# DAM ENGINEERING AND SOCIO-ECOLOGICAL SYSTEMS FINANCING THE PREVENTION AND MITIGATION OF SILTATION REPORT

*J van Zyl, A Eilers, A Cartwright*

National Dam Siltation Management Programme

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

WATER RESEARCH COMMISSION

3007/1/21

# NATIONAL DAM SILTATION MANAGEMENT PROGRAMME (NATSILT)

## DAM ENGINEERING AND SOCIO-ECOLOGICAL SYSTEMS

## FINANCING THE PREVENTION AND MITIGATION OF SILTATION REPORT

Report to the

**Water Research Commission**

By

J van Zyl, A Eilers, A Cartwright

Zutari and Econologic

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**Private Bag X03**
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# Accronyms and Abbreviations

| Term | Definition |
|---|---|
| AFDB | African Development Bank |
| ARC | Agricultural Research Council |
| BGCMA | Breede-Gouritz Catchment Management Agency |
| BRIP | Berg River Improvement Plan |
| CARA | Conservation of Agricultural Resources Act |
| CBO | Community-Based Organisations |
| CMA | Catchment Management Agency |
| CSI | Corporate Social Investment |
| CUC | Capital Unit Charge |
| DALRRD | Department of Agriculture, Land Reform and Rural Development |
| DBSA | Development Bank of South Africa |
| DFFE | Department of Forestry, Fisheries and Environment |
| DFI | Development Finance Institution |
| DMRE | Department of Mineral Resources |
| DOA | Department of Agriculture |
| DPWI | Department of Public Works and Infrastructure |
| DWS | Department of Water and Sanitation |
| EI | Ecological Infrastructure |
| EPIP | Environmental Protection and Infrastructure Programmes |
| EPWP | Expanded Public Works Programme |
| ESG | Environmental, Social, Governance |
| FIBC | Future Infrastructure Build Charge |
| GCF | Green Climate Fund |
| IAP | Invasive alien plant |
| IB | Irrigation Board |
| IBDR | International Bank for Reconstruction and Development |
| IDA | International Development Association |
| IDP | Integrated Development Plan |
| IUCMA | Inkomati-Usuthu Catchment Management Agency |
| IUDG | Integrated Urban Development Grant |
| KOBWA | Komati Basin Water Authority |
| MFI | Microfinance Institution |
| MIG | Municipal Infrastructure Grant |
| MPRDA | Mineral and Petroleum Resources Development Act |
| MTEF | Medium-Term Expenditure Framework |
| NatSilt | National Dam Siltation Management Strategy |
| NEMA | National Environmental Management Act |
| NGOs | Non-Governmental Organisations |
| NRM | Natural Resource Management |
| NW&SMP | National Water and Sanitation Master Plan |
| NWA | National Water Act |
| NWRIB | National Water Resources Infrastructure Branch |

| | |
|---|---|
| NWRS | National Water Resource Strategy |
| ORASECOM | Orange-Senqu River Commission |
| PES | Payment for Ecosystem Services |
| RBIG | Regional Bulk Infrastructure Grant |
| RQO | Resource Quality Objectives |
| RWQO | Resource Water Quality Objectives |
| SAAFWUA | South Africa Federation for Water User Associations |
| SALGA | South African Local Government Association |
| SANBI | South African National Biodiversity Institute |
| SANParks | South African National Parks |
| SANRAL | South African National Roads Agency SOC Ltd |
| SMME | Small Medium and Micro Enterprises |
| SP | Sub-Project |
| TCTA | Trans-Caledon Tunnel Authority |
| TNC | The Nature Conservancy |
| WDCS | Water Discharge Charge System |
| WSIG | Water Services Infrastructure Grant |
| WB | World Bank |
| WCWDM | Water Conservation and Water Demand Management |
| WSDP | Water Services Development Plan |
| WfW | Working for Water |
| WMA | Water Management Area |
| WRC | Water Research Commission |
| WRIC | Water Resource Infrastructure Charge |
| WRMC | Water Resource Management Charge |
| WUA | Water Users Association |

# Glossary of Terms

| | |
|---|---|
| Basin | The dam basin is that area or volume behind a dam wall that can be filled with water. It is often interchangeably used with “reservoir”. Note that the word “basin” in American English, is also often used as being synonymous with “catchment area” but that is not the case in this text. |
| Catchment | An area of land where all water drains naturally to a single stream, river or dam. |
| Dam | An artificial structure or wall used to impound water or regulate flow. |
| Reservoir | A large natural or artificial basin or lake in which a large volume of water can be stored |
| Sedimentation | The process whereby sediment is deposited or settled out of a water body in which the sediment is entrained. |
| Siltation | Sediment related pollution referring to the increased concentration of suspended sediment and the increased accumulation of fine sediment of water bodies. |

Note: The words “siltation” and “sedimentation” are used interchangeably in this report. It is, however, noted that the project brief makes regular reference to the word “siltation” even though the more correct term to describe the process is called “sedimentation”.

# 1 Introduction

## 1.1 Assignment overview

The Water Research Commission (WRC) appointed Zutari (Pty) Ltd to lead the development of the National Dam Siltation Management Strategy (NatSilt), Sub-Project 2 (SP2): Dam Engineering and Socio-Ecological Systems. Funding for the project was provided by the Department of Water and Sanitation (DWS) who is also the end client and main beneficiary of the study.

## 1.1. Project context

The overall aim of the NatSilt programme as a whole is to develop a strategy for the control and management of dam sedimentation in South Africa. Most dams have a limited viable lifespan due to sedimentation. Globally, storage losses due to sedimentation range from 0.3% per year to 1% per year (ICOLD, 2009a).

The overarching objective of the NatSilt programme is to produce tools and know-how to arrest the situation and mitigate future increases in sedimentation through the deployment of social, economic, technological, engineering and management tools and systems."

The programme's objectives are as follows:

1. Development of a Sedimentation Management Strategy and related tools for dams;
2. Piloting of the draft Strategy, Models and Tools for finalisation; and
3. Review and revision towards a final Strategy, with relevant models and tools.

Within the overall programme, four sub-projects are being managed, integrated and delivered to meet the desired objectives.

1. Sub-project 1 (SP1): Strategy development
2. Sub-project 2 (SP2): Dam Engineering and socio-ecological systems
3. Sub-project 3 (SP3): Sustainable Dam Dredging
4. Sub-project 4 (SP4): Training and Capacity Development

Sub-project 2 specifically aims to develop a set of tools and guidelines to be used by dam sedimentation managers in future to control the impact of sedimentation. The main premise is to expand the footprint of dam management to encompass all upstream activities. This sub-project is sub-divided into the following main tasks:

- Task 1: Project inception
- Task 2: Literature review
- Task 3: Dam storage classification
- Task 4: Dam operations model
- Task 5: Institutional and finance guidelines
- Task 6: Pilot testing
- Task 7: Reporting
- Task 8: Project management

## 1.2. Report objective and structure

This report builds on the information presented in Report No 1001032/12602 (i.e. the Institutional Report). Once the problem of dam siltation is recognised, water resource managers are confronted with the challenging task of financing siltation prevention, mitigation and removal measures. Hence, the objective of this report is to analyse funding, finance and cost recovery options for sediment management interventions.

*Section 2* develops a motivation for investing in sediment management in South Africa.

*Section 3* presents an assessment of the economic case for siltation management, particularly regarding blended finance and also considering the co-benefits.

*Section 4* presents possible funding mechanisms for siltation management interventions in South Africa. These have been broadly divided into the following sub-sections:

- Financing siltation prevention interventions, from both public and private sources.
- Financing siltation management interventions, from both public and private sources.

*Section 5* provides an evaluation of who should be responsible for implementing the different interventions.

*Section 6* presents a summary of conclusions and recommendations.

# 2 The case for investing in siltation management

## 2.1 The economic case for siltation management

The landscape is naturally eroding and the sediment cycle is closely linked to the hydrological cycle. Dams trap sediment entrained in inflows and interrupt the continuity of sediment transport through rivers. Trapped sediment results in the loss of storage and reusable life for the reservoir which intensifies the risk of water scarcity. This is particularly prevalent in South Africa, given the over-allocation of water in many catchments and high reliance on surface water resources. Erosion also deprives downstream reaches of sediment essential for channel form and aquatic habitats (Kondolf et al., 2014).

The traditional discourse on sediment problems focused on increased erosion and sediment loads from poor land use (Walling, 1999). However, most rivers have shown a decrease in sedimentation rates because of trapping by upstream dams (Walling and Fang, 2003). In line with the global trends, many storage reservoirs in South Africa have experienced ongoing loss of capacity as a consequence of high sediment yields within their catchment areas. Sedimentation rates have generally declined since the 1950s as livestock densities have decreased. There is, however, some evidence of recent increases in sedimentation rates, possibly due to more intense rainfall events or the encroachment of peri-urban settlements into water supply catchments.

A 2016 assessment by the CSIR estimated 9% (2.3 billion $m^3$) of South Africa's dam storage capacity has been lost to sedimentation to date. In some catchments, the absolute rates of dam sedimentation are extremely high – Shongweni Dam (62.2%) and Hazelmere Dam (26.1%) in KwaZulu Natal are among South Africa's major dams known to be worst affected (CSIR, 2016). Almost 25% of the total number of South African reservoirs that were analysed had lost between 10% and 30% of their original storage capacity, which equates to an estimated mean annual loss in original storage capacity of 0.4% per year (Msadala and Basson, 2017). Although below the estimated global reservoir sedimentation rate (0.8% per year) (ICOLD 2009a), loss of dam storage capacity in a country that is frequently water-stressed, constitutes a major environmental and economic concern. South Africa has high levels of water impoundment and already allocates most available water for domestic and agricultural use. As such, the loss of storage capacity in reservoirs, the loss of topsoil that can hold water and the degraded water quality that accompanies erosion, all threaten water security. Figure 2-1 provides an estimated prediction of the storage loss in reservoirs due to sedimentation up to 2050.

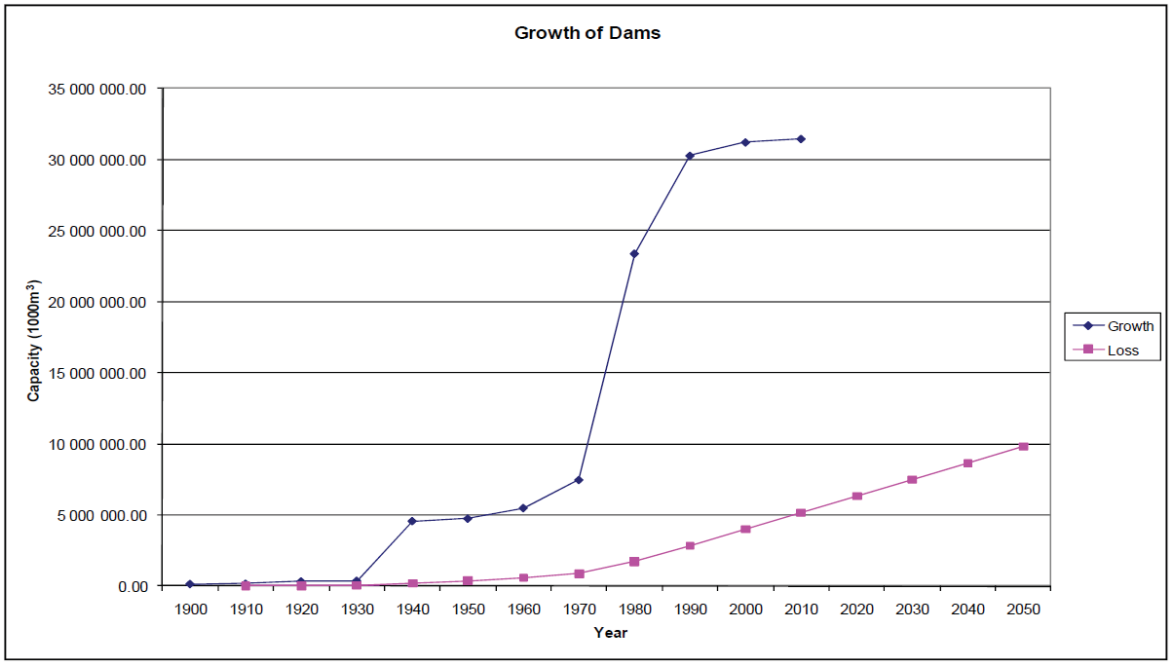



**Figure 2-1: Predicted reservoir sedimentation in South Africa (ICOLD, 2009b)**

Although erosion is a natural process, it is accelerated by human activities. Erosion has negative impacts on soil productivity, water quality and reservoir storage capacity, and there has been significant focus on the issue by the government with regards to erosion as a form of land degradation. The government's focus on land degradation originated in the early part of the 20th century for the arid parts of the country where observed declines in vegetation cover and associated soil loss were attributed primarily to overgrazing (Boardman, 2012). This view was encouraged by Acocks (1953), with a primary focus on the Eastern Cape. The first national review of the veld and soil degradation by Hoffman et al. (1999) and subsequent work by Hoffman and Todd (2000) and Hoffman & Ashwell (2001) concluded that soil and veld degradation was greatest in "communal areas" and the result of concatenated environmental, political and economic factors. Their work is important to this study in that it traces the source of dam sedimentation not just to land-use, but to the underlying social, economic and political factors that influence land-use.

During the past three decades the Agricultural Research Council (ARC) and the Water Research Commission have funded national research projects aimed at quantifying the spatial variability of sediment yield and its causative processes. In a seminal study, Rooseboom et al. (1992) compiled a Sediment Delivery Potential Map for Southern Africa, using Geographical Information Systems. The Rooseboom study was followed by further research into the spatial extent of erosion, culminating in the Erosion Susceptibility Map (Pretorius, 1995) and the Predicted Water Erosion Map (Pretorius, 1998). These national perspectives were further extended by the Land Degradation Review undertaken by the South African National Biodiversity Institute (SANBI) (Garland et al., 2000). Msadala et al. (2010) updated the Sediment Delivery Potential Map by incorporating much additional data and new soil erosion hazard maps, as well as employing new estimation techniques. The resulting research output and tools, documented in "Sediment Yield Prediction for South Africa" are valuable for large-scale estimates, but lack the definition necessary to support reservoir-related decision-making at a local scale.

## 2.2 The challenge of valuing natural capital

Most efforts at sedimentation prevention in South Africa have focussed on the effective management of land-use, vegetation types and vegetation cover – which are often termed "ecological infrastructure" or "nature-based" solutions. Cost-benefit analyses of ecological infrastructure (EI) approaches in South Africa have tended to track additional water yield as a proxy for benefits that arise from investing in catchments.

