the Nature Conservation Ordinance 1974, the Western Cape Biosphere Reserves Act 2011 and more. Provincial ordinances and acts relevant to environmental conservation include, but are not limited to:

- **Eastern Cape:** Cape Nature and Environmental Conservation Ordinance 19 of 1974, Draft Eastern Cape Environmental Management Bill of 2019 (it is proposed in the draft bill that the following Acts applying in the Eastern Cape are repealed: Nature and Environmental Conservation Ordinance, 1974; Nature Conservation Act, 1987 Ciskei; Environmental Conservation Decree, 1992 Transkei and Mountain Catchment Areas Act, 1970), Regulations Relating to the Eastern Cape Land Development Objectives in terms of the Development Facilitation Act 67 Of 1995, Eastern Cape Land Disposal Act 7 of 2000, Eastern Cape Roads Act 3 of 2003
    - Repeal of Local Government Laws: Eastern Cape Act 1 of 2020 (Land Use Planning Ordinance was officially repealed in the Eastern Cape Province by the Repeal of Local Government Laws (Eastern Cape) Act 1 of 2020 which commenced on 17 December 2020.)
- **Free State:** Nature Conservation Ordinance 8 of 1969, QwaQwa Nature Conservation Act 5 of 1976, Bophuthatswana Nature Conservation Act 3 of 1973, Bophuthatswana Protected Areas Act 24 of 1987;

- **Gauteng:** Town-Planning and Townships Ordinance No.15 of 1986, Transvaal Nature Conservation Ordinance 12 of 1983;
- **KwaZulu-Natal:** Kwa-Zulu Nature Conservation Management Act 9 of 1997, KwaZulu-Natal Planning and Development Act No. 6 of 2008;
- **Limpopo:** Limpopo Environmental Management Act 7 of 2003, Town-Planning and Townships Ordinance, 1986 (Ordinance 15 of 1986);
- **Mpumalanga:** Mpumalanga Nature Conservation Act 10 of 1998, Mpumalanga-Town-Planning-and-Land-Related-Repeals-Act 2 of 2016 effective from 1 October 2019 (Town-Planning and Townships Ordinance, 1986 repealed in so far as it applies to Mpumalanga Province), MTPA Act (Act 5 of 2005);
- **North West**: North West Biodiversity Management Act of 2016 (will repeal Transvaal Nature Conservation Ordinance 12 of 1983 once in force), Bophuthatswana Protected Areas Act 24 of 1987, Cape Nature and Environmental Conservation Ordinance 19 of 1974 (geographic scope includes parts of North West Province and excludes the former Boputhatswana, ordinance to be repealed by the North West Biodiversity Management Act, 2016 in as far as it applies to the North West Province when that Act comes into force), Town-Planning and Townships Ordinance, 1986 (Ordinance 15 of 1986), Transvaal Nature Conservation Ordinance 12 of 1983 (this Ordinance will be repealed in as far as it relates to the North West Province when the North West Biodiversity Management Act, 2017 comes into force);
- **Northern Cape**: Northern Cape Nature Conservation Act 9 of 2009; Nature Conservation Ordinance 19 of 1974, Northern Cape Planning and Development Act No. 7 of 1998;
- **Western Cape:** Western Cape Biodiversity Act No. 6 of 2021, Western Cape Land Use Planning Act of 2015, Western Cape Biosphere Reserves Act 6 of 2011.

Some of the environmental management / biodiversity acts as listed above are discussed below, specifically in relation to the project's target DMs and associated provinces.

The **Draft Eastern Cape Environmental Management Bill of 2019** seeks to supplement national legislation in the Province where necessary to protect the environment by providing reasonable measures for the:

- Management, protection and conservation of certain areas of ecological or environmental importance;
- Promotion of the sustainable utilisation of the areas of ecological or environmental importance; t
- Management, protection and conservation of biological diversity and of the components of such biodiversity; and
- Use of indigenous biological resources in a sustainable manner.

The bill also aims to provide for sound environmental management, enhancing and encouraging sustainable use of resources, conservation and a risk averse approach as well as setting provincial requirements, norms and standards for provincial environmental management according to best practices.

The **Limpopo Environmental Management Act (Act 7 of 2003**) establishes environmental advisory bodies and protected areas. It also includes provisions with regards to wild and alien animals; professional hunting; aquatic biota and aquatic systems; invertebrates; indigenous plants; Convention on International Trade in Endangered Species of wild fauna and flora; preservation of caves and cave-formations; limited development areas; mountain catchment areas; environmental pollution;

waste management; environmental compliance officers; permits, permissions, exemptions and exclusions; and offences, evidence, penalties and forfeitures. The act does prioritise biodiversity management but there is little mention of climate change.

The **Mpumalanga Nature Conservation Act 10 of 1998** consolidates and amends the laws relating to nature conservation within the Province and includes provisions for the protection and hunting of wild animals, professional hunters and hunting outfitters, problem animals, fisheries, indigenous plants, endangered and rare species of fauna and flora, and cave formations, amongst others.

In addition, Mpumalanga has the **MTPA Act (Act 5 of 2005)** that establishes the MTPA whose responsibilities include conservation management of the natural resources of the province with specific emphasis on broadening the participation in conservation management of previously disadvantaged individuals and communities.

The **North West Biodiversity Management Act of 2016** provides for the management and conservation of the North West Province's biophysical environment and protected areas within the framework of NEMA including provisions for the protection of species and ecological systems that warrant provincial protection; and for the sustainable use of indigenous biological resources.

Policies relating to climate change, DRR, ecosystem, or environmental policies at a provincial level in the Eastern Cape, North West, Limpopo and Mpumalanga provinces could not be found online.

Local Analysis

DMs and LMs govern their areas of jurisdiction through by-laws and policies, and these are assessed below:

Alfred Nzo DM

The DM does not have any climate change by-laws, but it does have a **water and sanitation services by-law (2009)** [4] which dictates offences and fines. The by-law does not make any specific mention of biodiversity, the environment or climate change, but does include provisions for pollution of the environment including: 1) unauthorised pollution of water or the environment including streams, rivers and dams; and 2) failure to provide the municipality with evidence that a sanitation facility is not likely to have a detrimental effect on health or the environment. Similarly, the DM also has a **water use policy (2010)** that aims to ensure sustainable use of water through the protection of quality water resources for the benefit of all users. However, there is no mention of climate change, EbA or the environment. In addition, the DM does not possess any environmental and climate change policies.

[4] Alfred Nzo DM: Water Supply and Sanitation Services By-law, 2009.

The following Alfred Nzo DM by-laws are noted; however these could not be accessed online[5]:

- Disaster Management By-law, 2009
- Municipal Health By-law, 2009
- Solid Waste Disposal By-laws, 2009
- Fire Safety By-law, 2009

Matatiele LM

The LM's **environmental by-law (2016)** does not make mention of climate change, EbA or biodiversity. The by-laws goes into detail regarding the regulation of the local environment including pollution of the environment. The LM has not developed any climate change policies that speak to sustainable use of the environment or biodiversity. Similarly, no by-laws relating to DRR, or DRM were observed on the LM's website. Matatiele's **Land Use Management System Scheme Regulations (2013)** does recognise conservation needs with the categorisation of nature reserves and protected land. In particular, the regulations emphasise the protection of flora and fauna in these indigenous botanical communities and the protection of water courses. It goes on to notes that no land use or development of any nature or extent may be undertaken, nor developed on any portion of these reservations or zones be permitted, until the proposed land use or development has been subject to proper assessment in terms of the Integrated Environmental Management process as contemplated in terms of the NEMA. The **waste management by-law (2019)** does not refer specifically to climate change, but it does note the need to promote and ensure environmentally responsible council services and commercial services. It goes on to emphasise the duty of people and institutions to protect the environment and ensure that their activities do not harm the environment with regards to waste management. The **public health by-law (2005)** notes the right t to an environment that is not harmful to people's health and wellbeing and includes several previsions related to environmental health practitioners. However, there is no mention of climate change in the by-law. The **advertising signs by-law (2005)** regulates the development and maintenance of advertising signs to ensure that they do not harm the environment including the need for environmental impact assessments where relevant.

The following Mataiele LM by-laws are noted; however, these could not be accessed online:

- Spatial Planning and Land Use Management By-laws, 2016

Umzimvubu LM

The LM's **Climate Change Policy (2019)** was developed in 2019 and aims to present a fundamental set of measures and guidelines that helps people understand and address the impact of global warming, increases "climate literacy" within Umzimvubu communities, encourage changes in peoples' attitudes and behaviour, and helps people to adapt to climate change-related trends. The objectives of the policy are to:

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[5] It is recommended that a comprehensive legal due diligence be conducted during implementation of the Eco-DRR project to assess all relevant legal documents at a national, provincial and local level.

1. Ensure that the Umzimvubu LM promotes and facilitates climate change awareness to the communities and more specifically into specific growth sectors and development projects.
2. Provide an integrated support mechanism to/from potential international and national investor community.
3. Create a policy framework that supports future resilience building and the reduction of vulnerability to climate change impacts.
4. Guide the adaptation of infrastructure design guidelines and considerations to expected hazard profiles linked to climate change;
5. Provide policy support to climate change mitigation and adaptation initiatives within the Umzimvubu LM;
6. Clarify roles, responsibilities and organisational opportunities in climate change mitigation and adaptation; and
7. Consult tradition leaders regarding a programme of awareness to local communities for factors that lead to climate change.

However, the policy does not specifically refer to EbA with focus being on agrobiodiversity rather than biodiversity as a whole.

The LM has an **Integrated Environmental Management Policy (2010)** that seeks to ensure that the LM practices cooperative governance with its neighbouring municipalities in all development planning processes and actively participates in environmental activities and programme of other organs of state. The policy does highlight the importance of ensuring that critical biodiversity areas are managed and protected for sustenance purposes. It also emphasises the need for conservation and protection of the natural environment. However, there policy does not mention climate change or EbA.

The LM has a **pollution control by-law (2010)** that includes provisions for noise pollution, air pollution, and smoke emissions. The municipality's **by-law relating to dumping, littering and waste collection (2008)** also has provisions related to pollution and protection of the environment. The **by-laws relating to outdoor facilities and municipal buildings (2008)** does note the prohibition of a person polluting or contaminating the water in any dam, river or water-course. It goes on to state that no person may misuse, pollute or contaminate any water source or water supply or waste water in or at any outdoor facility or municipal building. The **LM's spatial planning and land use management by-laws (2015)** stipulate that the LM must determine the use and development of land within the municipal area to which it relates in order to promote a healthy environment that is not harmful to a person's health. The **Land Use Scheme Regulations (2016)** for the LM does not apply to proclaimed protected areas where all aspects of the management of such protected areas and activities within them are regulated by the provisions of NEMA, NEMBA, NEMPAA and associated regulations. It should be noted that none of the by-laws mentioned above include provisions with respect to climate change, EbA or biodiversity.

The LM has a **disaster management by-law (2023)** that seeks to manage hazards and reduce the vulnerability and risk of disasters to protect and minimise the loss of life and property thereby alleviating human suffering through effective responses at all levels of disaster management. The by-law provides for the impending occurrence of disasters; preparation and hosting of public events; fire and rescue services / disaster management requirements; major hazard installations; minimum requirements of the emergency plan; operating procedures; and local disaster management committees. The by-law does not include any provision that speak directly to climate change or EbA.

Joe Gqabi DM[6]

The DM does not have any policies that speak to climate change or environmental management, but it has several relevant by-laws. The **water and sanitation services by-law (2015)** includes provisions for the protection of water infrastructure as well as the restriction of water consumptions to help conserve water resources during droughts or other water shortage events. The by-law also notes the need to protect the environment with regards to disposal of industrial effluent. It goes on to highlight the need to prevent significant environmental damage or water pollution with the inclusion of several provisions. However, the by-law does not mention climate change, EbA or biodiversity.

The DM adopted its **Disaster Management Policy and Framework in 2009** and later reviewed it in 2015. The framework addresses disaster management and planning in the district (Joe Gqabi DM, 2020). A process to develop a District Disaster Management Scientific Assessment Plan has been initiated since.

Elundini LM

The LM does not have any policies in relation to climate change, the environment or biodiversity. The LM's **parks and open space by-law (2008)** makes provisions for the municipality to control, manage and develop public open spaces that is environmentally sustainable and is in the interest of the community including future generations. It its **nuisance by-law (2008),** it is noted that a person may not commit, cause or permit to be committed any act causing or contributing to the pollution of water. The **waste disposal sites by-law (2013)** seeks to the dumping of waste and management of disposal sites to ensures a safe and healthy environment for the benefit of residents. All of the by-laws mentioned above do not include any provisions related to climate change, EbA or biodiversity and no environmental by-law could be found on the LM's website. Similarly, no DRR or DRM-related by-law could be found on the LM's website.

The LM has a **spatial planning and land use management by-law (2021)** that is unique in that it makes reference to climate change, noting that any approval is subject to conditions that relate to requirements aimed at addressing climate change. It also notes the need for a spatial development framework that provides detailed priorities in relation to land use planning and, in so far as they are linked to land use planning, biodiversity and environmental issues.

Senqu LM

The Senqu LM does not possess any policies with regards to climate change, the environment, EbA or biodiversity. **The by-law on nuisance control (2017)** does give the municipality power to protect any aspect of the environment within a public place. The **by-law on outdoor advertising and signage (2017)** notes that no sign or advertisement may be designed or displayed that detrimentally impacts the environment. It also requires all applications for outdoor advertising signs in conservation areas to obtain the input of the relevant local body concerned with environmental and conservation matter. The by-law grants the LM the ability to request a submission of any or all or specific phases of an environmental impact assessment. The LM's **by-law on waste management (2017)** requires that waste be avoided, minimised, reused, recycled,

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[6] The Joe Gqabi DM has been assessed in this feasibility study as the DM was identified as a potential site for interventions during the candidate site selection process. However, the DM has been excluded in the list of final sites that have been presented in the FFP and this is discussed in more detail in Section 9.

recovered, and disposed of in an environmental sound manner. Senqu LM has a **by-law relating to air quality management (2017)** that aims to ensure that air pollution is avoided, or where it cannot be altogether avoided, mitigated or minimised. The LM's **Land Use Scheme Regulations (2017)** is similar to Umzimvubu's in that it does not apply to proclaimed protected areas where all aspects of the management of such protected areas and activities within them are regulated by the provisions of NEMA, NEMBA, NEMPAA and associated regulations. It should be noted that these by-laws do not make specific mention of climate change, EbA or biodiversity. In addition, no environmental by-law could be found on the LM's website.

Ehlanzeni DM

The DM does not possess any climate change and environmental policies. With regards to by-laws the DM's **municipal health services by-laws (2018)** includes provisions with regards to land, water and air pollution. For land and soil pollution control, the by-law prohibits disposal of chemical toilets contents, pesticide contents, oil, hazardous wastes, building rubble and litter. The by-law also notes that no person is allowed to pollute any water source or dispose of any hazardous material into water sources. The by-law does not include any climate change, EbA or biodiversity specific provisions.

Thaba Chweu LM

By-laws and policies for the LM regarding environmental management, EbA, climate change, DRR or biodiversity could not be found on the LM's website.

Bushbuckridge LM

Similar to Elundini's, Bushbuckridge LM's **spatial planning and land use management by-law (2022)** makes reference to climate change, noting that any approval is subject to conditions that relate to requirements aimed at addressing climate change and biodiversity conservation and management. It also notes the need for a spatial development framework that provides detailed priorities in relation to land use planning and, in so far as they are linked to land use planning, biodiversity and environmental issues. Unfortunately, by-laws and policies related to the environment, EbA, biodiversity or climate change could not be found on the municipality's website.

Ngaka Modiri Molem DM

Searches on the DM's website did not reveal any by-laws or policies regarding the environment, EbA, climate change or biodiversity.

Ramotshere Moiloa LM

The LM's **spatial planning and land use management by-law (2015)** makes reference to climate change, noting that any approval is subject to conditions that relate to requirements aimed at addressing climate change and biodiversity conservation and management. It also notes the need for a spatial development framework that provides detailed priorities in relation to land use planning and, in so far as they are linked to land use planning, biodiversity and environmental issues. Online searches on the LM's website did not reveal other by-laws or policies with regards to climate change, EbA, environment or biodiversity.

Sekhukhune DM

The DM's **water and sanitation services development charges policy (2017)** notes that the DM shall strive to ensure that municipal services are provided to the local community in a financially and environmentally sustainable manner. In terms of by-laws, the DM's **water and sanitation by-law (2010)** prioritises the conservation of water resources and pollution prevention. It's **waste management and refuse removal by-laws (year unknown)** also seek to protect the environment with regards to waste collection, disposal and transport. The DM's **sanitary by-law (year unknown)** applies to sewer and drainage installations with the by-law incorporating 1-in-50 year floods. The **health services by-law (year unknown)** includes provisions for air pollution as well as other provisions related to protection of the environment. The **noise abatement and prevention of nuisance by-law (year unknown)** also prohibits a person from causing or permitting any foul or polluted waste, liquid or objectionable material to run or flow on any land. The DM's **emergency management services by-law (year unknown)** has provisions for fire protection and firefighting (including firebreaks).However, there is no mention of climate change, EbA or biodiversity in the above by-laws.

Elias Motsoaledi LM

The LM does not have any policies that target climate change, EbA, biodiversity, DRR or environmental management. The LM has a **refuse removal, refuse dumps and solid waste disposal (waste management) by-law (2017)** that seeks to ensure that waste is avoided, minimised, reused, recycled, recovered and disposed of in an environmentally sound manner. The by-law notes the need to educate employees regarding environmental risks of their tasks. The by-law also requires that the municipality's integrated waste management plan ensures that waste management does not harm the environment - specifically water, air, soil, plants and animals. However, the by-law does not make mention of climate change, EbA or biodiversity. In addition, searches on the LM's website did not reveal any by-laws related to the environment.

Its **spatial planning and land use management by-law (2016)** makes reference to climate change, noting that any approval is subject to conditions that relate to requirements aimed at addressing climate change and biodiversity conservation and management. It also notes the need for a spatial development framework that provides detailed priorities in relation to land use planning and, in so far as they are linked to land use planning, biodiversity and environmental issues. The municipality's **land use management scheme regulation (2020)** builds on the by-law by including the category of "conservation area". This is defined as an area associated with the purposes of "*preservation or protection of the natural or built environment, including the preservation or protection of the physical, ecological, cultural or historical characteristics of land against undesirable change or human activity. This may include but is not limited to water courses, wetlands and sensitive eco-systems, heritage sites, historical buildings or sites of cultural significance. These areas, erven or buildings need special management and maintenance in order to preserve the identified natural, historical or cultural characteristics*" (Elias Motsoaledi LM, 2020). The regulation also includes protected areas such as nature reserves (including wilderness areas and protected environments); specially protected forest areas, forest nature reserves and forest wilderness areas; mountain catchment areas; heritage sites; world heritage sites; provincial nature reserves; and sites of ecological importance, protected environments, private nature reserves or resource use areas as indicated in the provincial conservation plan.

Makhuduthamaga LM

The LM does not have any policies or by-laws that focus on climate change, EbA, biodiversity, DRR or environmental management. With regards to by-laws, the **spatial planning and land use management by-law (2019)** notes that any approval is subject to conditions that relate to requirements aimed at addressing climate change and biodiversity conservation and management. It also notes the need for a spatial development framework that provides detailed priorities in relation to land use planning and, in so far as they are linked to land use planning, biodiversity and environmental issues. The LM also a **waste management by-law (2022)** that aims to ensure that waste is collected, reused, recycled or disposed of without causing harm to human health or the environment and, in particular, without risk to water, air, soil, plants or animals. However, the by-law does not mention climate change, EbA or biodiversity. In addition, online searches on the LM's website did not reveal if the LM has any environmental or DRR by-laws that target climate change or EbA.

Fetakgomo Tubatse LM

Online searches on the LM's website did not reveal policies or by-laws that speak directly to climate change, biodiversity, EbA, DRR or environmental management. The LM does have a **land use management by-law (2018)** that is similar to other LMs in that it makes reference to climate change, noting that any approval is subject to conditions that relate to requirements aimed at addressing climate change and biodiversity conservation and management. It also notes the need for a spatial development framework that provides detailed priorities in relation to land use planning and, in so far as they are linked to land use planning, biodiversity and environmental issues.

Planning Instruments and Tools

National Analysis

South Africa's national strategies and plans are comprehensive with regards to climate change and mainstreaming adaptation into climate response. Environmental-related strategies and plans all highlight the threat of climate change and the need for adaptation interventions including EbA.

In the water sector, the National Water Resources Strategy Third Edition includes strategic actions such as developing climate change adaptation studies and plans as well as developing and reviewing climate change mitigation, adaptation and response strategies for the water and sanitation sector. Under Strategic Objective 2, specific mention is made of investing in ecological infrastructure, especially Strategic Water Source Areas, as an important mechanism for long-term adaptation to the effects of climate change on water provision growth and development. Strategic Objective 3 is wholly focused on developing appropriate adaptation measures to maximise water security and resource protection under changing climate conditions. The strategy goes on to note the need for adaptation measures to improve the resilience of societies and economies in the region, including mechanisms to reduce the risks associated with extreme events such droughts, floods and wildfires. The strategy also reflects on other climate change strategies (both national and international) as well as the need to ensure alignment of the water sector with climate change goals and objectives (DWS, 2023). The National Water and Sanitation Master Plan (2019) prioritises the protection and restoration of ecological infrastructure in response to degradation and climate change (DWS, 2019). The water sector has also developed the Water and Sanitation Sector Policy on Climate Change (2017) and NCCAS (2014) for the Water Sector in South Africa – all of which showcase the sector's aims to address the impacts climate change through adaptation and mitigation measures as well as implementing an integrated approach that is aligned with other departments and international obligations.

However, it should be noted that the JET IP does not include any activities related to EbA. In addition, sector-specific strategies - such as those for agriculture, health, and human settlements – are only partially aligned with the NCCRP. In particular, planning instruments for human settlement does not adequately address DRM from a preventative and reduction perspective (Kong, et al., 2016). As a result, there are many planning instruments across sectors that do not sufficiently incorporate climate change adaptation in alignment with NCCRP, NCCAS and the updated NDCs.

Provincial Analysis

Provinces are responsible for developing strategies, plans and other planning instruments to guide DMs and LMs as well as ensuring alignment between local and national objectives. As per the NCCAS, provinces are required to develop their own climate change adaptation strategies that identify the threats posed by climate change and identifies measures to address these threats. The strategies include adaptation responses and associated implementation plans to guide climate response in the province. These strategies and associated implementation plans should be reviewed and updated every five years. The Let's Respond Toolkit resulted in the development of provincial climate change strategies for all four provinces within which the DMs are located. The highlights from these strategies are presented below:

Table 3-3: Provincial climate change strategies

Strategy	Highlights
Mpumalanga Climate Change Mitigation Strategy and Implementation Plan (2022)	• The strategy focuses on mitigation with only minor focus on adaptation. • Prioritises the identification, restoration and expansion of protected key ecosystems / areas such as wetlands, forests and grasslands for carbon sequestration.
Eastern Cape Climate Change Adaptation Action Plan Final Draft (2017)	• The strategy is over 5 years old and requires a review / update. • Programme 1 focuses on the integration of biome-specific climate change adaptation measures into municipal Climate Change Response Strategies, IDPs and spatial planning, as well as into community-based adaptation and ecosystem - based adaptation projects. • Programme 2 seeks to strengthen sustainable rangeland farming through biome-specific ecosystem based adaptation measures as well as appropriate incentives and enablers
North West Climate Change Strategy and Implementation Plan (2021)	• The strategy is relatively recent and is supported by a detailed climate risk and vulnerability assessment (CRVA) of the province. • One of its goals includes building climate-resilient ecosystem infrastructure (terrestrial and aquatic ecosystems) with associated actions. • The strategy also prioritises the implementation of EbA projects in rural areas of the province.
Limpopo Climate Change Strategy (in progress)	• At the time of writing this report, the Limpopo province is in the process of updating its climate change strategy. The updated strategy will include both mitigation and adaptation (Let's Repond, n.d.)

Provinces also develop relevant plans and strategies in relation to climate change, the environment and DRM. The planning instruments of each province with regards to climate change and environmental management are presented below.

Table 3-4: Planning instruments in relation to climate change and environmental management

Strategy / Planning Instrument	Highlights
Eastern Cape	
Eastern Cape's Annual Performance Plan (2023-2026)	• Highlights the impact of climate change with the province continuing to rollout the Climate Change Programme as well as the mainstreaming of climate change into the provincial economic development strategy. • Under the environmental affairs programme, the provincial government seeks to promote climate change adaptation and mitigation projects; protect biodiversity by maintaining and expanding biodiversity parks; promote safe and healthy air, land and water environment; and implement and enforce environmental legislation and regulations. • The plan also notes the need for EbA to ensure DRR.
Eastern Cape Biodiversity Strategy and Action Plan (2018)	• Recognises the pressure of climate change and associated risks. • Notes the need for climate change adaptation measures. • Recognises the need to protect ecological infrastructure and associated ecosystem services. • Specific activities regarding EbA is absent.
Eastern Cape Vision 2030 Provincial Development Plan	• Notes the environmental challenges related to climate change including threats to biodiversity, water quality and waste management. • Understands the need to improve resilience of rural communities to the effects of climate change. • No mention of EbA.
Eastern Cape Industrial Development Strategy (2010)	• Identifies green industries as a key sector including environmental management and linkages between green industries and rural development. • For provincial skills requirements, highlights the need for biodiversity managers, coastal and marine management as well as geographic information system specialists. • Strategy is outdated and does not mention climate change or EbA.
Eastern Cape Agricultural Economic Transformation Strategy (2016-2021)	• Strategy is outdated. • No mention of climate change, EbA, biodiversity or DRR.
Eastern Cape Tourism Master Plan (2009—2014)	• Notes the need for tourism development that protects the natural habitat, underlying ecosystems and other environmentally sensitive areas. • Strategy is outdated and does not mention climate change or EbA.
Mpumalanga	
Department of Economic Development and Tourism Strategic Plan (2020-2025)	• Green economy is included as a programme with focus on implementing measures to minimise the effect of climate change, enforcing legislation regarding pollution control, amongst others. • No mention of EbA or biodiversity.
Mpumalanga Spatial Development Framework (2018)	• Recognises the threat the climate change poses to different sectors such as energy and agriculture. • Biodiversity and ecosystems is highlighted as well as the impact of climate change. • Include map of biomes in the province and protected areas. • Notes the need for adaptation measures to mitigate the impacts of climate change.
Mpumalanga Vision 2030 Strategic Implementation Framework (2013-2030)	• Highlights the challenges of climate change as well as the impacts on the coal sector. • Notes the need for clearly defined responsibilities between spheres of government with regards to environmental management, strengthened cooperative governance, and increased capacity. • Recognises that municipalities concentrate on water services, without sufficient attention to water conservation and demand-side management. • Includes a Environmental Sustainability Programme that looks at integrated spatially-based sustainable development; better exploitation of reserves and parks; provision of services and infrastructure on an environmentally sustainable basis; fostering environmentally targeted rural enterprise development; and regulating

Strategy / Planning Instrument	Highlights
	and monitoring key sectors, regarding environmental impact and trade-offs in resource use. • Promotes environmental management and conservation as a key driver. • Little mention of adaptation measures, DRR and EbA.
Mpumalanga Provincial Growth Development Strategy (2008)	• Identifies environmental sustainability as an area of priority. Themes under this include local government's capacity on environmental management issues, water demand management, and improved management of environmental impact assessments. • Also notes the protection of sensitive ecosystems. • Limited inclusions regarding climate change, adaptation, DRR, and EbA.
North West	
Department of Economic Development, Environment, Conservation and Tourism Performance Plan (2022/23)	• Includes an outcome that speaks to protection and sustainability of environmental assets and natural resources including implementation of climate change adaptation and mitigation strategies. • Key focus includes building a climate resilient province with targets related to % increase in conservation estate, environmental management instruments and planning tools developed, % compliance to environmental legislation and % of environmental authorisations / biodiversity permits issued within legislated timeframes. • Includes an output and targets that speaks to implementation of climate change response plans to reduce risk to climate change-related vulnerabilities. • Limited reference to EbA and DRR.
North West Renewable Energy Strategy (2013)	• Developed in response to climate change. • No mention of adaptation, EbA or DRR. • Strategy is outdated.
North West Province Environmental Implementation Plan (2020-2025)	• Outlines activities related to climate change including development of North West Climate Change Response Strategy. • Presents progress on other activities including mitigation and adaptation responses (building capacity in DMs/LMs, establishing a provincial climate change forum, implementing the provincial Ambient Air Quality Monitoring Programme, mainstreaming climate change into identified sector plans, supporting the National Local Government Programme on Climate Change, conducting awareness raising, and incorporating green building elements in infrastructure projects). • Presents progress on activities related to biodiversity and ecosystem health and outlines activities going forward. • Includes activities related to DRR. • Limited mention of EbA.
North West Spatial Development Framework (2016)	• Focuses on impact of climate change. • Lists core protection areas with regards to biodiversity features. • Strategic objective 2 includes protection of biodiversity, water and agricultural resources including climate change mitigation and adaptation strategies. • Highlights important ecological process issues for climate change adaptation that must be considered in spatial planning and development.
Limpopo	
Limpopo Development Plan (2020-2025)	• Outcome 2 under Agriculture notes the need to respond to climate change and building adaptive capacity through climate smart agriculture, conservation agriculture, improved rangeland management and awareness raising. • Another priority under spatial transformation includes looking after the environment with a focus on nature reserves and supporting the Land Care Programme. • Limited reference to EbA and DRR.
Limpopo Provincial Spatial Development Framework (2022)	• Notes the importance of biodiversity and ecosystem services including management and protection of Critical Biodiversity Areas. • Also highlights the need to respond to climate change.

Strategy / Planning Instrument	Highlights
	• Specifically mentions EbA as an opportunity of addressing climate change impact in Limpopo and should be considered in the implementation framework. • Notes gender, youth, environment and climate change, and DRM as cross-cutting issues. • Emphasises the need to improve DRM in support of regional resilience. • Notes the need for security from water-related disasters: including policy provisions covering people's protection from water-related disasters; disaster prediction, and management and mitigation.
Limpopo Annual Performance Plan (2023/2024)	• Notes the provinces climate change strategy as an important document for the province. • Recognises that recent water shortages can be attributed to climate change. • No targets that speak to climate change, EbA or DRR.
Limpopo Green Economy Plan (2013)	• Notes that the province is a climate change hotspot and the need to build resilient communities through green economy thinking, planning and implementation. • Recognises that the invasion of alien species poses a big threat to the ecosystem. • Notes that the province has unexploited biodiversity resources for green tourism and payment for ecosystem services (PES). • Focuses on resource conservation and management and the need to review economic instruments and ecosystem service assessment to understand the value of biodiversity. • Another focus areas includes establishing a sound network of ecological infrastructure to provide reliable ecosystem services in Limpopo. • Recommends relooking current building specifications and the impact these had on climate change. • Notes the need for an empowering framework for conservation of the ecosystem and biodiversity. • Proposes pricing ecosystem goods and natural systems as part of infrastructure that supports society/life. • Also recommended the development of natural capital indicators and defining the carbon sync value of ecosystems within cities. • Seeks to develop a research plan for further valuation of ecosystem services/ natural resources. • Document is outdated and needs to be updated to reflect latest climate change strategy. • Little mention of DRR.

At a catchment level, catchment management strategies play an important role in guiding management of the catchment's water resources and is developed by the CMA. The Breede-Oliphants CMA has developed a **catchment management strategy** which does incorporate climate change and recognises the need to adapt existing climate change strategies to water resources resilience in the Breede-Overberg, strengthen information acquisition and assessment related to climate change and development (trends), build institutional flexibility for resilience and mainstream water in DRM. The strategy also places emphasis on the provision of longer term datasets and information to support understanding of hydrological variability and adaptation responses. Prioritised actions are noted that speak to protection and maintenance of ecological infrastructure - especially wetlands and rivers – and includes the:

- Development and implementation of management plans for priority wetlands in the WMA,
- Planning and enforcing instream and riparian habitat protection for priority rivers, and
- Aligning invasive alien vegetation clearing plans with the Breede-Overberg priorities (Breede-Olifants CMA, n.d.)

The Inkomati-Usuthu CMA also developed its **Catchment Management Strategy (2023-2028)** which prioritises the need for sustainable governance and adaptation towards building resilience to climate change within WMA through the development of climate change resilience strategies. The strategy does note the need for the CMA to develop a climate adaptation strategy and undertake IAP removal as they threaten the aquatic system's ability to maintain a crucial integral component in the landscape. The CMA aims to remove invading alien plants in the river systems (Sabie, Crocodile, Usuthu and Komati rivers) which can improve the hydrology (runoff and inflows into dams) of the catchments (Inkomati-Usuthu CMA, 2023).

In terms of DRR, according to the Disaster Management Act (2002), provinces are required to develop **Provincial Disaster Management Frameworks (PDMF).** These frameworks are the primary guiding and coordinating policy instrument at a provincial level that aims to ensure an integrated and uniform approach to DRM. Limpopo's PDMF (2007) is extensive, but does not make specific reference to climate change. Online searches for the other four provinces' PDMFs did not yield any results. In addition, annual reports must be submitted by the PDMCs for each province. However, access to these reports on the NDMC website was not possible and an assessment of PDMCs' report was not done.

Local Analysis

Alfred Nzo DM

Although outdated, the DM has developed an **Environmental Management Plan (2010)** which highlights the importance of ecosystem services to its communities and the need to protect them for human wellbeing. Some of the key activities include protecting and rehabilitating ecosystems that provide some mitigation against climate change effects in key areas (Alfred Nzo DM, 2010). However, the plan does not make specific reference to EbA or adaptation measures.

The Environmental Management Plan has several annexures with one focusing on biodiversity. The *Biodiversity Annex* details the findings from the DM's biodiversity prioritisation process which provides biodiversity priorities that can inform developmental planning. The *Climate Change Annex* focuses on the causes of climate change and how the DM can mitigate the impacts of climate change. Although adaptation is noted in the annex, detail is scarce regarding the types of intervention and location.

The municipality also developed a **Climate Change Response Strategy (2015)** with the support of Conservation South Africa and SouthSouthNorth. The strategy builds upon the Alfred Nzo District Climate Change Vulnerability Assessment and identifies specific responses to address the vulnerabilities identified in the vulnerability assessment. The strategy emphasises the use of EbA to address climate change issues including climate-related disasters. Focus is also placed on improved DRM in conjunction with adaptation measures (Conservation South Africa, 2015).

The **Alfred Nzo DDM One Plan (2021)** identified spatial restructuring and environmental sustainability as a priority including protecting, nurturing and harnessing natural environment and resources. The plan also recognises the impacts of climate change on the district, noting that rural communities are particularly vulnerable due to their strong dependence on the natural environment for their livelihoods (Alfred Nzo DM, 2021). The plan does not make mention of ecosystem EbA or specific adaptation interventions.

Alfred Nzo's IDP (2022) includes in its vision the need for a sustainable and well-protected natural environment. It recognises the impacts of climate change on the district, and it proposes the development of a provincial green economy strategy to mitigate the climate change effects, to keep local spaces clean and to ensure sustainable development. It also seeks to scale up environmental Expanded Public Works Programme (EPWP) and implement environmental sustainability programmes by 2027 (Alfred Nzo DM, 2022).

The DM's **Small, Medium, and Micro Enterprises** (**SMME) Sector Plan**, dated 2012, does not make any reference to climate change, EbA or adaptation. However, it recognises the importance of the agriculture sector in the DM as well as programmes being undertaken by DALRRD including the Eastern Cape Communal Soil Conservation Scheme, Land Care Programme and Soil Conservation Scheme.

While the DM's **Economic Leakage Study (2011)** does not include any reference to climate change, EbA or adaptation interventions, it acknowledges the over-exploitation of the natural resources due to extraction of resources and changes in land use, especially linked to agricultural-based rural livelihoods which reduces the area's biodiversity through unlicensed sand mining, unmanaged harvesting of various endemic species and uncontrolled felling of mangrove forests and other forest stands. This is compounded by low levels of oversight which result in non-compliance. Furthermore, the DM notes degradation of ecosystems including erosion and river siltation.

The DM adopted their **Disaster Management Plan** in 2012 followed by the **Disaster Management Policy Framework** in November 2014 with its purpose being to comply with statutory DRM responsibilities (in terms of the DMA, 2002; (South Africa, 2005); and the Policy Framework of the Province of the Eastern Cape. The Alfred Nzo DM disaster management mandate is comprehensive in its approach covering all aspects of DRM. This policy framework serves to guide the development and implementation of uniform and integrated DRM across in the Umzimvubu, Ntabankulu, Matatiele and Mbizana LMs in the Alfred Nzo DM (Alfred Nzo DM, 2020).

In 2020, the DM did a **review of their Disaster Management Plan** which serves as a framework for the practical implementation of all aspects of disaster management within the district and acts as a management decision-making tool that will assist with the identification of disaster risks. The plan notes the need for a task team responsible for environmental degradation that will study and analyse processes induced by human behaviour and activities (sometimes combined with natural hazards) that damage the natural resource base or adversely alter natural processes or ecosystems (Alfred Nzo DM, 2020). The Plan does note climate change and EbA in relation to relevant national legislation and policies. The **DM's Disaster Management Guidelines (2010)** supports the Disaster Management Plan and includes similar elements around environmental degradation.

In addition to the above, there is the **Umzimvubu River Catchment report** developed by Freshwater Health Index in partnership with Conservation International and the Umzimvubu Catchment Partnership. The catchment runs through Alfred Nzo DM. The report evaluates the overall health of the catchment including ecosystem vitality, ecosystem services and governance and stakeholders. The report's findings noted the degradation of the ecosystem which is impacting ecosystem services (the latter being scored the lowest in the report) (Freshwater Health Index, 2022) .

Matatiele LM

The LM's **IDP (2022-2027)** presents the LM's vision: "*Where Nature, Agriculture and Tourism are Investments of Choice*". The IDP acknowledges the impact of climate change and the threat it poses to human settlements, infrastructure, human health, agriculture, wate availability and biodiversity. Goal 13 in the IDP requires the LM to take urgent action to combat climate change and its impacts while Goal 15 prioritises the protection, restoration and promotion of sustainable use of terrestrial ecosystems as well as the sustainable management of forests, combatting desertification, halting and/or reversing land degradation, and halting biodiversity loss. With regards to spatial restricting and environmental sustainability, the LM envisages that, by 2050, developmental challenges are addressed in a manner that ensures environmental sustainability and builds resilience to the effects of climate change, particularly in poorer communities. The LM notes that investment in skills, technology and institutional capacity is critical to support the development of a more sustainable society and the transition to a low-carbon economy. The LM is also looking to develop a climate change strategy as well as a disaster management plan with the latter being supported by an integrated disaster and fire management centre. In addition, the LM is prioritising awareness campaigns regarding fire belts and fire suppression. In the IDP, the LM notes its work with Environmental and Rural Solutions and Conservation South Africa in mitigating climate change resilience and listed several ongoing and planned projects:

1. Alien plant management (wattle clearing in wards 7,22,19,7,14,9).
2. Stewardship awareness outreaches to traditional authorities.
3. Ecofutures training for youth in the green economy (training of 30 students through Environmental Rural Solutions).
4. EbA through Conservation South Africa.
5. Restoration of grasslands/rangelands management.
6. Livestock improvement programmes.
7. Planting of trees at schools, community halls and around the towns of Matatiele, Cedarville and Maluti.
8. Awareness campaigns on wetlands and donga rehabilitation.
9. Clean- up Campaigns and educating the community on illegal dumping awareness.

The IDP also mentions the Matatiele Watershed Protection and Stewardship Project which is discussed in 3.6.

The provincial IDP reflects that Alfred Nzo DM's Council has approved the development of a disaster management plan between the years 2021-2022. However, no records could be found regarding progress since.

The LM developed a **Spatial Development Framework in 2020**.Of note is the LM's emphasis on the framework's response to climate change under its environmental management priorities. The framework understands the need to consider climate change during every planning process, or when existing plans are modified and updated. Its spatial development vision notes the need for sustainability and resilience with a focus on mainstreaming and coordinating environmental planning, resilience and climate change as a means of protecting and conserving environmentally sensitive areas and prime agricultural land within the municipality as well as encompassing the integration of social, economic and ecological factors into all planning, decision making and implementation. This will 1) build resilience to extreme weather events, and enable long term adaption to climate change; 2) reduce GHG emissions to mitigate climate change; 3) promote positive environmental quality and introduce environmentally sensitive management of development; 4) promote a spatial form that supports a world class/globally competitive and financially efficient region; 5) promote an inherent value of the natural and built environment and an understanding of the environment's role in providing natural resources to underpin sustainable socioeconomic development; 6) retain and enhance natural qualities and assets of the LM; 7) alleviate environmental and pollution related health hazards; and 8) empower citizens and build urban resilience in response to a future that is increasingly uncertain promote food security and food sovereignty.

The LM does not possess its own DRM plan and its annual report (2022/23) recommended that the LM work with Alfred Nzo DM and COGTA to obtain assistance in formulating its own disaster management plan.

Umzimvubu LM

The municipality's **IDP (2022-2027)** stresses the impact of climate change on the agriculture sector in its area of jurisdiction as well as recognising the need for climate change adaptation and mitigation measures. The plan acknowledges the importance of ecosystem services and potential use of PES to incentivise landowners and communities to maintain intact ecosystems, restore the natural environments of degraded land, and use natural resources sustainably. The framework notes that farmers and communities could implement activities related to carbon credits or offsets, biodiversity agreements, catchment management, sustainable firewood and vegetation collection and sustainable small-scale fishing and collection of coastal resources to help maintain and protect ecosystems. However, mention of adaptation initiatives that focus on EbA was not observed.

The LM's **Review of Spatial Development Framework (2015)** acknowledges the threat of climate change and the need to plan for long-term change and unexpected events, in particular those predicted for global climate change. In response to climate change impacts, the framework outlines possible activities including:

1. Implementing an educational programme addressing climate change issues.
2. Initiating and maintaining a 5-year extension programme within the Alfred Nzo DM to promote best-practice range management and catchment protection, including conservation farming, rangeland management and community-based natural resource management extension to the various projects and communities.
3. Where practical and important (e.g. near rivers that are used for potable water), implementing reclamation projects to stabilise and reclaim erosion gullies.
4. Diligently monitoring implementation of environmental assessment recommendations.
5. Producing a detailed and spatially-explicit alien plant intervention plan for the district.
6. Conducting feasibility and business plan studies on infestations that appear to be economic opportunities for charcoal, plantations, etc.
7. Reducing the area of alien tree infestation in the district by 20% focusing on priority areas identified in the intervention plan.
8. Partnering with DFFE's Working for Wetlands.
9. Identifying areas where there is leadership control to implement good range management practices and where there is a reasonable chance of reversing the trend.
10. Using extension staff and budget.

11. Using extension officers to interact with communities to develop sound range management practices that promote rotation, rest and good fire practice.
12. Partnering with Eastern Cape Parks and Tourism Agency and Eastern Cape's Department of Economic Development, Environment and Tourism (EC: DEDEAT) to formally protect key areas through stewardship or other mechanisms within the priority biodiversity areas.
13. Establishing a team to provide conservation farming, rangeland management and community-based natural resource management extension to the various projects and communities.
14. Conducting an assessment to identify which communities (people) and habitats and species are most vulnerable to climate change and how their vulnerability can be reduced.
15. Monitoring roads and bridges to ensure proper designs for minimum 1:50 year flood events, and construction according to specification.
16. Managing burning and providing education to improve range land management to increase ground cover, biodiversity and resilience to extreme weather events.
17. Providing more protection for existing water resources (wetlands, dams, springs and rivers) to support their natural function and resilience.
18. Improving the quality of sewage systems through appropriate design, location, monitoring, maintenance and upgrading to prevent floodwater infiltration and consequent damage and contamination.
19. Improving management of surface run-off through appropriate drainage design to reduce storm water damage and impacts on outfall areas e.g. rivers adjacent to towns becoming filled with solid waste after storms from run-off, and side drains becoming incised from storm run-off.
20. Increasing public awareness about the need for resilient landscapes and infrastructure design, and possible alternative agricultural production strategies.

Joe Gqabi DM

The **JGDM's DDM One Plan (2021)** prioritises environmental sustainability and highlights certain challenges in the district such as:

- The non-existence of an environmental management unit within the district to handle environmental sustainability matters.
- Wetlands being threatened by agricultural and development activities.
- Absence of information regarding current water quality of rivers in the district.
- Vegetation cover being poorly conserved (Joe Gqabi DM, 2021).

The plan goes on to note the need to develop a biodiversity-invasive alien species eradication plan, map all conservation areas, and develop a wetland management plan. Furthermore, it also highlighted the importance of integrating climate change into IDP processes and other municipal sector plans. Some of the DM's priorities with regards to environmental sustainability is the establishment of dedicated environmental management units in the DM and LMs; facilitating environmental management and conservation; developing capacity of the DM to undertake compliance and enforcement activities in terms of NEMA and other environmental management Acts; and ensuring communities are empowered and capacitated on environmental management issues through education and awareness campaigns, implemented through the DM. Additionally, other strategies that the DM put forward in terms of biodiversity and conservation include:

1. Formal partnership between national and provincial departments and the DM with clear deliverables, roles and responsibilities on various programmes.
2. A district-wide wetland assessment initiative, in collaboration with DFFE's Working for Wetlands project.
3. Community participation and awareness programmes relating to sustainable agricultural practices and wetland conservation.
4. Identification and protection of key conservation areas within environmental sensitive areas and critical biodiversity areas.
5. Better planning and coordination, especially through the use of the Joe Gqabi District Environmental Management Forum.
6. Assistance to develop and implement biodiversity sector plans.
7. The maintenance and management of the Orange River catchment area.
8. PES for water resource protection to ensure the protection of vegetation types dominated by wetlands (Joe Gqabi DM, 2021).

The **Joe Gqabi IDP (2022-2027)** also recognises the impacts on climate change on the area and its citizens and the municipality has prioritised the development and updating of a Climate Change Vulnerability Assessment and Climate Change Response Plan. In partnership with DFFE, the DM developed a Climate Change Mitigation and Adaptation Response Plan (2018) as well as a District Climate Change Vulnerability Assessment and Response Plan (2023) through the Local Government Climate Change Support Programme. The plan notes that the DM's responses to climate change are also guided by the Eastern Cape Climate Change Strategy in order to proactively respond to climate change matters. The plan also highlights that the DM has established a climate change function within the Natural Resource Management Section and designated the Manager as an Environmental Management Officer. The IDP goes on to detail the impact of climate change on biodiversity and the environment as well as identifying key projects such as the inclusion of a biodiversity chapter in the IDP. The main biodiversity objectives are: 1) manage loss of high priority biomes; 2) manage increased impacts on the environment due to land use change; and 3) manage loss of priority wetlands in river ecosystems. EbA is not mentioned in the plan (Joe Gqabi DM, 2022).

Online searches only provided results for the DM's **2019 Climate Change Mitigation and Adaptation Response Plan** and not the 2023 version. In the 2019 plan, climate change responses are provided per sector with a focus on both mitigation and adaptation measures. With regards to biodiversity and the environment, actions include:

1. Managing the loss of high priority biomes through inclusion of a biodiversity chapter in the DM's IDP.
2. Managing increased impacts on environment due to land-use change by eradicating alien plants (wattle) in Chevy-Chase and Elundini LMs (DALRRD, DFFE, Mondi and community members) as well as conducting awareness campaigns and capacity building initiatives in the DM (DALRRD).
3. Managing the loss of priority wetlands and river ecosystems through the rehabilitation of wetlands in Gatberg, Elundini LM (DFFE, Joe Gqabi DM).

In terms of disaster management, infrastructure and human settlements, the following actions were proposed: managing potential increased impacts on strategic infrastructure by developing resistant infrastructure for roads and bridges within five years. However, mainstreaming of EbA and its incorporation in plans for build and ecological infrastructure was absent in the plan.

There is mention that the district uses its **Environmental Management Plan (year unknown)** to guide climate change measures at a local level, however it was not possible to access this document online to assess if the plan is adequate with regards to adaptation and EbA.

The **DM's Spatial Development Framework Review (2009)** is relatively outdated and does not include any reference to climate change or DRR. However, it does acknowledge the need to maintain biodiversity in near natural state with minimal loss of ecosystem integrity, further adding that no transformation of natural habitat should be permitted. It also notes the need to manage functional landscapes for sustainable development, keeping natural habitat intact in wetlands (including wetland buffers) and riparian zones. Environmental authorisations that are granted for functional landscapes should support ecosystem integrity.

The DM's District Disaster Management Unit is still in the process of developing a **DRM Plan** as noted in the 2023/2024 IDP. This disaster risk assessment will identify and quantify the various risks the area is exposed to, and develop strategies on how prevention, mitigation and responses should be arranged and managed by all stakeholders.

The DM recognises that the impacts of storm events will affect communities located in informal settlements, on flood plains and where there is poor drainage infrastructure. Community vulnerabilities identified in the Joe Gqabi DM are presented in the table below:

Table 3-5: Community vulnerabilities in Joe Gqabi DM

Origin	Phenomena
Hydro-meteorological hazards	• Floods • Tornadoes • Drought • Veld fires • Severe snowfalls • Gale force winds
Biological hazards	• Outbreaks of epidemic diseases: • Cholera • Human immunodeficiency virus (HIV) / Acquired immunodeficiency syndrome (AIDS)
Industrial or technological accidents	• Domestic failures • Forest and structural fires
Pollution	• Air • Water • Toxic Waste

In response to the risks associated with frequent snowfalls and associated downstream flooding, along with high vulnerability to snow and flood incidents, the DM has developed and approved an **incidence protocol (2013)** in consultation with stakeholders. Strategies for addressing risks and community vulnerabilities identified include for example:

- Events management safety and security plan;

- Firefighting services master plan;
- Forest and veldt fire management plan; and
- Flood incident management response plan.

Furthermore, the DM's District Disaster Management Unit has developed strategies and programmes that include early warnings using various media such as local radio stations, disaster management forums, public education, awareness campaigns, and issuing out winter/summer season contingency plans.

As noted in the DM's IDPs, the DM combines the work of DRM with infrastructure and human settlements, noting that climate change impacts will affect disaster management, infrastructure and human settlements in several ways. This lumping of DRM efforts with infrastructure and human settlements means that the DM does not have specific programmes and/or projects that directly target risk and hazard reduction. However, the programmes that are in place address secondary disaster impacts such as damage to strategic infrastructure and rural-urban migration as a result of low service delivery in rural communities.

EWS has been initiated and proposed through the infrastructure and Incident Command System (ICS). The next phase of development of the ICS will add connection capabilities for prompt weather alerts. The DM was a pilot for the GEM3 System installed by the province, but the system is not linked to other municipalities. The Joe Gqabi District Disaster Centre is in a process of developing the Cross Border Mutual Aid Agreements with neighbouring municipalities and DM offers disaster and fire services in an attempt to cater for risks and community vulnerabilities. Community participation in DRM interventions implemented by Joe Gqabi DM create a conducive platform for the integration of Eco DRR in the municipality.

Elundini LM

Elundini LM's **IDP (2023/24)** is cognisant of climate change impacts and notes that the LM has not yet developed its Climate Change Strategy as well as an Environmental Management Plan due to budget constraints. The municipality has requested the Joe Gqabi DM's Environmental Management Unit as well as EC: DEDEAT for assistance with the development of these tools. The IDP does recognise the importance of biodiversity and ecosystem services and details some of the threats including unsuitable agricultural practices such as increasing irrigation in areas of poor soils and cash crop cultivation in marginal areas. The LM acknowledges that it doesn't have any dedicated persons looking at environmental issues. The IDP does not make specific reference to adaptation initiatives or EbA.

The LM has a **Spatial Development Framework (2019)** which notes the threat of climate change, particularly with regards to increased rainfall and storm activity – prompting the need for appropriate disaster management relief programmes. The framework also lists other environmental concerns such as absence of an environmental policy and/or plan; limited capacity to undertake compliance, monitoring and enforcement; land degradation including soil erosion; depletion of natural resources and the subsequent loss of habitat and biodiversity; lack of basic infrastructure leading to various environmental problems; water pollution; and the presence of IAPs. The framework has three classes (natural landscapes, near natural landscapes, and towns and settlements) with regards to biodiversity with each having different requirements to maintain biodiversity and the ecosystem.

The LM does not have its own approved Disaster Management Plan but fully recognises the value and importance of having one. The disaster risk assessment that will be conducted by the Joe Gqabi DM will be incorporated and assist in the development of a disaster management plan for LM. While continuing to use the district-wide disaster management plan, the LM has put plans in place to free resources in order to develop their own plan. The municipality is planning a review of its organogram to accommodate the planned shared fire services model in partnership with Joe Gqabi DM and Working on Fire (Elundini LM, 2020).

Senqu LM

The LM's **2023/24 Review of the IDP (2022-2027)** notes its struggles in dealing with the impact of climate change including increased severity of events such as mass flooding. As a result, the LM is looking to mitigate against climate change as well as adapting its infrastructure to cater for these changes. Goal 13 in the IDP refers to Climate Action and includes activities such as training on climate change reduction strategies and exploring partnerships to implement climate change. The LM also prioritised the development of an environmental framework that includes a climate change strategy, energy efficiency programmes, and a disaster management plan. This is coupled with the finalisation of climate change and air quality plans.

Some of the environment challenges noted in the review are listed below:

1. Presence of IAPs such as crack willows along the DM's river courses as well as increased invasion by alien and undesirable species like Slangbos and blue bush near Lady Grey.
2. Firewood collection and indiscriminate removal/damage of trees.
3. Indiscriminate burning of grasslands creating air pollution and loss of biodiversity. ·
4. Incorrect placing of drainage culverts adding to gulley erosion.
5. The proximity of wastewater treatment works at both Lady Grey and Barkly East to rivers which poses a risk as they could be susceptible to potential flood damage. ·
6. Soil erosion, due to marginal soils being utilised for inappropriate agricultural practices.
7. Limited human and financial capacity in the LM to implement environmental by-laws and act on environmental issues. This is changing due to the training of officials as peace officers, but it will be a while before the impact of this intervention is realised. ·
8. Limited capacity of both human and financial resources in the LM to undertake and develop climate change and air quality management plans and strategies. Financial and human resource assistance has been requested from EC: DEDEAT by the LM to assist the Community Services Directorate to educate the LM's administrative and political leadership about the importance of planning for climate change and environmental protection and developing a more sustainable and ecologically sensitive service delivery approach. ·
9. Increased sedimentation and eutrophication as well as pollution of water sources.
10. Limited protection of environmentally sensitive areas, especially vleis, wetlands and springs.
11. Flash floods resulting in rapid runoff and accelerated donga erosion.

Of note is the LM's commitment in the IDP to adopt EbA to address the impacts of climate change. The LM understand that such an approach will require intensive training of the political and administrative arms of the LM to ensure buy-in as well as that of traditional leaders and communities. This will ensure that indigenous knowledge is applied in the design of projects as well as ensuring that projects remain sustainable. The LM also states in its IDP the need to strengthen stormwater management systems to better deal with climate change, but highlights the LM's lack of funding to develop a stormwater plan and bring all infrastructure up to standards required by climate change.

The LM's **Spatial Development Framework (2016)** does refer to climate change and the impact it has on the LM's area of jurisdiction. A key principle that the framework is built on is the integration of built and non- built environments, in order to achieve the economic, environmental and recreational interaction that potentially exists between them and to make maximum productive use of urban resources. One of the spatial considerations necessary to improving basic essential service and infrastructure delivery, as noted in the framework, is to ensure that environmental factors and constraints are taken into account in the delivery of services. The framework goes on to state that land use planning and development in the municipality should protect existing natural, environmental and cultural resources. The framework identifies the need to do environmental rehabilitation of the Sterkspruit River which requires a radical change in land use in certain areas which are close to the river.

The LM has a **Draft Disaster Framework** which was adopted in May 2018. The district is currently busy with risk assessments and a preliminary report is being presented to communities for public participation. The Joe Gqabi DM is developing the disaster risk assessment to determine the municipal risk profile per LM which will be informed by priority risks as well as the identification of communities vulnerable to natural disasters. The disaster risk assessment will be incorporated into the development of a local-level disaster management plan (Senqu LM, 2019).

Ehlanzeni DM

The district does have its own **Climate Change Vulnerability Assessment and Response Plan (2016)** which follows the province's climate change strategy and aims to provide guidance on the implementation of climate change measures at a local level. The plan's proposed activities under the biodiversity component include:

1. Research and improve understanding of climate change impacts on biodiversity.
2. Research and improve understanding of ecosystems services.
3. Promote knowledge generation, knowledge sharing, stakeholder participation and awareness-raising regarding biodiversity management.
4. Strengthen management plans on grasslands, to enable effective monitoring and the ability to respond to the change.
5. Implement evidence based monitoring initiatives that feed into management systems.
6. Incorporate biodiversity management into planning systems for other sectors.

The plan also aims to minimise the physical isolation of rural communities as a result of poor rural roads and increased flooding and erosion with regards to human settlements. This includes identifying roads at risk of flooding and erosion and prioritise those for upgrading and maintenance as well as building climate change resilient road infrastructure that serves as a link for rural areas.

The DM also possesses a **Wetland Strategy and Action Plan (2017-2022)** with the aim of identifying the gaps in management and support with devising new and better wetlands management strategies going forward. The strategy notes the high value of wetlands in terms of ecological infrastructure and the ecosystem services they provide. In addition, the strategy recognises the importance of wetlands in DRM and reducing the impact of climate change Threats to the DM's wetlands include historical degradation, mining, afforestation, water abstraction, pollution and dumping and encroachment of IAPs. The focus areas of the strategy include stakeholder and community engagements, research and mapping, education and awareness raising, clarifying roles and responsibilities, job creation through wetland rehabilitation, and exploring alternative sources of funding.

The district's **IDP (2023)** notes the threat of climate change and recommends the strengthening of relations with Local Government Sector Education and Training Authority in providing both financial and technical expertise in training personnel and communities to aid with disaster response and relief programmes, and cleaning of towns, amongst others. The IDP also mentions the development of Ehlanzeni Wetlands Report in partnership with the International Council for Local Environmental Initiatives that mapped all the degraded wetlands within the district with the aim of increasing awareness on the importance of wetlands as one the most vulnerable ecosystems in South Africa as well as the impact of climate change on wetlands in the district. However, it was noted that the district does not have a biodiversity specialist. In addition, the plan proposes the development of an updated climate change adaptation strategy as well as an environmental management framework. The IDP does not mention EbA, however, the DM has comprehensive disaster management framework as well as a disaster management plan (Ehlanzeni DM, 2023).

Ehlanzeni's DDM One Plan (2022) prioritises infrastructure engineering – specifically the need for infrastructure to be resilient to climate changes weather patterns given that major parts of Ehlanzeni has both high and low-lying areas. Another strategic objective is to protect biodiversity, water and agricultural resources including the following:

- Conserving and expanding where possible protected areas and critical biodiversity areas to meet targets as set by the National Biodiversity Framework and NBSAP.
- Developing a protected areas network.
- Incorporating land management objectives as per the Mpumalanga Biodiversity Sector Plan 2015 into municipal spatial development frameworks and land use schemes.
- Managing the region's water resources, especially the ecological infrastructure related to water resources (Ehlanzeni DM, 2022).

The DDM One Plan does not make reference to EbA or adaptation activities.

In the DM's **Spatial Development Framework (2010),** emphasis is placed on protection of the DM's biodiversity and ecosystems as well as providing for the protection and sustainable management of protected areas (nature reserves, national parks, world heritage sites, and protected environments), irreplaceable areas, high significance areas, important/necessary areas and areas of least concern. Bearing in mind the date of the framework, the document does not mention climate change.

Many areas in the Ehlanzeni DM are prone to natural disasters such as floods, wildfires and strong winds. Such challenges require the municipality to take precise steps to act in advance to deal with adverse climate impacts when they occur. Since 2008 the DM has adopted their **Disaster Management Plan** that seeks to address ongoing and unforeseen occurrences.

Although some LMs in the district don't have disaster management plans, R1 million has been set aside by the DM to assist LMs to develop plans and/or update existing ones.

The council for the Ehlanzeni DM has adopted the **District Disaster Management Framework** with the following objectives:

- Institutional arrangement and capacity as part of the establishment of the disaster management centre;
- Disaster risk assessment;
- DRR;
- Response and recovery concerning the need for EWS;
- Information and communication;
- Education, training, public awareness and research; and
- Funding arrangements for DRM (Ehlanzeni DM, 2022).

Thaba Chweu LM

The LM's **Reviewed IDP (2023/24)** notes the implementation of activities in relation climate change including the development of a climate change response and adaptation strategy. Under the Waste Management and Environmental Services unit in the LM, promoting environmental awareness and education on air pollution and climate change is emphasised. The IDP does not make reference to EbA or other adaptation initiatives. The plan makes note of the LM's Disaster Management Plan within the Community Services Unit as well as the need to upgrade fire fighting vehicles and equipment coupled with refurbishment of the control rooms in the disaster centre.

The LM's spatial development framework could not be found online.

The LM has approved its **Disaster Management Plan** which was effective from December 2017 and has improved the minimum standard requirement for the municipal disaster situation. The plan was under review and was set to be approved by the end of the 2021/22 financial year. The draft plan has been presented to the relevant portfolio committee within the LM with the reviewed plan indicating the top four risks for the LM i.e. sewerage disruption, illegal solid waste disposal, land invasion and service delivery water failure (Thaba Chweu LM, 2020). However, no record could be found online regarding the updated disaster management plan and the current plan does not reflect any integration of Eco-DRR.

Bushbuckridge LM

The LM's latest IDP was not available online for review, but the **2017/22 IDP** was accessible. With regards to environmental management, the IDP highlights the ineffective rendering of environmental managements services resulting in non-compliance to environmental legislation, negative climate change effects, unsustainable utilisation and degradation of natural resources. In this regard, the LM is looking to develop and implement an environmental management plan and a climate change adaptation and mitigation strategy. The LM also undertook ecosystem rehabilitation projects during the reporting period. The IDP does not mention EbA. In terms of DRM, the plan notes the need to implement the disaster management plan and to ensure a rapid response to disasters and emergencies.

Bushbuckridge LM's **Spatial Development Framework** was developed in 2010 and it takes note of the threat of climate change. One of the principles of the framework includes ensuring that planning and zoning developments spatially within protected areas use an integrated approach between conservation and development and to maintain the integrity of the biodiversity and cultural resources. The framework also incorporates the need to conserve the natural and built environment.

The LM developed and adopted their **Disaster Management Plan** in April 2013. The LM has ensured that disaster is managed through the implementation of its disaster management strategic plan, as stipulated by the Act, national framework and provincial framework in the context of the capacity realities and availability funding (Bushbuckridge LM, 2017). The objectives outlined in the plan include preventing or reducing the risk of disasters; mitigating the severity or consequences of the disasters; emergency preparedness; a rapid and effective response to disasters; and post-disaster recovery and rehabilitation.

Ngaka Modiri Molema DM

NMMDM's DDM One Plan does not make specific mention of climate change but does note the need to develop an environmental management framework. It also emphasises challenges with regards to disaster management such as:

- Lack or poor implementation of the requirements of the Disaster Management Act particularly with five municipalities except for Mahikeng LM;
- Lack of disaster response vehicles and control room attendants or dispatchers for 24/7 services;
- Lack of support for DM intergovernmental relations structures and poor stakeholder participation in intergovernmental relations structures; and
- Insufficient resources for DRM (Ngaka Modiri Molema DM, n.d.).

NMMDM's latest IDP (2024/25) does not mention any targets or projects related to climate change or environmental conservation (Ngaka Modiri Molema DM, 2024).

The DM has a **Climate Change Vulnerability Assessment and Response Plan (2016)** outlines several key activities under biodiversity including:

1. Research and improving the understanding of climate change impacts on biodiversity.
2. Research and improving understanding of ecosystems services.
3. Promoting knowledge generation, knowledge sharing, stakeholder participation and awareness-raising regarding biodiversity management.
4. Strengthening management plans on grasslands, to enable effective monitoring and the ability to respond to the change.
5. Implementing evidence based monitoring initiatives that feed into management systems.
6. Incorporating biodiversity management into planning systems for other sectors.

Some of the priority actions regarding human settlements include identifying roads at risk of flooding and erosion and prioritise those for upgrading and maintenance as well as building climate change resilient road infrastructure that serves as a link for rural areas.

The DM's spatial development framework could not be accessed online.

Ramotshere Moiloa LM

The **LM's IDP (2020/21)** does not make specific reference to climate change or EbA, however, it does mention the importance of critical biodiversity areas and ecological support areas. It also identified the need for environmental conservation in the Maramage ward as well as environmental maintenance in the Ikageleng, Kruisriver, Sandvlagte and Henryville settlements. In terms of housing objectives, the IDP notes the need to protect environment when undertaking any housing development projects.

The LM's spatial development framework could not be found online.

The municipality does not have a disaster management plan, as noted in its IDP (2020/21).

Sekhukhune DM

Sekhukhune DM's **DDM One Plan (2021)** highlights the challenges the region faces with regards to climate change and detailed possible interventions such as:

- Reviewing and strengthening public health, monitoring and surveillance systems to increase their ability to detect climate change and health trends at an early stage;
- Strengthening information and knowledge of linkages between disease and climate change;
- Conducing educational campaigns to inform and encourage citizens to adopt actions and behaviours that minimise environmental damage and prepare individuals to cope with the effects of climate change and an increase in the frequency of disasters or service disruptions;
- Identifying communities vulnerable to climate change in the district and developing mechanisms that will enable these communities to respond to the spread of vector-borne diseases;
- Improving the bio-safety of the existing strategies that control the spread of vector-borne diseases to incorporate the effects of the changing climate; and
- Commissioning reliable air pollution monitoring systems to alert communities on atmospheric conditions. (Sekhukhune DM, 2021).

However, the DDM One Plan does not make reference to EbA or adaptation initiatives.

The DM's **IDP (2021/22-2025/26)** acknowledges the impact of climate change on human health, agriculture, water, biodiversity (loss of grasslands), environment and human settlements (increased isolation of rural communities and displacement). The IDP also notes the impact of mining for heavy metals, inappropriate land management, rural sprawl and unsustainable use of natural resources on biodiversity and ecosystem services. With regards to spatial development, one of the DM's guiding principles is to manage the conflicting demand between agriculture / mining, urban expansion and biodiversity conservation areas (tourism focus areas). However, the IDP does not mention any EbA or adaptation specific activities. Furthermore, the IDP notes the development of an Integrated Environmental Management Plan, but this could not be found on the internet.

The DM developed a **Climate Change Vulnerability Assessment and Response Plan (2016)** that sets forth priority actions in adaptation and mitigation. The plan is similar to other DM plans with a focus on biodiversity-related activities such as research, knowledge generation and sharing, stakeholder participation and awareness-raising, strengthening management plans, implementing evidence based monitoring initiatives and incorporating biodiversity management into planning systems for other sectors. Other relevant priority actions regarding human settlements include identifying roads at risk of flooding and erosion and prioritise those for upgrading and maintenance as well as building climate change resilient road infrastructure that serves as a link for rural areas.

The DM adopted its **Spatial Development Framework** in 2018 which aims to guide spatial development in the district to address spatial, environmental and economic issues confronting both the urban and rural areas of the District. The framework recognises the threat of climate change but namely on the agriculture sector. The framework identifies resource critical zones in the DM that have valued mineral resources, and are areas of great importance to biodiversity and critical water production. The district prioritises the aggressive protection and enhancement of the Province's natural resources, including scarce fresh water sources and high biodiversity landscapes. The framework also identifies critical biodiversity areas and environmental concerns.

The DM has developed a **Bioregional Plan (2018)** which aims to inform land-use planning, environmental assessment and authorisations, and natural resource management. The plan acknowledges climate change as well as the importance of ecosystem services and ecological infrastructure. It identifies elements that can support climate change adaptation including ecological corridors, climate change refuges and high diversity areas.

The DM's **DRM Plan and Framework (2022/23)** notes the threat posed by climate change and identified priority activities:

1. Establish Sekhukhune DM climate change technical committee with different stakeholders within the DMAF to champion climate change issues.
2. Review and strengthen public health, monitoring and surveillance systems to increase their ability to detect climate change and health trends at an early stage.
3. Strengthen information and knowledge of linkages between disease and climate change.
4. Conduct an educational climate change campaign to inform and encourage citizens to adopt actions and behaviours that minimise environmental damage and prepare individuals to cope with effects of climate change and an increase in the frequency of disasters or service disruptions. Such campaigns may include encouragement of a culture of disaster preparedness.
5. Identify communities that are vulnerable to climate change.
6. Develop mechanisms that will enable communities vulnerable to climate change to respond to the spread of vector borne diseases.
7. Improve the bio-safety of the existing strategies that control the spread of vector borne diseases to incorporate the effects of the changing climate.
8. Commission reliable air pollution monitoring systems to alert communities on atmospheric conditions and possible exceedances of legislated standards.

The plan did not include any EbA or adaptation initiatives.

The disaster risk assessment revealed several hazards that are likely to have a negative impact on critical infrastructure and the lives of the citizens (Sekhukhune DM, 2020).

Elias Motsoaledi LM

The LM's **IDP (2023/24)** does consider climate change and notes projects it's implemented to address climate change impacts' – namely the planting of 400 trees. The LM also acknowledges that more needs to be done including addressing other environmental challenges such as water pollution, waste management and expansion of settlements coupled with clearing of natural vegetation. Under Programme 12: Environmental Management, short-, medium- and long-term strategies are outlined which are listed below:

Table 3-6: Short-, medium- and long-term environmental actions for Elias Motsoaledi LM

Timeframe	Strategy
Short-term (1-2 years)	• Develop Environmental Master Plan • Monitor implementation of waste management programme • Enforcement of relevant by-laws • Implementation of strict pollution control • Monitoring of water quality, air quality management, noise management • Awareness campaigns on environmental issues • Hosting of events on environmental calendar • Initiate green –economy programmes coupled with creating awareness amongst communities
Medium-term (3-4 years)	• Continue monitoring implementation of waste management programme • Continue enforcement of relevant by-laws • Continue implementation of strict pollution control • Continue monitoring water quality, air quality management, noise management • Continue with awareness campaigns on environmental issues • Continue hosting of events on environmental calendar • Develop climate change programmes in response to critical elements of climate change
Long-term (>5 years)	• Continue monitoring implementation of waste management programme • Continue enforcement of relevant by-laws • Continue implementation of strict pollution control • Continue monitoring water quality, air quality management, noise management • Continue with awareness campaigns on environmental issues • Continue hosting of events on environmental calendar

The IDP does not mention EbA, biodiversity conservation or adaptation activities.

With regards to DRR, the IDP does note the development of the LM's disaster management plan, noting that the LM frequently experiences heavy rains during the summer season which causes flooding in some villages. The LM's IDP present the area's hazard profile which identifies riverine flooding, severe storms and drought as major climate hazards affecting the LM as well as subsidence, erosion and land degradation. The IDP emphasises the need for urgent attention regarding preventative measures for floods, in the form of storm water drainage which will contribute tremendously to the prevention of mud houses being washed away by floods. In this regard, the LM is looking to develop a storm water master plan.

The LM's **Spatial Development Framework (2018)** does note the threat of climate change, but little detail is provided in terms of how the LM will consider this in spatial planning and development. The framework does contain maps that identify the LMs protected areas and areas with high mining sensitivity.

The LM has an approved **Disaster Management Plan**, with a particular focus on disaster awareness campaigns, relief response and mitigation. The LM has conducted an assessment and hazard identification as well as spatially enabled hazard mapping. Some of the key challenges in the LM are veld fires, erosion, land degradation, storms and flooding (both large scale and localised flooding). The LM notes that urgent attention is needed to implement preventative measures for floods, including infrastructure-based approaches to improve storm water drainage improvements. This would help protect local structures - especially mud houses that are often damaged or even washed away by floods. The development of a Storm Water Master Plan to address the entire LM was also indicated in the IDP (Elias Motsoaledi LM, 2023).

Makhuduthamaga LM

The **IDP (2022/23)** for the LM does recognise the threat of climate change, particularly with regards to agriculture. One of the projects prioritised by the LM is the development of a climate change strategy. The LM is also cognisant of the importance of biodiversity and ecosystem services to food security and sustainable agricultural production in its IDP. In terms of environmental management, the IDP notes the need to develop an environmental management system based on International Organisation for Standardisation's Standard 144001 for LM to ensure protection of the integrity of the environment and sustainability of the municipality. It will also ensure participative greener governance. Some of the environmental management challenges and proposed interventions are presented below:

Table 3-7: Environmental challenges in Makhuduthamaga LM from IDP 2022/23

Challenge	Intervention
• Increasing number of illegal activities by inhabitants leading to degradation of the environment • Lack of coordination in ensuring the protection of the environment within the municipal space • Lack of capacity in environmental management	• Increase law enforcement initiatives • Conduct environmental awareness campaigns • Strengthen the role of the Environmental Management Committee • Capacitate the environmental officials in environmental management, compliance and enforcement training

The IDP does not make specific reference to EbA or adaptation initiatives.

With regards to DRR, the IDP notes the LM's Disaster Management Plan as well as disaster-related activities implemented by the DM including disaster relief, awareness raising campaigns and participation in disaster advisory forums.

The LM's **2021 Spatial Development Framework** does not make reference to climate change or EbA but does note critical biodiversity and environmentally sensitive areas in the LM as well as cases of non-alignment between critical biodiversity areas and transformed land uses. To better prevent the potential loss of ecological processes that support critical biodiversity areas due to land uses that result in irreversible modification of natural habitat as well as reducing the potential threat to ecological processes that support critical biodiversity areas due to altered land uses, the LM proposes the following:

1. Capacitate local, district and provincial authorities to enforce the bioregional plan.
2. Enforce environmental impact assessment requirements.
3. Institute penalties if required.
4. Enforce water use licencing / authorisation requirements.
5. Institute penalties if required.

6. Enforce planning controls to stop the spread of incompatible land use.
7. Monitor threat areas for further spread of incompatible land use and monitor trends in other areas.

The LM developed and adopted a **Disaster Management Plan** during the 2007/8 financial year. The plan is aimed at disaster prevention, mitigation, preparedness, response, recovery and rehabilitation. It serves to provide an enabling environment for disaster management in the municipal area (Makhuduthamaga LM, 2020). The plan sought to be proactive in DRM through the implementation of risk reduction programmes and response to emergency incidences. The DMP has not been revised since 2008, meaning that it may contain outdated information related to hazards and risks in the area.

Fetakgomo Tubatse LM

The LM's **IDP (2023/24)** acknowledges the impacts of climate change and notes the establishment of IDP working committees/groups established in terms of the municipal key performance areas to align the municipal strategic objectives and implementation of the IDP phases. These working groups are tasked with incorporating cross-cutting issues such as climate change in IDP processes and products. The LM also recognises the need to develop a climate change adaption strategy which it considers a key performance indicator. It also prioritises the development of a green infrastructure plan to support the transition to a lower carbon economy as well as responding to climate change. The IDP also notes the loss of ecosystem services in its area of jurisdiction and has highlighted the need to develop a bioregional plan. This is coupled with the LM needing to develop an environmental management plan to ensure that the environment is managed and protected.

While the IDP makes reference to the LM's spatial development farmwork, this could not be accessed on the internet.

In response to the LM's prioritisation of natural disaster prevention, response, and mitigation, a **Draft Policy on Disaster Relief** was established (Fetakgomo Tubatse LM, 2022). The LM aims to introduce and promote community-based disaster management and response through range of activities including community involvement, improved communication and development of methods to prevent and cope with future disasters.

3.4.2 Institutional Analysis

An institutional framework that supports horizontal and vertical coordination and collaboration with clearly defined mandates is critical for the implementation of climate change initiatives – particularly are a local level. However, this is one the hardest things for countries to get right due to the complexity of mainstreaming climate change across sectors and spheres of government as well as securing adequate buy-in and support from private sector, political figures, and government departments as well as communities and traditional authorities. In particular, the support of communities and traditional authorities is paramount to ensure effective implementation of EbA. Bearing the above in mind, understanding and evaluating the institutional context at the different spheres of government and the interlinkages between different role players in the climate change space is necessary to support the implementation of the Eco-DRR project.

Provincial Analysis

From a provincial perspective, the Eastern Cape is one of the provinces in South Africa where there is both significant disaster impacts – especially when it comes to droughts, floods and wildfires - but also a paucity in resources within the DRM structures. Local disaster management centres often lack resources and capacity. The **Eastern Cape PDMC** is a regular participant at the district-level Disaster Management Advisory Forum (DMAF), and the province supports municipalities financially as well as providing technical support during incidents. However, with the PDMC located in Bisho, the centre oversees a significantly large and often difficult-to-reach geographical extent, where access to areas across the province is often constrained and road conditions are poor. Therefore, interactions between role players are more localised and based on specific projects, with virtual engagements through discussions and meetings often being the only option. However, these types of engagements are not conducive to engage local communities who do not have access to the internet and require translators for non-English speaking community members.

Within **Mpumalanga, the PDMC** is active in a range of natural disasters, including floods and wildfires, and there is close cooperation between the provincial centre in Mbombela and the Mpumalanga Provincial DMAF. The forum consists of 44 members representing 37 stakeholders across the disaster management spectrum in the province. The forum gives advice, undertakes monitoring and makes recommendations on disaster-related issues and risk management, as well as gathering critical information regarding provincial capacity to assist in disasters and to access resources. It also implements response management systems enabling a systematic approach to the effective utilisation of facilities, personnel, equipment, resources, procedures and communication. Although physical access and communications infrastructure between the PDMC and urban and rural settlements are relatively good, capacity at a LM level is a challenge with many LMs only providing fire services in their areas of jurisdiction while relying on the DM for broader DRM services.

The **PDMC in North West province** is located in Mahikeng and is focused primarily on disaster response (although there is some risk assessment and prevention planning being undertaken). The province has recently faced challenges associated with service delivery and governance stability, making it increasingly important for the PDMC to not only consider natural disasters in its planning but to also incorporate human-induced impacts and influences in its systems and processes. As such the PDMC control room collaborates with the South African Police Services in the region (South African Government , 2023). The PDMC is active in creating awareness among communities of impending disasters – especially advance weather warnings, since the floods in the area often affect areas that are densely populated and close to flood plains, wetlands and in the vicinity of dams. With the geography being very flat, flooding is often extensive and, in many cases, towns and settlements are significantly affected - particularly when long-duration heavy downpours occur. Similarly, during drought conditions and when severe fires occur, the PDMC steps in to support. The PDMC is often active at a municipal level where there may be a lack of local capacity with municipal disaster management centres. For example, the PDMC activates disaster management official teams across all LMs and DMs to respond to incidents throughout the rainy season to assist communities affected by floods. These officials conduct assessments to determine the extent of the damages and to coordinate interventions from stakeholders which can include the South African Red Cross Society, South African Social Security Agency, Gift of the Givers, government departments and other social partners.

The work of the **PDMC in the Limpopo province** is often observed in the form of collaborative efforts and joint operations to provide assistance and relief to communities that have been impacted by droughts, severe storms and floods (Government Communications and Information System, 2011). The PDMC is located in Polokwane, from where actions are coordinated across the province. Advisory services include advance warning and recommendations on how to avoid harm. However, challenges exist in attending to significant prevention and mitigation activities since large expanses of low income settlements dilute the opportunity for large-scale risk reduction approaches.

Local Analysis

A critical element for the implementation of climate change adaptation and DRR initiatives is securing support and buy-in at a local level. This also requires an appropriate institutional framework at a DM / LM level that creates a suitable environment for implementation. In addition, these institutions need to be sufficiently capacitated - technical, financial and human resources - to undertake such activities, especially with the new Climate Change Act requiring DMs and LMs to develop and implement climate change strategies (Climate Action Tracker, 2020).

A study conducted by Sibiya et al. (2023) provides a high-level overview of the barriers to climate change adaptation in South Africa at different government levels (Sibiya, et al., 2023). Some of the major barriers are listed below, in order of importance as noted by respondents (government officials) during the study:

1. Inadequate financial resources across all government levels.
2. Lack of human capacity at provincial and local level.
3. Limited political will at local level.
4. Limited understanding by communities.
5. Inadequate coordination across government levels.
6. No legal mandate at local level.
7. No climate change unit at district and local levels.
8. Lack of knowledge by some staff members who are tasked with environmental duties at the district and local government levels.
9. Not enough climate change plans in place at local level.
10. Outdated information used in IDPs (Sibiya, et al., 2023).

For the Eco-DRR project, understating the institutional context at a DM / LM level in the priority areas will be vital to determine the types of interventions needed to strengthen the enabling environment.

Alfred Nzo DM

The DM has several functions with regards to climate change, environmental management and DRR and this is presented in the table below:

Table 3-8: Functions and powers of Alfred Nzo DM

Public Service	Role by DM
Water and sanitation	Water service authority and water service provider for the
Air pollution	The municipality renders the service from the Community Development department. The core function is local economic development and environmental tourism.
Fire fighting	The DM is performing the function under the department of Community Development Services
Local tourism	The DM does this under the Planning and Economic Development department. There is staff available for rendering the service but there is limitation of budget for development of local tourism attractions/destinations
Municipal planning	The municipality has staff and equipment available for rendering the service.
Municipal health services	This is performed by the DM who has dedicated staff for this purpose.
Fencing and fences	The DM renders this infrastructure as part of the Agri-Parks Development Programme.

Markets	The DM does not perform this function as yet, however, there are plans to have a market in the silo facility precinct in EmaXesibeni town.
Municipal roads	The DM responsible for development of Rural Road Asset Management System.

As noted in its 2023/24 IDP, the **Environmental Management sub-unit** is located in Water Services Unit and is responsible for the environmental management issues across the district including:

- Facilitating and coordinating environmental impact assessments and water use licenses,
- Conducting environmental monitoring to ensure compliance,
- Conducting water quality monitoring,
- Supporting process audits,
- Supporting Blue and Green Drop reports / assessments,
- Coordinating and convening the district environmental management forums (DEMF),
- Participating in the provincial environmental quality and management forum,
- Implementing environmental projects,
- Support LMs in all environmental management programmes, and
- Convene district-wide climate change committee,

The Disaster Risk Assessment of the DM lists extreme weather conditions (heavy rains, lightning, snowfalls, and hailstorms) as well as drought as priority hazards. The DM's DRM centre is located in Mt Ayliff while permanent satellite offices are situated in each of the LMs across the district, with Mbizana LM having a satellite office that operates from a temporary structure (Alfred Nzo DM, 2020). The Alfred Nzo DM's Disaster Management Information Management and Communication System is functional in accordance with the National Disaster Management Policy Framework the DM collaborates with SAWS on information dissemination of early warnings that are generated for local communities (Alfred Nzo DM, 2017).

Disaster management projects embarked on by the DM include a of the DRM plan, education, training, awareness raising, research, and roll-out of volunteer programmes which include capacity building. Significant efforts towards the improvement in the provision of relief and support during and after disasters also form part of their annual budget allocations.

The **DRM Services sub-unit,** which serves as the MDMC for the district, sits within the Community Development Services unit and is responsible for disaster management services, risk reduction, recovery and rehabilitation, and awareness and information. The main DRM centre is located in Mt Ayliff and satellite offices are situated in each LM. The Mbizana Satellite Office is currently operating in a temporal structure. The DM established the DMAF which is supported by three technical task teams: 1) Capacity Building Coordinating Task Team, 2) Emergency Coordinating Task Team and 3) Social Relief Coordinating Task Team. Additionally, the DM procured and installed a Disaster Management Information Management and Communication System in accordance with the National Disaster Management Policy Framework (2015).

During the site visits, the Alfred Nzo DM showed willingness to engage and participate in the Eco-DRR project, however it was highlighted that capacity in LMs is limited. **DFFE: EP** is active and capacitated in the area. Within the DM, there is a strong presence of NGOs / civil society such as **Conservation South Africa; Environmental and Rural Solutions, the Umzimvubu**

Catchment Partnership and LIMA Rural Development Foundation – all of which implement EbA in the areas and have actively engaged and worked with the communities in the district.

During site visits and district workshops, stakeholders identified high priority villages and wards in the DM which are listed below:

- Overall high priority: ward 2 (Vukayibambe), ward 11 (Pele Pele) and ward 15.
- Floods: ward 14 (Mbongweni, Meje village), ward 15 (Khanyayo), ward 5 (Mbhobeni), ward 3 (Ntshangase), Imizizi A/A (Mobeni, Greenville), ward 2 (Vukayibambe), ward 11 (Pele Pele), ward 15, ward 23, ward 24, ward 25, ward 27, ward 28; Amadiba A/A (Baleni, Maqongwana, Mtayisa, Mbongweni), Ndunge, Ntshamathe, Bulala, Mnceba, Dumsi
- Fire: Imizizi A/A (Mobeni, Greenville); Pele Pele; Dumsi (T32G); Mangqufoza; Eplangweni; Kumabula; Mpetshneni; Chithwayo; Mthentswana; Mtentu Catchment (T60C); Mandiliva; Xopo (T33G); Bomvini (T32H), ward 14 (Mbongweni, Meje village), ward 15 (Khanyayo), ward 5 (Mbhobeni)and ward 3 (Ntshangase)
- IAPs and bush encroachment: Amadiba A/A (Baleni, Maqongwana, Mtayisa, Mbongweni); Amakhanyayo A/A (Khanyayo, Mthentswana); Pele Pele; Ntlozela (T60A); Mangqufoza, Eplangweni, Kumabula (T40E).
- Soil erosion: Mpetshneni
- Drought: Lufafa, Mjila, Dadamini, Dutyini, Dungu, Mbangwani

Matatiele LM

The LM's **Environment and Waste Management Unit** in the Community Services Department is responsible for all environmental issues including climate change. As noted on the LM's website, the unit deals with environmental impact assessments, climate change issues, greening activities, conservation initiatives and participation in for a with relevant stakeholders such as Maloti Drakensberg Transfrontier Project, DALRRD, DFFE, EC: DEDEAT and NGOs. The LM does acknowledge capacity challenges with regards to spatial planning, specifically the inability to retain professional staff due to uncompetitive salaries and limited budget to increase the capacity. This has negatively impacted enforcement capabilities in the LM.

The LM's **Public Safety Unit** under the Community Services Department performs disaster management functions in collaboration with Alfred Nzo DM, PDMC and NDMC. The disaster management functions of the LM consist of immediate reactive response to disasters affecting the community, in which the district disaster management team contributes proactively. The LM provides immediate disaster relief, and supports other initiatives throughout the local municipal area. The IDP notes an ineffective fire services department including shortage of fire fighters and equipment, budget constraints, and the absence of a fire management centre.

Umzimvubu LM

The LM's Local **Economic Development and Environmental Management Department** is responsible for environmental management including climate change activities. The **Community Services Department** is responsible for disaster management services (immediate local relief).

The IDP (2022-2027) does highlight that the LM does not have an adequate environmental policy framework in place to govern development, and this is further hindered by the lack of human resource capacity that is involved with environmental affairs. This has resulted in delays the issuance of permits for environmental compliance.

Joe Gqabi DM

The **Natural Resource Management Unit** in Community Services Department is tasked with managing and protecting the environment in the district. However, it is not clear how the unit is structured and staffed with reports only noting the appointment of an acting manager. The DDM One Plan does note the non-existence of an environmental management unit within the district to handle environmental sustainability matters. The IDP makes notes of a DEMF that the DM participate in, but it is not clear who is responsible for coordinating and facilitating the forum.

The DM's **District Disaster Management Unit** has been established in the Community Services Department to develop the DM's capacity to deal with disasters. The roles and responsibilities of the unit are to coordinate, plan, build capacity and to prevent and mitigate potential disasters that the area is prone including tornados, floods, thunder storms, snow, swine fever, cholera and diarrhoea. In addition, local offices have been established by the DM to perform these functions at LM level. Four satellite offices have been established in Mount Fletcher, Burgersdorp, Aliwal North and Lady Grey. A well-equipped district disaster centre is in the process of being established in Barkly East and Aliwal North. The unit participates in the monitoring of the airstrips for safety landing as well as conducting safety inspections on an ongoing basis to identify and respond to potential disaster risk areas. The unit plays an advisory role in the DMAF which sit quarterly and involves sector departments and communities. Some of the work that the unit focuses on are listed below;

- Special building designs that can withstand the forces of nature,
- Planting of trees to create windbreaks,
- Community awareness and capacity building programmes to inculcate risk avoidance behaviour,
- Emergency preparedness such as community awareness, preparedness training, drills and rehearsals for disasters that cannot be prevented or mitigated, as well as for those that cannot reasonably be predicted.

Site visits and engagements with the DM revealed that the DM has capacity and the ability to support the implementation of EbA. Additionally, Joe Gqabi DM has identified priority areas for EbA which the Eco-DRR project can build upon. It should also be noted that Joe Gqabi DM has a politically stable environment with strong political support being provided for the Eco-DRR project during site visits. **DFFE: EP** is active and experienced in the area as well as having successfully mobilising the community to support EbA. **SANParks** also indicated their presence in the district, with reference to the Grasslands National Park programme that they're looking to implement in the DM. The traditional authorities in certain areas are supportive and can be a useful resource when engaging with communities. Based on experiences during the site visit, there is a strong presence of NGOs and civil society in the district who can support implementation **including World Wide Fund for Nature (WWF) and LIMA Rural Development Foundation**.

During site visits and district workshops, stakeholders identified high priority villages in the DM which are listed below:

- Flooding: Popcorn Valley in Ugie.
- Other high priority areas: Joveleni, Herschell, Tenahead (QC D12B).

- Silting up of Mt Fletcher, Gariep and Umzimvubu dams

Elundini LM

The functions of environmental management lie with the **Community Services Department** in the LM. The objectives of the department are:

- To deliver on its constitutional mandate i.e. a sustainable environment that is free from harm, is safe and healthy for the benefit of current and future generations.
- To provide and maintain municipal public amenities to all by ensuring easy, affordable and equitable access thereto.
- Anchor and implement all government programmes aimed at providing job opportunities and skills to the unemployed through EPWP, Community Works Programme and other projects.

Environmental management is paired with waste management functions – specifically refuse removal, landfill site management, waste minimisation and recycling, and environmental education and public awareness. The LM does notes its IDP (2023/24) the lack of adequate capacity to enforce environmental management by-laws.

DRM functions is also found in the **Community Services Department** with a focus on fire and emergency services. The LM does not have a fully staffed disaster management centre and relies on the DM to undertake these functions. The LM's IDP (2023/24) does note the capacity challenges with only fire and disaster management officers being employed. The LM also doesn't have a disaster management plan and uses the DM's plan.

Senqu LM

The **Integrated Environmental Development Services Unit** within the Community Services Directorate is tasked with environmental management in the LM. However, the IDP (2017-2022) does highlight that environmental management is poor due to limited staff and budget with many by-laws not being enforced. Many town planning by-laws are broken and illegal land invasion occurs on a regular basis.

The LM's **Fire Services Unit** is housed within the Community Services Department and is responsible for providing fire services to the LM. However, this does not include management and reduction of other services and the LM relies on the DM for support in DRM and DRR. The LM's IDP (2017-2022) notes that it does not have the capacity to deal with disaster management in its entirety.

The LM's Review of the IDP (2022-2027) notes that the municipality has failed to live up to its vision, especially with regards to climate change. The LM goes on to say that Batho Pele principles must be promoted to strengthen collaboration and coordination as well as exploring alternative approaches that go beyond "business as usual".

Ehlanzeni DM

The DM's **Environmental Management Services Unit** in the Community Services Department is responsible for maintaining a clean and healthy environment within the district. The functions of the unit include:

1. Developing and implementing strategies to mitigate environmental risks and promote sustainability.

2. Monitoring air and water quality, waste management, and pollution control.
3. Ensuring compliance with environmental regulations and standards.
4. Promoting environmental education and awareness within the community.
5. Managing green spaces and natural resources to enhance the quality of life for residents.

While the DM has capacity to undertake environmental management and climate change activities, it was noted in its annual reports that the DM lacks a biodiversity specialist. While there is mention of a DEMF in the district, it is not clear who is responsible for coordinating and facilitating the forum.

With regards to DRR, the **Disaster Management Unit** in the Community Services Department is responsible for ensuring the municipality's preparedness for emergencies and disasters with their functions being to:

1. Develop comprehensive disaster management plans and protocols.
2. Coordinate emergency response efforts and resources.
3. Conduct disaster preparedness training and public education.
4. Collaborate with local and regional agencies to enhance disaster resilience.

The DM's Disaster Management Unit is the primary entity responsible for disaster management within its area of jurisdiction. In compliance with the Disaster Management Act, the DM established its DMAF which is responsible for providing a platform to stakeholders involved in DRM to engage with DM. The forum makes recommendations to the municipal council concerning the DRM policy framework to ensure the application of the principle of cooperative governance for the purpose of DRM in the municipality. The forum is also tasked with introducing actions to promote intergovernmental coordination and the application of joint standards of practise (Mpumalanga News, 2015).

Engagements with the DM during site visits and workshops revealed that the DM has some capacity with CRVA being conducted for the Bushbuckridge LM. There is some experience in ecosystem-based interventions through previous work, however, the capacity, competencies and the resources to take such interventions to scale are limited. **DFFE: EP** is active and capacitated in the district with a history of IAP clearing coupled with the presence of civil society / NGOs such as **Conservation South Africa**, **Kruger 2 Canyons and AWARD** – all of which are present to provide technical and operational support.

During site visits and district workshops, stakeholders identified high priority villages and areas in the DM which are listed below:

- Hendriksdal Brondal (X22D and X22E) – drought (fire as a second prioirty).
- God's Window – fire, important strategic water source area , Inhaca dam in this area.
- Matibidi, Vaalhoek, and Pilgrim's Rest (B60B and B60D) – drought and fire, community reliant on grazing land and other ecosystem services, impacted by climate variability.
- Mashishing / Lydenburg (B42B) and Sabie and Lone Creek (X31A and X31B) – flood and fire.
- Casteel / Zoeknog and tributaries (X32A, B D, E, F) – unmanaged forest, sand mining, high fuel loads and fire risk.
- Maviljan, Dwarsloop and Shatale in X32E have floods and excessive soil erosion (informal settlement built on hillside, pollution).

- X32F Violet bank, Casteel, Arthurseat, Greenvalley and Acornhoek – localised flooding, IAPs, sand mining.
- X32H and X40C (Welverdiend, Manyeleti, Ludlow and Hlubukani)– drought, high flood and fire risk, rangelands being converted to development.
- Welverdient / Hlaukani (X32H) – encroachment, drought and fire in western area.
- Agincourt / Xanthia to X32L (Mkhuhlu) – flooding due to deforestation.
- X31G and Lower parts of X31L (Mkhuhlu to Belfast) – localised floods.

Thaba Chweu LM

The **Waste and Environmental Management Sub-Directorate**, located in the Community Services Directorate, is responsible for coordinating and rendering environmental services to its area of jurisdiction including climate change activities. The sub-directorate actively takes part in the DEMF as well as other environmentally relevant fora. The functions of the sub-directorate are listed below:

1. Monitor compliance to environmental legislation and regulations.
2. Develop air quality management plans and minimum standards.
3. Monitor compliance to prevent emission and noise that cause disturbances.
4. Promote environmental awareness and education on air pollution and climate change.

The IDP (2022-2027) notes that the LM lacks capacity to effectively address environmental issues.

The **Disaster Management and Emergency Services Sub-Directorate**, located in the Community Services Directorate, is tasked with rendering all disaster and emergency management services. Its functions include:

1. Providing fire rescue services.
2. Developing and implementing fire preventions plans.
3. Conducting fire awareness campaigns to the business and communities.
4. Ensuring compliance to fire prevention prescripts of buildings and storage of flammable liquids registration.
5. Conducting fire risk assessments.
6. Facilitating the issuance of permits regarding transport of flammable goods.

The LM does not undertake all activities related to DRM but rather only focuses on fire services. It shares its DRM responsibilities with Ehlanzeni DM where the expectation of the LM is to only coordinate whereas the district resides with the direct responsibility of DRM and DRR. The sub-directorate has engaged with the DM to assist and use the district's Disaster Management Centre as shared service in case of emergency disasters.

Bushbuckridge LM

The **Economic Development, Planning and Environment Directorate** is responsible for environmental management. It is not clear where exactly the functions of DRM sit within the municipality, but the IDP(2021/21) notes that LM is looking to build capacity and establish a disaster management centre in its structure. As such, it is assumed that the LM relies on the Ehlanzeni DM for DRM and DRR services. The IDP (2020/21) does emphasis the capacity challenges in the LM in terms of DRM with emergency preparedness being a challenge due to staffing constraints.

Ngaka Modiri Molema DM

Reviews of the DM's IDP, reports and website did not provide clarity on where environmental management functions reside in the DM. For DRM, the responsibility of DRM lies with the Community Services Department – specifically the **Disaster Management Services Unit**. The unit serves as the district's MDMC and is responsible for:

- Initiating the implementation of any contingency plans and emergency procedures.
- Promoting capacity building in disaster management.
- Implementing risk reduction plans and recovery strategies in communities.
- Ensuring that all operational tools and equipment are in good working condition.
- Preparing monthly reports of statistics of incidents and formulate service level agreements with bordering municipalities.

No mention of the district's DMAF could be found online.

The 2022 IDP (Ngaka Modiri Molema DM, 2022) mentions that disaster management structures are in place but not administratively supported in five of the LMs expect the Mahikeng LM. Challenges common to the DM and its LM include:

- Lack or poor implementation of the requirements of the Disaster Management Act, particularly for the LMs (excluding Mahikeng LM);
- Lack of disaster response vehicles and control room attendants or dispatchers for 24/7 services;
- Minimal support for DM intergovernmental relations structures and poor stakeholder participation in intergovernmental relations structures; and
- Insufficient resources for DRM.

These challenges have resulted in the non-delivery of DRR and DRM services in the DM. In order to urgently address the above mentioned challenge, one of the DM's goals is to implement disaster awareness campaigns and conduct a review of the disaster management plan. Critical elements that are missing from the plan include information and communication networks as well as EWS. The DM, going forward, has placed significant emphasis an integrated disaster management approach.

During site visits and engagements in the district, it was noted that the DM has some capacity and has developed flood risk maps for the area. In addition, the DM is very supportive of the Eco-DRR project, as evidenced during stakeholder engagements and site visits. The working relationship between Ngaka Modiri Molema DM and the **Provincial Department of Economic Development, Environment, Conservation and Tourism (NW: DEDECT)** is particularly strong with joint interventions being undertaken to understand and address climate vulnerabilities. **DFFE: EP** does have capacity to support in the region and is currently involved in interventions that include wetland and shallow well management. Engagements and site visits revealed that there are no NGOs or civil society present in the district.

Stakeholders identified high priority villages and areas in the DM during the site visits and workshops which are listed below:

- Main areas include Kraaipan, Mareetsane and Deelpan.

- Flood prone areas: Makgobistad, Madibogo, Madibogopan, Motsitlane, Deelpan, Kraaipan, Mareetsane, Brooksby, Mokgola, Gopane, Shiela, Verdwaal and Lokaleng.
- Drought prone areas: Madibogo, Setlagole, Dingateng, Kabe, Modimola and Madibe a Makgabane.
- Wild fire prone areas: Setlagole

Ramotshere Moiloa LM

The functions of environmental health and disaster management lies with the **Community Services Directorate**. It was not clear based on reviews of the LM's IDPs what specific environmental functions are assigned to the Directorate and if there are sub-directorates that are delegated these functions. Similarly, it was not possible to determine the exact functions related to DRM that lies with the LM versus those that belong to the DM.

Sekhukhune DM

The **Municipal Health Services Division** in the Community Services Department is responsible for rending environmental health services and management. The **Environmental Management Services Sub-Division** is tasked with implementing environmental management and enforcing environmental management compliance.

The **Disaster Management Division** in the Community Services Department is assigned the functions integrating institutional capacity, conducting disaster risk assessments, undertaking DRR and cooridnating and facilitating disaster response and recovery. The division serves as the MDMC and has 5 disaster management officers and one manager.

Based on engagements and observations during site visits and stakeholder engagements, the DM's capacity to support the implementation of climate change measures is limited. While the DM has some experience in flood management, their overall capacity is weak and staff turnover is high, which further exacerbates the capacity challenges being faced. **DFFE: EP** has previously worked in the area, mainly around bush encroachment and do have capacity to support future projects, however this is not certain with regards to EbA. The engagements and site visits revealed that there are no NGOs and civil society present in the DM to support climate change activities at a local level.

Stakeholders identified high priority villages and areas in the DM during the site visits and workshops which are listed below:

- Flood prone areas: Mamone, Mogorwane, Skinot – Phase 4, Ga-Pahla, Marulaneng, Phokwane, Uitvlugt, Legolaneng and Cyplas.
- Drought prone areas: Across most of the LMs (Makhuduthamaga, Elias Motswaledi, Ephraim Mogale, Fetakgomo, and Greater Tubatse LMs).

Elias Motsoaledi LM

Community Services Department in the LM is responsible for environmental management as well as coordinating disaster management and emergency services. A review of the LM's IDP and website did not reveal how environmental management is undertaken in the department with regards to structure and staffing. With regards to DRM, the department only undertakes some functions of DRM such as conducting disaster awareness campaigns, relief response and mitigation. The other functions associated with DRM and DRR lie with Sekhukhune DM.

Makhuduthamaga LM

The **Environmental and Waste Management Services Division** in the Community Services Department is responsible for providing environmental management services. The current structure of the division strongly focuses on waste management with no specific post dedicated to environmental management or climate change. The LM's IDP(2022/23) does recognise that it has insufficient capacity to adequately deal with environmental management issues.