Crookes and Blignaut (2019) reviewed studies of 37 South African restoration projects, and focused on the impact on food, water, and biodiversity. They found that the cost of investing in land restoration was often significantly lower than the income derived from the direct and indirect economic benefits of these interventions. This opportunity cost associated with EI investments where the benefit of the investment exceeds its cost presents a strong case for valuing natural capital. However, it is very difficult to give an exact value or cost to this benefit. The study calculated that the cost of not restoring degraded land for the 37 study sites ranges between R400 and R6,100, per hectare per year. This broad range implies that these interventions could have a high opportunity cost and present a strong economic case, or not.

The study considered management interventions ('restoration methods') which targeted the clearing of alien invasive plants, non-clearing related restoration (e.g. wetlands, gullies, reseeding / replanting of denuded areas) and also restoration related to agricultural / game / wildlife management systems, all of which would have an impact on the sedimentation of dams. More specifically, the study found simply reseeding and replanting eroded gullies avoided a loss of R800 per hectare while invasive alien clearing and reseeding and replanting avoided losses of R6,200 per hectare. Hence, the case for investing in siltation management is persuasive.

When focussing on water, the value of redeemed water varies depending on "water for who, when and where". An additional cubic metre of water is worth roughly R0.05 in tariff revenue for a Catchment Management Agency, roughly R20 in sales revenue to a metropolitan municipality, R100 if that water prevents the need for a new desalination plant (levelized costs) and possibly over R1,000 (or more) if that water prevents the destruction of an orchard in a drought. Furthermore, these values do vary depending on the location, and the cost of alternative sources. It is possible that the same $m^3$ of water can deliver on a number of these values simultaneously.

The subjective value given to water, combined with the fact that this value often accrues to multiple people in different ways, means that even when the opportunity cost of sedimentation is factored into decision making, the cost tends not to translate into projects or activities that enhance sedimentation prevention. Effective analyses of the merits of sediment management will consider not just additional water yields, but both the economic-financial benefits and the co-benefits to general society. These include job creation and improved livelihoods, that cannot be directly converted into return on investment benefits.

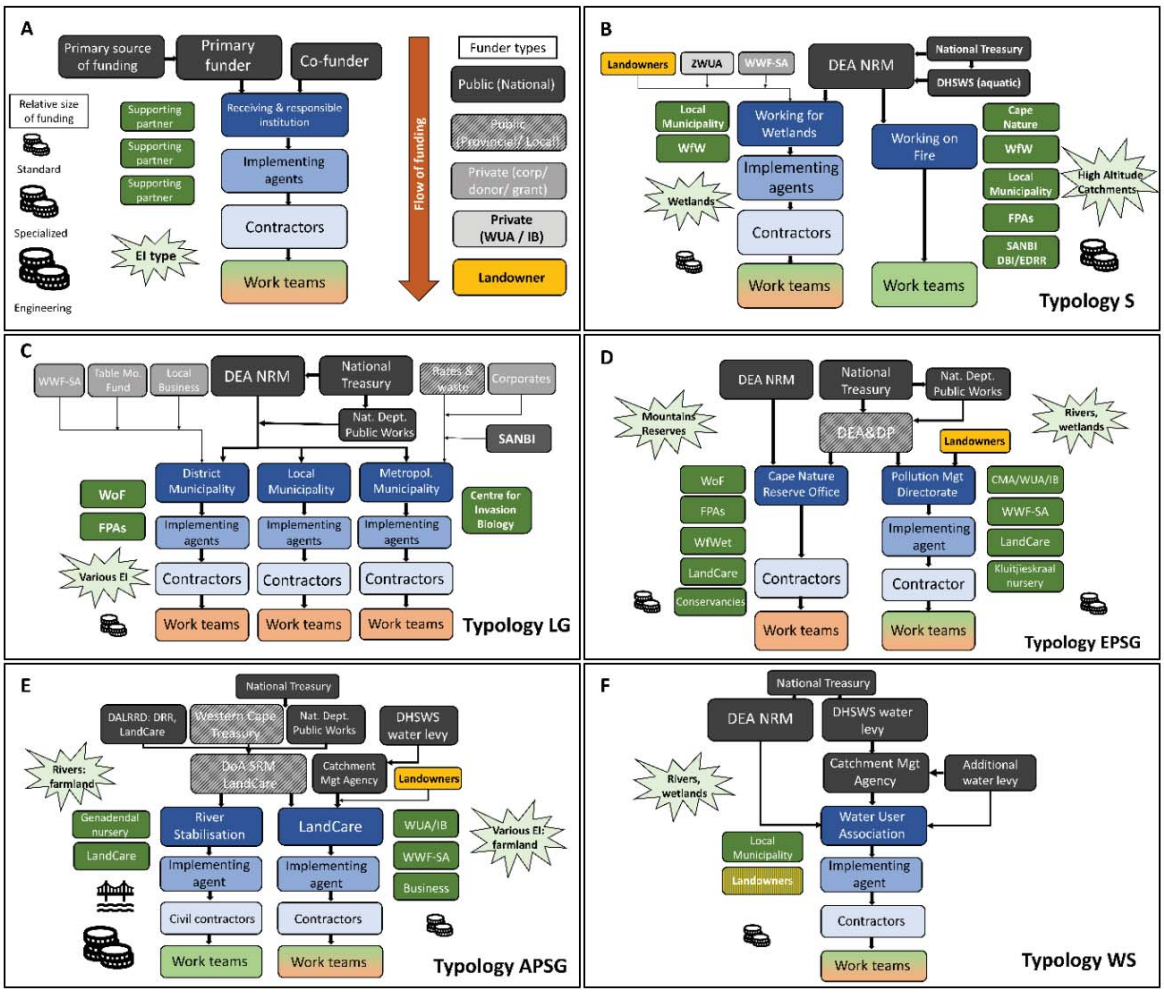
Mitigation measures to prevent soil erosion have proven difficult to finance and implement globally. Commenting on damage caused by "muddy flooding" on the South Down's in the United Kingdom, Boardman (2020) observed, "*Mitigation measures to control runoff and prevent flooding are widely discussed but, in general, not put into practice. Learning from these experiences was tortuous and uncertain and it is still unclear if the lessons were sufficiently absorbed to prevent a recurrence…*". The dislocation between upstream sediment sources and downstream sites of physical impact, as well as the influences that confound attribution between these sites, are two of the reasons given for the difficulty to implement ecological infrastructure measures.

# 3 Financing siltation management

Integrated water resource management (IWRM) is a founding principle of South Africa's National Water Act (Act 36 of 1998). The Act recognises the importance of functional catchments, but implementation of the Act is undermined by financing challenges. A key part of the difficulty in implementing the Act has been the inability to unlock the synergies between sustainable catchments and water security by enforcing compliance with the Ecological Reserve and by adequately applying water-pricing instruments such as the Water Resource Management charge, intended for use in "maintenance and restoration of ecosystems" among other things.

As Young (2005, p.7) points out, "*No single magic number represents the economic benefits of water……..the price signals that reflect scarcities for goods and services are usually absent or distorted for water, complicating public sector decision making*".

Midgley et al. (2021) addresses the complexities of financing ecological infrastructure (EI) interventions, and the multiple funding agencies involved. Figure 3-1, from Midgley et al. (2021), shows the unique funding streams identified for nine different water-related EI intervention typologies. It is apparent that there is no "one-size fits all" approach to funding sediment management. The location of the intervention, landowner, etc. will all determine the type of funding that should be applied.



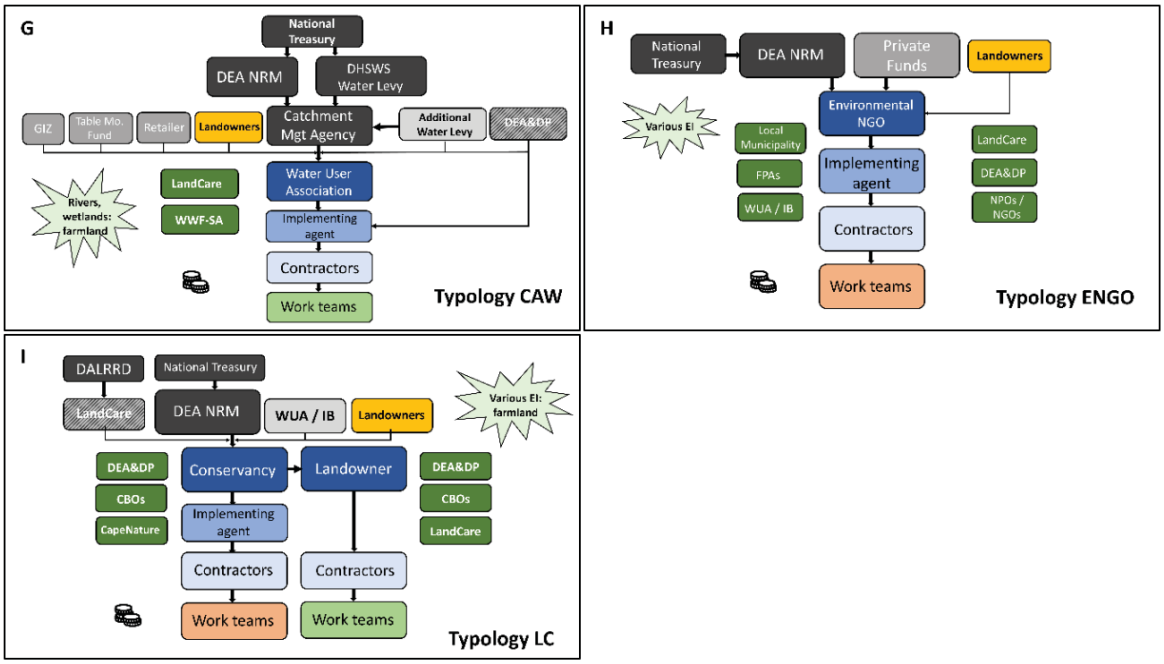



**Figure 3-1: Schematic diagrams of all qualitative water-related EI intervention typologies in the Breede River and Berg River catchments.** ***From Midgley et al. (2021)***

## 3.1 Mapping the co-benefits

Multiple economic, social and environmental co-benefits are associated with the proposed interventions for siltation management. These are outlined in Deliverable 5a of this project which links the infrastructure with community benefits and proposes a methodology to assess these. The co-benefits for each siltation management intervention are summarised in Table 3-1. What is apparent is the large number of co-benefits associated with interventions in the source and transfer zone, in comparison to the sink zone. Furthermore, interventions in the source zone are associated with more social co-benefits than those in the transfer zone. The nature of these co-benefits is important to consider when looking for additional financing, as different funds and funding organisations have their own priority sectors. The next step would be to link the co-benefits with the relevant funding sources which could be mobilised.

**Table 3-1: Social, environmental and economic co-benefits of the siltation management interventions**

| | | | Social | | | | | | | Environmental | | | | Economic | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Increased crop productivity | Better livestock grazing | Increased water security | Increased custodianship | Rural development and tourism | Decreased flood damage | Better transport access | Improved water quality | Carbon sequestration | Biodiversity conservation | Erosion and sediment reduction | SMME development | NRM employment | Construction employment |
| Source | Improve vegetation cover | Veld management | ♦ | ♦ | | ♦ | ♦ | | | | | ♦ | ♦ | | | |
| | | Conservation agriculture | ♦ | | | ♦ | ♦ | | | | ♦ | | ♦ | | | |
| | | Rainwater harvesting | ♦ | | ♦ | | ♦ | | | | | | | | | ♦ |
| | | Agroforestry | ♦ | | | ♦ | ♦ | | | | ♦ | | ♦ | ♦ | | |
| | | Natural grassland management | | ♦ | | ♦ | ♦ | | | | ♦ | ♦ | ♦ | | | |
| | | Wetland rehabilitation | | | | ♦ | ♦ | | | ♦ | ♦ | ♦ | | | ♦ | |
| | | Clearing of alien invasive plants | | | ♦ | ♦ | ♦ | | | | | ♦ | | ♦ | ♦ | |
| | Reduce rill erosion | Contour ridging | ♦ | ♦ | | ♦ | ♦ | | | | | | ♦ | ♦ | | |
| | | Vegetation rows | ♦ | ♦ | | ♦ | ♦ | | | | | | ♦ | ♦ | | |
| Transfer | Reduce gully erosion | Gully prevention | | | | | | ♦ | ♦ | ♦ | | | ♦ | | ♦ | |
| | | Stone check dams | | | | | | ♦ | | ♦ | | | ♦ | | ♦ | |
| | | Brushwood check dams | | | | | | ♦ | | ♦ | | | ♦ | | ♦ | |
| | | Vegetation barriers | | | | | | ♦ | | ♦ | | | ♦ | | ♦ | |
| | | Gully reshaping | | | | | | ♦ | | ♦ | | | ♦ | | ♦ | |
| | | Roadside management | | | | | | ♦ | ♦ | ♦ | | | ♦ | | | ♦ |
| | Reduce riverbank erosion | Re-establish meandering rivers | | | | | | ♦ | | ♦ | | ♦ | | ♦ | ♦ | |
| | | Stream/riverbank management | | | | | | ♦ | | ♦ | | ♦ | ♦ | | ♦ | |
| | | Reconnect river and floodplain | | | | | | ♦ | | ♦ | | ♦ | ♦ | | ♦ | |
| | Trap sediments upstream of dam | Small dams | | | | | | ♦ | | | | | ♦ | | | ♦ |
| | | Vegetation screens | | | | | | ♦ | | | | ♦ | ♦ | | | ♦ |
| | | Sabo dams | | | | | | ♦ | | | | | ♦ | | | ♦ |

| | | | Social | | | | | | | Environmental | | | | Economic | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Increased crop productivity | Better livestock grazing | Increased water security | Increased custodianship | Rural development and tourism | Decreased flood damage | Better transport access | Improved water quality | Carbon sequestration | Biodiversity conservation | Erosion and sediment reduction | SMME development | NRM employment | Construction employment |
| Sink | Route sediments | Sediment bypass | | | | | | | | | | | | | | ♦ |
| | | Sediment pass through | | | | | | | | | | | | | | ♦ |
| | Sediment removal | Flushing or sluicing | | | | | | | | | | | | | | ♦ |
| | | Pressure flushing | | | | | | | | | | | | | | ♦ |
| | | Empty flushing | | | | | | | | | | | | | | ♦ |
| | | Dry excavation | | | | | | | | | | | | | ♦ | ♦ |
| | | Dredging | | | | | | | | | | | | | ♦ | ♦ |
| | Adaptive strategies | Redistribute sediment | | | | | | | | | | | | | | ♦ |
| | | Reallocate storage | | | | | | | | | | | | | | ♦ |
| | | Modify infrastructure | | | | | | | | | | | | | | ♦ |
| | | Adjust to reduce benefits | | | | | | | | | | | | | | ♦ |
| | | Repurpose or decommission | | | | | | | | | | | | | | ♦ |

## 3.2 The need for blended finance

Despite the numerous barriers to financing siltation management, it is clear that the benefits of silt management accrue across multiple stakeholders, in different forms, and over different timescales, as shown in Figure 3-2. It is precisely because of these multiple benefits that special efforts are required to blend financial support from a variety of public and private sources, particularly for siltation management interventions in the source and transfer zones, which have a number of economic, social and environmental co-benefits. Blended financing is much venerated in the climate and ecological space, but is complex in nature. To ensure blended financing that is sustainable, the following criteria must be met.

- The multiple benefits must have been documented at the catchment scale, and the respective beneficiaries of these benefits identified (Cartwright, 2021). Typically, a value must also be attributed to these benefits, which as previously discussed, can be a challenge.
- The institutional capacity to oversee the process must be in place. This can also pose a stumbling block in the South African context

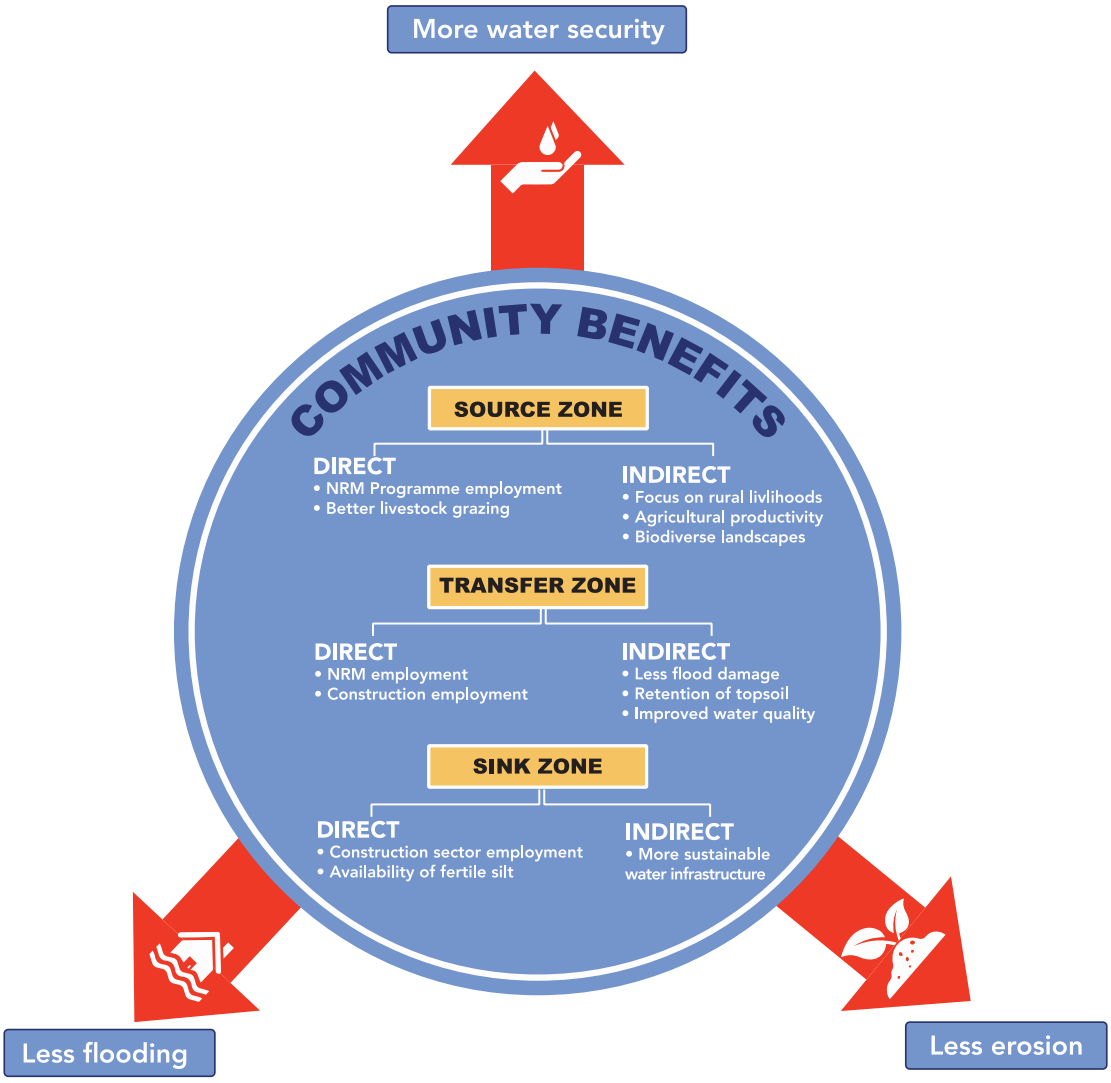



**Figure 3-2: Example of the multiple direct and indirect benefits that arise from silt management.**

# 4 Funding options for siltation management

Funding sources can be public, including all funds derived from the fiscus, or private, i.e. not related to government funding, taxes or public tariffs. Different types of funding under these two brackets are discussed further in Sections 4.1 and 4.2. For public funding, all funds are ultimately derived from National Treasury, however these sections refer to the institutions or facilities which channel these funds.

Further to this, funding sources can broadly be divided into prevention and management financing. Prevention financing would be used to fund interventions (typically focused on infrastructure development) which prevent siltation from happening. Alternatively, management financing would be used to fund interventions which manage, mitigate, or control the impacts of siltation, and also to generate revenue used for the servicing of capital loans.

The financing of implementation activities will involve both capital expenditure (CAPEX), which will occur during implementation, and operational expenditure (OPEX), which may occur before or after an intervention is implemented. CAPEX is relatively straightforward to calculate as it relates to the money spent on labour, materials etc. OPEX is more complex as it could include the money spent on specialist studies or research prior to the implementation of the intervention as well as the money spent on monitoring and evaluation after the intervention has been implemented. These costs should be made clear to funders as it is a critical component of sustainable dam siltation management. The possible financing mechanisms detailed in Sections 4.1 and 4.2 are summarised in Table 4-1.

**Table 4-1: Summary of possible financing mechanisms**

| | PREVENTION | MANAGEMENT |
|---|---|---|
| **PUBLIC** | • Infrastructure grants (RBIG, MIG and IUDG) for upstream interventions<br>• Landcare grants<br>• Natural Resource Management "Working for" Programmes.<br>• Mine rehabilitation funds to trap erosion, stabilise soils and enrich soil carbon. | • Water Resource Management Charge.<br>• Water Resource Infrastructure Charge<br>• Waste Discharge Charge<br>• Raw water tariff or scheme charge\<br>• Environmental levy<br>• Presidential Infrastructure Fund |
| **PRIVATE** | • Commercial banks<br>• Development financing<br>• Climate financing<br>• Private landowners contributing to Landcare<br>• Carbon revenue for soil carbon sequestration.<br>• Corporate Social Responsibility | • Revenue from products<br>• Revenue from mines<br>• Mine rehabilitation funds<br>• Global Water Funds<br>• Non-Governmental Organisations (NGOs)<br>• Microfinance<br>• Farmers<br>• Capital Unit Charge<br>• Carbon revenue for reforestation and grassland rehabilitation. |

When considering the applicable funding for each intervention, it is important to consider the enabling role of co-benefits in mobilising financing, as discussed in section 3.1. Interventions that provide direct siltation management, such as dredging, may have the greatest impacts on siltation management, and

may thus be well-motivated for DWS funding. However, such an intervention has limited co-benefits for improved social, economic and environmental well-being and will thus fail to mobilise external financing. Catchment management interventions, such as veld management, may have less direct impact on sedimentation management, but will provide more development funding opportunities considering the wide range of social, economic and co-benefits that they provide.

Table 4-2 links possible public and private financial sources with the individual sediment management interventions. It must be noted that general institutions, such as DWS, have not been indicated as a financial source, but rather the specific funds from which DWS mobilises financing.

**Table 4-2: Possible public and private funding sources per sediment management intervention**

| | | | Public funding | | | | | | | | | | | Private funding | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dam owner (DWS, water board etc.) | Comprehensive Agricultural Support Grant | Infrastructure grants (e.g. RBIG, MIG, IUDG) | Municipal Disaster Grants | Landcare | "Working for" Programmes | Water Resource Management Charge | Water Resource Infrastructure Charge | Waste Discharge Charge | Raw Water Tariff/Scheme Charge | Environmental levy | Commercial banks | Development Financing | Climate financing | Mine rehabilitation funds | Corporate Social Responsibility | Revenue from products | Revenue from mines | Global Water Funds | NGOs | Microfinance | Farmers | Carbon Revenue |
| Source | Improve vegetation cover | Veld management | | | | | | | | | | | | | | ♦ | | | | ♦ | | | | | |
| | | Conservation agriculture | | | | | | | | | | | | | | ♦ | | | | ♦ | ♦ | | ♦ | ♦ | ♦ |
| | | Rainwater harvesting | | | | | | | | | | | | | | | | ♦ | | | | | | | |
| | | Agroforestry | | | | | | | | | | | | | | | | | | | | | ♦ | | ♦ |
| | | Natural grassland management | | | | | | | ♦ | | | | | | | ♦ | | | | | | | | | |
| | | Wetland rehabilitation | | | | | | ♦ | ♦ | | | | | | | ♦ | | | | | | | | | ♦ |
| | | Clearing of alien invasive plants | | | | | | ♦ | ♦ | | | | | | | | | | ♦ | | | | | | |
| | Reduce rill erosion | Contour ridging | | | | | | | | | | | | | | | | | | | | | | ♦ | |
| | | Vegetation rows | | | | | | | | | | | | | | | | | | | | | | ♦ | |
| Transfer | Reduce gully erosion | Gully prevention | | | ♦ | | ♦ | | ♦ | | | | | | | | | | | | | | | | |
| | | Stone check dams | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |
| | | Brushwood check dams | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |
| | | Vegetation barriers | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |
| | | Gully reshaping | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |
| | | Roadside management | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |
| | Reduce riverbank erosion | Re-establish meandering rivers | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |
| | | Stream/riverbank management | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |

| | | | Public funding | | | | | | | | | | | Private funding | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dam owner (DWS, water board etc.) | Comprehensive Agricultural Support Grant | Infrastructure grants (e.g. RBIG, MIG, IUDG) | Municipal Disaster Grants | Landcare | "Working for" Programmes | Water Resource Management Charge | Water Resource Infrastructure Charge | Waste Discharge Charge | Raw Water Tariff/Scheme Charge | Environmental levy | Commercial banks | Development Financing | Climate financing | Mine rehabilitation funds | Corporate Social Responsibility | Revenue from products | Revenue from mines | Global Water Funds | NGOs | Microfinance | Farmers | Carbon Revenue |
| | | Reconnect river and floodplain | | | ♦ | | ♦ | | | | | | | | | | | | | | | | | | |
| | Trap sediments upstream of dam | Small dams | | | | | | | | | | | | | | | | | | | | | | | |
| | | Vegetation screens | | | | | | | | | | | | | | | | | | | | | | | |
| | | Sabo dams | | | | | | | | | | | | | | | | | | | | | | | |
| Sink | Route sediments | Sediment bypass | ♦ | | | | | | | | | | | | | | | | | | | | | | |
| | | Sediment pass through | ♦ | | | | | | | | | | | | | | | | | | | | | | |
| | Sediment removal | Flushing or sluicing | ♦ | ♦ | | | | | | | | | | | | | | | | | | | | | |
| | | Pressure flushing | ♦ | ♦ | | | | | | | | | | | | | | | | | | | | | |
| | | Empty flushing | ♦ | ♦ | | | | | | | | | | | | | | | | | | | | | |
| | | Dry excavation | ♦ | ♦ | | | | | | | | | | | | | | | | | | | | | |
| | | Dredging | ♦ | ♦ | | | | | | | | | | | | | | | | | | | | | |
| | Adaptive strategies | Redistribute sediment | ♦ | | | | | | | | | | | | | | | | | | | | | | |
| | | Reallocate storage | ♦ | | | | | | | | | | | | | | | | | | | | | | |
| | | Modify infrastructure | ♦ | | | | | | | | | | | | | | | | | | | | | | |
| | | Adjust to reduce benefits | ♦ | | | | | | | | | | | | | | | | | | | | | | |
| | | Repurpose or decommission | ♦ | | | | | | | | | | | | | | | | | | | | | | |

## 4.1 Financing sedimentation prevention

Possibly the most effective way to prevent sedimentation in dams is to invest in either upstream ecological infrastructure that prevents erosion or dam-scale infrastructure that manages silt build-up, when the reservoir is constructed. This allows the cost of silt management to be included in the cost of the reservoir construction and crucially enables the various public and private finance instruments used to construct reservoirs in South Africa, to be deployed in silt management. This was done for Berg River Dam where the cost of clearing the catchment of invasive alien plants was part of the construction cost as negotiated during the authorisation process for the building and financing of the dam.

This deployment does depend on a greater awareness of the interaction between built and ecological infrastructure and the potential for functional ecological infrastructure to enhance the value of built infrastructure such as reservoirs.

Given the South African context described above, it is negligent to allocate either public or private funds to the building of a reservoir, without considering, and where necessary mitigating, the risk of siltation.

### 4.1.1 Government

The South African fiscus uses allocations (budget "votes") to support the work of departments such as DWS, as well as grants to provincial and local governments. The country's infrastructure tends to rely on grants, and the Infrastructure Investment Office in the Presidency has focussed on rapid roll-out of infrastructure as part of the COVID-19 response.

The following grants hold the potential to be used in silt and sediment management deemed appropriate for discussion in this report:

#### 4.1.1.1 Infrastructure grants

**Regional Bulk Infrastructure Grant**

The Regional Bulk Infrastructure Grant (RBIG) is administered by the Department of Water and Sanitation and has an allocation of a 3-year Medium Term Expenditure Framework (OUTA, 2016). The Government Gazette No 42464 (pages 436-437) published on 17 May 2019 provides a summarised overview of the RBIG funding.