The **Community and Social Service Division** in the Community Services Department is assigned the functions of coordinating disaster management services with Sekhukhune DM. The LM primarily assists in terms of providing relief materials in the form of temporary shelters, sponges and blankets as well as education and awareness raising campaigns. The DM is responsible for the broader DRR and DRM functions.

Fetakgomo Tubatse LM

The **Community Services Department** is responsible for the provision of environmental management services. Based on reviews of the LM's IDP and website, it was not possible to determine if there is a dedicated unit in the LM for DRM, but the IDP does not that the function of DRM lies with both the LM and Sekhukhune DM. In addition, the IDP (2023/24) notes the need to revive the disaster management committee and develop a disaster management centre.

3.4.3 Gaps and Challenges in the Enabling Environment

Operational Challenges and Resource Constraints in DFFE and DFFE: EP

DFFE is the primary entity responsible for climate change planning and policy making, coordination of climate change interventions with other government departments at different levels and ensuring integration and alignment with national and international climate change goals and objectives. However, ongoing reductions in budget allocation over the past few years and with no increase expected in coming years has resulted in capacity challenges (human, technical and financial) within DFFE. This has impacted the department's ability to provide effective and efficient services to the public. While DFFE has prioritised building human resource capacity within its directorates, the department is working on building and strengthening partnerships with different sectors of society and key stakeholders, including international donor organisations to secure alternative sources of funding (DFFE, 2022).

Within DFFE is the **DFFE: EP branch** that is responsible for implementing DFFE's mandate through the EPWP approach. The EPWP is a public employment intervention that aims to contribute towards addressing poverty, inequality and unemployment. DFFE: EP support the EPWP by liaising with other branches in DFFE to ensure implementation of policy commitments. DFFE: EP implements its projects by appointing service providers as well as utilising its in-house project management capacity. DFFE: EP's contributes to the following outcomes:

- Creation of and sustaining jobs that prioritise youth, women, and persons with disabilities.
- Ecosystems rehabilitated and managed.
- Integrated fire management.
- Infrastructure, adaptation, and DRR.
- Healthy, clean, and safe coastal environment (DFFE, 2023).

DFFE: EP has two chief directorates, namely the Environmental Protection and Infrastructure Programmes (EPIP) and the Natural Resource Management (NRM) directorate. Under DFFE: NRM (now restructured to be only Environmental Programmes), several sub-programmes are implemented: 1) Working for Water, 2) Working for Ecosystems, 3) Working for Forests, 4) Working on Fire, and 5) Working for Wetlands. DFFE: EP is seen as a critical partner in the Eco-DRR project as their mandate aligns closely with the vision of the Eco-DRR project.

The Working for Water sub-programme draws workers from the ranks of historically disadvantaged people (i.e. people disadvantaged by apartheid) in mainly rural areas, where unemployment is rampant. Current management operations aim to reduce or reverse the abundance and extent of target species to achieve low levels of invasion that could be sustainably controlled at a relatively low cost in perpetuity. The Working for Water sub-programme has grown to become the world's largest publicly funded programme targeting biological invasions having spent more than ZAR 7.1 billion to clear at least 178 species covering 27 275 km^2 since its inception in 1995. The Working for Water sub-programme has adopted a contractor model, which is intended to provide inexperienced contractors with opportunities to secure funding and to employ people. The Working for Water sub-programme funding is contingent on maximising employment opportunities, and the Department of Labour has thus set an upper limit on per-person cost of employment and labour-intensive clearing methods are prioritised. Generally, the Working for Water sub-programme's operations have not included restoration efforts, at least in part because there is little or no funding for implementing active restoration projects at the necessary scale – most sites are left for passive restoration.

While it is commendable what DFFE: EP seeks to achieve through the EPWP approach, the model does have its challenges. In 2016, DFFE undertook a study to evaluate the socioeconomic, environmental and economic impact of selected EPWP programmes within the DFFE: EP for the period 2012 – 2016. The evaluation notes that the relevance of the DFFE: EP branch and the use of the EPWP model cannot be denied when considering the scale of degradation and high levels of unemployment in South Africa. The impact of DFFE: EP and EPWP work has been recognised – particularly through:

- The development of models for ecological restoration,
- The use of IAPs through value added industries,
- Generating legislation to enable enforcement of environmental protection,
- Engaging in partnerships with various stakeholders and spheres of government in the implementation of environmental interventions,
- Development of a knowledge resource on NRM in the environmental sector, and
- Investing in ecological restoration and infrastructure in many rural previously neglected communities (DEA, 2019).

However, the study also emphasised some concerns with the approach, with specific reference to budgetary and human resource constraints. This impacts the sustainability of the programme and will require DFFE: EP leveraging financial resources from outside government. In addition, the sustainability of specific environmental interventions at a local level was questioned in the report, noting that ongoing maintenance often falls on the shoulders of other entities that is beyond the control of DFFE: EP. Related to this is DFFE's limited ability to generate an evidence base that cleared areas remain un-infested, and that assets and services, which have been transferred to the owning entity, are still actively in service (DEA, 2019).

Further to the above, the nature of the employment and amounts paid to people involved in the EPWP approach poses challenges. As stated in the evaluation, the on-the-ground work is often hard, technically-difficult and entails working in unpleasant conditions and dealing with IAPs that are difficult to remove. The model draws on unemployed individuals in rural communities who are not necessarily motivated to do the work. This is compounded by the low EPWP salaries, which has resulted in people taking part in the free training but leaving the project thereafter. The temporary nature of the EPWP model also resulted in decreased gross household income, with an increase in the number of households without any income once a particular project was completed and salaries were no longer paid (DEA, 2019). The duration of the jobs created has also been recognised as a challenge with participants noting that some EPWP projects have a very short duration, and that, even though new EPWP projects are in the pipeline, new employment contracts are needed for re-employment (Dladla & Mubangizi, 2024).

Compliance with administrative processes, while good intentioned, has also impacted DFFE: EP's ability to implement its EPWP work within budget and timeframes due to administrative delays (DEA, 2019). Supply chain management and procurement requirements also result in significant delays in implementing on-the-ground initiatives which impacted DFFE's ability to meet targets on time. There is need to align project delivery timetables with timelines for administrative process.

One of the major challenges with DFFE: EP's programme is its inability to generate evidence that cleared areas remain un-infested, and that assets and services, which have been transferred to the owning entity, are still actively in service. It has also been noted that the organisational structure of DFFE: EP's management structures require a review to show that the national return on investment will be greater if emphasis is reduced on job numbers and the management structures are adequately funded to ensure that those jobs are doing the right things in the right places and benefit the right people (DEA, 2019). Additionally, other issues with DFFE: EP's implementation of EPWP include the following:

- While EPWP work experience provides large numbers of young people with their first work experience to promote labour market access, there is limited evidence of enhanced labour market access arising from participation in the programme.
- The EPWP delivers environmental assets and services that contribute to protecting the environment from further degradation and enhancing livelihoods and wellbeing for communities through access to water and healthier environments. However, more evidence is needed to assess how the assets created, and services delivered contribute to productivity gains (DEA, 2019).

The evaluation goes on to note that the scale of implementation is not anywhere close to addressing the scale of need in respect of both the poverty eradication and environmental degradation. As such, much more is needed in terms of resources and funding to effectively and innovatively address these environmental challenges (DEA, 2019).

Bearing in mind the challenges in implementing EPWP through DFFE: EP's sub-programmes (including financial, operational and technical challenges), there is need for a new model to implement restoration and rehabilitation activities that is sustainable and impactful in the long-term while also contributing to meaningful job creation and livelihoods within communities.

Limitation in the Working for Water sub-programme include the lack of clear measurable goals to guide activities (beyond employment creation). The Working for Water sub-programme assists landowners, but typically has not taken responsibility for goal setting or planning. Furthermore, the current Working for Water sub-programme's operations are unguided by any management plans. This is supported by an assessment conducted by van Wilgen et al. (2022) that notes some of the challenges with the Working for Water sub-programme as well as possible recommendations. These are summarised below:

- The need for a focussed vision: the initial vision set out in 1995 was "...create 20 000 jobs for 20 years in winning the war against invasive plant". While laudable, this was overly ambitious due to the extent of the problem, re-allocation of funds, and the overall high costs of removing all IAPs in the country.
- Absence of adequate funding: Competing demands, and growing austerity measures will impact the sub-programme's ability to secure an increase in budget allocation in the next couple of years. Additional funding will need to be sourced from private sector.
- Ineffective approach to IAP removal: Past and current approaches have been ineffective, and it is recommended that conservation triage be implemented i.e. focus on a manageable and pragmatic set of projects within key priority areas.
- Lack of management plans for priority areas: There is need to develop long- and medium-term management plans with clear and realistic goals for priority areas as well as moving away from moving away from the issuance of short-term contracts to larger, longer-term contracts.
- Need to rationalise and integrate value-added projects: Currently, the element of value-added products manufactured from biomass generated by IAP removal is run independently from the Working for Water projects. Going forward, these types of initiatives will need to be linked to the goals of IAPs removal in priority areas.
- Need to maximise the use of biological control: While biological control solutions will not be found for all IAPs, there is substantial scope for expansion of this element, even if it's only partial control.
- Need to focus on eradicating high-risk species: The sub-programme should target the detection of new incursions, assess species with restricted distributions that may be targets for nation-wide eradication, and eradicate them where feasible.
- Inefficient management: There is opportunity to improve management of the sub-programme and its projects by employing best management practices, better training and utilising mechanised equipment.
- Insufficient monitoring of progress: There is room to strengthen monitoring of Working for Water initiatives by expanding its indicators and assessing interventions in terms of the goals of the interventions. This can also strengthen the evidence base for these types of interventions that target ecological infrastructure (Van Wilgen, et al., 2022).

Overlapping Mandates

Roles and responsibilities between different institutions at national, provincial and local levels regarding climate change is not clearly defined which has hampered implementation of adaptation and mitigation measures. This has also negatively impacted communication between institutions and has limited effective engagement between various climate change actors (Averchenkova & Gannon, 2019). While DFFE is responsible for protecting and managing the environment through legislative and other reasonable measure, there are several other government entities that manage, conserve and ensure sustainable use of South Africa's biodiversity assets including SANBI, SANParks, DWS, and provincial government – namely the environmental affairs departments (DFFE, 2019). While this allows for other institutions to take responsibility for the country's biodiversity, there is a blurring of mandates which has resulted in duplication of efforts.

Difficulty Ensuring Compliance Across Ministries and Departments

DFFE is mandated to deal with all climate change matters in the country and is responsible for regulating the climate change and environmental management spaces. However, resource constraints (human and financial) have limited DFFE's ability to effectively undertake compliance, monitoring and enforcement. Furthermore, it has limited political clout over other line departments and sectors due to a weak legislative basis. However, it is expected that the Climate Change Act will strengthen DFFE's ability to regulate the sector (Climate Action Tracker, 2020).

Limited Vertical and Horizontal Intergovernmental Coordination

Climate change and the implementation of EbA requires coordination across multiple sectors and government spheres. While the IGCCC is the primary structure to support vertical coordination between the different spheres of government, its efficacy and influence is limited. A similar case is evident with regards to cross-sectoral coordination between different departments and sectors which impacts the ability to mainstream climate change into actionable and implementable interventions. The horizontal coordination structures, such as IMCCC, IGCCC and FOSAD, have not significantly influenced policy and planning within line ministries (Climate Action Tracker, 2020). The limited intergovernmental and cross-sectoral coordination can be attributed to an absence of high-level direction, unclear mandates regarding implementation; insufficient political clout in DFFE; inadequate resources and the lack of capacity in public and private institutions (Cerna, 2013; Adom, et al., 2022).

Exacerbating the lack of a coordinated approach is the absence of CMAs in the country. With only 2 CMAs out of 9 being established, there is no guiding catchment-level institution and associated catchment management strategies for the other WMAs, which includes the areas that 4 of the DMs are located in (Alfred Nzo, Joe Gqabi, Sekhukhune and Ngaka Modiri Molema DM). This has contributed to the fragmented nature in which these catchments and associated ecological infrastructure are managed with no single existing institution having the requisite mandate to develop and implement a catchment management strategy.

Limited Financial and Technical Resources to Affect the National Vision for Climate Change

As with most countries in the continent, there are insufficient financial resources to support the government of South Africa in achieving its international and national climate change targets. While DFEE gets its budget from the national fiscus, there is no specific budget for climate change projects. As such, the climate change function in the DFFE is heavily reliant on donor funding (Climate Action Tracker, 2020). In addition, current austerity measures being implemented by National Treasury means ongoing budget cuts to government departments including DFFE, SANBI, NDMC and other relevant entities that play a role in climate change and environmental management. As a result, recruitment processes will need to be halted, and projects downscaled - all of negatively effect on-the-ground project implementation.

This exacerbates capacity constraints that are prevalent across national, provincial and local levels. This is most true for institutions at a local level that often lack the requisite technical and financial resources to effectively implement climate change-related interventions. In this regard, government is still reliant on external consultants to undertake climate change studies and interventions (Climate Action Tracker, 2020). This is further compounded by the growing complexity in designing and implementing climate change programmes, particularly at a local level (Adom, et al., 2023).

Poor Translation of DRM Legislation for Implementation at Local Level

South Africa is well positioned to take up any work related to DRR and DRM, this is mainly due to the impressive collection of legislative and policy frameworks developed over the past 20 years. The work of DRR and DRM is taken up at all three tiers of government beginning from national, provincial and district and filters down to LMs. Institutionally, the country is well versed with structures aligned to the tiers of government - namely the disaster management centres that have been set up across each province which are documented in the IDPs and Disaster Management Framework. Due to legislative requirements, most DMs' and LMs' IDPs make mention of DRM and disaster management plans. Most IDPs for DMs are well structured and give good accounts of disaster management plans and progress thereof including any monitoring and evaluation. This is mainly attributed to the legislative frameworks in place which requires ongoing revisions and regular updates. With the above being said, South Africa still experiences a lack of prompt disaster management response and adequate interventions due to poor practice and implementation at local levels.

Inadequate EWS and Monitoring Networks

Monitoring networks and EWS are well mentioned - particularly across the priority DMs' and associated LMs' IDPs - but there is no clear update on the status and functioning of the monitoring stations as well as progress on the development of EWS. Monitoring of existing early warning alerts and hazard information distribution in LMs to assess their effectiveness is limited. Furthermore, a review of local disaster management plans showcase prioritisation of response and recovery tasks with limited focus on DRR . This is a result of a lack of technical staff and expertise at the LM level. Experience and observations demonstrate that LMs are under-capacitated when it comes to the interpretation and use of the data and information received from SAWS and other data entities. Hence, the lack of preparedness in disaster management. Ensuring that memorandums of understanding are put in place between LMs, and data owners is critical to allow LMs to freely access data – similar to how NDMC and the other disaster management centres operate (Department of Environmental Affairs, 2016). Most importantly, there is need for the discussion around access to data to be revised with a stronger focus on information and knowledge. Since LMs aren't equipped with technical skills, disaster management should focus on relaying information that is easy to understand. The use of large scientific datasets is often limited to communities of practice such as commercial farmers, environmental practitioners and the aviation sector who have the technical skills to interpret data and use it accordingly. However, for the general public disaster alerts, the information provided must be concise and easy to understand.

Limited DRR and DRM Capacity at Local Level

The need for education, training, public awareness and research are crucial to address the lack of capacity experienced in LMs. For effective DRR and DRM to take place well-trained staff are needed (Botha & Van Niekerk, 2013). It is vital that capacity-building and training regarding DRM and DRR be promoted, especially at local government level. LMs and DMs must be committed to building the skills and competencies of officials as well as community leaders, particularly to drive community-based DRR / DRM interventions. A survey study conducted by Botha et al., (2011) revealed that provincial level government officials felt that staff at local government level were not adequately trained (Botha, et al., 2011). This is reflected in the inadequate disaster management services that communities receive on the ground. While the NDMC and PDMC support local government in terms of education, learning and training support, there is still need for this to be strengthened to develop leadership and professional competencies. This can support the formulation, management and review of DRR policies, and strategies as well as the evaluation of the success and effectiveness of programmes and projects. Once this is achieved, LMs can look towards building technical skills and expertise associated with the required duties in specific sectors, interventions and approaches.

Lack of Financial Capabilities and Resources for DRR And DRM

Communities such as those found in priority DMs are rural and are the most vulnerable to disasters. Unfortunately, most LMs in these DMs don't have the capacity and financial resources to effectively undertake DRM. As a result, they resort to response activities instead of prevention and mitigation measures. The findings from a survey study conducted by Botha and van Niekerk (2013) revealed that although LMs often have a budget available for carrying out DRM and DRR activities, these are usually not sufficient for their needs, or the successful and sustained implementation of projects. Furthermore, budgets allocated are stretched between costs related to training, capacity-building, public awareness, workshops and expenditures for direct implementation of risk reduction projects and provision of emergency relief supplies (Botha & Van Niekerk, 2013).

Further to the above, according to Botha and van Niekerk (2013), the impact of poverty is a pivotal factor in the progression of vulnerability to hazards. This is of particular relevance to South African municipalities, which are faced with the legacy left by the apartheid government, especially for those municipalities located in former homelands which are characterised by impoverished and disadvantaged communities who are, as a result, vulnerable to disasters. Exacerbating this is the low revenue collection by LMs which impacts their ability to effectively carry out critical community services including disaster management interventions. This is primarily due to populations in these LMs having low to no income because of high unemployment rates. This leads to LMs being more reliant on government transfers and additional funds from executive bodies such as National Treasury, COGTA and/or SALGA which is not sufficient for comprehensive DRM.

Poor Information Management and Communication Towards Effective DRR and DRM

Understanding the importance of information management and communication is critical to the work of DRR and Eco-DRR. Effective disaster management requires the existence, access to, and proper management of information and its dissemination to the relevant and targeted stakeholders (Kunguma, 2020). Contributing factors for a successful information management and communication system are stakeholder engagements; access to data / information; proper usage of resources; implementation of legislations; and the provision of political, social, and economic services and public goods by the state. In essence, this system requires technology, software, data, information, communication, networking, people, organisational structures and tasks that work together to support decision-making (Van Niekerk, et al., 2018). For many LMs, information dissemination is a challenge – especially for rural LMs that lack financial resources, technical expertise and necessary infrastructure. In this regard, LMs that lack effective information management and communication systems often undertake responsive - and recovery-focused efforts instead of proactive and preventative disaster management interventions. Most LMs' IDPs do not elaborate on how and where data is sourced from, who are the custodians / owners and who are the key stakeholder that must be engaged with in terms of DRM and DRR information.

Access to information and adequate capacity in the form of expert knowledge is critical within municipalities to deliver critical community services such as disaster management. For proper information management and messaging to occur, information management and communication systems must be prioritised. This will promote the collection, analysis, storage and dissemination of disaster risk information. An example of an effective intervention to enhance an area's information management and communication system is presented in the box below:

CASE STUDY: KZN PDMC BENCHMARKING EXERCISE

The frequent occurrence of severe storms and floods prompted the KZN PDMC to conduct a benchmarking exercise seeking to improve the information management and communication system in the province and achieve international best practice in the process. The aim was to reach citizens faster, allowing them to quickly evacuate flood plains and areas that were likely to be affected by floods. Early warnings of this nature, along with addressing reduced runoff through catchment interventions via improvement in ecosystem functions, would enable effective flood impact reduction.

An important element of the intervention toward DRR is a focus on cooperation and collaboration. To achieve this, an Inter-Departmental Task Team was formed which consisted of key stakeholders including COGTA officials representing communications, corporate services, information and communication technologies, finance, and development information services; municipal disaster management centres of iLembe and eThekwini, Department of Transport; Department of Health; and Provincial Treasury.

The benchmarking exercise gave the relevant municipalities substantial insight on critical components to consider when they begin to build their system. From the various systems examined, the task team nominated Cal OES as the most appropriate system with the municipalities looking to establish memorandums of understanding. This will be coupled with the employment of highly qualified and skilled personnel to run the centre and continue with this kind of research to better their systems (Kunguma, 2020).

Need to Integrate Citizen Science and Indigenous Knowledge into DRR and DRM

Citizen science and indigenous knowledge are key elements for effective Eco-DRR. Hazard-prone communities have developed traditional knowledge to better cope and adapt to natural hazards. This knowledge has been built upon from generation to generation and has created effective risk reduction practices that do not rely on advanced technology or equipment. As noted earlier, information management and communication is a challenge in municipalities. In this regard, there is the opportunity to build off and leverage existing indigenous knowledge and integrate this with citizen science. Indigenous knowledge often sits with the older population in communities therefore is it important for the LMs to conduct site visits and hold forums to collect this knowledge in order to facilitate information transfer between communities and the disaster management units in municipalities. The knowledge gathered from communities significantly elevates local understanding of risks and greatly enhances DRR efforts (Botha & Van Niekerk, 2013). The disaster management and risk reduction units in all tiers of government must prioritise indigenous knowledge preservation by recognising the importance of participation and inclusion as stipulated in the DMA. This suggests having community champions and dedicated municipal staff that will engage residents and conduct data collection, analysis, storage and communication.

Need to Strengthen the use of Language and Governance in DRR and DRM

The definition of disaster is broad and covers a multitude of sectors including health risks, environmental risks, financial risks and security risks. At a DM and LM level, it's difficult to narrow down what municipalities are referring to when they speak about disaster. For the work of Eco-DRR to be effective, one would have to narrow the scope of work covered in DRR and DRM. On paper, the definitions may be correct, but operationally at a LM / DM level, DRR and DRM spans across various sectors and is not limited to the environment. Effective DRM necessitates clearly defined and allocated roles, responsibilities and authority levels for organisations and officials within the relevant line ministries and local administrative offices (Botha & Van Niekerk, 2013). Furthermore, the establishment of links and exchanges between local and national government levels, as well as between legislators and implementing authorities, is also fundamental. For effective local risk governance to take place, it is important that local government officials targeted with disaster prevention have sufficient expertise, including technical, management and planning skills, to plan and implement DRR actions (Van Niekerk, et al., 2018).

3.5 SECTOR FINANCING ANALYSIS

A range of national instruments focus on the criticality of ensuring future climate resilience, outline the significance of the scaled-up resources needed to mainstream interventions and approaches. South Africa, like many other sub-Saharan countries, faces the challenges of endeavouring to ensure developmental gains while realising that these are potentially at risk of being undermined by rampant climate change through droughts, flooding, wildfires, water scarcity, land degradation and poor air quality. Investing in the development, management and maintenance of infrastructure, both ecological and built, will be essential in reducing country and local level vulnerabilities.

The South African economy is unable to support the full cost of the needed transition that will ensure future climate resilience (DEA, 2011). Public finance has played an important and catalytic role and should continue to be utilised to leverage additional sources of finance that can be used appropriately to unlock technology, drive efficiencies, create innovative economic opportunities and create jobs. Private sector finance has been critical in unlocking project and programme implementation and innovative financing mechanisms to support a range of climate resilient infrastructural solutions (DEA, 2018).

In 2011, the ***NCCRP White Paper*** (DEA, 2011b) outlined the importance of complementing domestic financial resources with those from international sources. This mix of finances needs to be aligned with a clear climate-finance strategy and architecture that provides a clear approach as to how these various sources can be appropriately mobilised, coordinated and structured (DEA, 2018). Equally, there is recognition of the importance of ensuring that public finance mechanisms are packaged and leveraged to address the various barriers that hinder private sector investment (UNEP, 2009).

The development of this climate finance strategy and architecture has been progressive in nature with a climate-finance co-ordination mechanism being outlined (Figure 3-2). The Third National Communication notes the need to strengthen this framing of the national climate financing architecture and to develop sectoral financing roadmaps that outline where public and private sector investments are needed (DEA, 2018b). More work in this regard is required to gain better levels of efficiency and effectiveness.

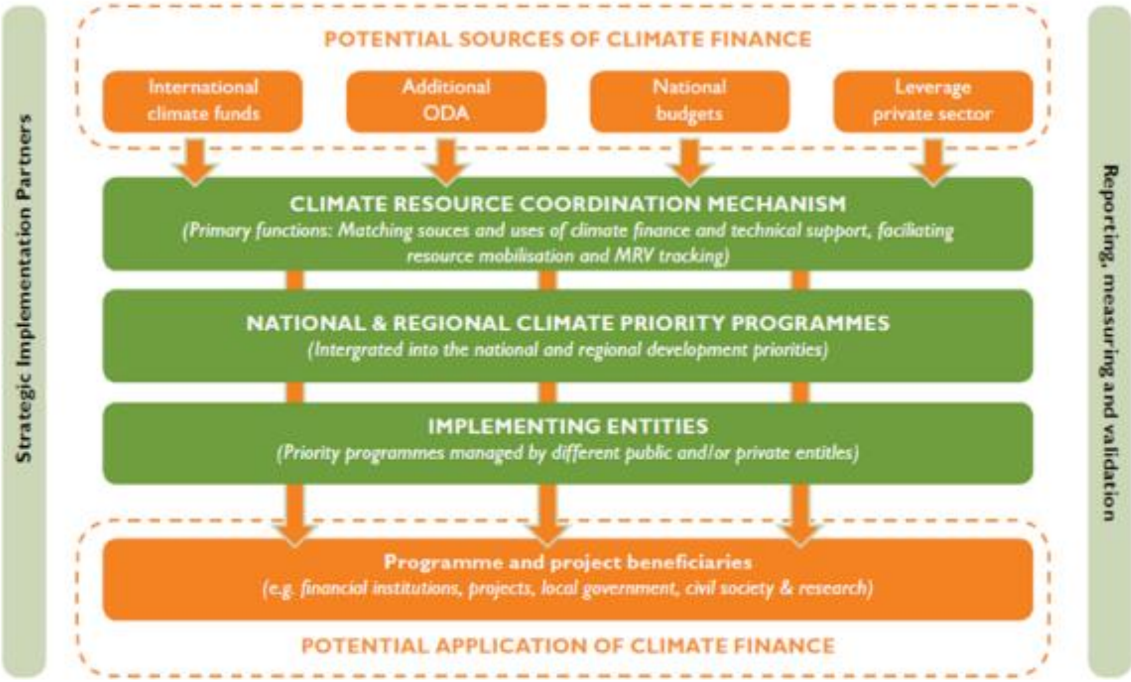

Figure 3-2: Prototype for climate coordination (DEA, 2011)

The ***South African National Adaptation Strategy*** (DFFE, 2020) recognises that the efforts to support climate adaptation are spread across government departments with financial resources being utilised to support interventions that are not labelled as climate adaptation. Direct allocations from the national budget through the Medium-Term Expenditure Framework have typically been the primary funding sources for adaptation activities. This includes a range of policy and governance aspects, research programmes as well as direct support to projects that build and support climate resilience (DFFE, 2020). National budget allocations to governmental public entities have been important in driving the research and innovation required to build climate resilience and hence, key actors such as SANBI, WRC, the Agricultural Research Council, SAWS, CSIR, and others, play a critical role in this.

Over and above the typical budgetary allocations to national and provincial level government departments, catchment and local level institutions that include CMAs and municipalities also rely on revenue generation as well as intergovernmental transfers to meet capital expenditure needs. These do provide opportunities to fund EbA and Eco-DRR related activities.

The ***Draft National Biodiversity Economy Strategy (2024)*** seeks to optimise biodiversity-based business potentials across the ecosystems, and to contribute to economic growth with local beneficiation, job creation, poverty alleviation, and food security, whilst maintaining the ecological integrity of the biodiversity resource base, for thriving people and nature. The strategy recognises two cross-cutting imperatives, namely: 1) leveraging the biodiversity economy to promote conservation and species and ecosystem management, thereby ensuring a positive feedback loop; and 2) promoting growth and transformation of the biodiversity economy (DFFE, 2024). In this regard, the strategy sets out four goals:

1. Goal 1: Leveraging biodiversity-based features to scale inclusive ecotourism industry growth in seascapes and in sustainable conservation land-use.
2. Goal 2: Consumptive use of game from extensive wildlife systems at scale that drive transformation and expanded sustainable conservation compatible land-use.
3. Goal 3: Consumptive use of wild and produced marine and freshwater resources that drives inclusive coastal socioeconomic development.
4. Goal 4: Well structured, inclusive, integrated and formalised bioprospecting, biotrade, and biodiversity-based harvesting and production sector that beneficiates communities (DFFE, 2024).

The South African view of green economy is one that sees sustainable development that recognises the interdependence between economic growth, social protection and natural ecosystems. A more formal definition is provided by the DFFE as a "system of economic activities related to the production, distribution and consumption of goods and services that result in improved human wellbeing over the long term, while not exposing future generations to significant environmental risks or ecological scarcities". This definition implies that economic growth is decoupled from resource use and environmental impacts so that biophysical throughputs are reduced (Ferguson, 2015; DEA, 2011). The National Strategy for Sustainable Development (NSSD) notes that this will require substantially increased investment in green sectors, supported by enabling policy reforms (DEA, 2011). In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services (UNEP, 2011). In this regard, government alone cannot manage and fund a just transition to a green economy, that the private sector and civil society must play a fundamental role (DEA, 2011).

The discourse regarding the requirements to shift to a green economy and the benefits that would be realised is varied and inconclusive (Death, 2014; Ferguson, 2015). Typically, while there are bright spots from localised or targeted projects and programmes, in many instances this remains "business as usual". Therefore, for many the mantra remains that progress is driven by economic growth with environmental resources being used to underpin development, and government must be understood as the custodians of this growth and development, setting policy and regulating behaviours and practice (Death, 2014). What is potentially required is a more far-reaching transformation of the government system and the economic, social and environmental metrics used to assess growth and development (Ferguson, 2015). While this takes significant political and social will to change, it is clear that the social, economic and environmental pressures that countries such as South Africa face could be seen as the tipping points that may catalyse the changes needed.

To support this the South African government has used an array of policy, strategy and planning instruments to push the green economy discourse forward. Likewise it has used public funds to support projects that create green jobs and has invested money into the establishment of funds to leverage the innovative and financial muscle of the private sector, as well as explored market-based mechanisms to incentivise investment. The NSSD, amongst other policy and strategy instruments, recognises the importance of private sector support particularly with regard to financial support noting that financial partnership with government and developmental finance institutions (DFIs) and donors will be important in unlocking initiatives that support sustainable development and future climate resilience (DFFE, 2020). This then calls for a more nuanced understanding of the ecological infrastructure and Eco-DRR investments required noting that these investments will likely require a blend of public, private and third-party support. This will in some instances require alignment with ongoing and funded interventions while identifying the financing and resource gaps that exist in the Eco-DRR focused interventions targeted in a specific catchment area (Department of Environmental Affairs and Development Planning, 2021).

Noting the increased recognition of the importance of blended finance mechanisms, this review follows the structuring as outlined in the below figure.

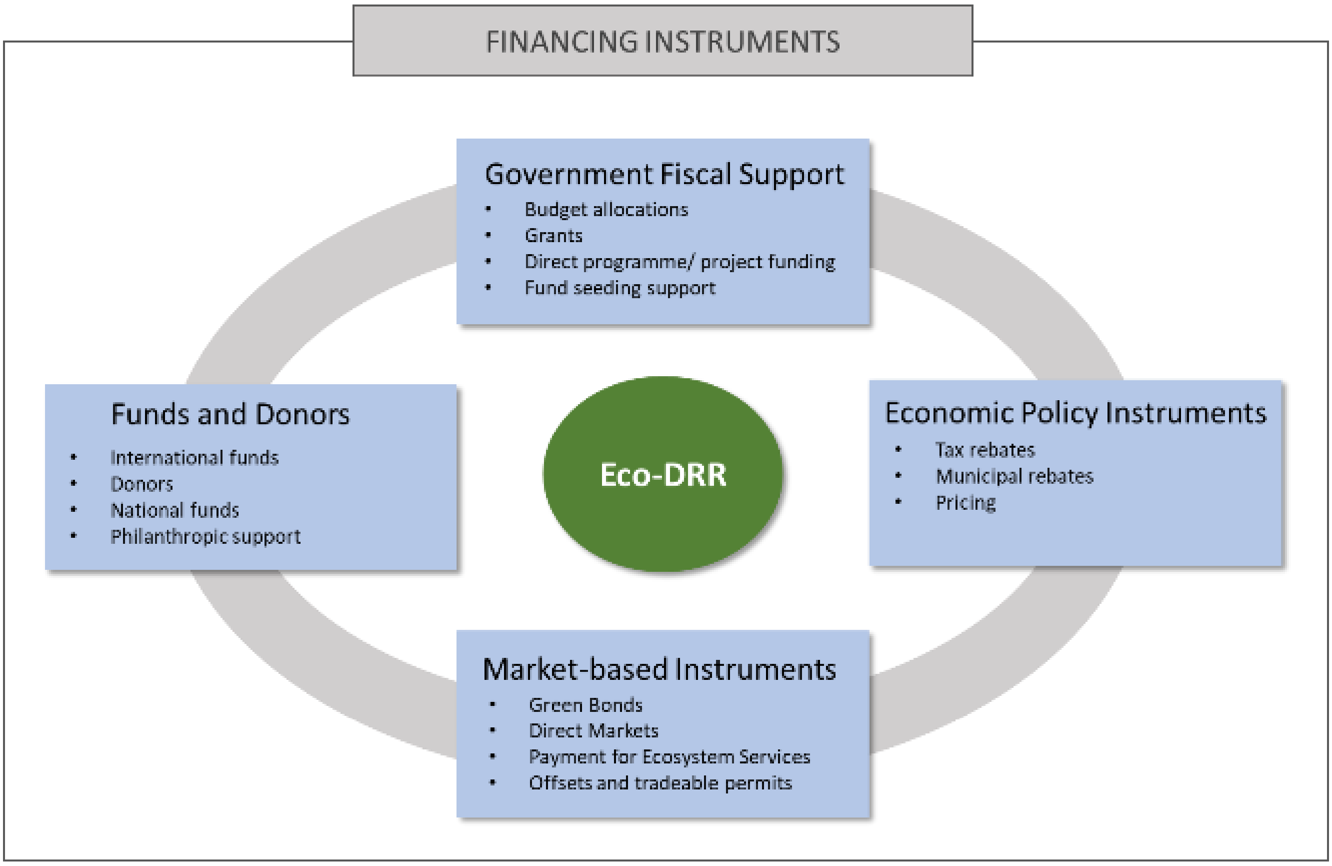

Figure 3-3: Various financing instruments that can potentially support Eco-DRR interventions

3.5.1 Government Fiscal Support

Government has the responsibility to undertake an array of legislative, policy-centric and strategic actions in the public's interest. This includes mandates regrading oversight and regulation which often are complex when one considers the role that the differing spheres of government play in terms of facilitating, supporting and guiding the introduction of improved practices and service delivery. In particular, national and provincial government play a key role in leading the development of policy, strategy and planning instruments (using funds from the national and provincial fiscus) which are then utilised by local government and various public entities (using funds from the national and provincial fiscus supported by revenue generated from service provision).

In order to support catalytic and transformational interventions, funds from the national fiscus can be transferred to public entities and local government. Funds may also be transferred to catalytic funds (e.g. the Green Fund) to leverage further investments by the private sector. These public investments are often blended with funds from international funds (e.g. GCF, Adaptation Fund, Global Environment Facility (GEF) etc) or from donors.

National and Provincial Budgets

Allocations of funding from the national and provincial fiscus are outlined in the Estimates of National Expenditure and the Medium Term Expenditure Framework (MTEF) and is planned using a three-yearly cycle that is adjusted annually. These funds are allocated to the various sector departments of government for use aligned to strategic plans and annual performance plans (Nationl Treasury, 2010).

These funds are critically important for supporting the development and amendment of legal, regulatory, policy, strategy and institutional instruments. The allocation of these funds to ensure that EbA and Eco-DRR is mainstreamed into these various instruments is important. Noting that these instruments effectively cut across aspects of environment, water, land, and cooperative governance there are sometimes challenges in aligning the use of these finances for a consolidated purpose. This does require engagement and the establishment of structures that will ensure these various sectors align functions and as a result budgets. In this regard the Intergovernmental Relations Framework Act (Act 13 of 2005) provides for the establishment of forums at national, provincial and local government levels.

National and provincial budgets through the differing line functions of the DFFE, DWS and COGTA will be available to support in addressing policy, planning related issues linked to Eco-DRR. Likewise, the fiscal support that is provided to public entities such SANBI, the NDMC, CMAs, and others, will enable these actors to engage with amendments to the array of instruments that will ensure Eco-DRR becomes mainstreamed.

Importantly, the national and provincial departments and associated public entities have convening power and as such can leverage fiscal support for engagement processes that create awareness, build a common understanding, support the establishment of 'communities of practice', and encourage involvement across public sector, private sector and civil society actors.

Additionally, national, provincial and local governments have a responsibility to ensure that laws and by-laws are adhered to, and as such will fund actions to ensure compliance with key pieces of legislation. Aligning these interventions with those of Eco-DRR will not only encourage the introduction of good practice but will also support the required monitoring and evaluation protocols needed in catchment areas to assess the impacts of Eco-DRR interventions.

Grants

Municipal Revenue

Local tax revenues are typically derived from property taxes and user charges for services provided by the municipality. Operating budgeting surpluses are used to fund capital expenditure and other special projects. These funds are supplemented by borrowing and intergovernmental transfers from national government. The intergovernmental transfer system plays a significant role in assisting under-resourced municipalities to address service delivery and infrastructure backlogs and for larger municipalities, maintaining and enhancing service delivery to communities (Oosthuizen & Thornhill, 2017). Although unconditional and conditional grants can be used for funding both operating and capital expenditure, in most cases capital expenditure is funded through conditional grants. In other words, the grant is made available to local government for the specific purpose of funding infrastructure (Mahabir & Mabena, 2015). The grants available to municipalities also vary depending on the type of municipality and purpose of the grant. These conditional grants include:

- **Urban Settlements Development Grant (USDG)**: The USDG is targeted towards the upgrade of informal settlements, either by creating formal housing or by upgrading services to informal settlements. Due to their economic role and urbanisation pressures, the larger metropolitan municipalities have been the focus of the USDG (Parliamentary Monitoring Group, 2012).
- **Integrated Urban Development Grant (IUDG)**: The IUDG was introduced as the incentive component to implement the Integrated Urban Development Framework (IUDF) in intermediary cities, to support infrastructure implementation linked to the National Spatial Development Framework and to support spatial transformation more broadly. The IUDG is used to fund public infrastructure investment for the poor and promote increased access to municipal own sources of capital finance to increase funding for investment in economic infrastructure. Ensuring that these public investments are spatially aligned and promote the sound management of the assets delivered by cities is a key outcome (COGTA, 2018).
- **Municipal Infrastructure Grant (MIG)**: The MIG was introduced to combine all existing capital grants for municipal infrastructure into a single consolidated grant. It was designed to overcome the challenges of uncoordinated and fragmented infrastructure planning and service delivery. As the MIG aims to assist the poor gain access to infrastructure, these funds can only be used for infrastructure relating to basic levels of service. MIG funds can be used to upgrade and build new infrastructure up to a basic level of service as well for rehabilitating existing infrastructure, as long as the infrastructure is for basic services for the poor. The MIG was designed to assist LMs and DMs (i.e. non-metropolitan municipalities) where the capacity to generate 'own revenue' is constrained.
- **Extended Public Works Programme Integrated Grant (EPWPIG)**: This grant was introduced to provide EPWP incentive funding to expand job creation efforts in specific focus areas, where labour intensive delivery methods can be maximised (National Treasury, 2020). The EPWPIG in general covers three sectors: Infrastructure, Environment and Culture and the Social sector. For each of these sectors, focus areas have been identified that have been tested and proven to be areas in which labour intensive delivery methods are successful. Public bodies have to identify the focus areas; and then projects within this, that is aligned to their growth and development plans to fund through the grant. Public bodies are advised to pursue a mix of projects across the relevant sectors and focus areas in order to achieve the Grant Full Time Equivalent Job (FTE) target.
- **Municipal Disaster Recovery Grant (MDRG)**: The MDRG aims to support municipalities to restore functionality of infrastructure following a disaster by rehabilitating and reconstructing disaster-affected municipal infrastructure. The grant funds are administered by COGTA through NDMC in consultation with National Treasury. The MDRG, allocated by Schedule 7B of the Division of Revenue Act is one of two types of disaster funding grants (the other being for Disaster Response). The conditional grant aims to provide immediate release of funds for disaster response within municipalities. Municipalities must align disaster recovery projects with projects under the Municipal Infrastructure Grant to ensure proper monitoring and reporting on implementation progress. After the initial response to a disaster has been addressed, including through funding from the municipal disaster relief grant, the repair of damaged municipal infrastructure is funded through the municipal disaster recovery grant.

- **Water Services Infrastructure Grant (WSIG)**: This grant aims to accelerate the delivery of clean water and sanitation facilities to communities that do not have access to basic water services. It provides funding for various projects, including the construction of new infrastructure and the refurbishment and extension of existing water schemes. It has both direct and indirect components. In areas where municipalities have the capacity to implement projects themselves, funds are transferred through a direct grant. In other areas, the Department of Water and Sanitation implements projects on behalf of municipalities through an indirect grant.

Conditional grants are administered and transferred by the relevant sector department in national government. The Department of National Treasury distributes the public finance budget allocation to sector departments, which become the conditional grant "custodians" and are required to monitor expenditure and performance in collaboration with provincial departments, as well as coordinate overall programme implementation for the conditional grants. The key transferring departments and high level allocation processes for the key conditional infrastructure grants are outlined in Table 3-9.

Table 3-9: Transferring departments and allocation of Conditional Infrastructure Grants

Grant	Transferring Department	Allocation Process
USDG	Department of Human Settlements	Grant allocated to all metropolitan municipalities with a base component (allocated according to the MIG formula), and funds from the National Electrification Programme and Upgrading of Informal Settlements Partnership added and ringfenced respectively.
IUDG	COGTA	IUDG includes a base component, a performance-based component and a once-off planning component.
MIG	COGTA	The municipal infrastructure grant is allocated through a formula that allocates resources between sectors and takes account of poverty, service delivery backlogs and municipal powers and functions in allocating funds to municipalities.
EPWPIG	Department of Public Works and Infrastructure	The EPWP grant allocations are based on past EPWP performance, the number of full time equivalent jobs created in the prior 18 months, past performance with regard to labour intensity in the creation of EPWP work opportunities, and service delivery information. Allocation criteria include a rural bias with rural municipalities also being prioritised in terms of technical support for implementation.
MDRG	COGTA	Allocation is based on approved post-disaster rehabilitation and assessment reports
WSIG	DWS	All allocations are based on the number of households with water and sanitation backlogs, prioritising the 27 priority DMs identified by national government.

There have been in recent years increasing levels of fiscal constraints and as a result the resources available to support the innovation required have been steadily decreasing. As part of government's fiscal consolidation policies over the medium term, transfers to government have been reduced. Notably, there has been a reduction to direct conditional grants to municipalities including reductions in the municipal infrastructure grant and the integrated urban development grant (PBO, 2021). At the local government level the declines in transfers and revenue collection have had impact on the ability of municipalities to implement the DDM and to address shortfalls in service delivery. On average (in 2020/21) 62,5% of municipal operating budgets is accrued through the collection of property rates and service charges. The main source of capital revenue to support capital expenditure are transfers from the national government and amounts to 53,9% of the total capital revenue adjusted budget. Generated revenue from service charges accounts for 27,8% of the capital revenue budget and borrowings account for 13,6% (PBO, 2021). It is also important to note that on average the operational revenue collection rates are comparable to a notional benchmark of 75%, yet capital expenditure rate has range between 50 and 67% over a four year period, reflecting the dire capacity constraints being experienced at municipal levels, especially in smaller towns. The highest proportion of capital budget spent by municipalities is on road transport, water, electricity, waste management and housing (PBO, 2021). To assist municipalities to improve financial management, National Treasury launched the Municipal Finance Improvement Programme in 2017.

The intergovernmental transfer system therefore plays a significant role in assisting under-resourced municipalities to address service delivery and infrastructure backlogs and for larger municipalities, maintaining and enhancing service delivery to communities (Oosthuizen & Thornhill, 2017). These intergovernmental transfers largely take the form of Conditional Grants are therefore critically important to LMs.

As outlined in Table 3-9., a number of conditional grants could be seen as possibilities for support interventions towards managing ecological infrastructure in support of Eco-DRR (SANBI, 2020). Typically, these grants are to aid municipalities in addressing infrastructure backlogs and to provide support to communities vulnerable to poverty, climate change, unemployment etc. In most instances, these grants are focused upon built infrastructure and only the EPWPIG specifically outlines support to sustainable land-based livelihoods. Therefore, effort would have to focus on developing approaches that would see ecological infrastructural solutions being integrated with that of built infrastructure, which these grants are focused on supporting. The opportunities for financial support for the management of ecological infrastructure linked to Eco-DRR are summarised in the table below.

Of these grants, the MIG, the largest of the conditional grants which all municipalities receive, is allocated based upon a formula established by National Treasury. The MIG formula also applies to the base component for several other grants outlined above. For example, allocations for the water and sanitation sub-components of the basic services component are based on the proportion of the national backlog for that service in each municipality. Other components are based on the proportion of the country's poor households, who are receiving basic services, located in each municipality.

Conversely, the EPWPIG, WSIG and MDRGs are project-based allocation processes and as such a detailed business plan needs to be prepared and submitted. A similar approach is taken for the MDRG, which only considers post-disaster reconstruction and rehabilitation projects that have been submitted for verification assessment within a six month time frame. The MDRG allocation is based on approved post-disaster rehabilitation and assessment reports, as well as proof that the municipality has exhausted their disaster management budget.

Table 3-10: Grants that could potentially provide financial support for the management of ecological infrastructure at municipal scale

Grant	Transferring Department	Strategic Goal	Allocation Process	MTEF Allocation for 2025/26 (ZAR)	Outcomes	Opportunity for Ecological Infrastructure
USDG	DHS	To create sustainable and integrated human settlements that enable improved quality of household life.	Grant allocated to all metropolitan municipalities with a base component (allocated according to the MIG formula), and funds from the National Electrification Programme and Upgrading of Informal Settlements Partnership added and ringfenced respectively.	9.3 billion	Support inclusive densification and transit oriented urban development, integrating existing and new urban developments. Providing adequate bulk and link infrastructure for mixed-income and mixed-use urban developments. Provide opportunities for leveraging public funds within partnerships for urban development projects. Provide resources for sustainable community development for social and economic infrastructure and meaningful participation.	• Integrating ecological infrastructure into urban design covering a range of ecosystem services. • Urban greening. • Integrated urban catchment management.
IUDG	COGTA	To support spatially aligned public infrastructure investment that will lead to functional and efficient urban spaces and ultimately unlock growth	IUDG includes a base component, a performance-based component and a once-off planning component. Focus is on intermediate cities and towns that are more densely populated and have high economic activity.	1.3 billion/	Improved access to municipal infrastructure. Improved quality of municipal services through infrastructure that is in better condition. Improved spatial integration.	• Integrating ecological infrastructure into urban design covering a range of ecosystem services. • Urban greening. • Integrated urban catchment management.
MIG	COGTA	To subsidise the capital costs of providing basic services to poor households. To subsidise the development of asset management plans for infrastructure	The municipal infrastructure grant is allocated through a formula that allocates resources between sectors and takes account of poverty, service delivery backlogs and municipal powers and functions in allocating funds to municipalities. Municipal allocations must be fully committed to registered projects prior to the year of implementation and be	19.1 billion	Improved access to basic services infrastructure for poor communities through the use of labour intensive construction methods where it is technically feasible. Improved reliability of basic services infrastructure for poor communities.	• Maintenance of roads for poor communities and rural areas • Renewal of eligible infrastructure servicing the poor together with funding operations and maintenance plans and commitments. • Integration with new and upgraded municipal bulk infrastructure

Grant	Transferring Department	Strategic Goal	Allocation Process	MTEF Allocation for 2025/26 (ZAR)	Outcomes	Opportunity for Ecological Infrastructure
		servicing poor households.	informed by the IDP, the three year capital plan, and aligned to the One Plan under the DDM.			• Integration of ecological infrastructure with basic residential infrastructure.
EPWPG	Department of Public Works and Infrastructure	To provide funding for job creation efforts in specific focus areas where labour intensive delivery methods can be optimised	The EPWP grant allocations are based on past EPWP performance, the number of full-time equivalent jobs created in the prior 18 months, past performance with regard to labour intensity in the creation of EPWP work opportunities, and service delivery information. Allocation criteria include a rural bias with rural municipalities also being prioritised in terms of technical support for implementation.	853 million	Improved quality of life of poor people and increase social stability through engaging the previously unemployed in paid and productive activities. Reduced poverty levels. Contribute to increased levels of employment Improved opportunities for sustainable work through experience and learning gained.	• Alein invasive plant removal • Wetland rehabilitation • Fire management • Catchment rehabilitation and restoration including erosion control, slope management, revegetation, riverine and wetland clean-ups.
MDRG	COGTA	To enable timely response to address community needs regarding impending or disastrous events classified by the NDMC	Allocation is based on approved post-disaster damage assessment reports and costing of repair.	407 million	Immediate consequences of disasters are mitigated or alleviated.	• Ecological infrastructure and catchment rehabilitation and restoration including erosion control, slope management, sedimentation removal, revegetation, riverine and wetland clean-ups.
WSIG	DWS	To provide water and sanitation services and reduce backlogs.	All allocations are based on the number of households with water and sanitation backlogs, prioritising the 27 priority DMs identified by national government.	4.2 billion (direct transfers)	An increase in the number of households with access to reliable, safe drinking water and sanitation services.	• Integrated planning for all projects funded though different grants and programmes. • Catchment restoration linked to availability of supply. • Demonstrate how ecological infrastructure supports sustained operations and maintenance of supply infrastructure.

*Allocations taken from Government Gazette 48665 linked to Division of Revenue Act 2023

As noted, the integration of ecological infrastructure into projects and programmes to address built infrastructure backlogs has been limited and as such the use of these grants for that purpose has been equally limited. A number of barriers exist that need to be addressed as outlined hereunder.

- **Limited experience with and understanding of ecological infrastructure**: An understanding of ecological infrastructure and what it means for municipal infrastructure and basic service delivery needs to be made explicit before conditional grants can become viable sources of finance (Colvin, et al., 2015; SANBI, 2020). In many instances municipalities have limited to no experience with or understanding of ecological infrastructure and thus there are few examples of grants being allocated to ecological infrastructure with the exception of the EPWPIG. In cases where there has been grant access these have been strongly driven by local champions.
- **Municipalities are not making the case**: Linked to the weak municipal understanding of ecosystem services and the benefits that are accrued from management of ecological infrastructure, municipalities are not motivating for this to be covered under grant awards. A key part of this is that typically ecological infrastructure is not seen as part of the municipal asset base. This is also linked to a range of challenges regarding the value of such assets and the ownership of these (Colvin, et al., 2015; SANBI, 2020). .
- **Implementation priorities**: There are very significant backlogs in the provision of basic services to communities and hence there are longer term plans to address these through built infrastructure interventions. As such, it is difficult (noting the weak understanding and evidence base) to get projects focused on ecological infrastructure into project plans and grant submissions (SANBI, 2020).
- **Complexities of CAPEX and OPEX for ecological infrastructure**: The opportunity costs for ecological infrastructure are not once-off and the medium-term direct costs are often difficult to accurately determine. There are complexities to determining the cost-benefit and these depend on whether ecological infrastructure is used instead of built infrastructure or in conjunction with as a hybrid solution. Additionally, the maintenance requirements are relatively unfamiliar and highly context-specific, often relying on qualitative estimations on anticipated activities in the context of a specific ecosystem as well as labour methods preferred by a municipality (Dunsmore, et al., 2019).
- **The complexity of the accounting of ecosystem services and goods infrastructure**: Determining the “fair” or “cost” value is a practical obstacle for many municipalities considering ecological infrastructure options. Translating concepts of ecosystem goods and services (currently outlined in frameworks such as natural capital and ecosystem accounts) into public financial management and accounting standards is still being developed at a national level and developing local capacity in this regard is much needed (SANBI, 2020).
- **Procurement challenges**: Current procurement processes within government is administratively complex and burdensome which creates significant delays and impacts project implementation. The current system is rigid and limits the ability of entities to rapidly respond to changing environments.
- **Administrative barriers related to grant conditions**: A key challenge for municipalities is the administrative burden associated with the conditional grant funding conditions. Noting the significant capacity constraints within most rural municipalities, compliance with grant conditions becomes a significant barrier. The widespread non-

compliance and poor financial performance observed across most municipalities in the country will preclude municipalities from receiving grant funding for even generally accepted application, making the case for ecological infrastructure applications even more difficult to communicate (SANBI, 2020).

Under the annual Division of Revenue Act release the various conditions and requirements for these grants are released. These are for many of the grants quite onerous and could be seen as being prohibitive for smaller and likely more vulnerable municipalities that may typically require the financial and technical assistance that grants afford. These conditions include providing for the following:

- Financial performance of the municipality on the whole;
- Evidence of grant funding needs based on natural disaster damage, under-served communities, or municipal capacity constraints;
- The specific uses and applications of the grant funding (for example, the types of infrastructure for which the grant is intended);
- Limitations on the proportion of the grant that can be spent on project and programme management costs, with some excluding any operations and maintenance costs;
- Means and frequency of reporting on project expenditure and implementation;
- Project and budget management according to grant payment tranches;
- Effective monitoring, evaluation and enforcement that ensures sustainability of infrastructure operation (for example, effective water demand management practices that improve the sustainability of water infrastructure financed through WSIG); and/or
- The adoption and adherence to a Performance Improvement Plan to become and remain eligible for specific grant funds.

3.5.2 Direct Government Funding

Direct government funding refers to funds being allocated by a department to specific programmes and projects. While much of the national and provincial budgets allocated from the fiscus are used by national departments to affect their mandate (including development of policies, strategies and plans), budget is also directed towards specific catalytic projects or programmes that the department is looking to implement in support of its mandate. DFFE has several sub-programmes under DFFE: EP, namely:

- Working for Water;
- Working for Ecosystems;
- Working for Forests;
- Working on Fire; and
- Working for Wetlands.

These sub-programmes aim to improve socioeconomic benefits within the environmental sector; improve sector education and awareness; restore and maintain ecosystem services; and conserve and protect biodiversity and mitigate the threats against biodiversity loss (DEA, 2019).

As noted in DFFE annual report (2022/23), DFEE: EP was allocated R3 216 587 000, of which R3 166 263 000 was spent. The expenditure of the programme increased from R2,586 billion in 2021/2022 to R3,166 billion in 2022/2023 billion with the increase being due to the finalisation of EPWP projects agreements and an increase in projects implementation as the programme recovered after the impact of the COVID-19. In particular, DFFE: NRM spent R 2 041 250 000 in that reporting period, followed by DFFE: EPIP (R1 057 094 000), Information Management and Sector Coordination (R 61 861 000) and Environmental Programme Management (R 6 058 000) (DFFE, 2022).

The Working for Water sub-programme's primary work has focused on the removal of IAPs in the country with the sub-programme also providing assistance to other entities who are in turn legally responsible for IAP control. As noted by van Wilgen et al. (2022) almost all funding that's been available for IAP control originated from the Working for Water sub-programme. Funding is granted by Working for Water and is subject to non-negotiable operating rules (e.g. labour-intensive methods are compulsory, pay scales are pre-determined, provision of training is mandatory etc.). Each project requires entering into a short-term contract between Working for Water and contractors to clear a selected area. Over the years, the Working for Water sub-programme has been the most influential in terms of managing invasive species at a national level (Van Wilgen, et al., 2022). While there are challenges in the Working for Water model and other DFFE sub-programmes such as Working for Wetlands, Working on Fire etc., there is opportunity to leverage future work planned under the sub-programmes. In 2023, it was reported that the Working for Water sub-programme would be allocated R2.67 billion over five years to combat IAPs in the country (Creecy, 2023).

It is also important to note EPWP allocations to public entities such as SANBI, SANParks etc. As reported by DFFE, the amounts allocated to public entities with regards to DFFE: EP and DFFE: EPIP projects is presented below for 2022/23:

Table 3-11: EPWP allocations to public entities (DFFE, 2023)

Project	iSimangaliso R'ooo	SANBI R'ooo	SANParks R'ooo	Total R'ooo
EPIP - EPWP Projects				
Biodiversity Economy: Other Projects	-	-	5,576	
Greening and Open Space Management	-	26,776	-	
Working for the Coast: Other Projects	7,199	-	39,930	
People and Parks: Other Projects	74,049	-	15,979	
iSimangaliso Wetland Park Authority: (Environmental Monitors in Parks)	8 790	-	-	
SANParks (Environmental Monitors in Parks)	-	-	537,667	
MCGP (in line with boundaries)	13,300	-	54,534	
TOTAL	**103,338**	**26,776**	**153,686**	**283,800**
NRM - EPWP Projects				
Status Report and Monitoring Relating to Alien and Invasive Species	-	3,206	-	
Early Detection of Emerging Species and Risk Assessments	-	22,645	-	
Eradication of Emerging Species	-	11,002	-	
Taxonomy and Research Relating to Alien Invasive Species	-	8,434	-	
Groen Sebenza NRM Project	20,000	100,000	-	
Planning and Communities of Practice	-	9,600	-	
Working for Water / Working for Ecosystems	80,000	-	232,301	
Working for Wetlands	3,945	-	16,378	
Eco-Furniture Programme	-	-	65,164	

Project	iSimangaliso	SANBI	SANParks	Total
	R'000	R'000	R'000	R'000
Working for Water / Working for Ecosystems: K2C	-	-	16,359	
Working for Water / Working for Ecosystems: Integrated Zones	-	-	23,748	
B105			4,000	
Working for Ecosystems Mountain Zebra and Camdeboo	-	-	1,500	
Total	**103,945**	**154,887**	**359,450**	**618,282**
GRAND TOTAL	**207,283**	**181,663**	**513,136**	**902,082**

The Eco-DRR project will seek to influence how the funding allocated to SANBI and SANParks through the EPWP programme is spent.

Fund Seeding Support

The are several funds that align closely with the objectives of the Eco-DRR project and can be leveraged off to support partnerships and alternative sources of funding.

Green Fund

The Green Fund, established in 2012, is currently managed by the Development Bank of Southern Africa (DBSA) and is aimed at facilitating the transition to a green economy by: 1) promoting innovative and high impact green programmes and projects; 2) reinforcing climate policy objectives and sustainable economic development through green interventions; and 3) building an evidence base for the expansion of the green economy; and by attracting additional resources to support South Africa's green economy development. Importantly, the Fund will only support initiatives which would not have been implemented without its support. The Green Fund provides funding for projects in South Africa up to the value of R25 million for project preparation / feasibility studies and technical support as well as up to R70 million for investment funding. Typical applicants of the Green Fund are private companies, SMMEs, municipalities, provincial government, state-owned entities, NGOs, research institutions and universities (DBSA, n.d.).

The Green Fund focuses on funding the following:

- Just transition and low carbon economy: Exploring opportunities to catalyse the just transition, supporting local green building technologies, accelerating technologies such as hydrogen fuel cells, and supporting greening within the transport sector.
- Alignment with the DDM and DFFE's Waste Phakisa Programme: Supporting resilience in the water sector including wastewater treatment and developing and funding waste management programmes and projects.
- Promoting market-based adoption of integrated biogas technologies in SMMEs.
- Providing support for youth development within a greening context (DBSA, n.d.).

The Green Fund is additional and complementary to existing fiscal allocations supporting the transitioning of the South African economy to a low-carbon, resource efficient and climate resilient growth path. The fund is managed by the DBSA underpinned by a Memorandum of Agreement with the DFFE in 2012. The assets, liabilities and operational management of the Green Fund was transferred to the DBSA in 2020.

While at this juncture, it would appear that the Green Fund would not be a viable funding option for Eco-DRR, there will potentially be interest in the specific value chains and the development of SMMEs linked to these. As the Eco-DRR project starts to develop investment packages and provide support to local SMMEs, linkages with the Green Fund should be explored. ***Climate Finance Facility***

DBSA's Climate Finance Facility aims to increase climate related investments in Southern Africa by providing lending that addresses constraints in the market and encourages the development of blended finance approaches. This facility therefore aims to de-risk and increase the bankability of climate projects in order crowd-in private investments in infrastructure projects that mitigate or adapt to climate change in South Africa, eSwatini, Lesotho and Namibia. The facility will target projects that are potentially, but cannot currently, attract market-rate capital at scale without credit enhancement. The focus of the facility is on infrastructure projects that mitigate or adapt to climate change (DBSA, n.d.).

The Facility had initially committed debt funding of R2 billion. With regards to its capital structure, the DBSA contributed $55 million through a 15 year loan and GCF contributed a $55 million dollar 15 year loan through DBSA as an accredited entity of the GCF In addition, DBSA and GCF each contributed a $0.6 million grant for set-up costs (Convergence, DBSA and Coalition for Green Capital, 2019).

As with the Green Fund, this would not immediately appear to be an option to support the further upscaling of Eco-DRR, but there may be potential linked to biomass value chains and other green economic activities that may surface during the course of the Eco-DRR project.

WWF Nedbank Green Trust

The WWF Nedbank Green Trust, founded in 1990 by Nedbank and the WWF-SA, funds innovative projects to help solve societal and environmental challenges in South Africa. The Trust seeks to maintain and enhance the integrity of South Africa's ecological assets, promote ecological systems and their services that underpin the social and economic wellbeing of South Africa, and address the risks and opportunities posed by climate change by providing funding for innovative environmental conservation solutions through a diversified portfolio of projects with geographic, thematic and multi-organisational representation (Morkel, n.d.). The trust targets the following priority areas with the goal of bringing people and nature together:

- Marine,
- Freshwater,
- Resilient landscape,
- Climate / low carbon transition,
- Species of special concern,
- Environmental leadership, and
- Community (Morkel, n.d.).

Funded through the Nedbank Green Affinity Programme that has raised over R350 million to support over 200 conservation focused projects that are *in-situ*, community focused, catalytic and can lead to upscaling of approaches. The WWF Nedbank

Green Trust is funded through contributions made by Nedbank and its Nedbank Green Affinity clients. Nedbank attracts Green Affinity clients through the impact of the environmental outcomes investments of the Green Trust and WWF directs the Green Trust funds into priority strategic environmental investment areas through strategic partners working in the environmental outcomes sector of South Africa. (WWF Nedbank Green Trust, 2014; Morkel, n.d.).

The Green Trust may provide support to localised SMMEs in terms of landscape and community focused interventions and may be a useful source of seed funding support to kick off Eco-DRR interventions in other parts of the country, using the methods and approaches developed by the Eco-DRR project.

The Green Outcomes Fund

The Green Outcomes Fund pilot phase was funded by the National Treasury of the Republic of South Africa's Jobs Fund, together with catalytic support from the Rand Merchant Bank Fund (part of the FirstRand Foundation).The fund aims to achieve clearly defined green outcomes, encourage greater capital allocation to green businesses by local fund managers, and catalyse higher quality, consistent reporting of green impacts. The fund incentivises local fund managers to use new approaches and financing models to target high potential and fast-growing SMMEs operating in South Africa's green economy (Climate and Development Knowledge Network, n.d.; Green Outcomes Fund , n.d.). . The types of SMMEs that the fund target include those involved in:

- Organic compost: Produces of organic biochar inoculated compost and super-soils that are derived from the clearing of IAPs in choked riverine catchments.
- Sustainable transportation: Mobility as a service provider and mobility technology platform.
- Battery manufacturing and energy storage: Manufacturers of lithium-ion battery energy storage systems as fully packaged solutions.
- Water filtration and reuse technology: Manufacturers and supplier of portable water purification and filtration system.
- Conservation agriculture: Focus on providing sustainable solutions to reverse degradation, improve livelihoods and promote inclusivity and sustainability across the livestock value chain.
- Energy efficient hardware: Builders of smart technology and systems that improve peoples' lives by making insurance simple, convenient, and affordable.
- Waste management: Collection, sorting and sale of paper, plastic, glass, and cardboard waste, for use by the recycling industry.
- Smart solar geysers: Supplier of electrical and solar geysers spares and accessories to the South African market, and the incorporation of smart technology into geysers (Green Outcomes Fund , n.d.).

The funding will enable lending and investment to SMMEs which would not be feasible without the Green Outcomes Fund's support. The fund looks to blend concessionary funding with private capital, thus enabling participating Catalytic Finance Partners to develop and adapt their SMME investment criteria and support services in ways that were not previously possible, thereby realising greater impact in terms of the types of SMMEs funded and green outcomes created. Some of the current catalytic finance partners in the fund include Business Partners Ltd, Conservation International, Mergence Investment Managers and Edge Growth (Green Outcomes Fund , n.d.). The funding is sourced from the United Kingdom

Department for International Development and the Swiss Agency for Development (Climate and Development Knowledge Network, n.d.).

The Presidential Employment Stimulus

The Presidential Employment Stimulus was launched in 2020 in response to the COVID pandemic and its impacts on the economy. The stimulus seeks to confront this impact directly, as part of government's broader economic recovery agenda by using direct public investment to support employment opportunities (The Presidency Republic of South Africa, 2020). The stimulus has focused on public employment programmes and livelihood support interventions and taking these to scale (State of the Nation, 2024). As part of its principle of "work for the common good", greening is a kye thematic area which looks at environmental action, biodiversity protection and climate change mitigation strategies (Presidential Employment Stimulus, n.d.). The Presidential Employment Stimulus has been confirmed for 2025 and provides an opportunity to leverage off government's existing programmes around employment creation in the climate change and environmental management space.

The examples listed above showcase the work that's been done in South Africa to explore alternative ways to fund green initiatives that promote sustainability and innovation.

3.5.3 Funds and Donors

International Funds

International climate fund support to South Africa has included the GCF, the Adaptation Fund as well as the GEF, with the latter having a longer track record of support to a range of environmental and EbA focused projects as far back as 2007. Under the 8th replenishment of the GEF Trust Fund, the System for Transparent Allocation of Resources had outlined over $13 million to support climate change and land degradation (GEF, 2022).

GCF's portfolio for South Africa shows a total of 9 projects being funded through GCF to the amount of $414.9 million. In addition, 3 readiness activities have been approved ($1.6 million) (GCF, n.d.). The Water Reuse Programme was approved by GCF in 2023 and aims to establish and operationalise a national water reuse programme to address the water scarcity issue by transforming the country's wastewater system. By treating water as a new asset class and stimulating and activating the water reuse market, South Africa can unlock future economic growth while protecting its scarce and increasingly demanded water-resources. The funding from GCF will reduce the risk exposure of potential private financiers and municipalities by blending GCF funds with funds from private investors while providing key stakeholders with technical assistance and capacity-building. The total project value is $1.5 billion with an estimated 7.3 million beneficiaries (GCF, n.d.).

More recent support from the GCF has been focused on supporting programmes that look to dual-benefit programmes that support private sector investment into built infrastructure. This includes the Climate Finance Facility and the Water Reuse Programme. DBSA (a GCF Accredited Entity) has together with DWS established a National Water Partners Programme that will aim to provide better coordination of a range of water sector focused programmes that will build increased climate resilience. While the scope of the pipeline of projects anticipated under this banner is largely focused on built infrastructure there is a keen focus upon the integration of ecological and built infrastructure solutions.

The **Adaptation Fund** also supports climate change adaptation work in the country and finances projects and programmes that help communities vulnerable to climate change in developing countries adapt to climate change. SANBI is a National Implementing Entity of the Adaptation Fund. The fund recently provided $ 2,442,682 towards the implementation of a small grant finance mechanism to address the financial, capacity and adaptation needs in the Mopani and Namakwa Districts. The *Community Adaptation Small Grants Facility* sought to increase climate resilience in rural communities and socioeconomic systems in these two DMs in South Africa, by working directly with local stakeholders and anticipated beneficiaries through a small granting mechanism. The overall goal of the project was to ensure that vulnerable, rural communities in the project target areas have reduced vulnerability and increased resilience to the anticipated impacts of climate variability and change. The objective was to incorporate climate adaptation response strategies into local practices so that assets, livelihoods and ecosystem services are protected from climate-induced risks associated with expected droughts, seasonal shifts and storm-related disaster events. The project ran for 6 years from 2015 to 2021 with a total of 13 Small Grant Recipient projects being contracted and 12 implemented in the two DMs - each project averaging a grant amount of US$ 95,000 (Adaptation Fund, n.d.; SouthSouthNorth, 2020).

Further to above, the Adaptation Fund funded the project titled: *Building Resilience in the Greater uMngeni Catchment, South Africa* (uMngeni Resilience Project) which was implemented through SANBI. The fund provided USD 7,495,055 for the project which aimed to reduce climate vulnerability and increase the resilience and adaptive capacity in rural and peri-urban settlements and small-scale farmers in productive landscapes in the uMgungundlovu DM that are threatened by climate variability and change, through an integrated adaptation approach (Adaptation Fund, n.d.).

GEF is also active in South Africa including in some of the DMs that the Eco-DRR project is targeting (i.e. Sekhukhune DM). The recent GEF 5 project titled: Securing multiple ecosystems benefit through sustainable land management in the productive but degraded landscapes of South Africa was completed in 2018 and sought to reduce pressures on natural resources from competing land uses in the wider landscape. The objective was to provide incentives (capacity, financial, governance) for the adoption of knowledge based sustainable land management models for land management and land/ecosystem rehabilitation in support of the green economy and resilient livelihoods. The budget was $4.2 million from GEF ($20.5 million through co-financing) and the implementers were UNDP, DFFE and CSIR (GEF, 2013). Another project, titled: Mainstreaming Sustainable Land Management for Large-Scale Impact in the Grazing Lands of Limpopo and Northern Cape provinces in South Africa, focused on GEF 7 with the aim of scaling-up and mainstreaming sustainable land management for large-scale impact in the grazing lands of the target sites. The project is currently being implemented with a budget of $3.6 million from GEF ($27.7 million through co-financing) (GEF, n.d.).

In addition, GEF is funding the *Ecological Infrastructure for Water Security* project, which is implemented by DBSA, and executed by SANBI. This project focuses on improving water security by integrating biodiversity and ecosystem services into planning, finance, and development in the water sector. The project is organised into three interdependent components: 1) systemic changes to better enable biodiversity and ecosystem services to contribute to improved water security; 2) demonstration of proposed approaches in the Berg-Breede and uMngeni River catchments; and 3) improving the integration of biodiversity and ecosystem services into the water value chain through social learning, credible evidence, and knowledge management (WRC, n.d.).

The Adaptation Fund, GCF and GEF are strongly aligned with the objectives of the Eco-DRR project and there is opportunity to build off the work that's been done as well as identifying synergies for future work. Additionally, drawing from the lessons learned during implementation of past Adaptation Fund, GCF and GEF work will ensure that the Eco-DRR project is effective going forward.

Further international public finance support has been channelled into South Africa through DFIs including the Multilateral Development Banks such as the World Bank, the African Development Bank and the Development Bank of Southern Africa. Official Donor Assistance has supported a range of programmes and projects focused on developing climate resilience with this support being channelled through bilateral partners such as the French Development Agency (France), German Technical Cooperation (GIZ, Germany), Foreign and Commonwealth Development Office (UK), US Agency for International Development (US), amongst others.

The support from these partners has been focused on building resilience at a range of scales from transboundary river basins through to municipal and community levels. Projects have focused on a range of adaptive responses to climate change in urban and rural contexts, with a focus on water security and livelihoods through climate resilient built infrastructure integrated with ecological infrastructure.

Donors

There are several major role players in the donor space that provide funding for climate change adaptation measure. **GIZ's Low Carbon and Climate Resilient Water and Wastewater Management Programme** seeks to make South Africa's water and wastewater sector more resilient to the impacts of climate change. It introduces adaptation and energy efficiency measures that contribute to realising national climate change objectives and respond to vulnerable groups' development needs. By expanding water and energy resource efficiency gains, introducing clean energy, reducing water losses, strengthening management capacities, and raising awareness on climate resilience, water and sanitation services are enhanced, particularly for vulnerable groups. Activities target at least two municipalities and result in a replicable model for more municipalities. Funding of €2,900,000.00 has been made available from the International Climate Initiative for the programme and the duration of the project is from 2022 to 2025. As the Eco-DRR project is implemented there could be interest from this programme to support Eco-DRR in municipal jurisdictions of interest to GIZ.

Furthermore, GIZ also implements the **Natural Resources Stewardship Programme** for Growth which is co-funded by the European Union, Foreign, Commonwealth and Development Office and PVH Corp. The programme applies a stewardship approach, empowering all users of natural resources to assume responsibility for available resources and develop joint solutions for their sustainable use. It supports the establishment of partnerships between actors of the private sector, public authorities and civil society. The partnerships jointly identify and develop measures to preserve natural resources, to which the private sector makes a significant contribution. The project provides expert advice and supports the introduction of national and international standards on the management of natural resources. The programme's term is from 2018-2023 but it is expected that the programme will be extended (GIZ, 2023). The programme provides a useful example of partnerships with private sector to explore and co-identify solutions to challenges affecting natural resources that goes beyond financing only.

There are also several programmes and projects being funded by the United Nations and its departments. United Nations Educational, Scientific and Cultural Organisations (**UNESCO's)** project, titled: Addressing Climate Risk and Building Adaptive Capacity in South Africa's Biosphere Reserves, focuses on climate change and strengthening the role of biosphere reserves to ensure the sustainable use of natural resources, build sustainable communities and strengthen education for sustainable development and capacity building. The project targets four biospheres with two (Kruger to Canyon Biosphere Reserve and Vhembe Biosphere Reserve) aligning with the DMs selected for the Eco-DRR project. The budget for the project is EUR 1.5 million and implementation is between 2021 and 2024 (UNESCO and Government of Flanders, n.d.).

In 2009, **United Nations Environmental Programme (UNEP)** identified priority areas for the South Africa that the programme would work towards addressing:

- Implementation of the Paris Agreement and climate change adaptation and mitigation;
- Domestication of the Sustainable Development Goals;
- Transition to an inclusive and green economy;
- Protection of ecosystems and biodiversity;
- Sustainable consumption and production patterns and the Ten Year Framework Programme;
- Sustainable cities including air and water quality, health and sustainable transport;
- Strengthening environmental governance;
- More effective science-policy interface; and
- Improved South-South cooperation (UNEP, n.d.).

In this regards, UNEP has funded and implemented several projects and studies including the Joe Gqabi EbA Pilot Project (ongoing), and the Ecosystem-Based Approaches to Climate Change Adaptation: Strengthening the Evidence of Informing Policy project (2015-2022) amongst others. UNEP also sources funding from other partners such as the Government of South Africa, European Union, Swiss Economic Cooperation Organisation, GEF, and GIZ (UNEP, n.d.).

United Nations Development Programme (UNDP) has confirmed its commitment to support South Africa in its development journey by investing in youth and women empowerment initiatives (skills development, employment promotion, and supporting entrepreneurship), promoting renewable energy, building state capability, disaster response, lobbying for biodiversity investments, and driving innovation. In its efforts to strengthen disaster management , UNDP supported the UN-joint emergency response where the UNDP placed four United Nations specialist volunteers at the KZN PDMC offices to support the recent flood disasters. The UNDP also supported the development and review of disaster management plans and frameworks, as well as provincial disaster risk profiles in districts in KwaZulu-Natal, to strengthen their institutional and technical capacity for DRM and coordination. In 2022, the UNDP, together with DFFE, implemented sustainable land management initiatives (e.g. rangeland rehabilitation, bush clearing, alien plants control, etc.) and placed 345,321ha under improved sustainable land management practices in three landscapes of Karoo, Olifants and Eastern Cape. Furthermore, the UNDP, through its flagship BIOFIN programme, supported DFFE in developing and launching the biodiversity sector investment portal which aims to encourage the growth of connections between communities and investor-ready and bankable intermediaries to ensure that the sector can contribute to the expansion of the economy and the welfare of society while preserving biodiversity (UNDP, 2022).

Philanthropic Funds

In addition to international, national and donor funds, there are philanthropic funds which are given as a gift, endowment, donation or bequest. Some of the philanthropic institutions that support climate change mitigation and adaptation initiatives in South Africa are discussed below. These may be accessed to obtain seed-funds that would help upscale Eco-DRR into new geographies or to assist fledgling SMMEs to get businesses started. These funds typically are very supportive of community focused interventions and could be supportive in providing catalytic finance.

The **African Climate Foundation** which opens philanthropic opportunities for climate action in the continent. The foundation provides a mechanism through which philanthropies can contribute to Africa's efforts to address climate change. The foundation works closely with philanthropic organisations to identify strategic opportunities to support adaptation, resilience and mitigation initiatives on the continent and to unlock new opportunities for sustainable development in Africa (The African Climate Foundation, n.d.).

The **Rockefeller Foundation** seeks to pioneer philanthropy that promotes the wellbeing of humanity through the identification and upscaling of solutions to advance opportunities and reverse the climate crisis. Their focus is on health, food, power, economic equity, innovation and innovative finance. The foundation provides grants to NGOs and other entities to address climate change issues. They also do convenings, residencies, and networks, to foster exchanges between likely and unlikely allies which surface and strengthen solutions and build the partnerships needed to have outsized impact on 21st century challenges (Rockefeller Foundation, n.d.).

The **European Climate Foundation** is a philanthropic initiative working to foster the net-zero transition and ensure a healthy, thriving planet for current and future generations. The foundation supports around 700 partner organisations in more than 100 countries to drive progress towards the goals of the Paris Agreement, promote practical policymaking in response to the climate crisis, and broaden political and public support for climate action. The foundation provides strategic and financial support to organisations working at the national and global levels to tackle the climate crisis (European Climate Foundation, n.d.).

Bloomberg Philanthropies aims to ensure better, longer lives for the greatest number of people by focusing on five key areas: the arts, education, the environment, government innovation, and public health. Its environmental programme focuses on climate change by :

- Advocating for global coal plant closures, clean energy policies, and mobilising capital.
- Leading sustainable finance work by supporting the private sector to reach net-zero emissions, disclose climate risks, and invest in the clean energy transition.
- Supporting local climate action with mayors and other local leaders.
- Partnering with cities to improve air quality.
- Protecting ocean ecosystems and coastal communities (Bloomberg Philanthropies, n.d.).

The **Bill and Melinda Gates Foundation** provides grants and strategic investments across the world towards a range of issues impacting society. Grants are targeted towards organisations looking to achieve measurable impact in the fight against poverty, disease, and inequity while investments are focused on the funding of entrepreneurs, companies, and other organisations to create incentives that harness the power of private enterprise to create change for those who need it most. The foundation does focus on climate change, specifically on supporting long-term, climate-smart agricultural development, research, and innovation to build resilience to such shocks in the future. To do this, the foundation seeks to mobilise resources for an inclusive agricultural transformation that helps smallholder farmers improve yields, earn more, and adapt to changes in climate (Bill and Meilnda Gates Foundation, 2023).

3.5.4 Economic Policy Instruments

Tax Rebates

Tax rebates refers to a reduction in an individual's / entity's tax liability whereby a certain amount is offset against the tax liability (or if there is a tax credit, then the excess tax will be paid out to the individual / entity). In South Africa, there are a few tax rebates that entities / individuals can apply for, and these are discussed below. These are provided to demonstrate how these rebates are incentivizing environmentally sound practices and it is debatable as to whether any of these can be applied to Eco-DRR interventions. Importantly, these demonstrate a willingness to employ such approaches and as such, during the implementation of the Eco-DRR project, the introduction of additional tax incentives should be explored. This may incentivise and assist SMMEs but could also be used to incentivize larger private sector actors to invest in Eco-DRR through such instruments as "Water Funds".

- *Section 37B*

Section 37B of the Income Tax Act was introduced in 2007 and provides for the deduction of capital expenditure in respect of environmental treatment and recycling assets and environmental waste disposal assets. With regards to environmental treatment and recycling assets, this refers to any air, water and solid waste treatment and recycling plant or pollution control and monitoring equipment if the plant or equipment is utilised in the course of a taxpayer's trade in a process that is ancillary to any process of manufacture. In this regard, the deduction equals a tax allowance of 40% of the cost of acquisition in the first year of assessment, and 20% in every succeeding year thereafter. For environmental waste disposal assets, 37B refers to any air, water and solid waste disposal site, dam, dump, reservoir, or other structure of a similar nature, or any improvement thereto, if the structure is of a permanent nature and utilised in the course of a tax payer's trade in a process that is ancillary to any process of manufacture. In this case, the deduction comprises a capital allowance of 5% of the cost of acquisition in the first year of assessment, and 5% in every succeeding year thereafter (Exceed, n.d.).

- *Section 12B*

Section 12B of the Income Tax Act provides for capital expenditure deductions for assets used in the production of renewable energy and particularly incentivises the development of smaller solar photovoltaic energy projects with an accelerated capital allowance of 100% in the first year for solar photovoltaic energy of less than 1 megawatt. It is important to note that biomass comprising organic wastes, landfill gas or plant material is considered an applicable types of renewable generation project (TGS South Africa, n.d.).

- *Section 12U*

Section 12U of the Income Tax Act provides for capital allowances for roads and fencing used in the generation of electricity greater than 5 megawatts from wind; solar; biomass comprising organic wastes, landfill gas or plant material; and hydropower to produce more than 30 megawatts. It is granted in full in the year of expenditure and covers improvements to the roads and fencing related to the generation project, as well as foundations or supporting structures (TGS South Africa, n.d.).

- *Section 37D*

Section 37D of the Income Tax Act provides biodiversity tax incentives for Nature Reserves and National Parks declared in terms of NEMPAA on communal or private land. Section 37D allows a taxpayer to deduct the value of their land declared in terms of NEMPAA, from taxable income. It supports the national biodiversity stewardship approach to securing protected areas through contractual agreements on non-state land and provides much needed financial sustainability to critical conservation efforts nationwide (Wilderness Foundation Africa, n.d.).

Municipal Rebates

Municipalities have the ability to provide rebates to entities / individuals in its area of jurisdiction to support sustainable use and management of natural resources. This includes activities to support protection of the natural environment or efficiency in energy and water use. It should be noted that the idea of a rebate that targets natural resources is not commonplace in South Africa's municipalities, but a few case studies are presented below which showcase municipalities creating some form of an incentive scheme to promote better management of natural resources.

During the course of the project and in considering the range of financial instruments and incentives, it will be important to consider how such rebates can be used to incentivise investments into Eco-DRR interventions at local levels.

- *Nelson Mandela Bay Municipality (NMBM) - Conservation Stewardship*

The NMBM was the first municipality to offer landowners a rates rebate to encourage conservation on private land. The new Rates Act in 2004 allowed municipalities to levy rates on rural properties whereas the old Rates Act only allowed municipal rates to be applied to properties within municipal boundaries. Under the old Rates Act, municipalities granted large rebates for agricultural land, but land not converted to agricultural use had to pay high rates and were penalised for conserving natural vegetation – thus creating a perverse incentive. With the promulgation of the new Rates Act, the NMBM revised its rates system to provide rate rebates that encourage protection of priority conservation areas. The NMBM had already identified priority areas for conservation based on a scientific systematic conservation planning exercise and ensured that new rates system was supported by local Spatial Development Framework committees. In addition, the NMBM ensured that conservation was mainstreamed and integrated into all municipal activities by having staff dedicated to conservation-related activities (Cape Action For People and the Environment, 2009)

- *Industrial Effluent Rebate*

The City of Cape Town implements an industrial effluent rebate where capital budget expenditure has been purposed by the owner to avoid detrimental impact to municipal infrastructure; to improve the quality of industrial effluent and quantity discharged into the municipal system (Green Cape, 2018) . The Overstrand Municipality has a similar mechanism in place where the municipality may determine a rebate if the owner or occupier discharges industrial effluent solely during periods specified by the municipality or by containing constituents which will have a beneficial effect on the effluent discharged from the sewage treatment plant (Overstrand LM, 2022).

Pricing

This refers to mechanisms that directly or indirectly fund management and protection of natural resources and includes incentive mechanisms, pricing strategies and entities that are specifically mandated to fund such activities. A brief overview of these mechanisms in South Africa is presented below:

- *Pricing Strategy for Raw Water Use*

In terms of the National Water Act (Act 36 of 1998), the Minister of Water and Sanitation, with the concurrency of the Minister of Finance, is empowered to establish a pricing strategy for charges of any water use within the framework of existing relevant government policy. The pricing strategy provides the framework for the pricing of the use of water from South Africa's water resources, i.e. the use of raw (untreated) water from the water resource and/ or supplied from government waterworks and the discharge of water into a water resource or onto land (DWS, 2022). Under Section 56(1) and (2) of the National Water Act the pricing strategy may set out the methodology for the determination of water user charges.

Under this strategy the Water Resources Management Charge (WRMC) funds water resource management activities in each of the Water Management Areas. These activities relate to the protection, allocation, conservation, management and control of all of the nation's water resources. The activities to be funded by the WRMC are tabulated in Table 3-12. EbA and Eco-DRR functions integrate significantly with many of these functions. Ultimately, the WRMC funds the day-to-day management of water quality such as penalties for pollution incidents and the authorisation of waste discharge activities (Reddy & Mgwebi, 2022).

Table 3-12: Water resource activities funded by the WRMC (adapted from DWS, 2022)

Function / Activity	Activity Description
1. Catchment management strategy and water resources planning	Resource studies, investigations and integrated strategy development.
2. Resource directed measure	Report against the achievement of the Class and resource quality objectives (RQOs). Report on the water balance per catchment (i.e. water available for allocation after consideration of ecological requirements).
3. Water use authorisation	Registration of water use. Maintenance of water management area register of water use.
4. Compliance monitoring and enforcement of water use	Compliance monitoring and enforcement of water abstraction and waste discharge. Conduct investigations of unlawful activities.
5. Disaster management/ pollution control and emergency incidents	Planning and preventative management of disaster (administration) including risk monitoring (management).
6. Water resources management programmes	Integrated water resources programmes, including implementing water management strategies such water conservation and water demand management.
7. Water related institutional development (stakeholder management empowerment)	Stakeholder participation, empowerment, institutional development and coordination of activities.
8. River health	Aquatic weeds control

Function / Activity	Activity Description
9. Maintenance and restoration of ecosystems to improve water resources	Planning and implementation of ecosystem maintenance and rehabilitation programs, required for water resource- protection and achievement and maintenance of RQO's, e.g. sediment control, nutrient trapping, riparian and wetland rehabilitation. Control of invasive alien plants with acknowledged negative impacts on water resources, e.g. riparian zones, mountain catchment areas, wetlands and in areas where there could be an impact of aquifers.
10. Geo-hydrology and hydrology	Groundwater and surface water monitoring. Extending and maintaining the hydrological database and compilation of information.

Activity 9 (Maintenance and restoration of ecosystems to improve water resources) can provide a possible mechanism to fund EbA activities related to ecosystem maintenance and rehabilitation in catchments. The Pricing Strategy for Raw Water Use and the WRMC seeks to expand the activities undertaken by CMAs to include restoration and rehabilitation of ecological infrastructure (Makate, et al., 2023).

- *Waste Discharge Charge System (WDCS)*

The WDCS was developed by DWS to promote waste reduction and water conservation and focuses on the impact caused by waste discharge, or the waste conveyed in the discharge. It introduces financial and economic instruments, such as the polluter pays principle, designed to internalise costs associated with waste and to encourage the reduction in waste and the minimisation of detrimental impacts on water resources. The WDCS and its charge, the Waste Mitigation Charge aims to finance strategic interventions to address specific targeted pollutants in threatened areas (Reddy & Mgwebi, 2022). While the construct of this system was primarily focused upon built infrastructure, there is potential that this could equally be expanded to ecological infrastructure such as wetlands, for example, that plays critical roles in environmental regulation such as DRR.

- *Trans-Caledon Tunnel Authority (TCTA)*

The TCTA is an agency of DWS and is a state-owned entity that is tasked with financing and implementing bulk raw water infrastructure projects in South Africa. The TCTA supports the government of South Africa in ensuring water security and universal access to water. In this regard, TCTA designs bankable projects, raises funding in capital markets, manages debt and implements infrastructure rollouts. The TCTA serves as a specialised liability management body that government can use to finance and build dams and transfer schemes off budget while within an acceptable risk framework and in a cost-effective manner. Through this financing mechanism, borrowing requirements are reduced and the cost of infrastructure is passed onto the consumer in alignment with the "user-pay principle" (TCTA, n.d.). Ensuring that ecological infrastructural aspects are integrated into the design and build of such schemes, with the associated costs mainstreamed into these overall project cost would see more climate resilient schemes being developed and funded.

- *The Land User Incentive Programme*

The programme was implemented by DFFE and sought to establish partnerships with various institutions interested in adding value to the operations of DFFE: NRM (now DFFE: EP). The programme focused on IAP management as well as repairing and protecting natural assets and value-added industries from IAPs and bush encroachment. The programme explored public-private partnerships to remove IAPs on both government- and privately-owned land and partners include NGOs, non-profit organisations, community-based organisations, government entities and other relevant organisations. Any project implemented under the programme was also required to follow the EPWP model (DEA, 2013; Lubisi, 2020). It is not clear if this programme is still being implemented by DFFE and would need to be explored during project implementation.

- *Local Government Pricing*

There is the opportunity of municipalities to use surplus revenue for funding climate change adaptation initiatives. However, this requires understanding the context of LM, especially those in rural areas with limited revenue streams. As noted in a report by the Parliamentary Budget Office, smaller LMs source 43.1% of revenue from transfers and subsidies followed by electricity revenue and property rates. This is very different to metropolitans and secondary cities which source most of their funding from electricity revenue (32.7% and 37.5% respectively) followed by transfers and subsidies. On average, some municipalities generate more than 80% of their operating revenues from fees for services provision (Parliamentary Budget Office, 2021).

While it is not clear how municipalities spend their revenue generated from the provision of electricity, water and other services, it may be possible to explore if these surplus revenues can be used to support the protection and maintenance of ecological infrastructure. This will need LMs to improve their revenue generation and to determine where surpluses can be achieved – something that is particularly challenging for rural LMs that do not generate significant revenue from service provision and are strongly reliant on transfers and grants from national government. Lessons can be drawn from the metropolitans and secondary cities who have a much bigger revenue base through the collection of monies from electricity and water provision as well as property rates.

3.5.5 Market-Based Instruments

Green Bonds

Bond structures are useful in that they provide immediate upfront cash flow to allow for large capital-expenditure investments. In particular, green bonds act as debt instruments where the proceeds are used to finance specific climate-related or environmental projects. Bond financing can spread the cost of green infrastructure over the bond's life and provides a means to match long-term infrastructure projects with long-term investments. Bond markets can offer liquidity which facilitates the flow of capital and encourages continued investment in green infrastructure. Bonds can also be structured to enhance transparency and accountability. In addition, bond issuance can mobilise significant amounts of capital by tapping into institutional investors, pension funds, and other long-term investors (Pegasys, 2023). There is a precedent of using bonds at a municipal level and these examples are presented below.

- *City of Johannesburg*

Johannesburg implemented green bonds to raise funds to support their response to climate change and to ensure sustainable natural resource management. In 2014, the green bond issued by the City of Johannesburg was worth $143 million and was funding projects across a range of sectors. The city viewed the use of green bonds as a success as it allowed for the city to show its commitment to environmental stewardship while also receiving a market-related financial return. The bond also provided a new funding source for the city and allowed for the city to expedite implementation of its climate change strategy (C40 Cities, 2016).

- *City of Cape Town*

The City of Cape Town issued an $83 million green bond in 2018 with a focus on financing of the city's water infrastructure in response to the 2015 drought (Environmental Finance, n.d.). The bond was used to invest in projects aligned to city's sustainability goals to adapt to and mitigate climate change including procurement of electric buses; energy efficiency in buildings; water resilience initiatives; sanitation treatment; and coastal structure protection and rehabilitation (Global Infrastructure Hub, n.d.).

Direct Markets

- *Nurseries*

Nurseries support food security and enhancing ecosystem services that are essential for agriculture (SANBI, 2016). These nurseries can generate income and job opportunities for the local community by providing a product that can be sold. Landscape restoration stimulates the demand for the products and services that support restoration interventions such as plant nurseries, material provision (e.g., eco-logs), and equipment and transport businesses. The provision of these secondary services linked to landscape restoration creates local SMME development / expansion opportunities. SANParks is currently implementing this in South Africa across several SANParks areas. More details regarding this can be found in Section 5.3.

- *Biomass Value Chains*

Tapping into the biomass value chain provides opportunities for communities to generate income and support job creation. A significant amount of biomass is produced through clearing of IAPs and bush encroachment which can be used in the local biomass value chain. This also offers opportunities for SMMEs and the opportunity to create jobs through wood-pelleting and eco-matting. An example of a local SMME that built its business on biomass from IAPs clearing and other associated activities is Meat Naturally. More details regarding biomass value chains can be found in Section 5.3.

A recent study investigated the potential for 'unlocking and retaining jobs in the alien vegetation added value chain (Jenkin and Mudombe, 2018). The case study highlighted:

- Specifically, the potential to create jobs in relation to wood-pelleting and eco-matting;
- The wider social arguments that should be taken into consideration including that the potential local market for wood pellets as fuel is among low-income households in peri-urban and mainly rural areas.
- A review of biomass value chains and case studies (Toma-Now, 2023) identified a number of applications in South Africa, including:

- A review of biomass value chains and case studies (Toma-Now, 2023) identified a number of applications in South Africa, including:Energy - biomass to energy (e.g., Sappi Ngodwana Mill), heat energy biomass pellets (domestic and commercial);
- Timber and fibre - DEA Eco-Furniture, KZN Department of Agriculture and Environmental Affairs Eco-Coffins, DEA Working on Fire Lighthouse Project; and
- Carbon – biochar, chipping, composting, activated carbon (water purification for industry) (Reliance Compost in the Western Cape, uses alien vegetation as well as household garden waste to produce organic compost on a viable commercial scale).

There is also the opportunity to promote SMME and enterprise development through the biomass value chain. This can build on existing work being implemented by SANParks. SANParks is engaged in the implementation of programmes with poor rural communities, to promote benefit sharing, socioeconomic development and improved living conditions for local communities adjacent to national parks. A number of initiatives are being implemented, including:

- **Community-run plant nurseries** - 12 initiatives to date across SANParks areas. These nurseries generate financial earnings and job opportunities and also offer potential wellbeing outcomes in terms of access to food (diversity) for local communities if the nurseries are expanded to include crop / vegetable seedlings. (Swemmer and Mmethi, 2016). For example, Ndindane nursery employs 30 people and produces cash crops, lala palm, medicinal and garden plants. IDP
- **Medicinal plant nurseries** are another focus. The Diepwalle Nursery in the Garden Route National Park is used to propagate plants used by traditional healers[7].
- **Farleigh Eco Furniture Factory** which uses wood from invasive exotic species and off-cuts from indigenous species to produce desks for schools and furniture for SANParks rest camps. The aim of the project is not to make a profit but to sustain employment. At full production 100 people will be employed at the factory.

In addition, SANParks prioritises capacity building as a component of benefit sharing through education programmes, formal and informal training and on-the-job experience (Swemmer and Mmethi, 2016).

Further to the above, landscape restoration stimulates the demand for the products and services that support restoration interventions such as plant nurseries, material provision (e.g., eco-logs), and equipment and transport businesses. The provision of these secondary services linked to landscape restoration creates local SMME development / expansion opportunities. However, a key concern in this regard is the longevity of such enterprises as there is the risk that once a restoration programme ends, there may be limited scope to expand these support services to other areas or to supply these services to other restoration programmes. In South Africa, nurseries produce vetiver plants which can be used in a range of applications, including:

- Agriculture;
- Reducing Soil Erosion;
- Treatment of Wastewater;

[7] Source: https://www.sanparks.org/about/connecting_to_society/ .

- Producing an Essential Oil;
- Make Biomass;
- Thatching and Weaving (Vetiver SA, n.d.).

Possible positive carbon sequestration benefits identified offer the potential to access the carbon credit market, thereby potentially leveraging private finance for the sale of carbon credits that can support overall project implementation. Similarly, the positive income benefits derived from improved livestock farming can be realised by an enabling livestock value chain. However, it is important to note that the proposed Eco-DRR interventions will not necessarily contribute to the development of value chains in and of themselves. Rather, enabling interventions (such as transport, storage, capacity, access to finance, markets, etc.) are required to support the value chains that in turn accommodate the potential benefits.

- *Ecotourism*

In addition to nurseries and biomass value chains, there is the opportunity to promote ecotourism linked to Eco-DRR and EbA. Ecotourism is known to support SMMEs, job creation and poverty alleviation. Ecotourism in 2018 generated $8.4 million in South Africa and created 5000 jobs (Mogashoa, 2019). In addition, ecotourism promotes sustainable development by strengthening the balance between human needs and preservation of natural resources (Eriksson & Lidstrom, 2013).

PES

PES refers to the involvement of beneficiaries / users of ecosystem services paying a certain amount to the stewards of the ecosystem services. The model follows a willing buyer-willing seller model and often requires voluntary participation. PES is often used to ecosystem services related to water, biodiversity conservation and climate change adaptation and mitigation. Payments are based on the costs of implementing a specific management action (e.g. IAP removal), the cost of maintaining the desired state of the ecological infrastructure, or a quantifiable service delivery (e.g. additional water flows in a river). PES schemes do include transaction costs relating to the mechanisms used to facilitate the payments and verifying delivery of the services paid for (Western Cape Government, 2021). There are several examples of PES in South Africa.

- *Business Case for Keurbooms and Karatara River Catchments*

PES was put forward as a mechanism to fund IAP clearing and restoration activities in the Keurbooms and Karatara River catchments. A business case was developed to determine the viability of such an approach which included stakeholder engagements and conducting a CBA. The outcomes from the business case indicated that there is a feasible opportunity for investment towards the operationalisation of a PES scheme that re-invest the offset value of water gained through IAP clearing and restoration activities (Western Cape Government , 2018).

- *Ethekwini's Sihlanzimvelo Stream Cleaning Programme*

The Ethekwini municipality implemented a programme that focused on reducing recurrent damage costs to road culverts caused by solid waste and build-up of IAP debris during flash floods through improved stream management in municipal land. Local community cooperatives were established and employed to implement the work that resulted in direct socioeconomic benefits for the community. The municipality self-funds the programmes and plans to expand it across other rivers and streams in its municipal area (Western Cape Government , 2018).

- *Working for Water and Working for Wetlands Programmes*

The two programmes implemented by DFFE: EP are regarded as PES mechanism. The Working for Water Programme hires unskilled workers, the unemployed and vulnerable / under-privileged groups in a community to remove IAPs. While more of the work is conducted on government land, work is also done on private land with a focus on small-scale farmers and high priority areas. Voluntary payments into the programme from municipalities, donors and private sector are encouraged, but 80% of the programme's funding comes from the national fiscus – particularly EPWP allocations. Similar to the Working for Water programme, the Working for Wetlands Programme employs the same groups of people in communities vulnerable to climate change to restore wetlands. It is also funded in the same manner as the Working for Water Programme. The major difference is the use of highly qualified personnel during implementation of activities as these require specialised planning and careful environmental considerations (Catie & The Global Mechanism of UNCCD, 2012).

- *The Nature for Water Facility*

The Nature for Water Facility is a partnership managed by The Nature Conservancy and Pegasys with the aim of providing the gold standard in technical assistance for NbS and to help local champions build out watershed investment programmes (Nature For Water, n.d.). The facility's flexible delivery model has been purpose-built to respond to partner-led demand and the facility has supported 25 local watershed investment programmes, with a further 12 locations in scoping / contracting (as of 2023). The facility works with local programmes addressing a broad range of water security challenges by providing technical assistance such as project management and facilitation, ecology and NbS best-practices, water sector management, hydrology and GIS, and economics and finance (Nature for Water Facility , 2023).

Offsets and Tradeable Permits

Tradeable permits can be defined as "institutional arrangements (or 'modes of governance') that entail the construction of markets to trade a specific form of rights – usually rights to exploit a natural resource or to emit harmful substances into the environment" (Serre, 2008). Tradable permits can be used to better regulate water pollution as well as land management which includes biodiversity protection. These types of permits are based on right-based schemes such as tradable development rights, conservation and wetland banking, and tradable quotas for land use (Serre, 2008). DFFE defines environmental offsetting as "an intervention, or interventions, specifically implemented to counterbalance an adverse environmental impact of land-use change, resource use, discharge, emission or other activity at one location that is implemented at another location to deliver a net environmental benefit" (Linkd Environmental Services, 2014). There are two main types of offsets:

- Direct offsets: Refers to measurable conservation gains in relation to the ecological variable/s negatively impacted, where compensation is in the form of habitat, functions, values or other attributes negatively impacted e.g. restoring or protecting an existing habitat; creating a new habitat; and/or reducing environmental threats.
- Indirect offsets: Refers to activities that provide a different but proportionate compensation e.g. financial or educational such as providing resources for research (Linkd Environmental Services, 2014).

A case study showing offsetting is presented below:

- *Project Boloka Metsi – The Emfuleni Water Conservation Project (South Africa)*

In 2011, Sasol signed a Memorandum of Understanding with the Emfuleni LM and GIZ. The project focused on water conservation / water demand management and looked to reduce water leaks to address shared water risks. A reliable supply of water is crucial for business operations in Sasol and any reduction of their water demand would not have as big an impact on the reduction of catchment-level water shortages as the implementation of water-saving measures amongst the domestic sector. Sasol committed R5 million to the project and leveraged an additional R5 million through partner funding to minimise unnecessary water losses form the Vaal system. By demonstrating the principle of water offsetting beyond fence-line initiatives, the project aimed to target a bigger scale that would benefit all water users in the catchment. The project managed to repair leaks to 108 000 households as well as effecting repairs to the municipal reticulation network. Through the project, the Emfuleni Municipality reduced their demand from 82 million m3 to 75 million m3 (Panday, 2015). The Boloka Metsi Project provides an excellent example of a successful public-private partnership where both public and private sector successfully implemented a water offset project that benefits both parties.