As per the Government Gazette, the strategic goal of RBIG funding is to facilitate achievement of targets for access to bulk water and sanitation through successful execution and implementation of bulk projects of regional significance. The Grant Purpose offers an opportunity for applying RBIG funding towards sediment management interventions, where it is *inter alia* stated:

*"To implement bulk infrastructure with a potential of addressing water conservation and water demand management (WC/WDM) projects or facilitate and contribute to the implementation of local WC/WDM projects that will directly impact on bulk infrastructure requirements"*

Although the RBIG has not historically been used in sediment management interventions, there is a strong "water conservation" argument for applying RBIG funding towards such interventions, particularly where sediment management, either upstream or in the reservoirs, can avoid or delay the need for new water infrastructure. Certainly, the RBIG can be used "*to develop new, refurbish, upgrade and replace ageing bulk water and sanitation infrastructure of regional significance*".

As with other Nationally funded infrastructure in South Africa, a project identified for implementation under RBIG funding must be referenced to and included in the municipal Integrated Development Plan

(IDP) and Water Services Development Plans (WSDP) and show linkages to projects under the Municipal Infrastructure Grant (MIG) and/or the Water Services Infrastructure Grant (WSIG).

The RBIG is only allocated to Water Services Authorities (water boards, local and district municipalities and municipal companies). The National budget for RBIG funding for the three most recent financial years is presented in Table 4-3. Given the magnitude of the RBIG budget, it is essential that this grant not only avoids environmental damage (including erosion) when it is spent, but also unlocks the complementarity between mutually enforcing built and ecological capital. This will require new skills and processes and must be carefully managed. Significantly, Section 30 of the Water Services Act entitles water boards to "provide Catchment Management Services to or on behalf of a responsible authority", the allowance is in line with Section 156(1) of South Africa's Constitution and could, arguably should, mandate institutions such as Umgeni Water and Rand Water, both of which receive RBIG grants and manage significant infrastructure portfolios, to take up responsibility for siltation management.

Historically, concerns were raised regarding the misallocation of the RBIG which may cause reluctance to allocate this grant towards novel causes that will complicate oversight. The same concerns could, yet, result in the grant being discontinued in 2022/23. The point remains, however, that investment in South Africa's water infrastructure must factor in the cost of erosion prevention and siltation management in order to ensure value for money.

**Table 4-3: National RBIG funding budget**

| Financial Year | Total Budget Amount (ZAR million) |
|---|---|
| 2019/20 | **5 103** |
| 2020/21 | **5 386** |
| 2021/22 | **5 790** |
| **Total** | **16 281** |

## Municipal Infrastructure Grants

Local governments (especially Metros), are recipients of large portions of South Africa's grant budget. Acting under Section 156(5) of the Constitution[1] some local governments have taken up increasing responsibility for their water security and environmental health. eThekwini Municipality's Transformative Riverine Management Programme, run by the municipality's Roads and Stormwater Management Department, has begun investing its budget allocation in riparian rehabilitation and river stewardship in order to prevent damage to roads and culverts. Beginning on 450km of river within the municipal boundaries, the programme invested R35 million in 2020, created 600 jobs and 86 co-operatives, and saved the municipality R22 million in damage to culverts alone. An economic analysis of the programme that looked to include a wider set of benefits, established the potential to generate R920 million over 20 years (Mander et al., 2021).

The approach adopted in eThekwini is illustrative of how the Municipal Infrastructure Grant (called the Integrated Urban Development Grant in the Metropolitan Municipalities) could be used more effectively and less wastefully if it began unlocking the synergies between built infrastructure and the ecological infrastructure (natural environment). This approach has the potential to release municipal grant funding for erosion control and siltation management.

[1] In terms of section 156(5) "A municipality has the right to exercise any power concerning a matter reasonably necessary for, or incidental to, the effective performance of its functions."

### Other Infrastructure Grants

Besides the grants discussed above, there are several other grants for projects where enhanced sediment management provide a secondary benefit. Human settlement infrastructure that is built with the risk of erosion in mind, for example, will not only reduce local damage but also reduce the sediment yield of a catchment.

These grants include:

- Human Settlements Development Grant
- Integrated Urban Development Grant (USDG) in Metropolitan Municipalities, as opposed to the MIG in other municipalities
- Integrated City Development Grant
- Rural and Community Development Fund (part of the National Empowerment Fund, overseen by the Department of Trade, Industry and Competition)
- Drought relief grants administered by DWS

It must be noted that the above grants are not recommended for funding of sediment management initiatives, but rather that the way they are dispensed and the resulting infrastructure built, should be more mindful of the need to prevent erosion and unlock the benefits of complementary ecological and engineered infrastructure. The Transformative Riverine Management Project in eThekwini Municipality provides an illustrative example. The programme is run by the Municipality's Roads and Stormwater Management Department in an attempt to prevent expenditure on damaged culverts but demonstrated a variety of co-benefits in terms of jobs, biomass, sense of place and ease of doing business.

In addition, the Water Services Infrastructure Grant (WSIG, administer by DWS) aims to support municipalities in implementing water conservation and water demand management (WC/WDM) projects, similar to what the RBIG funding aims to achieve. However, the WSIG funding does not have a focus on the development of bulk infrastructure. It should therefore not be applied for the development of bulk infrastructure as part of sediment management initiatives.

## 4.1.1.2 Non-infrastructure grants

### Municipal Disaster Grants

Two primary municipal disaster grants are available:

- Municipal Disaster Relief Grant: Intended to mitigate the immediate consequences of disasters, such as the emergency repair of critical goods and services. The grant is transferred through the Department of Cooperative Governance and Traditional Affairs
- Municipal Disaster Recovery Grant: Intended to be used for the reconstruction and rehabilitation of municipal infrastructure damaged by a disaster. The grant is transferred through the Department of Cooperative Governance and Traditional Affairs

### Comprehensive Agricultural Support Grant

The Comprehensive Agricultural Support Grant, administered by the Department of Agriculture, Land Reform and Rural Development (DALRRD) enables the construction and rehabilitation of the capital required to support agriculture. It is scheduled to receive R1.1 billion a year in the Medium-Term Expenditure Framework (MTEF) and could be used to rehabilitate smaller farm dams.

### 4.1.1.3 Landcare Programme

The Landcare Programme Grant (Landcare) is administered by DALRRD based on the Conservation of Agricultural Land Resources Act, Act 43 of 1983 (CARA). The programme receives an allocation from within the Department's MTEF. The Government Gazette No 42464 (pages 315-317) published on 17 May 2019 provides a summarised overview of the Landcare funding.

As per the Government Gazette, the strategic goal of Landcare funding is to optimise productivity and sustainability of natural resources leading to greater productivity, food security, job creation and better quality of life for all. The Grant Purpose offers an opportunity for applying Landcare funding towards sediment management interventions, where it is *inter alia* stated:

*"To promote sustainable use and management of natural resources by engaging in community-based initiatives that support the pillars of sustainability (social, economic and environmental), leading to greater productivity, food security, job creation and better well-being for all"*

If the Grant Purpose, as well as the outcome statements and outputs as per the legislation are considered, then it is evident that Landcare funding should be applied to interventions in the catchment (i.e. the source and transfer nodes) and not at the sink (i.e. the reservoir). Landcare has five "focus areas": soilcare, watercare, veldcare, conservation agriculture and juniorcare, all of which relate to sedimentation management.

A business plan for projects identified for implementation under Landcare funding must be developed by provincial departments and approved by the National DAFF, included in the municipal Integrated Development Plan (IDP) and Water Services Development Plans (WSDP) and show linkages to projects under the Municipal Infrastructure Grant (MIG) and/or the Water Services Infrastructure Grant (WSIG)

The Landcare grant is allocated to Provincial Departments of Agriculture. In 2019/20 the national Landcare programme received R82.2 million from the national fiscus. The Western Cape programme was successful in raising additional budget from landowners for work performed. In 2018/19, Landcare rehabilitated 26,357 hectares and created 4,689 work opportunities. In the context of the Presidential Economic Stimulus following the COVID pandemic, these jobs proved crucial. Based on these precedents, there is scope for further increasing this type of work as a means of not only managing erosion and silt, but also creating the type of employment that currently unemployed people can access.

**Table 4-4: National Landcare funding budget[2]**

| Financial Year | Budget Amount (ZAR million) |
|---|---|
| 2019/20 | **82.2** |
| 2020/21 | **83.3** |
| 2021/22 | **84.9** |
| **Total** | **250.4** |

To date, much of the Landcare work has focussed on the removal of invasive alien plant clearing to reduce water losses and damage to riparian infrastructure such as bridges that results when this vegetation becomes dislodged and stacks up against weirs and bridges. There is considerable scope for including silt management practices in the Landcare initiatives, especially given that removing riparian trees can result in riverbank erosion and the mobilisation of silt.

[2]http://www.treasury.gov.za/documents/National%20Budget/2021/ene/Vote%2029%20Agriculture,%20Land%20Reform%20and%20Rural%20Development.pdf

Landcare is instrumental in promoting South Africa's regenerative agriculture programme. This programme, which prioritises the retention of soil cover and the build-up of soil carbon, has the potential to improve the agricultural sector's resilience and profitability (Oelofse et al., 2021). Where successful, it would also reduce erosion and prevent the mobilisation of silt. As the conjoined problems of food security, water security and dam siltation receive greater attention, there is a strong case for evoking CARA more effectively, increasing Landcare allocations and securing investment from private and communal landowners in support of regenerative agriculture that would also prevent dam siltation.

#### 4.1.1.4 'Working for' Programmes

The Department of Forestry, Fisheries and Environment (DFFE) receives funding from National Treasury for its Environmental Programmes, of which the Working for / on Programmes form part. The programmes also receive funding from the Department of Public Works and Infrastructure (DPWI) which through its Expanded Public Works Programme (EPWP) funds the labour wages on the Working for / on Programmes. The triggering legislation for the Working for / on Programmes are listed in Table 4-2 of Report No 1001032/12602 (i.e. the Institutional Report).

The programmes, covered in detail in the institutional report of this project, are divided under Working for Water, Working for Wetlands, Working for Land, Working for Ecosystems and Working on Fire and are run by the DFFE and covered in detail in the above Institutional Report of this project. The programmes were internationally and locally celebrated for promoting work opportunities, but were also criticised for the inefficiency (Van Wilgen and Wannenburg, 2016)[3]. Ensuring that the programmes worked to achieve some common themes, including siltation management, would assist coherence and efficiency, while mobilising investment towards the strategic cause of protecting soil fertility and reservoir storage capacity. The construction of 'artificial wetlands' above dams, for example, would create similar employment, biodiversity and water quality benefits associated with the current Working for Wetlands programme while trapping silt that would otherwise accumulate in dams.

### 4.1.2 Non-governmental / Private Sector finance

#### 4.1.2.1 Commercial Banks

Private sector investors in South Africa engage the country's water infrastructure through loans to companies, farmers, public entities such as municipalities and water boards. They also purchase infrastructure bonds. In each of these instances, the insurance industry underwrites the project that is being financed. South Africa's private finance sector is under increasing pressure from sector bodies to report on Environment, Social and Governance (ESG) considerations.

The South African finance industry has proven adept in managing project-scale risks, currency fluctuations and liquidity requirements. It has proven more difficult, however, to channel private finance into 'public good' projects with systemic benefits, such as catchment stewardship or erosion prevention (Cartwright, 2021). In part, this is due to limited capacity within the State to enter into public private financing agreements. Typically, a Finance Direct Agreement between the lending commercial bank and the Government Department is required to outline an appropriate share of risks and returns. In practice, striking the right distribution of risks and returns across public and private entities has proven difficult.

[3] Van Wilgen, B and Wannenburgh, A (2016) Co-facilitating invasive species control, water conservation and poverty relief: achievements and challenges in South Africa's Working for Water programme. Current Opinion in Environmental Sustainability, 19, pp.7-17.

### 4.1.2.2 Development financing

Development financing from various institutions is commonplace in South Africa. Traditional funding mechanisms typically include grants (where no repayment is required), equities, guarantees, insurance and loans (with varying levels of interest rates) (Table 4-5) and South Africa has received development finance from traditional Development Finance Institutions (DFIs) such as the World Bank, bi-lateral development agencies (such as USAID) and dedicated funds or facilities (such as the Green Climate Fund (GCF)).

**Table 4-5: Traditional financial mechanisms for development financing From *Global Green Growth Institute (2016a)***

| Most of the financial mechanisms used by the public and private sectors are comprised of the following five instruments: | | |
|---|---|---|
| **Category** | **Types of Instruments** | **Example Use/Benefits** |
| Grant | Technical assistance<br>Grant capital | Provide early stage capital to advance project development |
| Equity | Equity investment<br>Tax equity | Incentivize investment by sharing risks |
| Guarantee | Partial risk guarantee<br>Sovereign risk guarantee<br>Counterparty risk guarantee | Provide credit enhancement to reduce counterparty risk |
| Insurance | Technology performance insurance<br>Interest rate insurance<br>Foreign exchange rate insurance | Protect against unforeseen impacts (e.g., currency fluctuations, political risk, technology underperformance) |
| Loan | Senior debt<br>Subordinated debt<br>Quasi-equity | Take on a junior or senior position, depending on investor's risk appetite |

Development Finance can be particularly useful when confronted with relatively novel, unfamiliar or complicated projects (such as siltation management) that conventional finance finds difficult to assess and support. The ability for development finance to take on more risk and demand lower returns, can bring other finance institutions into the market; this was certainly the case for the initial phases of South Africa's Renewable Energy Independent Power Procurement Programme. Where the effectiveness of a silt management practice, or the cost of sediment removal, for example is not totally clear, DFIs can enter into first-loss agreements that provide commercial financiers with the degree of comfort they require to mobilise funding.

Table 4-6 provides a general overview of the development banks, but new funding mechanisms with a more specific focus are regularly launched. For example, the Development Bank of South Africa (DBSA) has launched a 100 million Euro Infrastructure Investment Programme funded by the European Union. The Programme aims to support the National Development Plan and Regional Infrastructure Development Master Plan of the SADC region. This fund is expected to support the implementation of the government infrastructure programme and to address the constraints to infrastructure development in South Africa and in the SADC region with a focus on water and energy.

Many of the financial mechanisms offered by DFIs are debt and equity based, with small grant portions. The grant portion is often offered in the form of preparation funding, which includes the feasibility and pilot phases. Once the project moves beyond the pilot phase, the DFI from which preparation funding was accepted will have first right of refusal to fund the project implementation phases. This may result in a fully debt and equity (no grant) funded implementation phase.

**Table 4-6: Comparison of development finance institutions that fund South African infrastructure**

| Name of bank | World Bank | African Development Bank | New Development Bank (NDB) formerly known as the BRICS Development Bank | Eastern and Southern African Trade and Development Bank | Development Bank of South Africa |
|---|---|---|---|---|---|
| Financial instruments | Loans, grants, Technical assistance, Guarantees, Equity | Loans, grants, Lines of Credit, Technical assistance, Guarantees, Equity | Loans, grants, lines of credit, technical assistance, guarantees, equity | Loans, Guarantees and Equity | Loans; equity |
| Entities eligible for funding | Primarily middle-income governments, also some creditworthy low-income countries. Private-sector firms in developing countries (middle- and low-income countries). | Primarily middle-income governments, also some creditworthy low-income government, Private-sector firms in developing countries. | BRICS (Brazil, Russia, India, China and South Africa) member states and other emerging economies and developing countries. | Regional Economic Communities (RECs) or any other African country that borders a member state. It is open to: (1) member states (or their designated institutions), (2) African institutions, (3) other African and non-African states (or their designated institutions) (4) any African or non-African public or private institution or corporate bodies. | Public sector parties (municipalities, state owned entities, government departments and regional bodies) or private institutions who have obtained a licence/concession on a competitive basis from a government that is within the DBSA's mandate. |
| Specific categories of interest in Africa/South Africa | Climate Change, Energy, Education, Poverty, Fragility, Conflict and Violence, Urban Development, Gender, Health, Financial Inclusion. | Agriculture & Agro-industries, Climate change, Economic &financial Governance, Education, Energy. | Clean energy, transport infrastructure, irrigation, water resource management and sanitation, sustainable urban development, economic cooperation and integration. | Petrochemicals, agriculture, minerals and raw materials, transport and communication infrastructure, manufacturing and energy. | Transport, Energy, Water and Sanitation, Information and Communication Technologies. |
| Geographical focus (activity in each region indicated as %) | Sub-Saharan Africa 26%<br>East Asia and Pacific 15%<br>Europe and Central Asia 14%<br>Latin America and Caribbean 12%<br>Middle East and North Africa 7%<br>South Asia 26% | West Africa 28%<br>Multiregional 25%<br>Southern Africa 17%<br>East Africa 17%<br>Central Africa 7%<br>North Africa 6% | Brazil 20%<br>Russia 20%<br>India 20%<br>China 20%<br>South Africa 20% | Kenya 36%<br>Mauritius 20%<br>Ethiopia 14%<br>Rwanda 10%<br>Tanzania 10%<br>Other 10% | South Africa, SADC region and select countries in the greater continent of Africa. |
| Budget available to Africa/South Africa | No specific information found. **International Bank for Reconstruction and Development (IBRD):** $17.86 billion disbursed in 2016. | No specific information found. $4.33 billion disbursed in 2016 | No specific information found | No specific recent information found. $1.79 billion disbursed in 2016. | No specific information found. |

| Name of bank | World Bank | African Development Bank | New Development Bank (NDB) formerly known as the BRICS Development Bank | Eastern and Southern African Trade and Development Bank | Development Bank of South Africa |
|---|---|---|---|---|---|
| | **International Development Association (IDA):** $10.6 billion disbursed in 2016. | | | | |
| Specified project values | Project dependent. No specific information found. | Project dependent. No specific information found. | Project dependent. No specific information found. | Project dependent. No specific information found. | Projects or programs with a minimum capital investment value of R500 million (or $/€ equivalent).If duly justified, projects with a smaller investment value will also be considered, notably if packaging of several projects as a program is feasible. |
| Examples of interest rates and other fees | Rates and fees are largely project dependent<br>**IBRD:**<br>6-month Libor, plus contractual spread of 0.5%-2%. Front-end fee of 0.25% -1% of principal loan, plus commitment fee of 0.25%<br>**IDA:**<br>0-1.25% dependent on nature of loan and project. Additionally, a 0.75 % service charge (SDR) is enforced. | Interest rates can vary from 0 -0.8% depending on the nature of the loan. Additionally, a service charge commitment fee of 0.75% per annum on outstanding balance is enforced, and a 0.50% per annum on undisbursed amount. | No specific information found. Dependent on nature of funds and project type. | No specific information found. Dependent on nature of funds and project type. | No specific information found. Dependent on nature of funds and project type. |
| Co-financing requirements | Yes | No | No | No | No |

### The World Bank

The World Bank is the largest and most influential source of funding for most developing countries and operates across five institutions. Two of the possible funding streams for siltation management from the World Bank include

**Investment Project Financing**:

IBRD loan, IDA credit/grant and guarantee financing to governments, for activities that create the physical/social infrastructure necessary to reduce poverty and create sustainable development. The focus is on capital-intensive investments, agricultural development, service delivery, credit and grant delivery [including micro-credit], community-based development, and institutional building. The funding typically runs over the medium to long-term (5 to 10-year horizon).

For siltation management, emphasis should be placed on the importance of catchment management for community-based development and institutional building. There are multiple online resources that provide **briefing notes**, the **relevant policies** governing the funding, and details around **how to apply** for such funding. It must be noted that all World Bank financing applications do contain a rigorous process, and clear indicators and monitoring and evaluation tools must be used.

**Trust funds and grants:**

Trust funds and grants to governments for scaling up of activities, notably in fragile and crisis-affected situations. These are performed under multiple umbrella programs including GWSP (Global Water Security and Sanitation Program) and ESMAP (Energy Sector Management Assistance Program). Any application for funding must be done through these programs directly, and **clear guides** on how to do so are available.

### The African Development Bank (AfDB)

As a multilateral development finance institution, the African Development Bank Group seeks to further the social and economic well-being of its regional member countries. It does so by providing concessional financing to low-income member countries through the African Development Fund (ADF), and a wide range of non-concessional loans and guarantees to all member countries through the African Development Bank (AfDB).

For South Africa, the only possible funding would be through the AfDB, and can consist of a varying number of **loans and guarantees** with different interest rates and requirements. For the purpose of siltation management, a strong case can be made for this project in relevance to the **environment** and **climate change** sectors which the bank focuses on.

In addition to the traditional financing pathways, the AfDB runs the **Green Bond** program. This program finances eligible climate change projects, such as biosphere conservation projects where the emissions from deforestation and degradation of ecosystems will be reduced. Siltation and catchment management interventions could form a part of this.

### Bilateral development agencies

Numerous bi-lateral development agencies exist, where the donor countries are typically high-income countries. For most international agencies, South Africa does not fall high on the priority list due to its middle-income status. However, there are a few bilateral agencies that do finance South African projects and are listed in Table 4-7. For most of these agencies, a considerable portion of the funds are channelled through NGOs and do not go directly to government institutions. In addition, the value of the contributions is typically small and used to fund local initiative projects such as implementing climate-

smart agriculture. While not always applicable to the large scale of this WRC project, bilateral agencies and their relevant NGOs could provide valuable funding for catchment specific interventions.

**Table 4-7: Bi-lateral donor agencies that provide funding in South Africa**

| Bi-lateral agencies | Priority sectors related to siltation management | Notes |
|---|---|---|
| **Finnish Development Agency (FINNIDA)** | • Water and Sanitation, Waterways<br>• Energy production and distribution<br>• Rural, agriculture and fisheries<br>• Forest<br>• Environment, biodiversity, minerals | A considerable portion of its funds are channelled through NGOs - must apply through an NGO |
| **French Development Agency (AFD)** | • Energy transition<br>• Territorial and ecological transition | Funding can be directed through the **Private-Sector Innovation Facility for Climate Change (FISP-CLIMAT)** |
| **German Development Agency (GIZ)** | SOUTH AFRICA PRIORITIES:<br>• Energy and climate | Funding for small scall climate-related measures can be accessed through their **projects portal**, which are updated on a regular basis |
| **Norwegian Agency for Development Cooperation (Norad)** | • climate change and environment<br>• energy | Norad development aid investment in SA is decreasing |
| **Korea International Cooperation Agency (KOICA)** | • water<br>• agriculture and rural development<br>• energy<br>• climate change and environment | South Africa is only considered a secondary partner, and most funding is very small and community based, channelled through Korean NGOs |
| **United States Aid Agency (USAID)** | • agriculture and food security<br>• environment, energy and infrastructure<br>• water and sanitation | Have scaled back a lot of their funding since COVID |

### 4.1.2.3 Climate financing

The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement adopted in 2015 defined a global action plan to limit global warming to less than 2°C above pre-industrial levels. The agreement included the creation of additional sources of finance for climate change mitigation, which became climate finance. Climate finance is "*finance that aims at reducing emissions and enhancing sinks of greenhouse gases and aims at reducing vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negative climate change impacts*", as defined by the UNFCCC Standing Committee. In a narrow sense, it refers to transfers of resources from developed to developing countries, and in a broader sense, it refers to all financial flows relating to climate change mitigation and adaptation.

Climate finance mechanisms and financial aid target development through capacity building, research and economic development. The largest international climate funds are the Climate Investment Funds, Green Climate Fund, Adaptation Fund, and Global Environment Facility. In 2016, these four funds approved $2.78 billion of project support.

General requirements for climate finance:

- Applications require clarification on what part of the scope generates revenue and what doesn't generate revenue.
- Applications require affordability/financial modelling, but GCF may assist with funding for this.
- Application process takes about 12 months.

The following examples of international climate financing facilities are compared in Table 4-8:

- Climate Investment Fund
- Global Environment Facility
- Green Climate Fund
- Adaptation Fund
- Loan from the European Investment Bank - the biggest multilateral financial institution in the world and one of the largest providers of climate finance

As for DFIs, climate financing options also do not often provide 100% grant funding for a project, however, their grant contribution can assist with reducing the debt and equity contributions required to fund the project.

**Table 4-8: Climate financing options comparison**

| Fund name | Climate Investment Fund | Global Environment Facility | Green Climate Fund | Adaptation Fund | European Investment Bank |
|---|---|---|---|---|---|
| Financial instruments | Grants, Contingent grants, Concessional loans, Equity, Guarantees | Grants, Concessional loans, Equity, Guarantees | Grants, Contingent grants, Concessional loans, Equity, Guarantees, Results-based finance | Grants | Loans, guarantees, equity investments and advisory services. Financing can be blended with additional sources of investment such as financial instruments and grants from the EU and other donors. |
| Implementation agent | Agencies | Agencies | Agencies | Agencies | Direct Financing |
| Entities eligible for funding | Public entity at the national level, Private sector, Non-profit or civil society organization, International organization, Other | Public entity at the national level, Private sector, Non-profit or civil society organization, International organization, Other | Public entity at the national level, Private sector, Non-profit or civil society organization, International organization, Other | Public entity at the national level, Private sector, Non-profit or civil society organization, International organization, Other | Public and private sector institutions, and philanthropic organization |
| Specific categories of interest in Africa/South Africa | **Clean technology (low carbon)**, **energy access**, climate resilience, and sustainable forests in developing and middle-income countries | Agriculture, Ecosystem adaptation, Education, Energy efficiency, Forestry and Land-Use, Industry and Infrastructure, **Renewable Energy**, Rural, Transportation, Urban, **Waste management,** Oceans and Coastal Resources, Disaster risk reduction, Health, Gender, Jobs and Livelihoods, Poverty, **Water** | Agriculture, Ecosystem adaptation, Energy efficiency, Forestry and Land-Use, Industry and Infrastructure, **Renewable Energy**, Rural, Transportation, Urban, **Waste management**, Oceans and Coastal Resources, Disaster risk reduction, Health, Gender, Jobs and Livelihoods, Poverty, **Water** | Agriculture, Ecosystem adaptation, Energy efficiency, Forestry and Land-Use, Industry and Infrastructure, **Renewable Energy**, Rural, Transportation, Urban, **Waste management**, Oceans and Coastal Resources, Disaster risk reduction, Gender, **Water** | Known to work with projects that support sustainable economic development. These projects typically include:<br>· Climate and environment<br>· Economic resilience<br>· Fragile economies<br>· Food security<br>· Gender equality<br>· Youth<br>· Regional integration |

| Fund name | Climate Investment Fund | Global Environment Facility | Green Climate Fund | Adaptation Fund | European Investment Bank |
|---|---|---|---|---|---|
| Budget available to Africa/South Africa | $2.16 Billion approved for Africa | No specific information found | No specific information found | No specific information found | No specific information found |
| Specified project requirements | No specific limitations found | No specific details found. However, the following project categories exist:<br>· Full-sized Projects (FSPs) - More than US$2 million<br>· Medium-sized Projects (MSPs) - Up to US$2 million<br>· Enabling Activities (EAs) - Up to $1 million | No specific limitations found | No specific limitations found. However, the following categories exist:<br>· Small sized projects and programs [up to $1 million]<br>· Regular projects and programs [over $1 million] | Long term projects over 3 years in economic life. up to 50% of the projects total cost with loans starting at €25 million |
| Examples of interest rates | 0.25% | 0.25% - 0.75% | 0.75% | N/A | Contract dependent- To be decided upon signature or at each disbursement. |
| Co-financing requirements | Yes | Yes | No – the GCF can pay the entire cost of a project if it deems that to be justified. However, the GCF does consider the amount of co-financing available when assessing the potential efficiency and effectiveness of a proposed project | No | Yes |

### Green Climate Fund (GCF)

The GCF supports countries around the world to meet their Nationally Determined Contributions and commitments that were made as part of the Paris Agreement. South Africa has had six GCF project, with the total GCF financing coming to 152.8 million South African Rand. GCF projects fall under three strategic areas:

- **Climate change mitigation** interventions that seek to reduce the release of greenhouse gas emissions, or to increase the capacity of carbon sinks.
- **Climate change adaptation** of the most vulnerable communities to water-related disasters, such as droughts, floods, tropical cyclones and storm surges, and heat-related disasters such as heat waves and wildfires.
- **Cross-cutting projects** that provide both mitigation and adaptation benefits.

Many of the siltation management interventions proposed as part of this project could qualify for both climate change mitigation and adaptation, such as veld management, natural grassland management, wetland rehabilitation (mitigation), clearing of alien vegetation (adaptation) and conservation agriculture, agroforestry (cross-cutting).

The GCF funding process is summarised in Figure 4-1. It must be noted that the GCF does not implement projects directly itself, but through partnerships with Accredited Entities. The Development Bank of South Africa (DBSA) and the South African National Biodiversity Institute (SANBI) are South Africa's locally accredited agencies. As with other international grants, GCF follows a stringent and competitive process for the application for funding, particularly around gender and safeguards.