Carbon Credits

As consensus is growing on the need to mitigate future climate change by reducing current emissions, companies have taken steps to reduce their carbon footprint, even though they are not required to do so by regulation. This "voluntary" demand for carbon offsets, generated by projects that reduce emissions, is driving the "voluntary carbon market" (Guigon, et al., 2015). Economists often describe climate change as the greatest market failure (de Jongh & Möllmann, 2014; Arp, et al., 2018). They argue that putting a price on carbon is the most cost-effective mechanism to reduce GHG emissions and thereby address climate change. It is predicted that climate change will have an estimated potential cost of a minimum of 5 per cent of annual global gross domestic product (GDP), if action is not taken (de Jongh & Möllmann, 2014). To remain competitive and profitable, companies will have to incorporate climate change and environmental awareness into their business strategies and operations or risk losing business from the growing number of environmentally concerned customers and consumers.

DFFE is in the process of developing a post-2020 Climate Change Mitigation System that aims to create the necessary framework for the country to meet its domestic mitigation ambitions and international commitments (de Jongh & Möllmann, 2014). Carbon budgets are a feature of the mitigation system being developed. Carbon budgets give allowances to emit a certain amount of GHGs, to be allocated to those entities required to report their GHG emissions. The proposed mitigation system is an absolute baseline-and-credit trading scheme, where entities emitting less than their carbon budget could sell carbon credits (Arp, et al., 2018). The mitigation system includes mandatory carbon budgets to be allocated to companies and other entities. These budgets provide the maximum amount of emissions that the entity is allowed to emit.

Emissions or carbon trading schemes have risen in popularity and are widely believed to be an effective, as well as economically efficient, measure and have become a favoured government strategy (Spash & Theine, 2016). Trading carbon emissions allows sectors with poor mitigation potential to fund deeper emissions reductions in sectors with better mitigation potential. It therefore helps to achieve overall emissions reductions across the economy at least cost (Bowmans, 2023; Needham, et al., 2019). Depending on the policy design, carbon emissions can be restricted through the implementation of a hard emissions cap, an absolute emissions reduction target, emissions intensity benchmark, or through carbon budgets. Imposing a restriction on carbon emissions converts it into a scarce resource which can be traded like any other commodity. Entities that emit below their cap, benchmark, or allocated carbon budget, are eligible to trade their unused carbon allowances or credits “carbon space” to other entities that emit over their emissions allowance (Arp, et al., 2018).

Some economists regard carbon trading as a cost-effective and economically efficient mitigation instrument, that achieves greater emissions reductions across the economy at the lowest cost to society (per unit of CO2e) relative to other policy instruments. In reality, this may not be the case, as a trading system may only cover sectors that provide easy mitigation opportunities – referred to as the low-hanging fruits in literature (Arp, et al., 2018). The proposed carbon price in South Africa is far below the global standard sitting at R120/tCO2e, which places it well below the existing median global carbon price of R192/tCO2e and world average of R351.39/tCO2e.25 In South Africa, under the maximum tax-free allowances, the effective carbon price drops to R6/tCO2e, making it amongst the weakest carbon price signals in the world, likely to result in perverse outcomes and nominal emissions reductions. Thus, WWF recommends a higher carbon tax rate of between R570 and R1 140/tCO2e (in 2020 prices), in line with what is required to meet the 2 °C temperature target (Arp, et al., 2018). A carbon tax is simpler to administer and, on average, provides a stronger carbon price relative to a free carbon market where the carbon price is left to demand and supply forces.

- *The Carbon Market Landscape*

A carbon price can be determined by two policy instruments – a carbon tax and/or a carbon market. A carbon tax is a price that government charges entities for every tonne of CO2e emitted. A carbon market is where demand and supply forces establish the price as it happens in the market for any other commodity. Within a carbon market, an entity’s emissions are capped or limited, in line with the overall emission reduction commitment of the country or region. If an entity emits less than its limit, the unused allowance is converted into an equivalent amount of tradable allowances or credits (Arp, et al., 2018).

Carbon markets exist in two general types: (1) regulatory markets under a compliance regime with formal rules for both trading and offsetting, alluded in the above section, and (2) voluntary offsets sold via typically informal arrangements. Voluntary offsets are a fast growing market, but they also involve fundamental problems relating to the verification and credibility of the claimed emissions reductions. Proponents of voluntary carbon trading tend to argue, from a purely deductive theoretical perspective, that redesign to match a market ideal can address all the problems (Spash & Theine, 2016).

Voluntary carbon markets / offsets have developed in parallel with the official and regulated emission trading systems and mechanisms. Guided by faith in the market system, voluntary offsets (like regulated ones) are promoted as creating price incentives for a low carbon economy based on consumer preferences expressed via willingness to pay (Spash & Theine, 2016). The emergence of voluntary carbon markets have seen an increase in recent years because (1) companies are gradually taking climate change mitigation more seriously and (2) a response to the lack of clear and robust policy and legislative frameworks which prevailed for many years and prevented companies to plan and invest with confidence (de Jongh & Möllmann, 2014). According to (Spash & Theine, 2016) the determinants and drivers for companies to enter the voluntary carbon market are legitimacy, the financial business case and moral responsibility. Legitimacy refers to the motivation to take action because stakeholders expect (or will soon expect) the private sector to do so. Moral responsibility refers to the company's perception of voluntary climate change mitigation as the right thing to do, considering the resource implications (time and/or money). Finally, the financial business case relates to actions taken by the companies that will either make or save them money.

- *Emergence and Progression of Voluntary Carbon Markets in South Africa*

The South African private sector is under enormous pressure to remain globally competitive while balancing the interests of society, the environment and its shareholders. The need for a transition to more sustainable consumption and production patterns is undeniable and sustainable economic growth must be placed at the heart of future development for all citizens. The uptake of climate change mitigation mechanisms has been difficult to implement hence, practitioners note that although climate change governance appears to be integrated and reported within governance activities, action is limited. It has been suggested that there are discrepancies between what companies say and what they actually do, as they are challenged to move from policy to action (Spash & Theine, 2016). Validation of actual reduction in carbon emissions is of major concern because entities are not forthcoming with emissions data and information. As such, independent verification processes must be initiated by DFFE to measure the impact of voluntary carbon projects and gauge if emissions are reduced. Emerging evidence from early projects suggests that not all expected projects may represent real and measurable emission reductions (Corbera, et al., 2009).

In contrast to mandatory government schemes, voluntary markets are basically unregulated and outside of legally binding frameworks and state emissions control. Voluntary offsets are traded carbon credits issued by companies and civil society groups (Corbera, et al., 2009). Voluntary markets do not entail a finite or regulated supply of allowances and there is no cap. Carbon credits (and associated offsets) are actualised when a new project is implemented. The created credits can subsequently be bought by polluters (e.g. firms or individuals) to offset their emissions. Companies and individuals freely choose to purchase those credits to offset their emissions (Spash & Theine, 2016). Voluntary carbon markets are therefore separate from, or go beyond, any legal requirements for individuals or organisations to purchase emissions permits and have been advocated as testing grounds for innovative approaches for GHG reduction (Spash & Theine, 2016). Their role outside of official schemes has then been seen by some as a positive aspect and a means of taking independent action. In this latter respect they can extend emissions reduction where regulated markets have not been established (e.g. international flights), and encouraging small projects below the scale of regulated markets. Examples of this can be found in countries where governments were outside the Kyoto protocol and/or national policies failed to materialise. Voluntary carbon markets were, thus, in part promoted by non-profit organisations providing carbon offsets for pro-environmental individuals or organisations who were attempting to bypass the political blockades around the establishment of Kyoto emissions reductions (Guigon, et al., 2015).

In South Africa, the carbon market landscape comprises of a range of legislative measures to evaluate and monitor carbon or GHG emissions, including the introduction of a Carbon Tax Act, in 2019, as a fiscal measure to reduce GHG emissions in South Africa, through the levying of a carbon tax on GHG emissions. The Act is being introduced in phases with the objective of creating parity in the third phase with global carbon pricing. The implementation is currently in the first phase with substantial allowances for GHG emitting taxpayers to minimise the impact on businesses and electricity prices. In the first phase, direct emissions are taxed (being the sum of GHG emissions from fuel combustion, industrial processes and fugitive emissions in accordance with an emissions determination methodology approved by DFFE) (de Jongh & Möllmann, 2014).

The scheme of the Carbon Tax Act allows for trade in emission reductions. In terms of the Carbon Offset Regulations, carbon reduction projects may be registered and used to offset a person's carbon tax liability, and ownership transfer of these projects can be registered through the government run Carbon Offset Administration System. Because of the low rate of carbon tax, presently there is not a large demand for this market but this is anticipated to increase as the price of carbon increases annually through the carbon tax. These measures together with the consolidated regulatory regime for climate change, the 'Climate Change Act, promise to greatly invigorate carbon emissions reduction projects and trade in carbon in South Africa in future (Bowmans, 2023).

Latest developments on carbon markets in South Africa is the newly launched the Johannesburg Stock Exchange (JSE) collaboration with Xpansiv which introduced voluntary carbon market to advance South Africa's carbon credit capability. This development establishes the joint venture between JSE and Xpansiv - an infrastructure provider for global environmental markets. The new market will operate under a separate entity called JSE Ventures and is intended to allow local participants to buy or sell carbon credits and energy certificates, that are held in either local or global registries. The basic premise of these markets is that companies can reduce their global carbon footprints by purchasing carbon credits, which are then offset against other activities that generate GHG. Voluntary carbon markets, such as the one now proposed by JSE Ventures, allow entities to buy carbon credits at their discretion to offset their emissions. Although the lines are becoming blurred, voluntary markets are traditionally distinguished from compliance markets, where companies buy carbon credits to meet obligations under domestic laws or international agreements, often under cap-and-trade structures like those in the European Union and California (Bowmans, 2023).

For the Eco-DRR project to enable or support the development of carbon projects, the following factors would need to be considered (Brand, et al., 2023):

- The carbon transaction must credible and definitely result in a reduction of carbon.
- It is important that the holder of the rights to a land-based carbon credit project has proper security of tenure and secure rights to the land on which the project will take place.
- The holder must either be the registered owner of the land, or the holder of a registered long term lease or other registered real right over the land. The rights must have preference over any mortgage bond or onerous title conditions or registered real rights in favour of any third party that are registered over the land.
- Ministerial consent is required before it would be possible to register any real rights over land for any project to be undertaken over a portion of farmland that is not registered as a portion in the deeds registry.
- The land must also be properly zoned for its intended use and appropriate regulatory approvals, including environmental approvals, would need to be obtained.

Biodiversity Market

Globally, governments and regulators face an ongoing trade-off between meeting economic development needs and conserving biodiversity. Biodiversity markets / offsets are increasingly promoted and adopted by governments and companies worldwide as a policy instrument to compensate for biodiversity losses from infrastructure and economic development projects (Koh, et al., 2019). Markets for biodiversity offsets are one tool which could secure biodiversity protection at lower costs to society whilst allowing some economic development to still take place. Some parts of the world already have strong regulations protecting biodiversity, however, in developing countries like South Africa, there are ongoing trade-offs between meeting economic development desires and securing biodiversity conservation (Maze, et al., 2016). Lowering the perceived cost of conservation is crucial in helping to reduce these development-conservation conflicts. Markets for biodiversity offsets are one such tool to lower costs but identifying how this market-like mechanism can be best implemented is a challenging task (Needham, et al., 2019).

Biodiversity offsets compensate for unavoidable damage from development by providing measurable conservation gains and are considered the final option under the mitigation hierarchy, once measures to avoid, minimise and restore have been undertaken (Maze, et al., 2016). Biodiversity offset policy documents often emphasise that the mitigation hierarchy (avoidance, minimising, restoring on-site, and finally compensating elsewhere) must be applied, but in reality, adherence to the mitigation hierarchy has been difficult to ensure because the first three steps tend to be overlooked (Koh, et al., 2019). Within the mitigation hierarchy, developers can offset directly or purchase offset credits from a third party provider who manages a parcel of land for its conservation value. Those in support of biodiversity offsetting argue that this allows for coordinated, large-scale restoration efforts which can provide quicker, more certain and cheaper conservation gains than site-by- site mitigation undertaken by developers. Furthermore, the market aspect of biodiversity offsets provides an on-going financial incentive for land owners to invest in conservation (Needham, et al., 2019). Biodiversity and conservation practitioners and critics indicate the risk of creating a 'license-to-trash' and 'biodiversity leakage' that are often problematic to account for. Furthermore, civil society organisations argue that biodiversity offsets poses social risks. Communities may lose access to nature and livelihoods if biodiversity losses in one place are compensated somewhere further away, or if access to compensation land becomes restricted. These risks must be considered prior to implementation of biodiversity offsets (Koh, et al., 2019).

Policies for offsetting biodiversity losses are used in at least 33 countries around the world, cumulatively restoring and protecting 8.3 million ha of land. The widespread use of biodiversity offsets has been led by three principal drivers: legislation and policies encouraging compensation by national governments, the European Commission (2011) and the Convention on Biological Diversity; (2) global financial institutions that require biodiversity offsets to be considered as a condition of being granted funding; and (3) voluntary commitments from corporations pre-emptively managing business risks (Koh, et al., 2019).

- *Biodiversity Markets in South Africa*

South Africa is rich in biological diversity, although measures to conserve this heritage are under-funded and are of relatively low priority at national level. Part of the problem is that the social value of biodiversity is unknown, and thus the potential impact of a loss of biodiversity on social wellbeing and environmental health is not recognised (Turpie, 2003). A central debate exists between market versus state approaches to environmental governance, with markets being perceived as more efficient than the traditional command-and-control policies that often characterise natural resource management schemes (Koh, et al., 2019). In South Africa, there are various gaps related to good conservation practices, and it is advisable that practitioners leverage upon biodiversity markets to ensure effective conservation action that can help solve the traditional state governance approach.

South Africa's biodiversity is under threat from processes such as land conversion and invasion of exotic species, the protection from which require costly conservation programmes (Maze, et al., 2016). However, these threats almost pale into insignificance compared with the more recently illuminated threat of global climate change on South African biodiversity, the prevention of which requires far more costly and complex action (Turpie, 2003). The biodiversity economy of South Africa encompasses the businesses and economic activities that either directly depend on biodiversity for their core business or contribute to conservation of biodiversity through their activities. South Africa faces significant biophysical impacts due to climate change over the next 50 years. One of the most startling predictions of a study on climate change is that of the shrinkage in distribution of the country's existing biomes, with more than half of South Africa's vegetation being replaced by unknown arid vegetation or desert. Such changes would be accompanied by a sizeable loss of species. Among the major casualties are Succulent Karoo and Nama Karoo biomes, with the former being lost over most of its range, and the Fynbos Biome, which may lose more than a third of its present range (Turpie, 2003).

The big questions is whether biodiversity offset markets prove to be a cost-effective conservation mechanism? In situations where there are already strong regulations safeguarding biodiversity, the benefit of biodiversity offset markets is in reducing the aggregate costs of conservation. If an appropriate geographic scale is chosen for biodiversity offset markets, there may also be benefits in terms of more coordinated conservation. However, these potential benefits must be weighed against the risk of slippage in poorly designed or regulated markets. Potentially bigger biodiversity gains through offsetting can be reaped in places where strong biodiversity protection measures do not yet exist and where finding a means to reduce perceived'biodiversity versus development' conflicts will be key to convincing reluctant regulators to implement stricter protection measures. For these gains to be realised, markets must be designed in a way which enhances the chances of cost-saving trades (Needham, et al., 2019).

A key takeaway from the literature has been that there are significant lessons to be learnt from tradeable pollution markets and how to enhance biodiversity offset markets in a way that does not undermine conservation goals. The key design parameters for biodiversity offset markets based on insights from theory and practice in tradeable pollution markets are:

- **Policy targets and exchange currencies**: the unit of exchange should be determined by the regulatory cap for a specified aspect of biodiversity where data can be readily collected and monitoring take place with relative ease;
- **The trading ratio**: A simple scheme of trading ratios is recommended that is consistent with the environmental objective, to avoid increasing transactions costs;
- **Market scale and trading volume**: A regional offset market must be embedded in a broader landscape plan to maintain an adequate scale of offset market whilst minimising uncompensated local impacts; and
- **Regulating the market:** the regulator should provide or enable a clearinghouse or bank(s) for offset trades, similar to a tradable pollution market (Koh, et al., 2019).

The recent Draft Biodiversity Economy Strategy (2024) does aim to address some of the challenges mentioned above by providing guidance on biodiversity-based business potentials. The strategy has been broadened to include ecotourism and all ecosystems in addition to the wildlife economy and equitable access and benefit sharing / biotrade. Goal 4 looks at establishing well structured, inclusive, integrated and formalised bioprospecting, biotrade, and biodiversity-based harvesting and production sector that beneficiates communities. The impact statement for this goal is includes increasing the GDP contribution of the bioprospecting / biotrade from R1 ,85 billion (2020) to R11,6 billion by 2036 through local beneficiation (finished pharmaceutical, cosmetics and food supplements products), and the development of SMME-based production systems for restoration and sequestration (DFFE, 2024).

In addition, BIOFIN (a UNDP-managed global programme) seeks to demonstrate how nature-positive economies can work for people and the planet. BIOFIN was initiated ten years ago by UNDP and the European Commission, in response to the urgent global need to divert more finance from all possible sources towards global and national biodiversity goals. BIOFIN works with governments, civil-society, vulnerable communities, and the private sector to catalyse investments in nature with the aim of protecting biodiversity, creating jobs and opportunities for communities reeling from the impacts of COVID-19 and securing a sustainable future for people and the planet (BIOFIN, 2021).

3.5.6 Review of Investment Experience

Barriers to Investment

Currently, a significant amount of catchment management funding comes from DFFE: EP which includes restoration, rehabilitation, IAP clearing etc. This is mainly funded through the national fiscus and the EPWP allocations. While this provides the necessary cash flow to keep DFFE: EP's programmes going, this type of funding is not sustainable as conservation outcomes become a side effect of poverty eradication intervention (Turpie, et al., 2007). As such, it is critical to explore alternative means of financing Eco-DRR and understanding what the barriers are to investing in climate change adaptation in the country.

The protection and maintenance of ecological infrastructure requires ongoing investments which will result in returns and net-benefits in the future. Traditional investments are often heavily focused on profitability with investors looking to get their money back with interest after a certain amount of time has passed. Investment in ecological infrastructure is very different in that they do not promptly generate financial returns, and positive impact may only be observed in the long-term. Due to the long-term nature of ecological infrastructure investments, there is a significant lag period between the investments and realising the full return. In addition, the positive impacts from improve ecological infrastructure are less tangible than what is observed in traditional investments. Although investments in ecological infrastructure generate benefits that are accrued to the broader public, it is often difficult to isolate the direct return on investment to a private sector investor. As a result, ecological infrastructure investments are not considered as commercially viable as traditional built infrastructure investments. Furthermore, the lack of a comprehensive and sound evidence base for EbA interventions has limited the amount of private sector investment in ecological infrastructure and its services. All of this hinders attempts to secure investments in ecological infrastructure. However, it cannot be denied that these investments add value to human upliftment and environmental protection and sustainability (Mbopha, 2019; SANBI, 2014; Brink, 2011).

Mechanisms to Unlock Private Sector Finance

- *Implementing incentive mechanisms and compensation measures*

A review of online literature revealed that private sector, particularly private landowners, are willing to participate in the protection and sustainable management of ecological infrastructure, provided that some form of an incentive mechanism / compensation measure is in place (Mbopha, 2019). The NMBM case study showcased this with the use of a rebate system that targeted private landowners increasing the number of landowners involved in ecological infrastructure protection. There is need for municipalities and provinces to create similar incentives that encourage and motivate private sector to support NRM activities.

- *Awareness raising campaigns and advocacy on the need to invest in ecological infrastructure*

Strengthening private sector investment in ecological infrastructure is underpinned by conservation values of the private sector to voluntary participate. Bearing this in mind, there is need to conduct awareness raising and advocacy campaigns to create awareness of the importance of ecological infrastructure and to promote a sense of custodianship amongst private landowners and other relevant role players.

- *Establish, communicate and monitor outcomes from ecological infrastructure investments*

One of the key challenges that was noted during the literature review was the absence of an evidence base to showcase the efficacy and effectiveness of ecological infrastructure-related activities. To improve private sector finance in the NRM space, there is need for ecological infrastructure investment funds to develop clear outcomes accompanied by a monitoring plan that demonstrate whether an intervention achieved its investment goal. This would attract private sector finance as investors will be able to see evidence of the success of such interventions (Mbopha, 2019).

- *Use of biodiversity stewardship to manage ecological infrastructure*

Biodiversity stewardship provides a holistic approach to landscape conservation where private landowners are encouraged to maintain ecological infrastructure as stewards of their lands. As noted in the paper by Mbopha (2019), it is possible to promote groups of private landowners to collectively manage a landscape through a biodiversity stewardship programme that is underpinned by the landowners' willingness to participate towards common conservation goals (Mbopha, 2019). This is supported by SANBI's approach to biodiversity stewardship in the country which recognises landowners as the custodians of biodiversity on their land. This approach is based on voluntary commitments from private and communal landowners using different types of Biodiversity Stewardship Agreements to support conservation and sustainable resource use. Furthermore, some types of Biodiversity Stewardship Agreements are formally declared as protected areas in terms of the Protected Areas Act, providing long-term security for the sites involved (SANBI, 2015).

- *Support public-private partnerships to scale up investments*

It is growing increasingly necessary to explore alternative funding models to help sustain ecological infrastructure, noting that government cannot be the sole role player in this space. The mobilisation of funds and technical expertise through public-private partnerships can establish risk mitigation support mechanism that delivers ecosystem services, protect businesses and strengthen long-term protection of ecological infrastructure. Such partnerships will need to draw on resources from private sector (insurance companies, corporations etc.), philanthropists and NGOs (Mbopha, 2019). Government will also need to create the necessary enabling environment to support the establishment of such public private partnerships by facilitating multi-sectoral coordination and collaboration within the public sector as well as with private sector actors.

- *Promote community of practice platforms*

Community of practice is a vital tool in the protection of ecological infrastructure as it encourages knowledge and learning exchanges between different stakeholders and across regions in the country. These platforms also allow for networking between conservationists and investors or potential funders (Mbopha, 2019). An example of a community of practice platform in South Africa is the Management, Research and Planning (MaReP) Forum which is used to provide feedback to stakeholders, project implementers and funders. The forum allows for natural resource managers within the IAP and land use incentive space as well as planners and researchers to come together to share the results from their interventions. Successes and failures are highlighted with the forum being used to co-create solutions (Marais & Mlilo, 2018).

Leveraging the Support from Funds

Accessing alternative funds often requires meeting stringent requirements and criteria through a rigorous application process that can take significant time and resources. As noted in a report by the European Parliamentary Research Service, many developing countries lack the capacity and/or resources to navigate the complexities of funding application processes (Jensen & Roniger, 2023). As such, targeted support is needed to unlock these types of funds. Noting the lag time between investment in ecological infrastructure and beneficiation, seed finance and support is often required. In many rural contexts, there is not the financial depth to wait for the return on investment. As such, these funds may through grant finance provide the necessary initial or bridging finance needed. As showcased in the Small Grants Facility project implemented by SANBI with the support of the Adaptation Fund, assisting communities vulnerable to climate change with applications and proposal writing helped these groups access climate-related funding and thus increased their local resilience to climate change (Conservation South Africa and IIED, 2021).

Potential Models for Private Sector Involvement and Investment

Involving private sector in EbA programmes and projects is crucial to ensure sustainability beyond the initial project / programme lifecycle. Understanding how private sector can be involved – from funding to implementation partners – is necessary and will support the development of a business case for the maintenance and protection of ecological infrastructure. As noted by Schaer and Kuruppu (2018), private sector can get involved in adaptation projects to protect their own interests by climate-proofing their value chains and business operations; and/or providing innovative products and services in response to a market need in support of adaptation efforts in communities vulnerable to climate change (Schaer & Kuruppu, 2018)

Some examples of private sector involvement in EbA is presented below:

- *Sustainable Finance Coalition*

The Coalition, in partnership with WWF, finds, designs and mobilises tailormade finance solutions for nature and enables the incubation and implementation of finance solutions at their point of impact to ensure effective and enduring natural landscapes across Africa. The Coalition has a three stage model: incubate, implement and amplify. During incubation, the viability of each new finance solution is determined by developing the building blocks that are required for effective implementation (timeline – 6 months). Implementation entails practical testing and piloting of the building blocks identified as well as the institutional adoption of the new finance solution(s) (timeline – 1-3 years). Lastly, amplification looks at new flows of finance that target real people in real places, at the point of impact (timeline – 3-5 years). The Coalition comprises of technical experts , private sector, NGOs, civil society and communities (Sustainable Finance Coalition , n.d.). The approach of using incubators to develop the finance solution concept that they are created for allows for new and sustainable financial mechanisms to be unlocked as well as providing a road map that determines the viability and ensures effective implementation (Stevens, et al., 2021).

- *Meat Naturally*

Meat Naturally is a company that partners with NGOs to offer rural farmers formal training on regenerative grazing techniques, rangeland restoration practices, cattle management, stock theft patrol, and predator control. Meat Naturally also supports NGO economic goals by organising mobile auctions and abattoirs to provide small-scale famers with the opportunity to reach new markets. In exchange for training, equipment and market access offered by Meat Naturally, farmers commit to preserving rangelands and providing quality meat products that are sustainably produced (Meat Naturally, 2018). Some of the key services that Meat Naturally offers include:

  - Organise mobile auctions to bring together rural farmers and commercial buyers together;
  - Provide livestock management training for herders, NGOs and farmers;
  - Organise mobile abattoirs to enable increased market opportunities for farmers;
  - Provide NGOs and farming communities with bulk purchasing power and access to critical farming equipment and vaccinations; and
  - Provide consulting services for implementing essential grazing practices, cattle management, tagging and stock antitheft (Meat Naturally, 2018).

Meat Naturally's aims to restore 1 million hectares of degraded rangeland and provide a scalable vehicle for 15,000 African communal farmers to enter a growing niche market for grass fed and sustainably produced meat and wool. Furthermore, their research and development activities seek to pioneer new mobile abattoir technology and unlock carbon finance for farmers for the reduced GHG emissions resulting from their improved rangeland management (Conservation International, n.d.). Due to Meat Naturally's success in in South Africa, the company is looking to explore partnerships between Conservation International and the Peace Parks Foundation to expand to communities adjacent to Trans-frontier Conservation Areas in five Southern African countries: South Africa, Botswana, Mozambique, Lesotho and Zambia (Conservation International, n.d.).

- *Microgrants*

A novel approach to building enterprise is that of 'bootstrapping' enterprises whereby a set of ideas, content, approach and methodology can be developed locally to support community based entrepreneurship development through the co-development and support of local businesses. Building on savings groups model (also known as Voluntary Savings and Loan Schemes, or 'stokvels'), there is need to place a greater emphasis on community empowerment / capacity building, to address the triple-bottom-line agenda of the country's NDP, and to create science-action partnerships that sustain the research being carried out in the catchment (Cockburn, et al., 2016).

In South Africa and many parts of the developing world, sustaining community-based habitat restoration programmes is highly dependent on providing adequate and sustained economic incentives for the community members involved (Milton, et al., 2003). Many models have been tested in this regard, with varying levels of success based on the socioeconomic, cultural and environmental contexts in which they have been applied (Milton, et al., 2003; Jellinek, et al., 2013). The idiosyncrasies associated with low income South African communities, and the challenges associated with interventions that selected for low income communities require a novel approach for incentivising and sustaining community involvement.

The approach is based on the idea of 'doing enterprises' or more specifically 'Organisation Workshop' which was originally proposed by de Morais (cited in (Carmen & Sobrado, 2013)) to capacitate large groups in economic and social development. This holistic approach was developed in Latin America in the 1960s and adapted to southern Africa over the last 30 years. It is a real-time, practical exercise to facilitate the development of organisational consciousness and enterprise management skills in a group that needs to act in an organised manner. The workshop design is based upon locally identified problems and local opportunities that cannot be addressed by an individual or small group. Provided the means exists for a community to contribute labour, the Organisation Workshop provides a framework that enables learning about the organisation while participants engage in productive work. In many instances, the Organisation Workshop is used to establish collective enterprises, provide technical skills training and build infrastructure. A few examples of the successful application of the organisation workshop in southern Africa include the following (information supplied by Aktivity Associates, Seriti Institute , Andersson Afrika - and more information on these can be found on their websites)

- In Zutshwa, deep in the Kgalagadi Desert of Botswana, an Organisation Workshop established a salt works supporting 80 families, which has thrived for almost 30 years;
- The Kwanda Learning Camp Organisation Workshop set up a working chicken farm and a vegetable and fruit farming cooperative, and equipped 5 teams of 100 people to work for transformation of their home communities;
- The Ntambanana Organisation Workshop established 8 farming enterprises (vegetables, livestock and chickens, fruit farming and others) and a sewing factory. This created 187 jobs in 6 weeks as well as setting up a technical and vocational education and training college and early childhood development facilities;
- In Mozambique agricultural infrastructure destroyed by the civil war was re-established and enterprises restored, creating several hundred jobs;
- The Westonaria Organisation Workshop saw participants restore a derelict hostel to make it into a community centre, establish an anchor farm as the centre of a local agricultural effort, build poultry houses, plant 2000 trees, create a sewing enterprise, form an early childhood development association (with members undergoing skills upgrading courses) and launch youth initiatives. In addition, it created the platform for ongoing development collaboration between community organisations, the mining houses and the municipality.

Though none of the examples listed above involves restoration of natural habitats, the principles upon which the Organisation Workshop is based lend themselves to the community-led activities associated with Eco-DRR. Generally, two separate and interacting organisations are required for an Organisation Workshop: The Facilitators' Enterprise (in this case implementers) and the Participants' Enterprise (in this case the community groups participating in Eco-DRR activities). The Facilitators' Enterprise is the organisational framework set up for facilitation of all organisational and training activities. Work is organised by the enterprise of the participants after negotiation of contracts with the Facilitators' Enterprise and is paid at market rates for the relevant jobs.

Participants will learn about work by running a complex working enterprise: in addition to managing work teams engaged in contracts involving restoration, nursery production, planting, manufacturing, alien clearing, monitoring and implementation activities, the Participants' Enterprise also has to cater for itself and tackle social challenges in the community. Apart from specific knowledge about enterprise management, participants start to build a metanarrative; a shared story, and shared concepts and language, which will serve as a unifying factor in all community endeavours going forward.

The workshops create the environment for skills development in several areas: practical enterprise organisation skills (including managing labour, financial transactions, tendering/quoting for work, work planning), vocational skills (such nursery set up and maintenance), literacy and numeracy development as well as non-production skills in areas as diverse as early childhood development and cultural activities.

Through this approach, a number of cooperative enterprises can be established, for example restoration-based enterprises, which could include active involvement and participation of women and youth. Another could focus on capacitating selected youth as monitoring contractors to provide a range of monitoring services in the catchments to collect, interpret and share data on the impact of the interventions.

This approach does require investments in time prior to technical implementation (at least one year) to build capacity, develop a common narrative and a mutually agreeable set of implementation priorities, which may also include non-Eco-DRR activities, but are considered locally critical for a variety of reasons. Here the facilitator is required to set some parameters to the Participants' Enterprise's potential activities, and in a manner that links explicitly to better management of ecosystems and biodiversity.

Through a revolving credit facility, and once priorities and actions have been agreed to, microgrants can be accessed by allowing community groups (Participants' Enterprises) to submit simple grant applications to address priority activities at a small scale, implement and report on the results (outputs, outcomes against plans and related information). Where the goals are clearly set and grounded (with the support of the Facilitators' Enterprise), this builds knowledge, confidence and understanding on how to 'do business' in the catchments. Attrition of some ideas / enterprises and groups is inevitable, while those demonstrating growth and success can access progressively larger grants to scale up the work.

3.6 PAST AND CURRENT PROJECTS IN THE DMS

Afred Nzo DM

District-Led Spring Rehabilitation in Matatiele LM

- **Budget: Unknown**
- **Year: 2022/23**
- **Project Implementer: Alfred Nzo DM**
- **Location: Matatiele LM**

The DM's Service Delivery and Budget Implementation Plan 2022/23 notes a spring rehabilitation initiative planned by the DM for Matatiele LM. As published in the Terms of References (2020/21), the overwhelming and continuous spread of IAPs and adverse drought conditions has placed pressure on water resources. Sources of water dry up and result in serious water shortages for communities. This provides the rationale for improved natural resource management along ecologically rich areas in Alfred Nzo DM that are vulnerable and under threat of becoming extinct. The spring rehabilitation programme sought to:

- Increase the level of water resource through clearing of IAPs which harvest a huge amount of water,
- Improve the level of water resource and boost the livelihood of living citizens in that particular community,
- Capacitate local people in protecting their natural resources (wetlands, water, flora, fauna and the catchment in general),
- Educate communities on the importance of clearing IAPs in their catchments.

Alfred Nzo DM Hameln Pyrmont Partnership

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: Alfred Nzo DM**
- **Location: Alfred Nzo DM**

Alfred Nzo DM has forged a partnership with the Hameln-Pyrmont municipality in Germany with the main purpose being to provide support and/or assistance to the district on climate change-related matters. Funding matters also forms part of this partnership which will be explored through proposals, business plans etc.

The project aims to strengthen partnerships between German municipalities and municipalities in the Global South to jointly address issues of climate change mitigation and adaptation. It also helps mobilise the comprehensive expertise available within the partner municipalities. Through this project, climate change mitigation and adaptation will be systematically integrated into the work of the municipal partnerships.

The DM has signed a Memorandum of Understanding detailing objectives and key points of the climate partnership. The district has also committed to the long-term cooperation with the Hameln-Pyrmont municipality in the field of climate change mitigation and adaptation. The DM will design a concrete programme of action for climate change mitigation and adaptation with the partner municipality (Hameln-Pyrmont) and stakeholders will be identified by the Alfred Nzo DM through the Climate Change Committee who will add value to the partnership (Alfred Nzo DM, 2023).

Service Statistics for Biodiversity and Landscapes – Wattle Clearing

- **Budget: R3.2 million**
- **Year: 2022/23 – ongoing**
- **Project Implementer: Matatiele LM**
- **Location: Matatiele LM**

The **LM's Annual Report (2022/23)** details the LM's activities over the reporting period and includes a biodiversity and landscape project that was funded through a grant from the EC: DEDEAT. The project focused on wattle clearing in 8 municipal wards and was a continuation of a project that sought to alleviate unemployment of youth as well as fight the spread of alien plants, land degradation and shortage of water caused by increased climate change impacts. Roughly 102 youths were trained and employed under this programme, and it is a continuous project. Local NGOs also have various projects within the wards in the jurisdiction of Matatiele LM which assisted communities with managed grazing that decreased land degradation. This project assisted communities with income as they were supported with local auctions of their livestock. As a result of this project, 93ha of wattle was cleared in the 8 wards. In addition, local SMMEs that were comprised of predominantly youth, were involved in wattle clearing was produced from the cleared wattle. Local NGOs also assisted to control grazing projects and animal auctions which led to income generating opportunities for rural communities (Matatiele LM, 2022).

Environmental and Rural Solutions' Work in Matatiele LM

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: Environmental and Rural Solutions**
- **Location: Matatiele LM**

Environmental and Rural Solutions is an NGO that operates in the Matatiele LM and partners with the LM in enhancing climate resilience of communities and priority areas. The NGO aims to build stakeholder capacity to engage in sustainable land use and green enterprises for financial independence as well as managing natural resources through collectively engaged strategies for conservation and development. The NGO has a footprint in 6 traditional areas and 10 wards in the LM. Some of their previous work includes:

- Hydrocensus completed for 320 sites.
- Budget for 41 springs secured through WWF.
- 12 springs completed.
- > 6000 people supported.
- 12 monitors trained.
- Developed the Umzimvubu Catchment Partnership spring toolkit.

- Undertaken water, sanitation and hygiene and waste awareness programmes.
- Conducted advocacy with Alfred Nzo DM and DWS.
- R32 million in auction turnover via 'Meat Naturally'.
- Created a 'job equivalent' of 1700 people.
- 27 conservation agreements signed with grazing associations.
- 6500 ha of grassland improved.
- 450 farmers with DALRRD registered brands.
- 3450 sheep sheared.
- Conducted regular vaccination days.
- 65 people organised into alien plant clearing teams.
- 4 SMMEs making charcoal via 'Inhlabathi'.
- R3,5 million secured through corporates.
- 265 ha of land cleared.
- Partnered with Working for Water for a 1000 ha project where 300 people are in a joint venture with LIMA.

Other activities that have been singled out by the LM with regards to Environmental and Rural Solutions is wattle clearing in wards 7,22,19,7,14,9; stewardship awareness outreaches to traditional authorities; and eco-futures training for youth in green economy (training of 30 students).

Matatiele Watershed Protection and Stewardship Project

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: Umzimvubu Catchment Partnership, Environmental and Rural Solution and Eastern Cape Parks and Tourism Agency**
- **Location: Matatiele LM**

The Matatiele Watershed Protection and Stewardship Project is an initiative that falls under the Umzimvubu Catchment Partnership Programme. The project is driven by Eastern Cape Parks and Tourism Agency and Environmental and Rural Solutions, with EC: DEDEAT, the Alfred Nzo DM, Matatiele DM, Maloti Drakensberg Transfrontier Project and various NGO partner's, including Endangered Wildlife Trust and Conservation South Africa, being activity involved and important role players in the project.

Funding is from the GEF 5 programme that is being administered by WWF's Nedbank Green Trust, the Eastern Cape Parks and Tourism Agency and Environmental and Rural Solutions. The Eastern Cape Parks and Tourism Agency is responsible for implementing, component 1.5 of the GEF 5 project, themed: "Improving Management Effectiveness of the Protected Area Network Project". The component seeks to establish new protected areas in upland areas of the higher altitude montane areas in the North Eastern Cape Grasslands regions of the Eastern Cape. The target area is situated along the Maluti escarpment, from Taba Chicha, which flanks the Ongeluksnek Nature Reserve on the western boundary, stretching to the northern most part of the Matatiele LM, bordering the KwaZulu-Natal border .

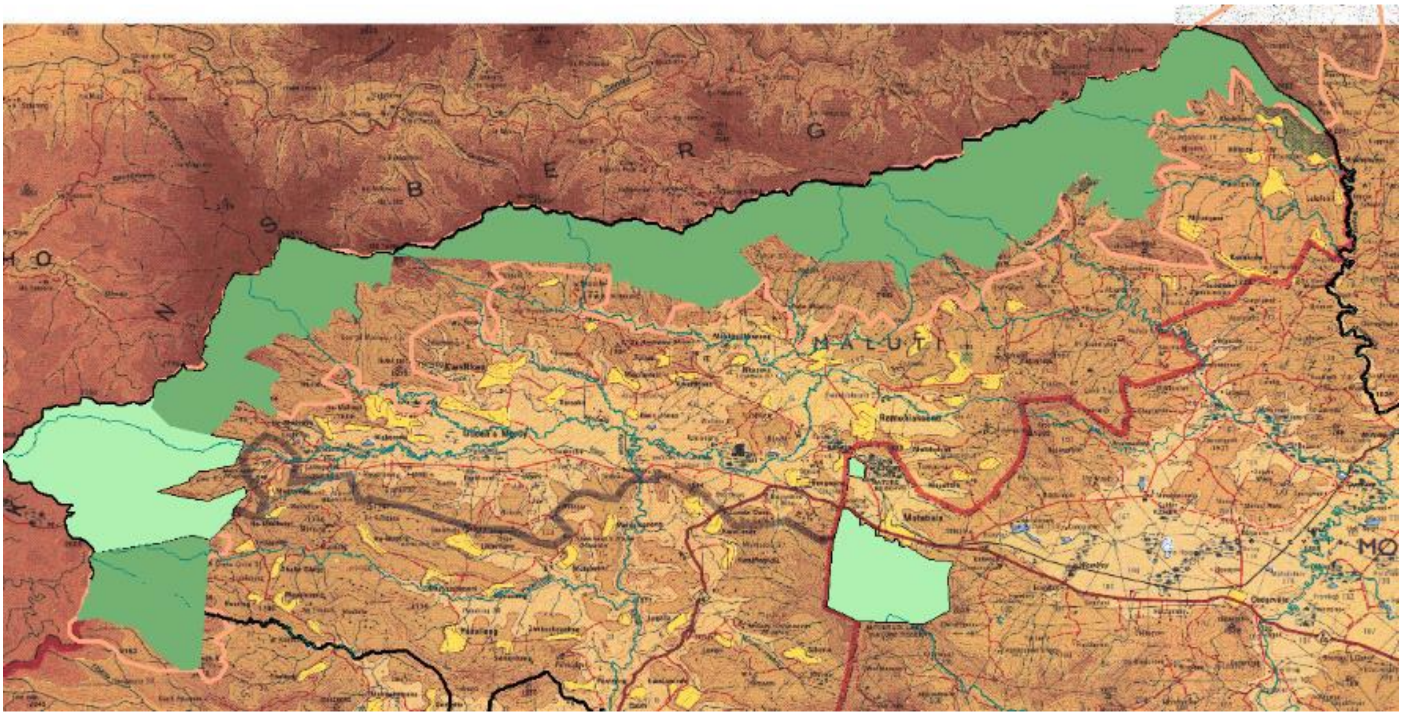

Figure 3-4: Target areas for the Matatiele Watershed Protection and Stewardship Project

More details regarding the project can be found in Matatiele LM's IDP (2022-2027).

Umzimvubu Catchment Partnership

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: Umzimvubu Catchment Partnership**
- **Location: Matatiele LM**

The Umzimvubu Catchment Partnership was established in May 2013 in Matatiele, by a voluntary alliance of over 35 civil and state partners, together with traditional and local authorities, based on a memorandum of understanding which underpins a common vision of working together to restore the natural resources and ecological functions of the catchment to secure livelihoods and boost climate change resilience.

Founder members, Environmental and Rural Solutions and Conservation South Africa, together with the EC: DEDEAT's regional office, drafted a 20-year vision, based on a catchment profile and a ToC, which focuses on restoring resilient landscapes to secure healthy livelihoods. The partnership is convened and chaired by local NGOs, with support from SANBI and WWF. Projects that the partnership undertake involve water supply, IAP clearing, rangeland restoration, waste management and involvement of youth in value chains. They also facilitate increasing research in the upper catchment, through active engagement with local and international academic and research institutions, highlighting the real research needs in the area which can benefit lives and help secure the landscape and biodiversity more effectively (Umzimvubu Catchment Partnership, n.d.).

The Partnership, with the support of DFFE's Working for Water programme, have supported the establishment of Meat Naturally, an NGO that institutes a sustainable farming model that creates economic and ecological balance. Meat Naturally's roots are founded in the intent to address environmental degradation in South Africa. From an economic perspective, communal farmers lack market accessibility, supplying only 5% of the meat market while owning roughly 50% of the livestock. Meat Naturally recognises that ecological restoration and rural economic development are not exclusive of one another. Farmers that collaborate with Meat Naturally produce wildlife-friendly, quality beef and healthy rangelands. These types of partnerships resulted in sustainable grazing practices being instituted in grasslands on communal (tribal) land. This model is now being developed elsewhere in similar environments (Meat Naturally, 2018).

Living Catchments Programme

- **Budget: Unknown**
- **Year: Closed out in 2024**
- **Project Implementer: SANBI**
- **Location: Matatiele LM**

The Living Catchments Project is a collaborative project that is being implemented and led by SANBI in partnership with the WRC through funding from DSI. The project was developed in response to the Water Research, Development, and Innovation Roadmap, which is a national planning intervention by the WRC, DSI, and DWS. The Roadmap is aimed at addressing water scarcity in South Africa over a ten-year period between 2015 and 2025. The Living Catchments Project responds specifically to the Roadmap's Supply Cluster 3: Improve adequacy and performance of supply infrastructure.

The project is being implemented in four unique catchments across South Africa including the Umzimvubu in the Eastern Cape. The intention of the project is to create more resilient, better resourced, and more relational communities with the ultimate vision being to strengthen an enabling environment for catchment governance and the integration of built and ecological infrastructure in support of water security, economic development, and livelihood improvement. The project also intends to strengthen an enabling environment for water governance at the nexus of landscapes and water supply in South Africa. The project is centred on co-learning and co-creation, through communities of practice, to enable collaboration, grow the practice of transformative social learning, and strengthen the practice of policy engagement and how biodiversity is mainstreamed into the water sector.

DFFE-Led Working for Water and Working on Fire Projects

- **Budget: R14.6 million**
- **Year: 2018 - Ongoing**
- **Project Implementer: DFFE EP**
- **Location: Matatiele and Umzimvubu LM**

Several projects have been implemented by DFFE: EP from 2018 onwards. Under Working for Water, IAP projects were implemented in Njinjini, Rolweni, Mabheleni, Madlangala, Mzongwana, Nkosana-Mafube, Mdakeni, Mvenyane and Ntsizwa while three projects were implemented under the Working on Fire programme (Mhlahlane, Matatiele, Ongeluksnek).

DFFE's Green Business Value Chain (GBVC)

- **Budget: R19.6 million**
- **Year: 2018 - 2021**
- **Project Implementer: Avo Vision, DFFE**
- **Location: Matatiele LM**

The GBVC is a Clear to Grow initiative managed by Avocado Vision in partnership with the DFEE, environmental organisations and businesses. DFFE was the primary funder, and the programme sought to integrate natural resource management, IAP removal programmes and related economic value chains in order to accelerate environmental, social and economic benefits that accrue from the eradication of IAPs by stimulating the economic utilisation of invasive biomass in productive economic value chains. The programme partnered with Avo Vision who provided training and mentoring support which allowed for corporate opportunities to be identified in the Green Economy and expansion of commercial activity to create new opportunities for existing SMMEs (Step Consulting (Pty) Ltd, 2021).

Joe Gqabi DM

DFFE-Led Rhodes Land Reclamation Project

- **Budget: R15 million**
- **Year: 2021/22-2022/2023**
- **Project Implementer: DFFE Environmental Protection and Infrastructure Programmes (DFFE: EPIP)**
- **Location: Senqu LM**

The project was driven and funded by DFFE: EPIP and was focused on the restoration and rehabilitation of degraded land through the construction of gabions coupled with revegetation activities. The project sought to enhance the stream flow capacity to sustain livelihoods as well as explore sustainability beyond the project phase (Joe Gqabi DM, 2021).

DFFE-Led Working for Wetlands' Gatberg Wetlands Project

- **Budget: R13 million**
- **Year: 2019/20 – 2020/21**
- **Project DFFE: EP**
- **Location: Elundini LM**

The project focused on wetland rehabilitation of the Gatberg wetland as well as improved ecosystem services (Joe Gqabi DM, 2021).

DFFE-Led Working for Wetlands' Gatberg Wetlands Project – Drought Response

- **Budget: R32 million**
- **Year: 2019/20 – 2020/21**
- **Project DFFE: EP**
- **Location: Elundini LM**

The project focused on wetland rehabilitation of the Gatberg wetland as well as improved ecosystem services with a focus on ensuring an effective drought response (Joe Gqabi DM, 2021).

DFFE-Led IAP Clearing Project in Upper Tsitsana

- **Budget: R1.8 million**
- **Year: Unknown**
- **Project DFFE: EP**
- **Location: Joe Gqabi DM**

The project was implemented by DFFE: EP and focused on IAP clearing in the Upper Tsitsana (Joe Gqabi DM, 2021).

DFFE-Led Working on Fire Project

- **Budget: Unknown**
- **Year: 2018/19 – 2021/22**
- **Project DFFE: EP**
- **Location: Joe Gqabi DM**

The project was implemented by DFFE: EP 's Working on Fire programme and sought to support fire control and prevention in the DM (Joe Gqabi DM, 2021).

DFFE-Led Working for Water Project in Upper Tsitsana

- **Budget: R2.2 million**
- **Year: 2019-2021**
- **Project DFFE: EP**
- **Location: Joe Gqabi DM**

The project was implemented by DFFE: EP 's Working for Water programme with the aim controlling IAPs and restoring degraded land in the Upper Tsitsana to improve ecosystem functioning. of alien invasive plants and restoration of degraded land to improve ecosystem functioning. Job opportunities created from this project was 72 (Joe Gqabi DM, 2021).

DFFE-Led Working for Wetlands Project

- **Budget: R9.1 million**
- **Year: 2018-2021**
- **Project DFFE: EP**
- **Location: Joe Gqabi DM**

The project sought to conserve and sustainably rehabilitate degraded land within the DM boundary in order to enhance ecosystem services and support the integrity of districts' and South Africa's natural resources (Joe Gqabi DM, 2021).

Joe Gqabi EbA Pilot Project

- **Budget: R15 million**

- **Year: 2020-2021**
- **Project Implementer: UNEP, Rhodes University and DFFE: EPIP**
- **Location: Elundini LM**

UNEP entered into an agreement with Rhodes University for providing support for effective implementation of EbA in the Elundini LM. This support has four project streams as follows:

- Review of the municipal IDPs to identify opportunities of mainstreaming EbA.
- Strengthening the collaborative governance platform between different government departments and entities for effective facilitation of EbA, and through citizen science.
- Rolling out pilot projects that are in line with EbA.
- Capturing of the project as an audio-visual case study.

It is estimated that approximately 200 people in five villages will benefit from the project (Joe Gqabi DM, 2021).

Senqu LM EbA Project

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: Rhodes University and DFFE**
- **Location: Senqu LM**

The project will involve intensive training of the political and administrative arms of the LM to ensure buy -in as well as securing support from traditional leaders and communities. This will ensure that indigenous knowledge is applied in the design of projects as well as ensuring that projects remain sustainable. Focus will also be on training, projects to decrease erosion such as stock and veld management, soil rehabilitation and improving household food security through the planting of water wise gardens and orchards. Further focus will be on improving water sustainability by utilising water wisely and increasing the capacity of water harvesting. This initiative is funded by the United Nations and implemented by Rhodes University and DFFE (Senqu LM, 2022).

SANParks Grasslands National Park

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: SANParks**
- **Location: Joe Gqabi DM (and Elundini and Senqu LMs)**

SANParks, in partnership with WWF and a range of national, provincial and local government (including the Joe Gqabi DM and Senqu and Elundini LMs) and non-government partners, is undertaking the establishment of a new national park in the Grassland Biome, in the Eastern Cape Province through its declaration in terms of NEMPAA. The model that is being considered for the establishment of the national park is novel, in that it is based on a combination of land purchase, the declaration of state land, the declaration of state-owned communal land and the declaration of private land. A priority footprint for the establishment of the national park has been spatially determined, in Joe Gqabi DM and Senqu and Elundini

LMs, based on the importance of biodiversity in the region and the presence of a nationally important strategic water source area. This footprint is intended to guide efforts to establish the national park but is not considered definitive, as it will not include the entire area and may include areas outside of it that have valuable biodiversity and other ecological values. The overall project objective is to establish an ecologically, economically and socially sustainable consolidated national park within the region through an innovative combination of conservation inclusion mechanisms and development options (Senqu LM, 2022).

Ehlanzeni DM

Kruger to Canyons Rangeland Restoration Project

- **Budget: Unknown**
- **Year: 2018 – ongoing**
- **Project Implementer: Conservation South Africa**
- **Location: Ehlanzeni DM**

Conservation South Africa supports livestock farmers to adopt and expand rangeland practices that foster restoration and maintenance of healthy savanna ecosystems. The principal project action is to shift livestock management from continuous grazing to planned rotational-rest grazing for cattle. This is done as a collective by the livestock farmers through adopting strategic herding and kraaling (practice of keeping cattle or other livestock in an enclosure overnight for protection) practices that align with the grazing plan as determined and implemented by the livestock farmers (Conservation South Africa, 2023).

The project is located on the communal rangelands of the Kruger to Canyons Biosphere Reserve in the Mpumalanga and Limpopo provinces of South Africa. The biosphere reserve is a landscape of significant global biodiversity stretching from the Kruger National Park in the east to the Blyde River Canyon in the west and includes a remarkably diverse suite of land uses ranging from formal conservation to peri-urban, urban, intensive commercial agriculture, subsistence agriculture, and livestock farming land uses. The first project instance includes communal rangelands of the Mnisi and Amashangana tribal authority totalling 6432 ha (Conservation South Africa, 2023).

The project started in 2018 with the signing of the first conservation agreement between the Ahitiriheleni and Nhlanganani grazing associations and Conservation South Africa. In addition, foundational steps were made towards enhancing internal governance of the grazing associations through capacity building, mentoring grazing associations on good governance and formalising a cooperative. In partnership with Meat Naturally, the benefits are focused on supporting improved livestock management in the form of market access for livestock, provision of fodder and/or nutritional support, provision of eco-trainers and provision of animal production (Conservation South Africa, 2023).

Project activities will restore the ecosystem functioning of the rangelands thus enhancing the resilience of communities that depend on the rangelands to the impacts of climate change. The project will also contribute positively towards the livelihoods and long-term wellbeing of communities in the project area by creating alternative sources of employment, building capacity in different skills as well as raising awareness about conservation. This will also impact the project's biodiversity objectives to conserve endangered flora and fauna in the project zone while restoring vegetation biodiversity in the rangelands. The project will sequester soil carbon by reducing bare soil and producing a natural shift from annual to perennial grass species as enabled by rotational grazing. Furthermore, GHG emissions from enteric fermentation will be reduced by changing the herd structure from older to younger animals (Conservation South Africa, 2023).

Kruger to Canyons Corridor Project

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: Kruger 2 Canyons**
- **Location: Ehlanzeni DM**

The initiative works to secure and improve management of key biodiversity and water corridors linking the Greater Kruger to the escarpment and Blyde River Canyon Nature Reserve. These corridors will secure critical riparian habitats which provide breeding ground and migratory routes between the Lowveld and the escarpment for various threatened species. Through this project, properties will be better secured through various biodiversity stewardship mechanisms such as the formal declaration of protected areas (nature reserves or protected environments) or more flexible conservation agreements (Kruger 2 Canyons, n.d.).

Kruger to Canyons Catchment Investment Programme

- **Budget: Unknown**
- **Year: Ongoing**
- **Project Implementer: Kruger 2 Canyons**
- **Location: Ehlanzeni DM**

The initiative aims to finalise and implement a Catchment Investment Programme (Water Fund) to protect the state of the Blyde River Catchment and other key catchments into the future. This will be achieved through a more integrated and collaborative approach to restoring and protecting key catchments in the Kruger 2 Canyon region that benefit multiple downstream stakeholders. Key implementation initiatives include IAP clearing, sustainable rangeland management and protected area expansion. Partners on this project include Conservation South Africa and The Nature Conservancy (Kruger 2 Canyons, n.d.).

DFFE Working for Wetlands – Bushbuckridge Project

- **Budget: Unknown**
- **Year: 2000 - 2006**
- **Project Implementer: DFEE: EP**
- **Location: Bushbuckridge LM**

The project started in 2000 and sought to rehabilitate three wetlands in the water-stressed Sand River catchment area. A primary reason for intervention in this area plagued by unemployment and poverty is to safeguard food gardens in the wetlands being threatened by erosion gradually destroying the wetlands. Rehabilitation work included deactivating gully head erosion and stabilising gully channel erosion in the wetland; blocking drains to raise the water table and restore the hydrological regime; and creating awareness of wetlands and their importance amongst the local community. Also included was the maintenance work required for previously constructed erosion control gabion structures that have been damaged, as well as ensuring there is no damage on previously eroded parts of the wetland that have been re-sloped and re-vegetated by Working for Wetlands. The project employed 41 people per year over the last 6 years, and cost R6 million (US$860,000) (United Nations Department of Economic Development and Social Affairs, 2008).

UNESCO Project - Addressing Climate Risk and Building Adaptive Capacity in South Africa's Biosphere Reserves

- **Budget: EUR 1.5 million**
- **Year: 2021-2024**
- **Project Implementer: UNESCO and DFFE**
- **Location: Ehlanzeni DM and Ngaka Modiri Molema DM**

The project targets UNESCO's designated Biosphere Reserves as well as priorities of the Man and Biosphere Programme. The strategic objectives of the project are to:

- Conserve biodiversity, restore and enhance ecosystem services, and foster the sustainable use of natural resources;
- Contribute to building sustainable, healthy and equitable societies, economies and thriving human settlements in harmony with the biosphere;
- Facilitate biodiversity and sustainability science, education for sustainable development and capacity building; and
- Support mitigation and adaptation to climate change and other aspects of global environmental change.

The project will particularly focus on the climate change as well as to strengthen the role of biosphere reserves to ensure the sustainable use of natural resources, build sustainable communities and strengthen education for sustainable development and capacity building. The project focuses on the prioritised areas that were identified in the recent report developed by DFFE: *Ecosystem-based Adaptation: Identifying spatial priorities for ecosystem-based adaptation Implementation in South Africa* (2019).The four biosphere reserves identified include: Kruger to Canyon Biosphere Reserve, Vhembe Biosphere Reserve, Marico Biosphere Reserve and the Breede-Gouritz Catchment, Gouritz Cluster and Cape Winelands Biosphere Reserves (UNESCO and Government of Flanders, n.d.).

DFFE-Led Projects Under Several Programmes

- **Budget: R172 million**
- **Year: 2014 - Ongoing**
- **Project Implementer: DFFE EP**
- **Location: Bushbuckridge and Thaba Chweu LM**

Several projects have been implemented by DFFE: EP from 2014 onwards. Under the Working for Water programme in Bushbuckridge LM, IAP projects and a dryland rehabilitation project were implemented in the LM – namely: Blyde Restoration Custodianship, Sabi Sands, Uppersand, Driekoppies Dam, and Manyeleti. Under the Working for Wetlands programme in Bushbuckridge LM, a wetland rehabilitation project was undertaken in the Lowveld. In Thaba Chweu LM, several projects were implemented under the Working for Water, Value Added Industries, Working for Land, Working for Wetlands, High Altitude, and Working on Fire programmes.

Ngaka Modiri Molema DM

UNESCO Project - Addressing Climate Risk and Building Adaptive Capacity in South Africa's Biosphere Reserves

- **Budget: EUR 1.5 million**
- **Year: 2021-2024**
- **Project Implementer: UNESCO and DFFE**
- **Location: Ehlanzeni DM and Ngaka Modiri Molema DM**

The project targets UNESCO designated Biosphere Reserves as well as priorities of the Man and Biosphere Programme. The strategic objectives of the project are to:

- Conserve biodiversity, restore and enhance ecosystem services, and foster the sustainable use of natural resources;
- Contribute to building sustainable, healthy and equitable societies, economies and thriving human settlements in harmony with the biosphere;
- Facilitate biodiversity and sustainability science, education for sustainable development and capacity building; and
- Support mitigation and adaptation to climate change and other aspects of global environmental change.

The project will particularly focus on the climate change as well as to strengthen the role of biosphere reserves to ensure the sustainable use of natural resources, build sustainable communities and strengthen education for sustainable development and capacity building. The project focuses on the prioritised areas that were identified in the recent report developed by DFFE: *Ecosystem-based Adaptation: Identifying spatial priorities for ecosystem-based adaptation Implementation in South Africa* (2019).The four biosphere reserves identified include: Kruger to Canyon Biosphere Reserve, Vhembe Biosphere Reserve, Marico Biosphere Reserve and the Breede-Gouritz Catchment, Gouritz Cluster and Cape Winelands Biosphere Reserves (UNESCO and Government of Flanders, n.d.).

DFFE-Led Working for Water and Working on Fire Projects

- **Budget: R26.9 million**
- **Year: 2003 – Ongoing**
- **Project Implementer: DFFE EP**
- **Location: Ramotshere Moiloa LM**

Most of the projects were under the Working for Water programme, namely: Groot Marico, Marico River Conservation Association, Zeerust, Tshego Wa Rona, Masoko Trading and Harrisia Balansae. One Working on Fire project was implemented in Madikwe.

Sekhukhune DM

DFFE-Led Working for Water and Working on Fire Projects

- **Budget: R13.1 million**
- **Year: 2014 – Ongoing**
- **Project Implementer: DFFE EP**
- **Location: Elias Motsoaledi, Fetakgomo Tubatse and Makhuduthamaga LMs**

Two projects were implemented in the DM under the Working for Water programme (Lower Olifants and Gaulanga Trading and Enterprise) with two being implemented under the Working on Fire programme, namely: Tzaneen and Nebo.

GEF 5: Securing multiple ecosystems benefit through sustainable land management in the productive but degraded landscapes of South Africa

- **Budget: $4.2 million from GEF ($20.5 million through co-financing)**
- **Year: 2014 – 2018**
- **Project Implementer: United Nations Development Programme (UNDP), DFFE, CSIR**
- **Location: Sekhukhune DM**

The project sought to reduce pressures on natural resources from competing land uses in the wider landscape with the objective being to provide incentives (capacity, financial, governance) for the adoption of knowledge based sustainable land management models for land management and land/ecosystem rehabilitation in support of the green economy and resilient livelihoods (GEF, 2013).

GEF 7: Mainstreaming Sustainable Land Management for Large-Scale Impact in the Grazing Lands of Limpopo and Northern Cape provinces in South Africa

- **Budget: $3.6 million from GEF ($27.7 million through co-financing)**
- **Year: 2021 - 2026**
- **Project Implementer: International Union for Conservation of Nature (IUCN), DFFE, DALRRD**
- **Location: Sekhukhune DM**

The project aims to scale-up and mainstream sustainable land management for large-scale impact in the grazing lands of the target sites. The project's major objectives are:

- Integrated sustainable land management responses (including restoration and drought resilience actions) are implemented in targeted landscapes, based on improved assessments and diagnosis.
- Government and customary land management institutions are strengthened to equitably natural resource management and improve response to recurrent drought emergencies.
- Communities financially benefit from investments from the private sector for sustainably produced commodities.
- Sustainable land management is mainstreamed at the local, national and regional level (GEF, n.d.).

Other Relevant Projects

Advancing Knowledge for Long-Term Benefits and Climate Adaptation Through Holistic Climate Services and Nature-Based Solutions (ALBATROSS)

The ALBATROSS project aims to advance climate adaptation in Sub-Saharan Africa through integrated climate services and nature-based solutions. ALBATROSS supports tailored climate adaptation plans by co-creating policy recommendations with local stakeholders and integrating reliable climate services. Its main objective is to strengthen climate resilience by translating scientific knowledge into actionable tools through the Climate Resilience Development Network. Operating across Ghana, Kenya, Tanzania, South Africa, and Madagascar, the Climate Resilience Development Network engages diverse stakeholders to co-design adaptation measures, including nature-based solutions. By integrating climate information and vulnerability indicators, ALBATROSS provides integrated tools for decision-making at all levels of society, addressing knowledge gaps and promoting sustainable development goals across Sub-Saharan Africa.

This project aligns closely with the goals of the SANBI Eco-DRR project in addressing climate change adaptation and DRR through ecosystem-based approaches. Both projects aim to scale up interventions that enhance ecosystem and community resilience in the face of climate-induced risks. ALBATROSS's focus on co-creating policy recommendations and decision-making tools mirrors SANBI's ecosystem-centred and community-based approach to DRR. By engaging local stakeholders and integrating reliable climate services, both projects seek to tailor adaptation measures to the specific needs of communities vulnerable to climate change. Additionally, ALBATROSS and SANBI Eco-DRR aim to strengthen the enabling environment for continued investment in ecosystem-based approaches, therefore promoting long-term climate resilience in South Africa.

The Restoring Landscapes in South Africa (ReLISA): Nature-based solution for climate, biodiversity and people project

The Restoring Landscapes in South Africa (ReLISA): Nature-based solution for climate, biodiversity and people project — part of the International Climate Initiative 2022 — aims to address landscape-wide degradation in South Africa's main biomes, including grasslands, savannas and thickets. Its primary objective is to make the economic case for restoration while ensuring a just transition of the land-use sector. ReLISA seeks to adapt to climate change, reduce biodiversity loss, and enhance rural livelihoods by mobilising investment at scale and restoring priority areas that have been degraded. Through stakeholder consultations, the project will develop and validate restoration strategies that align with political priorities and stakeholder needs. It will also focus on leveraging finance from private and public sources, making restoration projects investible for impact investors. Additionally, ReLISA will provide technical support for on-the-ground implementation of restoration projects, focusing on selected rural landscapes and critical watersheds. The project will disseminate innovative models, technical solutions, and fundraising strategies nationally and internationally to promote ecosystem restoration at a large scale.

Programme of Investment in Ecosystem DRR (Eco DRR) and EWS

As part of the Transformative Riverine Management Programme, the eThekwini Municipality, in partnership with the Department of Urban Planning and Development Studies of the University of KZN , invested in and implemented catchment management interventions in the Palmiet Catchment near Durban. The Minister of forestry, fisheries and the environment intends to scale this project to all eThekwini Metropolitan Municipality district catchments. The project aims to build community resilience against the impacts of climate change and improve water security by, inter alia, developing social networks, restoring ecosystem services in river catchments and building state-citizen relations.

Leveraging partnerships and financial support from multiple sources such as the Adaptation Fund, GEF, GCF, Government of Flanders, and DBSA, the project seeks to scale up initiatives like the uMngeni Ecological Infrastructure Partnership and the Palmiet Rehabilitation project to address water security challenges and community resilience. In addition, through collaborations like the Living Catchments project and the Multi-Hazard EWS developed in the uMgungundlovu DM, the project aims to build partnerships, enhance collaboration, and upscale EWS across multiple districts in South Africa. The project's overarching goal is to implement nature-based solutions and integrated approaches to climate adaptation, thereby promoting sustainable development and resilience in South Africa's vulnerable regions.

Alignment and Complementarity With Other Projects

The proposed project has been designed to create synergy and complementarity with a raft of ongoing projects and initiatives related to climate-induced impacts, with a number of these also having valuable geographic congruency. These provide for valuable entry points in some of the sites, an ability to dovetail and expand the reach of the project for greater aggregated impact, important approaches to both the science and community engagement process that will support the project. The table below describes this in more detail.

Table 3-13: Complementarity to the Eco-DRR project

Project Name	Complementarity to the Eco-DRR project
uMzimvubu Catchment Partnership's work in the DM (ongoing)	The project only focuses on the uMzimvubu catchment in the Eastern Cape and there is the opportunity to draw lessons learned to other parts of Alfred Nzo DM as well as other parts of the country.
South African National Biodiversity Institute's (SANBI's) Living Catchments programme (closed out in 2024)	The programme was focused on the uMzimvubu, Thukela, Berg–Breede and the Olifants catchments. Lessons learned from this initiative can be upscaled or replicated in other parts of the country.
Department of Forestry, Fisheries and the Environment (DFFE) - led Working for Water and Working on Fire Projects (2018 – ongoing)	These projects occur in small areas and greater impact can be realised by upscaling DFFE's work in priority DMs.
Conservation South Africa's Kruger to Canyons (K2C) Rangeland Restoration Project (2018 – ongoing)	Conservation South Africa's experience in Mpumalanga through this project can be drawn upon to support the interventions planned for Ehlanzeni, noting that this can build off existing work that Conservation South Africa has done.
Global Environment Facility (GEF) 5: Securing multiple ecosystems benefit through sustainable land management in the productive but degraded landscapes of South Africa (2014 – 2018)	The project was completed in 2018, and its target areas were Karoo, Eastern Cape and Olifants landscapes. Good practices established in the project can be replicated in the DMs of Ngaka Modiri Molea, Ehlanzeni and Sekhukhune.
GEF 7: Mainstreaming Sustainable Land Management for Large-Scale Impact in the Grazing Lands of Limpopo and Northern Cape provinces in South Africa (2021 – 2026)	The project is being undertaken in Sekhukhune DM (Limpopo) with a focus being on grazing lands. The work done under this project can inform implementation in the other DMs, with a focus on improved landscape and rangeland management.

3.7 SUMMARY OF FINDINGS

Mainstream Eco-DRR into Legislation, Policies and Planning Instruments

A review of national legislation, policies and planning instruments revealed that climate change and EbA are prioritised with emphasis being placed on the need to explore how these approaches can be implemented to reduce the impacts of climate change. However, translation of this into provincial- and local-level policies, regulations and planning instruments is limited. While almost all provincial and municipal plans recognise the threat of climate change, the concept of EbA and its linkages to DRR is not understood and thus absent in these documents. Where adaptation was noted in some plans, very few actually planned and budgeted for adaptation-related activities. Exacerbating this is the outdated nature of many provincial, district and local policies and plans with some being more than a decade old. As a result, these instruments are based on old information and do not recognise newer concepts such as EbA or Eco-DRR.

Most provincial plans and policies recognised the threat of climate change and promoted mitigation and adaptation measures, with the expectation being that DMs and LMs will incorporate this into their by-laws, policies and plans. However, most DMs and LMs did not include any items related to adaptation or EbA in their regulatory or policy frameworks. Where activities were included, this was centred around capacity building and awareness raising of community members or leveraging off existing NRM projects being implemented by DFFE.

DMs, being more capacitated than LMs, often outlined some activities dedicated to climate change and were able to partner with DFFE, SALGA and/or NGOs to support implementation. On the other hand, LMs lacked this recourse due to funding constraints, limited human capacity and lack of technical expertise related to climate change.

Overall, a review of LMs' IDPs revealed a general recognition of the impacts of climate change, but there were no activities planned or budgeted for to address this (excluding a few awareness raising campaigns). This could be attributed to lack of capacity and technical expertise, especially as most did not understand the benefits of EbA and its contributions to DRR and DRM. Where there was a strong local NGO / civil society presence in relation to the implementation of EbA and adaptation measures, LMs were more willing to implement these types of initiatives through partnership with these NGOs / civil society.

When evaluating district and local plans, policies and by-laws, it was clearly evident that prioritisation of climate change-and ecosystem-related activities was low. In contrast, initiatives related to spatial development and DRR were included in almost all documents reviewed. This can be due to strong legislation that requires DMs and LMs to develop appropriate frameworks and implement measures that must be reported against on a regular basis. For example, all LMs had a spatial development framework supported by relevant and up-to-date by-laws to enforce this. This was also coupled with their IDPs including several spatial land use management and development activities that were clearly planned, budgeted for and monitored. Similar observations were made with regards to DRR as DMs and/or LMs are legally required to develop disaster management plans and establish appropriate institutional mechanisms to coordinate DRR across their areas of jurisdiction. Conversely, environmental management activities were infrequent in IDPs with most being linked to waste management or awareness raising of communities.

At a local level, climate change is regarded as a component of environmental management which is often housed in the community services department of a LM. In most cases, environmental management is paired with waste management and the sub-department is often structured and staffed according to waste management needs. As a result, environmental concerns are subsumed into waste management and most environmental activities are related to management, transport, collection and disposal of waste. This is also evident in the organograms of LMs where an environmental manager is only appointed due to legislated waste management requirements. Any other staff appointed under the environmental manager are dedicated to supporting waste management functions.

From a DRR perspective, due to comprehensive legislation requiring DMs and LMs to implement DRR and DRM functions in their areas of jurisdiction, resources and budget are allocated to these functions which is clearly observed in the IDPs. All DMs had a MDMC, as required by law, and supported the LMs in their disaster-related functions. It should be noted that most LMs reported capacity challenges with regards to DRR and required the DM's assistance in coordinating, facilitating and implementing DRM. There was also no evidence that DRR was being linked to EbA and DRM was implemented in a siloed manner that did not incorporate environmental considerations.

Most LMs' environmental plans were extremely outdated and did not adequately consider climate change, mitigation or adaptation. LMS' IDPs do recognise these issues and often indicate the need to develop new environmental plans, but funding and capacity challenges hinder their attempts to update the plans.

DMs were aware of the need to develop climate change strategies and plans. All the DMs had a climate change strategy that was developed through the Let's Respond Toolkit programme, but these are outdated and there is need for the DMs to update them. In addition, these strategies did not include any prioritised actions related to EbA linked to DRR. Future climate change strategies for the DMs and LMs will need to be underpinned by comprehensive CRVAs which require capacity and technical expertise. Furthermore, the CRVAs and climate change strategies will need to align with updated environmental management plans.

Although a few LMs noted the need for a climate change strategy, lack of funds (or reallocation of funds to other service delivery issues), low prioritisation, insufficient human resources and absence of technical expertise resulted in many not developing their strategies or pushing these out to the next reporting period. This links to the absence of any legislated requirements for LMs to develop climate change strategies with clear indicators and targets that they can report against in their IDPs.

It is expected that the Climate Change Act (2024) will create the necessary legislative framework to compel LMs and DMs to prioritise climate change adaptation and mitigation. The Act requires municipal climate change forums to be established, as well as climate change needs and response assessments (with implementation plans) being undertaken for provinces and DMs. Additionally, the legal provision requiring the development of a national adaptation objective, indicators and scenarios together with the devolvement of national and sector-specific adaptation strategies will further support the prioritisation of climate change adaption at a provincial and local level.

Build Capacity at DM and LM Levels to Plan, Design, Implement and Monitor Eco-DRR Activities

It is a well-known fact that capacity at a local level is insufficient to address climate change issues. Most LMs (and DMs) do not possess the requisite skills to undertake climate change studies or on-the-ground initiatives. Due to the absence of technical expertise, most staff at LMs do not understand the linkages between climate change, environmental management and DRR, which results in departments operating in siloes. Environmental management units are often understaffed in LMs and are linked to waste management functions, leading to staff prioritising waste management over environmental affairs.

Many LMs noted in their IDPs the inability to conduct environmental compliance, monitoring and enforcement due to staff shortages. This is also reflected in the priority actions put forward by LMs in their IDPs with focus being on waste management activities and only a few community awareness campaigns being planned with regards to environmental management. If LMs do include restoration, rehabilitation or IAP clearing activities, this is leveraged off planned DFFE activities that have already been budgeted for by DFFE.

Similar findings could be observed in the DRR space with most LMs not having adequate capacity to undertake DRM. These LMs rely strongly on the DM's disaster management department to plan and respond to disasters with most LMs not having a fulling staffed disaster management centre. As a result, disaster management for LMs focus strongly on response mechanism with little mention of EWS or DRR in the IDPs. Again, there was no evidence that DRR plans at a DM or LM level incorporated EbA.

Improve Intergovernmental and Cross-Sectoral Coordination at a Local Level

Online research and reviews of local planning instruments highlighted the siloed manner in which environmental management – and associated climate change initiatives – are implemented. It is evident from the review of DM and LM documents that there are a number of innovative and successful activities being implemented in the priority areas related to climate change, EbA and adaptation. However, these have not been implemented in an integrated manner and there is often duplication.

In addition, as noted in DFFE's evaluation of the selected EPWP programmes (DEA, 2019), the lack of ongoing monitoring of past and current NRM initiatives – both for government-led and private / NGO-led initiatives – has resulted in the absence of a comprehensive evidence base indicating the effectiveness (or ineffectiveness) of such interventions. Undertaking this level of monitoring requires significant coordination and collaboration across sectors and government spheres with the involvement of NGOs, communities and traditional authorities. The current approach being used to implement climate change and NRM initiatives does not allow for such coordination and a more transformative and innovative approach is needed that goes beyond the "business-as-usual" model.

Further to the above, this builds on the DDM model being implemented by government. The DDM model creates a new district-based approach to address service delivery challenges by focussing on the implementation of immediate priority projects, stabilisation of local government and long-term institutionalisation of integrated planning, budgeting and delivery. Through the model, government seeks to enable synergies between national, provincial and local priorities as well as implementing immediate priorities in an integrated and coordinated manner (COGTA, 2023). While the DDM One Plans developed by the 5 DMs vary in their structure and prioritisation of climate change, EbA or biodiversity, there is the opportunity to leverage these existing plans and mainstream Eco-DRR through alignment with existing priorities within the One Plans. If gaps exist in the One Plans with regards to climate change, EbA or Eco-DRR, the project can help address this by incorporating these elements into future One Plans coupled with awareness raising and capacity building at a municipal level.

Undertake Comprehensive Financial Structuring and Investment Planning

The options analysis for the financing of EbA revealed that, beyond what is funded through the national fiscus, there are multiple alternative finance mechanisms that can be implemented to support the upscaling of Eco-DRR. However, accessing and/or implementing such mechanisms require capacity and technical expertise. As a result, examples of metropolitan municipalities implementing / pursuing different finance mechanisms were evident across South Africa. On the other hand, smaller municipalities do not have the necessary resources (financial and technical expertise) to utilise these funding mechanisms, or they are unaware that such mechanisms exist. In addition, metropolitans have a significant private sector presence that is actively engaged with when climate change initiatives are being implemented. As a result, private sector is more willing to partner with metropolitan municipalities to help finance Eco-DRR and climate change adaptation initiatives. This is compared to smaller and more rural municipalities that do not have major industries present and lack the internal capacity to engage with private sector.

Going forward, within each of the four DMs, the Eco-DRR project will need to develop a well-structured investment plan for the catchment that provides clear financial arrangements which balance public and private sector finance. This will need to be based on a comprehensive understanding of the local economy as well as social and environmental considerations within each site.

Table 3-14: Summary of receiving environment for each DM and LM

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
Alfred Nzo DM	• No climate change specific by-laws.	• Could not find any relevant policies on DM's website.	• Could not access DM's spatial development framework. • Environmental Management plan (2010) is outdated. • Climate Change Response Strategy (2015) needs to be updated. • DDM One Plan (2020) highlights the need to address climate change issues. • Disaster Management Plan (2020)notes the challenges posed by climate change. • IDP (2022) recognises the risks of climate change and puts forward some activities.	• Environmental Management sub-unit is sufficiently capacitated. • DRM Services sub-unit is well-capacitated.	• Alfred Nzo DM Hameln Pyrmont Partnership (ongoing)	• Conservation South Africa; Environmental and Rural Solutions, the Umzimvubu Catchment Partnership and LIMA Rural Development Foundation are active in the DM. • DFFE: EP is active and capacitated in the area. • DM showed willingness to engage and participate in the Eco-DRR project, however it was highlighted that

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
Matatiele LM	• Environmental by-law gazetted, but no strong reference to climate change. • Other by-laws accessible on website. • No reference to disaster management by-laws. • LM has a Spatial Planning and Land Use Management By-laws (2016).	• Could not find any relevant policies on LM's website.	• IDP (2022-2027) prioritises climate change actions. • Spatial development framework (2020) also notes climate change issues. • Does not possess own DRM Plan and relies on DM.	• Environment and Waste Management Unit has capacity issues with regards to spatial planning, enforcement and inability to retain professional staff. • Public Safety Unit focuses on reactive response to disasters and relies on DM for DRM / DRR. Unit has an ineffective fire services department including shortage of fire fighters and equipment, budget constraints, and the absence of a fire management centre.	• District-Led Spring Rehabilitation in Matatiele LM (2022/23) • Service Statistics for Biodiversity and Landscapes – Wattle Clearing (2022/23 - ongoing) • Environmental and Rural Solutions' Work in Matatiele LM (ongoing) • Matatiele Watershed Protection and Stewardship Project (ongoing) • Umzimvubu Catchment Partnership (ongoing) • Living Catchments Project (ongoing) • DFFE-Led Working for Water and Working on Fire Projects (2018-ongoing) • DFFE's Green Business Value Chain (2018-2021)	capacity in LMs is limited.
Umzimvubu LM	• No specific climate change or environmental management by-law. • Does have a disaster management by-law and other by-	• Does have a climate change policy (2019) however there is no mention of EbA. • Has an Integrated Environmental	• IDP (2022-2027) notes the impacts of climate change and importance of ecosystem services. • Review of Spatial Development Framework (2015) puts forward several activities related to climate change	• Economic Development and Environmental Management Department does not have an adequate environmental policy framework and lacks human resource capacity which has resulted in delays the issuance of permits for	• DFFE-Led Working for Water and Working on Fire Projects (2018-ongoing)	

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
	laws are accessible on its website.	Management Policy (2010) but this is outdated and does not mention climate change or EbA.		environmental compliance. • Community Services Department relies on DM for DRM / DRR.		
Joe Gqabi DM	• Could only find the DM's water and sanitation by-law on its website which does not mention climate change or EbA. • No climate change specific by-laws.	• Could not find any relevant policies on DM's website.	• DDM One Plan prioritises environmental sustainability and the need to integrate climate change into IDP processes and other municipal sector plans. • IDP (2022-2027) prioritised the development and updating of a Climate Change Vulnerability Assessment and Climate Change Response Plan (2019). • Unable to access environmental management plan. • Spatial Development Framework (2009) outdated and does not reference climate change.	• DDM One Plan notes the non-existence of an environmental management unit within the district to handle environmental sustainability matters. Also not clear how the NRM unit is structured and staffed. • Well-staffed District Disaster Management Unit that supports LMs in its area of jurisdiction.	• DFFE-Led IAP Clearing Project in Upper Tsitsana (year unknown) • DFFE-Led Working on Fire Project (2018-2022) • DFFE-Led Working for Water Project in Upper Tsitsana (2019-2021) • DFFE-Led Working for Wetlands Project (2018-2021) • SANParks Grasslands National Park (ongoing)	• WWF and LIMA Rural Development Foundation present in DM. • SANParks has a presence in the district, with reference to the Grasslands National Park programme. • DFFE: EP is active and experienced in the area as well as having successfully mobilising the community to support EbA. • The traditional authorities in certain areas are supportive and can be a useful resource when

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
Elundini LM	• Has several by-laws but none specific to climate change and environmental management. • Has a spatial planning and land use management by-law that references climate change.	• Could not find any relevant policies on LM's website.	• IDP (2023/24) notes that the LM has not yet developed its Climate Change Strategy as well as an Environmental Management Plan due to budget constraints. • Spatial Development Framework (2019) lists several environmental concerns and the need for appropriate disaster management relief programmes.	• Community Services Department responsible for both environmental management and DRM. • Department does not have adequate capacity to enforce environmental management by-laws. • Also lacks a fully staffed disaster management centre and relies on the DM to undertake these functions.	• DFFE-Led Working for Wetlands' Gatberg Wetlands Project (2019-2021) • DFFE-Led Working for Wetlands' Gatberg Wetlands Project – Drought Response (2019-2021) • Joe Gqabi Ecosystem Based Adaptation Pilot Project (2020-2021)	engaging with communities.
Senqu LM	• Has several by-laws but none specific to climate change and environmental management.	• Could not find any relevant policies on LM's website.	• IDP (2022-2027) prioritises the development of an environmental framework that includes a climate change strategy and a disaster management plan as well as adopting EbA to address the impacts of climate change. • Spatial Development Framework (2016) notes the need for integration of built and non- built environments.	• Integrated Environmental Development Services Unit has limited staff and budget with many by-laws not being enforced. • Fire Services Unit provides fire services to the LM. This does not include management and reduction of other services (LM lacks to capacity for this) and the LM relies on the	• DFFE-Led Rhodes Land Reclamation Project (2021-2023) • Senqu LM EbA Project (ongoing)	

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
				DM for support in DRM and DRR.		
Ehlanzeni DM	• Could only find the DM's municipal health services by-law which does not prioritise climate change or EbA. • No climate change specific by-laws.	• Could not find any relevant policies on DM's website.	• Climate Change Vulnerability Assessment and Response Plan (2016) is outdated. • Wetland Strategy and Action Plan (2017-2022) notes the high value of wetlands in terms of ecological infrastructure and ecosystem services. • IDP (2023) notes the threat of climate change and the need for further training regarding climate change. Also notes the need to update climate change adaptation strategy and environmental management framework. • DDM One Plan (2022) prioritises the development / maintenance of climate-resilient infrastructure and	• Environmental Management Services Unit has capacity to undertake environmental management and climate change activities, but it lacks a biodiversity specialist. • Disaster Management Unit is well staffed.	• Kruger to Canyons Rangeland Restoration Project (2018-ongoing) • Kruger to Canyons Corridor Project (ongoing) • Kruger to Canyons Catchment Investment Programme (ongoing) • UNESCO Project - Addressing Climate Risk and Building Adaptive Capacity in South Africa's Biosphere Reserves (2021-2024)	• Conservation South Africa, Kruger 2 Canyons and AWARD are present in the DM. • DFFE: EP is active and capacitated in the district with a history of IAP clearing. • DM has some capacity with CRVA being conducted for the Bushbuckridge LM. There is some experience in ecosystem-based interventions through previous work, however, the capacity, competencies and the resources to take such interventions to scale are limited.

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
			to protect biodiversity, water and agricultural resources. • Spatial Development Framework (2010) is outdated but does prioritise protection of environment and biodiversity.			
Thaba Chweu LM	• Could not find any relevant by-laws on LM's website.	• Could not find any relevant policies on LM's website.	• IDP (2023/24) notes the need to develop a climate change response and adaptation strategy and promoting environmental awareness and education on climate change.	• Waste and Environmental Management Sub-Directorate lacks capacity to effectively address environmental issues. • Disaster Management and Emergency Services Sub-Directorate focuses on fire services and coordination. The LM shares its DRM responsibilities with Ehlanzeni DM.	• DFFE-Led Projects Under Several Programmes (2014 - ongoing)	

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
Bushbuckridge LM	• Could only find spatial planning and land use management by-law which notes the challenges of climate change. • No climate change specific by-laws.	• Could not find any relevant policies on LM's website.	• IDP (2017-2022) notes the ineffective rendering of environmental managements services and need to develop a environmental management plan and a climate change adaptation and mitigation strategy. • Spatial Development Framework (2010) is outdated but does note the need for integrated approach between conservation and development d to maintain the integrity of the biodiversity.	• Economic Development, Planning and Environment Directorate has capacity constraints to effectively undertake environmental management. • It is not clear where the functions of DRM sit within the municipality, but the LM is looking to build capacity and establish a disaster management centre in its structure. It is assumed that the LM relies on the Ehlanzeni DM for DRM and DRR services. • The LM has capacity challenges in terms of DRM with emergency preparedness being a challenge due to staffing constraints.	• DFFE Working for Wetlands – Bushbuckridge Project (2000-2006) • DFFE-Led Projects Under Several Programmes (2014 - ongoing)	

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
Ngaka Modiri Molema DM	• Could not find any relevant by-laws on DM's website.	• Could not find any relevant policies on DM's website.	• DDM One Plan does not make mention of climate change but does note the need to develop an environmental management framework. • IDP (2024/25) does not mention any targets or projects related to climate change or environmental conservation. • Climate Change Vulnerability Assessment and Response Plan (2016) is outdated	• It is not clear where environmental management functions reside in the DM. • Disaster Management Services Unit has limited capacity.	• UNESCO Project - Addressing Climate Risk and Building Adaptive Capacity in South Africa's Biosphere Reserves (2021-2024)	• No NGOs or civil society present in the DM. • DFFE: EP does have capacity to support in the region and is currently involved in interventions that include wetland and shallow well management. • DM has some capacity and has developed flood risk maps for the area. The DM is very supportive of the Eco-DRR project. • The working relationship between the DM and NW: DEDECT is particularly strong with joint interventions being undertaken to understand and address climate vulnerabilities.
Ramotshere Moiloa LM	• Could only find spatial planning and land use management by-law which notes the challenges of climate change. • No climate change specific by-laws.	• Could not find any relevant policies on LM's website.	• IDP (2020/21) does not make specific reference to climate change, but it does mention the importance of critical biodiversity areas and ecological support areas and the need to protect them.	• Community Services Directorate is responsible for both environmental management and DRM. • Capacity constraints are an issue.	• DFFE-Led Working for Water and Working on Fire Projects (2003 - ongoing)	

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
Sekhukhune DM	• No climate change specific by-laws. • Has several by-laws but none make specific mention of climate change.	• Could only find water and sanitation services development charges policy which does not mention climate change.	• DDM One Plan (2021) presents some interventions to address climate change. • IDP (2021-2026) notes the threat posed by climate change but does not put forward specific interventions to address this. • Climate Change Vulnerability Assessment and Response Plan (2016) is outdated. • Spatial Development Framework (2018) identifies are areas of great importance to biodiversity and critical water production and the need to protect such areas. • Bioregional Plan (2018) acknowledges climate change and identifies elements that can support climate change adaptation including ecological corridors, climate change refuges and high diversity areas. • DRM Plan and Framework (2022/23) notes the threat posed by climate change	• Environmental Management Services Sub-Division has capacity challenges. • Disaster Management Division is capacitated.	• GEF 5: Securing multiple ecosystems benefit through sustainable land management in the productive but degraded landscapes of South Africa (2014-2018) • GEF 7: Mainstreaming Sustainable Land Management for Large-Scale Impact in the Grazing Lands of Limpopo and Northern Cape provinces in South Africa (2021-2026)	• No NGOs or civil society present in the DM. • DFFE: EP has previously worked in the area, mainly around bush encroachment and do have capacity to support future projects, however this is not certain with regards to EbA. • DM's capacity to support the implementation of climate change measures is limited. While the DM has some experience in flood management, their overall capacity is weak and staff turnover is high.

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
			and identifies priority activities.			
Elias Motsoaledi LM	• No climate change specific by-laws. • Has a spatial planning and land use management by-law that notes the challenges of climate change.	• Could not find any relevant policies on LM's website.	• IDP (2023/24) puts forward several activities to address climate change as well as emphasising the need for urgent attention regarding preventative measures for floods including the development of storm water master plan to support its disaster management plan. • Spatial Development Framework (2018) does	• Community Services Department responsible for environmental management as well as coordinating disaster management and emergency service. • Limited capacity to effectively undertake environmental management and DRM.	• DFFE-Led Working for Water and Working on Fire Projects (2014 - ongoing)	

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
			note the threat of climate change, but little detail is provided in terms of how the LM will consider this in spatial planning and development.	Strongly reliance on the DM for DRM.		
Makhuduthamaga LM	• No climate change specific by-laws. • Has a spatial planning and land use management by-law that notes the challenges of climate change.	• Could not find any relevant policies on LM's website.	• IDP (2022/23) prioritises the development of a climate change strategy as well as an environmental management system. • Spatial Development Framework (2021) does not make reference to climate change or EbA but does note critical biodiversity and environmentally sensitive areas.	• Environmental and Waste Management Services Division's structure has strong focuses on waste management with no specific post dedicated to environmental management or climate change. The division has insufficient capacity to adequately deal with environmental management issues. • Community and Social Service Division primarily assists in terms of providing relief materials in the form of temporary shelters, sponges and blankets as well as education and awareness raising campaigns. The DM is responsible for the	• DFFE-Led Working for Water and Working on Fire Projects (2014 - ongoing)	

DM / LM	By-Laws	Policies	Strategies / Plans	Institutional Capacity	Past and Current Projects	Presence of NGOs, Civil Society and Other Relevant Actors
				broader DRR and DRM functions.		
Fetakgomo Tubatse LM	• No climate change specific by-laws. • Has a land use management by-law that notes the challenges of climate change.	• Could not find any relevant policies on LM's website.	• IDP (2023/24) notes the establishment of working groups tasked with incorporating cross-cutting issues such as climate change in IDP processes and products. Also highlights the need to develop a climate change adaption strategy.	• Community Services Department is responsible for environmental management, but it poorly staffed. • The LM does not have a dedicated unit for DRM and relies on the DM. The IDP does note the need to develop a disaster management centre.	• DFFE-Led Working for Water and Working on Fire Projects (2014 - ongoing)	

4 Undertaking Feasibility Studies for Eco-DRR

4.1 APPROACH TO THE FEASIBILITY STUDIES

The following chapter provides a description of the project areas for which this feasibility study has been undertaken.

Through extensive desktop analysis and expert input, a number of priority areas for possible investment in ecosystem-based climate adaptation actions were identified across the respective DMs. These identified sites were initially workshopped with stakeholders in the respective districts in October 2022. Based on the results of this initial workshop, and subsequent stakeholder inputs, as well as additional risk and vulnerability analyses conducted during the baseline study, potential areas of investment and implementation were identified. However, in order to refine priority sites for implementation of Eco-DRR within the respective districts and to allow for final stakeholder feedback, an additional site visit and stakeholder engagement process was undertaken during August 2023. This included an initial workshop where the project team shared the findings of recent research and thereafter allowed stakeholders to provide feedback on areas within the district that have shown particular vulnerabilities to climate hazards. Stakeholders invited to the workshop and subsequent site assessments included government officials (e.g. DMs, LMs, Provincial Government, COGTA), NGOs, civil society, private sector, and water users. The workshop approach was to undertake participatory mapping exercises with stakeholders with the objective of:

- Identifying areas of high risk / vulnerability in relation to droughts, floods and wildfires;
- Identifying key risk areas and potential mitigation actions, including
    - Biophysical (e.g. IAPs; encroachment; droughts, floods and wildfires prone areas);
    - Infrastructure (e.g. roads, bridges, water infrastructure);
    - Social (e.g. communities vulnerable to climate change, subsistence and commercial agriculture); and
- Giving stakeholders the opportunity to provide additional suggestions and input to assist with refinements of priority areas identified through the desktop mapping exercise.

The following sections provide an overview of site selection, summary of the climate rationale, descriptions of the priority study areas, including a summary of the vulnerabilities identified through the stakeholder engagement and site assessment process and the climate hazards associated with these areas. A more detailed climate assessment can be found in the *CRVA* that forms part of the annexures accompanying the FFP.

4.2 SITE SELECTION

4.2.1 Initial Selection of the Seven DMs

The Eco-DRR site selection process commenced with the identification of seven priority DMs. These DMs were as follows (Figure 4-1):

1. Waterberg District – in Limpopo Province;
2. Garden Route – in Western Cape Province;
3. Alfred Nzo District – in Eastern Cape Province;
4. Joe Gqabi District – in Eastern Cape Province;
5. Ehlanzeni District – in Mpumalanga Province;
6. Sekhukhune District – in Limpopo Province; and
7. Ngaka Modiri District – in North West Province.

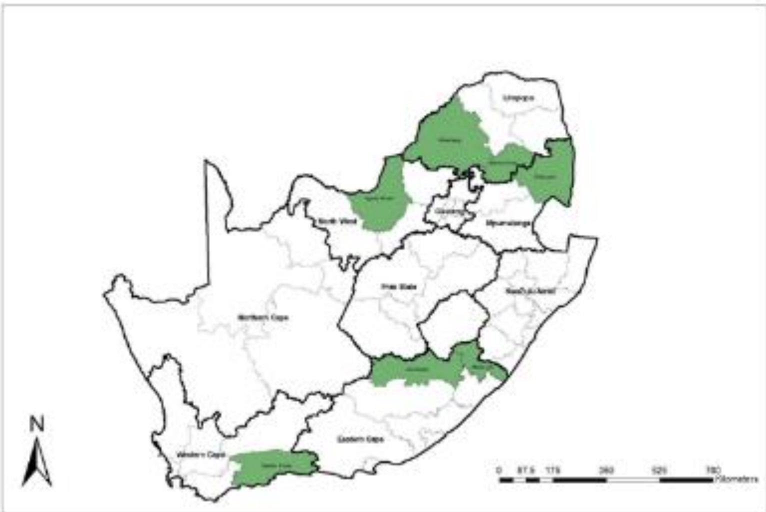

Figure 4-1: The seven selected DMs

A study into future climate drivers of disaster risks across the seven DMs was undertaken by experts from the University of Cape Town's African Climate and Development Initiative (ACDI). The study, drawing on data generated by Silmann et. al. (2013), provided a first order assessment of projected changes in climatic drivers of four climatic hazards – drought, flooding, wildfire and heat stress (Sillmann, et al., 2013a; Sillmann, et al., 2013b). The study was reported on by New (2021) and indicated that all seven DMs, across the four climatic hazards considered, *will experience increased climate risk which will be statistically significant* at 2.0 °C of warming, and in many cases, at 1.5 °C of warming, making them suitable candidates for climate change adaptation responses and interventions (New, 2021). These assessments are further supported by municipal level climate fact sheets, based on both CMIP 6 and CORDEX-CORE data, under development by the Global Change Institute, University of the Witwatersrand.

The table below presents the severity of projected changes in the climate hazards considered, over the rainfall regions[8] within which the seven selected DMs s are located (New, 2021). The numbers in the table are interpreted as follows: A

[8]The truly high intensity flooding is often not the simple summer conventional thunderstorm, but rather linked to the formation of cut-off lows (Xulu, et al., 2023). Overall, rainfall is greatest in the east and gradually decreases westward, with some semi-desert areas along the Central-southern Karoo and western edge of the country. For most of the country, rain falls mainly in the summer months with brief afternoon thunderstorms. The exception is the Western Cape where the climate is Mediterranean and it rains more in the wintertime. In

severity of 3, 2, 1 correspond to the projected changes being statistically significantly different from today's climate at 1.5, 2.0 and 2.5-3.0 °C warming, respectively, while a severity of 0 (zero) means that the change is not significant, even at 3.0 °C of warming. Indices representative of different climate hazards that were considered during the analysis include annual maximum 1-day rainfall (RX1DAY), total heavy rainfall (R99P), total annual rainfall (PRCPTOT), longest period of consecutive dry days (ALTCDD), mean air temperature (TAS), frequency of very hot days (TX90P), frequency of very hot nights (TN90P), warm spell duration (heat waves) (WSDI), and mean wind speed (MWS).

Table 4-1: Average of ranking of metrics for each hazard, via taking the mean of the ranking for each metric, and then the overall average across all hazards (New 2021)

Province	DM	Rainfall Region	Flooding	Drought	Fire	Heat	All
Western Cape	Garden Route	South Coast	0.5	3.0	3.0	3.0	2.2
Limpopo	Waterberg	North East Interior	3.0	2.7	2.0	3.0	2.6
Eastern Cape	Alfred Nzo	Transkei Coast	2.0	2.0	2.3	3.0	2.1
Eastern Cape	Joe Gqabi	Central-South Interior and Transkei Coast	2.5	2.7	2.5	3.0	2.6
Mpumalanga	Ehlanzeni	North East Lowveld	3.0	2.0	1.8	3.0	2.3
Limpopo	Sekhukhune	East Interior	3.0	2.0	1.5	3.0	2.2
North West	Ngaka Modiri Molema	North East and Central Interior	3.0	2.7	2.0	3.0	2.6

It was noted that all the DMs will experience statistically significant increases in heat stress risk at 1.5 °C warming, noting the consistent increases in mean temperature and extreme warm temperature metrics across the whole country (Table 4-2). The Ngaka Modiri Molema, Waterberg, Sekhukhune and Ehlanzeni DMs are projected to have the most significant increases in rainfall-driven flood risk, all of which become statistically different from the present day at 1.5 °C of warming. These DMs also have moderate projected changes in drought risk, which would become significant at 2.0 °C of warming, while the Ngaka Modiri Molema and Waterberg DMs also have significant changes in fire risk at 2.0 °C warming (New, 2021).

the summer rainfall region, in the central and northern parts of the country, rain falls from October to February and is often heavy, with the amount of precipitation increasing from west to east. The Eastern Cape experience both summer and winter rainfall, which may come down in the form of severe downpours. The arid regions in the north-west, has the driest areas being the north-west coast. The interior plateau, the eastern Free State, KwaZulu-Natal, Eastern Cape and Mpumalanga Provinces receive almost all its rain as thunderstorms (convective rains related to high temperatures). Cut-off lows, which can occur at any time of the year, are often the proximate cause of the most severe flooding (Xulu et al 2023).

Table 4-2: Severity of projected changes in climate metrics relevant to flooding, drought, fire and heat stress over the rainfall regions within the seven DMs[9]

Province	DM	Rainfall Region	Flooding		Drought			Fire				Heat Stress		
			Increase in maxi-mum daily rainfall	Increase in total heavy rainfall	Decrease in annual rainfall	Increase in evap-orative drying	Increase in dry spell	Higher fuel dryness	Higher dryness and fuel flammability		Stron-ger wind	Higher Temp-eratures		More heat waves
			RX1DAY	R99P	PRCPTOT	TAS	ALTCDO	PRCPTOT	TAS / TX90P	WSDA	MSW[10]	TX90	TN90	WSDI
Western Cape	Garden Route	South Coast	1	0	3	3	3	3	3	3	++	3	3	3
Limpopo	Water-berg	North East Interior	3	3	2	3	3	2	3	3	-	3	3	3
Eastern Cape	Alfred Nzo	Transkei Coast	2	2	1	3	2	1	3	3	+	3	3	3
Eastern Cape	Joe Gqabi	Central-South Interior and Transkei Coast	3	2	2	3	3	2	3	3	+	3	3	3
Mpum-alanga	Ehlan-zeni	North East Lowveld	3	3	1	3	2	1	3	3	-	3	3	3
Limpopo	Sekhu-khune	East Interior	3	3	0	3	3	0	3	3	-	3	3	3
North West	Ngaka Modiri Molema	North East and Central Interior	3	2.5	2	3	3	2	3	3	-	3	3	3

[9] A severity of 3, 2, 1 correspond to the projected changes being statistically significantly different from today's climate at 1.5, 2.0 and 2.5-3.0 °C warming, respectively, while a severity of 0 (zero) means that the change is not significant, even at 3.0 °C of warming. Indices representative of different climate hazards that were considered during the analysis include annual maximum 1-day rainfall (RX1DAY), total heavy rainfall (R99P), total annual rainfall (PRCPTOT), longest period of consecutive dry days (ALTCDD), mean air temperature (TAS), frequency of very hot days (TX90P), frequency of very hot nights (TN90P), warm spell duration (heat waves) (WSDI), and mean wind speed (MWS).

[10] For windspeed, quantitative information on windspeed at different warming levels was not available, but an assessment from secondary information in (ref needed) was used to assess the magnitude of change in the future (++ = clear increase; + = moderate increase; - = no increase).