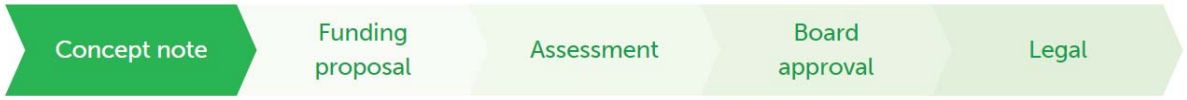



**Figure 4-1: Summary of GCF funding process** https://www.greenclimate.fund/projects/process

## 4.1.2.4 Carbon revenue for soil carbon sequestration

Under South Africa's carbon tax, implemented in 2019 for the first time, companies can reduce up to 10% of their carbon tax liability through offsetting. This policy places South Africa in line with international efforts in which carbon pricing, in its various forms (tax, cap-and-trade, shadow pricing), will play an important role in fulfilling the Paris Agreement. At the same time some South African projects have begun trading carbon credits on the voluntary market, independently of the tax or quota system. One carbon credit represents ownership of one metric ton of carbon dioxide (or its equivalent in other greenhouse gases) that has either avoided emission or sequestrated from the atmosphere in soil or plants.

Rural landowners can receive carbon credits in exchange for implementing land management practices that sequester high levels of carbon. Carbon dioxide can be removed from the atmosphere by various means such as agroforestry or perennial grasses and securely storing it in forms such as biomass or soil organic matter. When this sequestration is "additional" to business as usual, "permanent" and "measured" and "verified" by a third party, the associated carbon credits can be sold for revenue. Typically, carbon credits are then bought by other organisations or individuals that emit greenhouse gases and want or need to compensate for their emissions. An example of the soil carbon market is shown in Figure 4-2.

On Spier wine farm in Stellenbosch, a regenerative agriculture cattle grazing project has sequestered 15,886 tons of carbon dioxide equivalent (CO2e) on 158 hectares of land since its inception in 2011. In the period 2017 to 2019 this secured the company nearly R400,000 as a complement to its ongoing work. As this market expands and matures in South Africa, it will generate further opportunities and finance for the type of rehabilitation that has proven so difficult to finance to date. It could also incentivize

the type of livestock grazing practices that reduce erosion. For example, carbon credits, and their corresponding monetary rewards, could be used as an additional incentive to promote regenerative agricultural practices. Soil that is rich in soil organic carbon tends to be less prone to erosion, and similarly soils that are covered with vegetation, and stabilised with plant roots, tend to erode less.

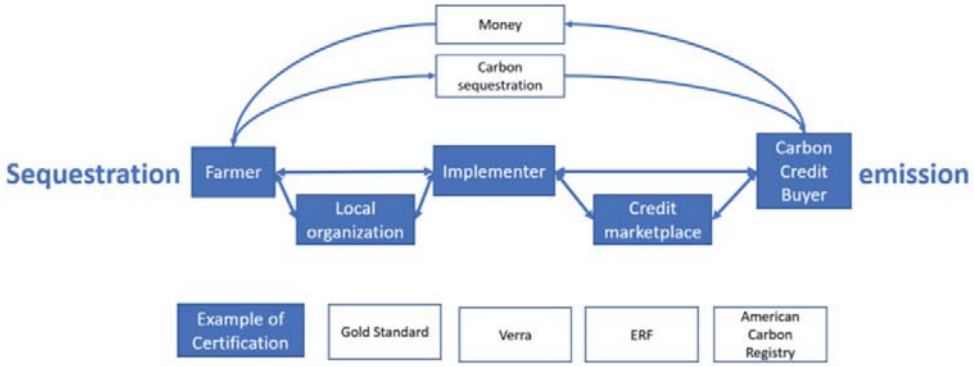



**Figure 4-2: Soil carbon market.** https://www.soilcare.eu/2020/09/24/how-to-get-carbon-credits-a-methodology-overview-for-soil-carbon-sequestration/

## 4.1.2.5 Other

### Mine rehabilitation funds

Mine rehabilitation funds are used to trap erosion, stabilise soils and enrich soil carbon.

### Corporate Social Investment

Many companies provide cash or in-kind funding as part of their corporate social responsibility (CSR) or corporate social investment (CSI). 90% of South African corporates invested something in CSR in 2019, cumulating in a documented R10.2 billion in that year (Cartwright, 2021).

In the context of siltation management, an example would be an industrial company installing a number of household rainwater tanks in the local community. It also entails money paid to the "Water Funds" by Pepsi, Levis, etc. CSI funding is however often quite rigid in what it can be used for.

## 4.2 Financing management

This section will cover mechanisms / avenues for revenue that can be generated to be used for either the operation and maintenance of siltation management measures, implementing management initiatives that do not require large up-front capital investments, or for the servicing of loans.

### 4.2.1 Government

South Africa's National Water Act recognises the multiple benefits that arise from healthy water catchments and functional hydrological systems and includes pricing instruments that can be used to invest in these public goods.

#### 4.2.1.1 Water Resources Management Charge

The Water Resources Management Charge (WRMC) is levied on all licensed water and intended to fund the activities of CMAs in each of the Water Management Areas (WMAs). These activities relate to the protection, allocation, conservation, management and control of all of the nation's water resources. The WRMC are levied by the Catchment Management Agencies (CMAs), where already established, or by the DWS Regional Offices. This responsibility is based on the CMAs and DWS Regional Offices' proximity to water users and the all-important catchments. The WRMC has two components, the abstraction water use charge and the waste discharge related water use charge. The WRMC is earmarked for 11 different types of functions or activities as shown below in Table 4-9. Item 9 in Table 4-9 (Maintenance and Restoration of Ecosystems to improve water resources), states that the following is included as an activity to be funded from the WRMC:

*Planning and implementation of ecosystem maintenance and rehabilitation programs, required for water resource protection, e.g.* ***sediment control****, nutrient trapping, riparian rehabilitation*

Considering the above, the WRMC can clearly be used towards the management of sediment in a catchment.

Chapter 5 Financial Provisions – Part I : Water Use Charges of the National Water Act (Act 36 of 1998) (NWA, 36 of 98) provides the foundation upon which the National Water Pricing Strategy for Water Use Charges (i.e. "the revised Pricing Strategy", currently published for public comment) have been drafted, and thus on which the Water Resources Management Charge are levied.

When considering the WRMC as it relates to sediment management, the revised Pricing Strategy is a definite improvement on the "*Pricing Strategy for Raw Water"* as published in Notice 1045 of 2005 in the Government Gazette No 27732 on 1 July 2005. Item 9 of the 2005 Pricing Strategy (related to Item 9 in Table 4-9 below) only allowed for activities related to Terrestrial Invasive Alien Plants (IAPs), whereas the revised Pricing Strategy has broadened this to include all activities dealing with the planning and implementation of ecosystem maintenance and rehabilitation programs required for water resources protection, including sediment control amongst others.

Section 56 (2) (a) of the NWA 36 of 98 states the following:

*"56 (2) The pricing strategy may contain a strategy for setting water use charges-*

*(a) for funding water resource management, including the related costs of-*

*(i) gathering information;*

*(ii) monitoring water resources and their use;*

*(iii) controlling water resources;*

*(iv) water resource protection, including the discharge of waste and the protection of the Reserve; and*

*(v) water conservation;"*

The waste discharge activities component of the WRMC (refer to Table 4-9) is also covered by the NWA, 36 of 98, as follows in Section 56 (5)

*"56 (5) The pricing strategy may provide for a differential rate for waste discharges, taking into account -*

*(a) the characteristics of the waste discharged;*

*(b) the amount and quality of the waste discharged;*

*(c) the nature and extent of the impact on a water resources caused by the waste discharged;*

*(d) the extent of' permitted deviation from prescribed waste standards or management practices; and*

*(e') the required extent and nature of monitoring the water use."*

The above provides clear justification for also including the waste discharge portion int the WRMC.

The challenge in applying the WRMC for the maintenance and restoration of ecosystems, is that there are significant delays in establishing the Catchment Management Agencies. In instances where the CMAs were established, the accounting systems does not necessarily distinguish between the WRMC received and other revenue.

Regardless of the institutional challenges that must still be overcome with the establishment of all the CMAs, higher WRM charges are required to support catchment rehabilitation and water security, as well as the local capacity to oversee the necessary projects. The exact extent of an increase in WRMC are not known, but will depend on, inter alia:

- The cost of rehabilitation. Precedents exist but the actual cost is known to vary with topography, extent of rehabilitation and methods applied.
- The proportion of the WRM charge allocated to "maintenance and restoration of ecosystems" (relative to the other 10 items),
- The extent of catchment rehabilitation that is paid by water users relative to contributions from other sources.
- The extent of water revenue that is actually collected (the 60% currently collected by Breede-Gouritz is considered a "good" level).

Given the above considerations, the quantification of an increase in the WRMC is likely to be different for every CMA / DWS Regional Office. However, the Breede-Gouritz CMA experience can be used as a case study to illustrate the magnitude of increase that can be expected.

For effective catchment stewardship in the Breede-Gouritz CMA, WRMC revenue would have to increase from R11 million in 2019/20 to an average of R100 million per annum for the period 2021 to 2026. In the Greater uMngeni the requirement is for an increase from R16 million to R100 million over the same period. This revenue increase could be achieved by increasing the WRMC paid by domestic and industrial users from its current level of R0.054 per $m^3$ to R0.410 per $m^3$ of water in the Berg-Breede CMA. The required revenue could be raised by a WRMC of R0.21 per $m^3$ on all users if the prevailing price cap on agricultural and forestry users were to be lifted, and the burden of raising money for catchment stewardship shared across all water users in the Berg-Breede CMA (Cartwright, 2021).

Funding a R250 million catchment rehabilitation programme over 5 years in the Greater uMngeni under the same assumptions, would require an increase of the WRMC from current levels of R16 million per annum (R0.033 per $m^3$ of water on average) to R100 million per annum (R0.22 per $m^3$ of water) for the municipalities and industrial users purchasing water from Umgeni Water (Cartwright, 2021).

While these increases are steep, they represent only a 1% - 2.5% increase in the net price for water paid by municipal and industrial users. Nonetheless, WRMC should be increased in a planned and gradual manner. This includes plans to remove the WRMC cap currently available to agricultural and forestry users.

The Department of Water and Sanitation does have the choice of increasing WRMC as above, or forging new partnership with other public entities (Environmental Affairs, Agriculture, Department of Trade and Industry, local governments) in order to co-fund catchment stewardship, in which case smaller WRMC increases are possible. Inaction, or continuation at current levels is not a defensible or prudent strategy, given policy obligations on the Department of Water or Sanitation to plan for and provide long term water security.

Regulations exempt historically disadvantaged farmers and foresters from WRMC increases, thereby removing the regressive implications of price increases. Banks and insurers will, however, be required to offer finance and incentives to allow municipalities and intensive water users to adapt to higher WRMC charges by becoming more water efficient.

Applying Section 30 of the Water Services Act to mandate irrigation and water boards, and possibly the Trans-Caledon Tunnel Authority, with catchment stewardship would bring new capacity to bear on the challenge of catchment stewardship while CMAs are still being formed. It would also allow for portions of the Water Resource Development charge levied on bulk infrastructure to be allocated to supplementary ecological infrastructure.

The current freeze on water price increases foments water insecurity risk by undermining investment in water governance and catchments. Programmes such as Landcare have demonstrated that users are prepared to pay for catchment rehabilitation, provided they see the benefits in terms of water security. Water catchments play a critical, and cost-effective, role in South Africa's water security and not applying the available pricing instruments to raise money and invest in them, represents a form of negligence.

**Table 4-9: Water Resource Management Charge**

| Function / Activities | Taking water (abstraction activities) | Waste discharge activities |
|---|---|---|
| **1. Catchment management strategy and water resources planning** | • Resource studies, investigations and integrated strategy development | |
| | • Allocation plans | • Water quality management plan |
| **2. Resource directed measures** | • Implement programmes to monitor Resource Quality Objectives (RQOs)<br>• Implement source-directed controls to achieve resource quality objectives<br>• Report against the achievement of the Class and RQOs<br>• 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 | |
| | • Abstraction & stream flow reduction activities Authorization | • Waste discharge activities Authorization |
| **4. Control and enforcement of water use** | • Control Monitoring and enforcement of Water Use | |
| | • Abstraction & stream flow reduction activities<br>• Dam safety control (private dams) | • Waste discharge control |
| **5. Disaster management** | • Planning and management of disaster (Administration) | • Pollution incident planning and response (management) |
| **6. Water resources management programmes** | • Integrated water resources programmes | |
| | • Implementing of water management strategies (e.g. water conservation and water demand management) | • Implementing of water management strategies (e.g. cleaner technology, dense settlements, waste discharge strategies) |

| | |
|---|---|
| **7. Water related institutional development (Stakeholder Management empowerment)** | • Stakeholder participation, empowerment, institutional development & coordination of activities<br>o Establishment and regulation of water management institutions<br>o Stakeholder consultations<br>o Capacity and Empowerment of stakeholders |
| **8. Water weed control** | • Aquatic weeds control |
| **9. Maintenance and Restoration of Ecosystems to improve water resources** | • Planning and implementation of ecosystem maintenance and rehabilitation programs, required for water resource protection, e.g. sediment control, nutrient trapping, riparian rehabilitation<br>• 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<br>• Compiling of maps and yield information<br>• Extending and maintaining the hydrological database & compilation of information |
| **11. Administration & Overheads** | • Administrative, institutional & overheads for regional office or CMA |

*Source - DWS National Pricing Strategy for Water Use Charges*

The DWS National Pricing Strategy for Water Use Charges provides specific guidelines for application of the WRMC to abstraction activities, as well as to waste discharge activities. The strategy provides information on exemptions and rebates that relates to WRMC. It is important to also note that the DWS National Pricing Strategy for Water Use Charges makes allowance for subsidisation across Water Management Areas. The pricing strategy states that "*where the quality of streamflow from an upstream WMA imposes a water quality management cost on the downstream WMA, this additional cost will be funded by WRM charges on waste dischargers in the upstream WMA.*"

Considering that sediment falls under the definition of 'waste' as per the NWA, 36 of 1998, there is a strong case to be made for funding from the WRMC of upstream WMAs to cover associated costs in downstream WMAs as it relates to sediment management.

For the waste discharge charge component, the calculation of charges will be based on the volume of wastewater discharged from a point source, and on the degree of management activity required for non-point source registered uses.

### 4.2.1.2 Water Resources Infrastructure Charge

The Water Resources Infrastructure Charge (WRIC) provides for the development and use of Government waterworks and may include the related costs of investigation, planning, design and construction of water schemes (i.e. engineering infrastructure), which constitute the capital cost of projects.

The pricing strategy considers the costs through the full lifecycle of the infrastructure and therefore makes provisions for four components to this charge, namely:

- Operations and Maintenance
- Depreciation / Refurbishment
- Future Infrastructure Build Charge (FIBC), and
- Capital Unit Charge, used to cover off-budget financing costs (i.e. interest charged by financiers), and discussed in section 3.2.1.3.