A summary of the results in the above table shows a pattern of highly significant increase in TAS, TX90P, TN90P and WSDI over the seven DMs. This on its own does not influence flood intensities - however, parched ground is less likely to absorb water and increases the risk of dangerous flash floods (Katwala, 2022). Therefore, where the trend is towards high intensity drought and dry periods, along with higher intensity precipitation, flooding is expected to be more severe. The study indicated that PRCPTOT shows varied patterns across the country – with the Alfred Nzo, Joe Gqabi, Ehlanzeni, Sekhukhune and Ngaka Modiri Molema DMs showing increased maximum daily rainfall. Heavy rainfall metrics (RX1DAY and R95P) are projected to increase across the north and east of the country – especially noting that in areas where future climate projections show that annual rainfall may not decrease much, heavy rainfall events increase. As a statement from the 2021 report of particular importance notes "*... even when total rainfall decreases, heavy rainfall stays the same or increases, indicating that more of the total rainfall falls as heavy rainfall events*" (New, 2021). This significant assertion highlights the importance, especially in the prioritised DMs, that flood hazards are very likely to increase, as a direct result of climate change. This information forced the foundation of the project to be undertaken in the development of the GCF FFP.

4.2.2 Candidate Site Selection

Candidate sites, in this report, refer to potential locations for intervention implementation within the DMs that were initially prioritised as potential implementation areas for the Eco-DRR project. The candidate site selection process recognised, to commence with, that all seven DMs have vulnerable populations and environments that are exposed to climate hazards and the potential impacts of climate change and climate variability. The aim of the candidate site selection process was two-fold – first to identify which of the seven DMs were most vulnerable – resulting in five DMs being identified - and second to identify potential locations *within* the then five DMs that are more vulnerable to climate-induced droughts, floods and wildfires . This two-fold process took into consideration biophysical data (rangeland condition, biodiversity resilience and ecological infrastructure condition, potential risk of ecological infrastructure loss), socioeconomic data (unprotected water sources, fuel for cooking, female and child headed households, poverty line), climate data and local stakeholder inputs, as well as expert inputs from DFFE: EP (Figure 4-2). Additional, finer spatial resolution from the Green Book's climate projections[11] were included in the assessment.

Rangeland ecological infrastructure condition was considered an important indicator, since rangeland (including grazing pastures which are important in the seven selected DMs as part of rural livelihoods, as well as woodlands and savanna) conditions are a good proxy for determining changes in the potential impact on each of the hazards identified, and was thus assigned the highest weighting of 3 for the biophysical prioritisation. Change in ecological infrastructure condition, using soil loss as an indicator, was also included, but with a lower weighting of 2. Finally, potential for ecological infrastructure

[11] The Green Book is an open-access online planning support tool providing quantitative scientific evidence to support planning and design of climate-resilient, hazard-resistant settlements. The Green Book looks forward to the year 2050 by projecting settlement growth and likely climate change impacts on settlements in South Africa (Le Roux, et al., 2019).

loss is driven by land transformation, was assigned a weighting of 1 as it is not a direct indicator of degradation of ecological infrastructure but is important in terms of the threat of loss of ecological infrastructure due to land transformation.

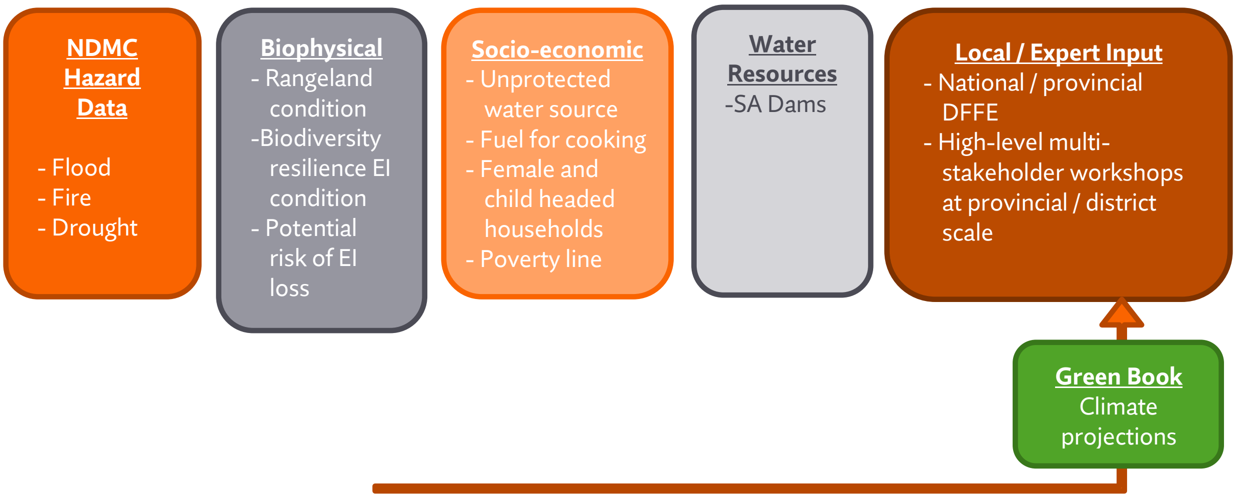

Figure 4-2: Data used for candidate site selection process

The data sources indicated in the figure above were analysed through a quantitative multi-criteria assessment (MCA) process using spatial and non-spatial data, and a qualitative process applying non-spatial information and knowledge gained through expert engagement. The result was a prioritisation of the DMs and the QCs within each of the seven DMs, based on relative assessment scores. The outcome of the MCA provided a score indicating the relative level of risk that each DM is subject to.

Of the seven DMs analysed, the Waterberg and Garden Route DMs had the lowest scores (for combined drought, flood and wildfire) when compared to the other DMs and were thus excluded from further analysis. The assessment identified potential locations for intervention implementation within the **remaining five DMs** that had the highest scores when compared to the other locations in their respective DMs (Table 4-3). In some instances, certain locations were removed from the selection due to the absence of settlements or the small size of the location (see crossed-out text in Table 4-3). The two top potential locations for intervention implementation within each of the five DMs were considered for the baseline assessment and CRVA. There were no climate projections from the Green Book for the Ngaka Modiri Molema DM and the analysis of the DM only considered climate hazard data, biophysical data, socioeconomic data and local / expert inputs from DFFE: EP.

Table 4-3: Candidate sites within the five DMs

Province	DM	LM	Proportion of LM in Potential Location (ha)	Top Two Potential Locations According to QCs[12]
EASTERN CAPE	**Alfred Nzo**	Umzimvubu	598.4	T32G
		Ntabankulu	24 217.5	
		Mbizana	13 660.2	

[12] When looking at potential locations, the use of QCs were considered within the five DMs due data availability and the hydrological nature of the areas, and these were taken further into feasibility.

Province	DM	LM	Proportion of LM in Potential Location (ha)	Top Two Potential Locations According to QCs[12]
		Umzimvubu	202.6	T40A
		Mbizana	12 717.1	
	Joe Gqabi	~~Elundini~~	~~291.4~~	~~T34H~~
		Elundini	23 600.6	T34A
		Senqu	478.6	
		Elundini	20 144.1	T35E
MPUMALANGA	Ehlanzeni	Thaba Chweu	7 880.1	B60H
		Bushbuckridge	15 749.5	X32F
LIMPOPO	Sekhukhune	Ephraim Mogale	1 010.2	B51H
		Makhuduthamaga	70 732.4	
		Makhuduthamaga	43 083.3	B52B
		Fetakgomo Tubatse	20 220.7	
NORTH WEST	Ngaka Modiri Molema**	~~Ratlou~~	~~10 756.5~~	~~D41C~~
		Ratlou	435 119.1	D41B
		Tswaing	73 738.4	
		Mafikeng	37 040.7	
		Ditsobotla	3 357.5	
		Ramotshere Moiloa	68 511.4	A31H

** More details regarding how the scoring was determined can be found in the Candidate Site Selection Report.*
***The results for Ngaka Modiri Molema DM do not incorporate climate data as this was not available at the time of analysis.*

In Figure 4-3, the location of the top two potential locations identified per the five DMs are shown in yellow with these two QCs being subjected to hydrological modelling (Section 6) and a CBA (Section 7) .

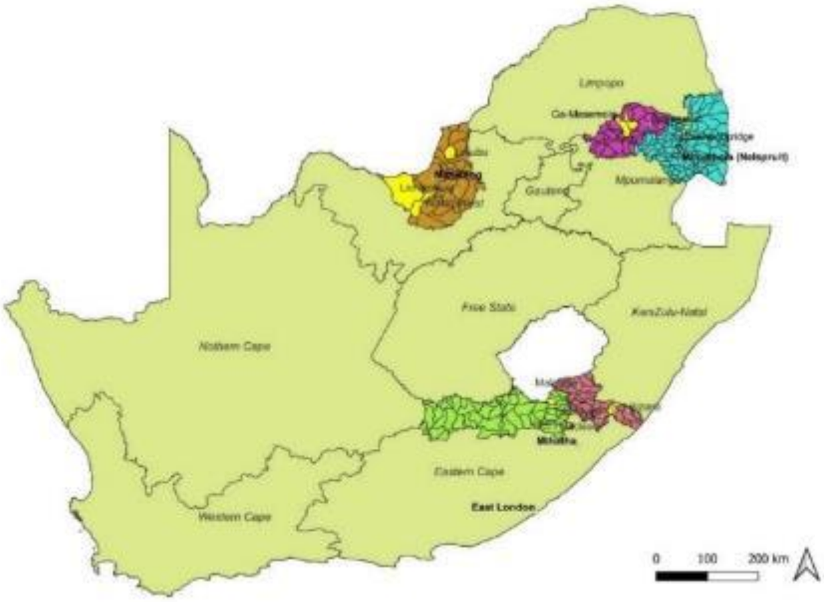

Figure 4-3: Map showing the potential locations (candidate sites) for intervention implementation within the five DMs

As mentioned earlier in Section 1, It is important to note that the feasibility study aims to assess the feasibility of undertaking Eco-DRR interventions within the 5 DMs. As such, this report reviews all 5 DMs – Joe Gqabi, Alfred Nzo, Ngaka Modiri Molema, Sekhukhune and Ehlanzeni – and presents findings for each DM and the reader is asked to bear this in mind.

Through the feasibility process and analysis, it was possible to determine which interventions are feasible and in which geographic areas. These results informed the finalisation of the site selection process and resulted in the exclusion of Joe Gqabi DM.

More details regarding the candidate site selection process can be found in the Report No. 2 titled "**Process and Selection Criteria for Candidate Site Identification and Prioritisation**" (SANBI, 2022) that was developed under this project.

4.3 CLIMATE RATIONALE

South Africa has sub-tropical and temperate climate conditions, with temperatures ranging from 15–36°C in summer and -2–26°C in winter (World Bank, 2021). This climate is influenced by the adjacent Atlantic and Indian oceans and extensive interior plateaus. Notably, South Africa's geographic location also exposes it to El Niño Southern Oscillation cycles, resulting in extreme fluctuations between drought and wet conditions (World Bank, 2021). Moreover, South Africa is situated within a drought belt; ~50% of the country is classified as arid or semi-arid (Beck, et al., 2018). As a result, it is the fifth most water-scarce country in sub-Saharan Africa (World Bank, 2021).

4.3.1 National Observed and Projected Climate Changes and Extreme Events

Temperature

Observed

The average air temperature in South Africa has increased by 1.5°C (~0.2°C per decade) since the 1960s (Figure 4-4), which is higher than the observed global average of 0.65°C (Republic of South Africa , 2018). Most of this warming has occurred in the country's interior and in late summer. In addition, extreme temperatures have increased in frequency and intensity across the country. Daily observed maximum temperatures have increased on average by 0.02°C per year since the 1960s (MacKellar, et al., 2014). Similarly to average temperature, this increase in maximum daily temperatures is highest in the central interior of the country in late summer, where recorded maximum temperatures have risen by ~2°C compared with 1960s temperatures.

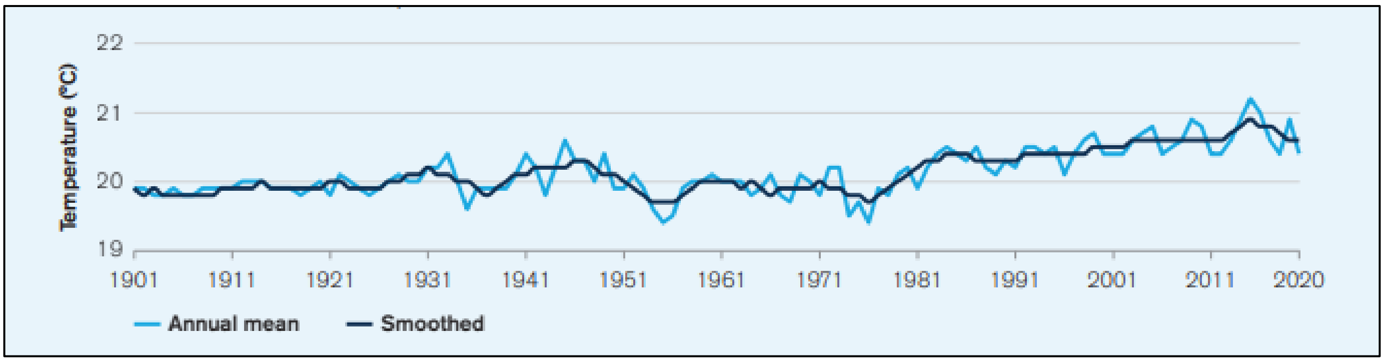

Figure 4-4: Observed change in average temperature in South Africa since 1900 (World Bank, 2021)

Projected

Future projections indicate an increase in average temperature from ~18.5°C to a median value of 19–23°C by 2100, depending on the emission scenario considered (see figure below). This translates to a rise in average monthly temperature of 2.0°C by 2050 and 4.2°C by 2090 under Representative Concentration Pathways (RCP) 8.5 (World Bank, 2021) with similar expectations emerging under the Shared Socioeconomic Pathways (SSP) 1-2.6 to SSP5-8.5. The most extreme warming is expected in the northern and inland areas of the country (Figure 4-5).

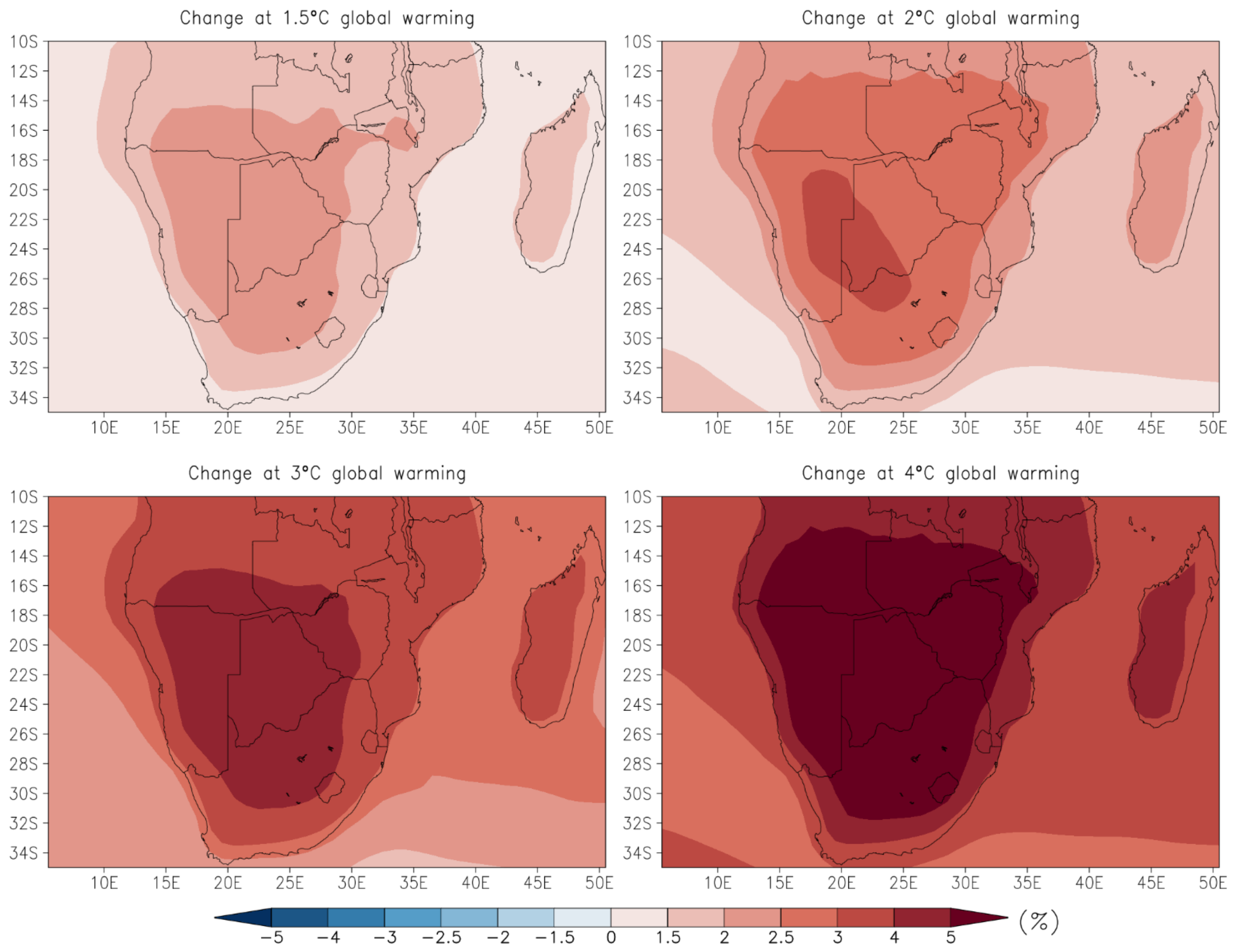

Figure 4-5: Projected change in average near surface temperature projected by CMIP6 SSP5 – 8.5 ensemble average across various levels of global warming compared to the 1959-1900 baseline period (Engelbrecht, et al., 2024)

A rise in average temperature is expected to increase the intensity of heat waves and higher evapotranspiration rates. In addition, the number of hot days per annum (TMax >35°C) is projected to rise in the country, with hot days in the country's northern areas — the Northern Cape, North West and Limpopo provinces — expected to rise by up to 80 days per year by the middle of the century (Engelbrecht, et al., 2019).

In addition, by the end of the century, projections indicate that hot days will occur on more than 120 days per year across South Africa's interior (Engelbrecht, et al., 2019).

Precipitation

Observed

There is no notable observed trend of changing average annual rainfall in South Africa; however, the frequency of rainfall events has declined significantly across most of the country. This reduction in rainfall frequency, coupled with prolonged dry spells, has resulted in the regular occurrence of drought. South Africa has been affected by at least seven major drought periods[13] over the last four decades, the most recent of which occurred in 2018–2020 (Meza, et al., 2021).

Although the frequency of rainfall events has declined, the intensity of rainfall events has increased in most of the country (World Bank, 2021). In the last 50 years, there has been an increase in the occurrence of heavy rainfall (>50 mm in a day) across ~70% of weather stations in the country. The increased intensity of single-event rainfall occurrences increase the risk of both pluvial (exceedance of ground infiltration and subsequent area inundation) and fluvial flooding (overtopping of river banks)[14] (which induce erosion and result in sedimentation downstream).

Projected

Rainfall projections remain uncertain and somewhat variable across South Africa; however, most models indicate declines in average annual rainfall in the west, with small increases in the east in coming decades (Figure 4-6).

[13] A period of abnormally low precipitation (compared with the long-term average climate of a given region), which is long enough to severely impact the hydrological resources

[14] pluvial flooding occurs when an extreme rainfall event creates a flood independent of an overflowing water body, whereas fluvial flooding is linked to overflowing waterbodies.

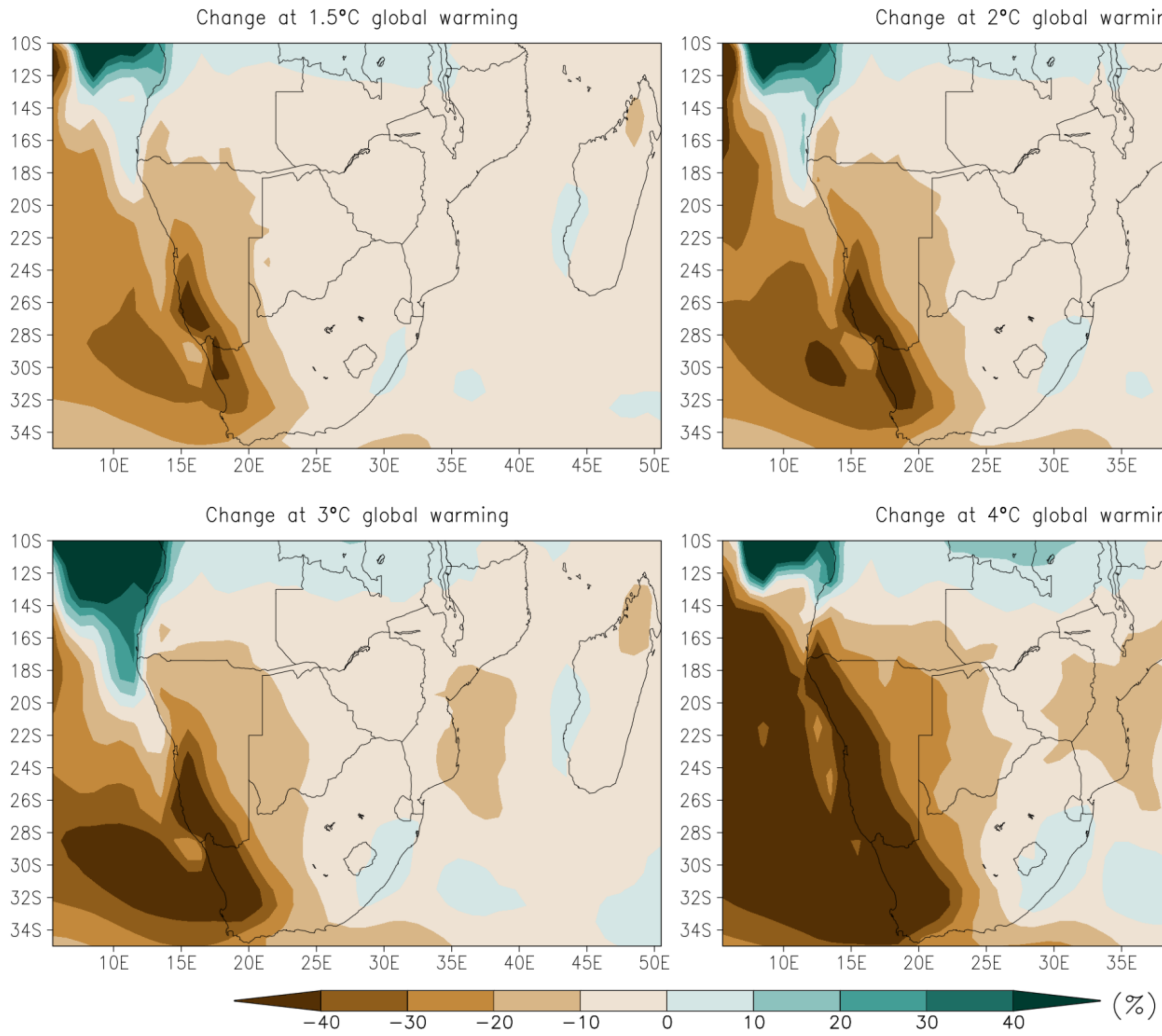

Figure 4-6: Projected change in average precipitation (as % change) projected by CMIP6 SSP5 – 8.5 ensemble average across various levels of global warming compared to the 1959-1900 baseline period (Engelbrecht et al 2024)

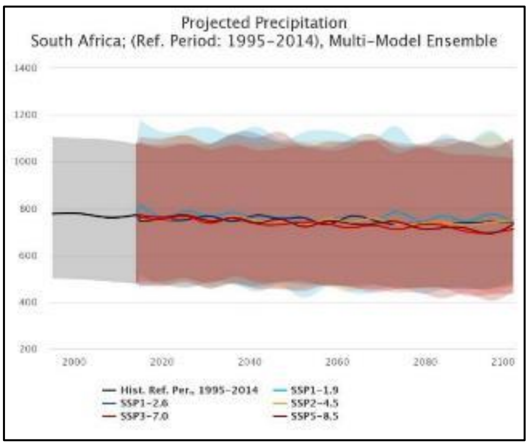

Figure 4-7: Projected changes in annual average precipitation in South Africa under SSP emissions scenarios (World Bank, 2021)

This is linked to a general strengthening of the subtropical high-pressure system over southern Africa, which is expected to prevent conditions necessary for the formation of rain-bearing systems. These future rainfall conditions over southern

Africa are projected to occur in association with a greater frequency of extended dry spells and drought (World Bank, 2021) whilst the intensity of rainfall events is expected to increase in the country, especially in the northern and eastern regions (Figure 4-8) (World Bank, 2021; McBride, et al., 2022).

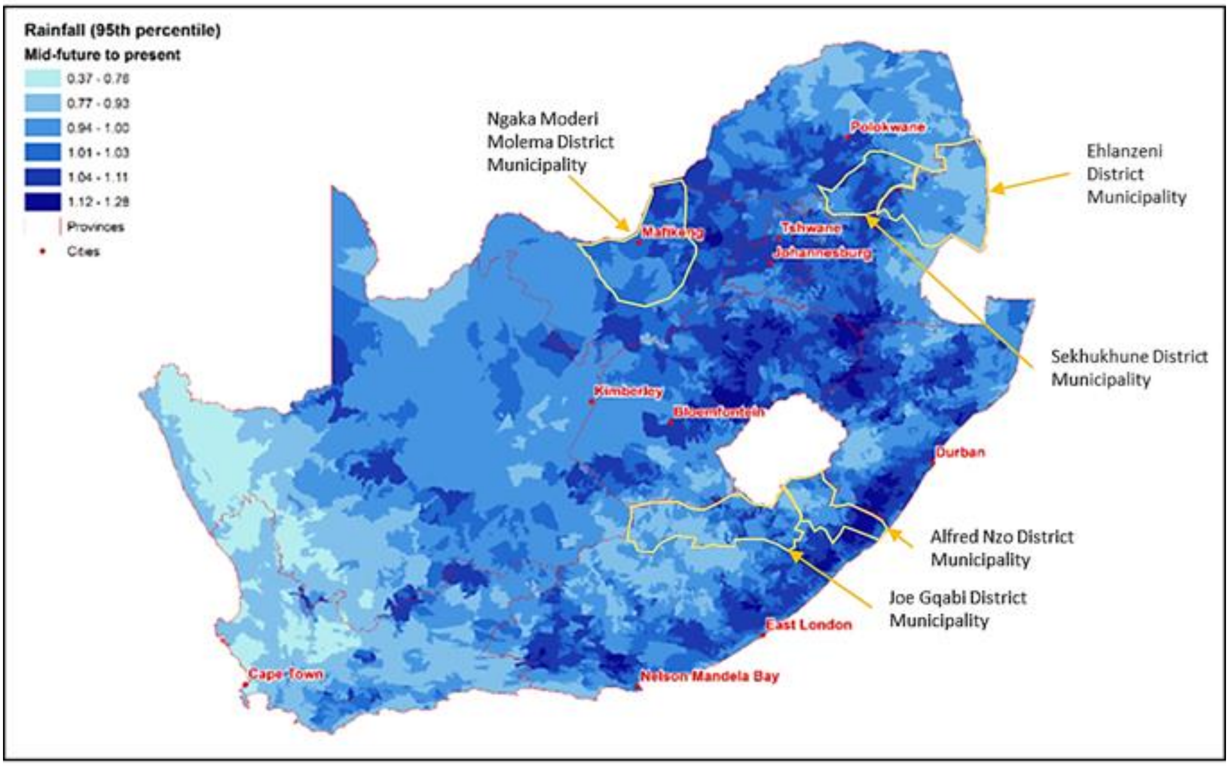

Figure 4-8: The mean ratio of the near future (2021-2050) and current (1971-2000) extreme daily rainfall (95th percentiles) for each quinary catchment. Values greater than 1.0 indicate an increase in the extreme daily rainfall (Le Maitre, et al., 2019)

Extreme Weather Events

Floods

The projected escalation in the intensity of rainfall events directly increases flooding risk in certain areas of South Africa. Floods are already the region's most frequently reported natural disaster (Le Maitre, et al., 2019) with South Africa having experienced at least 77 major floods between 1980 and 2010, resulting in the death of at least 1,068 people (Le Maitre, et al., 2019). In 2022, heavy rainfall caused severe flooding and landslides, leading to 448 deaths, displacing more than 40,000 people and destroying more than 12,000 houses in the country's eastern region (ReliefWeb, n.d.).

Changes in flooding intensity are expected to differ temporally and between catchments, making it difficult to predict flood hazards. Notwithstanding this, some trends regarding flooding intensity can be detected for different areas of the country. Most models indicate that pluvial and fluvial flooding intensity will increase in South Africa's northern and eastern areas in response to increased rainfall intensity and associated increases in runoff. They also indicate increased flooding intensity in the Eastern Cape and Limpopo provinces (World Bank, 2021).

Droughts

In southern Africa, droughts have a long historical track record (Ballard, 1986), with major drought periods in the past few decades including 1982–1984, 1991–1992, 1994–1995, 2004–2005, 2008–2009, 2015–2016, and the most recent in 2018–2020 (Mahlalela, et al., 2020; Walz, et al., 2020; Unganai & F.N., 1998). Currently, most of South Africa has at least a medium risk of drought, with east central areas of the country — including proposed project sites — having a medium–high risk (Figure 4-9). Climate observations across southern Africa as well as future modelled scenarios indicate a high likelihood of a further increase in the occurrence of multi-year drought events in the region. Moreover, according to South Africa's third national communication to the UNFCCC, future climate change projections show a significant increase in the frequency, duration and severity of hydrological drought events in South Africa during the second half of the 21st century (Republic of South Africa , 2018).The report also emphasises that drought conditions are expected to be especially impactful in the country's summer rainfall catchments — including the proposed project's target areas. In areas where droughts are particularly impactful, increased denuded land cover is expected.

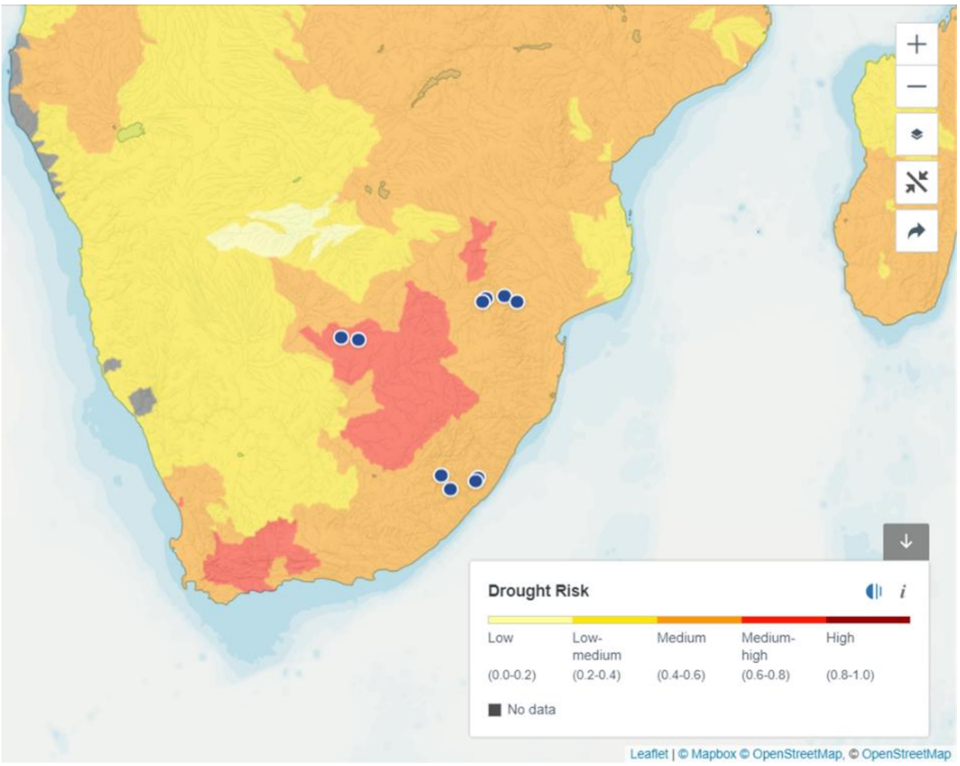

Figure 4-9: Drought risk across Southern Africa, with point locations in blue indicating sites within the QCs for this project (Water Resources Institute, n.d.)

Wildfires

The spatial distribution of the average number of high fire-danger days[15] indicates a decreasing trend in the number of days from the north-west to the south-east. This indicator, however, only measures the probability of intense fires in relation to

[15] The fire danger rating uses five climate variables, including temperature, humidity, wind speed, precipitation amount and number of days since the last rain event to provide an indication of the potential intensity of fires if they occur on a given day.

daily weather conditions and does not account for other factors that determine fire intensity and occurrence such as topography, fuel load and vegetation. When looking at the historical distribution of fires in South Africa there is a high density of wildfires located along major mountain ranges and within predominantly grassland, fynbos and savanna ecosystems (Strydom & Savage, 2016). Related to these factors, the highest frequency of current fire incidences occurs in the Western Cape and provinces in the north-east of the country, including Mpumalanga and the North West Province in which several of the target areas are located. Across the country, there has been an increasing trend in fire frequency from 2003–2013. Moreover, the years with the highest frequency of fires correlated with the warmest years, suggesting a link between fire occurrence and air temperature.

The projected increase in average temperatures as well as number of high heat days and associated prolonged dry conditions in South Africa contribute to a projected increase in the number of high fire danger days. Human interaction with the natural environment further influences the level of risk through their forcing of changes in land use, rangeland management, vegetation types and soil health. As a result, increased wildfires occur based on the complex interaction of bioclimatic factors, ecological responses (including invasive proliferation) and anthropogenic contributions.

Healthy savanna and grassland ecosystems can be classified as "fuel build-up limited" (Alvarado, et al., 2020). This means that the risk of wildfire is controlled in healthy ecosystems when there is a balance between biomass buildup and fire heat intensity. Climate change impacts, such as droughts, floods, heat days and CO_2 fertilization effects are anticipated to facilitate the establishment of both exotic and indigenous invader (weedy) species, many of which have higher oil content and/or burn rates, and may dramatically alter fire (Leishman & Gallagher, 2015; O'Connor & van Wilgen, 2020).

Changing land use patterns which are part of the anthropogenic influences in rural areas in particular, influences fire frequency and intensity and modify fire suppression dynamics. Human activities further increase ignition sources, and inappropriate rangeland management in a changing climate converts vegetation structures to be more fire prone.

A more detailed climate assessment can be found in the *CRVA* that forms part of the annexures accompanying the FFP.

4.4 STAKEHOLDER ENGAGEMENTS TO DATE

4.4.1 Stakeholder Engagement Process

The goal of the project is up-scale ecosystem-based techniques to manage disaster risks that are intensified by climate change in South Africa's vulnerable areas. Ecosystem-based strategies are widely regarded as a viable and affordable method of fostering resilience in at-risk areas. Being upfront about a project, taking in and considering the feedback from the stakeholders, and doing so not only makes the project operate more smoothly, but it also actively improves the organisation's reputation and fosters support for the initiative.

The stakeholder consultation and engagement process followed not only the Batho Pele Principles (people first), adopted by the South African Government, but also aligned with the principles and approaches outlined in Gann et al (2019) and

Dudley et al. (2021) and was benchmarked against global principles and the GCF's "*Sustainability Guidance Note: Designing and ensuring meaningful stakeholder engagement on GCF-financed projects*" (Gann, et al., 2019; Dudley, et al., 2021).

Emphasising the local-level scale that the interventions will take, ensuring meaningful inclusive participation was important. Guidance from GCF's environmental and social management system, the environmental and social safeguards (GCF, Development Bank of Southern Africa), Revised Environmental and Social Policy, and Indigenous Peoples Policy of GCF were key guidance documents. In addition, to the above, consideration of gender strongly influenced the approach to stakeholder engagements. Stakeholder engagements were designed to be gender-responsive and sensitive to gender-based power dynamics and aligned with SANBI's Gender Mainstreaming Framework and their Gender Mainstreaming Policy together with, the DFFE's Gender Strategy for the Environment Sector and GCF's Toolkit For Mainstreaming Gender and Gender Policy.

Therefore, given the initial scale of the proposed areas (five DMs) as well as the need to manage expectations, it was proposed that the process of identifying implementation be undertaken in a top-down and bottom-up approach:

a) With national- and provincial-scale stakeholders; and
b) With local-level and site-level stakeholders, once a suite of potential sites and EbA have been identified.

Using the above, and the National Climate Change Gender Action Plan, an overall approach was outlined to guide stakeholder engagements going forward for the project, which ensures inclusivity, transparency, accountability and non-discrimination. In addition, this emphasis ensures that gender considerations are included throughout the planning and engagement processes going further. Identification and mapping of stakeholders was critical, both at the early phases of the project as well as when the candidate and implementation sites were selected. Early involvement makes it possible to identify important issues and influence relevant decisions.

The process followed for stakeholder engagements is summarised in the figure below:

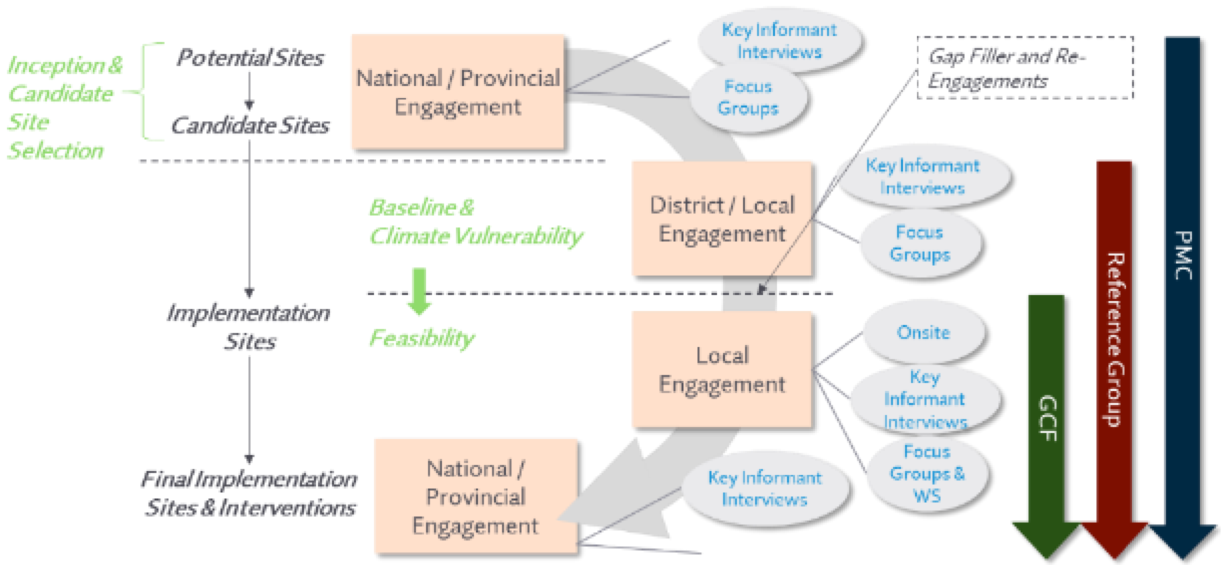

Figure 4-10: Stakeholder engagement process

Key stakeholders were regularly kept informed of project developments, updates, and community comments. This was done via recurring reports and presentations/meetings that describe the progress of the engagement and site selection initiatives to date.

When conducting stakeholder engagements, due process was followed which was determined by government authorities. This required engaging with entities at a national level first before moving to provincial, district and local levels. This allowed for buy-in to be secured from the top-down with national-level stakeholders ensuring that approvals are granted at a provincial, district and local level to engage with the project. This process also allowed for national, provincial and district authorities to identify local stakeholders to engage with.

Provincial and district officials did note that community engagements will need to be handled cautiously to manage expectations and reduce stakeholder and research fatigue, which is the condition in which stakeholders become reluctant to participate in the collection of human subject data because they have had unpleasant experiences with the process and the outcomes promised or believe that researchers undervalue them (Taylor, et al., 2021). DMs and LMs emphasised during engagements the need to engage with communities only when the project has landed and is close to implementation. It was also proposed that community engagements be facilitated through the collaboration with civil society organisations, NGOs and LMs / DMs, given their familiarity with the local context and established relationships within the communities.

In order to identify implementation sites, a three-step process was followed (see figure below). This built on the previous work undertaken by SANBI, NDMC and DFFE: EP where project areas i.e. seven DMs were identified as priority areas for the project.

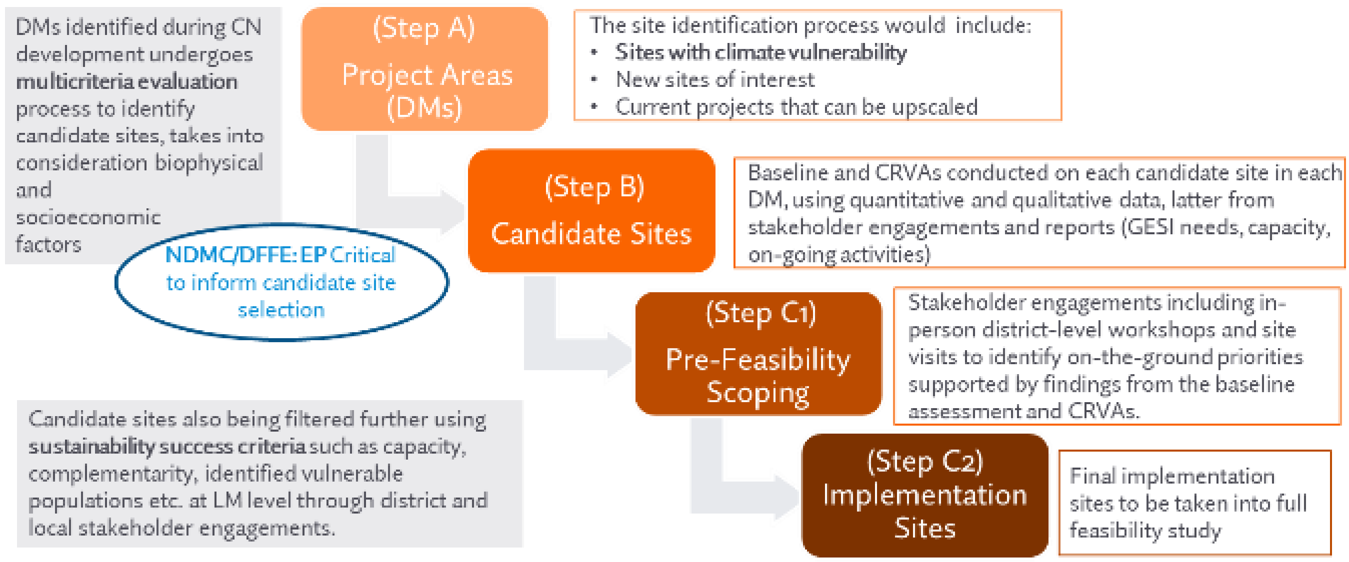

Figure 4-11: Process towards identification of final implementation sites

At each stage of the process to identify implementation sites, stakeholder engagements were conducted with further engagements being undertaken after identification of implementation sites (see figure below).

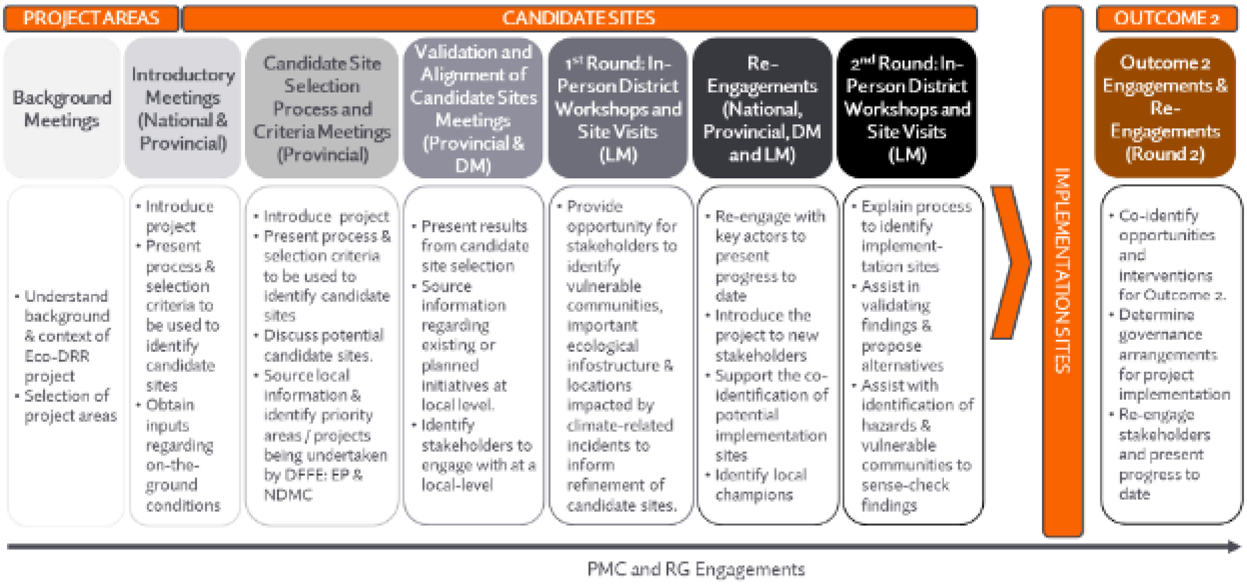

Figure 4-12: Stakeholder engagements to identify implementation sites

4.4.2 Stakeholder Inputs Regarding Droughts, Floods and Wildfires

During the site visits and workshops that were held with a range of stakeholders within each of the five DMs (Alfred Nzo, Joe Gqabi, Ehlanzeni, Sekhukhune and Ngaka Modiri Molema), discussions included a focus on floods, droughts and wildfires (and the inter-relationship between wet and dry periods/events) and potential for interventions regarding these and associated hazards specific to each DM. The stakeholders included provincial and municipal officials, local NGOs as well as community leaders, along with representatives from DFFE. Through this discourse, the most significant concern across all the DMs were noted as the rapid onset and impacts of flooding, bearing in mind that rural communities in particular, across the DMs, are extremely sensitive to the impacts of flood events. Further, due to limited response time and adaptive capacity at a local level towards floods in particular, the rural communities and communities that live in often semi-formalised settled areas but outside of larger towns, are highly vulnerable. With regard to droughts, there was varying perspectives across the DMs, with some – notably those toward the north (Ngaka Modiri Molema, Ehlanzeni and Sekhukhune) reporting a higher vulnerability and perceived higher frequency of droughts, with higher heat intensities in the drought periods, than those toward the south (Alfred Nzo and Joe Gqabi). Nevertheless, even those toward the south still noted droughts as a concern due to the intensity of such events, when it does occur. However, many stakeholders highlighted drought as a district-wide concern across the five DMs, rather than a site specific occurrence.

During the site visits, district-level workshops and engagements with local experts, challenges regarding the status of ecological and built infrastructure alike, in all the five DMs, were noted to further exacerbate these impacts of floods and droughts. Previous climate vulnerability studies undertaken in the period 2016-18 (Let's Respond Toolkit, n.d.) confirm these stakeholder inputs, all indicating that rural communities are highly sensitive to the impacts of flooding and droughts, and thus these hazards should be a priority focus to enable the building of climate resilience in such rural areas.

Based on area-specific and focus-hazard inputs, insights and requests from the local stakeholder engagements, it was agreed that the Eco-DRR project would focus primarily on droughts, floods and wildfires. Considering that drought (and wildfire) incidences lead to degraded landscapes, the interaction between these hazards often gives rise to increased flood impacts. This interaction between droughts, floods and wildfires, coupled with further land degradation, has been underlined by the South African Government's declaration of a National State of Disaster in February 2023, noting flood impacts across various provinces especially those provinces in which the five priority DMs are located. The floods to which the latest declaration relate were all caused by heavy rainfall, affecting seven provinces including the Eastern Cape (where Joe Gqabi and Alfred Nzo DM's are located), Northern Cape, Mpumalanga (Ehlanzeni DM), KwaZulu-Natal, and North West (Ngaka Modiri Malema DM) (FloodList, 2023).

Whereas floods in South Africa are usually fast onset events, the slow onset impacts of drought are well recognised across the country. Due to the recurring nature of dry spells in the southern Africa region, and frequent occurrence of high numbers of heat days, national, provincial and local spheres of government have existing programmes focussing on building adaptive capacity to more effectively support communities during these slow-onset events. Likewise, the management of fire regimes in natural landscapes and the presence of, for example, Fire Protection Associations and local civil society groups involved in landscape-based fire management programmes, provide capacity to support management and mitigation of the prevalence of fire under ever-warming climates. With regards to flooding, however, there is consistently reported limited capacity to address the rapid onset and ever-increasing variability of precipitation-related hazards. The contrasting nature of flooding, with huge deluges of water appearing and often disappearing within short timespans, versus droughts which come and go at a slow pace, puts the capacity of communities to the test. This testing occurs constantly and without reprieve, no matter what season it is, or which Oscillation pattern - El Niño and La Niña (the two opposite phases of the El Niño-Southern Oscillation cycle) - is present. Rapid onset floods *versus* slow onset droughts, are usually addressed through separate initiatives, hence the decision to focus primarily on floods in the Eco-DRR project, with secondary consideration given to droughts.

The site visits to areas across the five DMs and stakeholder engagements during site visits with local experts, as well as via virtual interviews after the visits, further revealed limited institutional, financial and technical capacity in municipalities as well as communities across all five the DMs. This capacity constraint reflects as an inadequate ability to prepare for, prevent, mitigate, respond to and manage the impacts of floods and droughts alike. Rapid onset of floods and lack of EWS for floods and droughts, but especially to flash floods, were mentioned as having significant impacts not only at the time of the event, but thereafter - usually derailing or delaying other development initiatives as a result. Although, in the case of droughts, the situation usually progressively becomes worse over longer periods, and more time is available to communities and institutions to theoretically better prepare for drought-related impacts, the reality is that early warning and preparedness is generally not applied. This lack of early intervention often is due to the communities and institutions having to deal with other and especially rapid onset events, resulting in an inability to attend to the slower-onset nature of droughts. As a result, communities and institutions tend to be almost entirely reactive when responding to droughts, floods and wildfires alike (rather than proactive). Such a responsive approach is not productive and low mitigation, prevention and adaptation outcomes result, with the ultimate consequence being even lower resilience, higher vulnerability, and livelihoods that rely on external assistance and developmental support.

The impacts of droughts, floods and wildfires and ultimately overall disaster risk levels, are explored in several publications, showing the complexity in understanding and addressing the impacts of climate change and climate variability on these hazards (Liu, et al., 2022; Sofia & Nikolopoulos, 2020).

The impacts of climate change related droughts, floods and wildfires disasters affect food production with subsequent impact on food security and human health and wellbeing – with subsequent stressors on governance and humanitarian actors when supporting communities affected by these hazards and secondary long-term impacts. droughts, floods and wildfires disasters alike often have devastating consequences on food production. Floods inundate settlements, farms, pastures and livestock, which could subsequently reduce crop yields and animal production. Similarly droughts impact food production through reduced yields, poor quality of produce, with lower subsequent market value and nutritional efficacy, or even entire crop failure. While natural fires contribute to the health of an ecosystem, uncontrolled wildfires cause significant damage to infrastructure, industrial facilities, livestock, fodder banks, agricultural equipment, plantations and homes as well as the loss of life (Field, 2024). The impact on wildfires on small-scale farming has a negative effect on food security and rural livelihoods that depend on agricultural activities. Floods also destroys physical infrastructure and disrupts socioeconomic activities which are linked to agriculture sector and could affect food production – inhibiting the ability of farmers to deliver their goods as well as communities to access markets. This eventually decreases food availability, accessibility, utilisation, and stability in the region (Atanga & Tankpa, 2021)

Therefore, the need to undertake drought-, flood-, or wildfire-related interventions require a much deeper understanding and an integrated approach, than merely considering one or the other hazard on its own. In areas where only one of the hazards dominate, it is feasible to have a singular focussed approach. However, where these hazards coalesce, a better understanding of how climate change induced ecosystem impacts occurs is becoming increasingly important. The integrated approach in areas where multiple hazards dominate is especially necessary in rural and peri-urban or under-serviced communities where sensitivity and vulnerability to the impacts of hazards are high and resilience and capacity is low. Furthermore, the nexus between droughts, floods and wildfires hazards requires integrated approaches, since only integrated approaches to **increase resilience** against these hydro-extremes can **bring the needed systemic changes** because of the complexity of their impacts (Aich, 2023). An example of recent efforts include the joint flood and drought programmes of the World Meteorological Organisation and Global Water Partnership. These efforts focus on a combined approach to address both hazards in an integrated manner whilst enabling EbA and NbS solutions on the ground, for example to protect services and road infrastructure, dwellings, crops and cropping as well as grazing land in differentiated manners against floods and droughts. As a result, the resilience of communities and institutions are enhanced to provide a combined approach to the two hazards. In this manner, a multiplication effect can be harnessed, where resilience is strengthened to both hazards at the same time, through improved capacity, awareness, and strengthening of community and institutional bonds.

4.5 ALFRED NZO DM

4.5.1 General Description

The Alfred Nzo DM stretches from the Drakensberg Mountains, bordering Lesotho to the north, to the OR Tambo DM in the south and Sisonke DM in the east. It is the smallest DM in the Eastern Cape and is considered one of the poorest. The DM is characterised by high levels of poverty (Beraki, 2019). It contains five LMs, namely: Matatiele, Ntabankulu, Umzimvubu, Winnie Madikizela-Mandela (previously Mbizana). Economic opportunities in the region include the potential for tourism and forestry, however, a challenge has been the provision of infrastructure to settlements in hilly areas and including the provision of basic services.

The Alfred Nzo DM covers an area of 10,731 km^2 and has a population of 936,462, growing at a rate of 1.5% per year (Stats SA, 2023). This DM has a large number of people who depend on the working-age population for support, with a dependency ratio of 74%, indicating many children and elderly who rely on others for their livelihood (Stats SA, 2016). There is a notable imbalance between the number of males (47%) and females (53%), largely as a result of men leaving the area to find work elsewhere (Stats SA, 2016).

Living conditions reveal that most homes (53%) are traditional structures, and the average household consists of about 4.7 people (Stats SA, 2016). More than half of these households (58%) are led by females, reflecting the impact of men leaving for jobs. Sanitation is a challenge, with only 5% of homes having a flush toilet and the vast majority (82%) using pit toilets (Stats SA, 2016). The majority of households (52%) do not have access to safe drinking water and most people (52%) source their water from rivers and streams (Stats SA, 2016).

The financial conditions are challenging, with a large portion of the community's income (94% in 2015) coming from government grants and subsidies (Stats SA, 2016). Moreover, 22% of the population falls below the poverty line (Stats SA, 2016). The level of education is low, with a decrease in the number of people attending educational institutions by 2% between 2011 and 2016. Alfred Nzo has the smallest percentage (17%) of people with secondary education in the Eastern Cape (Stats SA, 2016). As a result the DM has a high level of unemployment (36% in 2016, ~3% increase since 2008), with 30% of the employment being informal, particularly in trade and construction (ECSECC, 2017). In 2016, the average annual income per capita in the DM was R20,500, and large number of families (22% in 2016) live on an annual income of R30,000 or less (ECSECC, 2017; Stats SA, 2023).

Agriculture involves the majority of households (52% in 2016), with a notable focus on chickens and livestock, such as goats and cows (58%), and very little involvement in industrial crops (less than 0.5% in 2016) (ECSECC, 2017; Stats SA, 2023). This sector is expected to see the most growth, at an average rate of 3.5% annually (projections from 2016). However, the high rate of poverty (78% in 2016) and a low Human Development Index (an HDI of 0.512 in 2016) highlight ongoing socioeconomic challenges (ECSECC, 2017).

Intensified rural housing sprawl and migration of households towards centralised towns were clearly visible across the DM when site visits were conducted. Although most agricultural activities are subsistence there are several commercial farms situated toward the northeast of the DM, around Cedarville town. Crop farming consists of mainly dryland farming, with some irrigated crops, and livestock herding includes goat, sheep, beef and dairy farming (Alfred Nzo DM, 2019).

The priority catchment in the Alfred Nzo DM, as per QCs, is T32G (Figure 4-13). Hydrologically, catchment T32G is located within the Mzimvubu/Umbashe primary catchment and the Mzimvubu secondary catchment. The main river located within this QC is the Mzintlala River, which is a tributary of the Mzimvubu River. This system is a headwater system, which means that there are no rivers contributing streamflow from surrounding catchments.

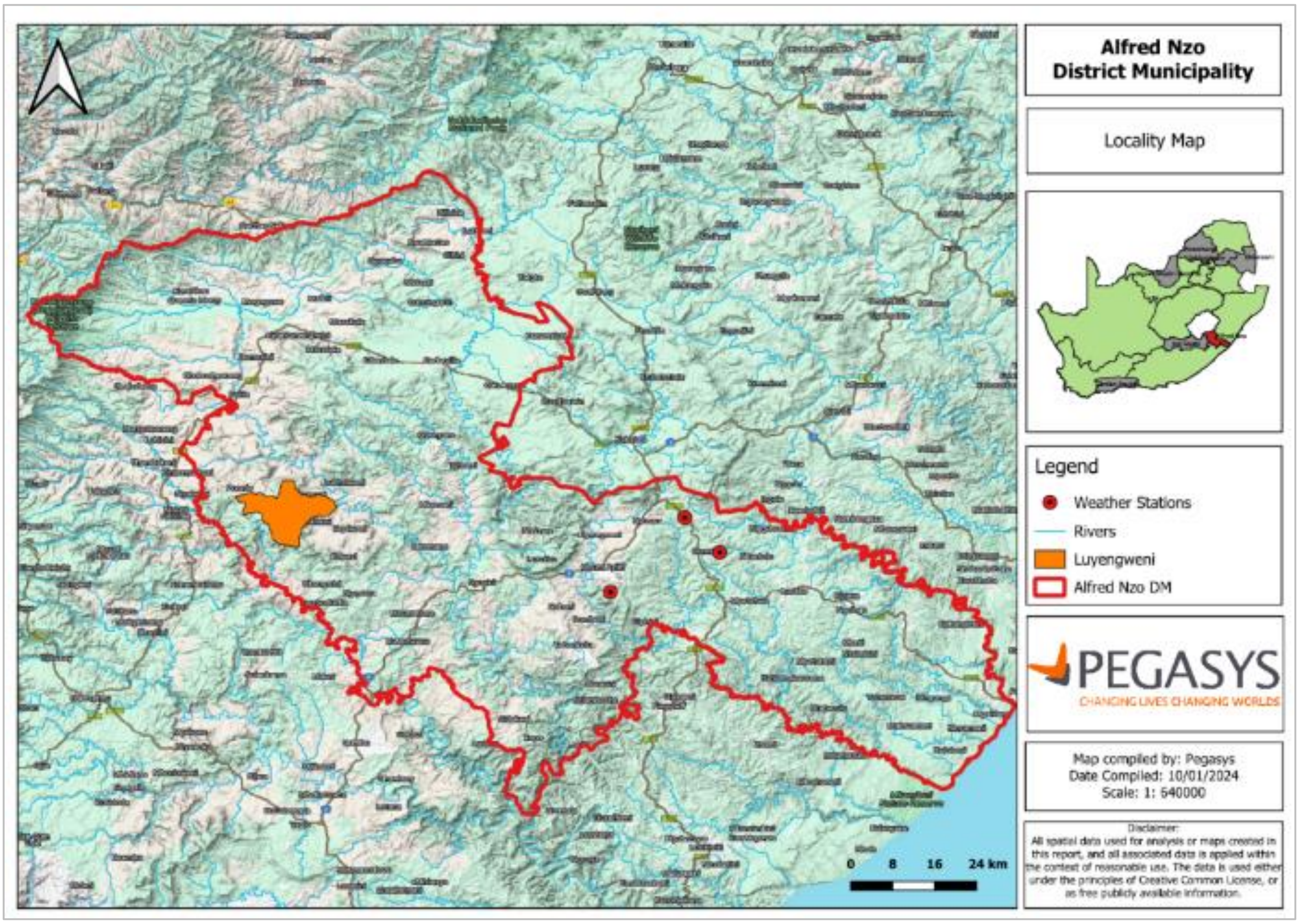

Figure 4-13: Alfred Nzo DM and Priority QCs

4.5.2 Identification and Selection of Priority Areas for Implementation of Eco-DRR Interventions

As described previously, through a process of desktop analysis coupled with expert input and several stakeholder engagement workshops and site assessments, priority areas for possible investment in ecosystem-based climate adaptation actions were identified. Stakeholders invited to the workshops and subsequent site assessments included government officials (e.g. DM, LM, Agricultural, Environmental Affairs, COGTA, NGOs and civil society, private sector, and water users). Flooding was recognised as a significant hazard in the DM by participants during the district-level workshop. The impact of flooding was felt on communities' dwellings as well as farmers' crops and livestock in the affected areas. Roads and bridges were also severely damaged during flooding periods and often resulted in villages being cut-off from services and surrounding towns. According to workshop participants, flooding was most prevalent during heavy rains and hailstorms in the region and was also exacerbated by deforestation, overgrazing, illegal sand mining, soil erosion due to steep slopes and terrain (especially the presence of large dongas i.e. dry gullies formed by the eroding action of running water). It was also noted that some houses have been built along drainage and flood lines, further increasing communities' risk to flooding. The wetlands in the area were noted as degraded by many of the attendees. The participants were in agreement with T32G being identified for intervention implementation in the district as well as being in alignment with DM and LM plans.

In addition, the site visit in the Alfred Nzo DM revealed the presence of IAPs, specifically wattle that was present in significant amounts (Figure 4-14). IAPs that are easily dislodged during heavy rains or floods (e.g. wattles and sesbania) tend to block watercourses, exacerbating the flood event or diverts flood water to other more vulnerable areas. There is also encroachment of "ouhout" bushes (*Leucosidea sericeas)*. The flowers and young shoots are browsed by cattle and goats in spring. However, it forms dense thickets on overgrazed, eroded or otherwise disturbed areas, and can therefore become a problem plant on farmland. Poor and inefficient rangeland management practices, coupled with climate change impacts on the drought-fire cycle exacerbates alien plant invasion and bush encroachment alike, and secondarily decrease undergrowth, resulting in increased runoff, erosion and subsequent flooding challenges downstream.

Figure 4-14: Examples of wattle invasive growth (photo on the left and on the top left-hand side of the photo on the right) and removal (right-hand side on the photo on the right) in Alfred Nzo DM

Figure 4-15: IAP clearing in Alfred Nzo DM: current activities (photo on the left) and historical clearance (photo on the right)

The site visits also highlighted current as well as historical IAP clearing activities (Figure 4-15), showcasing strong intent and commitment within the DM to address IAP issues. At the same time, it was established that there is opportunity to build on previous work, and expand and upscale existing strategies whilst learning from the previous experiences.

During the site visit, there was also clear evidence of erosion during heavy rains which threatens households as well as roads and bridges (see Figure 4-16 and Figure 4-17). Significant erosion challenges were visible, especially where infrastructure development was poorly implemented. An example is where the size of culverts are too small for the volume of runoff that is being experienced, and erosion subsequently occurs on both sides of a road where this is prevalent. In other instances, floods/floodplains exceed the span of bridges, and surrounding road infrastructure is eroded away. In yet other examples, pipe installations and road construction does not accommodate the level of flood and extent of downpours, resulting in landslides cliff-road failures, downstream flooding and siltation, etc. In some locations, entire settlements were close to sliding down hillsides due to erosion and subsequent flooding. It was also noted during the site visit that pollution (i.e. nappies) are blocking culverts, which exacerbates flooding across much of the DM.

Figure 4-16: Examples of erosion and run-off threatening households in Alfred Nzo DM

Figure 4-17: Example of erosion and flood extent threatening a bridge in Alfred Nzo DM

Wetland degradation was also seen during the site visits due to pollution, encroachment of villages and poor agricultural practices, although this is related more to poor spatial planning and lack of local enforcement.

A rainfall analysis as well as a drought hazard and socioeconomic vulnerability assessment was undertaken for the DM and the findings from these analyses can be found in the *CRVA* that forms part of the annexures accompanying the FFP.

4.6 JOE GQABI DM

4.6.1 General Description

As presented in Figure 4-18 the Joe Gqabi DM borders the Free State Province and Lesotho to the north, Alfred Nzo DM is to the east and Chris Hani and OR Tambo DMs are to the south. The southern Drakensberg Mountains form a watershed that separates the eastern and western parts of the DM. The DM falls within the Umzimvubu and Orange River Basins and is largely rural in nature with a few smaller urban nodes. The Joe Gqabi DM contains three LMs, namely the Elundini, Walter Sisulu and Senqu LMs.

The Joe Gqabi DM, encompassing an area of 25,663 km^2, has a population of 372,912, and an annual growth rate of 1.2% (Stats SA, 2023). The community is relatively young, with 77% of the population below the age of 34, and shows a gender distribution of 47% male and 53% female (Stats SA, 2016). A large number of individuals, including children and the elderly, depend on the economically active segment of the population (64% dependency ratio) (Stats SA, 2016).

Approximately 30% of households in the DM are living in traditional or informal dwellings. The average household size is 3.2 people (Stats SA, 2016)., and 20% of households have five or more members, with nearly half (47%) of households led by females (Stats SA, 2016). While sanitation infrastructure is more developed compared to other districts, 46% of households do not have toilets connected to a sewage system (Stats SA, 2016). Furthermore, a large portion of households (27%) do not have access to safe drinking water and 23% of the population sources their water from rivers and stream (Stats SA, 2016).

Education levels are low, with more females (8.4%) than males (7.7%) having no schooling, and only 20% of the population have completed secondary education (Stats SA, 2016). The low education level affects employability and the district's attractiveness to investment, which requires skilled labour (Joe Gqabi DM, 2022).

About half of the people that can work are doing so (49% labour participation rate in 2016), but unemployment has increased in the last decade. Between 2010 and 2020, unemployment increased from 25% to 39% (Joe Gqabi DM, 2022). Almost a third the people employed are working in the community services sector, which is predominantly government services (29% of total employment). While the trade sector sees the highest number of informally employed individuals (Joe Gqabi DM, 2022).

The DM relies heavily on grants and subsidies, which accounted for 79% of the total income in 2015 (Stats SA, 2016). The average annual income per person is ~R15,000, with an increasing poverty rate reaching 73% below the poverty line in 2020 (Joe Gqabi DM, 2022). Furthermore, the Human Development Index (HDI) stands at 0.61, below both the Eastern Cape and national averages (0.66 and 0.71, respectively) (Joe Gqabi DM, 2022).

Agriculture is important part of the local economy and livelihoods of the community (Joe Gqabi DM, 2022; DALRRD, Joe Gqabi DM & Province of the Eastern Cape, 2016) , with 20% of farming subsistence and 80% commercial. The large majority of households involved in agricultural activities raise chickens and livestock, such a sheep, goats and cattle (67%), while fewer households grow grain and vegetables (24%), and less than 1% are involved in industrial crops (Stats SA, 2016).

Despite limited land suitability for cultivation, the district supports grazing for farming stock and has a significant share of young working-age individuals (22% between 20 and 34 years old in 2020) and is projected to grow at an average rate of 3.8% annually (Joe Gqabi DM, 2022).

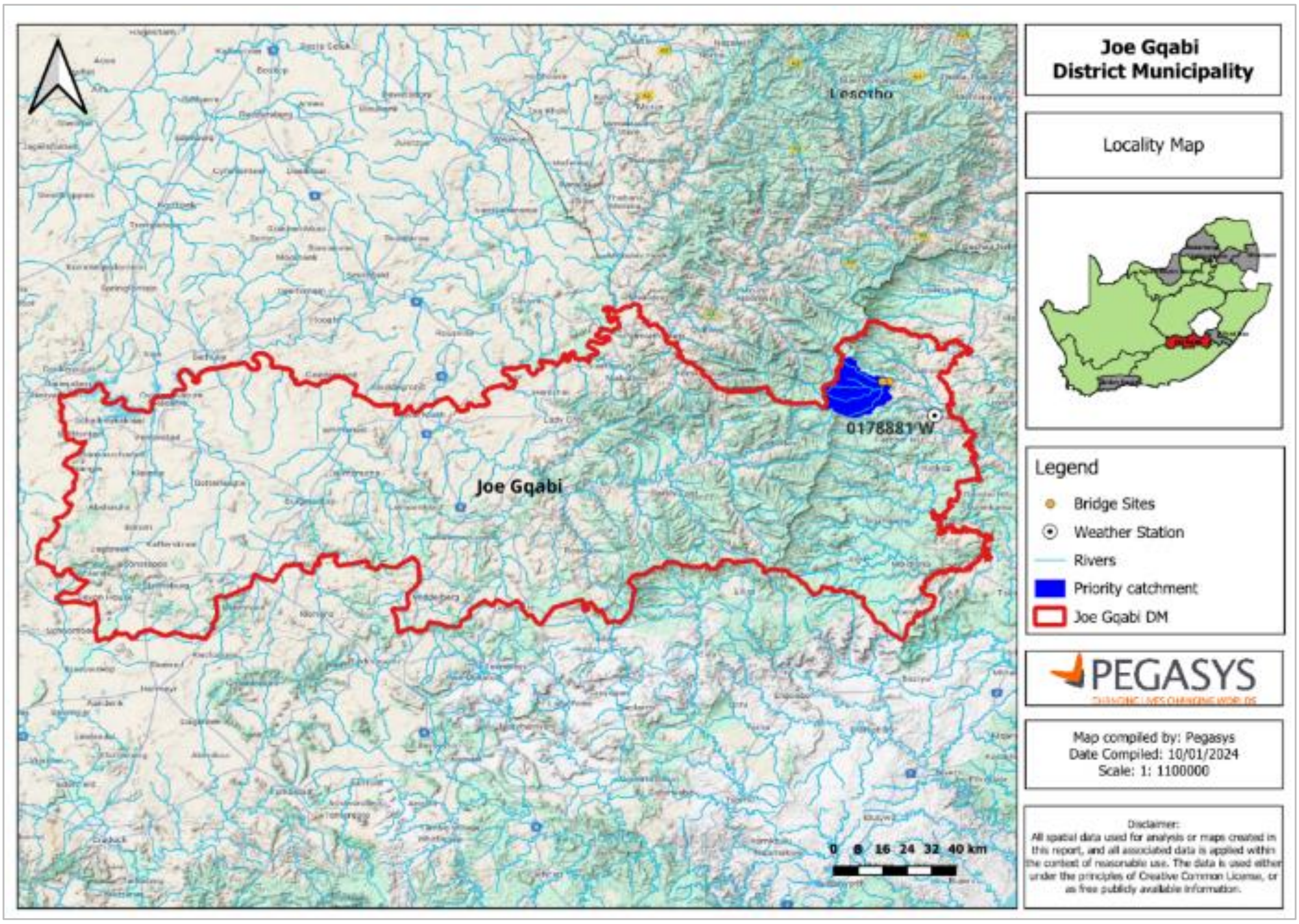

Figure 4-18: Joe Gqabi DM and Priority QCs

4.6.2 Identification and Selection of Priority Areas for Implementation of Eco-DRR Interventions

As presented previously the priority areas for Eco-DRR interventions, within the Joe Gqabi DM, were selected based on several engagements with stakeholder groups and broader vulnerability assessments. Through this process QC T34A (at approximately 30°38'8.45"S and 28°13'14.01"E was selected as the broader catchment area within which Eco-DRR investments are most required. This catchment is located on the edge of the Great Escarpment within the Mzimvubu/Umbashe primary catchment (T) and the Mzimvubu secondary catchment (T3). The main rivers within QC T34A are the Thina, Vuvu and Khohlong rivers. This catchment is a headwater system meaning that there are no upstream flow contributions to the river system from surrounding catchments.

During the workshops, flooding was cited as the most prevalent hazard across the DM, with particular vulnerabilities noted to occur with the impact of floods on roads and bridges, affecting accessibility to schools, health facilities and retail, followed by the impact of floods on dwellings and crops. During the stakeholder engagement process, several areas of vulnerability were identified, however, the area that came across as being the most vulnerable was towards the east of DM, in QC T34A.

Further to the flooding vulnerabilities highlighted during the stakeholder engagement workshop, floods were identified as a critical issue during the site visit, with numerous areas within the T34A catchment being observed to be associated with a high flood risk. Flooding vulnerabilities are exacerbated by the presence of extensive IAPs, soil erosion, habitat destruction, poor agricultural land management, bush encroachment, overgrazing, wetland degradation and poor governance. In particular, local impoundments, such as the Mt Fletcher Dam (Figure 4-19 below) showed significant silting which results in a reduction of storage capacity and therefore negating attenuation of floods and increasing the flood risk to the downstream communities.

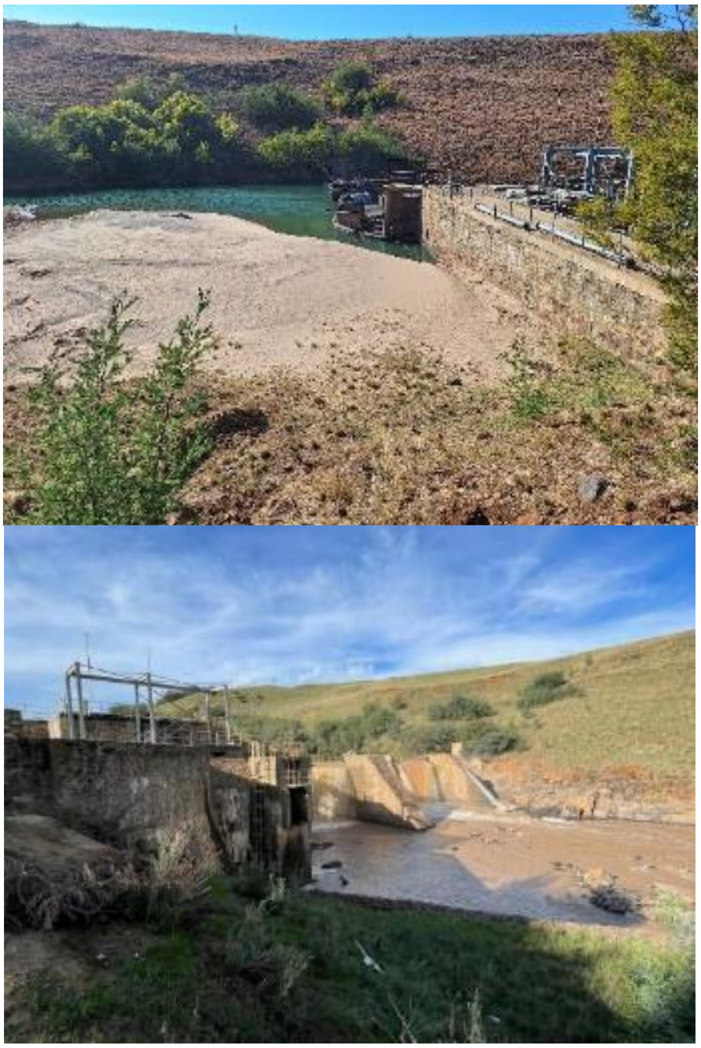

Figure 4-19: A dam in Joe Gqabi DM that has reduced capacity due to siltation

In addition, numerous areas of significant erosion was noted during site visits. In several instances the gullies associated with the areas of erosion threatened the structural integrity of dwellings located in close proximity to the area of impact (see figure below).

Figure 4-20: Example of erosion threatening households in Joe Gqabi DM

Figure 4-21: Presence of IAPs along a river in Joe Gqabi DM

As depicted in the photograph above, IAPs have established themselves along the riparian areas of rivers and streams. This trend was evident across most of the DM. In addition to the riparian area infestation, numerous areas of far more extensive infestation (outside of the riparian areas) was observed. During the site visit, it was also noted that poor rangeland management and grazing strategies have significantly contributed to environmental degradation, which has ultimately resulted in the erosion related issued highlighted above.

A rainfall analysis as well as a drought hazard and socioeconomic vulnerability assessment was undertaken for the DM and the findings from these analyses can be found in the *CRVA* that forms part of the annexures accompanying the FFP.

4.7 EHLANZENI DM

4.7.1 General Description

The Ehlanzeni DM is located in the north-eastern part of the Mpumalanga Province and is bordered by Mozambique and Eswatini. The DM contains four LMs: Thaba Chweu, City of Mbombela, Nkomazi and Bushbuckridge. The Ehlanzeni DM falls within the Komati and Olifants River Basins. This is an important watershed area, which, because of high rainfall, is a source of a number of perennial rivers as well as containing important wetlands (Partridge, et al., 2010).

Mpumalanga has substantial coal mining activity and an active mining sector. It produces close to 90% of South Africa's coal and is home to three of the biggest coal power stations in Southern Africa. In addition to mining, other major sectors in the province include forestry and agriculture. The province also has a large fruit and vegetable market.

In 2022, the Ehlanzeni DM has a population of 2,270,897 and annual population growth rate of 3% (Stats SA, 2023). This region displays a gender distribution of 53% females to 47% males (Stats SA, 2023). A significant portion of the population, 37% as of 2016, falls within the 15 to 34 age bracket, indicating a youthful demographic (Stats SA, 2016).

The large majority of households (96%) live in formal dwellings, and the working-age population constitutes 65% of the total in 2022, with a dependency ratio of 54% (Stats SA, 2023). Educationally, 14% of the people have not received schooling, and only 41% have completed secondary education (Stats SA, 2023). The average household has 4.1 members, with ~30% of households having five or more members, and nearly half (48%) of households led by females (Stats SA, 2023). Less than half of the households (36%) have flush toilets connected to sewerage, while the majority (55%) make use of pit toilets (Stats SA, 2023). Furthermore, 20% of households do not have access to safe drinking water, and 4% rely on streams or rivers for their water supply (Stats SA, 2023).

The employment landscape has shown a slight increase annually by 1% from 2008 to 2018 (Ehlanzeni DM, 2022). Employment sectors vary, with trade contributing 24% to total employment, community services, predominantly government services, contribute 23% and agriculture accounts for 17% of total employment (Ehlanzeni DM, 2023). Migration patterns in 2016 show 11% moved to Ehlanzeni in search of paid work (Stats SA, 2016). However, unemployment rose to 31% in 2018, recording a 7% increase since 2008, with the expanded unemployment rate for females reaching 47% in 2020, compared to 38% for men (Ehlanzeni DM, 2023). Accordingly, 67% of people are living below the poverty line (2018), which has decreased from 75% in 2018 (Ehlanzeni DM, 2022).

Ehlanzeni is recognised for its agricultural potential, particularly suited for the cultivation of subtropical, citrus and deciduous fruits such as mangoes, litchis, papaws, bananas, avocados, guavas, granadillas and tomatoes (Ehlanzeni DM, 2023). Nuts, tobacco, wood and vegetables are other crops grown in Ehlanzeni area. Yet, agriculture competes with forestry for resources (Ehlanzeni DM, 2023). Agriculture engages 18% of households at the provincial scale in 2016 (Stats SA, 2016), within the DM household agricultural activities include raising chickens (25%), growing vegetables (24%), grain and food crop cultivation (21%) and livestock (13%), with a less than 1% of households engaged in industrial crops (Stats SA, 2016).

Tourism plays an important role, contributing R9.1 billion to the DM's GDP in 2015, largely due to the Mpumalanga gates to the Kruger National Park (Ehlanzeni DM, 2023). Despite these economic activities, the Human Development Index (HDI) was 0.6 in 2020 (Ehlanzeni DM, 2023), the lowest among the districts in Mpumalanga, reflecting ongoing livelihood challenges in Ehlanzeni.

The priority catchment for the Ehlanzeni DM is located to the north of the DM, as presented in the Figure 4-22 below, and includes QC X32D. Catchment X32D is located entirely within Ehlanzeni DM.

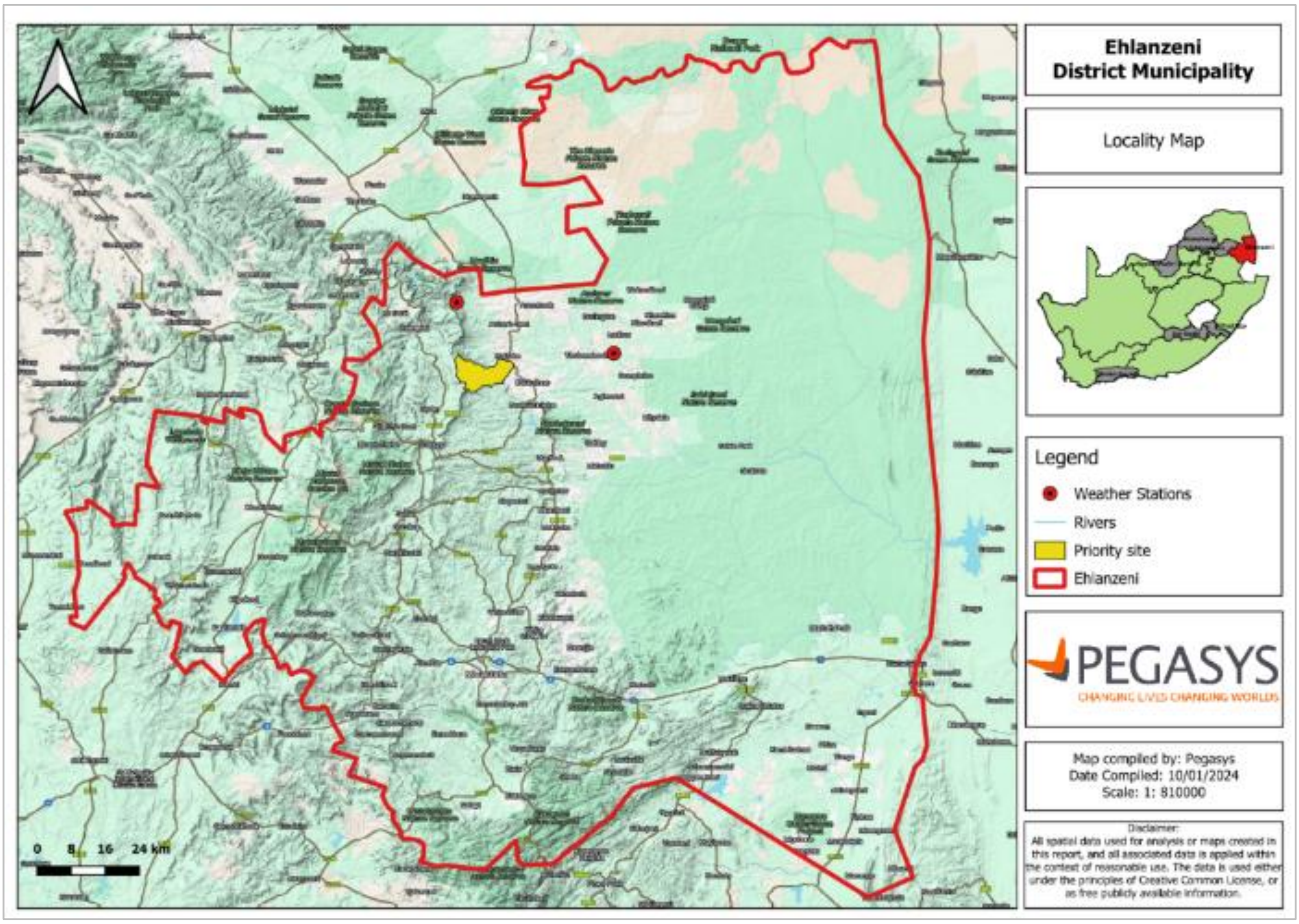

Figure 4-22: Ehlanzeni DM and Priority QCs

4.7.2 Identification and Selection of Priority Areas for Implementation of Eco-DRR Interventions

As described previously, through a process of desktop analysis coupled with expert input and several stakeholder engagement workshops and site assessments, priority areas for possible investment in ecosystem-based climate adaptation actions were identified. Stakeholders invited to the workshops and subsequent site assessments included government officials (e.g. DM, LM, Agricultural, Environmental Affairs, COGTA, NGOs and civil society, private sector, and water users). During the district-level workshop, flood was reported as a high priority hazard, particularly within the Bushbuckridge LM. Localised flooding was common within the LM due to sand mining; deforestation; overgrazing; unplanned settlements; limited or ineffective land use planning and associated poor services delivery; limited waste and road infrastructure; and poor drainage resulting in excessive soil erosion. Workshop participants also highlighted the impact of floods on dwellings, roads and crops (amongst others).

The site visit in Ehlanzeni reaffirmed what was observed during the DM workshop in that flooding is a major risk. Localised flooding has occurred in the Casteel area and stakeholders emphasised the issue of tropical cyclones moving overland from the Indian ocean, and the dangers that intense rainfall and high wind strengths associated with these cyclones pose to the communities homesteads and livelihoods, and to bulk infrastructure. Recent tropical cyclones that moved overland from southern Mozambique across South Africa, has been reported to impact this area and high levels of intense rainfall associated with these events have been reported by residents and stakeholders.

Furthermore, the site visit showed the presence of IAPs Stakeholders during the site visit also emphasised the importance of a number of upstream wetlands in the area that are in various states and require introduction of improved management regimes as well as interventions to rehabilitate them. Additionally, erosion was high in many areas visited during the site visit coupled with poor bank stabilisation. Culverts and bridges were also linked to erosion and poor bank stabilisation (see Figure 4-23)

Figure 4-23: Small-scale built infrastructure in the Bushbuckridge area can be undermined by flooding

Other challenges observed during the sight visit included poor waste management practices, with refuse being discarded and blocking culverts and bridges (see figure below).

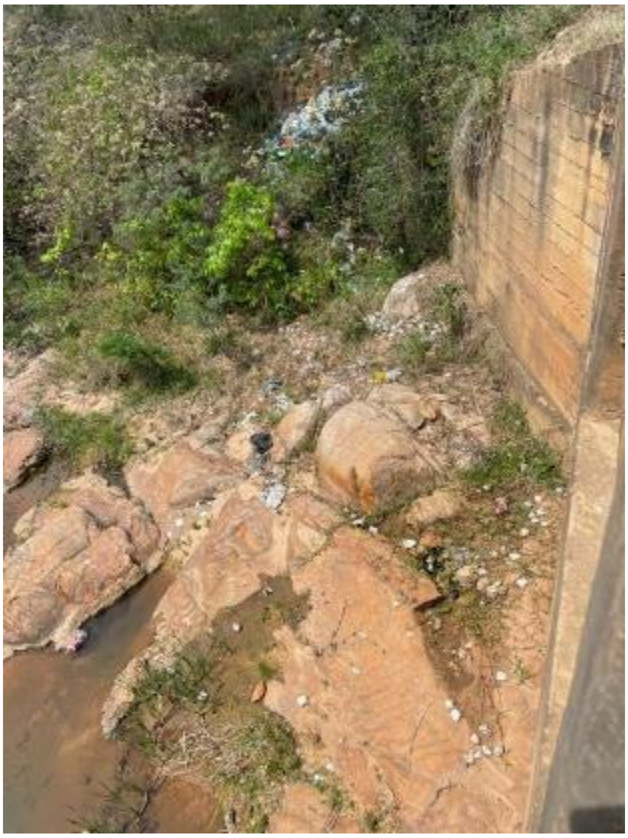

Figure 4-24: Presence of refuse in Ehlanzeni DM

A rainfall analysis as well as a drought hazard and socioeconomic vulnerability assessment was undertaken for the DM and the findings from these analyses can be found in the *CRVA* that forms part of the annexures accompanying the FFP.

4.8 NGAKA MODIRI MOLEMA

4.8.1 General Description

As presented in Figure 4-25, the Ngaka Modiri Molema DM is located in the North West Province and border with Botswana. The province is known for its rich natural resources, wildlife and mining and agricultural sectors. The capital of the province, Mahikeng, occurs within the DM. The DM comprises of five LMs: Mahikeng, Ratlou, Ramotshere Moiloa, Ditsobotla and Tswaing. The province is dominated by a flat savanna and grassland landscape, with hills and ridges, such as the Magaliesberg and Pilanesberg ridges, dividing the landscape and the Kalahari Desert occurring in the west of the province.

The Ngaka Modiri Molema DM, with a population of 937,723 in 2022, has experienced a moderate annual growth rate of 1% (2011–2022) (Stats SA, 2023). The DM has a gender distribution of 51% females to 49% males (Stats SA, 2023). A significant majority of the population, 91%, live in formal dwellings (Stats SA, 2023). The working-age group comprises 63% of the population (Stats SA, 2023), alongside a dependency ratio of 59% (Stats SA, 2023), suggesting that over half of the population relies on the working-age group for support.

In terms of education, 11% of the population have not received any formal schooling, while only 32% have completed secondary education (Stats SA, 2023). The district has an average household size of 3.6 members, with females heading 49%

of these households (Stats SA, 2023). Nearly half the population (48%) of households have flush toilets connected to sewerage systems, though a similar proportion (47%) still rely on pit toilets (Stats SA, 2023).

Financial dependency on grants and subsidies is notably high, accounting for 98.7% of total income in 2015 (Stats SA, 2016). The district has become a destination for educational migration within the North West, with 16% moving to the DM for education in 2016. However, access to safe drinking water remains a challenge for 15% of the population (Stats SA, 2016).

The unemployment rate in Ngaka Modiri Molema stood at 20% in 2018, notably lower than the overall North West rate (Ngaka Modiri Molema DM, 2022). Total employment consist of 34% informal sector. Agriculture is a substantial employment sector, with more than 288,000 individuals employed in this field in 2018, contributing R2.7 billion to the Gross Value Added (GVA) in 2020 (Ngaka Modiri Molema DM, 2022).

The district's Human Development Index (HDI) in 2018 was 0.58 (Ngaka Modiri Molema DM, 2022). Literacy remains an area of concern, with 26% of the population identified as illiterate (Ngaka Modiri Molema DM, 2022). The community service sector, including government services, plays a crucial role in contributing to the GVA, especially in smaller and more rural municipalities (Ngaka Modiri Molema DM, 2022). Both the agriculture and mining sectors have shown growth volatility from 2010 to 2020 (Ngaka Modiri Molema DM, 2022), indicating fluctuating economic conditions within these industries in the Ngaka Modiri Molema DM.

The priority catchment for the Ngaka Modiri Molema is located to the north of the DM close to the border with Botswana (see Figure 4-25). A31H occurs within the Limpopo River Basin (Primary Basin A) and is a headwater catchments. The main river within catchment A31H is the Sandspruit River, which is a tributary of the Marico River.

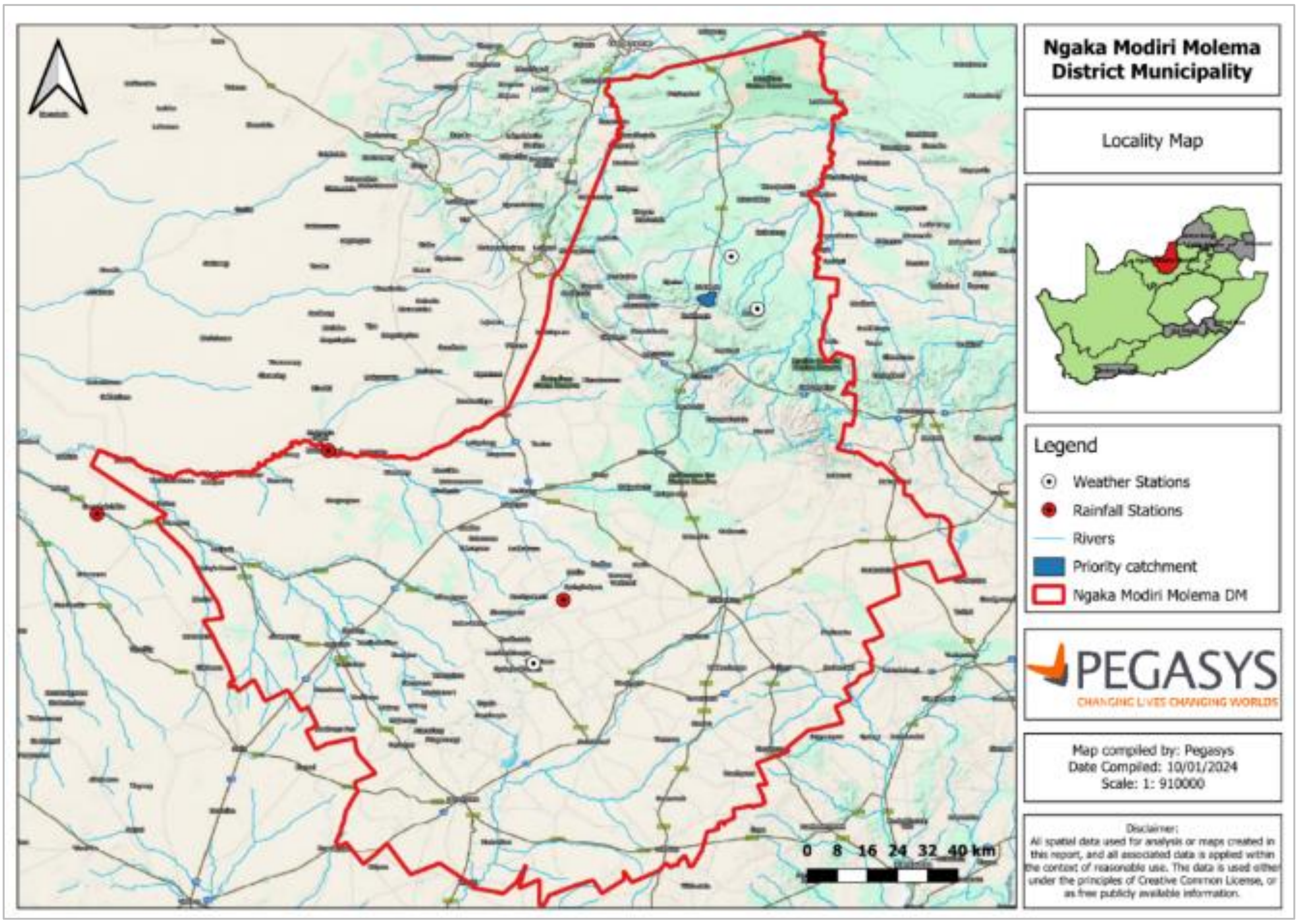

Figure 4-25: Ngaka Modiri Molema DM and Priority QCs

4.8.2 Identification and Selection of Priority Areas for Implementation of Eco-DRR (Key Findings from Stakeholder Engagements and Site Visits)

As described previously, through a process of desktop analysis coupled with expert input and several stakeholder engagement workshops and site assessments, priority areas for possible investment in ecosystem-based climate adaptation actions were identified. Stakeholders invited to the workshops and subsequent site assessments included government officials (e.g. DM, LM, Agricultural, Environmental Affairs, COGTA, NGOs and civil society, private sector, and water users). Through the stakeholder engagement workshops and site visits, it was confirmed that flooding is a consistent issue experienced throughout the DM. It was also confirmed that during flood events, the region experiences excessive soil erosion and poorly developed road and bridge infrastructure often collapses (as presented in the figure below). Homes, schools, hospitals and shops also become inaccessible to communities during floods. Additionally, houses become flooded, and personal assets are destroyed. Poor settlement planning has resulted in some communities settling on pans, thus increasing their vulnerability to environmental hazards such as floods.

During the site visit, the issue of flooding was emphasised with a focus on localised and sporadic flooding. Communities in the areas were more spread out and ranged from rural to peri-urban in nature. Stakeholders that were engaged with during the site visit indicated that communities are increasingly impacted by these flooding, particularly with respect to property and livestock. There were also concerns regarding water security and supply challenges with most being dependent on groundwater supply, due to the area being typically arid.

Figure 4-26: Bridge washed away near Kraai Pan during flooding, Ngaka Modiri Molema DM

In addition to the evidence of flooding across the project area (mainly though damage to bridge infrastructure) erosion was observed during the site visit (see Figure 4-27) and this was typically associated with roads and culverts. In certain areas of the DM, the communities expressed their concerned about the dangers of flash flooding, particularly their children that have to walk home each day. Furthermore, poor rangeland management practices linked to livestock also contributed to erosion and environmental degradation in these areas of Ratlou LM.

Figure 4-27: Donga development alongside roads in Ratlou LM that experience flash flooding during extreme rain events

Overall, the Ngaka Modiri Molema DM has a history of flooding and flood reduction interventions would be well placed to reduce the impact of future floods and protect the lives and livelihoods of those living in the area. Based on the engagements with stakeholders during the initial workshop, as well as the continued engagements during the site visit, the two main areas of particular flood vulnerability were highlighted to be in the Koedoespruit River located in QC D41B near Kraaipan and the Klipspruit River located in QC A31H near the village of Mokgola.

During the engagement process, the project team was taken to the area of Deelpan (within the D41B catchment area) where dwellings were, and some still are, inundated from water stored in the adjacent pans. Based on this site assessment and subsequent analysis, it was concluded that flooding in this area is as a result of the endorheic nature of the pans (where runoff accumulates in the pans as there is no natural discharge point). It was therefore agreed that the opportunities for Eco-DRR interventions in the Deelpan area are limited. The solutions for the flooding problem in this area is likely to be the resettlement of communities. This falls outside of the ambit of this study. Therefore, the focal area for possible Eco-DRR interventions and investment was within the QC A31H near the village of Mokgola, as presented in Figure 4-25**.**

A rainfall analysis as well as a drought hazard and socioeconomic vulnerability assessment was undertaken for the DM and the findings from these analyses can be found in the *CRVA* that forms part of the annexures accompanying the FFP.

4.9 SEKHUKHUNE DM

4.9.1 General Description

The Sekhukhune DM is located in the Limpopo Province, in the south-eastern part bordering on the Capricorn and Mopani DMs in the north, Waterberg in the west, Nkangala in the south and Ehlanzeni DM in the east. The main sectors of the Sekhukhune DM that contribute to the growth of economy in the district are agriculture, mining and community services. Mining is the biggest contributor to the economy of the district (Sekhukhune, 2022). This has influenced the population growth rate, particularly in areas within the Fetakgomo Tubatse LM. The rural nature of the district provides less job opportunities therefore males migrate to the big cities in search for work.

The Sekhukhune DM has four LMs: Elias Motsoaledi, Ephraim Mogale, Makhuduthamaga and Fetakgomo Tubatse. There are new mining developments concentrated in one LM (Fetakgomo Tubatse), while other parts of the district have little potential for increased income levels, and thus expected to remain suffering high levels of poverty (Sekhukhune DM, 2022).

The Sekhukhune DM, with a population of 1,336,805 in 2022, has an annual growth rate of 2% (2011–2022) (Stats SA, 2023). The DM has a gender distribution of 53% females to 47% males (Stats SA, 2023). The majority of residents (95%) live in formal dwellings, and the working-age group constitutes 60% of the population, with a high dependency ratio of 66%, indicating a significant reliance on the working-age population by dependents such as children and the elderly (Stats SA, 2023).

Educationally, 15% of the population have not received any formal schooling, and only 31% have completed secondary education (Stats SA, 2023). The district's households typically consist of 3.9 members, with more than half (53%) led by females (Stats SA, 2023). In terms of sanitation, only 24% of homes have flush toilets connected to sewerage systems, while a predominant 68% rely on pit toilets (Stats SA, 2023).

Approximately 33% of households consist of five or more members, showcasing the prevalence of larger family units. A notable concern within the municipality is access to safe drinking water; the Ephraim Mogale LM reports the highest number of households without access to safe drinking water (58.3%), with 38% of households district-wide facing similar challenges and 15% sourcing water directly from rivers or streams (Stats SA, 2016).

Agriculture plays a significant role in the community, with 24% of households in Limpopo, translating to ~390,000 households, engaged in agricultural activities (Stats SA, 2016). These activities predominantly include raising livestock (36%) and chickens (33%), alongside grain and food crop cultivation (13%). Despite the importance of agriculture, a large majority of farmers (70%) operate on a subsistence level, with a lack of skills being a significant barrier to increasing their productivity (Sekhukhune DM, 2023).

Financially, the district is heavily reliant on grants and subsidies, which constituted 87.1% of total income in 2015 (Stats SA, 2016). The mining sector is the largest within the Sekhukhune District in 2023, contributing 53% to the total GVA and growing at an average rate of 5.6% annually (Sekhukhune DM, 2023). Following mining, agriculture emerges as the second largest employment sector, providing jobs for over 16% of the population (Sekhukhune DM, 2023). However, water scarcity in the area necessitates expensive irrigation infrastructure for effective large-scale farming (Sekhukhune DM, 2023).

The district is known for producing a diverse range of agricultural products, including citrus fruits, table grapes, vegetables, maize, and potatoes, among others. Land use is primarily dominated by subsistence farming (18%), with potential conservation areas making up the second significant land use (24%) (Sekhukhune DM, 2023).

Employment challenges persist, with the total number of unemployed individuals rising to 93,900 in 2018, an increase from 87,600 in 2008. The unemployment rate stood at 29% in 2018, with the Makhuduthamaga LM recording the highest rate at 38% (Sekhukhune DM, 2023). The average household income is reported to be just below R46,000 per annum (Sekhukhune DM, 2023), reflecting the economic conditions within the Sekhukhune DM.

The priority catchment identified in the Sekhukhune DM include QC B51H located towards the centre of the DM (Figure 4-28). The DM has significant undulating plains, with the Klein Drakensberg Mountains covering the north-eastern and eastern side of the Municipality. The main river located within the catchment is the Lepellane River, which is a tributary of the Olifants River and ultimately drains to the Limpopo River. The B51H catchment is at the headwaters of the system, and therefore has no other catchments draining into it.

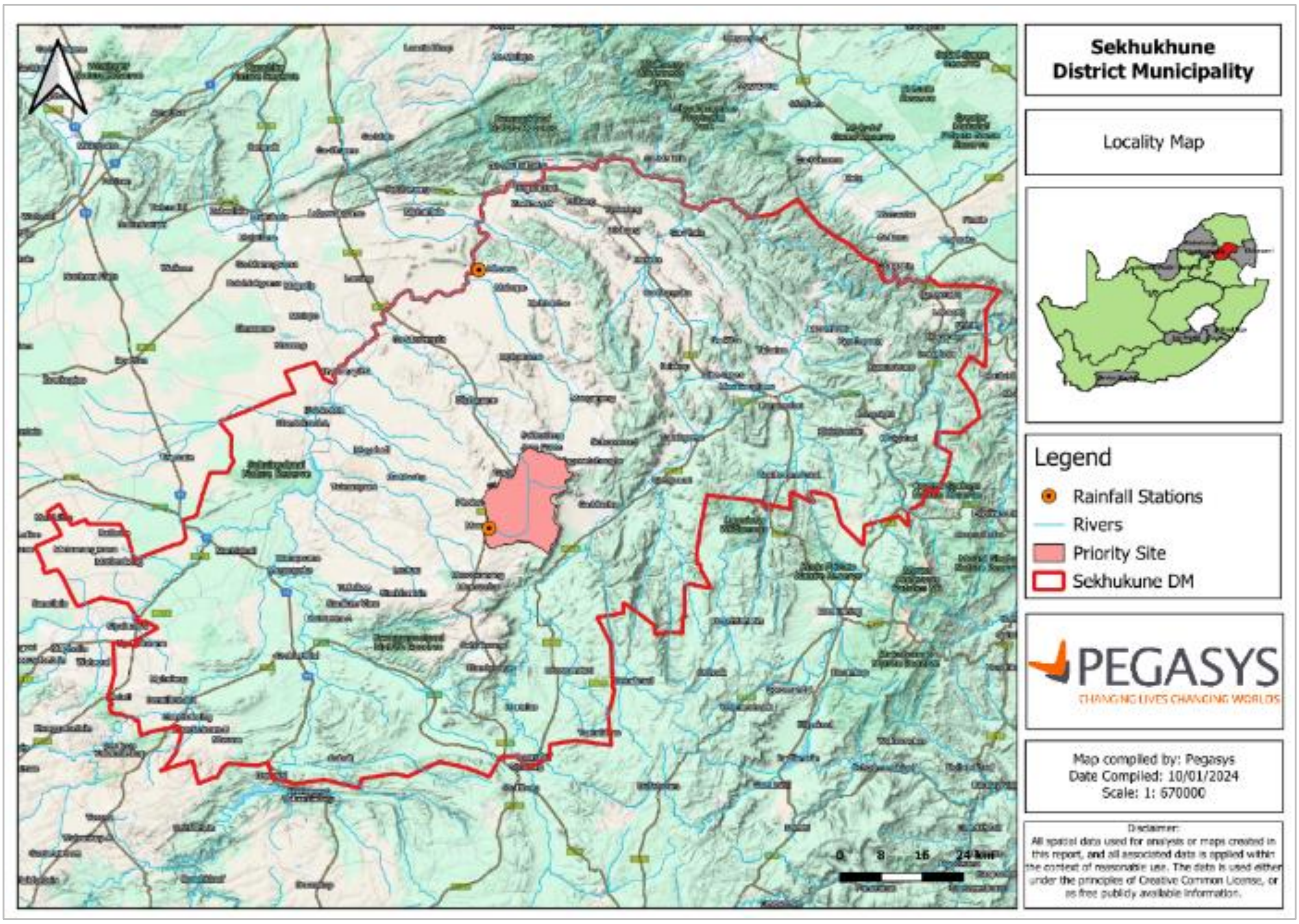

Figure 4-28: Sekhukhune DM and Priority QCs

4.9.2 Identification and Selection of Priority Areas for Implementation of Eco-DRR Interventions

As described previously, through a process of desktop analysis coupled with expert input and several stakeholder engagement workshops and site assessments, priority areas for possible investment in ecosystem-based climate adaptation actions were identified. Stakeholders invited to the workshops and subsequent site assessments included government officials (e.g. DM, LM, Agricultural, Environmental Affairs, COGTA, NGOs and civil society, private sector, and water users). During the district-level workshop, the impact of floods was highlighted by participants, specifically the impact on dwellings, roads, bridges, crops and cropping land. Access to services such as healthcare was also raised at the workshop with such services often being difficult to access during floods. Participants also noted that flood events were exacerbated by overgrazing and illegal sand mining in the area which often resulted in open dongas. The geographical slope of the region was also cited as a key contributor to soil erosion during flooding.

The site visit confirmed the occurrence of flood in B51H with the flood risk being medium to high. Much of the areas visited were densely populated and peri-urban in nature. Due to poor settlement planning at a DM and LM level, regular flooding often negatively impacted communities. In some instances, communities were located close to flood plains, within known floodlines, and within wetlands. This indicate that local spatial planning does not always confirm to accepted standards or norms. Furthermore, due to the nature of the steep topography, very localised flash-flooding is known to occur which threaten homes, livelihoods and lives.

The site visits also highlighted the presence of IAPs in the QC and was linked to bush encroachment. Further, in some contexts, wetland degradation was also linked to poor rangeland management and the management of livestock.

Due to extensive erosion during rains, gullies and dongas were evident in the QC during the site visit (Figure 4-29 and Figure 4-30). which present a risk to communities' livelihoods and households / property. Dongas were also linked to culverts and bridges.

Figure 4-29: Examples of dongas and erosion in Sekhukhune DM

Figure 4-30: High levels of erosion near households in Sekhukhune DM

A rainfall analysis as well as a drought hazard and socioeconomic vulnerability assessment was undertaken for the DM and the findings from these analyses can be found in the *CRVA* that forms part of the annexures accompanying the FFP.

5 Eco-DRR Interventions

5.1 INTERVENTIONS TO SUPPORT ECO-DRR

The underling logic for this project is to provide targeted support for the co-identification, co-design, and co-implementation of Eco-DRR approaches towards preparedness for increasingly severe and more frequent floods, droughts and wildfires due to climate change. It is envisaged that such Eco-DRR approaches will improve ecosystem services and enhance the ability of built and ecological infrastructure to reduce the impacts of floods, droughts and wildfires, particularly when supported by transformational change in policy, planning and financial and institutional capacity. As a result of this, the level of hazard posed by flooding, drought and wildfires may be reduced and the resilience of communities vulnerable to these hazards will be strengthened.

In line with this, the ToC for this project aligns with the reduction of the impacts of these hazards on communities vulnerable to climate change; and creating an enabling environment that is strengthened for continued investment in the management, upscaling, and development of Eco-DRR approaches.

Further to the ToC developed for the broader project objectives, a framework that links the ToC to a roadmap of causal pathways associated with catchment vulnerabilities and potential Eco-DRR interventions, to achieve reduced flood and drought vulnerabilities, is provided in Figure 5-1. This framework has been divided into four broad bands (red, orange, green and blue), which differentiates identified issues associated with the catchment degradation that contributes to increased vulnerabilities and impaired ecosystem services (i.e. “The Problem” in the red band), the implications of these catchment impediments (i.e. “The Result” in the orange band), solutions that may be implemented to remedy the negative impacts of catchment degradation (i.e. “The Solution” in the green band) and then finally, in the blue band, the potential benefits of the implementation of the Eco-DRR related interventions.

As described earlier, through extensive stakeholder engagement as well as several site assessments to the areas of interest, the broad areas of catchment degradation that were identified included degraded rangelands (grasslands), degraded wetland systems, severe gully erosion and extensive areas of IAP’s. The implications of these are described as follows:

- **Degraded Grasslands**: Degraded grasslands are associated with a lower density of vegetation cover and reduced rooting systems. These landscapes experience heightened surface runoff during rainfall events, leading to increased erosion and sedimentation in water bodies. The reduced capacity of degraded soils to absorb and retain water results in diminished groundwater recharge, influencing the availability of water resources, particularly during the drier winter months. Streamflow patterns are altered, exhibiting flashier responses to storms and reduced base flows between precipitation events. Furthermore, degraded grasslands contribute to a decline in water quality as pollutants are transported into aquatic ecosystems. The impacts extend to heightened flood risks during intense rainfall and increased vulnerability to drought conditions. Ecologically, the loss of habitat and disruption of diverse species further exacerbate the consequences of grassland degradation. The degraded quality of these rangelands allows for the encroachment of alien species that tend to dominate indigenous species and creates excessive biomass that exacerbates the intensity and extent of wildfire. More recent rangeland management practices have shifted from this approach and has been replaced with continual grazing, or relatively short rest periods, with little to no herding of the cattle. This caused the vigour of the grass sward to decline, unpalatable species of grass to proliferate, soil sealing and erosion to greatly increase, soil organic matter concentrations to decrease and livestock productivity of the landscape to decline. The interplay between rangeland degradation and the frequency or intensity of floods, droughts and wildfire underscore the need for sustainable land management practices to enhance resilience and mitigate the adverse effects of climate-related extremes in ecosystems.

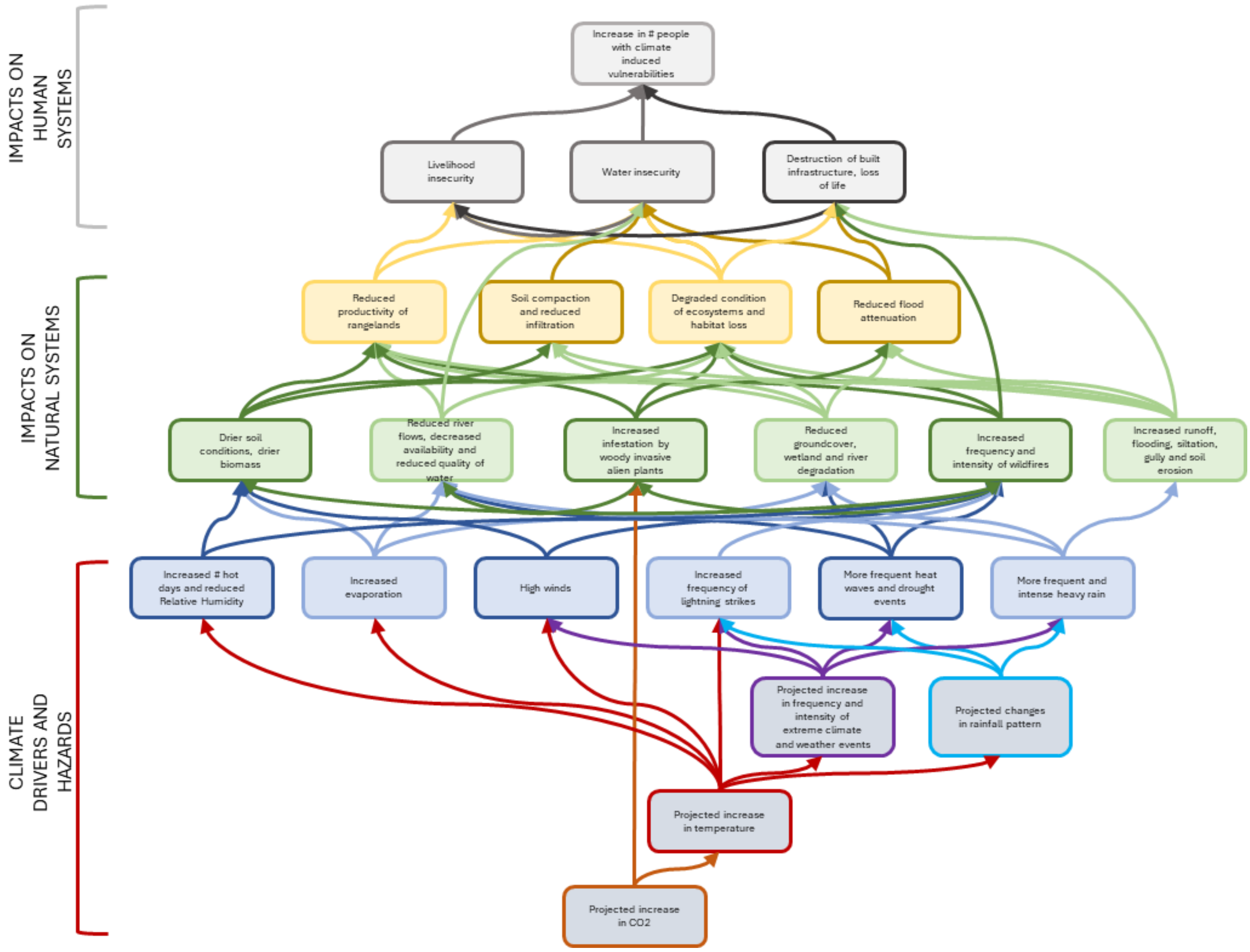

Figure 5-1: Climate impact pathways

- **Degraded Wetland Systems**: When wetlands are degraded, ecosystem services such as water storage and absorption capacities are compromised. Further to this, the ability of the wetland systems to delay and retain a flood pulse is reduced, resulting in areas downstream of the wetland systems becoming more susceptible to flooding. The compromised ability of degraded wetlands to retain water during dry periods, exacerbates the impacts of droughts. The decline in wetland health also contributes to the loss of biodiversity, and are less effective at filtering pollutants and maintaining water quality, leading to downstream consequences for both potable water supplies and the health of aquatic ecosystems.

- **Severe Gully Erosion**: Gully erosion occurs when there is a reduction in ground cover, reducing infiltration and allowing water to concentrate in channels, leading to the formation of deep, often steep-sided channels in the landscape. The impact of gully erosion, including the rapid removal of soil and continued development of deep channels, results in significant losses to the fertility of topsoil, diminishing agricultural productivity and jeopardising the stability of infrastructure (particularly where dwellings are located near to a developing gully). Altered landscape structures contribute to habitat fragmentation, disrupting biodiversity and isolating plant and animal populations. In terms of flooding vulnerabilities, the deep channels formed by gully erosion act as conduits for rapid and concentrated water flow during heavy rainfall, increasing the likelihood of flash floods. These intensified runoff events not only contribute to more frequent and severe floods but also elevate the risk of downstream inundation. The eroded soil from gully systems is often deposited in river channels, reducing their capacity and leading to elevated water levels during rainstorms. Water quality is compromised as sedimentation increases, introducing pollutants into rivers and water bodies.
- **IAPs**: Proliferation of invasive species can significantly influence hydrological patterns in a catchment (Le Maitre, et al., 2020). In the context of floods, invasive plants often alter the natural flow of water in rivers and streams. During the site assessment, significant accumulation of debris on bridge piers was noted. The impact of this is a reduced capacity of the bridge or culvert to convey flood waters, resulting in the bridge being overtopped and, in some instances, washed away. The source of debris was noted to be predominantly from IAP's that had grown on the banks and riparian areas of the rivers or streams. Within the context of droughts, invasive plants can intensify competition for limited water resources, reducing water availability for native vegetation and other uses. The proliferation of IAPs, exemplified by species like wattle (Acacia), exerts detrimental impacts on the hydrological system (Ngubo, et al., 2022). Wattle's high water consumption rates and dense growth alter the natural water balance, intensifying competition with native vegetation and reducing water availability for other plants (Dye & Jarmain, 2004; Moyo & Fatunbi, 2010). The invasive plants also modify streamflow patterns by intercepting water, potentially diminishing groundwater recharge and altering baseflow in streams (Le Maitre, et al., 2020). The encroachment of invasive plants along riverbanks and watercourses can further contribute to channel narrowing, and reduced water conveyance capacity, amplifying the potential for flooding during intense storms (Henderson, 2020). Additionally, the displacement of native vegetation by invasive plants diminishes the natural flood attenuation capabilities of ecosystems (Gaertner, et al., 2016). Encroachment into riparian zones disrupts ecosystems and poses threats to biodiversity (Tiawoun, et al., 2022). Furthermore, the increased flammability of certain invasive plants, including some Acacia species, raises the risk of wildfires, with implications for soil stability and overall ecosystem resilience (Kraaj, et al., 2024) .

Through the rehabilitation of rangelands, wetlands, gullies and the removal of IAP's, much of the vulnerabilities associated with flooding and droughts as a result of catchment degradation can be reversed and resilience to the impacts of climate change can be achieved. The following chapter provides details on Eco-DRR interventions that were identified for the project areas.

5.2 POTENTIAL TECHNICAL INTERVENTIONS FOR ECO-DRR ACROSS PROJECT SITES

In this chapter, we consider the typical land covers that are likely to occur in the study sites, which are largely rural and under communal tenure arrangements (Table 5-1) and associated technical ecological infrastructure interventions to address the specific aspect of ecological infrastructure (Table 5-2).

Table 5-1: Basic description of land cover categories and conditions

Landcover / land use	*Condition*	General description / assumptions
Grassland / Rangeland (including savanna)	*Good*	Generally consisting of good basal cover Some gullies and cattle paths.
	Poor	Generally consisting of poor basal cover, sheet erosion and small gullies (Note: Large gullies addressed in the 'gullies' category).
	Old lands (poor)	Previously cultivated land now abandoned. Poor basal cover and small gullies.
Wetlands	*Good*	Wetland with good cover of wetland species; little or no erosion.
	Poor	Degraded wetlands which are eroded; poor or erratic cover.
Gullies	*Poor*	Large gullies that in addition to needing overall revegetation require (1) interventions around head cuts to slow and reduce the velocity of runoff entering gully and (2) hard structures such as gabions and concrete walls to capture sediment within the gully
IAPs	*Poor*	Focus is particularly on woody invasive species, primarily wattle
Timber	*Transformed*	Includes private sector and state-owned plantations as well as community owned woodlots. These are often upstream and require improved management practices to reduce downstream impacts that are exacerbated by climate change induced hazards. Engagement with the role players is required to encourage better management of problem areas; Forest Stewardship Council certification as the incentive.
Agriculture	*Transformed*	Subsistence and small-scale agriculture located in communal areas. Consists primarily of homestead farming of maize, legumes and squashes
Infrastructure	*Transformed*	Built infrastructure, particularly roads, which influence runoff and drainage, road drainage is often a starting point for erosion and soil loss as flow is concentrated. Bridges and river crossings also impact on hydrology and potential soil loss / degradation.

Table 5-2: List of potential technical interventions considered for implementation in the proposed project sites

Intervention	Description
Improved grazing system	Introduce rotational resting for grazing areas. Employ eco-champs / enviro-champs to control livestock movement.
Stone Lines	Use of stone lines placed along contours to reduce runoff velocity and capture sediment.
Pathway revets	Used to control erosion on pathways. Poles placed across pathways and secured in place to capture sediment and divert water off the pathway.
Contour brushpacks	Branches from woody aliens are placed and secured along contours in degraded and denuded areas to reduce runoff and capture sediment.
Revegetation / reseeding	Sowing of indigenous grass seed mix on denuded areas, behind contour structures and in rehabilitated gullies.
Gabions	Stones packed into wire baskets as mass-gravity structures to slow runoff and capture sediments.
Dry stone walls	Also known as dry stacking, this involves the construction of interlocking stones similar to brick construction, but without mortar.
Concrete weirs	Concrete walls established in degraded wetlands (gullies and head cuts) to capture and spread water and sediment. Can work better than gabions as there are no opportunities for water ingress and subsequent water flow and erosion around the structure. However, expensive and low levels of community benefit.
Rock packing	The placement of piles of rock in small gullies to capture sediment and reduce runoff. These rocks are stacked in piles, much like building a garden rockery. Unlike dry stone walls this does not require high levels of building skills.
Ecologs	Mesh tubes filled with wood processing fibre and secured along contours to reduce runoff and capture sediment.
Earth works	Manual digging and shaping of donga walls to create shallower, more even slopes for installing ecologs and eco-mattresses.
Eco-mattresses	Mats made of biodegradable, photodegradable material such as coconut fibre, wood fibre and straw. These are placed over bare soil as a blanket to retain moisture and reduce raindrop impact to allow seeds to germinate.
Vetiver lines	The planting of vetiver slips along contours. Once the grass has established it provides a living barrier to runoff and traps sediment.
Broad brushpacking	The spreading of brush, usually from woody alien species, across denuded areas to provide shade and moisture retention for seed germination while also discouraging livestock access.
Ponding	Ponding (also known as pitting) involves constructing a series of shallow ponds over a degraded area and planted with seeds. The ponds capture water to promote germination and growth of grass cover.
Fencing	The establishment of fences to prevent livestock access allowing grasslands to recover or prevent further gully formation
Vetiver lines - agricultural	The establishment of vetiver contours in fields to reduce erosion.
Contours - agriculture	The establishment of earthen contours in agricultural fields.
Conservation agriculture	A cropping system that reduces erosion and improves productivity of cropped lands; based on three principles: (1) limited soil disturbance, (2) retaining a cover over the soil, and (3) crop rotation.
Clearing invasive aliens - manual	The removal of woody alien plants by cutting the stem or trunk and treating with herbicide. For this initiative the removal of aliens is primarily to supply materials for brushpacking and large-scale alien species removal is not considered.
Clearing invasive aliens - biological	The use of biological control to reduce or reverse alien infestation. This could be applied in the conservation areas.

5.3 DESCRIPTION OF POTENTIAL INTERVENTIONS

Addressing land degradation involves, at a fundamental level, preventing soil erosion, which is based on three principles:

- Reducing the velocity of runoff water (and in so doing, reduced the energy to erode and carry soil)
- Increasing the infiltration rate of water into the soil
- Dissipating the kinetic energy of raindrops before they impact on the soil (Lotter, et al., 2009).

This can be achieved through a variety of interventions that support the functioning of ecological infrastructure using a combination of hard and soft interventions, in tandem with social and knowledge exchange activities with role-players to build capabilities and sustain investments into the future. Recognising that integrating ecological infrastructure management and planning into supporting improved livelihoods and enhancing resilience to climate impacts, the following benefits are identified:

- Enhanced and sustained livelihoods in the identified catchments, particularly those that are reliant on the use of natural resources;
- Building resilient and productive landscapes that deliver a range of services for local and downstream users;
- Reduced vulnerability to shocks including climate shocks, especially floods, droughts and fires;
- Ongoing and dedicated monitoring to apply adaptive management to sustain the benefits and to quantify the costs and benefits of management actions to support replication and upscaling; and
- Multistakeholder approaches that achieve meaningful participation by communities living in the catchment in decision-making is necessary.

The following challenges to ecological infrastructure are identified:

- Degradation of terrestrial and aquatic ecosystems through inappropriate land use practices;
- Degradation of rangelands due to overgrazing, inappropriate burning regimes and loss to other land uses (e.g. housing);
- High reliance on natural resources for water, fuel, food and building materials; and
- Lack of effective protection and management of natural resources to sustain livelihoods and ecosystem services.

And based on this, the following objectives are identified for the identified catchments:

- To enhance groundwater recharge through improved landcover management (reduced overland flow and sediment transport);
- To enhance water security for local and downstream users in the catchment, with a focus on flood reduction;
- To enhance the structure and function of natural and semi-transformed systems to buffer water flows;
- To enhance the diversity, condition and productivity of rangelands (improved cover to prevent soil erosion);
- To protect 'intact' areas from further degradation (avoiding future degradation);

- To address the underlying causes to mitigate and prevent further erosion and degradation (avoid and limit future degradation);
- To implement, where practical, interventions that maximise local benefit (e.g. labour absorbing, build capacity, enhance livelihoods); and
- To introduce and promote practices that reduce vulnerability and enhance resilience (improved ability to resist erosion and buffer floods and enhance drought resilience.

There are a variety of techniques that can be applied to achieve one or more of the above principles and these are briefly described below. Note that this chapter does not provide an exhaustive nor detailed approach to the methods, but is intended to provide an indication of the principles, practices and potential benefits of the different implementation interventions focused largely on the biophysical outcomes in terms of improved ecological function to contribute to the reduction of climate hazards from a local and downstream perspective.

5.3.1 Woody Invasive Alien Plant and Bush Encroachment Control

IAPs and bush encroachment generate a number of environmental and socioeconomic dis-benefits, including:

- Higher evapotranspiration of water, impacting negatively on water yield and stream flows, especially winter baseflows.
- Loss of productive grazing areas
- Increased erosion as a consequence of loss of soil cover below the tree canopy

Common practice is to fell the larger woody plants (aliens or encroachers) and treat the cut stumps with herbicide to prevent regrowth. In cases where felling is dangerous (e.g. on steep slopes) or not feasible for other reasons, ring-barking or frilling can also be applied. Smaller woody plants and regrowth where the herbicide has not been effective (coppicing) can be either removed by hand, or be subjected to foliar spray by herbicides. Where alien species are cleared, a number of follow-up treatments are required to bring the site back to maintenance condition (i.e. spot spraying of small areas of regrowth once or twice per year (Lotter, et al., 2009). Up to eight follow ups may be required to get the site to maintenance condition (Braack, 2024)

Rehabilitation of cleared areas is necessary to prevent further erosion and establish a permanent ground cover. This provides benefits in terms of increasing infiltration and reducing runoff and also providing competition with invasive plants to reduce regrowth. Different interventions to rehabilitate degraded and cleared areas are discussed below, but detailed site specific plans will need to be developed in consultation with local communities.

Value Adding Opportunities Associated With IAP / Bush Encroachment

There are a number of entrepreneurial / socio – economic opportunities associated with the removal of woody plants species, which include:

- Fuel wood and building materials for homesteads.
- Sale of commercial wood to processors (e.g. sawmills, pulp and paper manufacturers).

- Charcoal production. Avocado Vision (www.avovision.co.za) is currently supporting a small business acceleration programme in Matatiele, Eastern Cape, one of which involves the production of charcoal from woody biomass There is an established business model, which can be applied and replicated at sites where woody alien plant removal is occurring.
- Biochar is another product that is receiving increased attention. It has been shown to be effective as a soil amendment and also can contribute to increased soil carbon stocks. Opportunities also exist to include biochar as a soil amendment in restoring degraded land. Processed biochar could be purchased from local biochar kiln operators and used in restoration.
- Brushpacking (see Section 5.3.6). Small leafy stems and branches can be used in restoration activities to build brushpacks or applied as broad brushpacking. In the case of leguminous woody species, the additional nutrients in the leaf material can also contribute to soil fertility.
- Processing of leaf material for animal feed. Leguminous trees have high concentrations of protein which can be milled and used as fodder for small and large livestock. In the case of wattle, high concentrations of tannins can be problematic, but this can be addressed through the addition of polyethylene glycol.

5.3.2 Vegetative Strips

Vegetative strips, usually planted at regular intervals along a contour line reduce surface runoff velocity, increase infiltration and increase soil moisture conditions. Vegetative barriers are planted as tightly packed continuous hedgerows that can effectively reduce runoff, collect sediment and increase infiltration. They can be applied in agricultural fields, small gullies, sheet eroded areas and other sparse land covers (e.g. overgrazed lands, old, abandoned crop lands).

Vetiver Grass

Vetiver grass (Chrysopogon zizanioides) is a sterile, non-invasive grass commonly used for this purpose to protect land from surface and wind erosion. Vetiver clumps are dug up and separated into slips which are planted along contours, or other areas where the application is required (e.g. streambanks, roadsides). Regular cutting of the grass encourages tillering and the formation of a thick robust hedge, and the grass cuttings can be used for mulch or animal fodder. The vertical interval (VI) between the contours is dependent on the erodibility of the soil, slope and land cover, but usually ranges from 1-5m VI.

Vetiver grass also presents a small enterprise opportunity where local farmers / households can grow vetiver and sell on to rehabilitation teams.

Grass Strips

Other grasses can also be used for this purpose, such as indigenous tuft-forming grasses like *Eragrostis curvula, Hyparrhania Hirta, Cymbopogon excavatus* and *Digitaria eriantha* Main benefits of this technology include improved water infiltration, reduced soil loss, reduced downstream siltation (Lotter, et al., 2009)

5.3.3 Grazing and Rangeland Management

Overgrazing is commonly linked to land degradation, subsequent soil erosion and flooding, particularly under communal tenure arrangements. Broadly there are two forms of grazing (1) continuous grazing, where livestock roam freely over the grazing area and selectively graze more palatable grass species and (2) rotational grazing, where livestock are regularly moved to new grazing areas, allowing grazed areas to rest and recover. Rotation grazing is generally considered to have greater benefits in terms of livestock productivity, increasing infiltration and reducing runoff, and increased biodiversity in rangelands (Smith, 2006),.

Rotational grazing is the practice of establishing grazing areas or camps with similar carrying capacity (i.e. how many livestock can graze an area and for how long – usually expressed on large stock units per hectare [LSU/ha]) and of a similar veld type and animals are moved regularly from camp to camp during the growing season, allowing the grass to regrow (Smith, 2006). This practice requires a sound understanding of carrying capacity, monitoring of the available grazing and a system to manage the grazing camps, either using herders or fencing.

Rotational resting is the practice of giving a designated area of grazing a full growing season's rest every four years. This allows for the recovery of the grass and associated root biomass, while also providing an opportunity for the grass to set seed (Smith, 2006). Rotational resting is simpler in that it requires the identification of one quarter of the grazing area (either one single grazing area, or multiple smaller grazing areas making up the one quarter) and excluding cattle from the area(s) to be rested. Usually, the rested areas is used as a fodder reserve for winter grazing and consequently is important to protect the rested area from fires using firebreaks.

It is also important to note that the herding of cattle in a tighter manner can result in them consuming most of the grass in a landscape, even tall unpalatable grass. This greatly reduces the fire risk in the landscape and cattle can consequently be used as a DRR, fire-management tool. In addition, when cattle are herded in a tight manner with long rest periods for the grazed grass, this can rapidly reinvigorate the grass sward, with all the associated DRR benefits of greater water retention in the soil and greater livestock productivity. Cattle can consequently be used as a DRR, drought- and flood-management tool. However, there are barriers to using cattle as a DRR tool in South Africa's savannas and grasslands including the provision of water to cattle in remote areas, insufficient numbers of cattle of the appropriate frame and breed, and equipment to facilitate the tight herding (e.g. mobile electric fences). In general, smaller framed animals are needed for tight herding. This is because larger framed animals lose condition in a tight herd as there is more competition for grass within such a herd, and insufficient intake of grass material to maintain larger body masses. Rural communities consequently need access to large herds of light-framed cattle in order to use the indigenous practices of tight herding. Financial constraints consequently usually prevent transitioning to indigenous herding practices. Furthermore, it is usually preferable to source the lighter framed animals from within the local area, as the animals have adapted to the local conditions (e.g. have resistance to diseases that are prevalent in the area). This is a constraint in that such animals need to be sourced, bought and then bred up into a large herd.

Benchmarking demonstrations can help livestock owners to better understand how grazing management can improve grazing. Specific grazing areas are set aside and fenced off to allow farmers to observed the change in fodder production over time (Lotter, et al., 2009). From a livestock productivity perspective, stocking within the grazing capacity of the veld is an important grazing principle because this directly dictates the calving or lambing percentage, weaning mass and percentage off-take of animal products. An ‘economic’ stocking rate would optimise production but in the communal areas an ‘ecological’ stocking rate occurs because numbers of animals are more important than production for direct financial gain. It is therefore up to the community to decide whether they wish to implement an ‘economic’ or an ‘ecological’ stocking rate. However, the inevitable consequence of implementing an ‘ecological’ stocking rate is a decline in veld condition and, ultimately, a reduction in the potential of the veld for livestock production (Smith, 2006).

Communal land includes grazing land, cultivation land as well as pathways, roads, and community properties, e.g. schools, clinics, etc. These areas are usually areas of erosion risk and transfer of sediment. Although the physical land management activities are the same for other land, the process to address hierarchy in tenure, and who is responsible for initiating and authorising activities on communal land needs to be appropriately followed. Tenure systems define and regulate how people, communities and others gain access to natural resources, whether through formal law or informal arrangements. The rules of tenure determine who can use which resources, for how long, and under what conditions. They may be based on written policies and laws, as well as on unwritten customs and practices (Braid, 2019). Practical lessons learnt about working in communal land are through projects such as the Green Village Project (Rowntree, et al., 2018) in the Eastern Cape and KZN where the authors focused on how green innovations and technologies can be utilised to create entrepreneurship or jobs that improve the economic conditions of communities living in marginalised rural areas. The Green Village project worked at a micro-catchment or village level. These are considered to be more practically oriented and are directly linked to the opportunities in the local context. Mini-projects were identified at the village level as opposed to the top-down strategic catchment plans. The Sinxaku Village in the Thina Catchment worked with a mini-project linked to a government-driven food garden initiative at a micro-catchment scale. Livestock management initiatives were also planned at the sub-catchment scale.

Overgrazing, trampling of vegetation and burning regimes reduces the natural ability of vegetation to protect soil from erosion. Livestock paths are also considered to be a significant driving factor in the formation of gullies in naturally active sediment systems (Van der Waal & Rowntree, 2017). Veld grazing, when to burn, how to harvest firewood and thatch-grass, and other issues relevant to managing natural resources in veld are collective decisions that need to be made through consensus building with land users – in this case mainly livestock owners. The veld management techniques include conservation and sustainable management practices which account for natural features, and regulate the periods of grazing, the number of animals allowed to graze on a given veld area, and intensity of use (Braid, 2019). These techniques promote continuous yield of veld products while protecting and improving the basic veld resources of soils and water - which support plant and animal life. Overgrazed land leads to increased soil erosion and loss of soil nutrients. This technique entails creating mechanisms to rest grazing land to allow vegetation to recover and protect the soils while other areas are being grazed in rotation.

Where land has been overgrazed, it needs to be rehabilitated in order to improve ecosystem function and goods and services provision. This technique assists with the rehabilitation and protection of overgrazed lands, which are linked to complementary rehabilitation and restoration activiteis, incuding:

- Rotational resting of rangeland to allow the grasses time to recover
- Soil erosion control measures to stop soil erosion and allow grasses to grow.
- Brushpacking (lay out the cut branches of trees with all their twigs and leaves in contours on degraded rangeland to protect grasses beneath from grazing for 2-3 years).
- For some degraded areas, take a large herd of animals through the area for a very short time (a few days, known has High Intensity Grazing, or Bioturbation) then rest the area for a long time (a few months) will enable enable the animals to bring seeds and dung into the degraded area.
- Cattle paths on slopes can be a major source of erosion that can form large gullies. Reducing cattle paths up slopes requires a combination of rehabilitating existing paths and using strategies to prevent future paths from forming including.
    - Identify the reasons why cattle walk along the same paths and methods to encourage the cattle to use different routes.
    - Distribute watering and feeding points away from rivers and sensitive soils to prevent cattle from following the same route to water every day.
    - Use gully rehabilitation methods to repair cattle paths. Allocate grazing blocks so that herders take animals to different areas of the grazing lands regularly and do not follow the same route every day. Encourage zig-zag routes on steep slopes rather than straight up and down.
    - Implement runoff prevent measures along the pathways to prevent erosion.

Firebreaks

When rotational systems are applied in rangelands, certain grazing areas are set aside for winter grazing. It is important that these areas are protected by the burning of firebreaks. Wildfires are prevalent throughout South Africa and firebreaks are necessary not only to protect rangelands, but also lives and property. Benefits include:

- Protection of winter fodder for livestock grazing
- Prevents runaway wildfires
- Protects homes and people

Management and Maintenance Needs

- Co-identification fire risks – engage with communities and farmers to identify historical sources of winter fires to identify locations for strategic firebreaks.
- Orient firebreaks perpendicular to prevailing winds (prevailing winds are generally south west / north east)
- Width of firebreaks in grasslands should be a minimum of 3 metres and should be a continuous and unbroken line across the landscape.
- Work with local FPAs to coordinate actions an ensure weather conditions allow for safe burning.
- Training should be provided to communities on proper firebreak establishment. This can be through the working on fire programme of the DFFE or through the local FPAs .

Resources Needed

- Establishment of fire management committees
- Proper personal protective equipment for fire teams (cotton overalls, fire resistant gloves, masks)
- Firefighting equipment (fire beaters, knapsack water sprayers)
- Herbicides and training for the implementation of tracer lines
- Maps of strategic firebreak areas

Monitoring Requirements

- Annual planning meetings to assess effectiveness of breaks and new fire risks.

5.3.4 Revegetation and Reseeding

Revegetation is the process of replanting vegetation and rebuilding the soil of disturbed land for the principal purpose of rehabilitating and/or protecting degraded land. This usually means a cover of local native plants and involves regeneration, direct seeding, and/or planting methods (Ngucha, 2017). Vegetative improvement provides a suite of benefits through increasing the cover and concentration of grass species. Climax tufted, large grass species are preferred as they established reasonably rapidly (assuming sufficient rainfall) have good canopy and basal cover, resulting in a reduction of all three fundamental causes of erosion. This is often done in conjunction with additional protection measures, including:

- Broad brushpacking
- Mulching
- Fencing (or other forms of livestock exclusion)

When over sowing grass seeds for revegetation, the addition of lime and kraal manure, in one experiment was found to me more effective than using only manure, only lime, or with no soil amendments (Lotter, et al., 2009). This highlights that additional external inputs are required for optimal results.

Revegetation involves ground preparation, for example by controlling weeds and ripping of the soil surface, and it also requires re-spreading topsoil to assist regeneration to occur naturally. In communal areas, kraal manure presents an opportunity to add organic matter to the soil from local sources. Where seeding and/or planting is necessary, the area may be seeded by hand or mechanically or plant with seedling grown in pots or tubestock placed in the soil by hand or machine. In some areas fertiliser application may be necessary to assist with plant growth (ibid). Effective revegetation practices help to accelerate the natural processes that occur following the clearing of vegetated areas and soil disturbance.

Bioturbation

Areas previously cleared of woody alien species and bush encroached areas, and degraded or denuded areas are normally characterised by poor basal cover and limited species diversity. Therefore, in the effort of actively facilitating the recovery of grasslands bioturbation is a process that can help to facilitate rangeland recovery and revegetation. The basic principle of bioturbation is that through concentrating livestock in degraded or denuded areas, hoof trampling by the cattle will break up the capped impermeable soil surface while depositing nutrients and grass seeds in manure. The hoof action also creates micro depressions that help to hold water on the area to be restored (Hawkins, et al., 2022)

The process of bioturbation involves kraaling cattle within a degraded area (in this case, areas cleared of wattle) overnight. Depending on the number and density of livestock kraaled, the process can take between four and eight weeks. Vegetation recovery can be supported by the broadcasting of indigenous grass seeds (either collected locally or purchased from commercial suppliers) to accelerate recovery. The process does require engagement and buy in from livestock owners and risks associated with livestock injuring themselves due to close proximity and theft need to be considered when implementing this type of intervention.

Veld restoration on Degraded Duplex Soils

Duplex soils can be particularly problematic when it comes to erosion. Simply put, Duplex soils have a distinct and marked textural change between the A and B soil horizons, with the B horizon generally having higher clay content and low permeability resulting in these soils being prone to runoff. In some cases, the B horizon is highly dispersive (breaks down and erodes easily), which over time can result in deep gully erosion (Fey, 2010) (Seutloali & Beckhedahal, 2015) (Lotter, et al., 2009; Joseph & Van der Westhuizen, 2021).

For veld restoration in duplex soils, soil samples should be taken to assess the chemical and physical properties of the soil as both chemical (fertiliser / lime) and mechanical (land preparation and planting) interventions are required. Gypsum is recommended as a soil amendment, along with the addition of organic matter (kraal manure works well). Locally occurring grasses should be selected where possible, and local seed harvested (this presents an additional income generating opportunity). Planting can be done using machinery, but hand planting in furrows or planting pits is preferred as it minimises soil disturbance. Broad brushpacking (see0), contour brushpacking (see 0) and stone barriers are recommended to reduce the risk of further erosion (Fey, 2010).

Ponding

Ponding is a form of Rainwater harvesting, also known as pitting or Zai pits. This practice involves constructing a series of shallow ponds over a degraded area. On flat areas the ponds should have a circular shape, on steeper slopes the ponds should take up a U-shape. Ponds are established in a staggered manner across the slope using the contour lines as guidance. During rainfall events, the ponds collect and hold water to allow for the establishment of vegetation. Locally harvested grass seeds or commercially available indigenous seeds can be placed in the pits to allow for germination and revegetation. Kraal manure, compost, or fertiliser can be added to improve water holding capacity and nutrients for better growth of vegetative cover (McCosh, et al., 2020).

Other Forms of Revegetation

Hand sowing

Hand sowing involves little in the way of soil disturbance and allows for more controlled placement of plants within a site. Hand sowing is useful for smaller revegetation jobs, on steep slopes and in areas where machinery cannot or should not go (FloraBank, n.d.)

Revegetation Using Farming Equipment

This is suited to large-scale revegetation establishment on flat to gently undulating plains. It can achieve high volume seedling planting.

5.3.5 Gully Control and Rehabilitation

Gully erosion is one of the most significant sources of the accumulation of sediment and pollutants to streams and has severe impacts on the environment and river health. Gullies (dongas) are common features of mountainous or hilly regions with moderate to steep slopes and are found throughout South Africa. Gullies normally start when fast-flowing water is concentrated on an area due to the shape of the land surface. This process can be natural or as a result of human activity such as overgrazing, livestock tracks, furrows and ruts left by farm machinery. However, as soon as the vegetation and topsoil are removed, gullies spread rapidly up and down drainage lines until there is insufficient runoff that will result in the formation of gullies. It has been proven that gully erosion is the most significant type of erosion that contributes to sediments affecting water quality of any catchment (Lotter, et al., 2009).

Gully erosion severely impacts soil fertility by:

- Removing top soil which is rich in nutrients and organic matter;
- Reducing the depth of soil available for rooting and for storing available plant water; and
- Reducing infiltration of water into soil and increasing run off.

On-site and off-site impacts of gully erosion are:

- Loss of productive agricultural land,
- The provision of a harbour for pests and invasive weeds,
- Deposition of sediments,
- Downstream sedimentation of waterways,
- Detrimental impacts to aquatic biodiversity, and
- The transportation of nutrients and contaminants from agricultural catchments

Rehabilitation approaches include two broad categories – ‘soft’ approaches and ‘hard’ approaches. Soft approaches aim to make use of simpler and lower cost interventions (ideally using materials that can be sourced locally) such as revegetation, brushpacks, stone packs and related interventions that slow the velocity of runoff and capture sediments. Hard approaches make use of earthworks and constructed barriers to erosion such as masonry stone walls, concrete weirs and gabions.

Process for Gully Rehabilitation

The first step in gully rehabilitation is to identify the underlying drivers or source of gully erosion. These could be overgrazing, lack of vegetation cover, pathways (human and livestock), roads, drainage systems or other forms of infrastructure. This first step should be implemented prior an any in-gully interventions.

Subsequent interventions are dependent on a number of factors including:

- The size of the gully – smaller gullies can be rehabilitated using soft options. Larger gullies usually require hard interventions. Very large gullies are usually not worth rehabilitating due to the high cost associated with rehabilitation.
- Whether it is actively eroding or not – actively eroding gullies with regular water flows generally require hard interventions, and interventions in the source area. Gullies which are not actively eroding (usually evidenced by stable vegetation growing in the base of the gully) would benefit from revegetation, brushpacks and other soft options to accelerate recovery,
- The soil type – highly erodible soils are more challenging,
- The size and frequency of water flow – this will determine the size and the spacing of the intervention to achieve reductions in runoff velocity, sediment capture and stabilisation.
- The topography of the area – shallower slopes are generally easier to rehabilitate than steeper slopes, and
- The desired use of the land after rehabilitation – the objective in gully rehabilitation is to stabilise the gully and reduce runoff. Robust, fast growing and deep-rooted species should be used where possible, as grazing improvement or biodiversity recovery are not primary objectives (Lotter, et al., 2009).

Regular monitoring and maintenance of gully stabilisation structures is necessary to ensure that the gully is stabilised and to prevent unanticipated erosion that could result from the interventions. A critical element of success is to ensure that the structure is either (1) 'keyed' in to the gully wall to prevent lateral erosion or (2) extends along the contour out of the gully to prevent lateral erosion.

Approaches and Techniques for Gully Rehabilitation

Gully rehabilitation involves many interventions. The rate of success depends on the planning, design, and techniques employed. The ultimate success is governed by the proper diagnosis of the problem, steps taken to eliminate the causes, and on drastic changes in land use to stabilise the ecosystem (Lal, 1992)

Weirs

Various types of weirs may be used to rehabilitate gullies. These include pervious weirs, concrete weirs, gabion weirs and/or sandbag weirs. Pervious weirs are weirs constructed from permeable material such as brush, logs, and wire netting with straw. They are termed 'pervious' because they let runoff pass through, but trap sediment. A series of small weirs made from wire netting, logs, or bundles of small tree branches, can trap sediment that encourages vegetative growth.

Concrete weirs are generally a high-cost option and are not suited to cracking clay soils. For concrete weirs, reinforcing mesh should be used in the weir and in the dissipater, and weep holes through the wall are necessary for drainage to relieve hydrostatic pressure behind the structure (Queensland Government, 2015)

Gabion or rock weirs are suited to all soil types, including cracking clays, however, care is required when used on dispersive soils where it may be necessary to treat the soil with a gypsum amendment. For a rock or gabion weir, a trench should be dug across the gully floor to a depth of up to 30 cm and keyed into the gully sides to a distance of 1 m. The trench should be lined with a suitable geofabric (filter cloth) that is then covered by a layer of topsoil before rocks are placed to form the weir. A rock apron is required for energy dissipation, with the downstream end of the apron level with or below the gully floor so there is no risk of a new gully head being established. Netting should be laid over the rock and pegged securely on a 1 m by 0.5 m grid. A stoloniferous grass planted into any sediment deposited among the rocks provides greater strength to the structure (ibid). Sandbag weirs are an alternative form of a concrete weir made of sand/cement mix.

Fencing Off Gullies

In many situations, fencing is the most practical option for stabilising a gully. Grazing animals are attracted to gullies, where there may be shade and shelter provided by trees and where there may be fresh growth of palatable plants after rain. Such areas can be subject to heavy grazing, and the development of stock pads can create further gullying. Stock walking around the head of a gully will create a pad that can hasten the advance of the gully head. Where future expansion of the gully is likely, this area needs to be included within the fenced-out area. For riparian areas, any gullies feeding into the stream should be included in the fenced-off area.

Reshaping or Filling a Gully

This option will rarely be cost-effective in grazing lands, unless the gully is threatening a valuable asset. In cropping lands, filling a gully may be cost effective only if the land can be reclaimed for cropping purposes, or for other more intensive land uses. Similarly, reshaping a gully may only be practical if the outcome provides other benefits, such as alternative land use or provision of a stable drainage structure. Whether a gully can be shaped or refilled depends on its size and the amount of fill needed to restore it to a desired shape. When filling a gully, each layer of soil progressively pushed in should be well compacted. Loosely deposited soil will offer little resistance to runoff erosion. Soils that are either too dry or too wet cannot be effectively compacted and may require watering (if too dry) before construction works, or alternatively (if too wet), should be left to dry out to an appropriate moisture content. (Queensland Government, 2015).

5.3.6 Brushpacks

Contour-Based Brushpacks

Contour-based brushpacks involve the placing, tightly packing, and securing of smaller, leafy branches from woody alien or bush encroaching tree species along a contour line. They act as a permeable barrier to runoff, slowing down the runoff velocity and capturing sediment on the uphill side of the brushpack. The leaves provide organic matter and nutrients that contribute to soil fertility to assist with the establishment and growth of vegetation. A contour is marked using an A-frame or dumpy level and pairs of 0.3 m apart pegs are placed at one-metre intervals. The brush is placed between the pegs, compacted down to create a tight, but permeable, barrier and secured in place using wire or string (see Figure 5-2). Brushpacks do degrade over time, lasting 3-5 years, so it is recommended that they are applied in conjunction with other measures, such as vetiver hedgerows and revegetation to provide longer-term protection against erosion. Exclusion of livestock is important during the establishment of vegetation and fencing is recommended to facilitate better establishment of a permanent vegetative cover. Regular maintenance of brushpacks is necessary to ensure that there are no holes or gaps that will allow runoff to be concentrated. Brushpack lines should not be higher than 0.3m to reduce the risk of undercutting on the downslope when they fill with sediment and water overtops during high rainfall events. A one-metre vertical interval between brushpacks is generally recommended, and additional brushpack may be established between existing brushpacks when they fill with sediment (McCosh, et al., 2020).

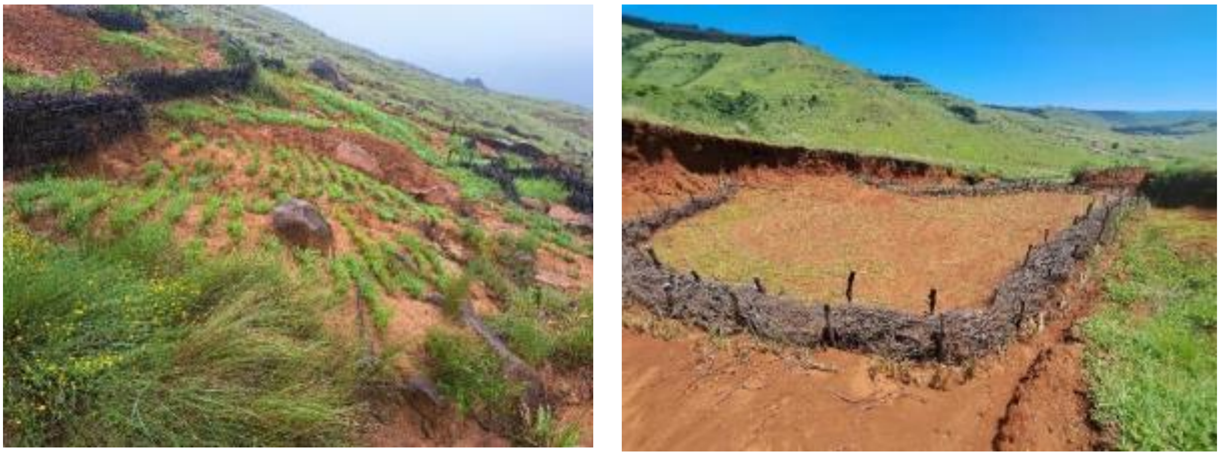

Figure 5-2 Brushpacks and revegetation in the uMkhomazi Catchment, KwaZulu-Natal demonstrating good grass establishment (left) and newly emergent seedlings from planting in November and December 2022 (right)

Broad Brushpacking

Broad brushpacking uses the same woody materials used in contour brushpacking. Branches are harvested from trees and shrubs within the local area and are chopped to about 30 cm. Thereafter, the chopped branches are packed widely over an area, at a depth of 5 to 10 cm, over the soil surface. The brushpacks act as protection for areas that have been reseeded by providing some shade and reducing evapotranspiration (moisture retention) while also reducing raindrop impact and runoff. Leafy material provides organic matter and nutrients to aid plant growth. Broad brushpacking also discourages livestock from grazing newly germinated seeds. Care must be taken to ensure that seed pods from woody alien species are not present when brushpacks are laid over newly seeded areas (McCosh, et al., 2020).

5.3.7 Wetland Rehabilitation

Introduction to Wetland Rehabilitation

The National Water Act, No. 36 of 1998 defines a wetland as "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is periodically covered with water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil". Wetland ecosystems provide a range of ecological and social services which benefit people, society and the economy at large. As outlined by (SANBI, 2014), for example, they:

- Offer services such as water provision, regulation, purification and groundwater replenishment are crucial in addressing objectives of water security and water for food security.
- Play a critical role in improving the ecological health of an ecosystem by performing many functions that include flood control, water purification, sediment and nutrient retention and export, recharge of groundwater, as well as acting as vital habitats for diverse plant and animal species.
- Provide ecological infrastructure, replacing the need for municipal infrastructure by providing the same or better benefit at a fraction of the cost.
- Retard the movement of water in the landscape, which offers the dual benefit of flood control as well as a means of purification. The slow movement of water allows heavier impurities to settle and phreatic vegetation and micro-bacteria the opportunity to remove pollutants and nutrients. For these reasons, artificially created wetlands are often used in newer urban drainage systems to aid both mitigation of flooding and improvement of water quality.
- Function as valuable open spaces and create recreational opportunities for people that include hiking, fishing, boating, and bird-watching.
- Have cultural, spiritual and commercial significance for the communities living nearby. Commercially, products such as reeds and peat are harvested from wetlands.

Recent figures provided by Working for Wetlands indicate that South Africa has lost approximately 50% of the original wetland habitat area within the Republic. Of the remaining wetland ecosystems, approximately 48% are critically endangered, 12% are endangered, 5% are vulnerable and 35% are least threatened (WfW, 2021). An important mechanism used to manage the current integrity and functionality of wetlands within South Africa is the rehabilitation of degraded systems. The successful rehabilitation of a wetland requires that the cause of damage or degradation is addressed, and that the natural flow patterns of the wetland system are re-established and it is important to note that rehabilitation is not a static end-point of a recipe-type process but rather a process on its own where an opportunity is provided to the wetland for a new beginning (SANBI, 2014).

For wetland rehabilitation to be successful, the following aspects must be followed as a guide:

A suitably qualified wetland ecology must conduct a detailed field survey of the proposed rehabilitation site to determine the current extent, present ecological state and ecosystems services delivery potential. Within this strategy the following items must be taken into consideration:

- Formulate a rehabilitation strategy.
- The current observed impacts on the wetland.
- Outline clear aims and objectives for the wetland rehabilitation.
- Identify interventions (soft and/or hard) that need to be instated to reinstate the wetland to its envisioned post-rehabilitation state. The interventions will be conducted in a specific order for the envisioned post-rehabilitation

state to be successful (e.g. if erosion exist within a wetland, backfilling with wetland sediment must be conducted before any revegetation).

- Lastly, determine the level of monitoring that will need to be conducted on the wetland to ensure that the objectives and goals are achieved. The three (3) different levels of monitoring prescribed by Cowden and Kotze (2009) include:
  - Level 1 – the outputs and basic outcomes of the wetland rehabilitation in terms of physical interventions;
  - Level 2 – the rapid assessments of the rehabilitation outcomes using appropriate assessment tools; and
  - Level 3 – the comprehensive assessment of the wetland rehabilitation outcomes determined by the rehabilitation objectives.

As noted in the aspects listed above therefore, there are hard and soft interventions to wetland rehabilitation, and these (interventions) are discussed in succeeding subsections (ENVASS, 2024).

Soft Approaches

Soft approaches may include the following (SANBI, 2014):

- The revegetation of stabilised areas with appropriate wetland and riparian plant species;
- The fencing off of sensitive areas within the wetland to keep grazers out and to allow for the re-establishment of vegetation;
- The use of biodegradable or natural soil retention systems such as eco-logs, plant plugs, grass or hay bales, and brushpacking techniques;
- The use of appropriate fire management and burning regimes
- The removal of undesirable plant and animal species; and
- IAP clearing

Hard approaches

Hard approaches include the following:

- Earth berms or gabion systems to block artificial channels that drain water from or divert polluted water to the wetland;
- Concrete and gabion weirs to act as settling ponds, to reduce flow velocity or to re-disperse water across former wetland areas thereby re-establishing natural flow paths;
- Earth or gabion structure plugs to raise channel floors and reduce water velocity;
- Concrete or gabion structures to stabilise head-cut or other erosion and prevent gullies; and
- Gabion structures (mattresses, blankets or baskets) to provide a platform for the growth of desired wetland vegetation.

5.3.8 Fencing

Fencing off areas that are being rehabilitated is generally recommended Fences are used as to exclude animals and humans from degraded land that is being maintained or rehabilitated. They provide a barrier to disturbing agents by enclosing and protecting the area. Fencing that effectively large and small livestock is recommended as this will also exclude cattle. Goats are usually responsible for damage to newly vegetated areas as they are more adept at finding and accessing newly established pastures. Once the vegetation is properly re-established (2-5 years, depending on local conditions), fencing can be removed and used elsewhere for rehabilitation purposes.

The issue of fending being stolen is recognised and partnerships with Traditional Leadership is needed to ensure this is protected. In many instances, cattle are free roaming do not return to the homestead or lots. When doing revegetation, the new plants are enticing to livestock and there is need for active livestock management to protect the new growth (i.e. fencing). The fencing is necessary for the first few years of an intervention to allow for recovery. Fencing is therefore a necessary component in conjunction with effective grazing management and control of livestock.

5.4 ECOSYSTEM-BASED DRR INTERVENTION OPTIONS

Community focused interventions include improving agricultural and rangeland management practices to strengthen communities' adaptive capacity through strengthening and further developing sustainable livelihood options. Additionally, undertaking capacity building, environmental education and awareness raising of communities will be critical in ensuring that community mobilisation measures are put in place to reduce vulnerability to flooding. In these deeply rural contexts, these improvements will save lives and livelihoods. A strong focus on women and marginalised groups will be needed to promote inclusion and gender equality, and noting the important role of women in these communities, will be an essential dimension of ensuring community mobilisation.

Further to the above, there is need for implementation of EbA to secure and develop ecological infrastructure such as wetland rehabilitation and/or restoration, rehabilitation of rivers and streams and improved slope management through vegetation cover as well as interventions to reduce erosion and the formation of dongas. There is also the opportunity to implement climate-smart infrastructure approaches and to look towards integrated solutions that effectively combine the use of ecological and built infrastructure. To support local level interventions, the development of community-based, cross-sectoral extension support systems would provide assistance to communities to develop EbA initiatives and would assist in monitoring and evaluating the state of ecosystems and ecological infrastructure. The provision of this extension service would therefore have an important community lens whilst providing guidance and insight to the LMs that undertake planning for the implementation of interventions to reduce community vulnerability to the impacts of increased flooding.

While the previous interventions focus on local-level and site-specific interventions, it is equally vital to strengthen the enabling environment for continued investment in the management, upscaling and development of Eco-DRR approaches. Crucial to this is the need to improve settlement planning that supports sustainable and resilient housing. This will require engagement with a range of government actors, both horizontally across sectors and vertically between spheres of government. This should be paired with the mainstreaming of Eco-DRR approaches into planning, policy and regulatory instruments such that built infrastructure and ecological infrastructure are more effectively integrated to reduce the risk of disasters linked to flooding. Considering that much of the enabling environment is managed by government, training and capacity building of local- and district-level municipal government is critical in ensuring that these interventions are sustained in the long-term. Moreover, developing an appropriately designed knowledge sharing system will enhance spatial planning and promote upscaling and knowledge sharing.

The last suite of possible interventions speaks to development of innovative finance mechanisms to sustain and upscale Eco-DRR approaches. In these rural municipalities the financial constraints are considerable and often restrictive for the introduction of innovative solutions. The rural economies of these areas are often not strong enough to underpin such Eco-DRR interventions, but the introduction of new livelihood options together with innovative financing options could provide the basis for transformational changes in these areas. This would therefore include the development of business cases to support the financial and operational sustainability of integrated ecological and built infrastructure solutions, as well as looking to the development and establishment of public and private partnerships and financing mechanisms.

6 Hydrological Evaluation

Hydrological models provide a means to simulate and analyse the complex interactions within a watershed, offering insights into the hydrological processes potentially influenced by restoration efforts. Therefore, by incorporating elements such as changes in land use changes and vegetation cover, and maintaining climate conditions and soil properties, hydrological models enable a quantitative evaluation of the impact of restoration practices on the hydrology of a catchment. This data-driven approach allows for a comprehensive understanding of how interventions, such as rangeland rehabilitation (including wetland rehabilitation), IAP clearing, and gully rehabilitation affect the catchment's hydrological dynamics. Moreover, hydrological models facilitate scenario analysis, helping to predict potential outcomes of restoration strategies.

The objective of the hydrological modelling exercise was therefore to understand level of impact that can be achieved through the implementation of restoration activities, ultimately to counteract the increases in flooding, drought and wildfire vulnerabilities associated with climate change.

6.1.1 Modelling Exercises

In contrast to the relatively few field data collection efforts, a number of modelling exercises have been conducted to evaluate the effect of land use change and degradation on surface runoff, erosion and flooding.

Gyamfi *et al*. (2016a, 2016b), applied the Soil and Water Assessment Tool (SWAT), to simulate sediment yield in the Olifants Catchment in eastern South Africa found that a decrease in rangeland area along with a concomitant increase in agricultural land and urban areas and forest resulted in a 47% increase in runoff generation.

Pretorius (2016) applied SWAT to derive sediment yields in the upper Tsitsa Catchment in the Eastern Cape Province, an area of approximately 200 km². The analysis showed an overall increase in gully erosion of 28% over the five-year period, with estimated sediment yields of 7 to 14 t/ha/yr from gullies, which cover 17 km², resulting in the delivery of sediment of between 140 000 and 280 000 t/yr. Between the period 2007 – 2012, gully erosion increased by 4 km² across the catchment. Sheet and rill erosion generated sediment that averaged 0.18 t/ha/yr, contributing 3 600 t/yr of sediment from the catchment. When effects of climate change were projected on these values, an increase of 15% in sediment yield was estimated.

Le Roux *et al*. (2015) modelled an average of sediment yield of 5t/ha/yr across the whole Mzimvubu River Catchment. When considering the upper Tsitsa catchment, which is in the north west of the Mzimvubu catchment, a sediment yield range of between 1 t/ha/yr and 20.5 t/ha/yr (equivalent to 350 000 – 10 000 000 t/yr for the whole upper Tsitsa catchment). These results indicated that, without proper siltation measures or design measures, the lifespan of the proposed Ntabelanga dam would be 34-49 years. The key recommendation emerging from the gully analysis was that vegetated and gully free areas that are susceptible to gully development be identified and protected with area-specific management and erosion control measures, noting that it was not financially feasible to rehabilitate large gullies at a catchment scale due to cost. It was emphasised that catchment processes upstream of the dam be managed to reduce runoff and rehabilitate eroded areas where possible, through interventions including grazing, sediment capture structures, re-establishment of vegetation communities, and rehabilitation of wetlands.

Bester *et al.* (2019) evaluated the intersection of human behaviour changes and restoration activities on the proposed Ntabelanga and Laleni Dams in the uMzimvubu Catchment, Eastern Cape. Through a catchment-wide system dynamics model that incorporated both the technical (i.e. restoration activities) and behavioural dimension, it was estimated that without mitigation measures (i.e. do nothing approach), the lifespan of the proposed Ntabelanga Dam was expected to decrease from 55-68 to 31-44 years, while the lifespan of the proposed Laleni Dam was expected to decrease from 26-33 to 16-21 years.

Hughes (2018) applied the Agricultural Catchments Research Unit (ACRU) model to consider the effect of various management options to improve the functioning of ecological infrastructure in the uMngeni catchment, demonstrating substantial hydrological gains, including sediment reduction, with a total of more than 1 million m^3 reduction in sediment delivery per year across the catchment (Table 6-1).

Table 6-1: Modelled increases in water yield (m^3/yr) and sediment yield reduction (m^3/yr) resulting from EI investments in the uMngeni catchment (Hughes, 2018)

	Midmar	Albert Falls	Henley	Inanda	Nagle	Durban	TOTAL
Gain in streamflow	2 153 600	305 679	3 400 544	863 384	84 468	379 465	7 187 139
Gain in baseflow	311 048	172 538	101 404	529 951	525 911	12 337	1 653 189
Sediment reduction	-99 419	-69 017	-146 440	-205 794	-488 631	-42 448	-1 051 749

Blignaut *et al.* (2010), in a similar exercise, applied the ACRU model in combination with economic modelling in the upper Thukela and upper uMzimvubu to evaluate the effect of improved grazing management and subsequent improvement in basal cover. The modelling exercise found significant positive impacts on:

- Reducing summer run-off stormflows;
- Increasing infiltration and thereby increasing winter baseflows;
- Maintaining the ecological reserve, i.e. the mandatory minimum;
- Baseflow to keep ecosystem services functioning, in rivers;
- Reducing soil erosion; and
- Increasing the soil carbon content.

From a biophysical perspective, improved management was estimated to generate an additional 3.9 million m^3 in baseflow in the upper uMzimvubu Catchment, which considered particularly important for many rural households who rely on rivers and springs for water, with a sales value (using water pricing) of R2.7million per annum. Further, it was estimated that management actions in the study areas had the potential to create 1 800 restoration-related jobs for the first seven years and almost 500 permanent jobs in catchment management. The economic analysis of the restoration actions in the upper Thukela suggested that natural capital can render a positive return on investment, providing multiple benefits of increased baseflows with a value of R3.8 million per year, reduced sediments to the value of R4.1 million per year and a total value of R16.7 million per year if carbon sequestration was included, compared with an annual management cost of R3.8 million per year and restoration costs of R31.9 million over the first seven years. Mander et al. (2017) had similar results in the Baviaanskloof, where the economic model applied suggested that ecological infrastructure investments had similar costs to built infrastructure in terms of hydrological benefits, but provided additional benefits (e.g. biodiversity, livelihoods).

The Socioeconomic Benefits of Ecological Infrastructure (SEBEI) programme has generated a number of studies on the benefits of ecological infrastructure investments using the Breede (Western Cape) and uMngeni (KwaZulu-Natal) Catchments as case studies (African Climate and Development Initiative, n.d.; Coldrey, 2020). Holden et al. (2022) found that IAP removal can help to mitigate but not eliminate anthropogenic climate change impacts in selected catchments in the Western Cape, focussing on the recent drought that occurred in this region (Holden, et al., 2022). Rasmussen et al. (2021), in a review paper, examined multidimensional socioeconomic impacts of ecological infrastructure investments across ten socioeconomic dimensions found that ecological infrastructure projects with high levels of participant involvement tended to have better socioeconomic outcomes, beyond environmental, income and employment benefits which are usually the key indicators that measured in projects of this nature, extending to natural capital, improved social relations, increased material assets, income, employment, property rights, , food security, and education (Rasmussen, et al., 2021). Notably, the review found that while many of the ecological infrastructure investments provided positive ecological and short-term employment outcomes, most cases lacked compelling evidence of longer term socioeconomic outcomes, highlighting that it is necessary to have robust and long term monitoring systems (beyond the project period), using quantitative and qualitative approaches, along with detailed participatory planning and engagement prior to implementation to enhance the likelihood of positive socioeconomic and ecological outcomes.

6.1.2 Description of the Hydrological Model Applied

Hydrological simulations of the catchments located in the vicinity of the identified areas of vulnerability were undertaken using the *ACRU* Agrohydrological Model (Schulze, 1995; Schulze and Smithers, 2004 and updates). This model has been, and is currently being, used extensively in Integrated Water Resources Management, flood studies, landuse impact assessments and climate change analysis (to name a few) in southern Africa. The major advantage of the *ACRU* Model is that it has been widely verified in South Africa. It also has a high level of process representation with physically-based input parameters/variables. Hence, it may be applied confidently in simulations involving "what-if" scenarios, as is the case in this study. In addition to this, streamflow simulations are given at a daily time-step, which is important when assessing impacts of changes of catchment landcover and catchment restoration efforts on flooding (which is generally a short-term event).

In summary, the *ACRU* Model is based on the following attributes (Smithers & Schulze, 1995);

- It is a daily time-step, conceptual-physical model;
- It has variables (rather than optimised parameters values) estimated from physically-based characteristics of the catchment;
- The model revolves around a daily multi-layer soil water budgeting; and
- It is a *multi-purpose* model which integrates the various water budgeting and runoff production components of the terrestrial hydrological system.

ACRU is not a parameter fitting or optimising model, as all variables are estimated from the physical characteristics of the watershed. When not all required variables are available, they are estimated within physically meaningful ranges based either on available literature or complex GIS analysis, or local expert knowledge.

6.1.3 Model Input Requirements

The ACRU model revolves around multi-layer soil water budgeting, as indicated in Figure 6-1. Runoff is generated as stormflow dependent upon the magnitude of daily rainfall in relation to dynamic soil water budgeting. Components of the soil water budget are integrated with modules in the ACRU system to simulate many other catchment components. The model is designed to simulate daily, monthly and annual soil water budgets for use in hydrological applications. The generation of runoff in ACRU is based on the premise that, after initial abstractions (through interception, depression storage and infiltration before runoff commences), the runoff produced is a function of the magnitude of the rainfall and the soil water deficit from a critical response depth of the soil (Schulze, 1997).

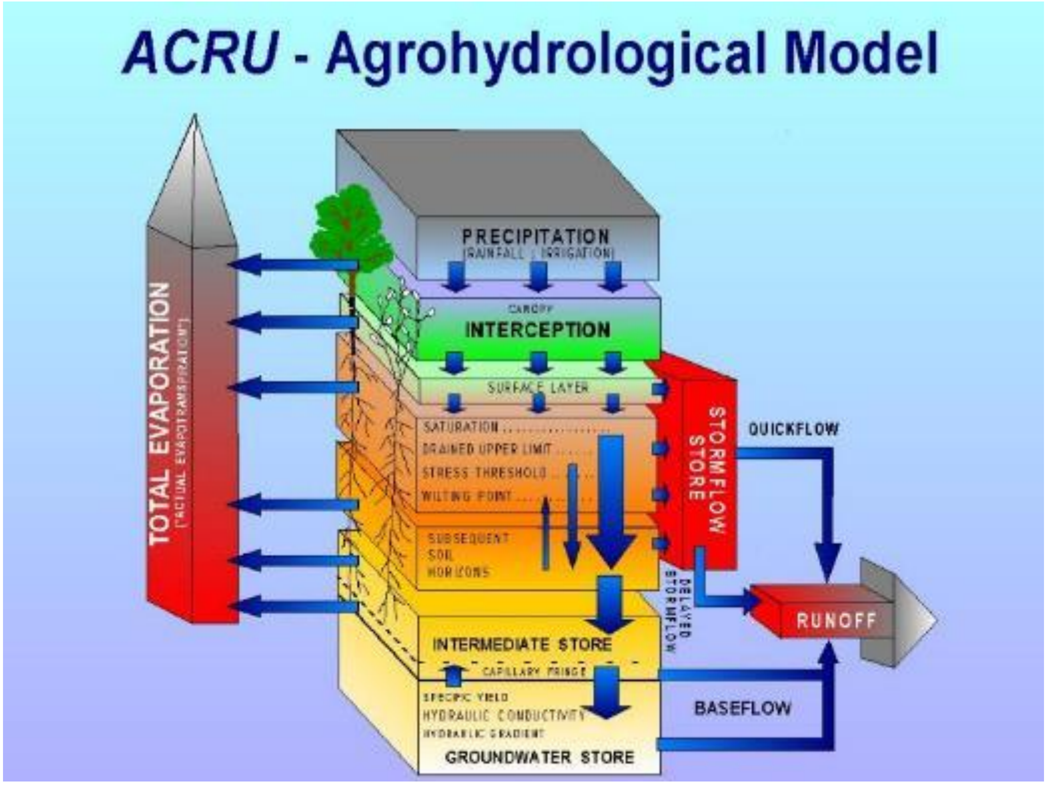

Figure 6-1 ACRU Model Configuration

The spatial organisation of sub-units in ACRU is flexible, and includes sub-catchments and hydrological response units (HRUs), which are largely classified according to landcover types and soil types that have a similar hydrological response to a rainfall event. ACRU is not a parameter fitting or optimising model, as all variables are estimated from the physical characteristics of the watershed. When all required variables are not available, they are estimated within physically meaningful ranges based either on available literature or complex geographic information system (GIS) analysis, or local expert knowledge. The more significant catchment attributes required for the configuration of the ACRU model, include the following:

- **Historical Climate Data**. As part of the model configuration a climate file containing daily rainfall and maximum and minimum temperature data is required. In each of the project areas, a detailed assessment of the available rainfall and temperature data was undertaken in order to select a representative climate station that has reliable data over a minimum period of at least 50 years. Generally rainfall and temperature data was available for the period 1950 to 2000. This record period is sufficient to allow for long-term statistical analysis of the resultant streamflow timeseries data and will enable the impact of catchment based restoration to be understood.
- **Land Cover Characteristics**. ACRU is land cover sensitive, the parameterisation of land cover dependent variables is important. The National Landcover Database (2020) (NLC2020) land cover/use dataset (DFFE, 2020) was used as the main source of information on the spatial distribution of present day landcover/use characteristics across the respective catchment areas. As mentioned previously, in each of the hydrological analysis scenarios undertaken for this feasibility study, the main change in the hydrological analysis was associated with landcover characteristics of the contributing catchment areas (for example, altering rangelands from currently degraded to an assumed future where the rangelands had been rehabilitated).
- **Soils Information**. Soil information for input for the ACRU model was obtained from the electronic data accompanying the South African Atlas of Climatology and Agrohydrology (Schulze, (Eds.) 2007). From this data source, information used in the ACRU model configurations included thickness of the topsoil and subsoil, as well as soil water content at the soil's lower limit (i.e. permanent wilting point), its drained upper limit (i.e. field capacity) and saturation for both the topsoil and subsoil.
- **Evaporation**. Evaporation takes place from previously intercepted water as well as simultaneously from the various soil horizons, in which case it is either split into separate components of soil water evaporation (from the topsoil horizon only) and plant transpiration (from all horizons in the root zone), or combined, as total evaporation. Evaporative demand on the plant is estimate according to atmospheric demand (through a reference potential evaporation) and the plant's stage of growth. Reference potential evaporation was calculated based on the (Hargreaves & Samani, 1985) equation, which uses daily temperature as the main input for this estimation.

The configurations of the ACRU model in this study made use of the Southern African QCs Database, (QCDB), (Schulze, et al., 2011) and subsequently the Southern African Quinary Catchments Database, QnCDB ((Schulze, et al., 2011). DWS uses a hierarchical system of catchments, composed of 22 Primary Catchments containing nested sets of Secondary, Tertiary and Quaternary Catchments. The QCDB contains, for each of the 1 946 QCs, a set of default climate, land cover and soils data for use in the ACRU model. In the QnCDB each QC has been sub-delineated into three altitude-based zones termed "Quinary Catchments", based on natural breaks in altitude, resulting in 5 838 Quinary Catchments. These altitude-based Quinary Catchments enable the differences in climates between the upper, middle and lower portions of QCs to be represented.

6.1.4 ACRU Model Scenario Analysis

As part of the feasibility study, scenario analysis was undertaken for each of the project areas. Scenario analysis using the ACRU model was aimed at illustrating the impact of the proposed interventions on the hydrology of the respective catchments (including a specific focus on the relative changes in high-flows associated with floods in the vulnerable areas). The scenarios that were configured and analysed included:

- **Scenario 1:** Hydrological analysis based on present day catchment conditions, including current levels of degraded rangelands (degraded grasslands), areas of gully erosion (exposed ground) and areas with IAP (predominantly wattle) infestations.
- **Scenario 2:** Hydrological analysis assuming that areas identified for rehabilitation (as outline later in Section 7.2.2 of the document) have been implemented.

As part of the analysis provided, both the broader catchment scale impact and hydrological impacts at an HRU level of detail have been extracted from the model. The reason for this is that although analysing the impact of the proposed interventions at a catchment scale is important for understanding the level of impact of the proposed interventions at the outlet of the catchment, it is also important to understand the more local impacts (at an HRU scale) of the proposed interventions (in the areas immediately downstream of the proposed intervention). At a catchment scale, the impacts of interventions are often diluted by the areas of the catchment that are not being impacted on by the rehabilitation activities Quantifying the level of impact at an HRU level also enables the potential scaling of the proposed interventions to be understood.

6.1.5 Sediment Yield Analysis

In order to quantify the impact of the proposed catchment rehabilitation alternatives on sediment loss rates, the Revised Universal Soil Loss Equation (RUSLE) was applied. Several models, often variations of the Universal Soil Loss Equation (USLE), have been developed to address understanding the quantities of sediment yielded from a catchment, particularly in addressing conservation planning efforts. An attempt to enhance the USLE equations led to the development of the Revised-USLE (RUSLE), which utilises new relationships to calculate the same six factors in the original equation (Renard & Ferreira, 1993; Yoder, et al., 2001). In both the USLE and RUSLE the fundamental equation is:

RUSLE Equation: $\boxed{\mathbf{A = RKLSCP}}$

Where:

A = computed annual soil loss;

R = rainfall-runoff erosivity factor;

K = soil erodibility factor;

LS = topographic factor combining slope length (L-m) and slope steepness (S-%);

C = landcover factor; and

P = support practice factor.

Elaborating on the above, the catchment attributes required for the configuration of the RUSLE model, include the following (Renard & Ferreira, 1993; Renard, et al., 1994):

- **The factor R:** derived from available rainfall data, specifically quantifies both the amount and intensity of precipitation. It signifies the primary driving force behind sheet and rill erosion. Variances in R correspond to fluctuations in the erosivity of the climate. For the purposes of the modelling undertaken for this assignment, annual rainfall erosivity for South Africa (and therefore that used for the respective project areas) was based on the work undertaken by Johnson (2018).
- **The K factor**: serves as a measure of the natural soil erodibility under the standardised conditions of the USLE unit plot, which is typically maintained in continuous fallow. The K factor was estimated using the soil texture class of the respective project areas (and particular soils linked to land uses within those areas), which in turn was based on information available from the South African Atlas of Climatology and Agrohydrology (Schulze, (Eds.) 2007).
- **The L and S factor**: RUSLE employs four distinct slope length relationships, three of which are based on slope steepness, similar to the USLE, and consider the soil's susceptibility to rill erosion compared to interrill erosion. Soil loss is considerably more responsive to changes in slope steepness than to alterations in slope length. In comparison to the USLE, the RUSLE features a slope steepness equation that is more nearly linear. Typical slope length and slope steepness were calculated for each of the respective project areas, with specific calculations undertaken for the respective landcover types in each catchment.
- **The C factor**: holds significant importance in estimating soil loss since it signifies conditions that can be altered through management practices (i.e. altering the landcover characteristics) to mitigate erosion. C factor values were calculated using Soil Conservation Services Curve Numbers to represent the classes of landcover forming part of the scenario analysis (i.e. for present day and for a rehabilitated landcover conditions).
- **The P factor:** primarily reflects how surface conditions influence flow paths and hydraulic flow dynamics. Derived from infield experiments, the P factor value is determined by ridge height, furrow grade, and erosivity. Updated P factor values have been devised to incorporate the impact of terraces on deposition within terrace channels. Additionally, buffer strips and a wider range of strip-cropping conditions have been introduced. For rangelands, conservation practice values are provided, necessitating estimation of the time required for reconsolidation post-disturbance, as well as changes in infiltration based on cover and roughness. Certain practice values are also contingent on the slope of the land, both for crops and rangelands.

Ultimately, in order to estimate the level of impact (in terms of changes in sediment yield) associated with rehabilitating a portion of land, all input variables for the RUSLE were maintained the same except for the C factor. By altering only the C factor, the level of impact associated with the proposed interventions, specifically with regards to changes in landcover characteristics (for example, rehabilitating rangelands from degraded to improved) will be realised.

6.2 MODELLING ANALYSIS RESULTS

The following analysis provides the details of the catchment specific inputs that were used for the configuration of the ACRU model and RUSLE at each of the respective project areas. Further to this, the results of the hydrological analysis, showing the implications of proposed Eco-DRR interventions, are also provided.

In order to test the feasibility of implementing Eco-DRR interventions, the following interventions were identified as possible interventions in each of the QCs in the five DMs and these were tested during the hydrological modelling exercise.

Table 6-2: Number of hectares per intervention in each DM that were tested during hydrological modelling

Intervention	Alfred Nzo DM	Ehlanzeni DM	Joe Gqabi DM	Ngaka Modiri Molema DM	Sekhukhune DM	Total ha per interventions
IAP Clearing	125 ha	219 ha	156 ha	-	111 ha	**611 ha**
Bioturbation	-	-	39 ha	-	-	**39 ha**
Revegetation	139 ha	268 ha	309 ha	70 ha	984 ha	**1 770 ha**
Gabions	3 ha	2 ha	3 ha	4 ha	5 ha	**17 ha**
Rotational Resting (Ecorangers)	13 313 ha	3 342 ha	33 791 ha	1 558 ha	12 928 ha	**64 932 ha**
Fencing	45 ha	-	186 ha	70 ha	-	**301 ha**
Firebreaks	-	-	7 439 ha	-	-	**7 439 ha**
Block Burns	-	-	7 439 ha	-	-	**7 439 ha**
Brushpacks	45 ha	26 ha	114 ha	7 ha	44 ha	**236 ha**
Vetiver	45 ha	106 ha	114 ha	7 ha	44 ha	**316 ha**
Concrete Weirs (Wetlands)	-	-	2 ha	-	-	**2 ha**
Soft Interventions (Wetlands)	192 ha	4 ha	172 ha	-	-	**368 ha**
Pitting (Zai Pits)	-	-	-	180 ha	-	**180 ha**
Total ha per DM	**13 907 ha**	**3 987 ha**	**49 764 ha**	**1 896 ha**	**14 116 ha**	

6.2.1 Alfred Nzo DM

The area identified as being most vulnerable to floods and droughts, and therefore the focal area for Eco-DRR interventions in the Alfred Nzo DM was within the Mzintlala River Catchment towards the western boundary of the DM. The following sub-sections provide details on the information used to configure the hydrological model for this river, located within the Alfred Nzo DM.

Rainfall Data

The Daily Rainfall Utility programme (Kunz, 2004) was used to assess rainfall stations in the vicinity of the study area. A number of rain gauges were identified in the vicinity of the project area, however, the Mount Frere station was selected as being the most representative and reliable station in this project area. Details on the driver rainfall station are provided in Table 6-3. This rain gauge has a record length of over 100 years, starting from the late 1880's and ending in 2000. For the time period 1950 to 1999, on which this study is based, 60 % of the rainfall gauges data was considered reliable (the remainder of the gauge data was patched using surrounding rainfall gauges).

Table 6-3: Key Study Site Catchment Characteristics

Catchment Name	Catchment Area (km²)	Rainfall Station	Rainfall Station Name	Gauge MAP[1] (mm)	Percentage of Reliable Data (%)
Mzintlala River	133	0179864 W	Mount Frere	751	59.8

Land Cover Characteristics

As presented previously, the present day landcover characteristics were extracted from the NLC2020 database. Based on information from the database, the catchment area was categorised into eight HRU's. The most prolific of these is degraded Highland and Dohne Sourveld (consisting of 59% of the catchment area, followed by indigenous forest and subsistence agriculture with a total of 29% of the catchment). Further to this, based on the NLC2020, approximately 2.12 km² of the catchment is classed as barren land or exposed soils. This is linked to the severe gully erosion associated with the catchment. The total area associated with IAP's (mostly black wattle) was equal to approximately 3.31 km². The degraded sourveld, open ground and gully erosion and IAP investigations constitute the degraded components of the catchment area.

Table 6-4: Summary of Land Cover Distributions in the Mzintlala River Catchment

Landcover Type (HRU)	Current Landcover (km2)	Post Rehabilitation Landcover (km2)
Exposed Soils (Gullies)	2.12	2.09
Cultivated Lands	17.90	17.90
Degraded Highland and Dohne Sourveld (Grasslands)	78.44	75.46
Indigenous Forest	18.86	18.86
Invasive Alien Plants (Black Wattle)	3.31	2.79
Residential	9.98	9.98
Wetlands	1.21	1.21
Improved (rehabilitated) Grassland	0.00	3.52
Total Catchment	**131.82**	**131.82**

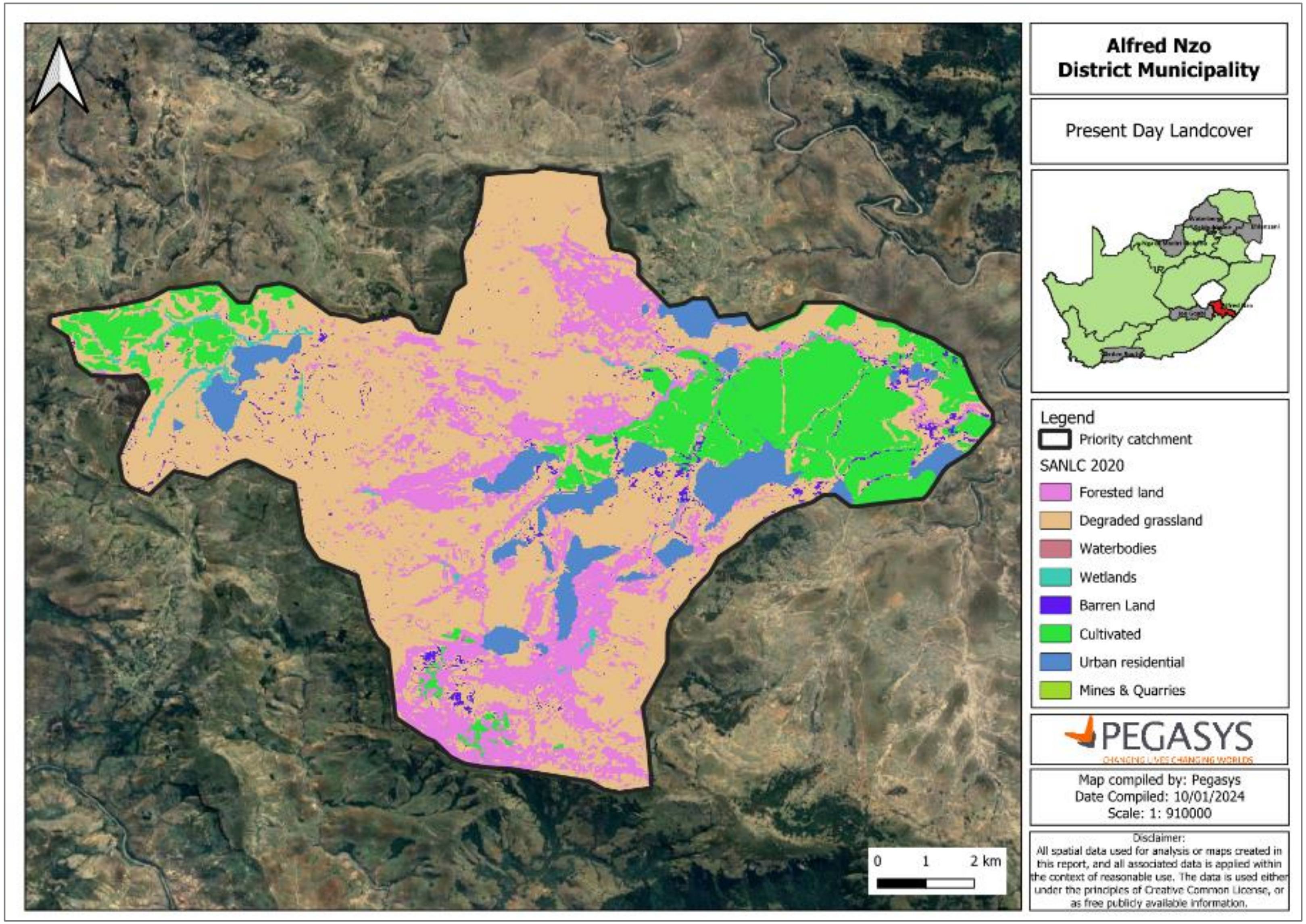

Figure 6-2: Present Day Land Cover Distribution of the Mzintlala River Catchment

In order to quantitatively ascertain the impacts of degraded grasslands, extensive gully erosion and IAP infestations on the Mzintlala River Catchment, the second modelling scenario was undertaken while assuming areas the degraded grasslands had been rehabilitated to healthy grassland systems, areas associated with gullies and exposed open ground areas had been rehabilitated to healthy grassland systems and the portions of the IAP areas had also been rehabilitated to healthy grassland systems.

Hydrological Analysis Results

As presented previously, the focus of hydrological simulation results analysis has been targeted towards changes in high-flow (flood) hydrology dynamics in the catchment. As noted previously, the most significant damage to road and bridge infrastructure is through high discharge events, particularly when the peak discharge rate exceeds the design capacity of the infrastructure (i.e. bridges, culverts or dams). Therefore, in order to understand the level of impact of the proposed catchment rehabilitation interventions on high stormflow and flood events, the annual maximum simulated discharge associated with Scenario 1 (present day landcover) and Scenario 2 (assuming the proposed interventions have been implemented) were compared. The results of this analysis are presented in Figure 6-3. From this graph, it is difficult to identify the differences in the high flows, therefore an additional analysis was undertaken by extracting the simulated annual maximum series (AMS) discharge data for the respective scenarios, as shown in Figure 6-4. A comparison of the AMS between the two scenarios showed that, on average, **a reduction of approximately 3% in the AMS is achieved though the proposed implementation of catchment restoration activities.**

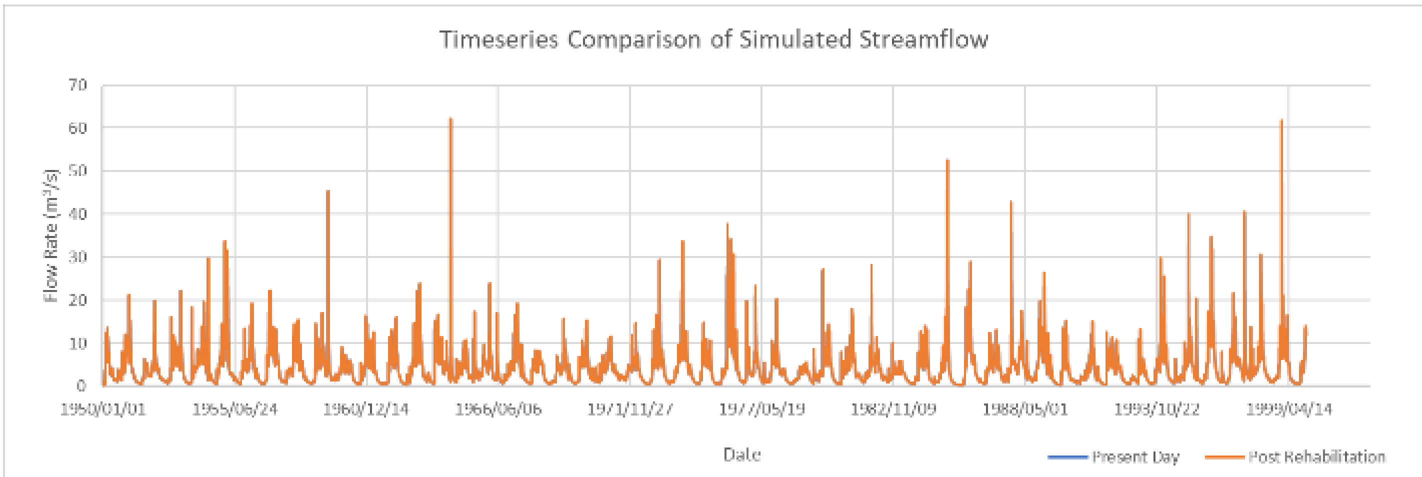

Figure 6-3: Streamflow timeseries comparison for Scenario 1 versus Scenario 2 for the Alfred Nzo DM

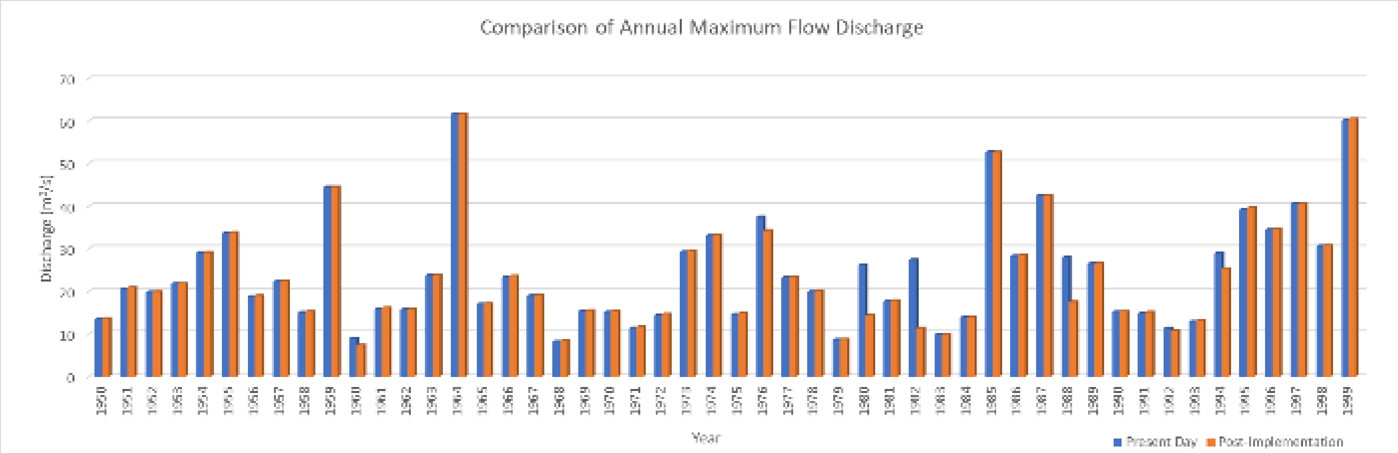

Figure 6-4: Annual maximum discharge comparison for Scenario 1 versus Scenario 2 for the Alfred Nzo DM

As presented previously, additional analysis was undertaken to understand the degree of change in high flows from the individual HRU's as a result of the proposed rehabilitation activities. This was illustrated through the analysis of the differences in runoff depths from the top ten simulated discharge events, as presented in Table 6-5. From this table it is noted that, once again, **the rehabilitation of rangelands and gullies resulted in significant reductions in the runoff depths through the proposed rehabilitation interventions**. From this analysis it is noted that the proposed rehabilitation of the areas associated with gullies resulted in a reduction in runoff depths from approximately 61 mm to approximately 36 mm. This represents a nearly 41% reduction in the peak discharge associated with the largest simulated flood event from the gully HRU. Similarly, changes in the other top nine flood events showed reductions of between 30% and 40%. Although not to the same extent, significant reductions in the high flow events were also noted through the rehabilitation of rangelands. For rangeland rehabilitation, reductions in high flows of between 28% and 37% were noted. **The changes in the high flow events associated with IAP removal (replaced with grasslands) was, however, noted to be negligible**. As mentioned previously, it is assumed that this is likely as a result of the interception that occurs with more dense canopy covers associated with forested areas. The **benefits of IAP removal are realised through the reduction in sediment yields** (as indicated later in Table 6-6), **as well as the increased water security** in the catchment as a result of lower evapotranspiration rates from forested areas.

Table 6-5: Simulated Impact of catchment rehabilitation initiatives on runoff depths (mm)

Stormflow Event Ranking	Gully Rehabilitation		Rangeland Rehabilitation		IAP Rehabilitation	
	Pre	Post	Pre	Post	Pre	Post
1	60.8	35.8	55.6	35.8	40.4	42.0
2	55.0	33.0	49.1	33.0	37.1	37.1
3	43.2	31.5	39.3	31.5	34.9	35.2
4	39.6	28.8	38.7	28.8	30.5	31.7
5	38.5	28.5	36.3	28.5	29.2	30.0
6	38.0	27.8	36.2	27.8	29.2	29.8
7	36.5	27.2	35.2	27.2	29.2	29.1
8	35.2	25.0	33.2	25.0	29.1	28.9
9	33.9	24.9	32.3	24.9	26.9	26.8
10	31.7	24.9	30.6	24.9	26.1	26.5

Sediment Loss Scenario Analysis Results

As presented in Section 6.1.5, the RUSLE was used to calculate sediment loss under pre-implementation (current day) landcover conditions and post-implementation (once rehabilitation efforts have been executed) landcover conditions. The results of this analysis are provided in Table 6-6. Through this analysis it is noted the **reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation, 40% for IAP removal and approximately 93% reduction for gully rehabilitation**. As mentioned previously, these results are achieved through only changing the land cover conditions of the respective HRU's (C factor as presented in Section 6.1.5). In each case, converting the areas that are identified as degraded, to a grassland system that is in pristine health, makes a significant impact on the volume of sediment emanating from the respective areas.

Table 6-6: Total Annual Sediment Yield (ton/ha)

Intervention	Scenario	Annual Sediment Yield (ton/ha)
Rangeland Rehab	Pre-Implementation	10.87
	Post-Implementation	2.17
IAP Removal	Pre-Implementation	5.44
	Post-Implementation	2.17
Gully Rehabilitation	Pre-Implementation	29.00
	Post-Implementation	2.17

6.2.2 Joe Gqabi DM

The area identified as being most vulnerable to floods and droughts, and therefore the focal area for Eco-DRR interventions in the Joe Gqabi DM was within the Thina River Catchment towards the eastern boundary of the DM. The following sub-sections provide details on the information used to configure the hydrological model for the Thina River located within the Joe Gqabi DM.

Climate Data

Climate data is key for the development of a representative hydrological model for the project area. The Daily Rainfall Utility programme (Kunz, 2004) was used to assess rainfall stations in close proximity to the study area. There are a number of rain gauges in the vicinity of the Thina River Catchment, each with varying record lengths and levels of reliable information. Ultimately the driver rainfall station for the Thina River catchment was selected based on:

- The location of the gauge relative to the focal catchment;
- The distribution of the gauge's median monthly rainfall pattern in relation to the pattern of rainfall in the study catchment;
- The gauges data reliability; and
- The record length.

Details on the driver rainfall station, used in the hydrological modelling, are provided in Table 6-7. This rain gauge has a record length of over 100 years, starting from the late 1880's and ending in 2001. For the time period 1950 to 1999, on which this study is based, 91 % of the rainfall gauge data was considered reliable (the remainder of the gauge data was patched using surrounding rainfall gauges). The reason that the modelling is limited to 1999 is that this is the period for which temperature data was available for the project area (temperature is used to calculate evapotranspiration in the hydrological model).

Table 6-7: Key Study Site Catchment Characteristics

Catchment Name	Catchment Area (km^2)	Rainfall Station	Rainfall Station Name	Gauge MAP[1] (mm)	Percentage Reliability
Thina River	338	0178881 W	Mt Fletcher (Mun)	687	91.2

Land Cover and Soils

Landcover characteristics for the Thina river catchment were extracted from the NLC2020 database. Based on information from the database, the catchment area was categorised into seven HRU's, including grasslands, rural residential, subsistence agriculture, areas with forests (both indigenous and alien), water bodies and wetland areas. The most prolific of these, as depicted in Figure 6-5 and Table 6-8, is grasslands (consisting of 82% of the catchment area), followed by rural residential and subsistence agriculture with a total of 10% of the catchment. During the site assessment it was noted that most, and if not all, of the grasslands associated with the project area are in a degraded (and severely degraded) state. Further to this, based on the NLC2020, approximately 3.13 km^2 of the catchment is classed as barren land or exposed soils. This is linked to the severe gully erosion associated with the catchment. The total area associated with IAP's (mostly black wattle), and to a lesser extent indigenous forests, is equal to approximately 12.38 km^2. The degraded grasslands, open ground and gully erosion and IAP investigations constitute the degraded components of the catchment area.

As indicated in Section 6, Scenario 2 of the analysis included undertaking simulations of changes to the catchment landcover characteristics based on identified interventions. As summarised in Table 6-8, degraded rangeland (grassland) rehabilitation, gully remediation and revegetation, and IAP plant removal in riparian areas were identified as the focal areas for rehabilitation in the catchment. The total area for rehabilitation equates to approximately 81 km^2, which in turn equates to approximately 24% of the delineated catchment.

Table 6-8: Summary of Land Cover Distributions in the Thina River Catchment

Landcover Type (HRU)	Current Landcover (km2)	Post Rehabilitation Landcover (km2)
Exposed Soils (Gullies)	3.13	3.13
Rural Residential Areas	14.53	14.53
Cultivated (Subsistence)	20.78	20.78
Forests and Alien Invasive Vegetation (IAPs)	12.38	10.82
Degraded Grassland	276.85	199.15
Improved (rehabilitated) Grassland	0	79.29
Waterbodies and Wetland Areas	7.83	7.83
Total Area	**335.54**	**335.54**

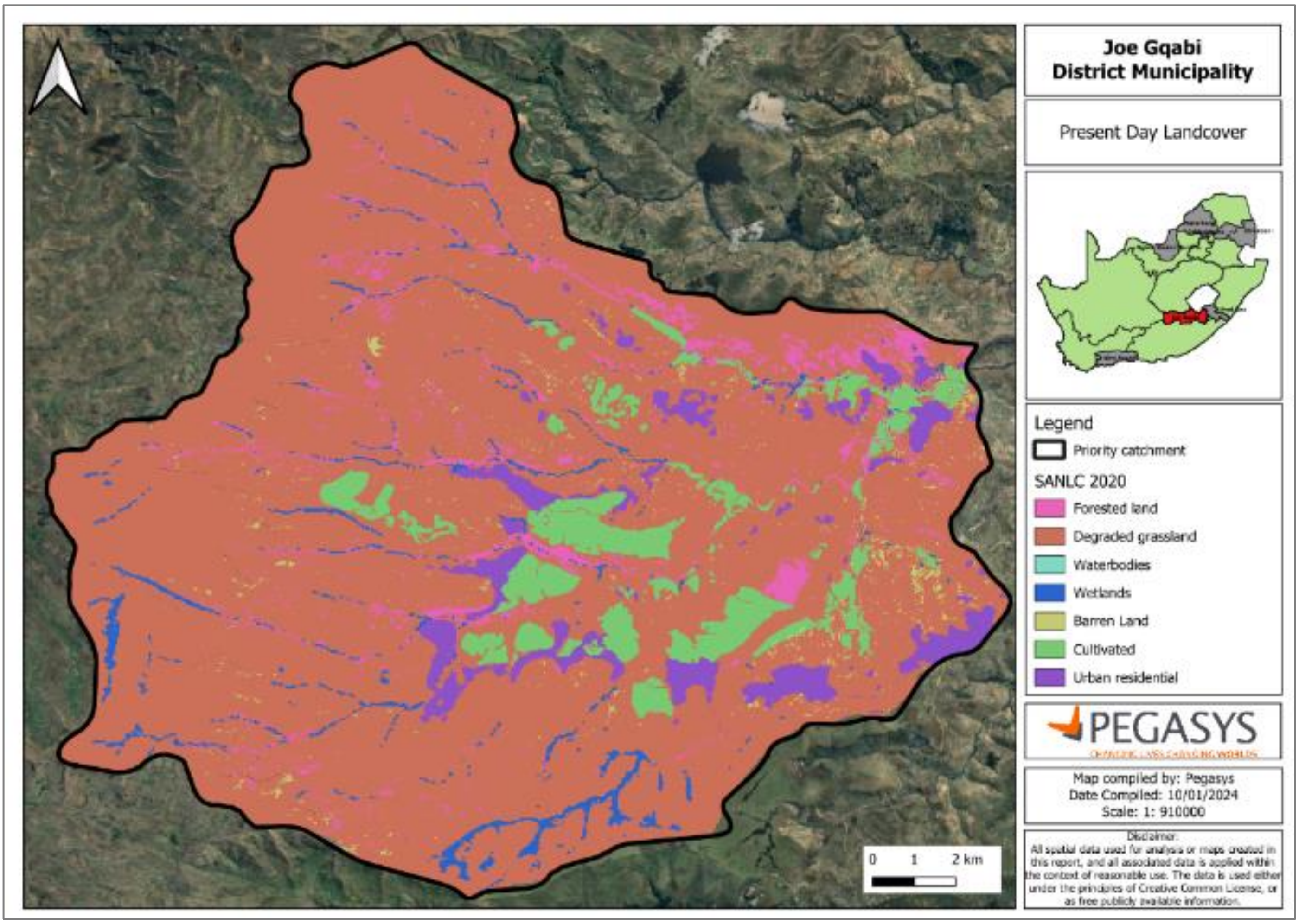

Figure 6-5: Present Day Land Cover Distribution of the Thina River Catchment

Hydrological Analysis Results

The focus of hydrological results analysis is targeted at changes in flood hydrology dynamics in the catchment. Simulated streamflow from the *ACRU* Model comprises of stormflow and baseflow. Stormflow is controlled by the magnitude of the effective rainfall and is divided into quickflow (i.e. same day response) and delayed stormflow.