Section 56 (2) (b) of the NWA, 36 of 1998 is the basis upon which the Water Resources Infrastructure Charge is derived at, as it is stated:

*"56 (2) The pricing strategy may contain a strategy for setting water use charges—*

*(b) for funding water resource development and use of waterworks, including-*

*(i) the costs of investigation and planning;*

*(ii) the costs of design and construction;*

*(iii) pre-financing of development;*

*(iv) the costs of operation and maintenance of waterworks;*

*(v) a return on assets; and*

*(vi) the costs of water distribution;"*

The Pricing Strategy states that in terms of development of new infrastructure, Department funding will in future be confined mostly to social water resource development or betterment projects, which conform to the purpose, set out in Section 2 of the NWA, 36 of 1998, and where the demand is not driven by specific commercial water users or sectors. Section 2 of the NWA is included below, with basically all of the factors listed that could be derived as a benefit from improved sediment management.

*"2. The purpose of this Act is to ensure that the nation's water resources are protected. used, developed, conserved, managed and controlled in ways which take into account amongst other factors—*

*(a) meeting the basic human needs of' present and future generations:*

*(b) promoting equitable access to water*

*(c) redressing the results of past racial and gender discrimination*

*(d) promoting the efficient, sustainable and beneficial use of water in the public interest*

*(e) facilitating social and economic development*

*(f) providing for growing demand for water use*

*(g) protecting aquatic and associated ecosystems and their biological diversity*

*(h) reducing and preventing pollution and degradation of' water resources*

*(i) meeting international obligations*

*(j) promoting dam safely*

*(k) managing floods and droughts*

*and for achieving this purpose. to establish suitable institutions and to ensure that they have appropriate community. racial and gender representation."*

Capital expenditure related to the social component of Government waterworks for the promotion of equitable access to water, as well as meeting current and future international obligations and dam safety betterments, will qualify for financing under Section 111 of the NWA:

*"111. The Minister may finance the acquisition, construction, alteration, repair. operation and control of' government waterworks from funds appropriated by Parliament or obtained from any other source."*

The WRIC is normally levied by the Trans-Caledon Tunnel Authority (TCTA) and Water Boards to repay loans for large infrastructure projects that are developed. A means of financing sediment management is possible if portions of the Water Resource Development (WRD) charges and Capital Unit Charges used to fund dam construction and service the finance used to construct dams, are earmarked for upstream ecological infrastructure. This can be achieved by applying both good financial logic in terms of protecting the assets being constructed and ensuring they deliver maximum value, and Section 30 of the Water Services Act to mandate irrigation and water boards, and possibly the Trans-Caledon Tunnel Authority, with the catchment stewardship (Cartwright, 2021). Section 30 of the WSA, 107 of 1997 states:

*"30. (2) Other activities of a water board may include, but are not limited to-*
*(c) providing catchment management services to or on behalf of the responsible authorities;*
*(f) performing water conservation functions"*

The success of this approach is contingent upon the entities responsible for water infrastructure in South Africa forging the partnerships that will enable them to engage local communities. Only once a shared 'outcome' to the problem of sediment is clearly defined, might the required finance be effectively spent. The financial and developmental success of eThekwini Municipality's Transformative Riverine Management Programme reveals what is possible when local communities are enfranchised in integrated water resource management (Mander et al., 2021).

#### 4.2.1.3 Capital Unit Charge

Water management institutions such as the TCTA, which are directed by the Minister of Water and Sanitation to implement and fund government water schemes off-budget, are entitled to raise loans to finance the development of new water resource infrastructure, and to service these loans through cost recovery. The TCTA or any future body responsible for off-budget national water resources infrastructure will determine the extent of charges as determined by the proposed financial modelling.

The primary charge will be the Capital Unit Charge (CUC). These charges must be developed after consultation with relevant water users. The charges may be developed on a project-by-project basis. However, if the institutional arrangements change to enable it, such charges may be dealt with on a scheme, system based or national approach as appropriate.

*The CUC is specifically used to cover the capital interest costs paid to private financiers. It is a "cost of off-balance sheet capital" that does not appear as a corresponding asset on their asset registry.*

The TCTA may enter into an implementation agreement with the Department of Water and Sanitation ("DWS") and DWS may thereafter enter into a water supply agreement with the end-users. Consequently, these agreements will be "back-to back" and serve the purpose of recording the rights and obligations of the parties in the implementation, financing and supply of water pertaining to the new government water work. In these instances, the TCTA will levy the CUC onto DWS and DWS will in turn levy the CUC onto the end-users. A cession may be signed between the parties whereby the CUC charge is paid directly to the TCTA.

It is technically possible to add specific infrastructural measures to deal with siltation of dams during construction of the schemes and recover through the CUC.

#### 4.2.1.4 Waste Discharge Charges

This Waste Discharge Charge System (WDCS) is based on the polluter pays principle and provides an economic instrument to assist other regulatory tools in moving towards (or maintaining) the desired state of surface water resources, represented by Resource Quality Objectives (RQOs) or Resource Water Quality Objective (RWQOs).

According to Section 56(5) of the NWA the pricing strategy may provide for a differential rate for waste discharges, taking into account the characteristics of the waste discharged, the amount and quality of the waste discharged, the nature and extent of the impact on a water resource caused by the waste discharged, the extent of permitted deviation from prescribed waste standards or management practices, and the required extent and nature of monitoring the water use.

WDCS was developed around the "polluter pays principle", and the use of economic instruments and aims to:

- Promote the sustainable development and efficient use of water resources
- Promote the internalisation of environmental costs by polluters
- Create financial incentives for dischargers to reduce waste and use water resources in a more optimal way
- Recover costs associated with mitigating the water quality impacts of waste discharge

As per the revised Pricing Strategy, the WDCS consists of two charges:

- The **Waste Discharge Levy** seeks to change discharge behaviour and is an unrequited payment (in that it does not recover any direct costs and is not related to receiving a particular service). The Waste Discharge Levy is thus an environmental tax, which requires the promulgation of a Money Bill in terms of NT's environmental tax policy.
- The **Waste Mitigation Charge** is intended to cover the costs of mitigation measures undertaken for the benefit of the water resource and will be applied in cases where it is more cost-effective to undertake joint measures for waste discharge mitigation.

Where the 2005 Pricing Strategy followed a very simplistic approach for Waste Discharge by simply linking it to the total registered salt and/or phosphate load for each wate ruse category, the revised draft Pricing Strategy distinguishes between the levy and charge as described above, and also links it to more nutrient parameters.

The intention is to implement the WDCS at a catchment or sub-catchment level as part of a water resources management planning process to support the achievement or maintenance of resource classification and the objectives of the Catchment Management Strategy. This approach should make it ideal for sediment management as the generation, transport and trapping of sediment would be catchment specific.

However, there are challenges foreseen with the implementation of the WDCS, inter alia:

- Erosion and generation of sediment generally occurs over a large area, i.e. it is generally a non-point source of pollution. Before the WDCS can be considered to be levied as a potential source of revenue for sediment management, appropriate methods need to be developed to 1) quantify the volume of sediment generated from specific land portions; 2) make a determination about the quality of the sediment (i.e. whether it is hazardous or not, etc.)
- The WDCS will be levied on water quality variables that critically impact on the RQOs, which will be selected with due consideration to the type of waste discharge sources, the nature of the waste typically discharged, and the cost-effectiveness of monitoring different variables. However, sediment is not listed a parameter to determine the resource quality (constituents contained in the sediment might be), and therefore there might not be any basis on which to levy the WDC.

#### 4.2.1.5 Raw Water Tariff or Scheme Charge

WUAs and Irrigation boards can develop their own tariffs as part of the raw water supply agreements with schemes such as TCTA. They can add additional charges to their water pricing which can include catchment management activities to safeguard and manage their resources.

#### 4.2.1.6 Environmental Levy

The "polluter pays principle" is taken up in the National Environmental Management Act, Act 107 of 1998 (NEMA, 107 of 1998) principles:

*"2 (4) (p) The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment."*

Further, the South African Revenue Service (SARS) is already responsible for collecting several environmental levies for various purposes. A potential disadvantage of levies collected by SARS is that they go into the general revenue fund and cannot easily be ring-fenced for use on a particular project.

Such a proposed environmental levy has the same type of challenges as the WCDS, in that it will be very difficult to determine the volume and characteristics of sediment generated by any specific land portion.

#### 4.2.1.7 Presidential Infrastructure Fund (administered by DBSA)

The Infrastructure Fund is intended as government funding and ancillary support for co-financing of blended finance programmes and projects. This includes financing from the local capital market and international financing institutions as a complement for broader budgeting reforms that the Government is undertaking to address problems in the infrastructure value chain.

Through the Infrastructure Fund, Government will provide support for co-financing of projects and programmes that blend public and private resources. Currently provision has been made for R100 billion over 10 years, with R10 billion funding in the current MTEF baseline. The Infrastructure Fund will be used as viability gap funding for large-scale infrastructure investments. The support will take different forms, including to fund deserving infrastructure projects, blended co-funding, capital subsidies or interest rate subsidies and guarantees.

The parties in the Infrastructure Fund include Infrastructure South Africa (ISA) in the Department of Public Works and Infrastructure (DPWI); the National Treasury and the Development Bank of Southern African (DBSA).

The responsibilities of ISA will be to, inter alia, co-ordinate the infrastructure value-chain through the development, assessment, management, project preparation, implementation and monitoring of a comprehensive infrastructure pipeline and related investment for South Africa.

The responsibilities of National Treasury will be to facilitate government's contribution of the funding by putting in place defined budgeting processes for the Infrastructure Fund.

The obligations of the DBSA towards the Memorandum of Agreement (MOA) will be to establish the Infrastructure Fund through a dedicated implementation unit housed in the DBSA and to manage and administer the Fund. The important responsibility of the DBSA will be to facilitate the financial structuring, procurement and implementation of priority blended-finance projects and programmes, as identified by ISA.

### 4.2.2 Non-governmental / Private

#### 4.2.2.1 Revenue from Products

The common conception is that most sediment management projects will not be economically feasible, if one is to rely only on the additional economic benefit from increased hydropower production and assurance of supply. It is for this reasons that other sources of revenue such as from the sale of potential waste products retrieved from the sediment management process must be explored.

The most obvious 'products' are the sediment removed from dams (also upstream check dams) and that can be applied to a multitude of uses, although there might be other products as well such as minerals that might be present in the sediment and that can be mined, or soil that can be used for land reclamation thereby creating new real estate. Section 4.3.4 of the Handbook for Assessing and Managing Reservoir Sedimentation (CMC (2019)) provides good examples of the possible uses of waste products obtained from sediment management interventions.

The manner in which the revenue from the sale of waste products is handled must be considered. The most appropriate arrangement would be where the service provider (e.g. the dredging company) collects the revenue from the sale of the waste products (with consideration of any sediment that might need to be released downstream of the dam to restore the ecosystem). Any procurement documents for a sediment management intervention must encourage / incentivize the bidders to incorporate innovative ways into their bids to recoup and sell waste products to reduce the waste disposal and to decrease the cost of the intervention.

However, whilst there can be clear tangible products that can be sold (e.g. reclaimed soil, new waterfront properties, etc.), there will be several other abstract benefits (e.g. increased assurance of supply, better water quality, increased crop yields, etc.), but the payment for these benefits should already be covered

under the Water Resource management charge, and thus it cannot also be levied for here otherwise of will be levy anything for it here, otherwise it will be charged double.

#### 4.2.2.2 Revenue from Mines

In certain catchments where it is evident that historical or current mining actions contributes or contributed to the sedimentation of dam, the option of recouping costs from mines should be explored as follows:

a) Mine liability

The mines have a liability to pay for environmental damage caused, and the issuing of mining licenses is contingent upon money being set aside for mine rehabilitation once the mine is decommissioned. A number of mines in South Africa, most notably certain Sibanye mines on the West rand, have recently begun the process of rehabilitation. These processes hold the potential, and the budgets, for the type of restoration that could prevent silt mobilisation. There are some challenges in tracing owners of discontinued (smaller) mines and the liability for mines that have untraceable owners or are "ownerless" rests with the State. For most mines, however, there are enforceable legal mechanisms whereby mines can be held liable for costs associated with the management of the environmental impact caused from mining operations.

b) Provisional Funds

Moneys set aside as provision for rehabilitation purposes can, under certain circumstances, be utilised by the Minister of Mineral Resources for sedimentation management where holders of new order or old order prospecting or mining rights are liable to pay for rehabilitation. These funds are not very large and are not envisaged to be a significant component of the cost recovery.

Consideration should also be given to the positive role mines could play to reduce treatment costs of water if mining areas are properly rehabilitated and healthy wetlands are created and maintained. Report No. TT 726/17 by the WRC (WRC, 2017) provide good motivation for benefits of healthy aquatic ecosystem services.

#### 4.2.2.3 Water Funds

The Nature Conservancy (TNC) has begun a process of mobilising private (and some public) funds in support of water funds (e.g. the Greater Cape Town Water Fund). The focus of these funds has been on water security, but their funds tend to be invested in the type of catchment stewardship that could prevent erosion and silt mobilisation and also intercept silt before it reaches dams and reservoirs.

As with other sources of funding, the key for TNC will be to align their investment in support of agreed-upon catchment management strategies to ensure complementarity and coherent investment.

Payment for Ecosystem Services (PES) is incentives that are offered to upstream users (such as farmers) in exchange for them managing their land in such a way as to provide an ecological service, such as practising organic farming that will not pollute waterways further down the catchment. In South Africa, it is not possible for PES schemes to facilitate a preferential position in the hierarchy of water users. That hierarchy is established in legislation and cannot be changed. However, a number of intensive water users have begun investing in water catchments as a means of enhancing the water security of the entire system on which they depend.

It should be noted that there is a distinction to be made between general Water Funds and PES schemes. Water Funds is primarily focused on water security, and it is driven by the private sector & private sector funding (with some public funding), whereas PES schemes should be driven by government (and collection of private & public funds) with the primary focus on improving the water quality in receiving catchments.

For the moment, most PES schemes are still in the pilot stages in most countries, and it is hard to quantify their benefits. Studies have shown that payments are often too low to cover the opportunity

costs of profiting off the natural resources, such as deforestation. It is also not typically financed by the private sector. Coca Cola has implemented PES schemes intended to support farmers to engage in sustainable land management practices, financed through payments from Coca Cola as a downstream water user. However, these examples are few and far between, and typically always require a financial partnership with a local water authority. The economic free-rider problem where other users benefit from the PES provides a big incentive for the private sector to rather utilise its funds for interventions that will primarily benefit themselves, such as water treatment facilities.