Generally, the most significant damage to road and bridge infrastructure is as a result of high discharge events, particularly when the peak discharge rate exceeds the design capacity of infrastructure. Therefore, in order to understand the level of impact of the proposed catchment rehabilitation interventions on high-flow (flood) events, the annual maximum simulated discharge rates (i.e. the AMS) for Scenario 1 (present day landcover) and Scenario 2 (assuming the proposed interventions have been implemented) were compared. The results of this analysis are presented in Figure 6-6 and Figure 6-7. Figure 6-6 shows a comparison of the streamflow timeseries between the respective scenarios at the outlet of the Thina River catchment, as depicted in Figure 6-5. Although slight differences in the high flow are evident in this graph, due to the scale of the simulation period (50 years), these differences are somewhat hidden. Therefore, Figure 6-7 has also been included in the results analysis. This graph shows the differences in the AMS of simulated discharge for the catchment. A comparison of the AMS between the two scenarios showed that, on average, **a reduction of approximately 6% in the AMS is achieved though the proposed implementation of catchment restoration activities**.

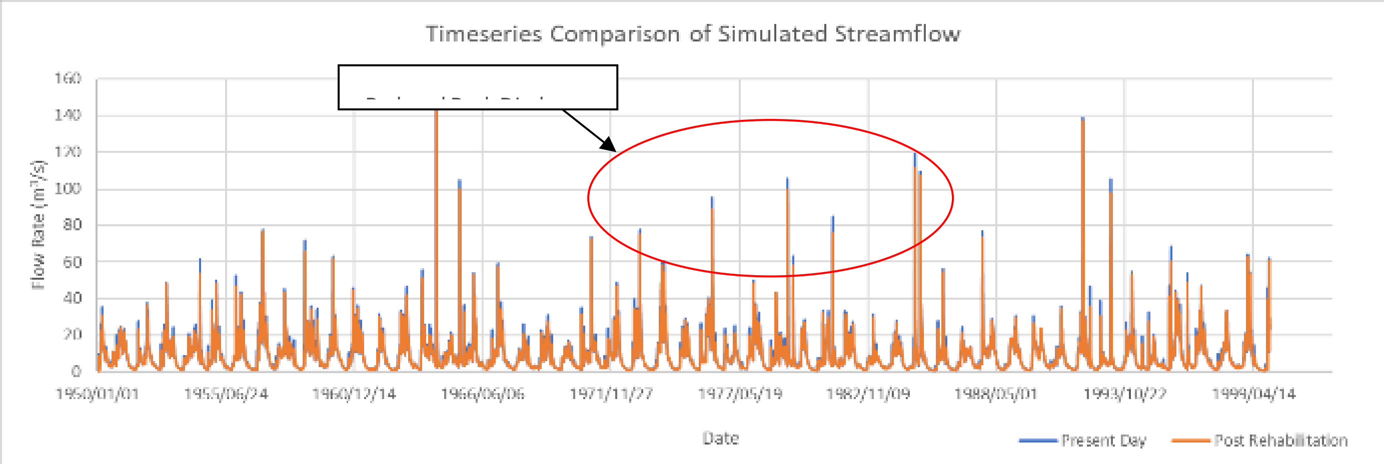

Figure 6-6: Streamflow timeseries comparison for Scenario 1 versus Scenario 2 for the Joe Gqabi DM

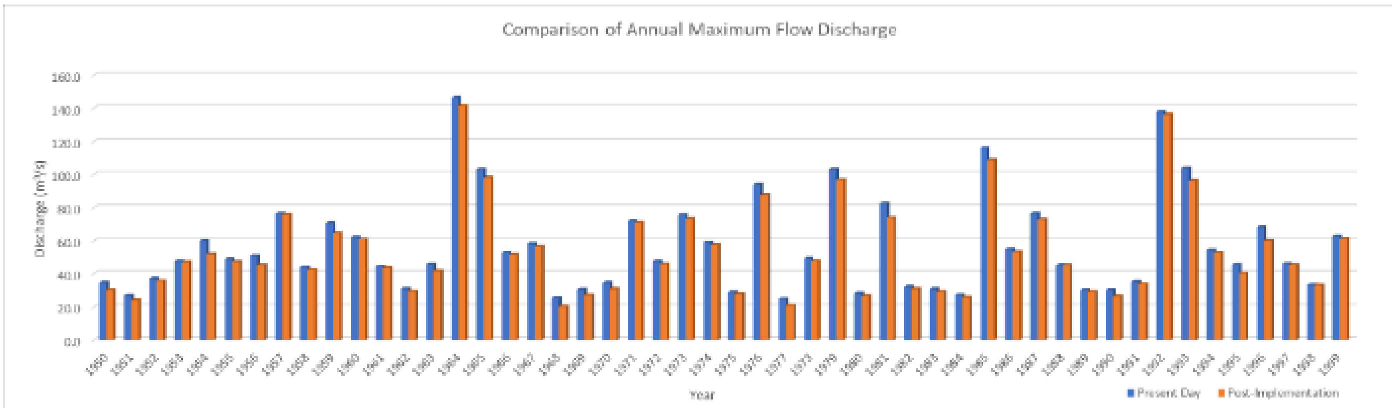

Figure 6-7: Annual maximum discharge comparison for Scenario 1 versus Scenario 2 for the Joe Gqabi DM

Further to the scenario analysis on total catchment discharge (as presented in Figure 6-6 and Figure 6-7 above), additional analysis was undertaken to understand the degree of change in high flows from the individual HRU's as a result of the proposed rehabilitation activities. In the ACRU model, runoff is calculated by multiplying the simulated runoff depth from HRU's by the area from which the runoff is being generated. Simulated daily runoff depths are therefore a good representation of catchment hydrology and stormflow response, particularly when needing to compare responses from different catchment areas. Runoff depths, and changes in runoff depths as a result of changing landcover conditions, were therefore used as a means of comparison between the scenarios that were simulated for HRU's that are to be rehabilitated. In order to illustrate the changes in flood hydrology, the top ten simulated discharge events were compared, as presented in Table 6-9.

Table 6-9: Simulated Impact of Catchment Rehabilitation Initiatives

Stormflow Event Ranking	Gully Rehabilitation		Rangeland Rehabilitation		IAP Rehabilitation	
	Pre	Post	Pre	Post	Pre	Post
1	60.22	34.82	53.84	34.83	41.09	40.99
2	50.66	29.82	46.17	29.83	33.38	34.67
3	44.9	29.33	40.21	29.34	32.76	33.64
4	44.01	26.67	40.2	26.67	29.42	29.33
5	42.89	24.76	39.17	24.77	28.7	29.32
6	41.85	24.37	38.09	24.38	28.65	28.65

Stormflow Event Ranking	Gully Rehabilitation		Rangeland Rehabilitation		IAP Rehabilitation	
	Pre	Post	Pre	Post	Pre	Post
7	36.94	24	33.9	24.01	28.6	28.46
8	35.57	23.89	33.37	23.9	25.78	26.94
9	35.48	23.13	33.05	23.13	24.22	25.49
10	33.97	21.66	31.8	21.67	23.87	24.45

From Table 6-9 it is noted that rehabilitation activities associated with the gully and rangeland rehabilitation resulted in a significant reduction in the runoff depths. Through the proposed rehabilitation of the areas associated with gullies, there was a reduction in runoff depth from approximately 60 mm to approximately 35 mm for the most extreme event over the simulation period. This represents a nearly 42% reduction in the peak discharge. Similarly, changes in the remaining top nine flood events showed reductions of between 30% and 40% as a result of the proposed rehabilitation. Although not to the same extent, significant reductions in the high flow events were also noted through the rehabilitation of rangelands, where reductions in high flows of between 28% and 37% were noted. The changes in the high-flow events associated with IAP removal (replaced with grasslands) was, however, noted to be negligible (in some cases an increase in flow depths was noted). It is assumed that this is likely as a result of the interception that occurs with more dense canopy covers associated with forested areas as well as the detention of runoff through the litter layer beneath the forest. The benefits of IAP removal are, however, realised through the reduction in sediment yields (as indicated later in Table 6-10), as well as the increased water security in the catchment as a result of lower evapotranspiration rates from forested areas.

Sediment Loss Scenario Analysis Results – Joe Gqabi DM

As presented in Section 6.1.5, the RUSLE was used to calculate sediment loss under pre-implementation (current day) landcover conditions and post-implementation (once rehabilitation efforts have been executed) landcover conditions. This analysis has been focused on typical HRU areas associated with proposed rehabilitation in the catchment. The results of this analysis are provided in Table 6-10. As presented in this table it is noted **the reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation, 60% for IAP removal and approximately 90% reduction for gully rehabilitation**. As mentioned previously, these results are achieved through only changing the land cover conditions of the respective HRU's (C factor as presented in Section 6.1.5). In each case, converting the areas that are identified as degraded, to a grassland system that is in pristine health, makes a significant impact on the volume of sediment emanating from the respective areas.

Table 6-10: Total Annual Sediment Yield (ton/ha)

Intervention	Scenario	Annual Changes in Sediment Yield (ton/ha)
Rangeland Rehab	Pre-Implementation	13.65
	Post-Implementation	2.73
IAP Removal	Pre-Implementation	6.82
	Post-Implementation	2.73
Gully Rehabilitation	Pre-Implementation	36.39
	Post-Implementation	2.73

It is noted that achieving rehabilitation from degraded to pristine conditions is not always fully achievable, however, the objective of this analysis is to illustrate that through a process of rehabilitation, one of the benefits would be a potentially significant reduction in sediment yield, which in turn will result in healthier river systems (improved water quality) and protection of water resources (reduced sediment ending up in dams), and more resilience towards flooding through increased storage capacity in dams and reduced sediment accumulation along the riparian areas of river.

6.2.3 Ehlanzeni DM

The area identified as being most vulnerable to floods and droughts, and therefore the focal area for Eco-DRR interventions in the Ehlanzeni DM was within the Sand River Catchment, which is located towards the central and north of the DM. The following sub-sections provide details on the information used to configure the hydrological model and provides a description of the results obtained through the scenario analysis.

Rainfall Data

Details on the driver rainfall station for the Ehlanzeni DM, and more specifically the Sand River Catchment, are provided in Table 6-11. This rain gauge has a record length of over 100 years, however, for the time period 1950 to 1999, on which this study is based, 99 % of the rainfall gauge data was considered reliable (the remainder of the gauge data was patched using surrounding rainfall gauges).

Table 6-11: Key Study Site Catchment Characteristics

Catchment Name	Catchment Area (km²)	Rainfall Station	Rainfall Station Name	Gauge MAP[1] (mm)	Percentage Reliability
Komati River	33	0595195 W	Bosbokrand-new Fores	908	99.9

Land Cover Characteristics

As presented previously, the present day landcover characteristics were extracted from the NLC2020 database. Based on information from the database, the catchment area was categorised into eight HRU's, as presented in Table 6-12. The greatest area, as depicted in Table 6-12 and Figure 6-8 is natural forest (consisting of 58.42 km2). Severe gully erosion is associated with approximately 0.05 km2 of the catchment area. The total area associated with IAP's (mostly black wattle) was equal to approximately 5.98 km². The degraded grasslands, barren land and gully erosion and IAP areas constitute the degraded components of the catchment area.

Table 6-12: Summary of Land Cover Distributions in the Upper Sand River Catchment

Landcover Type (HRU)	Current Landcover (km²)	Post Rehabilitation Landcover (km²)
Indigenous Forests	58.42	58.42
IAPs	5.98	3.75
Degraded Grassland	1.16	0.00
Barren land and Gulley Erosion	0.05	0.03
Cultivated fields	3.45	1.78
Residential	6.82	6.82
Wetlands	1.40	1.40

Improved (rehabilitated) Grassland	0.00	5.06
Total	**77.27**	**77.27**

In order to quantitatively ascertain the impacts of degraded grasslands, extensive gully erosion and IAP infestations on the Sand River Catchment, the second modelling scenario was undertaken while assuming that portions of the degraded grasslands had been rehabilitated to healthy grassland systems, portions the gully and exposed open ground areas had been rehabilitated to healthy grassland systems and areas associated with IAP's have also been rehabilitated to healthy grassland systems, as shown in Table 6-12. The proposed interventions in this catchment constitute 7% of the total catchment area.

Hydrological Analysis Results

As presented previously, the focus of hydrological simulation results analysis has been targeted towards changes in high-flow (flood) hydrology dynamics in the catchment. As noted previously, the most significant damage to road and bridge infrastructure is through high discharge events, particularly when the peak discharge rate exceeds the design capacity of the infrastructure (i.e. bridges, culverts or dams). Therefore, in order to understand the level of impact of the proposed catchment rehabilitation interventions on high stormflow and flood events, the annual maximum simulated discharge associated with Scenario 1 (present day landcover) and Scenario 2 (assuming the proposed interventions have been implemented) were compared. The results of this analysis are presented in Figure 6-9. From this graph, it is difficult to identify the differences in the high flows, therefore an additional analysis was undertaken by extracting the simulated AMS discharge data for the respective scenarios, as shown in Figure 6-10. A comparison of the AMS between the two scenarios showed that, on average, **a reduction of approximately 1% in the AMS is achieved though the proposed implementation of catchment restoration activities**.

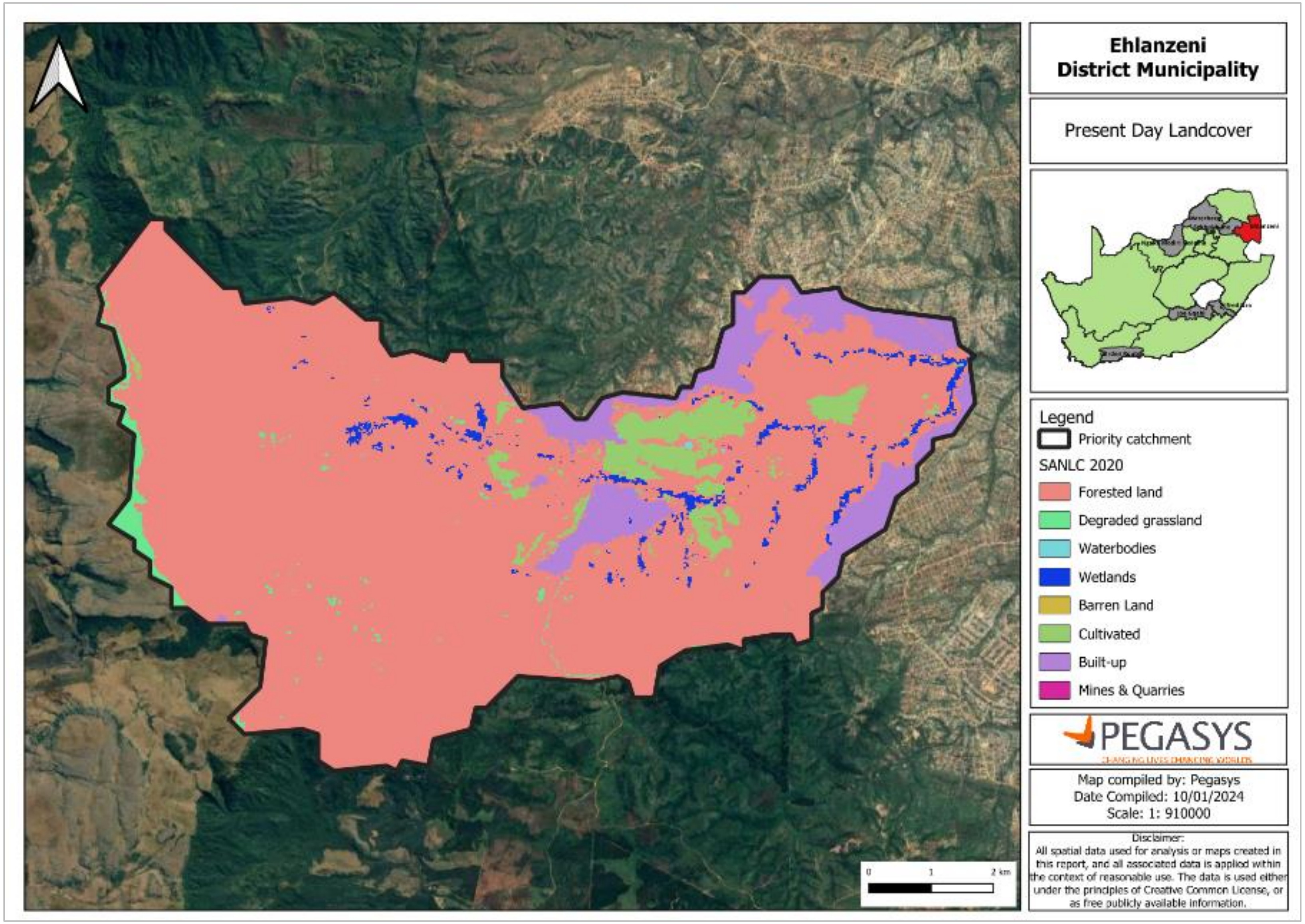

Figure 6-8: Present Day Land Cover Distribution of the Upper Sand River Catchment

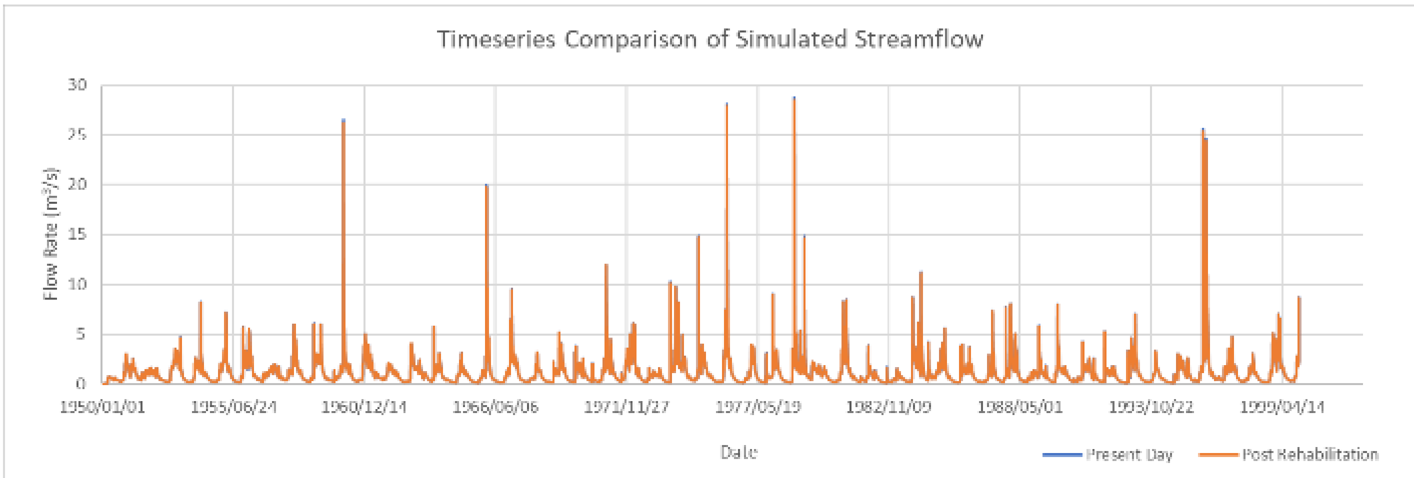

Figure 6-9: Streamflow timeseries comparison for Scenario 1 versus Scenario 2 for the Ehlanzeni DM

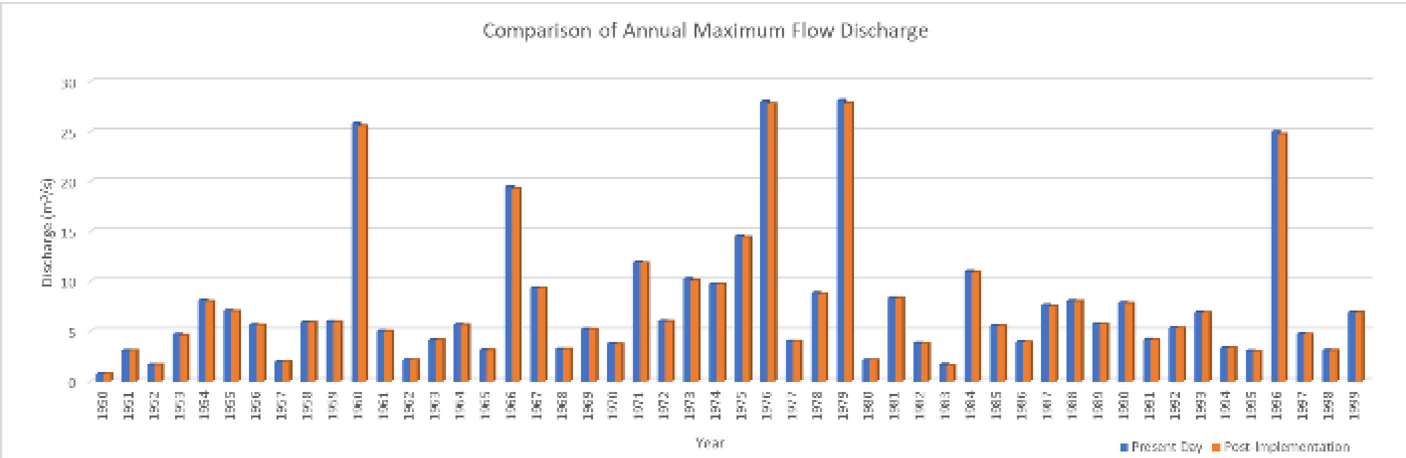

Figure 6-10: Annual maximum discharge comparison for Scenario 1 versus Scenario 2 for the Ehlanzeni DM

As presented previously, additional analysis was undertaken to understand the degree of change in high flows from the individual HRU's as a result of the proposed rehabilitation activities. This was illustrated through the analysis of the differences in runoff depths from the top ten simulated discharge events, as presented in Table 6-13. From this table it is noted that, the **rehabilitation of rangelands and gullies resulted in significant reductions in the runoff depths** from these respective HRU's. It is also noted that the proposed rehabilitation of the areas associated with gullies resulted in a reduction in runoff depths from approximately 48.3 mm to approximately 27.9 mm. This represents a nearly 42% reduction in the peak discharge associated with the largest simulated flood event from the gully HRU. Similarly, changes in the other top nine flood events showed reductions of between 20% and 40%. Although not to the same extent, significant reductions in the high flow events were also noted through the rehabilitation of rangelands. For rangeland rehabilitation, reductions in high flows of between 21% and 37% were noted. **The changes in the high flow events associated with IAP removal (replaced with grasslands) was, however, noted to be less significant**. Through the removal of IAPs, the reduction in sediment yield equated to between 4% and 12%

Table 6-13: Simulated Impact of catchment rehabilitation initiatives

Stormflow Event Ranking	Gully Rehabilitation		Rangeland Rehabilitation		IAP Rehabilitation	
	Pre	Post	Pre	Post	Pre	Post
1	48.3	27.9	44.0	27.9	31.7	27.9
2	44.5	27.9	40.6	27.9	31.2	27.9
3	43.2	27.4	40.0	27.4	29.1	27.4
4	42.8	25.6	39.5	25.6	28.7	25.6
5	42.0	25.1	38.5	25.1	28.3	25.1
6	34.8	24.8	34.0	24.8	27.7	24.8
7	34.3	24.6	33.2	24.6	26.9	24.6
8	34.2	22.9	31.5	22.9	24.1	22.9
9	27.9	21.9	27.6	21.9	23.2	21.9
10	27.7	21.7	27.4	21.7	22.6	21.7

Sediment Loss Scenario Analysis Results

As presented in Section 6.1.5, the RUSLE was used to calculate sediment loss under pre-implementation (current day) landcover conditions and post-implementation (once rehabilitation efforts have been executed) landcover conditions. Through this analysis it is noted the **reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation, 60% for IAP removal and approximately 92% reduction for gully rehabilitation** (Table 6-14). As mentioned previously, these results are achieved through only changing the land cover conditions of the respective HRU's (C factor as presented in Section 6.1.5). In each case, converting the areas that are identified as degraded, to a grassland system that is in pristine health, makes a significant impact on the volume of sediment emanating from the respective areas.

Table 6-14: Total Annual Sediment Yield (ton/ha)

Intervention	Scenario	Annual Sediment Yield (ton/ha)
Rangeland Rehab	Pre-Implementation	20.45
	Post-Implementation	4.09
IAP Removal	Pre-Implementation	10.22
	Post-Implementation	4.09
Gully Rehabilitation	Pre-Implementation	54.53
	Post-Implementation	4.09

6.2.4 Ngaka Modiri Molema DM

The area identified as being most vulnerable to floods and droughts, and therefore the focal area for Eco-DRR interventions in the Ngaka Modiri Molema DM, was within the Sandspruit River Catchment, which is located towards the northern boundary of the DM. The following sub-sections provide details on the information used to configure the hydrological model for the Sandspruit River located within the Ngaka Modiri Molema DM.

Rainfall Data

The Daily Rainfall Utility programme (Kunz, 2004) was used to assess rainfall stations in the vicinity of the study area. A number of rain gauges were identified in the vicinity of the Sandspruit River Catchment, however, the Enzelberg Rainfall station was selected as being the most representative and reliable stations in this project area. Details on this driver rainfall station are provided in Table 6-15. This station has a rainfall record length of over 100 years, starting from the late 1890's and ending in 2000. For the time period 1950 to 1999, on which this study is based, 76 % of the rainfall data was considered reliable (the remainder of the gauge data was patched using surrounding rainfall gauges).

Table 6-15: Key Study Site Catchment Characteristics

Catchment Name	Catchment Area (km^2)	Rainfall Station	Rainfall Station Name	Gauge MAP[1] (mm)	Percentage Reliability
Sandspruit River	16	0546412 W	Enzelberg	593	76.7

Land Cover Characteristics

As indicated previously, the present day landcover characteristics were extracted from the NLC2020 database. Based on information from the database, the catchment area was categorised into five HRU's, including grasslands, rural residential, subsistence agriculture, barren land and degraded thornveld, as presented in Table 6-16 and Figure 6-11. The majority of the catchment is residential areas (5.38 km2) followed by degraded grasslands (5.03 km2) and degraded thornveld (3.48 km2). Further to this, approximately 1.26 km2 of the catchment is classed as barren land or exposed soils. This is linked to the severe gully erosion associated with the catchment. The catchment area's deteriorated components include grasslands, open ground and gully erosion, and degraded thornveld.

As presented in Table 6-17, the proposed rehabilitation activities in the catchment include rehabilitation of the gully and eroded areas as well as the rehabilitation of the degraded grassland and thornveld areas. The total area of rehabilitation equates to approximately 2.78 km^2, which constitutes approximately 18% of the catchment area.

Table 6-16: Summary of Land Cover Distributions in the Sandspruit River Catchment

Landcover Type (HRU)	Current Landcover (km2)	Post Rehabilitation Landcover (km2)
Natural forest	3.48	3.48
Degraded Grassland and Thornveld	5.03	2.29
Cultivated fields	0.41	0.41
Exposed Soils (Gullies and Eroded Areas)	1.26	1.22
Residential	5.38	5.38
Improved (rehabilitated) Grassland and Thornveld	0.00	2.78
Total	**15.56**	**15.56**

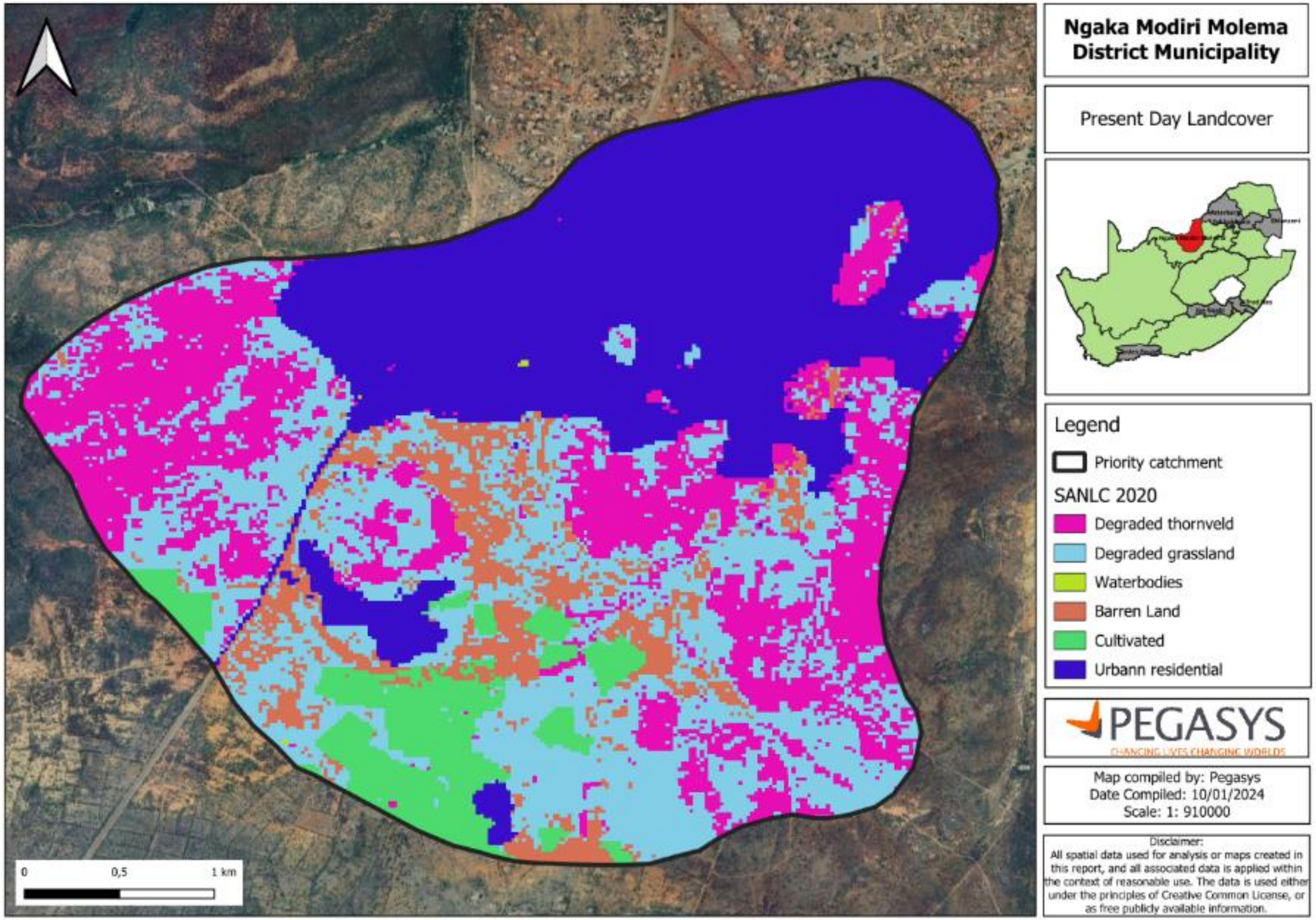

Figure 6-11: Present Day Land Cover Distribution of the Sandspruit River Catchment

Hydrological Analysis Results

As presented previously, the focus of hydrological simulation results analysis has been targeted towards changes in high-flow (flood) hydrology dynamics in the catchment. As noted previously, the most significant damage to road and bridge infrastructure is through high discharge events, particularly when the peak discharge rate exceeds the design capacity of infrastructure associated with bridges, culverts or dams. Therefore, in order to understand the level of impact of the proposed catchment rehabilitation interventions on high stormflow and flood events, the annual maximum simulated discharge associated with Scenario 1 (present day landcover) and Scenario 2 (assuming the proposed interventions have been implemented) were compared. The results of this analysis are presented in Figure 6-12. From this graph, it is difficult to identify the differences in the high flows, therefore an additional analysis was undertaken by extracting the simulated AMS discharge data for the respective scenarios, as shown in Figure 6-13. A comparison of the AMS between the two scenarios showed that, on average, **a reduction of approximately 1.5% in the AMS is achieved though the proposed implementation of catchment restoration activities.**

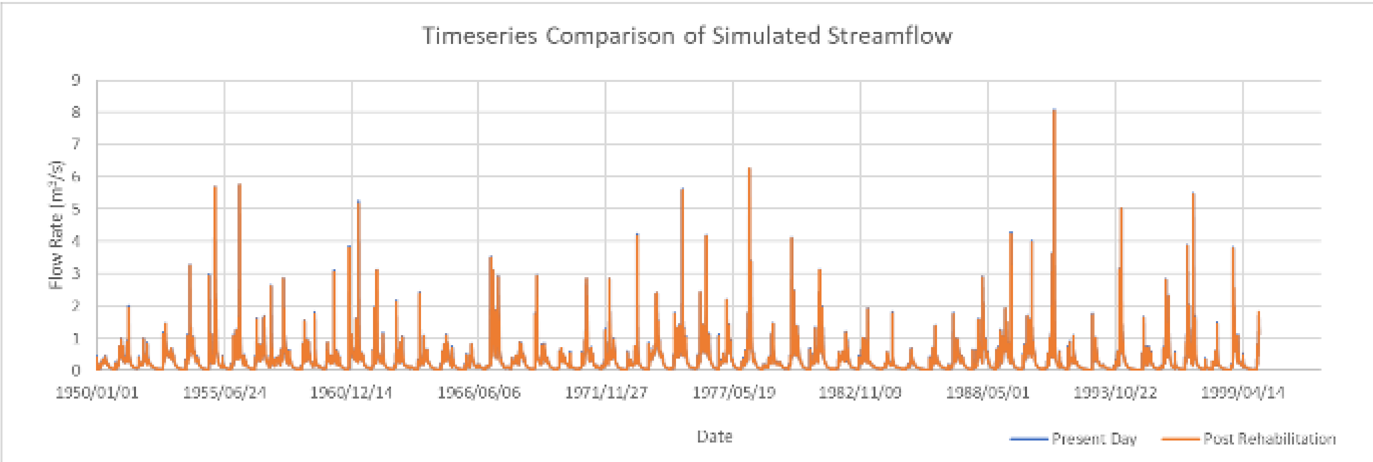

Figure 6-12: Streamflow timeseries comparison for Scenario 1 versus Scenario 2 for the Ngaka Modiri Molema DM

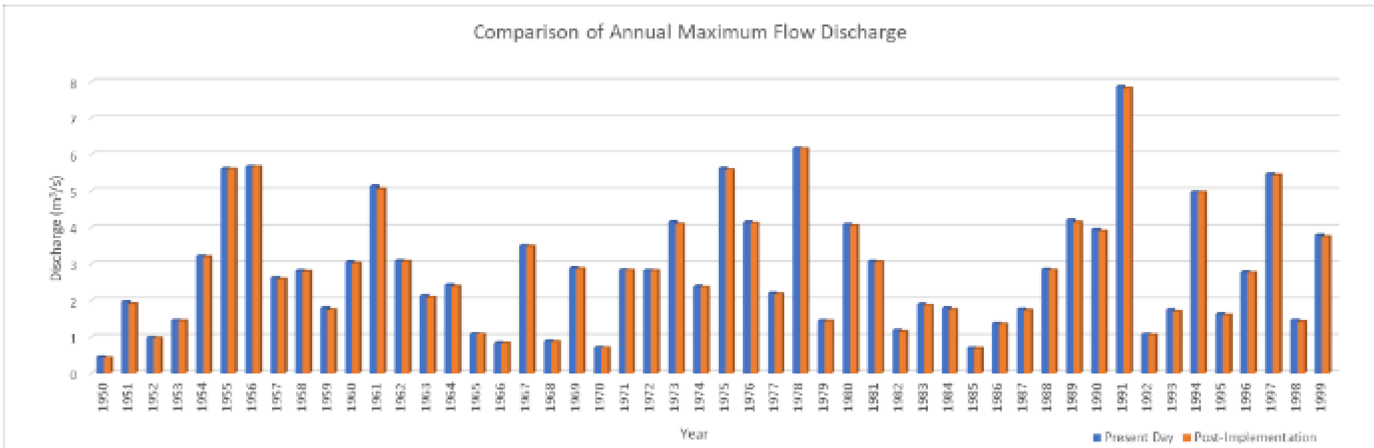

Figure 6-13: Annual maximum discharge comparison for Scenario 1 versus Scenario 2 for the Ngaka Modiri Molema DM

As presented previously, additional analysis was undertaken to understand the degree of change in high flows from the individual HRU's as a result of the proposed rehabilitation activities. This was illustrated through the analysis of the differences in runoff depths from the top ten simulated discharge events, as presented in Table 6-17.

FromTable 6-17, it is noted that runoff depths associated with the more extreme storm events were significantly reduced through both gully rehabilitation and the rehabilitation of the degraded grasslands and thornveld areas. The most significant reduction in stormflow is observed through gully rehabilitation. Across both rehabilitation areas, the reduction in the high flow depths associated with the HRU's ranges between 20% and 40%, which is significant in the context of climate resilience with particular regards to flooding hazards.

Table 6-17: Simulated Impact of catchment Rehabilitation Initiatives

Stormflow Event Ranking	Gully Rehabilitation		Rangeland Rehabilitation	
	Pre	Post	Pre	Post
1	56.4	32.7	51.1	32.7
2	39.5	29.0	37.5	29.0
3	38.1	28.3	36.5	28.3
4	37.7	28.0	35.5	28.0
5	37.7	26.5	35.4	26.5
6	37.6	25.6	35.1	25.6
7	37.5	25.2	34.4	25.2
8	36.8	25.0	33.6	25.0
9	33.3	24.1	32.1	24.1
10	32.4	23.6	31.0	23.6

Based on the results obtained from the hydrological modelling, it is noted that **there are limited differences in flood hydrology from the entire catchment**. However the differences in stormwater runoff depths from HRU's are far more significant. The lack of significant differences in high-flows from the greater catchment are likely as a result of the **significant portion of the catchment that is associated with residential areas (therefore high stormflow potential), which overshadows the potential gains in reducing high-flows from the areas of rehabilitation.**

Sediment Loss Scenario Analysis Results

As presented in Section 6.1.5, the RUSLE was used to calculate sediment loss under pre-implementation (current day) landcover conditions and post-implementation (once rehabilitation efforts have been executed) landcover conditions. The results of this analysis are provided in Table 6-18. Through this analysis it is noted the **reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation and approximately 93% reduction for gully rehabilitation.** As mentioned previously, these results are achieved through only changing the land cover conditions of the respective HRU's (C factor as presented in Section 6.1.5). In each case, converting the areas that are identified as degraded, to a grassland and thornveld systems that is in pristine health, makes a significant impact on the volume of sediment emanating from the respective areas.

Table 6-18: Total Annual Sediment Yield (ton/ha)

Intervention	Scenario	Annual Sediment Yield (ton/ha)
Rangeland Rehab	Pre-Implementation	8.58

	Post-Implementation	1.72
Gully Rehabilitation	Pre-Implementation	22.87
	Post-Implementation	1.72

6.2.5 Sekhukhune DM

The area identified as being most vulnerable to floods and droughts, and therefore the focal area for Eco-DRR interventions in the Sekhukhune DM was within the Lepellane River Catchment which is located towards the centre of the DM. The following sub-sections provide details on the information used to configure the hydrological model and provides a description of the results obtained through the scenario analysis.

Rainfall Data

As indicated earlier, representative climate data is key for the development of a representative hydrological model for the project area. The Daily Rainfall Utility programme (Kunz, 2004) was used to assess rainfall stations within the study area. There are a number of rain gauges in the vicinity of the Lepellane River Catchment, each with varying record lengths and reliabilities. Details on the selected driver rainfall station are provided in Table 6-19. This rain gauge has a record length of over 100 years, and for the time period 1950 to 1999, on which this study is based, 89.2 % of the rainfall gauge data was considered reliable (the remainder of the gauge data was patched using surrounding rainfall gauges).

Table 6-19: Key Study Site Catchment Characteristics

Catchment Name	Catchment Area (km²)	Rainfall Station	Rainfall Station Name	Gauge MAP[1] (mm)	Percentage Reliability
Lepellane River	251	0592474 A	Nebo	618	89.2

Land Cover Characteristics

The present day landcover characteristics were extracted from the NLC2020 database. Based on information from the database, the catchment area was categorised into ten HRU's, as shown in Table 6-20. The most prolific of these, as depicted in Figure 6-14 and Table 6-20 is subsistence agriculture covering an area of roughly 129.14 km2 followed by sandy highveld vegetation (49.34 km2) and rural residential areas approximately 47.14 km2. Further to this, based on the NLC2020, approximately 4.32 km2 of the catchment is classed as barren land or exposed soils. This is linked to the severe gully erosion associated with the catchment. The total area associated with IAP's (mostly black wattle) was equal to approximately 0.04 km². The degraded grasslands, open ground and gully erosion and IAP areas constitute the degraded components of the catchment area.

Table 6-20: Summary of Land Cover Distributions in the Lepellane River Catchment

Landcover Type (HRU)	Current Landcover (km2)	Post Rehabilitation Landcover (km2)
Barren land	4.32	4.28
Cultivated fields	129.14	37.80
Dams	0.35	0.35
Degraded grassland	49.34	0.00
Mines and quarries	0.29	0.29
Natural forest	9.70	9.70
IAP	0.04	0.00

Landcover Type (HRU)	Current Landcover (km2)	Post Rehabilitation Landcover (km2)
Residential	47.14	47.14
Wetlands	0.08	0.08
Sourish mixed bushveld	10.80	151.55
Total	**251.20**	**251.20**

In order to quantitatively ascertain the impacts of the degraded portions of the Lepellane River Catchment, the second modelling scenario included Eco-DRR interventions, linked to rangeland rehabilitation, abandoned agriculture land rehabilitation, gully erosion rehabilitation and IAP removal. The proposed interventions in the Sekhukhune DM constitutes approximately 60% of the catchment area.

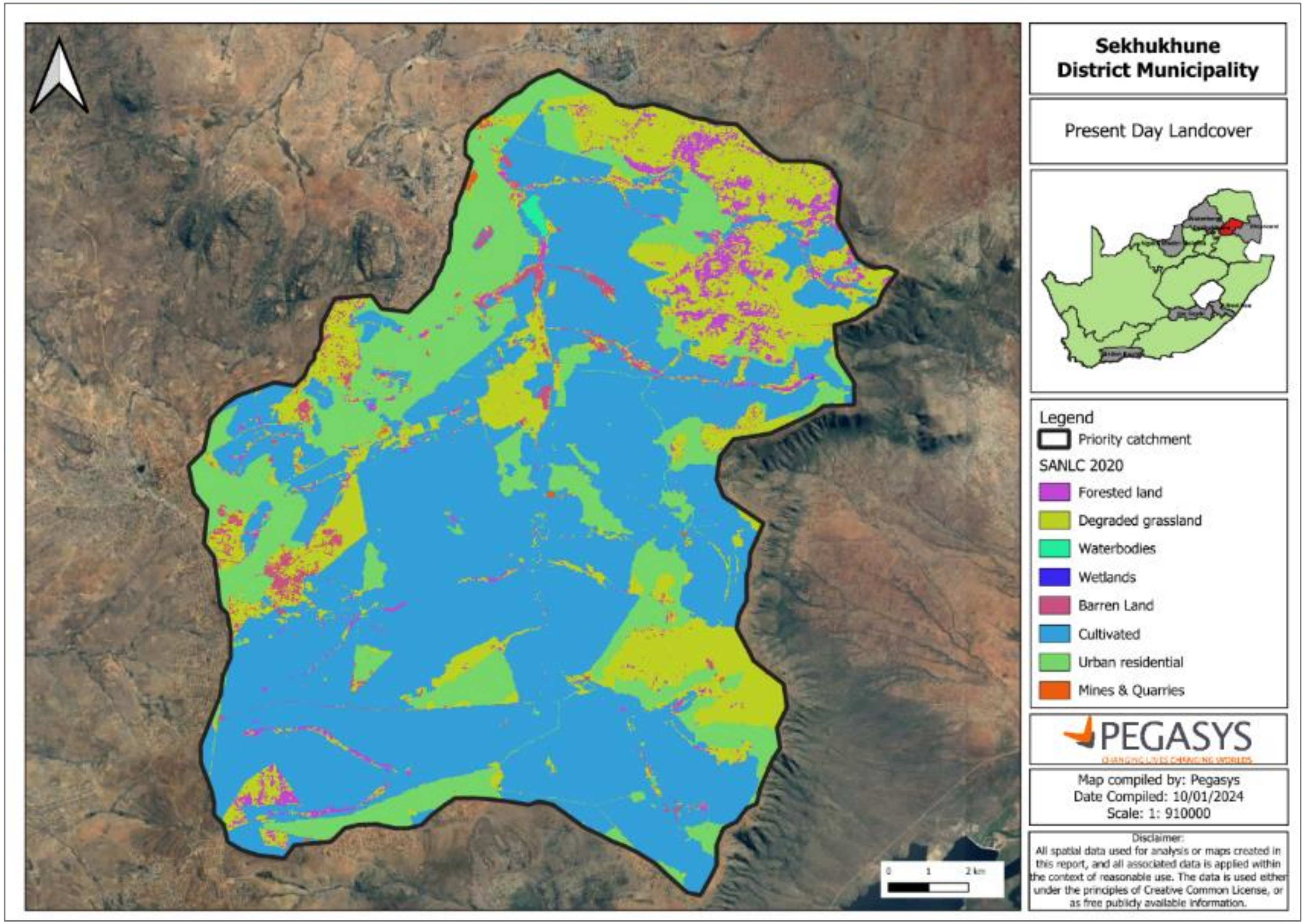

Figure 6-14: Present Day Land Cover Distribution of the Lepellane Catchment

Hydrological Analysis Results

As presented previously, the focus of hydrological simulation results analysis has been targeted towards changes in high-flow (flood) hydrology dynamics in the catchment. As noted previously, the most significant damage to road and bridge infrastructure is through high discharge events, particularly when the peak discharge rate exceeds the design capacity of the infrastructure (i.e. bridges, culverts or dams). Therefore, in order to understand the level of impact of the proposed catchment rehabilitation interventions on high stormflow and flood events, the annual maximum simulated discharge associated with Scenario 1 (present day landcover) and Scenario 2 (assuming the proposed interventions have been implemented) were compared. The results of this analysis are presented in Figure 6-15. From this graph, differences in the high flows are noted, however, these differences are overshadowed by the extent of the streamflow timeseries analysed. Therefore, additional analysis was undertaken by extracting the simulated AMS discharge data for the respective scenarios, as shown in Figure 6-16. A comparison of the AMS between the two scenarios showed that, on average, **a reduction of approximately 15% in the AMS is achieved though the proposed implementation of catchment restoration activities**.

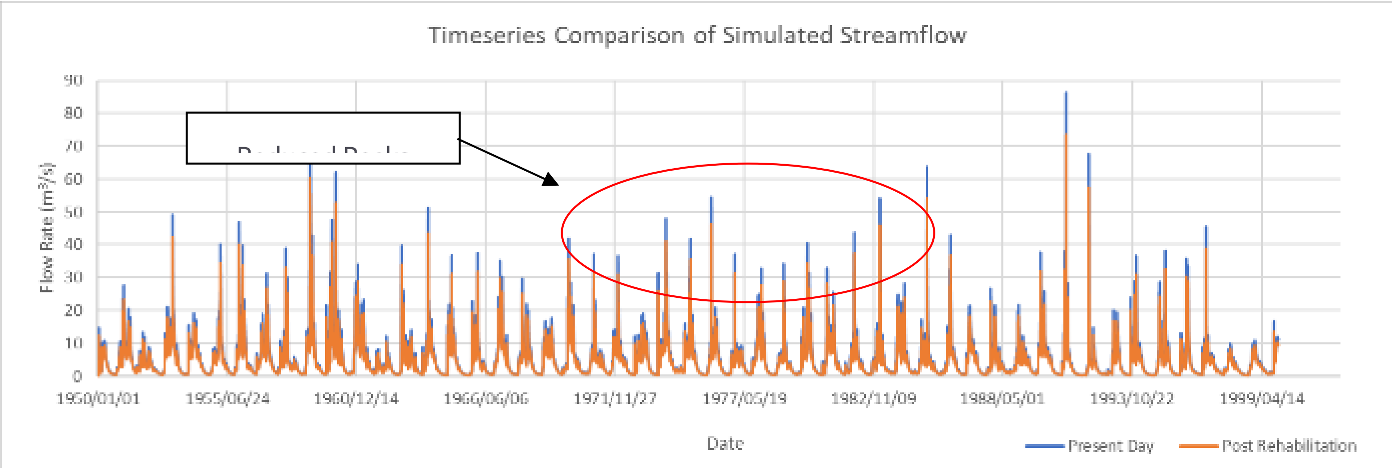

Figure 6-15: Streamflow timeseries comparison for Scenario 1 versus Scenario 2 for the Sekhukhune DM

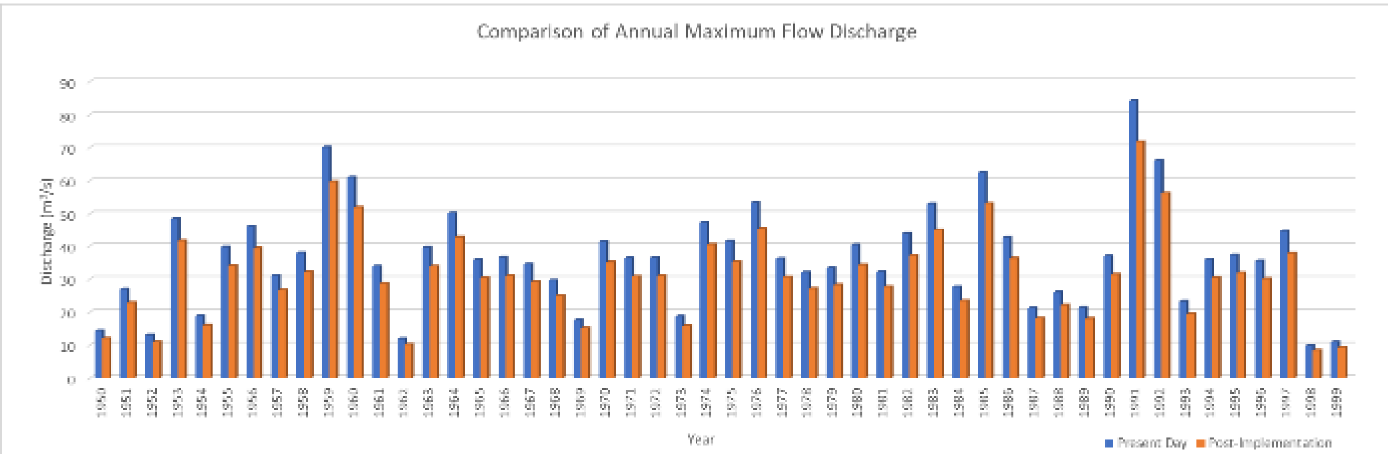

Figure 6-16: Annual maximum discharge comparison for Scenario 1 versus Scenario 2 for the Sekhukhune DM

As presented previously, additional analysis was also undertaken to understand the degree of change in high flows from the individual HRU's as a result of the proposed rehabilitation activities. This was illustrated through the analysis of the differences in runoff depths from the top ten simulated discharge events, as presented in Table 6-21. From this table it is noted that, the **rehabilitation of rangelands and gullies resulted in significant reductions in the runoff depths from these respective HRU's**. From this analysis it is noted that the proposed rehabilitation of the areas associated with gullies resulted in a reduction in runoff depths from approximately 41 mm to approximately 25 mm. This represents a nearly 38% reduction in the peak discharge associated with the largest simulated flood event from the gully HRU. Similarly, changes in the other top nine flood events showed reductions of between 27% and 39%. Similar reductions in the high flow events were also noted through the rehabilitation of rangelands, where reductions in high flows of between 27% and 38% were noted. The **changes in the high flow events associated with IAP removal (replaced with grasslands) was, however, noted to be negligible**, and in some instance opposite to the impacts of the gulley and rangeland rehabilitation. As mentioned previously, it is assumed that this is likely as a result of the interception that occurs with denser canopy covers associated with forested areas therefore reducing the depth of effective rainfall and stormflow runoff. The benefits of IAP removal are realised through the reduction in sediment yields (as indicated in Table 6-22), as well as the increased water security in the catchment as a result of lower evapotranspiration rates from forested areas.

Table 6-21: Simulated Impact of catchment Rehabilitation Initiatives on runoff depths (mm)

Stormflow Event Ranking	Gully Rehabilitation		Rangeland Rehabilitation		IAP Rehabilitation	
	Pre	Post	Pre	Post	Pre	Post
1	40.64	25.04	39.84	25.03	28.02	29.61
2	31.81	20.65	31.22	20.64	22.54	23.94
3	31.57	19.39	31.1	19.38	21.24	22.85
4	29.18	19.21	28.73	19.2	20.38	21.66
5	28.07	18.57	27.62	18.56	20.05	21.44
6	25.62	18.05	25.22	18.04	19.51	20.92
7	24.78	18.02	24.77	18.01	18.24	19.63
8	24.7	16.25	24.33	16.24	17.22	18.68
9	23.71	15.91	23.56	15.91	16.72	18.01
10	23.4	15.76	23.06	15.75	16.48	17.65

Sediment Loss Scenario Analysis Results

As presented in Section 6.1.5, the RUSLE was used to calculate sediment loss under pre-implementation (current day) landcover conditions and post-implementation (once rehabilitation efforts have been executed) landcover conditions. Through this analysis it is noted a **significant reduction in sediment yield can be achieved through the proposed interventions. It was noted that an approximately 80% for rangeland rehabilitation, 60% for IAP removal and approximately 92% reduction for gully rehabilitation**. As mentioned previously, these results are achieved through only changing the land cover conditions of the respective HRU's (C factor as presented in Section 6.1.5). In each case, converting the areas that are identified as degraded, to a grassland system that is in pristine health, makes a significant impact on the volume of sediment emanating from the respective areas.

Table 6-22: Total Annual Sediment Yield (ton/ha)

Intervention	Scenario	Annual Sediment Yield (ton/ha/annum)
Rangeland Rehab	Pre-Implementation	23.24
	Post-Implementation	4.65

Intervention	Scenario	Annual Sediment Yield (ton/ha/annum)
IAP Removal	Pre-Implementation	11.62
	Post-Implementation	4.65
Gully Rehabilitation	Pre-Implementation	61.98
	Post-Implementation	4.65

6.3 TECHNICAL APPRAISAL OF SITE-BASED INTERVENTIONS

The following chapter provides a summary of the climate change hazards identified across the respective project areas, and links these hazards to direct and indirect impact of the identified climate hazards on infrastructure. Thereafter, the potential offsetting of the identified hazards on exposed and vulnerable infrastructure is provided. These results are based on the hydrological modelling undertaken, as presented in Section 6.2.

6.3.1 Infrastructure Risk Identification

Through the site visits undertaken at the respective project areas, as well as a GIS based analysis, direct and indirect impacts of flooding on infrastructure, either within the identified catchment or in close proximity to the catchment, were identified. Focus was given to bridges, culverts and dams that could be directly impacted upon by increased flooding risk. Indirect impacts associated with damage to this infrastructure included restricted access to or from households related to damaged bridge or culvert crossings as well as impacts associated with loss of supply due to potential damaged or loss of dam infrastructure. The quantity of the identified infrastructure assets across the respective DM's is presented in Table 6-23. The location of the identified infrastructure assets, as well as the location of households that may be indirectly impacted on as a result of damage to the infrastructure assets are presented Figure 6-17 to Figure 6-21.

Table 6-23: Direct and indirect impacts associated with infrastructure vulnerability within the DMs

DM	Directly Impacted Infrastructure			Indirect Impacts		
	Dams	Bridges		Household Affected by Accessibility		Water Supply
		Number of Bridges	Road Class Associated with the Bridge	Moderate Impact (alternative access routes available)	High Impact (no alternative access routes)	
Joe Gqabi	-	1	5	1 474	745	-
Alfred Nzo	-	2	5	644	-	-
Ehlanzeni	-	2	2 and 5	435	-	-
Sekhukhune	1	11	2 and 5	4 475	-	Water supply to the Jane Furse Area (5.54 Ml/day)
Ngaka Modiri Molema	-	3	5	-	82	

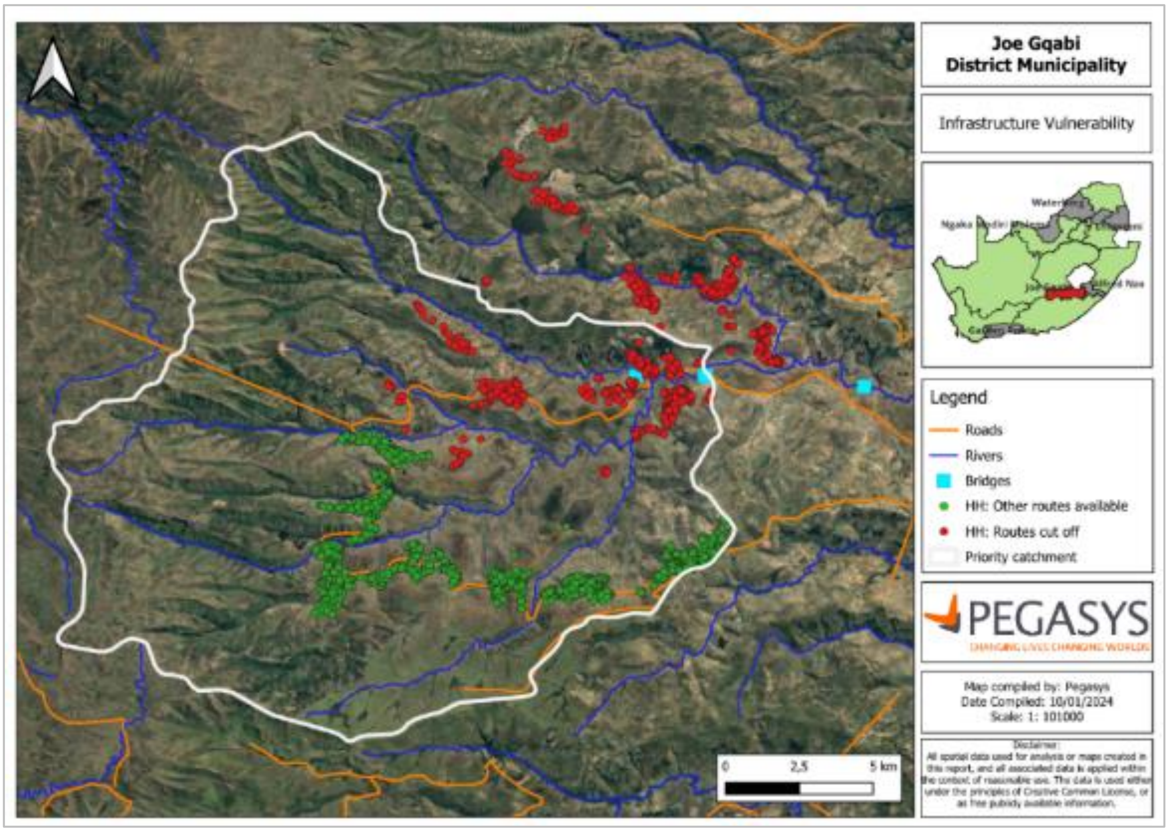

Figure 6-17: Infrastructure based direct and indirect impacts associated with flooding in the Joe Gqabi DM

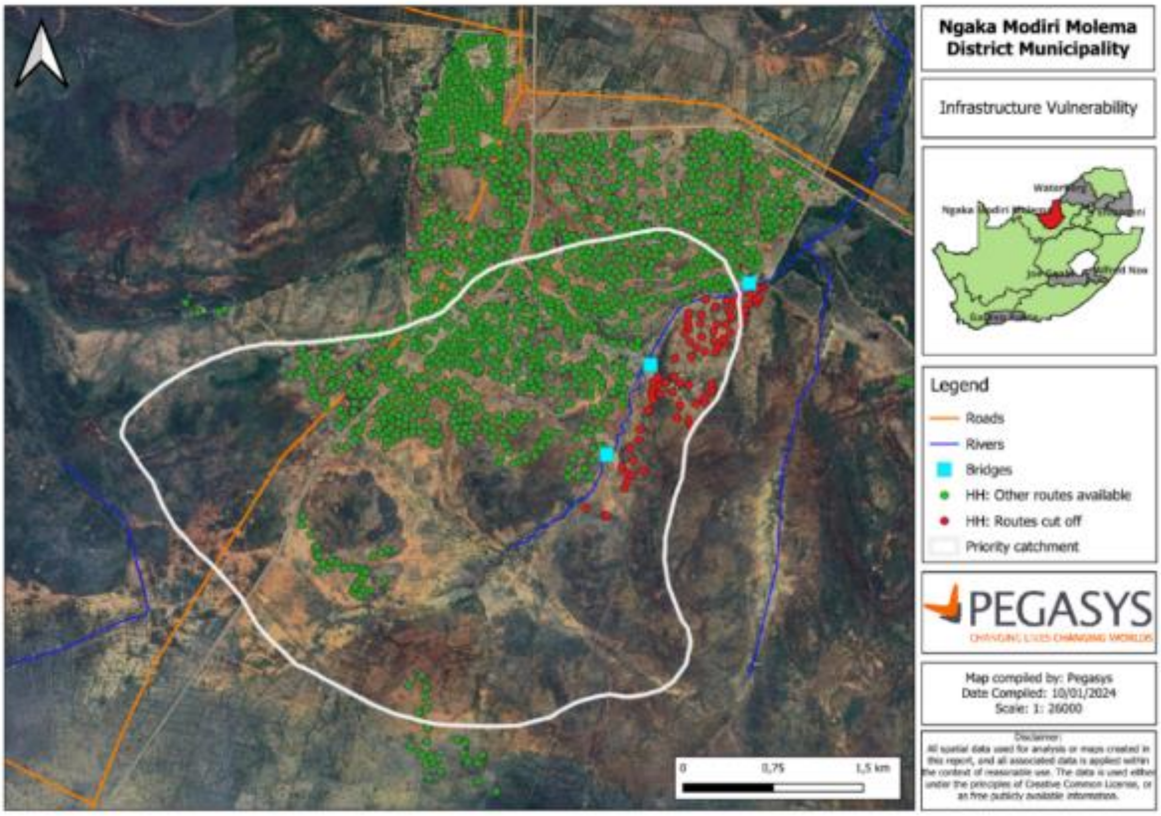

Figure 6-18: Infrastructure based direct and indirect impacts associated with flooding in the Ngaka Modiri Molema DM

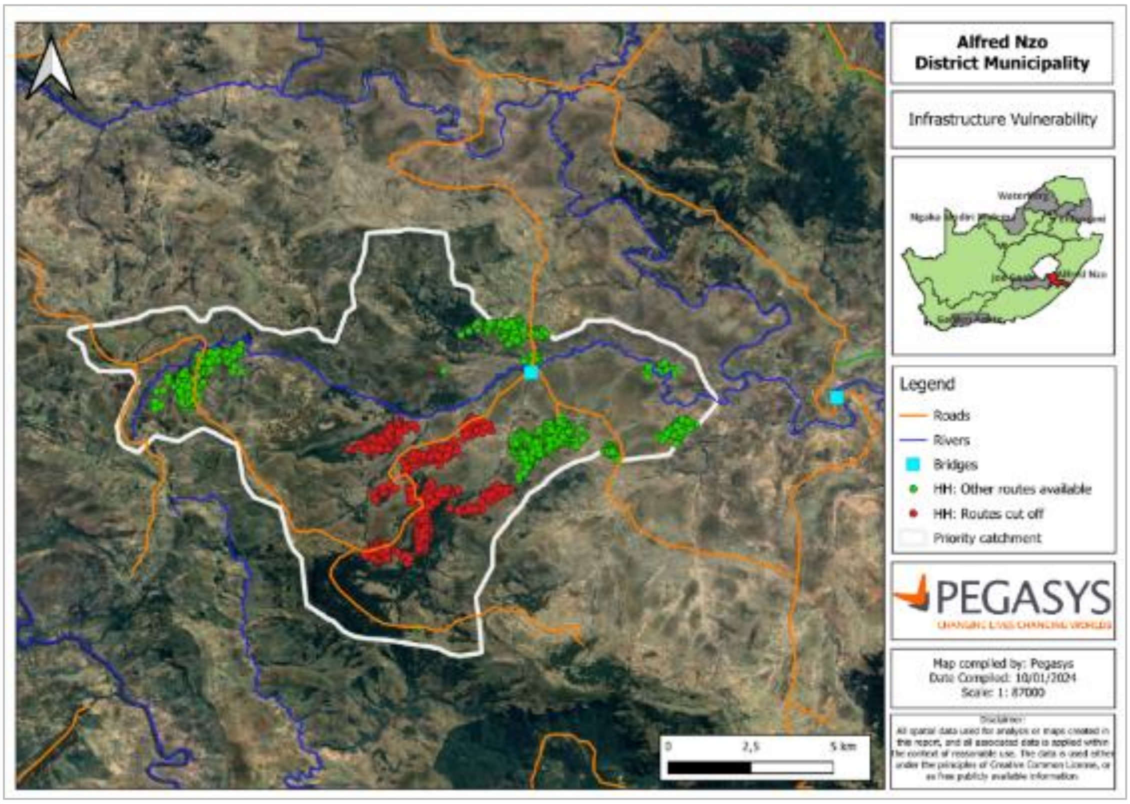

Figure 6-19: Infrastructure based direct and indirect impacts associated with flooding in the Alfred Nzo DM

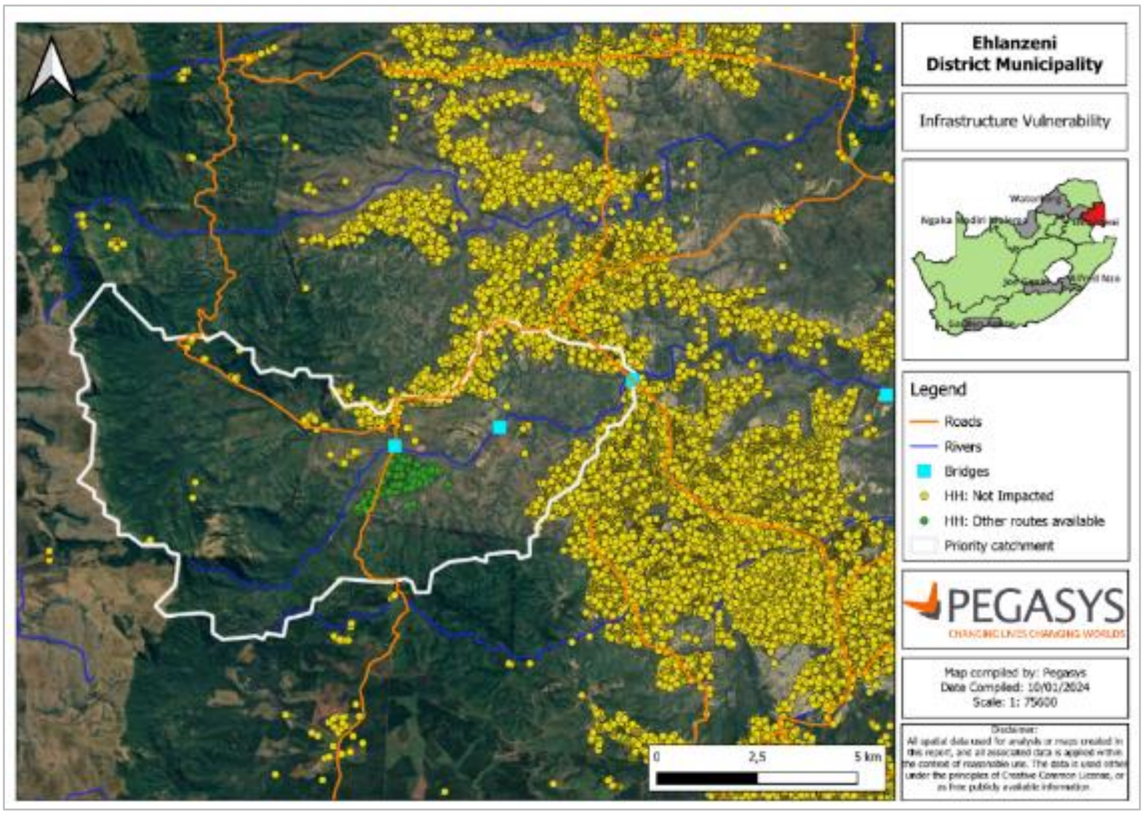

Figure 6-20: Infrastructure based direct and indirect impacts associated with flooding in the Ehlanzeni DM

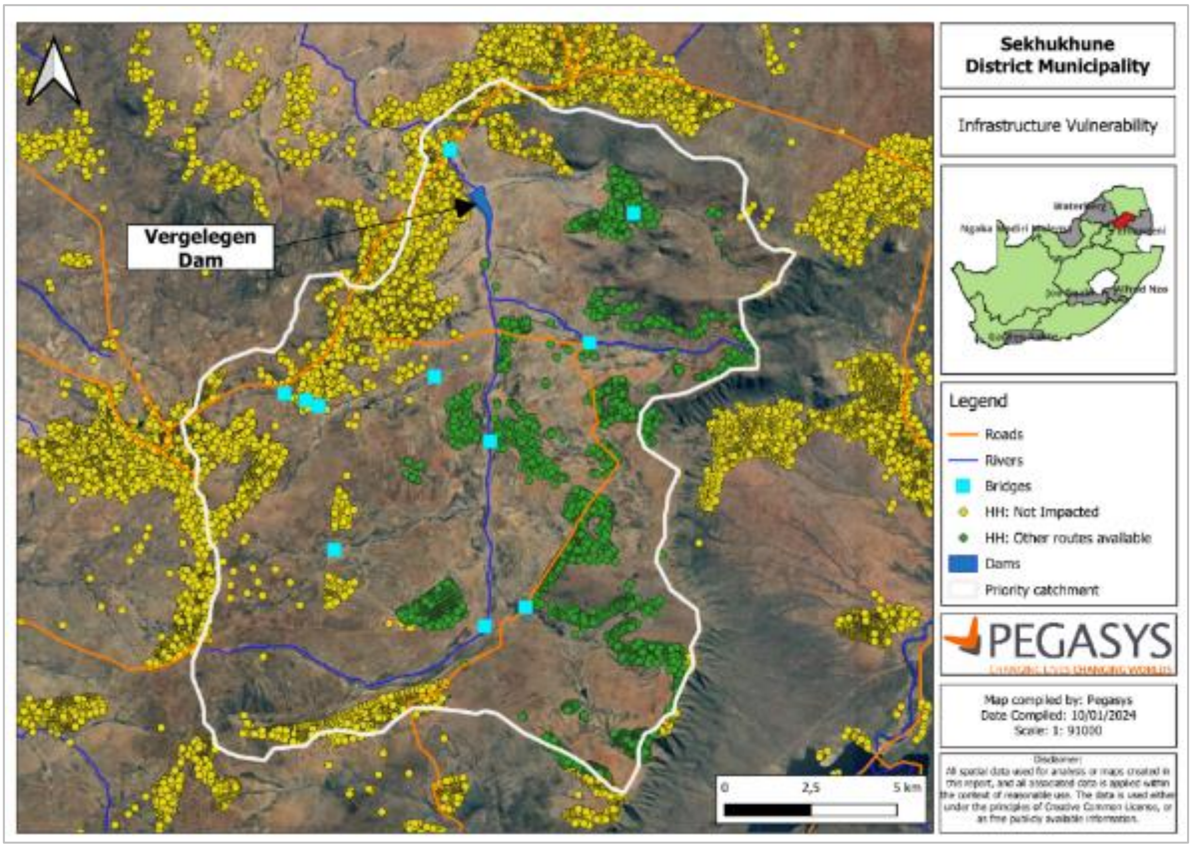

Figure 6-21: Infrastructure based direct and indirect impacts associated with flooding in the Sekhukhune DM

6.3.2 Flood Hazard and Vulnerability Assessment Summary

As presented in Section 6.2, the infrastructure that was identified as being exposed to flooding across the respective priority catchment areas included bridges, culverts and a dam (i.e. the Vergelegen Dam in the Sekhukhune DM). In order to assess the level of vulnerability of these infrastructure assets to projected changes in flooding hazards, an understanding of the design capacities associated with the infrastructure is required. This understanding is detailed below.

Bridge and Culvert Capacity Design Criteria

The Drainage Manual (SANRAL, 2013), applies procedures and design requirements described in a Code of Procedure book, which dictates the capacity requirements of bridge and culvert infrastructure, based on the Road Class associated with the bridge or culvert, as defined in the Drainage Manual (SANRAL, 2013), and the 20-year return period indicator flood. Table 6-24 presents a summary of the return period capacity requirements for the six different road classes in South Africa. As presented in Table 6-23, the road classes associated with roads traversing the respective project areas range between Class 2 and Class 5 roads. Therefore, the design requirements for the bridge and culvert infrastructure associated with the priority catchment areas ranges from 5- to 50-years. Changes in the flood hydrology associated with the 5- and 50-year flood hydrology was therefore used to generate an understanding of the vulnerability of the road and bridge infrastructure associated with the respective project areas.

Table 6-24: Design flood frequency requirements for various road classes (SANRAL, 2013)

	Road class	Proposed return period (T) based on the magnitude of the Q_{20} flood		
		$Q_{20} < 20\ m^3/s$	$20\ m^3/s < Q_{20} < 150\ m^3/s$	$Q_{20} > 150\ m^3/s$
1	Primary distributor	50	$T = 42{,}31 + 0{,}385Q_{20}$	100
2	Regional distributor	20	$T = 15{,}39 + 0{,}231Q_{20}$	50
3	District distributor	10	$T = 8{,}46 + 0{,}077Q_{20}$	20
4	District collector	5	$T = 4{,}231 + 0{,}0385Q_{20}$	10
5	Access roads	2	$T = 1{,}539 + 0{,}0231Q_{20}$	5
6	Non-motorised/ Access ways	2	$T = 1{,}539 + 0{,}0231Q_{20}$	5

Dam Spillway Capacity Design Criteria

As indicated in Table 6-23, a significant dam is located at the outlet of the priority catchment located in the Sekhukhune DM. This dam is known as the Vergelegen Dam, and is a medium-sized earthfill structure designed to cater primarily for domestic water supply to the town of Jane Furse and its surrounding villages. This dam was constructed in 1970 and subsequently raised in 1995. The dam wall spans a length of 600 m and it has a design storage capacity of 1,550 million m^3. The dam features a concrete ogee spillway to manage overflow during peak flow periods.

In South Africa, the design of spillways in dams are required to adhere to the guidelines outlined by the DWS, particularly the "Guidelines for Safety Risk Management of Dams in South Africa." These guidelines emphasise the importance of ensuring spillway adequacy to safely manage flood flows and prevent overtopping of the dam, which could lead to catastrophic failure. Design capacity requirements of spillway are based on the hazard rating of the dam. In line with this, it is noted that the Vergelegen dam is a category II dam based on the fact that it is a Medium sized Dam with Significant hazard potential rating. The recommended design flood (RDF), in terms of recurrence interval for a category II dam (Medium Dam, Significant Hazard Rating) is the 1:100 year flood event (Guidelines on Safety in Relation to Floods – Table 5.4, SANCOLD, 1991). Based on Table 5.2 of the same publication the Safety Evaluation Discharge (SED) is equal to the Regional Maximum Flood (RMF). Therefore, any change to the magnitude of the 1:100 year flood event and/or the RMF event, could have potential impacts on the safety of the dam and the amount of freeboard available.

Changes in Flood Hazards

Analysis of the projected changes in extreme rainfall was undertaken using information extracted from the Climate Change Knowledge Portal (World Bank, 2021), which in turn is based on CMIP6. Focus was given to SSP5-8.5, and centralised over the 2050 period, using the 50th and 90th percentiles of multi-model ensembles. This provides a conservative picture of climate change, and in particular, anomalies of forecasted extreme rainfall events.

Changes in rainfall extremes was used as a proxy for the assessment of changes in flooding risks. In line with this, it has been assumed that changes in the depth and frequency of extreme rainfall is representative of changes in frequency and magnitude of flood events. From the analysis undertaken, it was noted that **both the frequency and the magnitude of flooding events is expected to increase across all priority catchments**, as illustrated in Table 6-25**.** Sekhukhune is identified as the DM with the highest increases in changes in exceedance probabilities, with the 100 year flood event showing to be exceeded more than once in every two years (exceedance probability change from 1% to 52% for 90th percentile model ensembles), and the 100 year event increasing from 99mm to 149mm.

Table 6-25: Summary of changes in rainfall exceedance probabilities using anomalies in forecasted extreme rainfall events

DM	Climate Scenario	Return Period Rainfall Depth (mm)				Changes in Exceedance Probability			
		5	10	50	100	5	10	50	100
Joe Gqabi	Present Day	71	87	126	146	20.0%	10.0%	2.0%	1.0%
	50th Percentile Model Ensembles	78	94	133	153	29.8%	14.4%	2.9%	1.4%
	90th Percentile Model Ensembles	116	132	171	191	62.5%	54.1%	13.3%	5.8%
Ngaka Modiri Molema	Present Day	84	102	144	163	20.0%	10.0%	2.0%	1.0%
	50th Percentile Model Ensembles	86	104	146	165	22.3%	11.1%	2.2%	1.1%
	90th Percentile Model Ensembles	138	156	198	217	62.5%	54.5%	16.7%	8.1%
Alfred Nzo	Present Day	84	112	150	166	20%	10%	2%	1%
	50th Percentile Model Ensembles	101	118	156	172	41.0%	13.6%	2.8%	1.4%
	90th Percentile Model Ensembles	151	168	206	222	66.8%	55.8%	21.8%	10.9%
Ehlanzeni	Present Day	98	125	212	263	20.0%	10.0%	2.0%	1.0%
	50th Percentile Model Ensembles	109	136	223	274	30.3%	14.0%	2.6%	1.2%
	90th Percentile Model Ensembles	143	170	257	308	55.8%	36.1%	4.5%	1.9%
Sekhukhune	Present Day	69	78	94	99	20.0%	10.0%	2.0%	1.0%
	50th Percentile Model Ensembles	84	93	109	114	49.6%	32.5%	9.4%	5.7%
	90th Percentile Model Ensembles	119	128	144	149	66.7%	62.6%	54.9%	52.3%

6.4 SUMMARY OF FINDINGS

Few studies have attempted to quantify exact or quantitative values for EbA benefits (Holden, et al., 2022; Rasmussen, et al., 2021; O'Farrell, et al., 2019), particularly in LMICs. Furthermore, there is a time lag between the implementation of the interventions and the impact (Annandale et al. 2016).

There is general agreement that field-derived quantitative data in the impact of restoration interventions is limited. In addition, several authors note that few studies in South Africa have gathered quantitative (in situ) data on soil erosion, flooding and drought benefits associated with ecological infrastructure and highlight the need for long-term field monitoring to inform modelling (e.g. Le Roux et al., 2007, Dlamini et al., 2011; Gyamfi et al., 2016).

The potential technical interventions considered for implementation in the proposed project sites include improved grazing system, stone lines, pathway revets, contour brushpacks. revegetation / reseeding, gabions. dry stone walls, concrete weirs, rock packing, ecologs, earth works, eco-mattresses, vetiver lines, broad brushpacking, ponding, fencing, vetiver lines – agricultural, contours – agriculture, conservation agriculture, clearing invasive aliens – manual, and clearing invasive aliens

– biological. Hydrological modelling was used to determine the level of impact that can be achieved through the implementation of these restoration activities, ultimately to counteract the increases in flooding, drought and wildfire vulnerabilities associated with climate change.

6.4.1 Alfred Nzo DM

In the Alfred Nzo DM, where interventions are proposed across **3%** of the catchment, an average reduction of **3%** in the reduction of the AMS was realised. The rehabilitation of rangelands and gullies resulted in significant reductions in the runoff depths through the proposed rehabilitation interventions (41% reduction with gully rehabilitation and 28-37% with rangeland rehabilitation). The changes in the high flow events associated with IAP removal (replaced with grasslands) was, however, noted to be negligible. The reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation, 40% for IAP removal and approximately 93% reduction for gully rehabilitation.

6.4.2 Joe Gqabi DM

In the Joe Gqabi DM, where interventions are proposed for **24%** of the catchment area, an average reduction of **6%** of the simulated AMS was realised. Rehabilitation activities associated with the gully and rangeland rehabilitation resulted in a significant reduction in the runoff depths (42% reduction with gully rehabilitation and 28-37% with rangeland rehabilitation). The changes in the high-flow events associated with IAP removal (replaced with grasslands) was, however, noted to be negligible (in some cases an increase in flow depths was noted). The reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation, 60% for IAP removal and approximately 90% reduction for gully rehabilitation.

6.4.3 Ehlanzeni DM

In the Ehlanzeni DM, where interventions are proposed across **7%** of the catchment, an average reduction of **1%** in the reduction of the AMS was realised. The rehabilitation of rangelands and gullies resulted in significant reductions in the runoff depths (42% reduction with gully rehabilitation and 21-37% with rangeland rehabilitation). The changes in the high flow events associated with IAP removal (replaced with grasslands) was, however, noted to be less significant. The reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation, 60% for IAP removal and approximately 92% reduction for gully rehabilitation.

6.4.4 Ngaka Modiri DM

In the Ngaka Modiri Molema DM, where interventions are proposed across **18%** of the catchment area, an average reduction of **1.5%** in the simulated AMS was realised. The runoff depths associated with the more extreme storm events were significantly reduced through both gully rehabilitation and the rehabilitation of the degraded grasslands and thornveld areas (between 20% and 40%). However, there are limited differences in flood hydrology for the entire catchment - likely as a result of the significant portion of the catchment being associated with residential areas (therefore high stormflow potential), which overshadows the potential gains in reducing high-flows from the areas of rehabilitation. The reduction in sediment yield through the proposed interventions equated to approximately 80% for rangeland rehabilitation and approximately 93% reduction for gully rehabilitation.

6.4.5 Sekhukhune DM

In the Sekhukhune DM, where interventions are proposed across **56%** of the catchment, an average reduction of **15%** in the reduction of the AMS was realised. The rehabilitation of rangelands and gullies resulted in significant reductions in the runoff depths (38% reduction with gully rehabilitation and 27-38% with rangeland rehabilitation). The changes in the high flow events associated with IAP removal (replaced with grasslands) was, noted to be negligible, and in some instance opposite to the impacts of the gulley and rangeland rehabilitation. Significant reduction in sediment yield can be achieved through the proposed interventions (80% for rangeland rehabilitation, 60% for IAP removal and 92% reduction for gully rehabilitation).

It should be noted that there is limited monitoring and datasets at a local level to conduct comprehensive modelling, particularly within the catchments selected for this feasibility study. As a result, a blanket approach was used to model the catchments that made use of the best available data.

7 Economic Evaluation

7.1 OVERVIEW

This section presents an analysis of the economic costs and benefits, and the economic rates of return associated with proposed project interventions in each of the study areas.

The underlying calculations of cost and benefit estimates are detailed in a CBA model which is available as a separate Excel workbook. All assumptions and data sources are clearly noted in the model, together with a number of explanatory notes. This section sets out:

- The approach to, and scope of, the CBA
- The nature and significance of anticipated benefits (primary and ancillary) resulting from the proposed interventions, including the methodologies used to quantify and value benefits where this was possible.
- The outcomes of the CBA, represented in terms of key decision metrics (Net Present Value, Economic Internal Rate of Return and Benefit Cost Ratio), including an analysis of the sensitivity of the outcomes to changes in the underlying assumptions and important caveats and limitations to consider in the interpretation of the results.

It should be noted that, owing to data limitations, the cost and benefit estimates are necessarily high level at this stage and are intended to be indicative only. Further refinements will be required at the detailed design stage to better reflect:

- The costs of materials, labour and transport associated with the construction and ongoing maintenance of interventions, accounting for local factors such as resource availability, distance to markets and ground conditions;
- Agricultural production systems in and around the specific areas to benefit from the interventions (livestock patterns, gross margins, etc.);
- The infrastructure at risk of climate change and the level of protection that it would be afforded as a result of the interventions, accounting for changes in the extent, depth and duration of flood events; and
- The nature and significance of wider ecosystem services benefits in the areas affected by the interventions.

7.2 APPROACH

7.2.1 Approach for the CBA

The aim of the CBA is to analyse the costs and benefits of the proposed interventions in each of the five project areas. The following key steps were applied in undertaking the CBA:

a) **Definition of an appropriate baseline or 'without intervention' scenario** against which the impacts of the proposed programme interventions can be compared over their lifetime. The baseline recognises that the current situation will not remain static in the absence of the interventions given the influences of factors such as changes in climate, demography and socioeconomic conditions. For the purposes of this study, two scenarios are assessed. The first considers the costs of damages and losses that would occur assuming no future climate change (i.e. based on current climate variability). The second examines the impacts (costs and damages) assuming climate change but without the proposed project interventions. Two future climate change scenarios are examined, based on the extreme precipitation anomalies extracted from the Climate Change Knowledge Portal (and based on SSP5-8.5) used in the hydrological modelling. The 50th percentile represents an average, middle-of-the-road climate change scenario; the 90th percentile represents a worse case climate change scenario. The baseline is also used to derive a measure of the opportunity costs associated with the proposed interventions, particularly insofar as these relate to foregone agricultural production and ecosystem services.

Note that the CBA considers two additional scenarios relating to area of rehabilitated grassland expansion. The primary grassland scenario is the currently proposed grassland area expansion across the five DM sites. The secondary grassland scenario assesses economic results under high grassland expansions for Joe Gqabi and Alfred Nzo DM sites specifically, equating to 200,000 ha over the five sites. CBS results are presented for both these grassland scenarios.

Table 7-1: Rehabilitated grassland extent (ha) under two implementation scenarios

	Joe Gqabi	Ngaka Modiri Molema	Alfred Nzo	Ehlanzeni	Sekhukhune	Programme level: across all five project sites
Existing planned grassland expansions (ha)	18,315	278	50,955	506	14,075	84,129
High grassland expansion scenario (ha)	53,076	278	132,065	506	14,075	200,000

b) **Estimation of the costs (including externality effects)** associated with each of the types of interventions identified. The analysis considers the whole life costs associated with each type of intervention including:

- The capital costs of providing the necessary infrastructure, or acquiring equipment, technologies and expertise for the implementation of measures;
- Ongoing operation and maintenance (Operations and Maintenance) costs; and
- Any projected unintended environmental and social costs (or externalities) associated with the implementation of the proposed interventions where these are foreseen and can be reliably quantified and valued. These include, for example, loss of productive land (e.g. where implementation of vegetated areas results in loss of agricultural output).

c) **Estimation of the economic, social and environmental benefits** of the proposed interventions. The Intergovernmental Panel on Climate Change Fourth Assessment Report defines adaptation benefits as “the avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures”. While many of the benefits are simply the averted losses and damages identified and quantified in step (a) above, some of the adaptation interventions, if carefully designed, may also deliver important co-benefits such as climate mitigation, habitat for biodiversity, improved communal farming outcomes, etc. which have been valued and factored into the analysis as far as possible. It should be noted that the nature and value of benefits from the same adaptation intervention may differ from one location to the next depending on, for example, existing vulnerability and the size of the beneficiary population and the physical and natural assets at risk. Benefits have been quantified and valued in monetary terms as far as possible and where it is proportionate to do so, based on a combination of the hydraulic modelling outputs, analysis presented elsewhere in the Feasibility Study, and a review of the relevant literature, including statistical publications from the relevant provincial government departments. In cases where it has not been possible to quantify and value certain material benefits (e.g. where the detailed data necessary to derive estimates is not available), these benefits (and their likely significance) have been described in either quantitative (where possible) or qualitative terms.

The types of interventions being proposed are anticipated to give rise to a range of market and non-market benefits and co-benefits. Market benefits include, for example, avoided or reduced flood damage costs, avoided indirect damages (such as avoided travel time delays for work and school travellers resulting from accessibility of affected bridges), water quality improvements associated with reduced sediment yields, and improved livestock productivity associated with increased grasslands. Quantifiable market benefits have been valued using established market prices. Non-market benefits include impacts on ecosystem services such as carbon sequestration, provision of raw materials, and cultural (gene pool protection) ecosystem services. These benefits are more challenging to value as they rely on scientific understanding and modelling of cause-effect relationships as well as an understanding of local preferences (demand) for the services and benefits in question. The non-market benefits have been described in qualitative terms and, where possible, valued with reference to values derived in other studies in similar contexts elsewhere, where available and relevant.

d) **Discounting and application of the appropriate decision rules.** The costs and benefits have been estimated over a 50-year period, starting in 2025. Net benefits have been calculated as the difference between the 'with project' and 'without project' scenarios converted to measures of Economic Net Present Value (ENPV) and Economic Internal Rate of Return (EIRR) using a social discount rate (SDR) of 6%. While a range of discount rates are evident in available literature, the discount rate is based on Peacock et al (2023) who showed that the vast majority of ecological restoration projects in South Africa utilise a 6 percent SDR.
e) **Sensitivity analysis.** Sensitivity analysis has been performed to test the sensitivity of the outcomes to changes in the underlying assumptions, focusing on key input variables with large uncertainties, including the discount rate.

7.2.2 Approach to Identifying and Costing Eco-DRR in the Selected Districts

Mapping Land Covers in the Priority Sub-Catchment

A number of GIS data sources were used to identify land covers and land conditions to inform the identification of potential interventions to be applied in the two selected sub catchments.

The South African Landcover Database

Landcover data was extracted from the South African Landcover (SALC) datasets. Thirty-two cover classes were extracted from the SALC and reclassified into 12 classes, as follows:

1. Active Cultivation

2. Bare and Rock Surfaces
3. Built-up (Commercial and Roads and Rails)
4. Eroded Lands
5. Fallow Lands and Old Fields
6. Forest and Woodland
7. Natural Grassland
8. Plantation
9. Residential
10. River and Water Bodies
11. Scattered Villages
12. Wetlands

Table 7-2 indicates how the refined land cover classes were derived.

Table 7-2: Reclassification of land cover classes from the National Landcover Dataset

Original Class	Description	Detail	New Class
Subsistence / small-scale annual crops	Cultivated	Temporary Crops	Active Cultivation
Natural rock surfaces	Barren Land	Consolidated	Bare and Rock Surfaces
Other bare	Barren Land	Unconsolidated	Bare and Rock Surfaces
Commercial	Built-up	Commercial	Built-up (Commercial and Roads and Rails)
Roads and rails (major linear)	Built-up	Transport	Built-up (Commercial and Roads and Rails)
Mines: extraction pits, quarries	Mines and Quarries	Extraction Sites	Built-up (Commercial and Roads and Rails)
Fallow land and old fields (wetlands)	Cultivated	Fallow Lands and Old Fields	Built-up (Commercial and Roads and Rails)
Eroded lands	Barren Land	Unconsolidated	Eroded Lands
Fallow land and old fields (trees)	Cultivated	Fallow Lands and Old Fields	Fallow Lands and Old Fields
Fallow land and old fields (bush)	Cultivated	Fallow Lands and Old Fields	Fallow Lands and Old Fields
Fallow land and old fields (grass)	Cultivated	Fallow Lands and Old Fields	Fallow Lands and Old Fields
Fallow land and old fields (bare)	Cultivated	Fallow Lands and Old Fields	Fallow Lands and Old Fields
Contiguous low forest and thicket	Forested land	Natural Wooded Land	Forest and Woodland
Dense forest and woodland	Forested land	Natural Wooded Land	Forest and Woodland
Open woodland	Forested land	Natural Wooded Land	Forest and Woodland
Natural grassland	Grassland	Natural Grassland	Natural Grassland
Contiguous and dense plantation forest	Forested land	Planted Forest	Plantation
Open and sparse plantation forest	Forested land	Planted Forest	Plantation
Temporary unplanted (clear-felled) plantation forest	Forested land	Planted Forest	Plantation
Residential formal (tree)	Built-up	Residential	Residential
Residential formal (bush)	Built-up	Residential	Residential
Residential formal (low veg / grass)	Built-up	Residential	Residential
Residential formal (bare)	Built-up	Residential	Residential
Residential informal (low veg / grass)	Built-up	Residential	Residential

Original Class	Description	Detail	New Class
Village dense (bare and low veg / grass combo)	Built-up	Village	Residential
Natural rivers	Waterbodies	Natural Waterbodies	River and Water Bodies
Artificial dams (including canals)	Waterbodies	Artificial Waterbodies	River and Water Bodies
Artificial flooded mine pits	Waterbodies	Artificial Waterbodies	River and Water Bodies
Bare riverbed material	Barren Land	Unconsolidated	River and Water Bodies
Village scattered (bare and low veg/ grass combo)	Built-up	Village	Scattered Villages
Herbaceous wetlands (currently mapped)	Wetlands	Herbaceous Wetlands	Wetlands
Herbaceous wetlands (previously mapped)	Wetlands	Herbaceous Wetlands	Wetlands

Degraded land

Degraded land was extracted from the national layer and clipped within the study area.

Wetlands

National Wetland Map 5, (SANBI, 2018) was used to identify wetlands which were clipped from the national layer to the priority sub catchments.

Gullies

Gullies (dongas) occurring within the priority sub catchments were derived from the national gully location map (Marakanye and Le Roux, 2012)

Gully Susceptibility

Erosion (gully) susceptibility was derived from a modelling exercise that identified gully erosion susceptibility to inform avoided degradation planning (Le Roux and van der Wall, 2020)

Invasive Alien Wattle

Without the availability on specific data on invasive alien infestation in the priority sub catchments, we drew on field observations conducted during site visits to identify areas infested with wattle near the riparian zone. Field observations indicated high levels of infestation by wattle, other woody species, or bush encroachment within riparian areas across the selected sub catchments. It was thus assumed that land cover classes classified as 'Plantation' or 'Forest and Woodland' within a 50 m buffer from the river were invasive woody alien species. The Buffer Analysis tool in ArcGIS was used to create a 50 buffer in the main rivers in the selected sub catchment. Within those buffer, smaller polygons were drawn around clusters of vegetation. Density within the polygons varied from sparse to very dense, with most being very dense.

Table 7-3: Classes from the land use land cover layer

Original Classes			New Classes
Contiguous low forest and thicket	Forested land	Natural Wooded Land	Forest and Woodland
Dense forest and woodland	Forested land	Natural Wooded Land	Forest and Woodland
open woodland	Forested land	Natural Wooded Land	Forest and Woodland

Original Classes			New Classes
Contiguous and dense plantation forest	Forested land	Planted Forest	Plantation
Open and sparse plantation forest	Forested land	Planted Forest	Plantation
Temporary unplanted (clear-felled) plantation forest	Forested land	Planted Forest	Plantation

The objective of the intervention feasibility analysis is to determine the likely level of impact of implementing the proposed Eco-DRR interventions in the catchment areas of the identified vulnerabilities. In line with this objective, hydrological models have been configured for the catchments corresponding to the respective project areas that have been identified as being vulnerable to flooding and/or drought. In each case, two scenarios of assessment were undertaken, including one that is representative of the current status of the catchment in question (i.e. based on current land use and landcover characteristics), and then a second scenario that is representative of the catchment if the proposed Eco-DRR interventions were to be implemented. The level of impact of the proposed interventions can be evaluated through a comparison of the simulated timeseries of runoff depths from the respective hydrological response units, at the project sites, for each of the respective scenarios (pre-implementation and post-implementation). The following chapters provide details on the hydrological modelling undertaken as part of this feasibility study.

7.3 COSTS OF INTERVENTIONS

7.3.1 Detailed Site Methodology and Costing of Site-Level Interventions

The approach to costing interventions involved a review of the literature and local knowledge specific to South Africa for ecological infrastructure interventions, drawing on the following:

- Meat Naturally / Conservation South Africa's Herding for Health Programme
- DFFE: EP's Norms and Standards, published papers (IAP clearing, wetland rehabilitation) (SANBI, 2014)
- Tsitsa Project Documents
- Studies on the Breede Catchment for riparian restoration
- Monitoring data from INR's work in the uMkhomazi (grazing, rehabilitation, conservation agriculture)
- uMngeni Resilience Project (firebreaks and block burns)
- LADA Project Document (best practices for sustainable land management)
- Recent costings from WRC's National Siltation Management Programme (unpublished)
- Personal communication with Michael Braack of DFFE: EP

The cost estimates were compiled into a spreadsheet tool to calculated unit costs (e.g. per hectare, per metre) based on a set of stated assumptions. The costings were reviewed in consultation with Mr Michael Braack of DFFE and a number of costs and assumptions were based on this input. The final costing framework is provided in the tables below. The costing model (available as a separate spreadsheet) links different landcovers to different interventions. For example, where gully erosion has been mapped, the gully erosion interventions are applied to the total area (i.e. 100%) to derive a maximum cost, and the proportion of the areas for a given intervention is iteratively reduced considering priorities for the sub catchment and budgetary considerations.

Assumptions and Limitations

The classification and associated cost estimates for the rehabilitation interventions was based on the following assumptions and limitations:

- The assessment was carried out at a desktop level with limited infield verification having taken place (apart from confirming that the specific types of degradation do occur in the identified priority areas). Detailed planning (including infield assessments) is necessary in the implementation phase to locate and identify priority rehabilitation areas within the respective areas, determine an accurate cost estimate for the rehabilitation and ensure that there is support from landowners and users
- Please note that the proposed interventions are indicative, and will be refined through site based participatory processes during implementation.
- The GIS datasets used were applied without field verification and in some cases, the differentiation between different types of degradation could vary in the field (e.g. cultivated lands could actually be old lands; or gully area could be larger than is indicated by the gully dataset)
- A standard rehabilitation approach was adopted for each category type of degradation, using a standard intervention type and spacing / volume; and
- Dimensions such as slope and depth of gullies could not be derived from the GIS, and this may influence the estimated cost and approach to the rehabilitation.

A budget summary for all districts is provided in the tables below and detailed budget breakdowns and maps are provided in subsequent sections of this chapter for each identified sub-catchment in the five DMs. The budget model and cots provide for the following costs associated with the implementation of rehabilitation interventions (see Table 7-4 for details and assumptions associated with the proposed interventions)

- Implementer fees (local project manager / implementer);
- Training of restoration teams;
- Materials and equipment (including personal protective equipment;
- Wages (pegged at the current minimum wage rate, not EPWP rates, which are below the legislated minimum wage); and
- Transport for restoration teams.

The budgets do not include provision for:

- Detailed surveys and associated professional fees, which will be required for site specific planning;
- Stakeholder engagement and facilitation to co-create implementation plans and support to the proposed interventions.

The total estimated costs for the direct implementation of Eco-DRR technical interventions is R518 043 871 and covers a total calculated area of 76 208 ha, as summarised in Table 7-6.

Table 7-4: Cost estimates per area and assumptions for potential interventions to be applied in the Eco-DRR project sites

Intervention focus area	Description	Unit	Cost per unit		Assumptions	Cost per ha	
			Low	High		Low	High
IAPs	Alien clearing	ha	38 000	38 000	Focussed only on riparian zones and infested areas. Includes seven follow ups. Wage cost is for private sector funding (i.e. paying legislated minimum wage, not EPWP rates); 20-person days per ha for initial clearing; 11-person days per ha per follow up.	38 000	38 000
IAPs	Rehabilitation - bioturbation	ha	20 000	25 000	Cattle are kraaled overnight at a density of ~1LSU / 3 sqm	20 000	25 000
IAPs	Restore riparian vegetation	ha	30 000	30 000	Active restoration and management. Focus on erosion prone areas and areas where runoff is focussed. This includes convergence zones associated with roads and river crossings; culverts discharging road runoff where erosion can be initiated / exacerbated.	30 000	30 000
Gullies	Gully rehabilitation - Gabions (including earthworks)	m3	7 500	7 500	32 cubic metres per gabion site; gabions every 40m within a gulley; assume a gulley is 5 metres wide. Cost is per ha of gulley (i.e. 5m wide and 2 000 long to give 10 000m2 (1ha) of area)	12 300 000	12 300 000
Rangelands - all	Ecorangers - rotational resting Rangeland / Grazing management -	per 2 500 ha	130 000	150 000	management support for Ecorangers provided through separate budget. R30 000 per 2500ha	52	60
Rangelands - all	Fencing - Rangeland / Grazing management (Rotational Resting)	metres	150	200	Square camps (i.e. 400m perimeter per ha of land)	60 000	80 000
Rangelands - all	Firebreaks (Rotational Resting) Rangeland / Grazing management -	kilometre	2 700	3 000	Strategic firebreak protects 200ha at a time (i.e. perimeter of 6000m); 20 of 200ha blocks require firebreaks	1 620	1 800
Rangelands - all	Planned burning (block burns) (Rotational Resting) Rangeland / Grazing management -	kilometre	2 700	3 000	Spring burn of 25% of protected blocks per annum (i.e. 5 blocks per annum from above)	405	450
Rangelands - degraded	Contour barriers - Brushpacks	metres	50	400	One brushpack every 3 horizontal metres across one hectare	350 000	500 000

Intervention focus area	Description	Unit	Cost per unit		Assumptions	Cost per ha	
			Low	High		Low	High
Rangelands - degraded	Contour barriers - Vetiver hedgerows - gullies and eroded areas	metres	50	150	One vetiver hedgerow every 3 horizontal metres	150 000	300 000
Rangelands - degraded	Revegetation / reseeding	hectares	30 000	44 000	Hand preparation (furrows) and hand broadcast at x kg of 'summer veld mix' (MacDonald's Seed) on degraded land and allow for follow up seeding where mortality occurs	30 000	44 000
Rangelands - degraded	Rainwater harvesting - Zai Pits (pitting)	ha	31 134	31 134	RWH ponds at 3m x 4m spacing, staggered across one hectare and seeded with native grass species	31 134	31 134
Wetlands	Wetland rehabilitation - soft	ha	5 000	10 000	Contour bunds and revegetation to 'push' wetland back towards a functioning system - bunds every 10-20m. Pole diversion barriers in pathways, revegetation, small gully and head cut rehabilitation	5 000	10 000
Wetlands	Wetland rehabilitation - hard (concrete weirs)	m3	9 000	12 000	Concrete weirs in eroded and degraded wetlands (gullies and head cuts) - one weir of 40m3 with 100m interval between weirs. Assume gully / head cut width is 5m. Cost is per ha of gully / head cut (i.e. 5m wide and 2 000 long to give 10 000m2 (1ha) of area)	7 320 000	7 320 000

Table 7-5: Summary of budgets and areas of interventions per district[16]

	Name of District	Joe Gqabi	Alfred Nzo	Ngaka Modirl Molema	Sekhukhune	Ehlanzeni	TOTALS
IAP Clearing	Area (ha)	156	125	-	111	219	**611**
	Cost	5 935 492	4 757 600	-	4 208 880	8 313 698	**23 215 670**
Bioturbation	Area (ha)	39	-	-	-	-	**39**
	Cost	976 232	-	-	-	-	**976 232**
Revegetation	Area (ha)	309	139	70	984	268	**1 769**
	Cost	9 272 057	4 170 000	2 088 000	29 516 700	8 028 600	**53 075 357**
Gabions	Area (ha)	3	3	4	5	2	**16**
	Cost	41 451 000	34 932 000	46 002 000	59 040 000	20 664 000	**202 089 000**
tional Resting (Ecoran	Area (ha)	33 791	13 313	1 558	12 928	3 342	**64 932**
	Cost	2 027 460	798 780	93 480	775 701	200 520	**3 895 941**
Fencing	Area (ha)	186	45	70	-	-	**300**
	Cost	14 853 600	3 568 000	5 568 000	-	-	**23 989 600**
Firebreaks	Area (ha)	7 439	-	-	-	-	**7 439**
	Cost	13 390 200	-	-	-	-	**13 390 200**
Block Burns	Area (ha)	7 439	-	-	-	-	**7 439**
	Cost	3 347 550	-	-	-	-	**3 347 550**
Brushpacks	Area (ha)	114	45	7	44	26	**236**
	Cost	48 322 500	18 955 000	3 123 750	18 742 500	11 007 500	**100 151 250**
Vetiver	Area (ha)	114	45	7	44	106	**316**
	Cost	25 582 500	10 035 000	1 653 750	9 922 500	23 820 000	**71 013 750**
Concrete Weirs (Wetlands)	Area (ha)	2	-	-	-	-	**2**
	Cost	13 615 200	-	-	-	-	**13 615 200**
Soft interventions (Wetlands)	Area (ha)	172	192	-	-	4	**368**
	Cost	1 720 000	1 920 000	-	-	40 000	**3 680 000**
Pitting (Zai Pits)	Area (ha)	-	-	180	-	-	**180**
	Cost	-	-	5 604 120	-	-	**5 604 120**
TOTALS		**180 493 792**	**79 136 380**	**64 133 100**	**122 206 281**	**72 074 318**	**518 043 871**

[16] This costing is based on possible interventions that were proposed for the 2 QCs assessed during this feasibility study. As such, the numbers are indicative and will be revisited during project inception when the specific types of interventions and locations are finalised.

7.3.2 Mapping of Degradation and Costing of Interventions

The approach to mapping interventions within each sub-catchment across the five districts involved firstly applying the land cover and degradation GIS datasets to identify potential areas where rehabilitation and restoration interventions were required. These were then refined through an iterative approach involving a visual assessment using Google Earth and comparing these against the GIS datasets. Considering that the costs of different interventions can be substantial, a combination of interventions were identified for each district considering the following:

- Cost of the different interventions (e.g. areas where high-cost interventions such as gabions and concrete weirs were kept to a minimum).
- Focus on degraded areas higher up in each catchment where possible.
- Prioritise, where appropriate, degradation that can potentially impact on local infrastructure (e.g. roads, houses).
- Where possible distribute the interventions within different parts of the catchment to distribute the benefits associated with employment, learning and capacity building opportunities.

The maps generated and the areas of interventions are provided and discussed for each district below.

Alfred Nzo DM

The Luyengweni sub-catchment in Alfred Nzo District is 13 298 ha in extent. The catchment has in its headwaters the Ncome wetland system, some 193 ha in extent. The wetland is considered to be in moderate to good condition, with a high conservation prioritisation. Incipient infestations of wattle, and minor degradation have been observed in the system (Exigent, 2018). There is extensive degradation in the middle and lower sub-catchment, with numerous gullies, riparian and terrestrial wattle infestations, plantations and low basal cover in many areas. Further, there are more than four road river crossings that could be impacted by flooding and the clogging of bridges and culverts with wattle debris from riparian zones. Additionally, there are large areas of abandoned agricultural lands that are subject to sheet and gully erosion. Given the extensive degradation, a limited set of interventions were identified which are shown as map in Figure 7-1 and described in more detail below.

- Clearing of Invasive woody alien plants, primarily wattle that are prevalent in most of the riparian zones in the catchment.
  - Wattle clearing 1 – riparian wattle of 14 ha in extent.
  - Wattle clearing 2 – riparian wattle of 66 ha in extent.
  - Wattle clearing 3 – 45 ha in extent. This terrestrial wattle is located in the upper middle catchment below the Ncome wetland. Field observations have confirmed the presence of extensive wattle stands in riparian areas, and evidence of woody debris from trees that have fallen into the stream and blocked bridges and culverts.
  - Bioturbation with livestock involving 25% of the cleared area (39 ha). This will be mainly on shallower slopes and not directly within the riparian zone to limit the risk of erosion.
  - Active revegetation applied to 50% of the cleared areas (78 ha)

    - The remaining 25% will be areas of lower and new infestations where natural recovery of vegetation is expected to occur spontaneously due to low density wattle in these areas.
- Rotational resting applying the Ecoranger herding model will be applied throughout the catchment area of 13 313 ha.
- Two gullies have been identified for the installation of Gabion structures to prevent erosion and reduce landscape connectivity. The two gullies are adjacent to each other, and both drain into an access road., with a number of homesteads nearby. Ongoing erosion poses a threat to the road and the homesteads. The two gullies are:
    - Gabion 1 – 0.84 ha in extent. Once gabions are installed, the following activity will be implemented.
        - Revegetation post gabion establishment – 0.84 ha
    - Gabion 2 – 2.0 ha in extent. Once gabions are installed, the following activity will be implemented.
        - Revegetation post gabion establishment – 2.0 ha
    - Fencing 1 – 14 ha in extent. This fence will enclose gabions 1 and 2 and also enclose the upper part of the catchment to allow recovery of vegetation to reduce runoff and enhance infiltration. Within the fenced area, the following actions will be implemented:
        - Contour-based brushpacks and vetiver planting (14 ha)
        - Revegetation (14 ha)
- One degraded rangeland area has been identified for fencing and additional activities to control erosion and re-establish vegetation. The interventions at this site are as follows:
    - Fenced area 2, which is 31 ha in extent. The area has numerous small gullies and very low basal cover and is located above roads and homesteads before draining into a nearby watercourse. In addition to fencing, the following interventions will be applied within the area:
        - Contour-based brushpacks and vetiver planting (31 ha)
        - Revegetation (31 ha)
- Wetland rehabilitation
    - The Ncome wetland area in the headwaters of the Ncome River, also known as 'Ncome Springs' provides an ideal opportunity for low cost interventions to maintain the condition of the wetland systems that are the source of the Ncome River through small-scale IAP removal, promoting wetland buffers and related soft interventions were small head cuts occur. Two wetland areas have been identified as follows:
        - Ncome wetland 1: - 163 ha
        - Ncome wetland 2 – 29 ha

The cost estimate associated with these interventions is R79 136 380 – a breakdown of costs and areas per intervention is provided in Table 7-6.

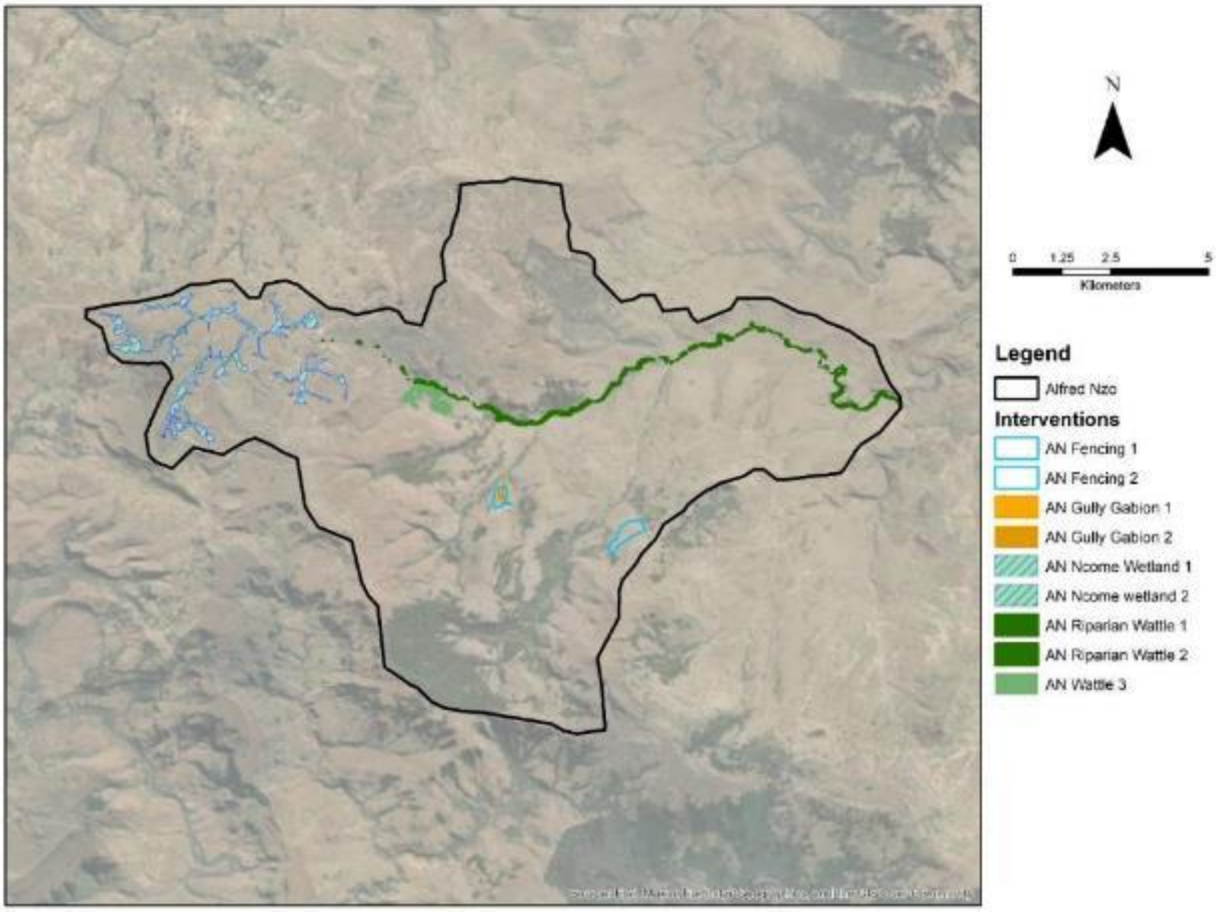

Figure 7-1: Map showing location of interventions in the Luyengweni area in Alfred Nzo DM

Table 7-6: Costing of selected interventions and areas – Luyengweni Sub Catchment in Alfred Nzo DM

		Cost / unit		38 000		30 000		12 300 000		60		80 000		425 000		225 000		10 000			
			IAP Clearing		**Revegetation**		**Gabions**		**Rotational Resting (Ecorangers)**		**Fencing**		**Brushpacks**		**Vetiver**		**Soft interventions (Wetlands)**		Cumulative area of individual interventions (ha)	Geographic coverage of combined interventions (ha)	
Landcover	Intervention	Unit	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal			**TOTALS**
IAPs	Invasive Alien Plant Clearing	ha	14	532 000	14	420 000		-		-		-		-		-		-	28	14	**952 000**
	Invasive Alien Plant Clearing	ha	66	2 508 000	66	1 980 000		-		-		-		-		-		-	132	66	**4 488 000**
	Invasive Alien Plant Clearing	ha	45	1 717 600		-		-		-		-		-		-		-	45	45	**1 717 600**
Gullies	Gully Rehabilitation - gabions	ha		-	14	420 000	0.84	10 332 000		-	14	1 120 000	14	5 950 000	14	3 150 000		-	57	1	**20 972 000**
	Gully Rehabilitation - gabions	ha		-		-	2.00	24 600 000		-		-		-		-		-	2	2	**24 600 000**
Grazing and rangeland management	Rotational Resting - ecorangers	ha / annum		-		-		-	13 313	798 780		-		-		-		-	13 313	13 313	**798 780**
	Fencing - recovery and rotational resting	ha		-	31	918 000		-		-	31	2 448 000	31	13 005 000	31	6 885 000		-	122	31	**23 256 000**
Wetlands	Wetland rehabilitation - soft interventions	ha		-		-		-		-		-		-		-	163	1 630 000	163	163	**1 630 000**
	Wetland rehabilitation - soft interventions	ha		-		-		-		-		-		-		-	29	290 000	29	29	**290 000**
		TOTALS	**125**	**4 757 600**	**139**	**4 170 000**	**3**	**34 932 000**	**13 313**	**798 780**	**45**	**3 568 000**	**45**	**18 955 000**	**45**	**10 035 000**	**192**	**1 920 000**	**13 877**	**13 635**	**79 136 380.00**

Joe Gqabi DM

The Thina sub-catchment in Joe Gqabi District is 33 758 ha in extent and is the largest catchment in which Eco-DRR interventions are to be implemented. Due to the large area and numerous sub-villages located in the catchment area, proposed interventions are spread over the catchment the location of the interventions to be applied within the sub-catchment are provided in Figure 7-2 and interventions are discussed in more detail below.

The main interventions that are proposed for this area are:

- Clearing of Invasive woody alien plants, primarily wattle that are prevalent in most of the riparian zones in the catchment. Field observations have confirmed the presence of extensive wattle stands in riparian areas, and evidence of woody debris from trees that have fallen into the stream and blocked bridges and culverts, presenting a risk to build infrastructure. 156 ha of riparian wattle is to be removed, along with follow up herbicide treatments and the revegetation of areas where wattle has been removed. Where revegetation is to be implemented, the following interventions will be applied:
    - Bioturbation with livestock involving 25% of the cleared area (39 ha). This will be mainly on shallower slopes and not directly within the riparian zone to limit the risk of erosion.
    - Active revegetation applied to 50% of the cleared areas (78 ha)
    - The remaining 25% will be areas of lower and new infestations where natural recovery of vegetation is expected to occur spontaneously due to low density wattle in these areas.
- Rotational resting applying the Ecoranger herding model will be applied throughout the catchment area of 33 758 ha.
- Two gully areas have been identified for the installation of Gabion structures to prevent erosion and reduce landscape connectivity. These are:
    - Gabion 1 – 0.49 ha in extent. Once gabions are installed, the following activities will be implemented.
        - Fencing of gully boundary – 0.49 ha
        - Revegetation post fencing – 0.49 ha
    - Gabion 2 – 2.88 ha in extent. Once gabions are installed, the following activities will be implemented.
        - Fencing of gully boundary – 2.88 ha
        - Revegetation post fencing – 2.88 ha
- A number of degraded rangeland areas have been identified for fencing and additional activities to control erosion and re-establish vegetation. These are as follows:
    - Fenced area 1, which is 59 ha in extent. This is identified as old abandoned agricultural fields. Fencing the area will exclude livestock and promote recovery of the grasses in this area. This area can also be used as a source of winter fodder for livestock owners, as winter grazing (after the first frost) does not impact on grass vigour.
    - Fenced area 2, which is 9 ha in extent. This area is subject to extensive sheet, rill and gulley erosion which is contributing to downstream gully formation and increasing catchment connectivity which, in turn contributes to flooding. In addition to fencing, the following interventions will be applied within the area:

        - Contour-based brushpacks and vetiver planting (9 ha)
        - Revegetation (9 ha)
    - Fenced area 3, which is 6 ha in extent. This area consists of old, abandoned agricultural lands, cattle paths and small gullies adjacent to the main stem of the Thina River. Rehabilitation of this area will reduce runoff and sediment directly into the river. Additional interventions in this area are:
        - Contour-based brushpacks and vetiver planting (6 ha)
        - Revegetation (6 ha)
    - Fenced area 4, which is 19 ha in extent. This microcatchment has low basal cover and includes wetland areas and wet drainage lines, and sheet and small gully erosion. The relatively large areas also create an opportunity to provide winter grazing for livestock additional interventions within the fenced area are.
        - Contour-based brushpacks and vetiver planting (19 ha)
        - Revegetation (19 ha)
    - Fenced area 7 (note, fenced areas 5 and 6 are association with gully protection – see below) is 51 hectares in extent. These are old, abandoned crop lands that would benefit from long term rest and grazing management as part of the rotational resting system. After a period of one growing season rest, a high intensity short duration grazing regime is recommended to introduce manure and encourage the grazing and trampling of less palatable grass species to encourage more diverse and palatable species.
    - Fenced area 8 is 39 ha in extent. This area has numerous sheet eroded areas and gullies which drain into a road-river crossing and ongoing erosion can potentially impact on the integrity of the road. In addition to fencing, the following will be applied:
        - Contour-based brushpacks and vetiver planting (39 ha)
        - Revegetation (39 ha)
    - Brushpack and Vetiver – an area of 41 ha has been identified for brushpacks and vetiver on contours. This area has low basal cover and surrounds Fenced area 2. Ecorangers will be required to exclude livestock from this area to allow recovery and revegetation which will be applied in conjunction with the brushpacks and Vetiver.
    - Three areas have been identified for revegetation, without fencing, brushpacks or vetiver. Livestock are to be excluded through the use of Ecorangers. The extent of these areas is as follows:
        - Revegetation 1 – 56 ha
        - Revegetation 2 – 17 ha
        - Revegetation 3 – 41 ha
- Firebreaks and block burns. As this is a grassland dominated system, resting of rangelands and judicious burning should be included in the management system. Five areas have been identified for firebreaks and block burns to be incorporated into the rotational resting grazing management strategy, accounting for approximately 25% of the grazing area. The precise location of the rested areas and associated firebreaks and subsequent block burns will need to be co-identified and agreed with the relevant local role-players and the rested areas will change on a seasonal basis. The areas identified for firebreaks and block burns are:
    - Firebreak 1 – 2 617 ha

- Firebreak 2 – 663 ha
    - Firebreak 3 – 2 306 ha
    - Firebreak 4- 1 204 ha
    - Firebreak 5 - 629 ha
- Wetland rehabilitation
    - An upland wetland in the sub-catchment of approximately 172 ha in extent has been identified for wetland rehabilitation activities. Head cuts in the upper parts of the wetland requiring concrete weirs covering 2 ha of gully / head cut have been identified.
    - Soft interventions across the whole wetland area of 172 ha have been identified for implementation.

The cost estimate associated with these interventions is R180 493 792 – a breakdown of costs and areas per intervention is provided in Table 7-7.

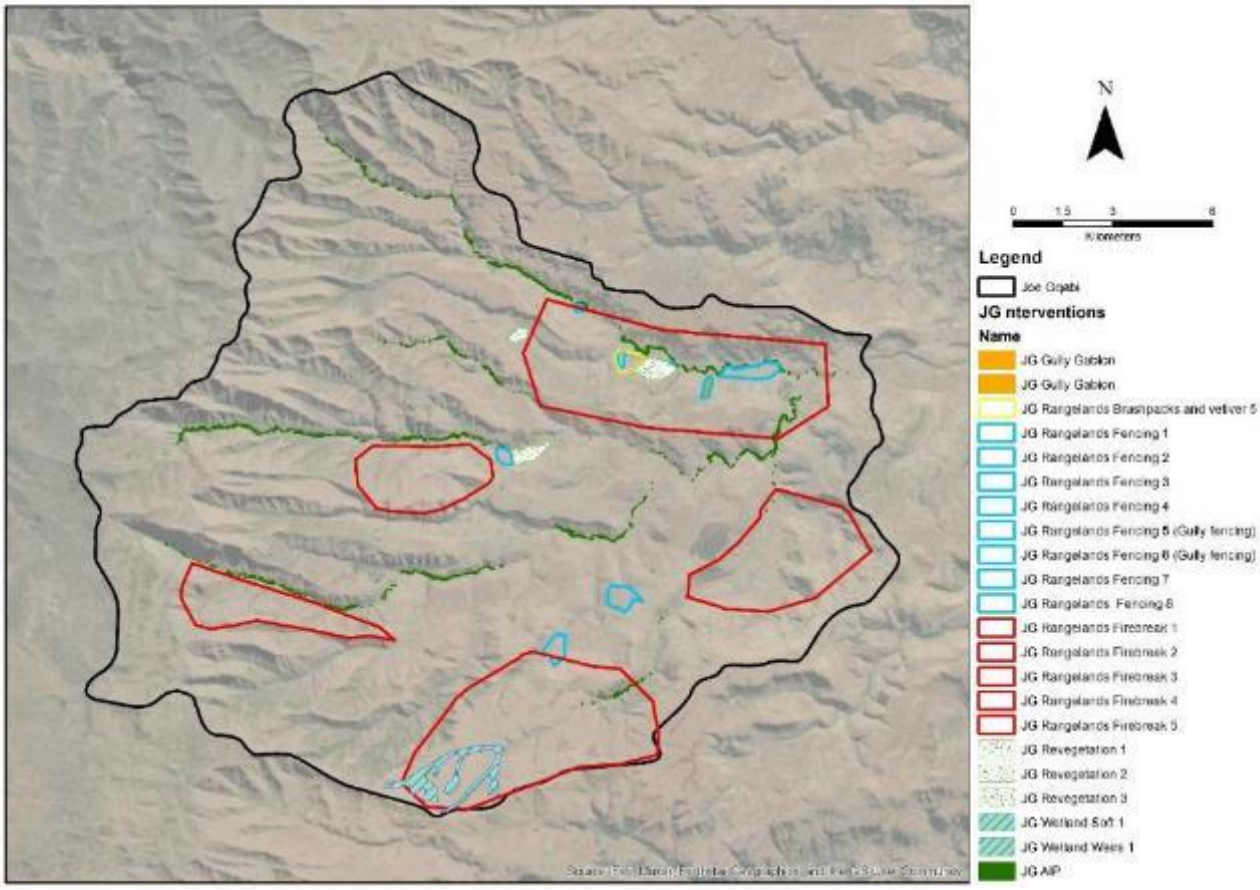

Figure 7-2: Map showing location of interventions in the upper Thina River Catchment in Joe Gqabi DM

Table 7-7: Costing of identified interventions and areas – Thina Sub Catchment in Joe Gqabi DM

		unit		38 000		25 000		30 000		12 300 000		60		80 000		1 800		450		425 000		225 000		7 320 000		10 000			
			IAP Clearing		**Bioturbation**		**Revegetation**		**Gabions**		**Rotational Resting (Ecorangers)**		**Fencing**		**Firebreaks**		**Block Burns**		**Brushpacks**		**Vetiver**		**Concrete Weirs (wetlands)**		**Soft interventions (Wetlands)**		Cumulitave area of individual interventions (ha)	Geogrpahic coverage of combined interventions (ha)	**TOTALS**
Landcover	Intervention	Unit	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal			
IAPs	Invasive Alien Plant Clearing	ha	156	5 935 492	39	976 232	78	2 342 957		-		-		-		-		-		-		-		-		-	273	156	9 254 682
Gullies	Gully Rehabilitation - gabions	ha		-		-	0	14 700	0.49	6 027 000		-	0.49	39 200		-		-		-		-		-		-	1	0	6 080 900
	Gully Rehabilitation - gabions	ha		-		-	3	86 400	2.88	35 424 000		-	3	230 400		-		-		-		-		-		-	9	3	35 740 800
Grazing and rangeland management	Rotational Resting - ecorangers	annum		-		-		-		-	33 791	2 027 460		-		-		-		-		-		-		-	33 791	33 791	2 027 460
	Fencing - recovery and rotational resting	ha		-		-		-		-		-	59	4 696 000		-		-		-		-		-		-	59	59	4 696 000
	Fencing - recovery and rotational resting	ha		-		-	9	265 800		-		-	9	708 800		-		-	9	3 765 500	9	1 993 500		-		-	35	9	6 733 600
	Fencing - recovery and rotational resting	ha		-		-	6	169 200		-		-	6	451 200		-		-	6	2 397 000	6	1 269 000		-		-	23	6	4 286 400
	Fencing - recovery and rotational resting	ha		-		-	19	564 000		-		-	19	1 504 000		-		-	19	7 990 000	19	4 230 000		-		-	75	19	14 288 000
	Fencing - recovery and rotational resting	ha		-		-		-		-		-		-		-		-		-		-		-		-	-		-
	Fencing - recovery and rotational resting	ha		-		-		-		-		-		-		-		-		-		-		-		-	-		-
	Fencing - recovery and rotational resting	ha		-		-		-		-		-	51	4 072 000		-		-		-		-		-		-	51	51	4 072 000
	Fencing - recovery and rotational resting	ha		-		-	39	1 182 000		-		-	39	3 152 000		-		-	39	16 745 000	39	8 865 000		-		-	158	39	29 944 000
	Firebreaks - rangeland protection	ha/annum		-		-		-		-		-		-	2 617	4 710 600	2 617	1 177 650		-		-		-		-	5 234	2 617	5 888 250
	Firebreaks - rangeland protection	ha/annum		-		-		-		-		-		-	683	1 229 400	683	307 350		-		-		-		-	1 366	683	1 536 750
	Firebreaks - rangeland protection	ha/annum		-		-		-		-		-		-	2 306	4 150 800	2 306	1 037 700		-		-		-		-	4 612	2 306	5 188 500
	Firebreaks - rangeland protection	ha/annum		-		-		-		-		-		-	1 204	2 167 200	1 204	541 800		-		-		-		-	2 408	1 204	2 709 000
	Firebreaks - rangeland protection	ha/annum		-		-		-		-		-		-	629	1 132 200	629	283 050		-		-		-		-	1 258	629	1 415 250
Degraded areas	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-		-	41	1 230 000		-		-		-		-		-	41	17 425 000	41	9 225 000		-		-	123	41	27 880 000
	Revegetation	ha		-		-	56	1 683 000		-		-		-		-		-		-	-	-		-		-	56	56	1 683 000
	Revegetation	ha		-		-	17	519 000		-		-		-		-		-		-	-	-		-		-	17	17	519 000
	Revegetation	ha		-		-	41	1 215 000		-		-		-		-		-		-	-	-		-		-	41		1 215 000
	Zai Pits	ha		-		-		-		-		-		-		-		-		-		-		-		-	-	41	-
Wetlands	Wetland rehabilitaiton - concrete weirs	ha		-		-		-		-		-		-		-		-		-		-	2	13 615 200		-	2	2	13 615 200
	Wetland rehabilitatation - soft interventions	ha		-		-		-		-		-		-		-		-		-		-		-	172	1 720 000	172	172	1 720 000
	TOTALS		**156**	**5 935 492**	**39**	**976 232**	**309**	**9 272 057**	**3**	**41 451 000**	**33 791**	**2 027 460**	**186**	**14 853 600**	**7 439**	**13 390 200**	**7 439**	**3 347 550**	**114**	**48 322 500**	**114**	**25 582 500**	**2**	**13 615 200**	**172**	**1 720 000**			**180 493 792**

Ehlanzeni DM

The Upper Sand River sub-catchment in Ehlanzeni District is 7 721 ha in extent. A large proportion of the upper catchment is commercial timber plantations that have not been included for interventions as part of this analysis as there are limited opportunities for Eco-DRR interventions in this area and the focal area for interventions is in the lower part of the sub-catchment of 3 342 ha as shown in Figure 7-3. This catchment is the headwaters of the Sand River Catchment, which joins the Sabie River and flows through Kruger National Park and into Mozambique. It is considered an important catchment to sustain environmental flows into the Park. The southern parts of this catchment show signs of degradation and western and northern areas are characterised by deep densely vegetated valleys. Proposed interventions are discussed in more detail below.

The main interventions that are proposed for this area are:

- Clearing of various invasive alien plants, primarily in drainage lines and riparian areas.:
    - IAPs 1 – 146 ha
    - IAPs - 73 ha
- Three gullies have been identified for the implementation of gabion structures.
    - Gabions 1 – 0.35 ha Once gabions are installed, the following activities will be implemented.
        - Revegetation – 0.35 ha
    - Gabions 2 – 0.96 ha Once gabions are installed, the following activities will be implemented.
        - Revegetation – 0.96 ha
    - Gabions 3 – 0.51 ha Once gabions are installed, the following activities will be implemented.
        - Revegetation – 0.51 ha
- Rotational resting – 3 342 ha. Given that large areas of the catchment are built up and much of the remaining areas are old cropping fields, compounded by low basal cover in the remaining natural grasslands, rotational resting will focus on the old lands. With the revegetation of two large areas indicated above, in combination with better management of current livestock in the area, benefits in terms of flood reduction, improved soil water and opportunities for improved livestock production are expected to emerge from the implementation of these interventions. A number of degraded rangeland areas have been identified for brushpacks and additional activities to control erosion and re-establish vegetation. These are as follows:
    - Brushpacks 1, which is 4 ha in extent. This is located directly below the sites for 'Gabions 1' and 'Gabions 2' to rehabilitate the degraded areas below these two gullies. In addition to Brushpacks, the following interventions will be applied within the area:
        - Vetiver planting (4 ha)
        - Revegetation (4 ha)
    - Brushpacks 2, which is 16 ha in extent. This area surrounds a local dam site and has very low cover and extensive rill and small gully erosion. In addition to Brushpacks, the following interventions will be applied within the area:
        - Vetiver planting (16 ha)

        - Revegetation (16 ha)
    - Brushpacks 3, which is 2 ha in extent. This area is located in degraded lands immediately downstream of 'Brushpack 2' and again has very low cover and extensive rill and small gully erosion. In addition to Brushpacks, the following interventions will be applied within the area:
        - Vetiver planting (2 ha)
        - Revegetation (2 ha)
        - Contour-based brushpacks and vetiver planting (6 ha)
    - Brushpacks 4, which is 1 ha in extent. This area has extensive pathways and localised gully erosion that would benefit from these interventions. In addition to Brushpacks, the following interventions will be applied within the area:
        - Vetiver planting (1 ha)
        - Revegetation (1 ha)
    - Brushpacks 5, which is 1 ha in extent. This area is denuded and located directly above a small gully system (see Brushpack 6). Interventions in this area will reduce runoff entering the existing gully system in addition to Brushpacks, the following interventions will be applied within the area:
        - Vetiver planting (1 ha)
        - Revegetation (1 ha)
    - Brushpacks 6, which is 1 ha in extent. This area is directly below Brushpack 5 with localised gully erosion. In addition to Brushpacks, the following interventions will be applied within the area:
        - Vetiver planting (1 ha)
        - Revegetation (1 ha)
- Three sites have been identified for brushpacks in combination with local pathway rehabilitation. These are
    - Brushpacks and pathway rehabilitation 1 - 0.62 ha. Steep eroded pathways leading from built up areas to the Sand River
    - Brushpacks and pathway rehabilitation 1 - 0.72 ha. Steep eroded pathways leading from built up areas to the Sand River, near the site directly above.
    - Brushpacks and pathway rehabilitation 3 - 0.81 ha. Eroded pathways in the southern part of the catchment
- Three sites have been identified for the restoration of riparian vegetation. This process involves controlling small invasive plant infestations and replanting of indigenous vegetation. The areas are as follows:
    - Riparian revegetation 1 – 101 ha
        - Vetiver planted in 33% of the area (34 ha) where localised erosion has been identified.
    - Riparian revegetation 2 – 119 ha
        - Vetiver planted in 33% of the area (40 ha) where localised erosion has been identified.
    - Riparian revegetation 3 – 20 ha
        - Vetiver planted in 33% of the area (7 ha) where localised erosion has been identified.
- Wetland rehabilitation – 4 ha. A small unchanneled valley bottom wetland has been identified for the implementation of soft wetland rehabilitation activities.

The cost estimate associated with these interventions is R72 074 318 – a breakdown of costs and areas per intervention is provided inTable 7-8.

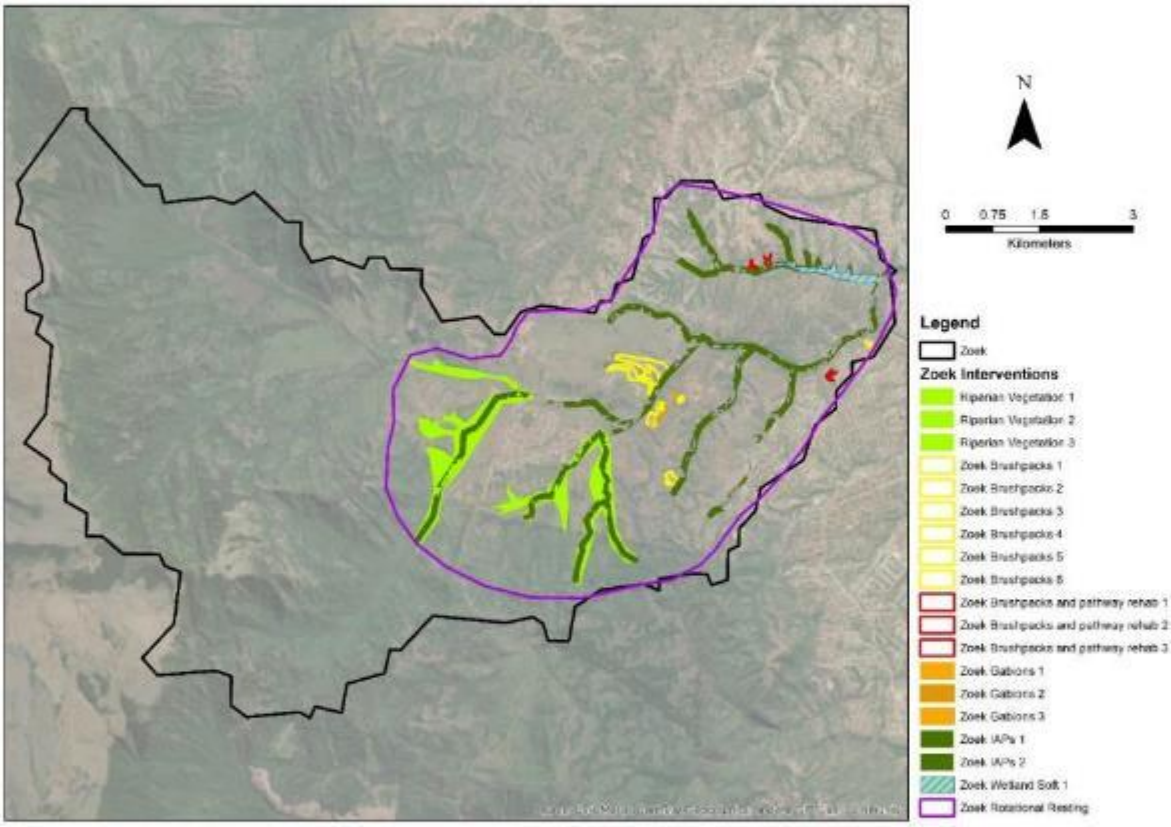

Figure 7-3: Map showing location of interventions in the Sand River Catchment in Ehlanzeni DM

Table 7-8: Costing of identified interventions and areas – Upper Sand River Sub Catchment in Ehlanzeni DM

		Cost / unit	38 000		30 000		12 300 000		60		425 000		225 000		10 000				
			IAP Clearing		**Revegetation**		**Gabions**		**Rotational Resting (Ecorangers)**		**Brushpacks**		**Vetiver**		**Soft interventions (Wetlands)**		Cumulitave area of individual interventions (ha)	Geogrpahic coverage of combined interventions (ha)	
Landcover	Intervention	Unit	No of uni	Subtotal	No of uni	Subtotal	No of uni	Subtotal	No of units	Subtotal	No of uni	Subtotal	No of uni	Subtotal	No of uni	Subtotal			**TOTALS**
IAPs	Invasive Alien Plant Clearing	ha	146	5 542 465		-		-		-		-		-		-	146	146	**5 542 465**
	Invasive Alien Plant Clearing	ha	73	2 771 233		-		-		-		-		-		-	73	73	**2 771 233**
Gullies	Gully Rehabilitation - gabions	ha		-	0.35	10 500	0	2 583 000		-		-		-		-	1	0	**2 593 500**
Grazing and rangeland management	Rotational Resting - ecorangers	ha		-	0.96	28 800	1	11 808 000		-		-		-		-	2	1	**11 836 800**
	Fencing - recovery and rotational resting	ha		-	0.51	15 300	1	6 273 000		-		-		-		-	1	1	**6 288 300**
	Fencing - recovery and rotational resting	ha / annum		-		-		-	3 342	200 520		-		-		-	3 342	3 342	**200 520**
Degraded areas	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-	4	119 400		-		-	4	1 691 500	4	895 500		-	12	4	**2 706 400**
	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-	16	477 000		-		-	16	6 757 500	16	3 577 500		-	48	16	**10 812 000**
	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-	2	64 500		-		-	2	913 750	2	483 750		-	6	2	**1 462 000**
	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-	0.54	16 200		-		-	1	229 500	1	121 500		-	2	1	**367 200**
	Rehabilitation - contour based structures (brushpacks and vetiver)				0.50	15 000		-		-	1	212 500	1	112 500		-	2	1	**340 000**
	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-	0.62	18 600		-		-	1	263 500	1	139 500		-	2	1	**421 600**
	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-	0.62	18 600		-		-	1	263 500	1	139 500		-	2	1	**421 600**
	Rehabilitation - contour based structures (brushpacks and vetiver)	ha		-	0.78	23 400		-		-	1	331 500	1	175 500		-	2	1	**530 400**
	Rehabilitation - contour based structures (brushpacks and vetiver)	ha/annum		-	0.81	24 300		-		-	1	344 250	1	182 250		-	2	1	**550 800**
	Revegetation	ha/annum		-	101	3 030 000		-		-		-	34	7 575 000		-	135	101	**10 605 000**
	Revegetation	ha		-	119	3 570 000		-		-		-	40	8 925 000		-	159	119	**12 495 000**
	Revegetation	ha		-	20	597 000		-		-		-	7	1 492 500		-	27	20	**2 089 500**
Wetlands	Wetland rehabilitaiton - soft	ha		-		-		-		-		-		-	4	40 000	4	4	**40 000**
		TOTALS	**219**	**8 313 698**	**268**	**8 028 600**	**2**	**20 664 000**	**3 342**	**200 520**	**26**	**11 007 500**	**106**	**23 820 000**	**4**	**40 000**	**3 966**	**3 832**	**72 074 318**

Ngaka Modiri Molema DM

The Mokgola Catchment is bounded on the northeast by fairly dense settlements in the village of Mokgola. To the northwest, west of the R49 road that traverses the catchment is largely woody vegetation, that did not appear to have large stands of invasive alien plant species when rapid field observations were conducted. The central and southern parts of the catchment are characterised by a highly degraded and eroded drainage lines, which is where the Eco-DRR interventions are to be focused (Figure 7-4). The interventions to be applied are summarised as follows:

- Rotational resting systems applied within the whole catchment (93 480ha)
- Fencing off the most severely degraded area, requiring 70 ha to be fenced to prevent further degradation and possible future impacts on the adjacent R49. This will allow for the protection of the following additional interventions to be applied within the fenced area:
    - Gabions in the most severe gullies covering an area of 3.74 ha.
    - Contour brushpacks and vetiver grass lines applied in the small gullies covering a total area of 14 ha.
    - Revegetation of the entire fenced area using indigenous grass and tree species (70 ha)
- Given the dry nature of this area, and additional 180 ha of degraded land in the southeast will be rehabilitated using Zai Pits as a rainwater harvesting tool, with indigenous grass species to be established in each of the pits. This will be applied in conjunction with grazing management where Ecorangers will actively exclude livestock as this area will not be fenced.

The cost estimate associated with these interventions is R64 133 400 – a breakdown of costs and areas per intervention is provided in Table 7-9.

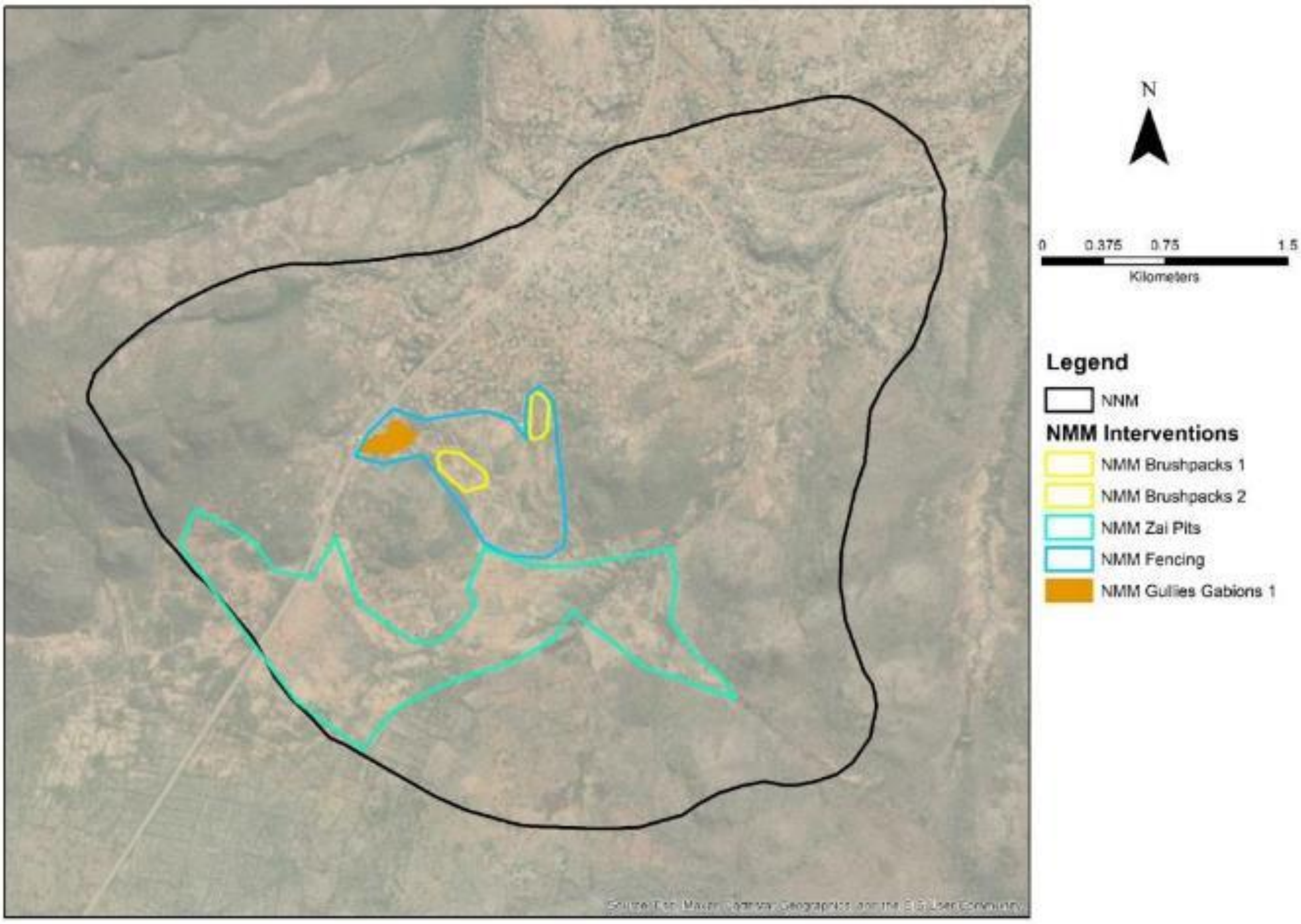

Figure 7-4: Map showing interventions and locations within Mokgola Catchment, Ngaka Modiri Molema Subcatchment

Table 7-9: Costing of identified areas and interventions –Mokgala Sub Catchment in Nkaga Modiri Molema DM

Landcover			Grazing and rangeland management		Degraded areas	**TOTALS**
Intervention			Rotational Resting - ecorangers	Fencing - recovery and rotational resting	Zai Pits	
Cost / unit		Unit	ha / annum	ha	ha	
30 000	**Revegetation**	No of units		70		**70**
		Subtotal	-	2 088 000	-	**2 088 000**
12 300 000	**Gabions**	No of units		4		**4**
		Subtotal	-	46 002 000	-	**46 002 000**
60	**Rotational Resting (Ecorangers)**	No of units	1 558			**1 558**
		Subtotal	93 480	-	-	**93 480**
80 000	**Fencing**	No of units		70		**70**
		Subtotal	-	5 568 000	-	**5 568 000**
425 000	**Brushpacks**	No of units		7		**7**
		Subtotal	-	3 123 750	-	**3 123 750**
225 000	**Vetiver**	No of units		7		**7**
		Subtotal	-	1 653 750	-	**1 653 750**
31 134	**Pitting (Zai Pits)**	No of units			180	**180**
		Subtotal	-	-	5 604 120	**5 604 120**
TOTALS		Area (ha)	1 558	158	180	**1 896**
		Cost	**93 480**	**58 435 500**	**5 604 120**	**64 133 100**

Sekhukune DM

The Vergelegen Dam sub-catchment in Sekhukune District is 25 120 ha in extent. Large areas of the lower and middle catchment are built up and semi-dense residential areas. There are extensive areas in the middle and upper catchment that is classified as cropping fields (13 000 ha), however an historical time series analysis using the Google Earth history function revealed that few of the fields have been cultivated as far back as 2011. Consequently, these are considered old abandoned agricultural lands for the purposes of the assessment. Reports from field visits indicated concerns regarding the sedimentation of the Vergelegen Dam and access to water as local challenges that were considered important. Inherently low rainfall was reported have resulted in limited field crop production or livestock keeping. Based on this, the following interventions were identified for this sub-catchment:

- IAP clearing of 111 ha, located within drainage lines and riparian areas. Clearing of Invasive woody alien plants, primarily wattle that are prevalent in most of the riparian zones in the catchment.
- Rotational resting applying the Ecoranger herding model will be applied throughout the catchment area of 13 313 ha.
- A single gully has been identified for the installation of gabion structures covering 4.8 ha in the head cut are of the gully to prevent erosion and reduce landscape connectivity. This gully drains directly into the Vergelegen Dam and was therefore considered a priority in terms of sediment reduction and improving water availability in the drainage line. In addition to the gabion the following intervention will also be implemented
    - Revegetation – 4.8 ha associated with the gully.
- A number of old abandoned agricultural fields have been identified Eco-DRR interventions. Given that these areas are soft-transformed (i.e. are not built infrastructure but have lost most indigenous plant biodiversity), a key objective of the revegetation is to re-establish good grass cover to (1) increase infiltration and reduce runoff to reduce flooding and improve baseflows, and (2) to provide improved grazing to support livestock-based livelihoods in this low rainfall area. The following have been identified for rehabilitation.
    - Brushpacks 1 - 15 ha. This area includes a small wetland that drains into a non-perennial watercourse. Areas adjacent to the wetland have extensive sheet, rill and small gully erosion. Brushpacks using nearby alien plant species are to be established to control erosion. Additional interventions are:
        - Vetiver hedgerows – 15 ha to be planted in support of brushpacks once sediment has collected.
        - Revegetation – 15 ha to rehabilitate this degraded area.
    - Brushpacks 2 – also 15 ha in extent. The area also has numerous small gullies and very low basal cover adjacent to a non-perennial water course and is located in the upper reaches of the catchment draining into the Vergelegen Dam. Brushpacks using nearby alien plant species are to be established to control erosion. Additional interventions are:
        - Vetiver hedgerows – 15 ha to be planted in support of brushpacks once sediment has collected.
        - Revegetation – 15 ha to rehabilitate this degraded area.
    - Brushpacks 3 – 14 ha. This degraded site is located in the headwaters of a small local tributary. Observation of the adjacent wetland tributary suggests that this area was likely part of a larger wetland system in the past (this would require specialist verification). The application of brushpacks and associated supporting

interventions will aid the recovery of vegetation, and capture sediment to increase water retention in the headwaters. Additional interventions are:

        - Vetiver hedgerows – 14 ha to be planted in support of brushpacks once sediment has collected.
        - Revegetation – 14 ha to rehabilitate this degraded area.
    - Revegetation 1 – 179 ha. This is a large area of old abandoned cropping fields that surround and drain into the area to be rehabilitated by 'Brushpacks 3'. As this is arable land, it is recommended that farming machinery be used for land preparation and planting, using hardy indigenous grass species that are suited to grazing. This complementary activity would improve functioning of the headwaters of this tributary by limiting further erosion and reducing potential threats to the existing wetland in this headwater tributary.
    - Revegetation 2 – 756 ha. This area is located in an upper sub-catchment in the south and in combination with 'Revegetation 1' should contribute to a reduction in runoff while improving availability of grazing.
- Rotational resting - 12 928 ha. Given that large areas of the catchment are built up and much of the remaining areas are old cropping fields, compounded by low basal cover in the remaining natural grasslands, rotational resting will focus on the old lands. With the revegetation of two large areas indicated above, in combination with better management of current livestock in the area, benefits in terms of flood reduction, improved soil water and opportunities for improved livestock production are expected to emerge from the implementation of these interventions.

The cost estimate associated with these interventions is R122 206 281 – a breakdown of costs and areas per intervention is provided in Table 7-10

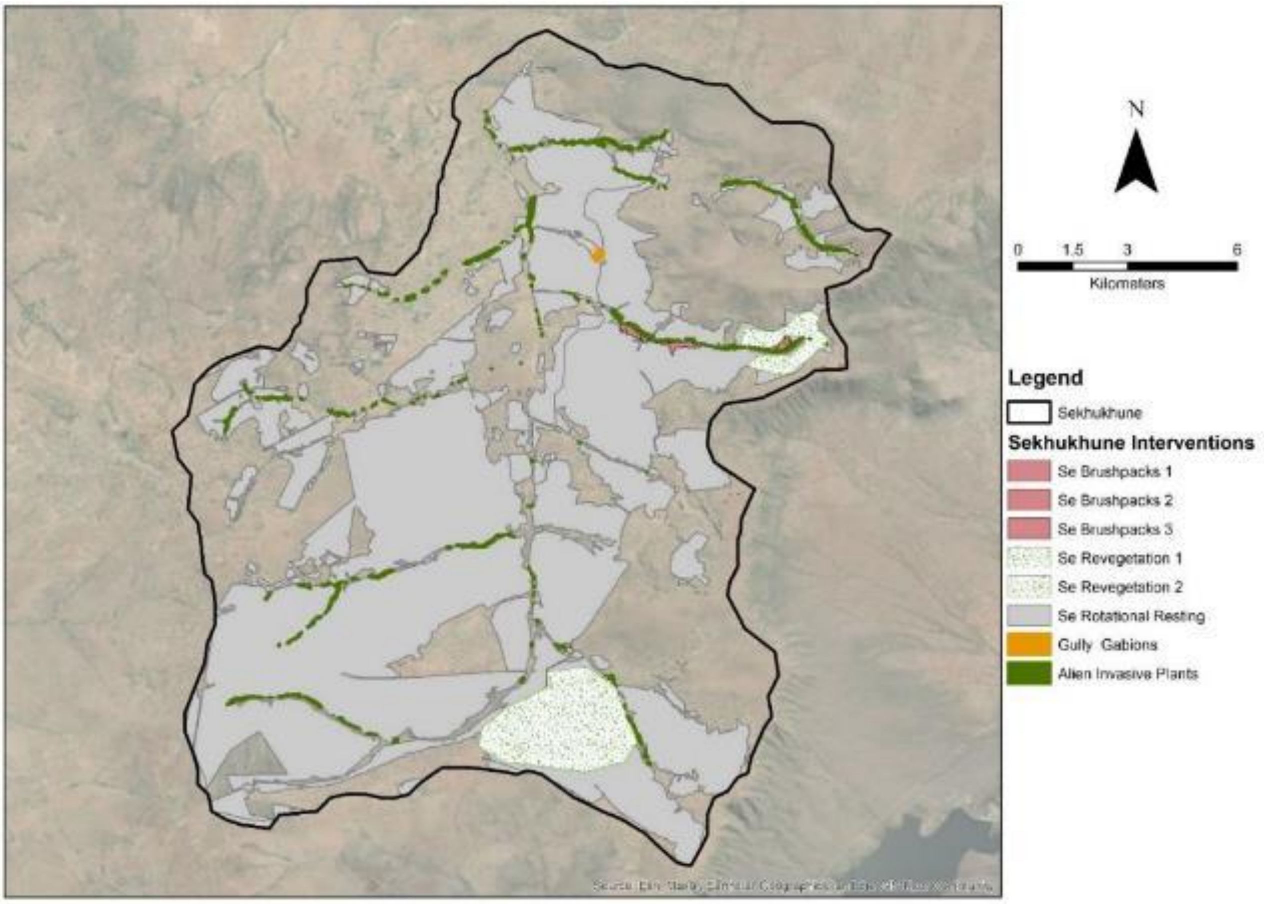

Figure 7-5: Map showing location of interventions in the Vergelegen Dam Sub Catchment in Sekhukune DM

Table 7-10: Costing of identified interventions and areas – Vergelegen Dam Sub Catchment in Sekhukhune DM

		Cost /		38 000		30 000		12 300 000		60		425 000		225 000			
			IAP Clearing		**Revegetation**		**Gabions**		**Rotational Resting (Ecorangers)**		**Brushpacks**		**Vetiver**		Cumulitave area of individual interventions (ha)	Geogrpahic coverage of combined interventions (ha)	**TOTALS**
Landcover	Intervention	Unit	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal	No of units	Subtotal			
IAPs	Invasive Alien Plant Clearing	ha	111	4 208 880		-		-		-		-		-	111	111	**4 208 880**
Gullies	Gully Rehabilitation - gabions	ha		-	5	143 700	4.80	59 040 000		-		-		-	10	5	**59 183 700**
Grazing and rangeland management	Rotational Resting - ecorangers	ha		-		-		-	12 928	775 701		-		-	12 928	12 928	**775 701**
	Fencing - recovery and rotational resting	ha		-	15	444 000		-		-	14.80	6 290 000	15	3 330 000	44	15	**10 064 000**
	Fencing - recovery and rotational resting	ha		-	15	447 000		-		-	14.90	6 332 500	15	3 352 500	45	15	**10 132 000**
	Fencing - recovery and rotational resting	ha		-	179	5 370 000		-		-		-		-	179	179	**5 370 000**
	Fencing - recovery and rotational resting	ha		-	756	22 680 000		-		-		-		-	756	756	**22 680 000**
	Fencing - recovery and rotational resting				14	432 000		-		-	14	6 120 000	14	3 240 000	43	14	**9 792 000**
		TOTALS	**111**	**4 208 880**	**984**	**29 516 700**	**5**	**59 040 000**	**12 928**	**775 701**	**44**	**18 742 500**	**44**	**9 922 500**	**14 116**	**14 023**	**122 206 281**

7.4 BENEFITS OF MEASURES

The benefits of the proposed interventions have been selected based on three key elements:

1. Local context (for example, high reliance on subsistence livestock warrants an examination of proposed interventions on determinants of livestock farming).
2. The level of detail and suitability of hydrological modelling.
3. The availability of input data, including relevant market prices (or suitable economic proxy values).

Overall, the proposed project is expected to benefit communities vulnerable to climate change in the respective project areas through reduced flood risks (including associated improvements to accessibility), increased provisioning and cultural ecosystem services, and improved agriculture productivity and food security. Many of these benefits are underpinned by improved grassland management – broadly, practices that minimise the adverse effects of fire and drought and use improved grazing management techniques that maximise grassland quality.

7.4.1 Avoided Costs of Direct Flood Damages

Benefits of measures

As noted above, the project sites are vulnerable to yearly riverine flooding events, causing direct loss to infrastructure and safety. The proposed project interventions are intended to alleviate some of these pressures by reducing the vulnerability of critical infrastructure to the impacts of flooding by reducing the flood peak (discharge).

Valuation basis

The valuation of avoided damages is dictated by the coverage and suitability of available hydrological input data. In this regard, the economic valuation utilised the available hydrological input data in the following ways.

First, avoided direct flood damages are assessed for key infrastructure (bridges, culverts and dams) only, since, according to the available flood hazard input data which was targeted towards understanding the magnitude of changes in high-flow (flood) hydrology dynamics in the catchment, agricultural, housing and industrial/commercial land covers appear to be unaffected by flooding (i.e., the flood lines do not reach irrigated land nor private housing, even under a 1:100 event).

Second, the hydrological input data dictated that damage be calculated by number of assets exposed rather than by area inundated (ha). Available damage value estimates at the asset level are difficult to obtain. Average damage values are therefore based on relevant (re)construction costs observed in similar projects (in terms of size and location) in South Africa (Table 7-11). These damage values represent those observed under baseline conditions.

Table 7-11: Average flood damage values (construction costs, 2024 prices)

	Bridge, per asset	**Dam**, *per asset*
ZAR	19,933,028*	775,659,168†
USD	1,080,381	42,041,147

* Based on average construction costs of a typical 100m-long, 14m-wide bridge in South Africa. Values sourced from two separate studies (contained in Excel model).
† Based on a conservative cost estimate of a small-medium dam in South Africa.

Third, the hydrological modelling input data provided does not disaggregate flooding hazard or extent by flooding depth, nor by return period (magnitude of event)[17]. Only the total number of assets affected by flooding in the baseline (no intervention) are provided (Table 7-11 above). Without depth-disaggregated information, this analysis assumes that under the without-intervention scenario, these vulnerable assets are damaged 40% of its total construction value ('full damage'); with intervention, damage is reduced to 'partial damage' (10% of total construction value). These damage factor assumptions are recommended upon hydrological modelling advice. They are intended to be updated with detailed hydrological modelling at a subsequent design phase.

Combining these assumptions and input data with average flood damage values yields average annual damages (AAD), presented in Table 7-12 below.

Table 7-12: Average annual damages

Project site	**Directly impacted assets (number)**		**WITHOUT INTERVENTION:** value of direct damages (USD) ** 40% of total construction value*		**WITH INTERVENTION:** value of direct damages (USD) ** 10% of total construction value*	
	Bridge	**Dam**	**Bridge**	**Dam**	**Bridge**	**Dam**
Joe Gqabi	1	0	432,152	-	108,038	-
Ngaka Modiri Molema	3	0	1,296,457	-	324,114	-
Alfred Nzo	2	0	864,305	-	216,076	-
Ehlanzeni	2	0	864,305	-	216,076	-
Sekhukhune	11	1	4,753,676	16,816,459	1,188,419	4,204,115

* Based on advice from the hydrological modelling team, average flood damage values (total asset construction value) is corrected by a factor of 40% in the without intervention scenario to illustrate average damage costs under baseline conditions. The intervention scenarios is expected to reduce this damage factor to 10% of total construction value. (see further detail below). Full cost value sources are contained in the Excel model.

Fourth, the hydraulic model estimated the extent of flooding discharge for the current baseline climate scenario (with and without interventions). Forecasted future flooding extent, however, was not available. In lieu of this information, simulated future climate change discharges were sought by equating the return periods for rainfall annual exceedances probabilities (AEPs) (see rainfall analyses in Table 6-25 above) to flooding discharges. This yields an important characteristic for this economic assessment of the present value of avoided damages (typically assessed as depth- and return period-disaggregated AADs multiplied by AEPs): owing to the absence of depth- and return period-disaggregated AADs (a result of absent forecasted flooding extent information), the change in present value damages from current climate to future climate scenarios (both 50th and 90th percentiles) is embedded not in the AAD (which stays constant), but in the change in

[17] Hydrological modelling focussed on assessing impacts associated with the top ten simulated discharge events only.

AEPs. This is an acknowledged limitation of the economic analysis, and may present skewed[18] results depending on the return period assessed. This limitation also applies to indirect avoided damages.

Overall, the reduced flooding benefits associated with the proposed interventions are calculated as the difference between the damage costs with and without the respective interventions under the two future climate change scenarios. These benefit estimates were then annualised (to obtain an estimate of the equivalent annual damage costs) using the appropriate probability of occurrence (or AEP). Four return period are assessed: 1:5, 1:10, 1:50 and 1:100.

Table 7-13 presents the total benefits of avoided direct damages to key infrastructural assets associated with the proposed interventions. Implementation of interventions was assumed to be over a 7-year period, for the purposes of this assessment and will be revised during the project Inception Phase. Therefore, it is assumed that benefits increase incrementally and equally (14.82%) over the 7-year period until 2032 at which point benefits start to accrue fully. Note that total avoided damage costs disaggregated by individual intervention types are not presented since it requires implementation of all types concurrently to yield avoided damage benefits.

For a more detailed understanding of input parameters and calculations used, please see the accompanying Excel model.

Table 7-13: Total value of avoided direct damages, USD, 2024 prices, undiscounted – 1:100 event, 50th Percentile climate change scenario

Avoided damage costs, USD (2024), undiscounted	Joe Gqabi	Ngaka Modiri Molema	Alfred Nzo	Ehlanzeni	Sekhukhune	**Programme level:** across all five project sites
Bridges	162,057	486,171	324,114	324,114	1,782,629	**3,079,085**
Dams	-	-	-	-	6,306,172	**6,306,172**

7.4.2 Avoided Costs of Indirect Damages

Benefits of measures

The damage to key infrastructural assets (namely bridges) explored above also presents indirect damage to local communities in the form of lost or diminished accessibility for travellers using the bridge, which in turn incurs travel time delays and associated costs. The proposed project interventions are intended to reduce flooding hazard to the bridges, thereby enabling accessibility for its users to engage in key economic activities.

Valuation basis

[18] The formula for present value of (avoided) flood damages is depth- and return period-disaggregated AAD multiplied by AEP. Considering a 1:100 event: while its probability of occurrence (AEP) may be lower than a 1:5 event, it's AAD if it does occur should be higher. Currently, the absence of depth- and return period-disaggregated AADs – a result of the absence of simulated flooding extent data – dictates that AAD remains constant regardless of the return period (the scale of the flooding event). This implies that present value of damage is only determined by AEP. Therefore, damages for lower return period floods (e.g., 1:5) are larger than for higher return period floods (e.g., 1:100) purely because they occur more often. This does not take into account the fact that these lower return period floods might not cause major damage to infrastructure. The converse is true for a 1:100 flood. Therefore, benefits are likely to be overestimated for lower return periods (1:5, 1:10) and potentially underestimated for higher return periods.

Improved accessibility is examined for business and school-going travellers. While accessibility is relevant and important for those travelling to healthcare, funerals and other economic activities, values for these users could not be quantified with reasonable confidence owing to data limitations.

Table 6-23 presents estimates of the number of households indirectly impacted by a damaged/impassable bridge. Impact is defined as moderate (where alternative access routes are available but at a journey travel time delay – assumed to be a 50% increase in journey travel time) or high (where no alternative routes are available, preventing access and therefore business and school participation). Under the baseline scenario, bridges are fully damaged (occurring in line with the relevant AEP) are therefore inaccessible while being reconstructed over a 1 year period. Under the intervention scenario, on the other hand, damage is reduced to 'partial damage' where inaccessibility is limited to 2 week only – as recommended by the hydrological modelling team. The duration of inaccessibility determines the number of trips business and school travellers forego. Between baseline and intervention scenarios, the number of foregone business trips per business traveller reduces from 502 to 20, while the number of foregone school trips per learner reduces from 400 to 20, based on the average number of working and school days per year and return[19] journeys.

The economic value of travel time for business travellers is taken as the national minimum wage. For school travellers, average future earnings associated with schooling participation is used, based on a 2020 Organisation for Economic Cooperation and Development (OECD) study that examined the impact of COVID-19 school closures on an individuals' lifetime income. The study showed that a 1.9% reduction in individual lifetime earnings – pooled across the US, Greece and Singapore – is associated with a 25% (or 50 days) loss of a schooling year (Hanushek & Woessmann, 2020). This economic value of travel time for school travellers is combined with average years in paid work (23.55 average across males and females) and the nominal minimum wage.

Both economic proxies are used alongside average travel and number of trips per mode (only walking and taxi/car/bus modes were examined) to yield the annual value of avoided indirect impacts to accessibility and travel time. Present values are found by multiplying the average annual value by the relevant AEPs (since the occurrence of (avoided) damage is dependent on the probability of a flooding event).

Table 7-14 presents the total benefits of avoided indirect damages to accessibility and travel time associated with the proposed interventions. Implementation of interventions was assumed to be over a 7-year period, for the purposes of this assessment and will be revised during the project Inception Phase. Therefore, it is assumed that benefits increase incrementally and equally (14.82%) over the 7-year period until 2032, at which point benefits start to accrue fully. For a more detailed understanding of input parameters and calculations used, please see the accompanying Excel model.

Table 7-14: Total value of avoided indirect impacts to accessibility and travel time, USD, 2024 prices undiscounted – 1:50 event, 50th Percentile climate change scenario

	Joe Gqabi	Ngaka Modiri Molema	Alfred Nzo	Ehlanzeni	Sekhukhune	Programme level: across all five project sites

[19] A return journey comprises two trips per day.

Avoided indirect impacts, USD (2024), undiscounted	1,315,201	79,026	349,727	225,816	1,718,545	3,688,315

Note that the same limitations of present value damage calculations observed in avoided direct damages – linked to the absence of simulated flooding extent data – occur in the calculation of avoided indirect damage. See Section 7.4.1 above for details.

7.4.3 Improved Water Quality (Reduced Sedimentation)

Benefits of measures

As outlined earlier in this Feasibility Study, soil erosion is a significant issue for the project sites. Increased sediment yields in surface runoff reduce overall water quality and diminish the total storage capacity of water bodies such as dams. The proposed sustainable land management interventions are envisioned to reduce this sediment yield, thereby presenting benefits measured in terms of avoided costs associated with water quality treatment, dredging or investment in additional storage capacity.

Assessing changes in sediment yield is important, despite the fact that only Sekhukhune has a large dam in its study area. Mander et al (2008) argue that reduced sediment yields are even more valuable in rivers without large dams, as large dams are usually over-engineered to take account of silt build-up that helps to regulate the sediment loads in lower reaches. Conversely, a system with no large dam is more reliant on additional baseflow during winter months since there is no engineered storage to capture the stormflow and to regulate the flow of the water from that point going forward.

Valuation basis

The economic valuation of reduced sediment yield utilises the hydrological input data from (Section 6.2), most notably the simulated sediment loss scenario analysis results as well as the analysis of land cover distributions.

The economic value of reduced sediment yield is assessed in terms two different ways, depending on the project location. The first approach – used for Joe Gqabi, Ngaka Modiri Molema, Alfred Nzo and Ehlanzeni, owing to the absence of dams – views reduced sedimentation in terms of avoided dredging costs, based on the approach used in Mander et al (2008). Siltation affects the carrying capacity of water outlets, or indeed areas higher along the river course. Removing this siltation incurs an economic cost of R32 (or $1.7) per m^3 of siltation in 2024 prices (Mander, et al., 2008). This approach equates the quantity of sediment yield to siltation. The second approach – used for Sekhukhune only owing to its impacted dam – examines reduced sediment yield in terms of the replacement cost of lost dam storage capacity (e.g. through raising the dam wall, constructing a substitute dam at a new site to make up the reduction in capacity or constructing check dams). This was done by estimating the amount of storage that would have to be constructed to prevent a similar amount of sediment from reaching downstream aquatic environments, using an average capital replacement cost of R11.9 (or $0.6) per m^3 (Turpie, et al., 2021).

Notably, the difference in sediment yield between with and without interventions (Table 6-10) is provided for current climate scenario only. However, the positive relationship between rainfall and sedimentation suggests that forecasted sedimentation impact should rise under future climate change scenarios. To account for this, future sediment impact is multiplied by the % growth rate in rainfall exceedance probability compared to the current climate baseline. Sediment impact is not multiplied by AEP - as is the case under avoided direct and indirect flood damages - since sedimentation is not determined exclusively by flooding (it is rather a function of rainfall and land/topographical and soil characteristics). Additionally, using the probability of flooding events (AEP) implies using its inverse: the probability of flood event not occurring, which would not reflect the current reality where sedimentation occurs even without large flooding events. Therefore, the sediment yield benefit of proposed interventions is the difference between future climate change sedimentation damages with and without intervention, presented by the return event of interest.

Table 7-15 presents the total benefits of avoided direct sedimentation damages to key infrastructural assets associated with the proposed interventions. Implementation of interventions was assumed to be over a 7-year period, for the purposes of this assessment and will be revised during the project Inception Phase. Therefore, it is assumed that benefits increase incrementally and equally (14.82%) over the 7-year period until 2032 at which point benefits start to accrue fully. For a more detailed understanding of input parameters and calculations used, please see the accompanying Excel model.

Table 7-15: Total value of avoided costs from reduced sediment yields, USD, 2024 prices, undiscounted – 1:100 event, 50th Percentile climate change scenario

Intervention type	Joe Gqabi	Ngaka Modiri Molema	Alfred Nzo	Ehlanzeni	Sekhukhune	Programme level: across all five project sites
IAP removal	33,681	-	8,976	72,162	553	115,372
Gully rehabilitation	5,331	4,466	4,249	5,325	4,552	23,923
Rangeland management	4,479,047	99,224	136,860	100,181	5,190,765	10,006,077
Wetland rehabilitation	-	-	-	-	-	-
All interventions	4,518,059	103,690	150,085	177,668	5,195,871	10,145,373

7.4.4 Provisioning and Habitat Ecosystem Services

Benefits of measures

The proposed measures are expected to deliver a wide range of ecosystem services (benefits of functioning ecosystems to people) through revegetation and sustainable land management of key land cover types such as grasslands and wetlands. The benefits may include important sources for food, building materials and provide valuable regulating services such as water treatment. This section focuses on provisioning (specifically raw materials) and habitat protection (gene pool) ecosystem services emanating from improved grassland management (assumed to have been transformed from degraded/unproductive to healthy, functioning states). These have been chosen based on their relevance to project and location-specific characteristics, and to avoid double counting with the other benefits estimated in this analysis. While improved wetlands may yield increased ecosystem services, data limitations regarding the extent to which interventions improve wetland condition and functioning suggest this ecosystem cannot be valued with reasonable confidence.

Valuation basis

The value of grassland ecosystem services specifically at the project sites could not be feasibly obtained from primary data collection. Therefore benefit transfer is used. In recent years several studies have attempted to derive estimates of the total economic value provided by grasslands**.** The Ecosystem Service Valuation Database is a globally recognised database that presents value estimates for a range of ecosystem services and biomes, with value estimates presented in monetary units/ha/year to allow easy retrieval for value transfer and meta-analysis. Monetary unit values (in $/ha/year) for the grassland biome were extracted for this assessment. Given the project and location-specific characteristics, provisioning (raw materials) and habitat protection (gene pool) ecosystem services specifically from grasslands were selected (De Groot, et al., 2012). These values are based on 32 studies, approximately 26% of which relate to Africa.

- Value of raw materials from grasslands (materials include woody products, thatched grass), inflated to 2024 (USD): $117.6/ha/year. A clearer understanding of the extent to which community members use these services specifically at the project sites will inform the accuracy/relevance of these proxy values. In lieu of this local context, the proxy values are deemed appropriate.
- Gene pool diversity from grasslands: $2.69/ha/year, inflated to 2024 value.
- These monetary values are then applied to the average area of rangeland that is rehabilitated from a degraded state to a healthy, functioning grassland ecosystem.
- 2/3rds of the total grassland area is assumed to be rehabilitated from a degraded state (severe or moderate condition in the baseline) i.e., 1/3rd of grasslands are presumed to be in 'good' condition in the baseline, and while interventions will benefit this condition further, the change is expected to be marginal[20].
- Estimates of additionality from restoration activities such as improved grassland management practices in provisioning and habitat services are scarce. A 2006 study found that restoration of natural capital from existing subsistence activities in Bushbuckridge could produce a 177% increase in total direct consumptive provisioning services (noting though that certain services are reduced) (Blignaut & Moolman, 2006). With this source and the general data limitations in mind, this assessment assumes a 100% additionality factor, effectively showing that provisioning and habitat ecosystem services are created with new grasslands compared with completely denuded and unproductive grasslands in the base case.

The resulting annual values are shown in Table 7-16. These emanate entirely from the rangeland management activities. Implementation of interventions was assumed to be over a 7-year period, for the purposes of this assessment and will be revised during the project Inception Phase. Therefore, it is assumed that benefits increase incrementally and equally (14.82%) over the 7-year period until 2032 at which point benefits start to accrue fully. It is important to note that ecosystem functions, the flow of ecosystem services, and the economic value to society and the economy are site specific and depend on the ecological, social and economic systems and their interactions. For this reason the value ranges in Table 7-16 need to be considered as indicative.

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[20] The 2/3rds correction factor is applied to Joe Gqabi and Alfred Nzo DM sites only. These sites included a significant expansion to grassland area, with 1/3rd of this area assumed to be in 'severely degraded', 'moderately degraded' and 'good' conditions each. The relatively smaller grassland expansion areas in the remaining DM sites were assumed to be in a degraded baseline condition (not disaggregated by severe, moderate or good), and therefore the full area extent benefits from rehabilitation.

For a more detailed understanding of input parameters and calculations used, please see the accompanying Excel model.

Table 7-16: Total value of grassland provisioning and habitat ecosystem services, USD, 2024 prices, undiscounted

	Joe Gqabi	Ngaka Modiri Molema	Alfred Nzo	Ehlanzeni	Sekhukhune	Programme level: across all five project sites
Existing planned grassland expansion scenario						
Value of provisioning ecosystem services (raw materials)	66,052,791	1,503,905	183,768,493	2,737,323	76,141,935	330,204,447
Value of habitat protection ecosystem services (gene pool protection)	1,512,983	34,448	4,209,339	62,700	1,744,081	7,563,551
High grassland expansion scenario*						
Value of provisioning ecosystem services (raw materials)	254,100,379	1,503,905	476,290,570	2,737,323	76,141,935	810,774,112
Value of habitat protection ecosystem services (gene pool protection)	5,820,337	34,448	10,909,750	62,700	1,744,081	18,571,316

*This scenario includes a greater extent of rehabilitated grasslands for Joe Gqabi and Alfred Nzo DM sites, equating to 200,000ha over the five sites

7.4.5 Income-Generating Opportunities (Livestock Production)

Benefits of measures

The proposed interventions are intended to rehabilitate and sustainably manage degraded land cover to a state of healthy and productive grasslands. Given the existing extent of degraded land at the project sites, healthy grasslands present an opportunity for local farmers to improve the conditions for enhanced livestock production – an important economic activity for many households at the project sites (30% of households in Joe Gqabi DM are involved in agriculture) (StatsSA, 2015). Improved grassland management broadly aims to employ practices that minimise the adverse effects of fire and drought and use improved grazing management techniques that maximise grassland quality.

Valuation basis

The economic analysis assumes that improved grasslands (transformed from a degraded to healthy, productive state) results in increased livestock production in two key ways: first, carrying capacity of the land increases under rehabilitated grasslands, supporting higher number of livestock; and second, improved grazing and land management practices (including grazing pressure distributed equally) improves the overall quality of livestock (measured in increased livestock weight and sales price) because livestock are better fed.

The following input variables and assumptions are used to calculate the economic value of higher income from improved livestock production.

- Under baseline conditions, carrying capacity is 0.096 LSU/ha (average between severely overgrazed / close to settlements and moderate condition /middle distance). Under the intervention scenario, improved grassland and livestock management practices increases average carrying capacity by 25% to 0.12 LSU/ha[21]. It is assumed that the increase in carrying capacity potential is realised by local farmers – that is, they can afford the costs of acquiring and managing additional livestock units.
- Carrying capacity is split 50%, 40% and 10% across cattle, sheep and goats respectively.
- Average weight of livestock under baseline conditions: 225kg/cow; 20kg/sheep; and 2kg/goat. Under the intervention scenario, improved livestock management and grazing leads to livestock weight gains of 1.25kg in cattle, 300g in sheep and 30g in goats (Samuel & Dines, 2023). Impact to birthing and weaning rates are not considered in this analysis.
- Average livestock price: $2.55/kg cattle; $3.09/kg sheep; and $1.50/kg goat. Assuming higher quality livestock receives higher market prices, a conservative 10% sales price premium is applied to livestock sold under the intervention scenario.
- 2/3rds of the total grassland area is assumed to be rehabilitated from a degraded state (severe or moderate condition in the baseline) i.e., 1/3rd of grasslands are presumed to be in 'good' condition in the baseline, and while interventions will benefit this condition further, the change is expected to be marginal[22].

Table 7-17 presents the total benefits of increased livestock income from rehabilitated grasslands. Implementation of interventions was assumed to be over a 7-year period, for the purposes of this assessment and will be revised during the project Inception Phase. Therefore, it is assumed that benefits increase incrementally and equally (14.82%) over the 7-year period until 2032 at which point benefits start to accrue fully. For a more detailed understanding of input parameters and calculations used, please see the accompanying excel model.

Table 7-17: Total value of income from increased livestock production, USD, undiscounted

Increased income from livestock production (USD)	Joe Gqabi	Ngaka Modiri Molema	Alfred Nzo	Ehlanzeni	Sekhukhune	Programme level: across all five project sites
Existing planned grassland expansion scenario	6,446,353	146,772	17,934,694	267,146	7,430,992	32,225,957
High grassland expansion scenario*	24,798,660	146,772	46,483,079	267,146	7,430,992	79,126,649

*This scenario includes a greater extent of rehabilitated grasslands for Joe Gqabi and Alfred Nzo DM sites, equating to 200,000ha over the five sites.

[21] Estimates provided by the engineering team (Jon McCosh).

[22] The 2/3rds correction factor is applied to Joe Gqabi and Alfred Nzo DM sites only. These sites included a significant expansion to grassland area, with 1/3rd of this area assumed to be in 'severely degraded', 'moderately degraded' and 'good' conditions each. The relatively smaller grassland expansion areas in the remaining DM sites were assumed to be in a degraded baseline condition (not disaggregated by severe, moderate or good), and therefore the full area extent benefits from rehabilitation.

7.4.6 Non-Quantifiable Benefits

In addition to the benefits that have been quantified and valued in the preceding sections, there are a number of other important benefits that are not amenable to monetary valuation. Some of the most significant of these benefits are described below.

Water security, drought

Infiltration potential is expected to increase as a result of the project's interventions. This will improve water security for local communities by improving the water table around the project sites that builds drought resilience and climate change adaptation capacity for dry seasons. This has particularly relevant for local farmers whose livestock rely on sufficient water supplies. However, the impact of interventions to groundwater and base flows were not assessed in the hydrological modelling, therefore they are excluded in the economic analysis.

Fire control

The proposed interventions include improved fire management activities. Understanding the economic impact of these activities is challenging, owing largely to the complex interactions of fires in grassland ecosystems. For example, wildfires and those that occur out of season or are unplanned can be destructive, damaging livestock and grassland fodder and releasing above-ground carbon stores. However, if planned and managed carefully (e.g., undertaken biennially in late winter or early spring) fires provide important stabilising services to grass bud banks and soil carbon stocks (Carbutt & Kirkman, 2022).

It is assumed that the proposed interventions such as firebreaks and improved livestock management will reduce the disbenefits and elevate the benefits of fire events. However, there is little available evidence of the extent to which benefits outweigh disbenefits i.e., the assessment is unable to distinguish between (beneficial) managed burning regimes and out-of-season, unplanned fires. This is complicated by the limited understanding of fire events at the project sites under baseline and intervention scenarios (for example, how many wildfires occur per year and at what duration).

A 2016 study in Zimbabwe estimated the willingness to pay (WTP) of farming communities' for effective fire management that reduces direct damage to key provisioning services such as livestock numbers, woody resources, thatching grass and grazing fodder. While these benefits are relevant to this proposed project, conceptually they are already contained in the estimation of provisioning services and livestock production above (although the contribution from fire management specifically cannot be disaggregated) . Including these WTP values would therefore result in double-counting.

Biodiversity

Healthy and productive grassland ecosystems play a pivotal role in supporting biodiversity, serving as habitats for diverse plant and animal species. Among their many ecological functions, grasslands contribute to pollination, a crucial process for plant reproduction and ecosystem stability. Pollinators such as bees, butterflies, and birds rely on the nectar and pollen provided by grassland plants for sustenance, in turn facilitating the fertilization of flowering plants that ensures the production of seeds and fruits (Johnson, et al., 2009). The preservation and restoration of grassland ecosystems are therefore essential for maintaining pollinator populations and safeguarding the intricate web of life they support.

There is evidence to suggest that restoration of natural vegetation (primarily through removing IAPs) leads to an increase in pollinators and their resulting pollinating services (Kaiser-Bunbury, et al., 2017). The degree of recovery may depend on the state of degradation prior to restoration intervention and the proximity to pollinator source populations in the surrounding landscape. The proposed intervention activities envisioned under this project will result in similar such pollination benefits, however there is limited understanding of baseline versus intervention conditions at the project sites to support the extent to which these benefits materialise. Most tellingly, there is limited evidence to show how changes in pollination services impact livestock production or provisioning services. Pollination and other biodiscovery benefits are therefore excluded from this assessment.

7.5 CBA

7.5.1 Economic Evaluation Results

The estimates of costs and benefits associated with the packages of interventions in each of the project areas have been profiled over a 50-year assessment period and then discounted using a social discount rate of 6% in the base case scenario. Interventions are assumed to be implemented over a seven-year period, starting in 2025. Benefits start to accrue incrementally until 2032, at which point they accrue fully. Four return periods are assessed, in line with the hydrological input data provided: 1:5; 1:10; 1:50; and 1:100. The benefits of the proposed interventions are estimated as the difference between the situation with climate change (two climate change scenarios are examined) with the proposed interventions, and the situation with climate change but no interventions.

The outcomes of the analysis at the individual project levels are shown in Table 7-18, considering a 1:100 return event and the 50th percentile climate change scenario.

Table 7-18: Cost-benefit outcomes (base case) – 2024 values, 1:100 event, 50th Percentile climate change scenario

	Joe Gqabi	**Ngaka Modiri Molema**	**Alfred Nzo**	**Ehlanzeni**	**Sekhukhune**	**Programme level** (total across all five project sites)
Existing planned grassland expansion scenario						
Total costs of interventions (US$, million, undiscounted)	10	3	5	4	7	29
NPV (US$, million, discounted)	30	-1.82	97.31	-1.49	41	164
Benefit cost ratio	4.56	0.36	25.73	0.53	8.32	7.88
EIRR %	31%	0.12%	181.4%	2%	57%	55.69%
*High grassland expansion scenario**						
Total costs of interventions (US$, million, undiscounted)	10	3	6	4	7	30

	Joe Gqabi	Ngaka Modiri Molema	Alfred Nzo	Ehlanzeni	Sekhukhune	**Programme level** (total across all five project sites)
NPV (US$, million, discounted)	133	-1.82	257.40	-1.49	41	427
Benefit cost ratio	16.40	0.36	56.63	0.53	8.32	18.19
EIRR %	106%	0.12%	377.6%	2%	57%	121.32%

*This scenario includes a greater extent of rehabilitated grasslands for Joe Gqabi and Alfred Nzo DM sites, equating to 200,000ha over the five sites.

Results at the Programme and Project Level (Existing Planned Grassland Expansions)

These results suggest that, under a 1:50 flooding event and the 50th percentile climate change scenario:

- The programme (encompassing all five project sites) is **strongly cost-beneficial** in terms of NPV, benefit cost ratio and EIRR.
- Proposed interventions are cost-beneficial in Joe Gqabi, Alfred Nzo and Sekhukhune project sites.
    - Area of grassland rehabilitation underpins many of the benefits. The relatively larger grassland areas in Joe Gqabi, Sekhukhune and particularly Alfred Nzo primarily drive their positive results.
    - The presence of a high number of bridges and the single dam in Sekhukhune compared with other sites strengthens its overall benefits through larger avoided direct and indirect damage costs. Avoided direct and indirect costs, however, are marginal across all sites when compared to the other benefits.
    - The positive results for Sekhukhune and Joe Gqabi occur despite their higher costs relative to the other sites.
- Proposed interventions are **not cost-beneficial** in Ngaka Modiri Molema and Ehlanzeni.
    - Ngaka Modiri Molema and Ehlanzeni see a significantly smaller area of grasslands rehabilitated, resulting in less co-benefits being realised. If rehabilitated grassland area is expanded, especially in Ehlanzeni, results are expected to rise to overall economic viability.
    - In Ngaka Modiri Molema and Ehlanzeni, numbers of households indirectly impacted are relatively lower than in most other DMs, resulting in less households receiving avoided indirect damage benefits.
- Under the high grassland expansion scenario, economic results for Joe Gqabi and Alfred Nzo DM sites are elevated significantly, in turn increasing overall programme economic feasibility.

Notably, results are sensitive to the choice of climate change scenario and return period. All sites become more economically viable when the 90th % climate change scenario (compared to the 50% scenario) is considered, as well as when more regular return periods are examined (1:50, 1:10 and 1:5).

Insights into Specific Benefit Drivers

- Consistent across all project sites, avoided direct and indirect damage costs are marginal, owing to the small number of assets exposed to flooding hazards.
- The highest benefit streams emanate from provisioning services.

- Avoided damages to sediment yield also contributes positively to the economic viability of the interventions. However, increased income from improved livestock production is arguably more telling, since this economic benefit channels directly to local farmers. The knock-on effects of improved household income, considering the poor economic state for most communities in the project sites, cannot be overestimated.

The economic evaluation demonstrates the marked benefits of rehabilitating grasslands to healthy and productive states. Most benefits, and certainly those that contribute most substantially, are underpinned by area of rehabilitated grasslands. While those benefits associated with avoided flood damages are relatively minor, the significant grassland-based benefits reveal the importance of sustainable grassland and grazing management practices that specifically mitigate other climate hazards such as fire and drought.

The potential to increase total area of rehabilitated land (to 200, 000 ha) under a high grassland expansion scenario will significantly enhance economic results Joe Gqabi and Alfred Nzo DM sites, and elevate an already-positive programme level.

7.5.2 Caveats and Limitations

The CBA is necessarily high-level and is therefore subject to a number of caveats and limitations, as follows:

- Hydrological modelling-linked benefits (namely avoided direct flood damages) are based on an original site scoping at the five sites. All remaining benefits are linked to an expanded sizing of site areas. Hydrological modelling could not be undertaken for the expanded area owing to data constrains. The difference in project area extent between hydrological modelling-linked benefits and others presents an inconsistency. However, given hydrological modelling-linked benefits are significantly smaller than the remaining benefits, this inconsistency does not significant bearing on the economic results. If hydrological modelling of expanded grassland area is done, this can be incorporated into an updated economic evaluation (and will certainly increase, albeit marginally, overall benefits).
- A number of important benefits are omitted from the quantitative analysis either because the data necessary to reliably quantify and value the benefits was not available, or because the effort required to derive estimates was considered disproportionate to the scale of benefits at stake. The analysis considers the impacts of changes in flood extent as a primary benefit, but the interventions are also likely to make a significant positive contribution to groundwater recharge which will, in turn, enhance agricultural productivity and household water security. Additionally, the estimates to do not include the value of reduced mortalities and morbidity, fire hazards, impacts to biodiversity (e.g., pollination services), and changes in methane and nitrogen oxide emissions. These exclusions suggest that current modelled results are underestimated.
- The benefits of some interventions (e.g. revegetation) may take several years to be fully realised but may then continue into perpetuity if interventions are properly managed and maintained. A 50-year assessment period may therefore be too short to capture the full benefits of the EbA measures.
- Hydrological input data that underpins most of the key benefits contain limitations that necessitated corrective assumptions for the economic analysis. These limitations include the fact that hydrological input data provided does not disaggregate flooding hazard or extent by flooding depth. Rather, only the total number of assets affected

by flooding in the baseline (no intervention) are provided. Without depth-disaggregated information, this analysis assumes that under the without-intervention scenario vulnerable assets are totally damaged ('full damage'); with intervention, damage is reduced by 50% to 'partial damage'. Most fundamentally, the hydraulic model estimated the extent of flooding discharge for the current baseline climate scenario (with and without interventions) only – forecasted future flooding extent was not available. In lieu of this information, simulated future climate change discharges were sought by equating the return periods for rainfall AEPs to flooding discharges. This yields an important characteristic for this economic assessment of the present value of avoided direct and indirect damages (typically assessed as depth- and return period-disaggregated AADs multiplied by AEPs): owing to the absence of depth- and return period-disaggregated AADs, these remain constant regardless of the return period. This implies that present value of damage is only determined by AEP. Therefore, damages for lower return period floods (e.g., 1:5) are larger than for higher return period floods (e.g., 1:100) purely because they occur more often. This doesn't take into account the fact that these lower return period floods might not cause major damage to infrastructure. The converse is true for a 1:100 flood. Therefore, benefits are likely to be overestimated for lower return periods (1:5, 1:10) and potentially underestimated for higher return periods. This is a limitation of the economic analysis.

7.6 DETERMINATION OF DIRECT AND INDIRECT BENEFICIARIES

For activities under Outcome 1 communities will benefit from rehabilitated, maintained and/or sustain-ably managed eco-systems through activities such as IAP removal and associated biocontrol, control of bush encroachment, changes in grazing management, revegetation with indigenous species and a combination of hard and soft erosion control measures. These activities will have direct impact on these beneficiaries by reducing their exposure to the climate change induced hazards of droughts, floods and wildfires.

Under Outcome 2, with a focus on disaster risk preparedness, it is important to recognise that DMs are taking the lead regarding improved early warning systems and the development of the necessary information dissemination methodologies. They will work with all LMs in their area of jurisdiction to improve these improved response approaches, including systems, communications, hazard avoidance and places of safety. This will have impact on all people living within the DM's area of jurisdiction. DMs also take the lead in terms of ensuring that all integrated planning at LM level takes place and is inclusive of connected issues between the LMs, particularly with regards to socio-economic, developmental and various aspects linked to environment, inclusive of disaster risk reduction.

The estimation direct and indirect beneficiaries for the project interventions focused at DM and LM levels are summarised hereunder. No beneficiary estimations have been made for those interventions focused on national aspects (i.e. Outcome 3).

Table 7-19. Summary of direct and indirect beneficiaries linked to project outputs – ARA1

Outputs	Definition of direct and indirect beneficiaries	Direct beneficiaries (disaggregated by gender)	Indirect beneficiaries (disaggregated by gender)
Outcome 1: The incorporation of Eco-DRR strategies into integrated landscape management enhances the resilience of ecological infrastructure and climate-vulnerable communities.			
Output 1.1. Ecosystems are	**Direct beneficiaries:** refers to the targeted communities within the selected project implementation sites in the four DMs (i.e.	366,088 persons	1 613 652 persons

Outputs	Definition of direct and indirect beneficiaries	Direct beneficiaries (disaggregated by gender)	Indirect beneficiaries (disaggregated by gender)
rehabilitated, maintained and sustainably managed for Eco-DRR.	Alfred Nzo, Ehlanzeni, Ngaka Modiri Molema and Sekhukhune DMs) where Output 1.1's interventions will be implemented. These communities will benefit from rehabilitated, maintained and/or sustainably managed ecosystems through activities such as invasive alien plant (IAP) removal and associated biocontrol, control of bush encroachment, changes in grazing management, revegetation with indigenous species and a combination of hard and soft erosion control measures. These activities will have direct impact on these beneficiaries by reducing their exposure to the climate change induced hazards of droughts, floods and wildfires. **Indirect beneficiaries:** refers to the population of the LMs within which the targeted communities i.e. direct beneficiaries are located in. The communities in the LMs will indirectly benefit by the sharing of an evidence base and building and transferring knowledge in other landscapes as well as promoting lesson learning from Output 1.1's activities. The LMs will also indirectly benefit by identifying opportunities for replication and/or upscaling within the broader area. The engagement of local government officials and traditional leadership, as well as various civil society actors present in these areas, will support in the exchange of knowledge and the opportunity to upscale across the local municipality, thereby reducing the exposure to droughts, floods and wildfire overtime as well as beyond the lifespan of the project.	(male 168 034, female 198 054)	(approx. male 747 270 female 866 382)
Output 1.2. Local, gender-inclusive and sustainable ecosystem-based livelihoods support locally led adaptation.	**Direct beneficiaries**: refers to the targeted communities within the selected project implementation sites in the two DMs of Alfred Nzo and Ehlanzeni where Output 1.2's interventions will be implemented. These communities will directly benefit from the introduction of gender-inclusive, ecosystem-based livelihood stacking strategies in the Alfred Nzo and Ehlanzeni DMs that addresses immediate climate adaptation needs and creates a compelling value proposition for private-sector investment. These will have direct impact on all those living within households in these areas of intervention. The household dataset was sourced from Eskom (2015) and then was mapped spatially using GIS coverages of the project intervention areas. It was assumed that each household comprises of 4 people. The ratio of female and male beneficiaries was determined by applying the ration within each LM using that derived by Statistics South Africa's 2022 Census[23]. This was then assumed across all households. **Indirect beneficiaries:** refers to the population of the LMs within which the targeted communities i.e. direct beneficiaries are located. These LMs are: • Umzimvubu and Ntabankulu LMs (Alfred Nzo DM), and • Bushbuckridge LM (Ehlanzeni DM). Firstly, it is assumed that the support to the development of localised livelihood options including the development of Small Micro and Medium Enterprises (SMMEs) will have downstream socio-economic impacts including linkages into an array of associated businesses. This will act as a stimulus to local growth and development in the two LMs. Secondly, with staff responsible for local economic development (LED) at each LM, as well as private sector and civil society, involved in the Eco-DRR project interventions there is opportunity for the transfer of knowledge and the benefit of sharing the evidence base generated. This will provide opportunity to upscale these across the LMs and into other local landscapes. Thus through lesson learning from Output 1.2's activities, these LMs will indirectly benefit by being able to	292 752 persons (male 134 355, female 158 397)	1 111 720 persons (approx. male 512 882 female 598 838)

[23] https://census.statssa.gov.za/assets/documents/2022/Provinces_at_a_Glance.pdf

Outputs	Definition of direct and indirect beneficiaries	Direct beneficiaries (disaggregated by gender)	Indirect beneficiaries (disaggregated by gender)
	identify opportunities for replication and/or upscaling within the broader area. The population of the LMs including male and female numbers were sourced from Statistics South Africa's 2022 Census[24].		
Outcome 2. The incorporation of Eco-DRR into transformative disaster preparedness and response reduces the adverse impacts of climate-induced hazards on built infrastructure and climate-vulnerable communities.			
Output 2.1. Local governments and communities implement improved Eco-DRR preparedness and response measures.	**Direct beneficiaries:** no direct beneficiaries have been determined. **Indirect beneficiaries:** DMs are taking the lead regarding improved early warning systems and the development of the necessary information dissemination methodologies. They will work with all LMs in their area of jurisdiction to improve these improved response approaches, including systems, communications, hazard avoidance and places of safety. This will have impact on all people living within the DM's area of jurisdiction. Indirect beneficiaries therefore refers to the population of the four targeted DMs (Alfred Nzo, Ehlanzeni, Ngaka Modiri Molema and Sekhukhune DMs) that will benefit from enhanced capacity within DMs and local communities to adopt more proactive responses to climate-induced hazards that are inclusive of Eco-DRR including improved dissemination of early warning products, messages and practices.	N/A	5 481 886 (male 2 598 883, female 2 883 003)
Output 2.2. Eco-DRR is mainstreamed into national and sub-national asset risk management, environmental policy and spatial planning.	**Direct beneficiaries:** no direct beneficiaries have been determined. **Indirect beneficiaries:** DMs take the lead in terms of ensuring that all integrated planning at LM level takes place and is inclusive of connected issues between the LMs, particularly with regards to socio-economic, developmental and various aspects linked to environment, inclusive of disaster risk reduction. They will take the lead in ensuring that policy and planning instruments developed across all LMs in their district are inclusive of climate change adaptation, of ecosystem-based adaptation and Eco-DRR. Indirect beneficiaries therefore refer to the population of the four targeted DMs (Alfred Nzo, Ehlanzeni, Ngaka Modiri Molema and Sekhukhune DMs) that will benefit from the improved capacity of policy and decision makers to understand the linkages between ecological infrastructure and vulnerability to climate change as well as mainstreaming of ecosystem-based adaptation and Eco-DRR measures into sub-national policy, planning and budgetary processes. This will result in improved levels of climate resilience over the duration of the project, and thereafter with subsequent iterations of policies and plans with time.	N/A	5 481 886 (male 2 598 883, female 2 883 003)
Outcome 3: An enabling environment is created for investment in Eco-DRR through a strengthened evidence base and improved learning and knowledge management.			
Output 3.1. Financial mechanisms developed and strengthened to enhance private and public sector investments in Eco-DRR.	No direct or indirect beneficiaries can be calculated for Output 3.1	N/A	N/A
Output 3.2. Informed decision making for Eco-DRR is supported and promoted.	No direct or indirect beneficiaries can be calculated for Output 3.2	N/A	N/A
Total		658 840 people (male 302 389 female 356 451)	13 689 144 people

[24] https://census.statssa.gov.za/assets/documents/2022/Provinces_at_a_Glance.pdf

Outputs	Definition of direct and indirect beneficiaries	Direct beneficiaries (disaggregated by gender)	Indirect beneficiaries (disaggregated by gender)
			(approx. male 6 457 918; female 7 231 226)

However, it is important to consider the issue of double counting of direct and indirect beneficiaries. In this regard, the total number of direct and indirect beneficiaries when considering double counting has been presented in the table below. Bearing in mind that the beneficiaries between Output 1.1 and 1.2 as well as Output 2.1 and 2.2 are the same, the table below presents the beneficiaries per outcome.

Table 7-20. Summary of direct and indirect beneficiaries linked to project outputs – ARA1 considering double counting

Outcome and Definitions	Adaptation Benefit	Direct beneficiaries (disaggregated by gender)	Indirect beneficiaries (disaggregated by gen-der)
Outcome 1: The incorporation of Eco-DRR strategies into integrated landscape management enhances the resilience of ecological infrastructure and climate-vulnerable communities. **Direct beneficiaries:** only considers the communities in the targeted project implementation sites in the 4 DMs under Output 1.1. These are inclusive of the same beneficiaries in Output 1.2. **Indirect beneficiaries:** considers the LMs within which the communities in the targeted project implementation sites reside (i.e. Umzimvubu and Ntabankulu LMs, Bushbuckridge LM, Ramotshere Moiloa LM and Makhuduthamaga LM). **As the indirect beneficiaries calculated under Outcome 1 will be also be indirect beneficiaries under Outcome 2, these indirect beneficiaries cannot be counted twice.**	Protection of vulnerable groups and ecosystems from floods, droughts and wildfires by clearing IAPs, improving rangeland management and conducting wetland and riverine rehabilitation.	366 088 people (male 168 034 female 198 054)	Not considered due to double counting
Outcome 2: The incorporation of Eco-DRR into transformative disaster preparedness and response reduces the adverse impacts of climate-induced hazards on built infrastructure and climate-vulnerable communities. **Direct beneficiaries:** no indirect beneficiaries were determined. **Indirect beneficiaries:** This only considers the four DM populations (Alfred Nzo, Ehlanzeni, Ngaka Modiri Molema and Sekhukhune DMs) minus the direct beneficiaries counted under Outcome 1.	Protection of vulnerable groups and built infrastructure from floods, droughts and wildfires through improved disaster risk reduction preparedness and response measures coupled with mainstreaming of Eco-DRR into policy and spatial planning.	N/A	5 115 798 people (male 2 430 849 female 2 684 949)
Outcome 3: An enabling environment is created for investment in Eco-DRR through a strengthened evidence base and improved learning and knowledge management. No direct or indirect beneficiaries can be calculated for Outcome 3.	Enhanced enabling environment by improving investment in Eco-DRR, developing finance mechanisms and promoting informed decision-making	N/A	N/A
TOTAL		**366 088 people (male 168 034 female 198 054)**	**5 115 798 people (male 2 430 849 female 2 684 949)**

8 Social Evaluation

This section outlines the efforts directed toward gender assessment and the formulation of a gender action plan. Contextually, the GCF operates via six investment criteria for proposal evaluation notably, sustainable development potential is one criterion gauged by considering broader economic gains, environmental impacts, and social as well as gender-related benefits. This criterion scrutinises a project's capacity to yield enduring advantages beyond the funding phase, assessing long-term viability, financial sustainability, and its ability to sustain positive impacts post-GCF financing. Emphasis is placed on integrating gender equality, environmental protection, social inclusion, and indigenous community support into projects and initiatives.

8.1 PROJECT-LEVEL ANALYSIS

Recognising gender's pivotal role in climate action, the GCF prioritises women's participation and decision-making in its supported projects. As such all its funded projects are required to promote gender equality, allocate resources to women-led initiatives, and conducting gender-responsive assessments for proposed interventions The focus extends to ensuring that GCF-backed projects aid vulnerable and marginalised communities, enhancing their adaptive capabilities against climate change impacts This involves provisions for clean water access, food security, and sustainable livelihood opportunities, particularly for those disproportionately affected by climate change. The GCF's objective is to foster a more equitable, sustainable future amid climate challenges.

To align with these requisites and ensure project sustainability while fortifying resilience within affected communities, we ensured the integration of gender considerations into our proposal. As necessitated, an understanding of the gender landscape in the country and project areas was pivotal.

Our approach was guided by a comprehensive review of the national gender status to gain a broader perspective. This entailed examining the country's policies, laws, and reports to the United Nations pertaining to sustainable goal number 5 and its targets. Despite commendable global indicators, various barriers and challenges hindering gender parity in South Africa persist, as elucidated in subsequent sections.

Upon identifying districts that are most vulnerable to climate change impacts, for Eco-DRR project implementation, assessing gender situations within these areas became imperative. Initial information gathering involved distributing questionnaires via email to DMs to assess the gender status and extent of gender-mainstreaming within the respective municipalities. These surveys aimed to discern whether gender mainstreaming was underway, the presence of a gender strategies and focal points, and any projects specifically targeting women's empowerment. In addition, we conducted a scrutiny of DMs' IDPs aimed to evaluate their responsiveness to gender differentiated needs in their jurisdictions.

During the Feasibility study phase, engagements with diverse stakeholder group, who included provincial government departments (DFFE, SANBI, COGTA, DM and LM officials, a few NGOs) were conducted in selected project districts. These sessions involved workshops emphasising the critical need for Gender Equality and Social Inclusion (GESI) and fostering dialogue through structured discussions. Insights gleaned from these engagements and primarily from field teams interactions with local women, revolved around four primary inquiries. These involved examples of vulnerability during prior climate disasters, the root causes of gender disparities, potential strategies to overcome barriers, and requisite support for addressing these disparities. These engagements were carried out in all districts except in the Ehlanzeni district, due to time limitations. As a result the engagements with Ehlanzeni were limited to online.

Findings from the national gender status review show South Africa's adequate legal support for gender empowerment and parity aspirations. However, the legal provisions have failed to transform gender perspectives on the ground. Concerning areas have persisted, and they include underrepresentation in science, technology, engineering and mathematics (STEM) fields, gender pay gaps, and alarming levels of gender-based violence and crimes against women. Rural women face exacerbated challenges compared to their urban counterparts, particularly regarding climate change impacts.

At the DM and LM level institutions, a stark realisation emerged—gender mainstreaming was notably lacking. Insufficient support systems and mechanisms for comprehending and appreciating gender mainstreaming were evident, reflected by absent gender plans or budgets in IDPs. Gender focal points, predominantly in charge of social services, lacked seniority to influence decisions and lacked action plans guiding their activities. In most of the cases the gender focal points failed to explain their roles and had no idea whether the municipality had a gender strategy or not. Across all DMs, gender focal positions were mere add-ons, lacking clear targets beyond monitoring women's numbers in municipal positions. This situation frustrated efforts to gather preliminary gender data from the institutions.

A glaring gap observed at all levels, both nationally and locally, was the dearth of gender-disaggregated data. Even the National Statistics Authority faced challenges obtaining such data, particularly from departments or authorities designated for statistical reporting.

In the district engagements, findings highlighted:

1. Vulnerabilities during Previous Climate Disasters: Women across districts consistently faced vulnerabilities during climate-related crises, experiencing disruptions in housing, access to services, income loss, and health-related crises during droughts, floods and wildfires. Droughts and wildfires exacerbated livestock and crop losses, leading to severe food insecurity while floods damaged infrastructure including homes, roads, clinics and schools.
2. Reasons Behind Gender Disparities: Various factors heightened women's vulnerability during disasters, including childcare responsibilities, physical vulnerabilities, cultural biases, reliance on government grants, limited clean water access, settlement in vulnerable areas, poor planning, and inadequate communication regarding impending events.
3. Addressing Barriers in Eco-DRR Projects: Stakeholders outlined strategies for inclusivity and mitigating vulnerabilities among women and marginalised groups This included affirmative actions, tailored interventions, income-generating projects, safety nets, improved communication, sustainable energy, and comprehensive settlement planning.
4. Support Required for Gender Disparities: Stakeholders advocated for gender awareness programs, skill development, empowerment in land ownership, leveraging change agents for gender mainstreaming, and continuous engagement during project implementation.

Recommendations stemming from these findings spanned national efforts requiring concerted action to address gender-based violence, incentivise girls and women to take up STEM, and ensure equitable remuneration. STEM fields offer significant opportunities to advance gender issues by challenging traditional gender stereotypes, empowering individuals through skills, creating role models, contributing to economic empowerment, and tackling global challenges such as climate change through research and innovations informed by all gender. While these challenges exceed the Eco-DRR project scope, mitigative actions can occur at project sites through awareness, training, and inclusive interventions Training in gender mainstreaming and the development of action plans and tools for gender focal points are crucial and can be integrated into the project Emphasis is placed on collecting, analysing, and producing gender-disaggregated reports as practically feasible

Consensus across surveyed districts and stakeholders underlines the critical challenges faced by women during climate disasters, warranting holistic interventions. These vulnerabilities emphasise embedding GESI principles within the Eco-DRR project framework. Recommendations stress immediate relief measures and long-term strategies empowering women, fostering resilience, and ensuring active participation in DRR initiatives. Such collective efforts are vital in establishing sustainable, gender-inclusive resilience against climate-related challenges within these communities.

The Gender Action Plan emerged from assessment findings, featuring a draft plan encompassing indicators and potential timelines. It outlines activities and interventions identified for each district at community and institutional levels. Additionally, it incorporates an activity to execute a gender baseline study specifically tailored for project intervention sites once identified. Activities aligning with project outcome 2 focus on plans integrating gender aspects, gender mainstreaming training, developing financial packages catered to women's and marginalised communities' needs, and addressing circumstances appropriately. The Eco-DRR Gender Action Plan aligns well with the National Climate Change Gender Action Plan that is under finalisation by DFFE.

8.2 SITE-LEVEL ANALYSIS

8.2.1 Alfred Nzo DM

The project sites in the Alfred Nzo District are Matatiele and Umzimvubu LMs. The Alfred Nzo DM is located in the northeastern corner of the Eastern Cape Province. It covers only 6% of the province's area, however boasts a rich cultural heritage. With a population of 936,462 (2022 census), the district's demographics reflects South Africa's general profile, with a youthful population (35.8% under 15 years old) and a growing elderly demographic (6.6% over 65 years old). The district's economy is driven by various sectors, including community services, trade, agriculture, and manufacturing.

Matatiele LM is the largest municipality in the Alfred Nzo District and covers an area of 4,352 square kilometres. With a population of 225,562, similarly Matatiele has a relatively youthful demographic profile and a growing elderly population. The municipality's economy is diverse, with community services and agriculture being major contributors. Matatiele's proximity to the Drakensberg Mountains signifies the importance of biodiversity conservation for the LM

Umzimvubu LM, spans 2,579 square kilometres and is characterised by rural landscapes and dispersed settlements. With a population of 214,477, Umzimvubu faces challenges such as high dependency ratios and aging demographics. The municipality's economy relies on various sectors, including government services, trade, and agriculture.

Gender issues

The issues were identified through stakeholder engagements:

- Impact of climate change: Women in these municipalities bear a disproportionate burden of the effects of climate change. They face income loss, displacement, and restricted access to essential services during extreme weather events. This exacerbates existing vulnerabilities and makes it challenging for them to cope with the changing climate.
- Entrenched gender roles: Traditional gender roles are deeply ingrained in the communities, leading to unequal distribution of responsibilities and opportunities between men and women. Thus, limiting women's access to resources, decision-making power, and economic independence.
- Lack of official identification: Many women in these municipalities were reported to lack official identification documents, which restricted their access to government services, financial resources, and employment opportunities. This further marginalises them and perpetuates their dependence on others. This was attributed to lack of any formal education.
- Inadequate healthcare: Women in the rural areas of Alfred Nzo, including the sick and elderly faced barriers to accessing healthcare services, including limited facilities and long distances to travel. This results in poorer health outcomes for women and contributes to their overall vulnerability.
- Deficiency of municipal services: The lack of essential municipal services, particularly in accessing water, poses significant challenges for households led by women. Without reliable access to clean water, majority of women and girls must travel long distances to fetch water, which affects their time, health, and economic productivity.

To address these gender issues, the Eco-DRR project proposes several interventions:

Safeguarding water sources: The project aims to preserve and protect water sources through land management strategies that mitigate erosion and sedimentation, innovative small infrastructure e.g. for spring protection. This is essential for ensuring reliable access to clean water, which is particularly critical for women and their households.

Empowerment of women: Livelihood programmes will be implemented to empower women and marginalised communities economically and socially, enhancing their autonomy and overall wellbeing. By providing women with skills training, income-generating opportunities, and support networks, the project seeks to strengthen their resilience to climate change and other challenges.

Engagement of NGOs and local leaders: The active involvement of NGOs and local leaders is crucial for ensuring that the project's interventions reflect the diverse perspectives and needs of the community. By engaging with stakeholders at all levels, the project can achieve more sustainable and inclusive outcomes.

Sustainable resource management: Prioritising sustainable resource management and land conservation initiatives will help protect environmental resources for future generations. By considering the needs and capabilities of vulnerable women and marginalised communities in these efforts, the project can promote equitable and sustainable development.

Overall, gender considerations will be integrated into all aspects of planning, implementation, and evaluation. By recognising and addressing the unique challenges faced by women and marginalised community members, the Eco-DRR project aims to promote gender equality and social inclusion while building resilience to climate change and other environmental hazards.

8.2.2 Joe Gqabi DM

The project interventions will be implemented in Elundini and Senqu municipalities. Elundini has a relatively young demographic profile as 30.9% of the population is under 15 years old. Education levels in Elundini vary, with 8.9% of the population having received no schooling and 5.6% having attained tertiary education. The dependency ratio, which measures the number of dependents (aged 0-14 and over 65) to the working-age population (15-64), stands at 67, indicating a significant portion of the population reliant on the economically active segment. Similarly Senqu LM has 31.1% of the population under 15 years of age, 59.7% aged between 15 and 64 years, and 9.2% over the age of 65. Its dependency ratio is 67.6 per 100 individuals aged 15-64. The is a much higher female population as shown by the sex of 86.8 males to 100. For those above 20 years of age ,10 % of the population have no formal education and 6.2% have achieved higher education qualifications.

Gender Issues

In the Joe Gqabi DM, and specifically in Elundini and Senqu municipalities, gender issues are prevalent and exacerbated by various factors, including cultural dynamics, socioeconomic challenges, and geographic isolation. Women in these areas face significant obstacles during disasters, with specific concerns related to water and food scarcity, disrupted access to vital services, and challenges in accessing education for schoolchildren due to impassable bridges.

The majority of households in the region are led by women and heavily rely on government grants for survival, indicating a disproportionate burden on women in terms of household responsibilities and economic sustainability. Agricultural output remains low due to various factors, including soil erosion, siltation in water sources, and overgrazing, further exacerbating women's challenges in providing for their families.

Cultural norms also play a significant role in inhibiting women's participation in disaster management initiatives and community decision-making processes.

Proposed solutions for addressing gender challenges in Elundini and Senqu include:

- Cultural Sensitivity: All proposed intervention will be designed to respect and accommodate cultural dynamics, and awareness programs will be couched in a language that is culturally sensitive while challenging societal perceptions that hinder women's active involvement.

- Improved Accessibility: All interventions will be planned and implemented with consideration of time, distance and general availability of different genders and delivered in a way that make them more accessible to women-led households during extreme events, ensuring that project designs accommodate gender's roles and time commitments within their families.
- Land Management: Enhancing and introducing sustainable land management practices, including rangeland management, to curb soil erosion and remove invasive species. Programmes will prioritise gender needs particularly those of women, youth, the elderly and people living with disability to ensure inclusivity.
- EWS: A review of the existing EWS with the intent to improve and design innovative means for disseminating early warning messages to communities, with a focus on reaching women and other vulnerable members of society, including the elderly and people living with disability.

The identified challenges and solutions are incorporated in the gender action plan which forms an annex of the full proposal for the Eco-DRR project aimed at fostering resilience and empowerment of marginalised community individuals and groups in Joe Gqabi.

8.2.3 Ehlanzeni DM

Ehlanzeni DM, located in the north-eastern part of Mpumalanga Province, comprises four LMs: Bushbuckridge, City of Mbombela, Nkomazi, and Thaba Chweu. Covering a geographical area of 27,895km², it represents over a third of the province's total landmass. The district's economy is diverse, with key sectors including community services, trade, finance, construction, agriculture, manufacturing, mining, and utilities. Despite its economic potential, the district faces challenges related to education attainment levels, with a notable percentage of adults lacking formal schooling.

Bushbuckridge LM, a pivotal area within the Ehlanzeni District, spans 10,248 square kilometres and serves as a gateway to prominent tourist destinations in Mpumalanga and the eastern part of the Limpopo Province. With a population of 750,821, Bushbuckridge is the largest municipality in the district. While agriculture and tourism anchor the local economy, developmental challenges such as infrastructure development and unemployment persist, requiring concerted efforts from local authorities and stakeholders.

Thaba Chweu LM covers an area of 5,710 square kilometres and is divided by an escarpment, with distinct economic activities in its western and eastern halves. Tourism plays a pivotal role in the municipality's economy, with notable landmarks and natural wonders attracting visitors. Key economic sectors driving the local economy include mining, forestry, agriculture, business services, and tourism. Despite a relatively young population and modest population growth, educational disparities remain a concern, highlighting the need for targeted educational initiatives and skills development programmes.

Gender Issues

In Ehlanzeni DM, specifically in Bushbuckridge and Thaba Chweu LMs, there are several gender issues exacerbated by recurrent flooding and food insecurity during droughts and wildfires. These challenges proportionately affect women and other marginalised community members amplify their vulnerabilities to climate change induced disasters.

- **Disproportionate Impact on Women**: Women are disproportionately affected by flooding and food insecurity (as a result of droughts and wildfires) due to various factors such as their roles as caregivers, limited access to resources, and societal norms. During disasters, women often bear the brunt of caregiving responsibilities, including taking care of children, elderly family members, and the sick. This increased burden further strains their physical and mental health, making them more vulnerable to the adverse effects of disasters.
- **Inadequate EWS**: Stakeholders have identified inadequacies in EWS as a significant contributor to exacerbating disasters. These systems often fail to effectively reach women, leaving them ill-prepared and intensifying their susceptibility to the impacts of droughts, floods and wildfires. Women may not receive timely and relevant information about impending disasters, making it difficult for them to take necessary precautions to protect themselves and their families.
- **Lack of Actionable Guidance**: Available information about disasters often fails to provide actionable guidance for effective disaster response, particularly for women. Women may not have access to resources or knowledge about how to prepare for and respond to disasters, further exacerbating their vulnerability.
- **Compounded Issues of Land Tenure**: The compounded issue of land tenure exacerbates the plight of women in disaster-affected areas. Women often have limited access to land and property rights, which hinders their ability to recover from disasters and rebuild their livelihoods.

Addressing these gender issues require the following:

There is a need for tailored information and support services that address the specific needs of women during disasters. Reforming governance structures and land tenure policies is essential for fostering more resilient and equitable land resource management, which is crucial for sustainable development.

- **Gender-Sensitive EWS**: The project will develop and implement EWS that are sensitive to the needs of women. This includes ensuring that warnings are disseminated through various channels accessible to women, such as community meetings, radio broadcasts, and mobile phone messages. Training community leaders and volunteers to effectively communicate warnings to women and providing them with resources to assist women in taking necessary precautions can also enhance the effectiveness of EWS.
- **Gender-Responsive Disaster Preparedness Training**: The project will provide gender-responsive disaster preparedness training to women and men in disaster-prone areas. This training aims to equip women with the knowledge and skills needed to prepare for and respond to disasters, including first aid, evacuation procedures, and emergency communication protocols. Additionally, training will address gender-specific vulnerabilities and strategies for mitigating risks, such as ensuring access to safe shelters and sanitation facilities for women and girls.
- **Strengthening Women's Land Rights**: The project will advocate for, and support initiatives aimed at strengthening women's land rights in disaster-affected areas. This may include legal reforms to recognise and protect women's rights to land and property, as well as community-level interventions to raise awareness about women's land rights and empower women to assert their rights. Secure land tenure can enhance women's resilience to disasters by enabling them to access resources for recovery and rebuild their livelihoods.
- **Promoting Women's Participation in Decision-Making**: Encourage and facilitate women's participation in decision-making processes related to DRR, preparedness, and response. This includes ensuring that women are

represented in local disaster management committees and other relevant forums where decisions are made about disaster preparedness and response strategies. Providing training and capacity-building opportunities to women leaders can also empower them to effectively advocate for their needs and priorities in disaster planning and decision-making processes.

Integrating Gender Mainstreaming in DRR: The Eco-DRR initiatives will integrate gender mainstreaming principles into all stages of DRR initiatives, from planning and implementation to monitoring and evaluation. This includes conducting gender-sensitive vulnerability assessments, incorporating gender considerations into DRM plans, and disaggregating data by gender to identify and address disparities in disaster impacts and responses. By mainstreaming gender considerations into DRR efforts, stakeholders can ensure that the specific needs and priorities of women are adequately addressed and that interventions are more inclusive and effective.

8.2.4 Ngaka Modiri Molema DM

Ngaka Modiri Molema DM, situated in the North West Province of South Africa, encompasses five LMs: Ditsobotla, Mahikeng, Ramotshere Moiloa, Ratlou, and Tswaing. Ramotshere Moiloa LMs.

Ramotshere Moiloa LM, formerly known as Zeerust LM, is a significant administrative division within Ngaka Modiri Molema DM. Covering 7,323 square kilometres, it is the largest municipality in the district and serves as a strategic location with borders shared with Botswana and the Limpopo Province. With a population of approximately 161,605 people (2022 Census), the municipality has a growth rate of 0.68% and a dependency ratio of 62.3. Education levels indicate that 13.7% of the population lack formal schooling, although 6.1% have attained tertiary education. The sex ratio is approximately 94.7 males per 100 females.

Gender Issues

In Ramotshere Moiloa LM, gender issues intersect with various challenges, particularly those stemming from climate change-induced disasters and socioeconomic factors. Our finding highlighted the following challenges.

Access to vital services: The vulnerable groups and in particular women, young children, the sick and elderly face restricted access to essential services such as healthcare, education, and clean water during climate change-induced disasters like droughts, floods and wildfires. This disproportionately affect women who are often responsible for caregiving and household management.

Economic empowerment: Women's economic empowerment is hindered by challenges such as unemployment, limited access to credit for agricultural production due to land tenure issues, and traditional gender roles that confine them to certain sectors of the economy. Without access to credit and land, women struggle to start or sustain agricultural enterprises, perpetuating cycles of poverty and disempowerment.

Gender discrimination and norms: Traditional gender roles and norms unjustly discriminate against women in, limiting their participation in decision-making processes and excluding them from various societal opportunities such as advancing in education. These norms perpetuate gender disparities and hinder women's ability to fully engage in community development and disaster management efforts.

Through discussions the following solutions are proposed for the project include:

- **Inclusive community engagement**: Ensuring as a policy that all engagements include the vulnerable and recognising and acknowledging the crucial role of women and other genders in disaster management and community engagements. Efforts should be made to involve them in decision-making processes, ensuring inclusivity and fostering a sense of ownership within the community.
- **Tailored support for women's livelihoods**: The interventions will be designed to include tailored support for women's and other marginalised communities' livelihoods and employment opportunities, aligning these interventions with their specific needs and skills, to enhance their economic empowerment and resilience to climate change impacts.
- **Policies promoting women's access to land and credit**: The project will advocate through the appropriate channels the development of policies and implementation frameworks that facilitate women's access to land and credit facilities, particularly in agriculture, in order to empower women economically and contribute to agricultural productivity and growth.
- **Strengthening institutional capacity for climate resilience**: The project aims at developing codes and standards that will guide investments in climate-resilient infrastructure, including gender-tailored infrastructure for roads and bridges, and strengthening institutional capacity for infrastructure maintenance to mitigate the impacts of climate change on women and their communities.
- **Integrating gender perspectives into initiatives**: The project will, across all sites implement awareness campaigns and initiatives that integrate gender perspectives into all project activities to contribute to greater gender equality, inclusivity, and resilience to climate change impacts in Ramotshere Moiloa and beyond.

8.2.5 Sekhukhune DM

Sekhukhune DM, located in the Limpopo Province, is the smallest district in the province, covering 13,527 square kilometres and comprising four LMs. The district major economic sectors, including mining, trade, financial services, and agriculture. With a population of approximately 1.3 million, the district faces challenges related to education and population demographics, despite its significant contributions to the province's economic and social landscape.

Elias Motsoaledi LM, a part of the Sekhukhune District, covers an area of and is home to Groblersdal and Roossenekal. Despite socioeconomic challenges, including high dependency ratios and limited educational attainment, the municipality's economic sectors such as agriculture and tourism offer opportunities for growth and development, contributing to employment and food security.

Fetakgomo Tubatse LM, the largest municipality in the Sekhukhune District, encompasses a diverse landscape and prominent urban centres like Burgersfort and Ohrigstad. Its economy is driven by agriculture, mining, trade, and tourism. However, it also faces demographic challenges such as skewed sex ratios and varying education levels within the population.

Makhuduthamaga LM, another one of the Sekhukhune District. Agriculture and farming are vital economic activities, although the municipality faces challenges such as limited resources and infrastructure. With a young population and moderate population growth, Makhuduthamaga grapples with issues like education levels and high dependency ratios.

Gender Issues

- In Sekhukhune, slightly over 50% of households are headed by females, which contributes to their vulnerability. The sex ratio indicates a higher proportion of females across all municipalities in the project sites. While not solely a gender issue, imbalances in sex ratios can have implications.
- Dependency ratios are high, placing additional burdens on the working class and affecting their ability to support themselves and their families. This may possibly hinder individuals, particularly women, from participating in the workforce or pursuing educational opportunities.
- Women and girls in the district and project areas have lower educational attainment compared to men due to social norms, economic constraints, and limited opportunities.
- Women in the project areas play crucial roles in agricultural production, including crop cultivation, livestock rearing, and food processing. However, their contributions are often undervalued and marginalised, with limited access to resources, land rights, and decision-making power.
- During consultations, women expressed greater challenges than men during droughts as they had to find water and food for their families. Additionally, they often lost their agricultural employment, further exacerbating their vulnerability.
- There are concerning levels of gender-based violence, and women reportedly feel insecure when traveling away from home to collect resources.
- Despite being the majority, women often felt excluded from decision-making processes. Some men attribute this to limited education among women, implying that they may not fully understand management issues and resource management strategies.

To address the gender issues outlined above, several strategies within the Eco-DRR will be considered for implementation:

- **Promoting Gender-Responsive Land and Resource Management**: Ensure implementation of the national gender framework to enable equitable access to land and natural resources for women through policies and programs that recognise and protect women's land rights. Review and identify barriers with the existing frameworks and develop alternative approaches to address the barriers. The project will implement initiatives that involve women in decision-making processes related to land use planning, conservation, and resource allocation.
- **Capacity Building and Training**: Across all project sites there will be targeted training and capacity-building programs for women in agricultural practices, sustainable land management, and climate-resilient farming techniques. These trainings will aim to empower women with the knowledge and skills needed to actively participate in agricultural production, natural resource management, and climate adaptation strategies.
- **Supporting Women's Economic Empowerment**: Working with other partners and department of trade efforts will be made to facilitate women's access to financial resources, credit, and markets to enhance their economic independence and resilience. Similarly, the project will promote women's entrepreneurship and income-generating

activities in agriculture and natural resource-based enterprises. Encourage the formation of women's cooperatives and self-help groups to strengthen collective bargaining power and access to markets.

- **Addressing Gender-Based Violence**: The project takes gender-based violence seriously and will implement a Sexual Exploitation, Abuse and Harassment policy. In addition, the project will implement community-based interventions to prevent and respond to gender-based violence, including awareness-raising campaigns, and support networks for survivors. The project will contribute to on-going efforts to curtail gender-based violence and will foster partnerships between local authorities, civil society organisations, and community leaders to address the root causes of gender-based violence and promote gender equality and social justice.
- **Strengthening Women's Participation in Decision-Making**: Within it's the project will advocate for women's inclusion and representation in local governance structures, natural resource management committees, and community-based organisations. It will provide leadership training and mentorship opportunities for women leaders to enhance their participation and influence in decision-making processes.

9 Recommendations for a Transformative Approach

9.1 THE NEED FOR A TRANSFORMATIVE APPROACH

There is strong evidence that EbA can be supportive in building climate resilience in communities vulnerable to climate change, within both urban and rural contexts. Many scientific studies support this assertion, and as a result, the policy and strategy instruments of South Africa have introduced EbA and Eco-DRR approaches into the national approach towards the management and development of natural resources. However, there is some uncertainty as to the magnitude of the role ecosystems can play in climate adaptation.

One important barrier to the uptake that is needed is the lack of demonstrable evidence of either the effectiveness of EbA approaches in meeting adaptation goals, or the delivery of other ecosystem service co-benefits that are attributed to these approaches (GIZ, 2017; Rawlins, et al., 2018). Therefore, initiatives that enable the measurement, comparison and communication of EbA costs, benefits and impacts are esential in supporting better informed and integrated planning and decision-making (GIZ, 2017). This then assists in identifying where EbA can contribute towards more effective, inclusive or sustainable adaptation solutions.

Typically, the available EbA decision-support tools and guidance documents focus on generalised principles and best practice for EbA, on identifying interventions and providing lists of examples for implementation, and on spatially identifying climate change and disaster risk impact hotspots to guide infrastructure investments. These tools are typically insufficient for supporting local level planning and implementation as they lack comprehensive spatial planning components, are not packaged in a simple and understandable format, or are limited in their integration of social, ecological and climatic aspects (Bourne, et al., 2016)

Another constraint is that, even though a variety of methods are available (and have long been used) to assess the costs and benefits associated with both adaptation infrastructure and ecosystem services, these have, as yet, seen limited application in the context of EbA (GIZ, 2017). Where these have taken place, there is often a focus on the quantitative analysis of cost-effectiveness, with these missing the range of qualitative benefits as well as the manner in which costs can be structured and discounted by looking at investments more holistically (Black, et al., 2016).

Given these informational and methodological gaps, decision makers often remain unaware of the potential advantages of integrating ecosystem-based measures into adaptation strategies. As such, it makes it challenging to demonstrate that EbA yields a worthwhile return on investment, as compared to or in combination with built engineering options. This uncertainty presents a barrier that currently limits the use and scaling of EbA and Eco-DRR and, hence, transformative approaches and projects are required that provide the evidence base to eliminate these barriers and enable ecosystem focused interventions to be deployed, quickly and widely.

Nevertheless, conventional coping strategies and incremental adaptation to climate change are proving ineffective at enabling people or ecosystems to reduce their long-term vulnerabilities to severe climatic changes. In response to climate change-driven droughts, floods and wildfires, people can borrow money to repair houses or replant damaged crops in the same location, but do not effectively undertake interventions that protect communities from increasingly severe and frequent droughts, floods and wildfires that result from changes in climate. In some instances, communities can incrementally adapt by improving local infrastructure or by building small-scale infrastructure that assists in dealing with these drought, flood and wildfire events. These responses are adaptive but do not effectively alter the social-ecological system within which they live and as such, still remain vulnerable to the climate induced hazard. In effect, what is really needed is to address the fundamental aspects of the socio-ecological system to provide longer-term resilience. Thus, the restoration of catchments, the rehabilitation of wetlands and the development of more sustainable land management practices would provide the transformative adaptation that is really required (Figure 9-2) (Fedele, et al., 2019).

Transformative adaptation aims to fundamentally improve the entire system's social and ecological properties and functions with the aim of reducing the root causes of vulnerabilities to climate change such as social, cultural, economic, environmental, and power relations, by transforming them into more just, sustainable, or resilient states (Future Earth, 2015; Fedele, et al., 2019).

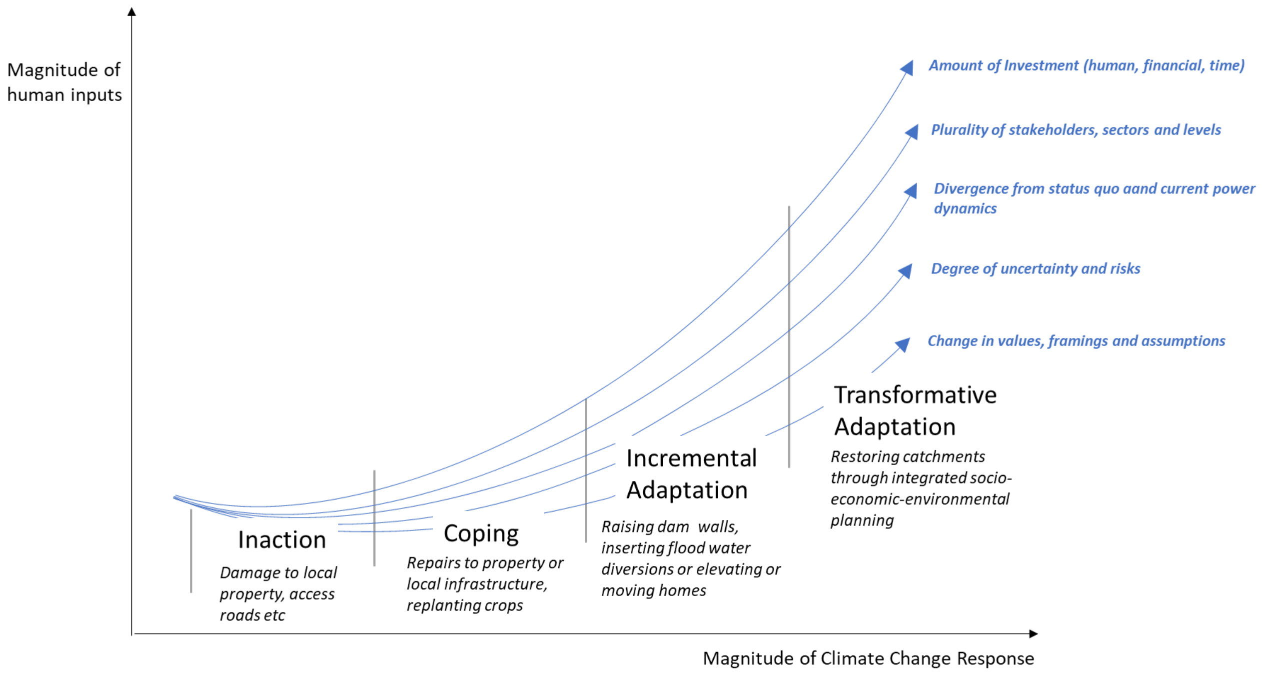

Figure 9-1: Types of strategies for reducing the impact of climate change on social-ecological systems, along a gradient of increasing magnitude of responses (adapted from Fedele, et al., 2019)

While there is increasing recognition of the need to shift away from incremental adaptation, there are barriers that hinder this and require redress if such approaches are to be upscaled. These include:

- **Level of investment**: Obtaining political, institutional, and social support can be difficult to attain when the levels of investment are significant from a financial and human perspective. This is exacerbated by the fact that often the time required for benefits to manifest can be extensive.
- **Complex institutional and stakeholder environment**: The complexity of engaging many different actors towards a more transformative approach can be prohibitive and, hence, institutions opt for simpler and more incremental adaptive responses that do not challenges the existing approaches.

- **Power dynamics**: Existing power dynamics and imbalances are difficult to challenge and adjust, particularly where vested interests are entrenching particular approaches to adaptation. These are often extremely complicated when one considers the complex institutional and stakeholder environment.
- **Uncertainty and risk**: The solutions under a transformative approach could be multiple with varying impacts. Decisions will potentially have differing costs and benefits that may impact different stakeholders and parts of the socio-ecological system to differing degrees. This introduces both uncertainty and risk for some that needs to be managed, noting that trade-offs ultimately can have some negative impacts.
- **Ethical alignment**: Establishing clarity in terms of principles, values and base assumptions is essential, but can be complex noting the range of stakeholders, power imbalances and potential vested interest.

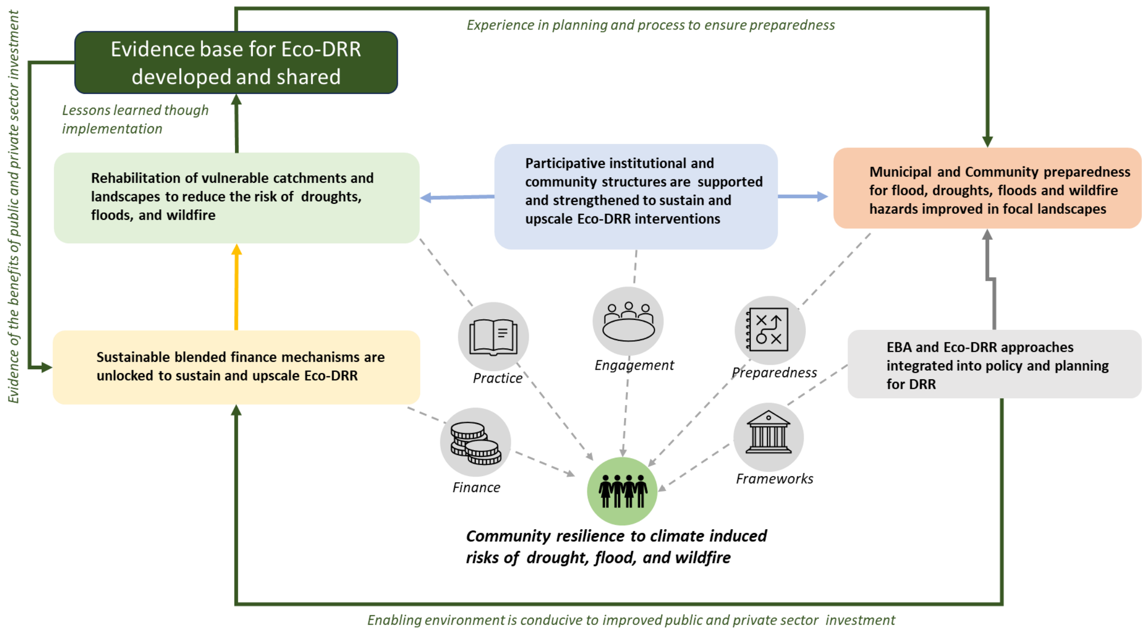

Figure 9-2: Towards a transformative approach to mainstreaming and upscaling Eco-DRR

It has become increasingly recognised that the goods and services accrued from ecological infrastructure play an important and increasing role in both adaptation and DRM. Interventions to support the rehabilitation and restoration of ecological infrastructure can serve to increase the resilience of societies to both abrupt and slow-onset climatic and non-climatic hazards, reduce impacts on human health and mortality, and improve overall liveability, wellbeing and sustainability of both urban and rural areas while also promoting biodiversity and environmental quality.

Ecosystem management not only offers an opportunity to strengthen natural infrastructure and human resilience against hazard impacts, but also generates a range of other social, economic and environmental benefits for multiple stakeholders, which in turn feed back into reduced risk. The Eco-DRR Project aims to support the sustainable management, conservation and restoration of ecosystems to reduce disaster risk in diverse ecosystems, with the aim to achieve sustainable and resilient development.

While EbA and Eco-DRR are often promoted or referred in a range of policy and strategy instruments, as the analysis above demonstrates, these interventions have not been mainstreamed or implemented in a structured and cohesive manner that provides the evidence base that is needed to justify the investment and upscaling. As a result, South Africa has seen a range of interventions undertaken in a piecemeal manner.

Veerkamp *et al* (2021) provided a useful assessment of the typical challenges that are experienced in endeavouring to implement Nature-based Solutions for climate change adaptation and DRR, as well as the requirements needed to support the upscaling of such interventions. These were drawn from an exhaustive list of sources and provides a useful "checklist" of aspects that require redress to implement Eco-DRR (see Table 9-1).

Table 9-1: Challenges that require redress to implement and upscale Eco-DRR (adapted from (Veerkamp, et al., 2021)

Typical Limiting Factors for Eco-DRR	Requirements for Successful Upscaling of Eco-DRR
Lack of political support	• Supporting legislation and regulatory instruments. Policy mechanisms are available to address gaps and encourage uptake. Strategies and plans incorporate Eco-DRR interventions.
Poor stakeholder engagement and attitudes	• Active stakeholder engagement at various levels of government and society to shift attitudes and approaches.
Social and cultural constraints due e.g., cultural preferences for certain aesthetics (what a landscape should look like), risk perceptions relating to different management practices and sense of ownership and place.	• Participatory approaches ensure a range of stakeholders are engaged including awareness building, giving a voice, fostering co-creation and enabling co-management where appropriate.
Physical and biological constraints due to e.g., degraded ecosystems as a starting point for NBS intervention	• Undertaking detailed assessments to ascertain the availability of existing healthy ecosystems and whether there is the ability to improve degraded ones.
Lack of land or space constraints for implementation	• Developing interventions at adequate scale requires active cooperation supported by incentives to encourage support.
Lack of cooperation and consent across institutions and agencies	• Working with institutions and agencies in the design and execution planning of interventions aids alignment and supports the building of shared institutional structures. The use of trusted agents and stakeholder engagement throughout planning and implementation is essential.
Incomplete demonstration of own or comparative benefits (e.g., knowledge gaps on limits and thresholds under which Eco-DRR approaches might not deliver adaptation benefits) and unclear cost effectiveness	• Implement and document projects that demonstrate the multiple co-benefits and ecosystem services. Demonstration of the cost effectiveness in comparison to alternatives, including for successful integration with built infrastructure with demonstrable benefits and leading to optimal planning and design.
Demonstration of effectiveness not tailored to purposes or not at an appropriate scale (e.g., water runoff reduction only demonstrated at plot level but not at catchment scale) and imbalance of knowledge sources underpinning assessments	• The development of interventions at adequate scale, including adequate monitoring mechanisms in order to demonstrate the effectiveness of Eco-DRR interventions.
Gap of knowledge between private benefits to individual entities and broader social costs and benefits for communities. Time lags in achieving and observing benefits.	• Intervention construct must enable the demonstration of both private and social costs and benefits over short- and long-term.

Typical Limiting Factors for Eco-DRR	Requirements for Successful Upscaling of Eco-DRR
Evidence is context specific and often not transferable and is not shared.	• Designing interventions across differing geographies, as well as incorporating existing knowledge and/or ongoing research and monitoring with common indicators and innovation, as well as reporting standards to build the evidence. Establishing knowledge sharing mechanisms, and education and training platforms are important.
Lack of finance for implementation of Eco-DRR (e.g., for land acquisition/compensation) and maintenance	• Leveraging of available finance including using multiple sources of finance linked to multiple benefits and multiple ecosystem services. Early budgeting and assignment of funds and responsibilities to meet operations and maintenance needs.
Difficulties in Eco-DRR tendering processes (e.g. lack of knowledge on how to present a convincing business case for Eco-DRR, lack of track record, lack of (experienced) suppliers, path dependency favouring engineered solutions).	• Engagement with technical and economics experts to gather supporting evidence for robust business case development. Early cross-departmental collaboration including engaging with procurement and finance units. Consideration of alternative procurement and delivery mechanisms outside own procurement.

Noting these aspects, it is clear that a transformative design is required to enable an Eco-DRR project (Figure 9-2). The identification of criteria for the selection of interventions, and their design, needs to underpin this transformative approach. The Concept Note for this project outlined the range of possibilities in terms of interventions both at national and local levels. This feasibility study has undertaken a range of assessments to identify what are the most suitable suite of interventions to provide for an implementable portfolio that enables Eco-DRR to be taken to scale. As such it is critical to ensure the design of a suite of activities that is most likely to have reduced uncertainty (i.e. more resources have to be applied to ensure project risk is reduced) and increased certainty of demonstrating impact (i.e. existing capacity and experience can be leveraged). This often requires trade-offs to get to the most optimal project design.

The framing of the Eco-DRR project at Concept Note level was built around three core components (Figure 9-3) and these are used to structure the approach to identifying the most appropriate suite of interventions. These three components effectively provide for:

- **Site level Eco-DRR focused implementation interventions** that work closely with local government and rural communities. These will aim to reduce the risk to droughts, floods and wildfires and by so doing generate the data and information required to strengthen the evidence base needed for upscaling. A key component will be engagement of communities and supporting stakeholders including NGOs that can support implementation, and the further upscaling.
- **Local government focused interventions** that will aim to integrate ecological infrastructure with built infrastructure through planning as well as exploring approaches to improve DRR and response. This will aim to build the capacity of government staff while looking at how systems can be put in place to have better response to climate induced hazards.
- **Multi-sectoral focused interventions** that aim to explore the various instruments and mechanisms that can be strengthened and developed to enable the upscaling of Eco-DRR interventions across the country. This will requires addressing the range of supportive policy and planning instruments and tools, while working with private and public

sector actors to develop innovative financing mechanisms. The experience and information generated through the site level implementation interventions will be critical in underpinning the development of these various polices, tools and approaches.

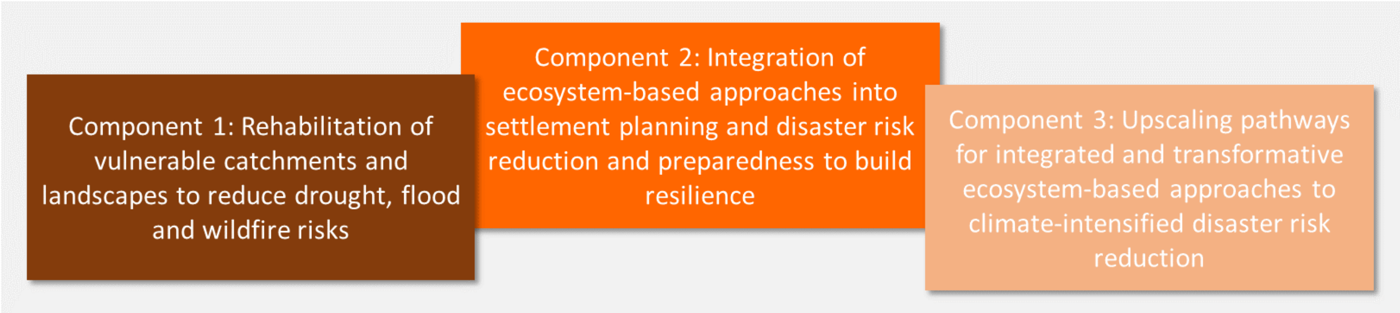

Figure 9-3: Three components of the Eco-DRR project as scoped in the Concept Note

9.2 ECO-DRR ECOSYSTEM SERVICE RESTORATION INTERVENTIONS

The feasibility assessment earlier in this report identified five DMs and potential implementation sites where Eco-DRR interventions were perceived to hold potential for providing impact in reducing climate induced hazards. The process to identify these sites is described above and was based upon a data-driven approach to identify areas within the five DMs where drought, flood and wildfire hazards would increase into an uncertain climate future. Site visits and local workshops with stakeholders then aimed to identify more local sites where project interventions would be practicable and at sufficient scale for the project to be able to work within the overall project budgets.

The assessments have shown varying levels of impact as can be expected. The sites are in varying parts of the country, with highly variable climatic and hydrologic conditions, as well as varying catchment conditions. It is clear from the modelling that Eco-DRR interventions do tend to have positive impact of the hydrology of these locations, trending towards reductions in the Annual Maximum Series (linked to flooding) and varying levels of positive impact on the baseflow (linked to droughts and improved water security).

The CBA also demonstrated varying level of positive impact. In these deeply rural contexts, the impact of flood events tends to be more on access roads and smaller bridges that can cut communities off from access to medical facilities, schools and commercial activities. However, from a CBA perspective, where there is larger infrastructure, the benefit of these interventions is more significant. For example, the presence of the Vergelegen Dam in the Ngwaritsi catchment of Sekhukhune DM has a significant impact on the CBA for the interventions in that area.

From this assessment it is clear that there exists a potential to re-look at the mix of projects and sites to get an improved level of impact and beneficiation, noting that the delineation of the project sites and the mix of interventions will influence this.

Importantly, it is then essential to look at the broader enabling environment to assess whether these project sites are likely to yield the longer-term innovative changes, be able to sustain that after the initial investment and then catalytically leverage and crowd-in future finance. To assess this a scorecard was developed, as outlined in Table 9-2, and is aligned to the GCF investment criteria.

Table 9-2: Scorecard for site level interventions

Investment Criteria	Sub-criteria	Description
Paradigm shift potential (Catalyse impact beyond a one-off project investment) (40% weighting)	Potential for scaling up and replication	Potential to replicate approach to introduce Eco-DRR interventions as well as capturing carbon.
	Institutional experience with EbA	Experience of Government staff in similar projects supported by other institutions including NGOs, civil society and Academia
	Promotion of innovation (new markets, new business models or new technologies)	Project potential scope introduces innovative solutions
Sustainable development potential (Broader benefits beyond climate impact) (30% weighting)	Environmental	The degree to which the project demonstrates positive benefits to the environment and considers the integrated use of nature-based solutions
	Social and gender sensitive development	The degree to which the project will integrate social and gender sensitive solutions
	Economic co-benefits	The degree to which the project will have local economic co-benefits
Efficiency and effectiveness (Economic and financial soundness) (30% weighting)	Transactions demonstrate leverage and the ability to crowd-in commercial investment	The ability of the project to crowd-in commercial finance
	Expected volume of finance to be leveraged by the proposed project/programme and as a result of the Eco-DRR financing, disaggregated by public and private sources	The expected volume of finance to be leveraged with a split between public and private sector contributions
	Expected indirect/long-term adaptation investment mobilized as a result of the implementation of activity	Assessment of the projected impact that the project will have in terms of leveraging investment into adaptation
	Economic / financial rate of return with and without the Eco-DRR project support (i.e. hurdle rate of return or other appropriate/relevant thresholds)	Assessment of the level of additionality realised through the project
	Project financial viability	Assessment of the project risk

The scorecard was then applied to each potential DM/ project site. The results for this assessment are provided in detail in the annexures to this report, and are summarised in Table 9-3, below.

Table 9-3: Assessment of the longer-term potential at each potential project site using the scorecard

Investment Criteria	Score (%)				
	Alfred Nzo	Ehlanzeni	Joe Gqabi	Ngaka Moderi Molema	Sekhukhune
Paradigm shift potential	83	83	92	42	33
Sustainable development potential	83	75	92	58	75
Efficiency and effectiveness	70	60	70	30	50

Investment Criteria	Score (%)				
	Alfred Nzo	Ehlanzeni	Joe Gqabi	Ngaka Moderi Molema	Sekhukhune
Score	79	74	85	43	51

This scoring indicated that undertaking local site-level Eco-DRR interventions in two of the sites (Ngaka Modiri Molema and Sekhukhune DMs) would likely not realise the longer-term innovation and beneficiation that would be expected after an investment into them.

Alfred Nzo DM

There is a history of engaging in such community level engagement projects through a range of externally funded project partners, supported by enabled and experienced NGOs and civil society that operate in this region. Likewise, the Provincial DFFE: EP teams have developed, through these projects, a rich experience in various aspects of EbA that is supportive. There has been levels of innovation through these interventions that provides a platform for the focus on Eco-DRR. Projects under the banner of Meat Naturally and Herding for Health, amongst others, are demonstrating the potential for scale and for further private sector investments, which can be leveraged. The extent of rangelands in the region will enable interventions to be taken to scale with investments in capacity. The potential to utilise carbon markets also provides the opportunity to scale interventions.

Joe Gqabi DM

Adjacent to Alfred Nzo DM, this area has a rich history of local-level projects supported by Provincial DFFE: EP, the municipalities, NGOs and civil society, as well as academia. The Tsitsa Project, which sees collaborative efforts working with communities led by a partnership of actors including the DFFE, Rhodes University, LIMA Rural Development Foundation, University of Fort Hare and University of the Free State, has undertaken catchment-level sustainable land management interventions within the Tsitsa catchment, proximate to the Thina River catchment. Hence, these partners and local NGOs in this area have undertaken a range of environmentally focused activities working with communities and this provides the opportunity for quicker project uptake in the area. This also provides the basis for upscaling into other catchments in the district. The NGOs that have worked in this area are also well placed nationally to take these approaches to other parts of the country, including linkages to on-the-ground teams in Ehlanzeni DM.

However, it is important to note that Joe Gqabi DM, and specifically the Elundini LM, is also scoped as a site for support under the EbA Farm project that is also being prepared for GCF. This project will be looking at climate resilient community-based agriculture particularly through the lens of drought and heat.

Ehlanzeni DM

The Bushbuckridge area of Ehlanzeni has seen a range of community development projects supported by a number of well capacitated NGOs that operate across the area. Conservation South Africa works in this area and is also present in the Eastern Cape and could provide useful connectivity between these areas. These NGOs, the Provincial DFFE: EP and the DM's DRR Unit have developed a working relationship that will enable local projects to not only realise local impact but also support the taking of these to scale across this area. These NGOs have also been exploring a range of market options to bring finance into the region, with very specific purposes, and will support this project in developing more sustainable financing mechanisms to take local interventions to scale. Due to the location of the Sand River in relation to this area, and the potential for this area to experience the impacts of tropical cyclones, there is potential in expanding the site used for the feasibility analysis to include a large downstream area that includes a significant number of bridges, roads and households. This would strengthen the financial rate of return. It is important to note that a large national insurance company has previously supported DRR related projects in this area before and this can also be leveraged.

Ngaka Modiri Molema DM

While the Provincial DFFE: EP is well capacitated with a rich understanding of EbA and the value of Eco-DRR, the capacity with the municipal environment is limited in this regard and really requires interventions to develop that understanding. Municipal priorities are wholly focused on built infrastructure projects. This is further exacerbated by there being no NGOs and civil society that work in this area with a focus on environmental aspects. There is also little experience of working with such funded projects and how to leverage private sector support into such projects. The geography and the nature of the climate hazards experienced question whether interventions here can be taken to scale, and how viable projects could be in this area. More baseline work would be required to bring this area up to project readiness, in the way that other areas are.

Sekhukhune DM

The CBA for this area is strong due to the presence of the Vergelen Dam, yet there are concerns here as to whether the institutional capacity of the area is able to support this project, to sustain it and then to take it to scale thereafter. While the Provincial DFFE: EP team has a solid experience of EbA ,there is little other institutional capacity, whether at municipal scale or within NGOs and civil society. Previously supported projects in this area have faced significant challenges with these aspects and have failed once the funding and technical support is withdrawn. Currently, there are no NGOs or civil society supporting this area and hence, the ability to leverage finance and maintain ongoing site level projects is questionable. With the potential for rangeland focused interventions in this highveld region these local projects could have strong potential for a return on the investment. However, at this juncture, there are no associated private sector actors that one sees in the three other DMs (i.e. Alfred Nzo, Joe Gqabi and Ehlanzeni DMs) and as a result the market would need to be fully initiated, requiring significant effort.

9.2.1 Eco-DRR Ecosystem Service Restoration Recommendations

Site-level implementation interventions are most likely to be scalable and sustainable within 3 of the 5 DMs that were initially identified. These being Alfred Nzo, Joe Gqabi and Ehlanzeni DMs. In these areas, the experienced NGOs are capacitated to support implementation and assist in facilitating private sector engagement.

However, with other project support being targeted for Joe Gqabi DM, it is recommended that the Joe Gqabi DM not be included in the Eco-DRR project, noting that the proximity of Joe Gqabi and Alfred Nzo DMs will still be supportive of ongoing knowledge exchange and co-learning between the two projects. This also enables funding to be used to implement at greater scale in the Alfred Nzo and Ehlanzeni DMs.

The enabling environment within 2 of the 5 DMs (namely Ngaka Modiri Molema and Sekhukhune DMs) requires significant capacitation and support to be ready to undertake local-level interventions for Eco-DRR and be able to sustain these into the future. The lack of a foreseeable market to bring finance into Eco-DRR in these districts will also require significant groundwork to prepare the enabling environment. As such, the lessons from the other site-based interventions will be important learning opportunities. It is therefore recommended to run demonstration interventions in these two DMs as part of the learning process.

With the focus of Eco-DRR ecosystem services restoration interventions on Alfred Nzo and Ehlanzeni DMs, the opportunity exists to scale up interventions from the original catchments. Noting the CBA findings that indicate the importance of downstream infrastructure as well as the benefit accrued through improved rangelands, these aspects should be brought into what could be larger catchment areas.

Building on the planning and capacitation that has be undertaken, the implementation of site -based Eco-DRR interventions will be critical in providing the data, information and knowledge necessary to develop the business cases required to support private sector investment. While the feasibility study has shown that working across large rangelands may have the most potential for securing private sector engagement, it is also important to undertake a variety of Eco-DRR focused actions to test and understand the impact that these may have in building improved levels of climate resilience against drought, floods and wildfires. This implementation is proposed take place in two DMs, namely, Alfred Nzo and Ehlanzeni DM, with the full support of an implementation hub that aims at providing support to the roll out implementation activities at relative scale. The implementation hub will test the possibilities of new operational and institutional modalities for these activities, learning from the experience of the "Working for Water" DFFE: EP programme and associated ecosystem focused programmes. This also includes the Social Employment Fund which aims to tackle unemployment through the strengthening of partnerships with social and civic partners, enabling them to create 'whole of society' initiatives for greater scale and impact across South Africa (IDC, n.d.).

This will then enable an upscaling of project activities in these areas as outlined in Table 9-4, covering an area of approximately 53,475 hectares. The earlier activities to establish governance structures, build capacity and undertake collaborative planning, may result in adjustments to these areas. However, these are usefully indicative of the potential as a baseline. In both DMs, the areas have been increased substantially from those sites tested in the local catchment-level analysis undertaken earlier in this report. These larger areas are shown in Figure 9-4 and Figure 9-5. Key points to note for these sites are:

- **Alfred Nzo**: Within the centrally located areas around Umzimvubu and Ntabankulu LMs the communities around Ntsizwa mountain will become increasingly vulnerable to water security challenge, impacting on their lives and livelihoods. Significant infestations of woody IAPs are impacting on local water security as well as increasing the potential for wildfires during drought periods. Additional rangelands allow the opportunity to take approach to rangeland management to scale where actors such Meat Naturally and Herding for Health have been providing support to communities. This area is also a priority area for the DM and would enable the Winnie Madikezela Mandela LM to also develop capacity, through learning exchanges, noting the levels of vulnerability across this LM.

- **Ehlanzeni**: The expanded site downstream to incorporate more of the Sand River catchment and incorporates the Dwarsloop area of Bushbuckridge. This introduces more road and bridge infrastructures and provides the project to engage in a range of wetland and riverine focused interventions as well as upstream rangeland work. Additionally, downstream of this catchment there are a number of community level agricultural projects that are being developed in Dingleydale and New Forest that will be dependent on sustainable water supplies from the upper catchment, introducing an upstream and downstream water security discourse.

Table 9-4: Summary of proposed ecosystem restoration and rangeland management interventions in Alfred Nzo and Ehlanzeni DMs[25]

Type of intervention	DM		Total
	Alfred Nzo (ha)	Ehlanzeni (ha)	
Clearing of IAPs (woody species)	2337.00		2,337.00
Improved landscape management in upper catchment areas		14,517.00	14,517.00
River rehabilitation and wetland restoration (including hard and soft interventions)	234.31	608,40	842.71
Rotational grazing/resting (eco-champs / enviro-champs)	10, 203.18	25,575.70	35,778.88
Total	**12,774.49**	**40,701.10**	**53,475.59**
Total Area of Land Under Improved Management	**12774.49**	**40701.10**	**53475.59**

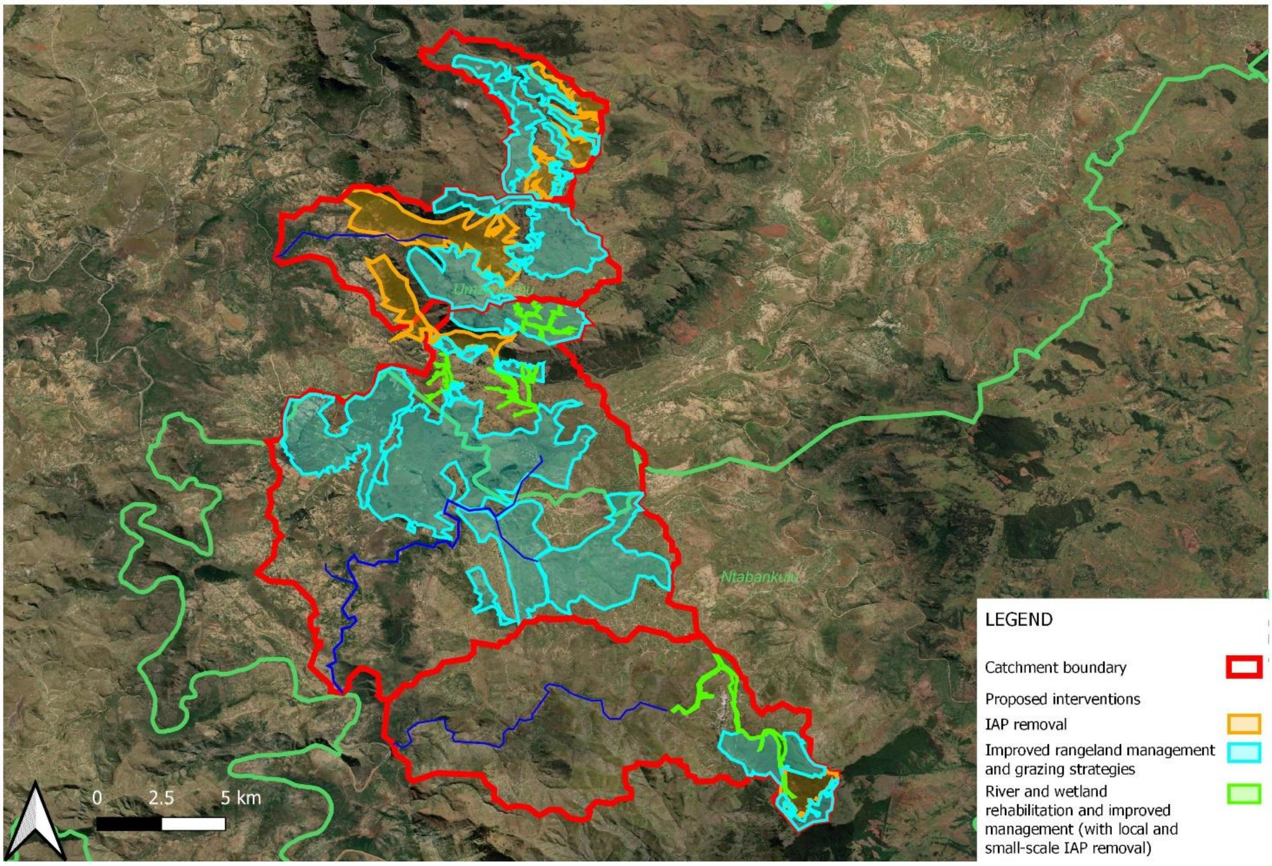

Figure 9-4: Recommended and mapped interventions within Alfred Nzo DM

[25] The interventions and hectares presented in the table are indicative only and will be confirmed during the inception phase of the Eco-DRR project.

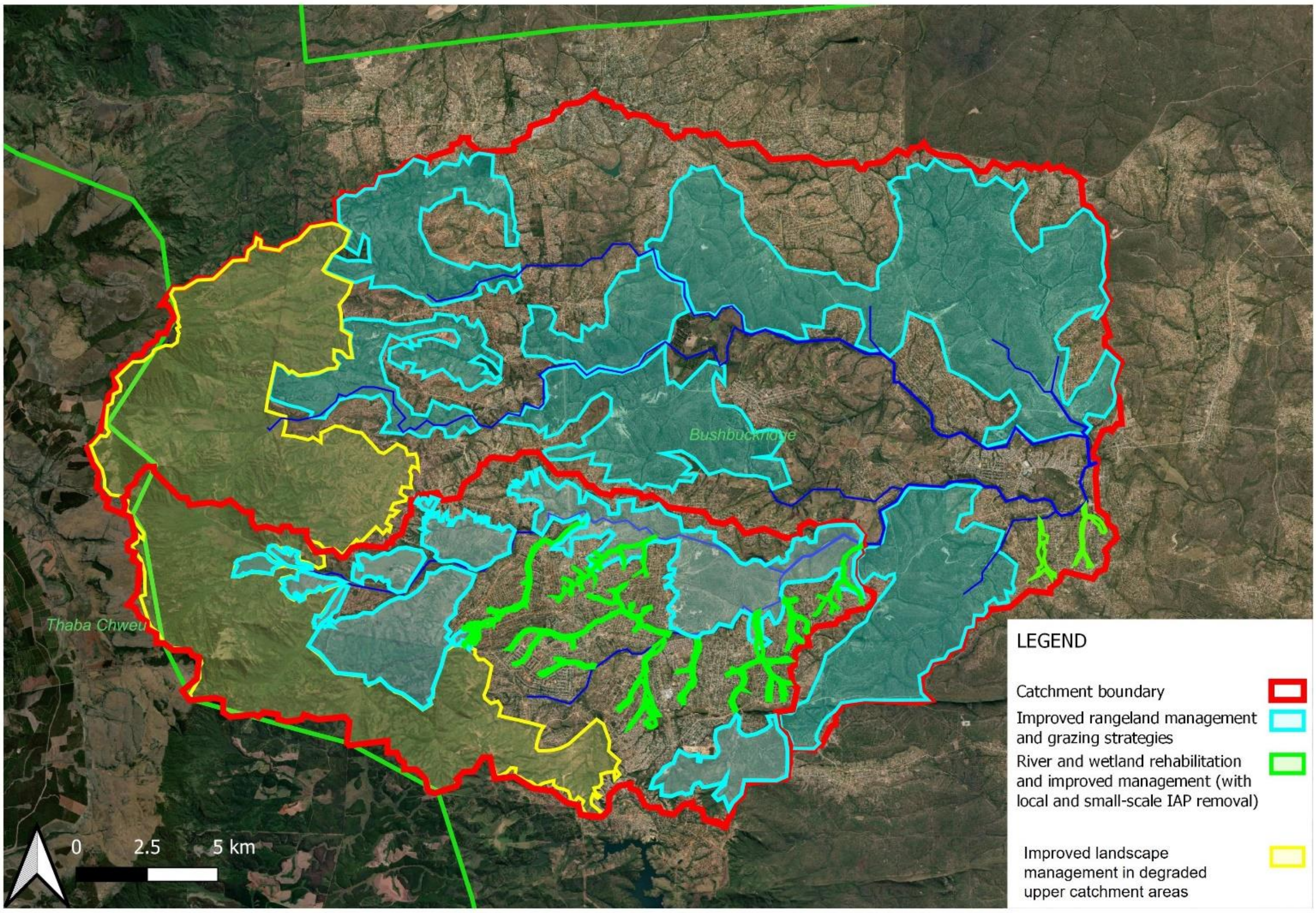

Figure 9-5: Recommended and mapped interventions within Ehlanzeni DM

Noting the challenges in the receiving environment within Ngaka Modiri Molema and Sekhukhune DMs, it is recommended that a demonstration approach be utilised while, over the duration of the project, ongoing efforts (supported by the demonstration) assist to build a more receptive and enabling environment for Eco-DRR. In effect, these interventions will then also support efforts to mainstream Eco-DRR and EbA approaches into municipal planning. These sites are as tested in the feasibility study but with some adjustments to the level of intervention and are shown in Figure 9-6 and Figure 9-7. Key points to note about these sites are:

- **Ngaka Modiri Molema DM**: The Mokgola area to the north of Zeerust will become increasingly water insecure with smaller communities being exposed to the extremes of droughts and floods. These communities are located downstream of the Klipspruit River with the upper catchment being significantly degraded. While the CBA assessment was not as strong as the other locations, this nevertheless provides a useful site for demonstrating the benefits of Eco-DRR and EbA, while building municipal capacity. Interventions will be able to explore the impacts of Eco-DRR interventions on the local road infrastructure, most specifically the R49. In addition, the Provincial DFFE: EP highlighted their increasing concern regarding the fragility of rangelands in this area, noting that this is also part of an area of increasing biodiversity concerns linked to migratory corridors through to Madikwe in the north.
- **Sekhukhune DM:** The concerns regarding the siltation of Vergelegen Dam remain, and as such, interventions in the upper catchment, largely focused on improved rangeland management, will provide useful demonstration of the

potential impacts that Eco-DRR can have on communities in this area - both from a water security perspective as well as from flooding during extreme events which do not get retained by the dam when it is full of sediment. There are extensive rangelands and old agricultural fields that, under improved management, can impact upon the dam and the CBA for this area justifies utilising this site to build municipal capacity through showcasing Eco-DRR impacts.

Table 9-5: Summary of proposed ecosystem restoration and rangeland management interventions in Ngaka Modiri Molema and Sekhukhune DMs[26]

Type of intervention	DM		Total (ha)
	Ngaka Modiri Molema (ha)	Sekhukhune (ha)	
Clearing of invasive woody alien plants		110.76	110.76
Improved rangeland management			
- Rotational resting and grazing	1558.00	12928.40	14486.40
- Rotational fencing	69.60		69.60
- Revegetation	69,60	28.19	97.79
- Zai Pits	180.00		180.00
Wetland and riverine rehabilitation			
- Brushpacks	9.16	23.40	32.56
- Vegetative strips	9.16	19.95	29.11
Total Area of Interventions	**1895.52**	**13110.70**	**15006.22**
Total Area of Land under Improved Management	**1558.00**	**12976.70**	**14534.70**

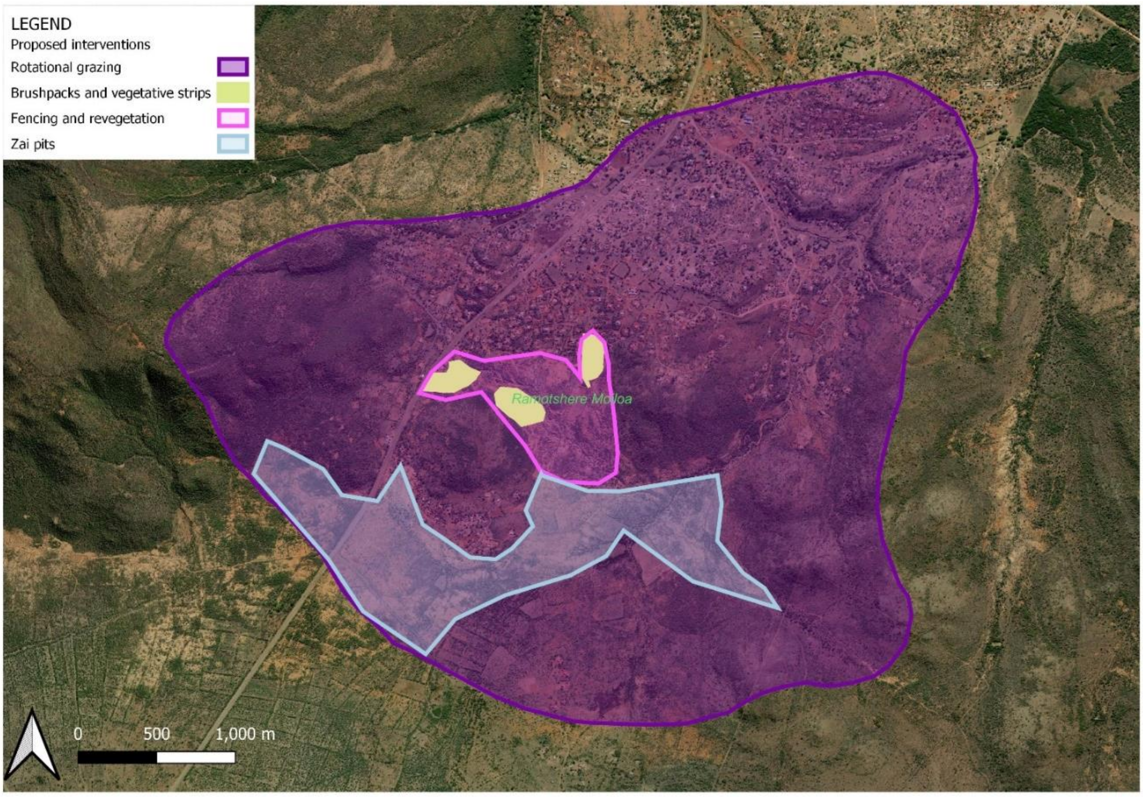

Figure 9-6: Recommended and mapped sites for Ngaka Modiri Molema DM

[26] The interventions and hectares presented in the table are indicative only and will be confirmed during the inception phase of the Eco-DRR project.

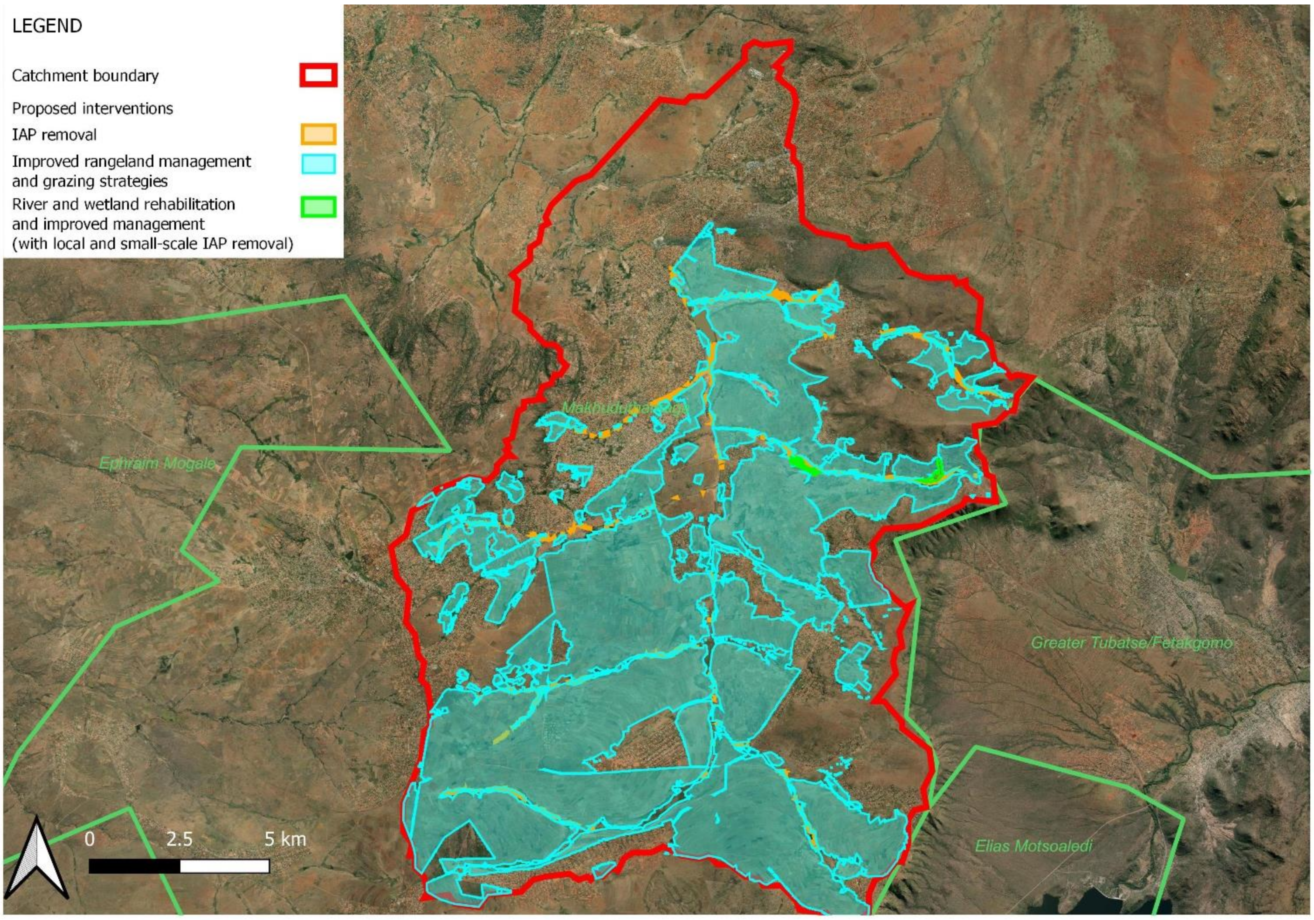

Figure 9-7: Recommended and mapped sites for Sekhukhune DM

Through these recommended site level interventions to restore ecosystem services, a total area of 68,010.29 ha would be under improved management. The number of direct beneficiaries, for these areas, are provided in Table 9-6.

Table 9-6: Direct beneficiaries from interventions to implement Eco-DRR through ecosystem service restoration[27]

DM	Number of Households	Total Number of People
Ehlanzeni	**62,281**	**249,124**
Female (52.8%)		131,537
Male (47.2%)		117,587
Alfred Nzo	**10,907**	**43,628**
Female (53.1%)		23,166
Male (46.9%)		20,462
Sekhukhune	**17,517**	**70,068**
Female (53.11%)		37,213
Male (46.89%)		32,855
Ngaka Modiri Molema	**817**	**3,268**
Female (51.31%)		1,677
Male (48.69%		816
Total	**91,522**	**366,088**

[27] To calculate the number of direct beneficiaries, the number of households in the sites were identified with this data being sourced from Eskom (2015). It is assumed that each household within these sites comprises of 4 people. Female and male numbers were determined by applying the percentage of male and female populations per LM (as per Statistics South Africa's 2022 Census) to the number of people per household.

To support the implementation of these interventions, staff will be required and thus jobs will be created. Typically, models to date have used staff on a part time basis or as part-time teams that service multiple areas. For the purpose of understanding the number of jobs created, Table 9-7 provides the level of effort (person days). This will provide the most significant opportunity for youth as well as young professionals, and will include equally a gendered approach.

Jobs will also be created through support to SMMEs and livelihoods. Resilient and sustainable economic frameworks for local communities will be strengthened through the introduction of gender-inclusive, ecosystem-based livelihood stacking strategies in the Alfred Nzo and Ehlanzeni DMs. These will enable local community members to secure and diversify their income sources, thereby reducing their vulnerability and improving their resilience to the adverse impacts of climate hazards. Through this activity, communities will be encouraged and capacitated to engage in economic activities that are both sustainable and complementary to the rehabilitation and sustainable land management.

Table 9-7: Employment creation through interventions to restore ecosystem services

DM	IAP Removal	Fencing	River and Wetland Rehabilitation	Revegetation	Brushpacks	Vetiver	Zai Pits	Rangeland Management	TOTAL
	Level of Effort (person days)								
Alfred Nzo	226 689		16 109					10 932	253 730
Ehlanzeni	70 407		59 015					27 403	156 825
Sekhukhune	10 744			2 734	33 298	9 018		13 852	69 646
Ngaka Modiri Molema		8 700		4 785	13 035	4 140	15 011	1 669	47 340

9.3 ECO-DRR FOCUSED DISASTER PREPAREDNESS AND PLANNING INTERVENTIONS

Improving the resilience of vulnerable populations and critical infrastructure against climate-induced hazards will require working with the various DMs and LMs, supporting Provincial Government departments, and a range of stakeholders to strengthen and improve the various strategies and planning instruments that underpin climate adaptation and support DRR. This does require that planning processes for built infrastructure solutions incorporate and integrate ecological infrastructure, as well as various and appropriate Eco-DRR interventions. To develop these, the necessary data collection and exchange protocols will require redress. During the analysis for this study, the lack of climatological and hydrological data was prohibitive and will need to be addressed to support the implementation of this project, as well as those to improve municipal scale planning and the design of appropriate infrastructural solutions. Data sharing and EWS are in their infancy in these more rural DMs where there is limited staff capacity and the lack of political will to prioritise these. The establishment of climate data-sharing protocols will also be supportive of developing accessible and fit-for-purpose EWS.

The policy and planning assessment provides a more detailed analysis of the instruments that DMs and LMs have in place. These are presented in a more comprehensive manner in Section 3. A more succinct summary of the planning environment within the DMs is provided in Table 9-8, which briefly considers how environmental aspects, climate change and/ or EbA are reflected. This shows that while all DMs have a range of planning instruments that look to climate-related risks, there is no recognition of EbA. The importance of environmental management - and in some instances ecosystem services - is mentioned. Master planning tools are wholly focused on built infrastructure. Hence the need to strengthen the integration of EbA and Eco-DRR into the various municipal planning instruments is prevalent across all 4 DMs.

Table 9-8: Summary of the inclusion of environmentally focused interventions in key planning instruments

DM	Overview of key planning instruments
Alfred Nzo	• The DDM One Plan emphasises the importance of environmental management, recognises the impact of climate change and the vulnerability of rural communities. No mention of EbA. • IDP notes actions to strengthen environmental management and the importance of the EPWP programme in supporting environmentally focused actions. • Disaster management plans note the importance of environmental degradation.
Ehlanzeni	• The DDM One Plan notes the need to protect biodiversity, water and agricultural resources and climate-proofing infrastructure. No mention of EbA. • IDP also notes importance of climate change and prioritises the development of an updated climate change adaptation strategy as well as an environmental management framework. • Wetland strategy and action plan developed. • Climate response plan recognises the importance of environment with specific mention of grasslands and their importance.
Ngaka Modiri Molema	• The DDM One Plan makes no mention of climate change but does recognise the importance of developing an environmental management framework as well as the challenges the DM faces with regards to DRM. • Latest IDP makes no mention of climate change or environmental conservation. • Climate response plan recognises the importance of ecosystem services.
Sekhukhune	• The DDM One Plan emphasises the importance of climate change but makes not linkages to environment or EbA. • IDP notes the importance of climate change and its impact on socioeconomic sectors. Notes unsustainable use of natural resources and its impact on biodiversity and ecosystem services, but no linkages to EbA or environmental management interventions. • Bioregional plan was developed to support environmental management and land use planning. Recognises ecosystem services.

9.3.1 Eco-DRR Focused Disaster Preparedness and Planning Interventions Recommendations

Through the workshops and project design discussions held, it is apparent that the Disaster Management Centres, that function at a district level, are typically under resourced and under capacitated. This presents significant logistical challenges when disasters occur, thereby placing lives and livelihoods at risk. This is particularly so for the more rural communities. In this regard, there are often poor communications and associated challenges that hinder rural communities from understanding the information relayed to them. There is a dire need to review and improve the manner in which early warning messaging is reaching communities. Additionally, there is little understanding of hazard avoidance practices.

It is therefore imperative that the project provides support to the 4 DMs to strengthen their EWS and the communications so that they are fit for purpose and are timeous to ensure communities vulnerable to climate change can avoid the loss of lives and livelihoods. The development of improved approaches to disaster preparedness provides a useful opportunity to share lessons and knowledge between the various DMs, and as such, SALGA will prove to be an invaluable partner to support capacity building. SALGA has also developed a suite of international partnerships that can be leveraged to bring in innovative approaches into the improvement of disaster preparedness.

Noting that the improvement of EWS at DM level will have impacts on all those people who reside within the DM, the number of indirect beneficiaries from these interventions, based on municipal reports (2022-2024), are given in Table 9-9.

Table 9-9: Number of indirect beneficiaries[28] across Alfred Nzo, Ehlanzeni, Ngaka Modiri Molema and Sekhukhune DM from improved EWS, communications and hazard avoidance practices

DM	Total Number of People
Ehlanzeni	**2,021,773**
Female (52.8%)	*1,064,324*
Male (47.2%)	*957,449*
Alfred Nzo	**892,833**
Female (53.1%)	*473,883*
Male (46.9%)	*418,950*
Sekhukhune	**1,266,737**
Female (52.9%)	*669,270*
Male (47.1%)	*597,467*
Ngaka Modiri Molema	**934,455**
Female (51.1%)	*477,472*
Male (48.9%	*456,983*
Total	**5,115,798**

Climate change and its impact of future hazards as well as the importance of ecosystem services in reducing the impact of these hazards, needs to be mainstreamed into all planning instruments. The varying levels of quality of these planning instruments regarding DRR also requires attention. Undertaking actions to strengthen planning across all 4 DMs will be imperative, with a focus on learning from the LMs where site level interventions will take place.

It is imperative that the importance of ecological infrastructure and associated ecosystem services is mainstreamed into planning instruments and especially into built infrastructure plans. Working with the DMs and LMs to identify critical built infrastructure where the integration of ecological infrastructure can improve climate resilience is key. Equally, integrating ecological infrastructure into new build plans is also a vital area of the Eco-DRR project to address. Supporting this will also build institutional capacity and will enable the transfer of these skills to other LMs.

This feasibility report has considered the enabling environment in which the project interventions are best suited to take place and the Eco-DRR project will ensure that the project placement is appropriate with the municipality's needs. It should be noted that provinces and municipalities in the country have their own spatial planning bylaws, disaster management policies and environmental regulations, tailored to local needs and contexts. Prior to commencement of proposed project activities, a thorough desktop review of any relevant provincial legislation and municipal by-laws in the targeted district and LMs must be done. Examples of the kinds of laws that may be relevant to the Eco-DRR project include by-laws related to stormwater management, spatial planning, biodiversity, waste management, fire safety, DRM and others. By-laws may require any person undertaking activities in that area to obtain a consent, authorisation or license before doing any work in that jurisdiction. The municipal and provincial officials should therefore be engaged in the early stages of the project to determine whether any applications should be made by the consultants of the Eco-DRR project, with the view to obtaining

[28] The number of direct beneficiaries for Outcome 2 considers double counting and excludes the direct beneficiaries counted for Outcome 1. Data sourced from https://census.statssa.gov.za/assets/documents/2022/Provinces_at_a_Glance.pdf

necessary permissions to undertake work in the area. If consents, authorisations or licences are required, then the turnaround for obtaining these permissions must be factored into the timeframes of the Eco-DRR project to ensure that there are no undue delays.

The Green Book is pivotal in helping South African municipalities understand and mitigate climate risks, contributing to the country's broader developmental goals. This tool provides critical, policy-relevant evidence that helps local governments integrate climate change considerations into their planning processes, enhancing resilience and promoting sustainable development. The Green Book has been widely used since its launch in 2019 and many sectors of government have come to depend on the information it provides. The fundamental data on which the evidence in the Green Book pivots, are socioeconomic and climate data. The Stats SA National Census 2022 has now been released and the Coupled Model Intercomparison Project Phase 6 (CMIP6) is also now available. Furthermore, there have been improvements in the approach to adaptation and these also need to be updated in the tool.

As this tool's primary aim is and remains to aid the public sector in integrating and prioritising climate change considerations within municipal planning for human settlements, providing support to get the Green Book updated and strengthened is important to support resilience building.

9.4 UPSCALING PATHWAYS FOR ECO-DRR

Within the environmental policy frameworks, the importance of climate change and EbA is clearly noted, yet in sectoral-based policy instruments this is less so. In South Africa, the impacts that climate change will have on the social economy and environment are broadly understood, but this has yet to mainstreamed into policy, strategy and planning within these key developmental sectors. As a result, the DFFE lead on most EbA activities such as IAP clearing, restoration and rehabilitation, which is primarily funded through the national budget and the EPWP. While public finance has provided essential seed finance for such EbA programmes, there is growing understanding that these funds should continue to be used to leverage additional sources of finance to develop a more sustainable financing model. Public funds should increasingly be utilised for unlocking technology, driving efficiencies and assisting to de-risk direct private sector investment. The development of blended finance solutions and other innovative mechanisms can then be used to create economic opportunities and jobs through the upscaling of Eco-DRR and EbA activities, and associated value chains.

The Draft National Biodiversity Economy Strategy (2024) places emphasis on the need to develop the biodiversity economy to promote conservation and species and ecosystem management. However, Death (2014) and McLean (2018) have noted that progress has been slow, commitment shallow, and efforts incoherent with regards to development of the green economy (Death, 2014; McLean, 2018). Private sector investment in EbA initiatives faces several barriers but particualrly the lack of evidence demonstrating the financial benefits of investing in ecological infrastructure and its services is essential to address. As such, the Eco-DRR project is seen as catalytic in not only coherently developing that evidence base but also in developing a suite of business cases that provide opportunity to efficiently upscale these interventions. Importantly, the data and information gathered through the site level Eco-DRR interventions, will be key in developing that evidence base.

Furthermore, the experience of organisations such as the NBI, the Sustainable Finance Coalition, Meat Naturally and a range of others can be leveraged to develop these business cases.

While there are opportunities linked to IAP removal through such value chains as biochar, and the growing of grasses such as vetiver to support with slope management and soil erosion, the increased revenue streams from improved livestock productivity are likely to form the basis of the business cases to present to private sector investors. However, from the analysis of the revenues from carbon credits, possible ecotourism and biodiversity credits could also be significant factors in certain landscapes. It will be important, through this project, to assess these opportunities for introducing such financing mechanisms. Analyses will be required to show how critical variables like change in livestock productivity, price of livestock commodities, price and number of carbon credits, and price and number of biodiversity credits influence the overall business case and the supporting cash flow models.

The analysis above has outlined that opportunity exists in the Voluntary Carbon Market as well as the upcoming Article 6 compliance market. As noted, the Johannesburg Stock Exchange (JSE) has established the JSE Venture Carbon Market and this could be leveraged. The Article 6 compliance market is still under development but is likely to become a multi-billion-dollar industry during the proposed GCF project's timeframe. Therefore, it is important for the Eco-DRR project to engage with policymakers to ensure that the government's policies are conducive to attracting investment into managing the country's rangelands and grasslands to be resilient to climate change impacts.

The international biodiversity credit market is, like the compliance carbon credit market, still under development and relatively nascent. There are, however, indications that this market is growing rapidly in size , and there is likely to be scope for including revenue streams related to the sale of biodiversity credits in the business cases developed by the project. In South Africa, Value Nature has done useful work in this regard and this can be leveraged. Likewise international funders would be interested should the busines case be attractive and should the South African government clarify a range of policy issues. It is consequently important that the Eco-DRR project quantifies the biodiversity benefits of indigenous practices in a rigorous manner.

Certainly the site level Eco-DRR interventions will provide the evidence and the initial conceptual design of these investment models, providing for a range of business cases. It is clear that as these are developed there is meaningful opportunity to learn from other sites across the country thereby developing a Community of Practice that goes beyond the geographic spread of the current sites and a broader suite of actors. Undertaking assessments of the viability of projects across a wider swathe of projects, over the duration of the project, then supported by catalytic investments to seed these projects will undoubtedly provide the direction and momentum to upscale investments in Eco-DRR.

It must be emphasised that through the course of the project design and the undertaking of this feasibility study, that the paucity of data and information has been constrictive and will further hinder the ability to plan Eco-DRR interventions and support the development of well-conceived business cases. It will be essential for the Eco-DRR to address these information generation and management challenges. Noting the potential for upscaling investments in natural capital through such mechansisms, it will be important for the Eco-DRR project to support approaches to impove the collection of data and information that underpins decision making. The project must support the comprehensive gathering of biophysical, social and economic data that will enable the modelling of selected ecosystem services, facilitating their valuation, and thereby supporting the determination of risks to populations, economic growth, financial markets, and the environment.

9.4.1 Upscaling Pathways for Eco-DRR Recommendations

Developing a viable business case to support investment in Eco-DRR will need engagement with the South African government regarding a range of policy matters that will require clarification. Whilst there is tactic support for the development of the biodiversity economy as outlined in the Draft National Biodiversity Economy (2024), there are various aspects to be addressed. As such, these need to be clarified to facilitate private sector investment. This discourse is complex and politically challenging and project design must recognise that this requires dedicated time and effort.

While these policy related matters are being resolved there will be opportunity to meet with a range of private sector investors to alert them to the project and the potential that this holds. This market sounding will also assist in the above-mentioned discussions with the South African Government by providing issues of concern and core elements of risk that financiers will want resolved.

The site level interventions outlined as part of the project design will provide a rich evidence base which will support the development of business cases that can be utilised to garner investment support. It is clear from this feasibility study that there are sites where Eco-DRR related activities are already underway (albeit piecemeal) and where the potential exists for upscaling. In this regard, it would strengthen the development of these business cases to pull together a wider pool of evidence and insight – both within the selected DMs or beyond. As such, it is recommended that the project design investigate, during its inception / start-up phase, sites where evidence and experience can be drawn to strengthen the development of these business cases.

Once the business cases have been developed, it would be useful to explore further sites where these could be implemented. Noting the Community of Practice that would have been developed, these could be fairly swiftly accessed. These will have to be assessed and the business case for these could then be tailored accordingly. The hosting of another market sounding would be important to endeavour to match projects with financiers. The development of a project prospectus would support this. A process for assessing this and the need for investment would need to be designed.

The data, information and knowledge gaps are significant. The data and information needed to support Eco-DRR and EbA will be clarified during the site level interventions, and the lessons from this will need to be shared with the key government departments and agencies in order to develop improved monitoring networks, better information management systems and revised data sharing protocols. This will require attention at national levels to support the development of Natural Capital Accounts, as a key priority for the government in driving towards better-informed decision making.

Knowledge exchange is critical noting that much of the information and knowledge regarding Eco-DRR and EbA is disparate and not necessarily coherent. The development of a knowledge hub will be a key step forward for promoting and mainstreaming Eco-DRR.

9.5 RECOMMENDED PROJECT INTERVENTION LOGIC

Based on the findings of this Feasibility Study, recommendations for the Eco-DRR project's intervention logic can be made. The overall goal of the project is to undertake Eco-DRR by building the social preparedness and economic resilience of rural and peri-urban communities to the increased intensity of droughts, floods and wildfires across South African. This will be achieved by undertaking interventions that develop the capacity of rural and peri-urban communities and the evidence base for Eco-DRR interventions, while working with the South African government to upscale the implementation of state-of-the-art Eco-DRR practices. It must be understood that there may be a lag between the undertaking of landscape focused interventions and the realisation of DRR and various socio-economic benefits. The nature and timing of this delay in beneficiation will be a key part of the evidence base derived and will impact on short term risk profiles of these communities. Addressing early warning response and preparedness approach are therefore important for community resilience. The development of pathways to upscale private sector investments will be essential in providing a more sustainable financing environment that will underpin the upscaling of Eco-DRR. This will require an engaged approach between government, private sector and civil society partners to both develop and implement, as well as the necessary evidence base to support decision making.

As such the intervention logic for the Eco-DRR project needs to be inclusive of the following core concepts which surface through the discussion across this Feasibility Study (Figure 9-8):

- Rehabilitation of vulnerable catchments and landscapes to reduce the risk of droughts, floods, and wildfire;
- Participative institutional and community structures are supported and strengthened to sustain and upscale Eco-DRR interventions;
- Municipal and Community preparedness for flood, droughts, floods and wildfire hazards improved in focal landscapes;
- EBA and Eco-DRR approaches integrated into policy and planning for DRR; and
- Sustainable blended finance mechanisms are unlocked to sustain and upscale Eco-DRR.

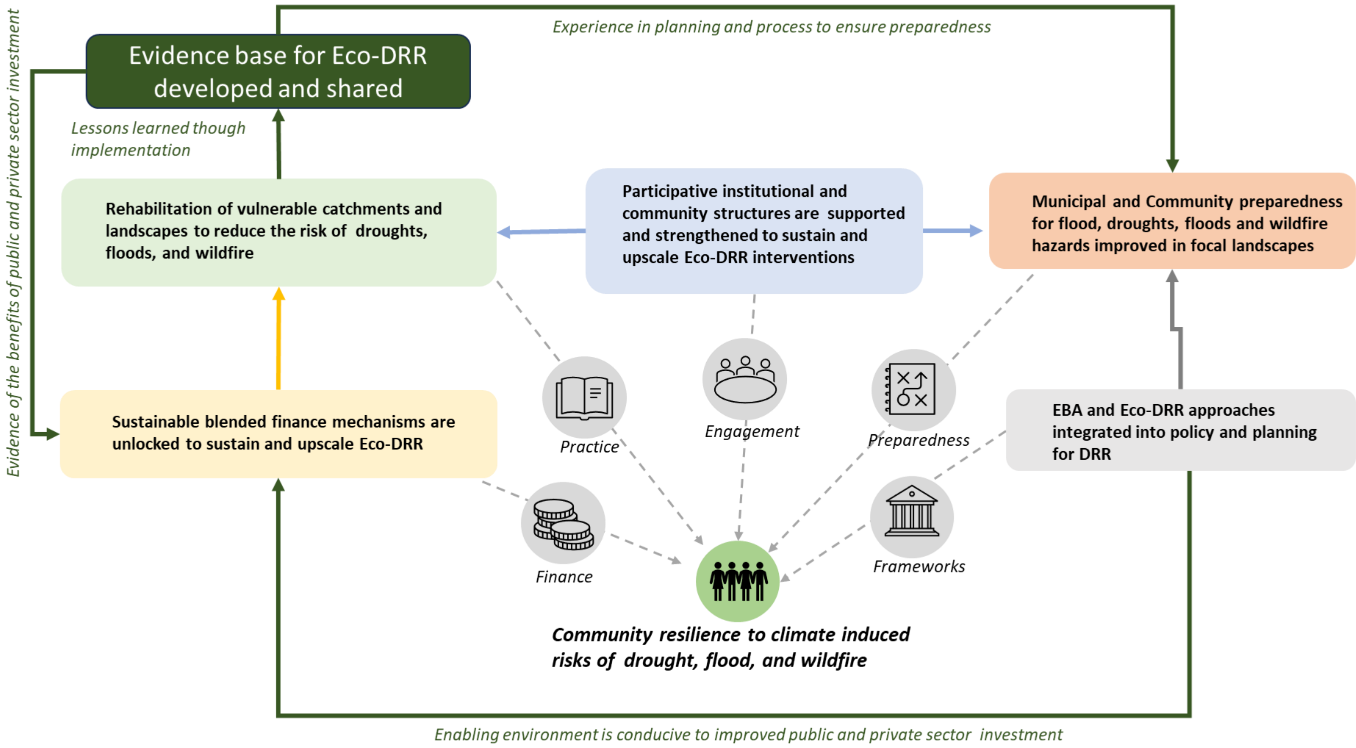

Figure 9-8: Core conceptual components required for upscaling Eco-DRR

To build climate change resilience and reduce the vulnerability of communities through tackling these components, the Eco-DRR project will principally need to:

- Invest in locally led, coordinated and cross sectoral interventions at national, sub-national and local levels that build capacity and agency for Eco-DRR responses to climate change;
- Strengthen landscape management and disaster preparedness and response tools and approaches in support of integrated Eco-DRR;
- Support intentional practices that draw on science and local knowledge, and are disruptive of gender-based discrimination; and,
- Adopt social learning processes to develop a strengthened evidence base for that informs implementation and for securing public and private sector investment in a scaled programme of work.

Based on the feasibility study the recommended project design is a presented in Figure 9-9, with a more detailed ToC being presented in the Funding Proposal.

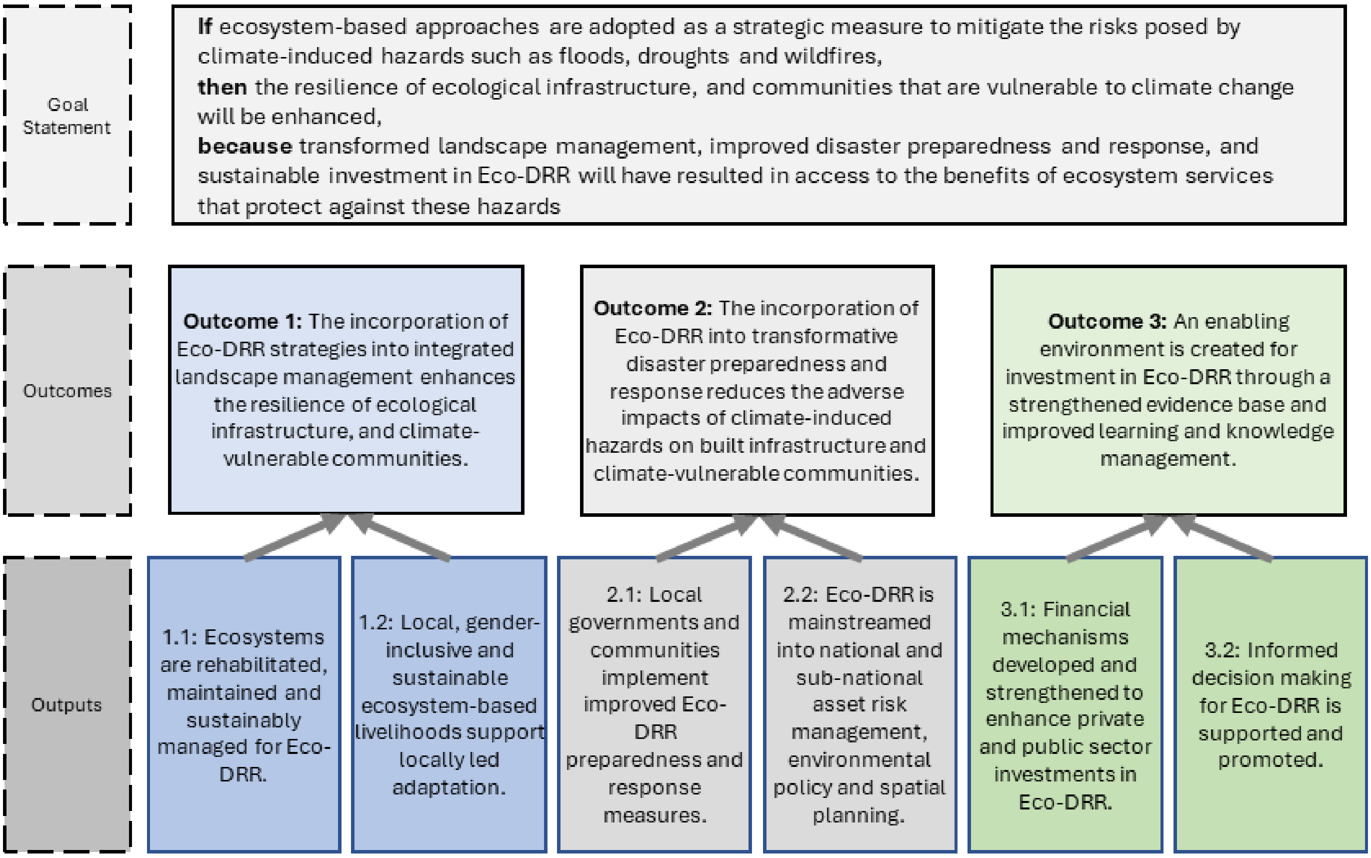

Figure 9-9: Eco-DRR project design

Outcome 1 will support the incorporation of DRR strategies into integrated landscape management towards enhancing the resilience of ecological infrastructure and climate-vulnerable communities. through a site-based programme of work that improves ecosystem condition and supports locally led adaptation. The site-based landscape management interventions will be complemented by investments in locally led adaptation through the development of resilient and sustainable economic frameworks for local communities, that introduce gender-inclusive, ecosystem-based livelihoods stacking strategies. This will enable local community members to secure and diversify their income sources, thereby improving their resilience to the adverse impacts of climate hazards.

Outcome 2 will support the incorporation of Eco-DRR into transformative disaster preparedness and response and the mainstreaming of Eco-DRR approaches into asset risk management, environmental policy and spatial planning processes. This will need to include national and sub-national policy, planning and budgetary processes. Supporting a range of technical interventions that are embedded at the sub-national level, and that build both institutional capacity and the evidence base for these approaches will be essential. Actions to capacitate local governments and municipalities with the tools and knowledge to effectively develop and implement Eco-DRR strategies will be critical to ensure sustained implementation support.

Outcome 3, will overcome barriers by creating an enabling environment for investment in Eco-DRR through a strengthened evidence base and improved learning and knowledge management. This should be done by developing, strengthening and promoting financial mechanisms to enhance private and public sector investments in Eco-DRR. It will also support the development of a business case for a transformed operational model for public sector employment and associated investments in natural resource management and Eco-DRR, that is informed by the activities of Outcome 1.

Noting the barriers linked to weak institutional capacity and the importance of an evidence base to support adaptive management and make the case for future investments, this Outcome will also support the consolidation of the data and information needed for decision making. This will be supported by the development of knowledge products and an information dissemination campaign. Working across all four DMs and at national levels, the roll out of the project level social learning process will enable the exchange of lessons to further enrich the knowledge base the project develops.

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