Costa Rica is perhaps the one country that has successfully been implementing PES since 1997 but operates under very different water governance mechanisms than South Africa. The national government in Costa Rica adopted a mix of economic and regulatory policies to protect its forests. This led to a dramatic increase in its forest cover, from less than 30% in the 1980s to 54% of its territory today. It is important to note that the PES success story in Costa Rica was driven by the government, and required a strong legal environment, political will, the existence of complementary policies, absence of perverse public policies, land tenure security, and most importantly, a sustainable financial structure.

Figure 4-3 provides the conceptual framework for PES, from the supply to the demand side of the equation, as well as the need for the implementing agency to have a sustainable finance structure.

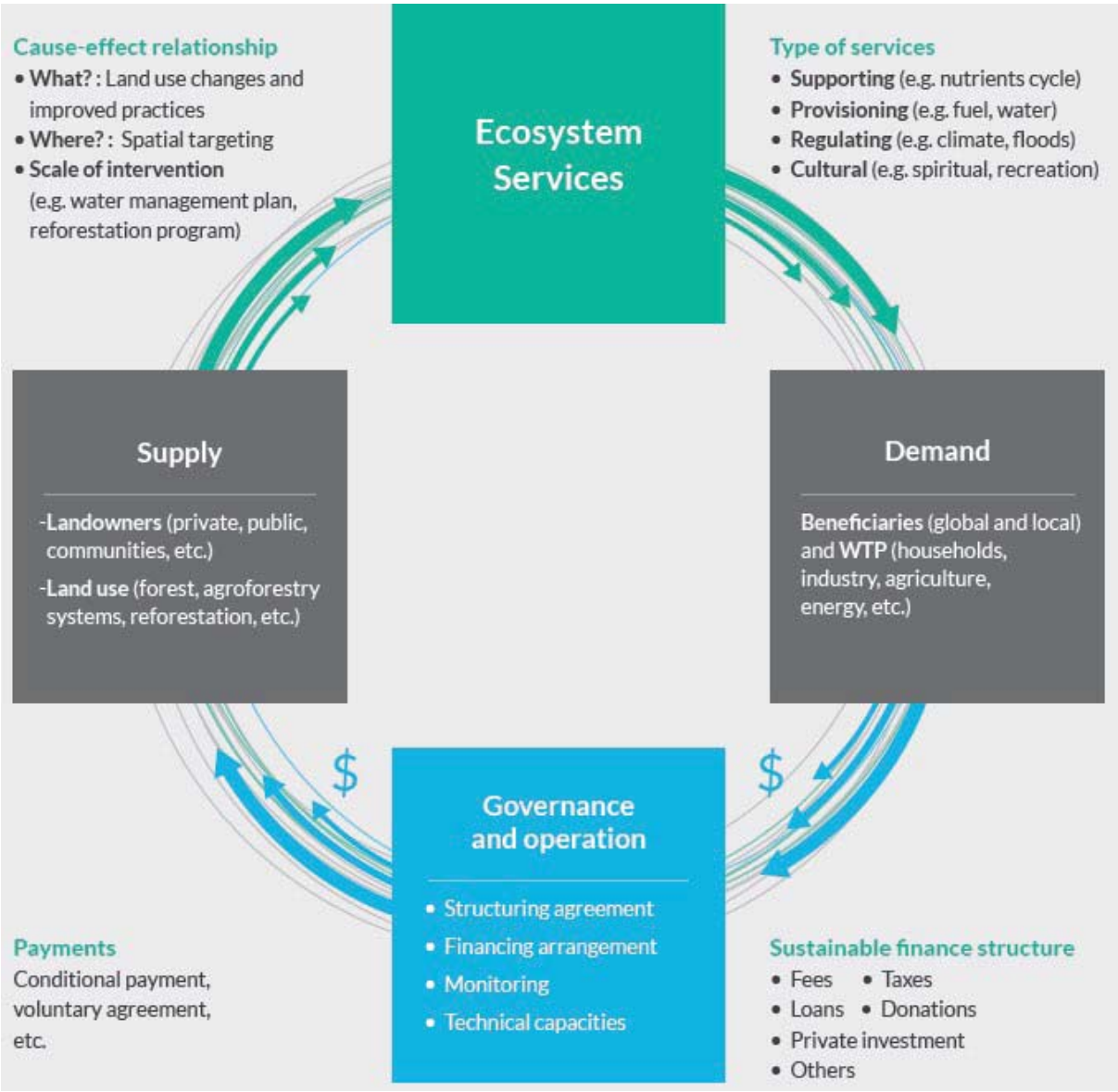



**Figure 4-3: Conceptual framework for PES. From *Global Green Growth Institute (2016b)***

#### 4.2.2.4 NGOs

Meat Naturally is an example of an NGO that could support sediment management. Meat Naturally is a critical link between Africa's small-scale farmers and commercial meat buyers, between NGOs and rural economic development, between economic and ecological enhancement, and between traditional farming methods and new market opportunities. Knowledge and tools are provided to the farming community to break down former economic barriers, while motivating them to invest in restoring Africa's rangelands and wetlands.

Meat Naturally collaborates with NGOs to deliver economic and environmental prosperity to local communities and emerging farmers. They partner with organisations, providing technical expertise, tools and resources for sustainable farming and rangeland restoration. Services include grazing plans and mapping, formal training for livestock farmers, vaccinations, tagging, and community-based market access reaching new buyers for rural farmers.

#### 4.2.2.5 Capital Unit Charge

#### 4.2.2.6 Microfinance

Microenterprises can often dominate the market, particularly in rural areas. These enterprises can have negative environmental impacts that, although perhaps small, can culminate in greater environmental degradation. Microfinance institutions (MFIs) therefore have a unique opportunity to stimulate the economic development of microenterprises whilst also addressing certain ecological problems.

An example of microenterprises that can have significant impacts on erosion and downstream silt problems are agriculture (crops and grazing cattle) and forest product collectors (both for fuel and timber-product). Farmers often obtain credit from MFIs to finance their seed and pesticide inputs. MFIs could therefore have impacts in the following ways:

- MFIs could provide economic incentives to farmers to purchase diverse seed types and promote crop rotation management practices. Incentives could include favourable interest rates or reduced premium, based on sound agricultural practices.
- MFIs could apply a loan application process where the farming methods are screened. Only farmers practising certain techniques (such as crop rotation or conservation tillage) will be approved for loans, or perhaps they will be approved for a more favourable loan.
- MFIs typically provide a variety of training opportunities to their clients, and this is often a prerequisite to obtaining a loan. These training programs could be leveraged to include training on environmentally sound crop and livestock farming practices.

While MFIs can play a fundamental role in shaping farming practices for small-holder farmers, they would require financial backing to support this initiative. Many farmers may require additional support in the beginning stages of switching to conservation agriculture, as their yields will likely decrease. Development finance institutions mentioned in Section 4.1.2.2 could provide capital here, as well as local governments.

# 5 Implementation of siltation management interventions

Implementing interventions for dam siltation management requires a feedback loop for all organisations involved at all levels (Figure 5-1). Although a Government Department will have a mandate for land or water resource management, this will need to be informed by specialist studies, research or monitoring in the field. Therefore, the needs of Government should direct research and institutions to collect relevant data for informed decision making. At the same time other external international or local organisations may have their own global or local priorities, which can be used by Government Departments, but will mainly inform the organisations' implementation of intervention activities. Government Departments can draw on both pools of evidence to make decisions about the "where, what and how" of dam siltation management which will then inform their own short- to long-term contracts with implementing agencies. Again, the external implementation will be confined to the legislation defined by these Government Departments; hence, there is a level of interaction with Government at this scale.

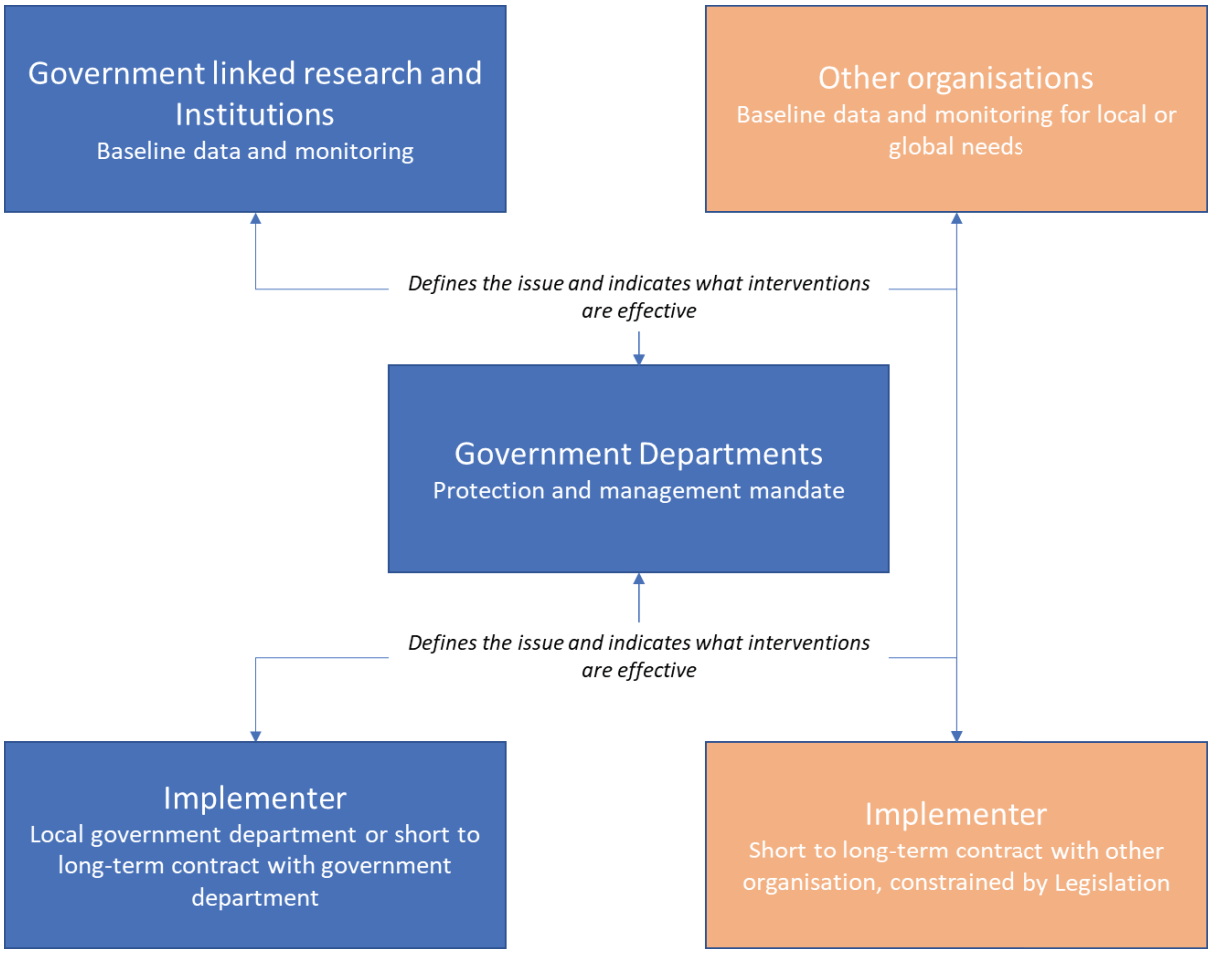



**Figure 5-1: The levels of interaction of different role players in prevention and management of dam siltation.**

The roles and responsibilities of different implementation agencies are outlined below. Table 5-2 distinguishes between the following potential implementation agencies and institutions:

- Mandated to implement or authorise individual interventions
- Main implementers of individual interventions, if they are different to those who are mandated
- Co-Participants in the implementation.

## 5.1 Government departments

The DWS is mainly a service-driven department, focusing on the delivery of water supply and sanitation services across the country. The department is envisaged to shoulder the responsibility of management of available water resources to balance the spatially and temporally variable availability of water resources for sustainable development. This is hampered by a large number of aging reservoirs experiencing steadily growing sedimentation problems. This underscores the need to analyse the sedimentation status and management potential for all reservoirs, and to begin aggressive implementation of technologies to sustain reservoir function. As with other services, however, the accumulation of silt in South Africa's dams requires the department responsible for service delivery to either take on unfamiliar responsibilities (such as catchment stewardship) or build the partnerships necessary to sustain the service.

The National Water and Sanitation Masterplan, released by DWS late in 2018, identified both the need for an expanded departmental mandate and new partnerships. Section 8 of the plan addresses the need for, "Protecting and Restoring Ecological Infrastructure" which in itself would go some way towards erosion and sedimentation prevention. In the South African context, the lack of national guiding principles on sedimentation management is a challenge to the implementation of an Integrated Sediment Management Framework, and it is therefore recommended that as a first step South Africa should develop high-level policies to guide both public and private stakeholders in managing sediment sustainably. This would help mobilise additional blended financing, which often requires a strong institutional capacity.

One of the stumbling blocks in implementing the NWA and preventing dam sedimentation has been overlapping mandates. The **Department of Forestry, Fisheries and Environment (DFFE)** has a mandate under the National Environmental Management Act (NEMA) (Act 107 of 1998) to protect the environment and has listed activities which require an environmental impact assessment. An amendment to this act in 2003 mandated the same department to prevent mining in strategic water source areas (Nel et al., 2013). At the same time, **the Department of Agriculture, Land Reform and Rural Development (DALRRD)** is responsible for the conservation of soil and land under the Conservation of Agricultural Resources Act (CARA) (Act 43 of 1983), the **DWS** is responsible for the hydrological functionality of water catchments and is the custodian of all water resources whilst **local governments** have the mandate to issue zoning proclamations that control the extension of human settlements. Integrated governance is further complicated by **private land ownership** in many water catchments, and by the land administration role performed by **traditional leadership** in KwaZulu Natal under the iNgonyama Trust.

Cartwright (2021) outlines various government institutions and their responsibilities for water management in South Africa in Table 5-1.

**Table 5-1: Institutions and their responsibilities comprising South Africa's water governance, from *Cartwright (2021)***

| Water Institution | Responsibility |
|---|---|
| **DWS (Department of Water and Sanitation)** | • Custodian of water resources and overall policy maker and regulator (there is no independent regulator).<br>• Oversees the activities of all water sector institutions.<br>• Responsible for national/international resource planning and allocation.<br>• Licenses water use and discharges and collects abstraction and discharge fees.<br>• Manages water resources infrastructure (for example, dams) and also some water services infrastructure. |
| **CMAs (Catchment Management Agencies)** | • Water resource planning and management at the catchment level (where CMAs are not established, DWS fulfil these functions).<br>• Provision of water services within their appointed areas. Includes metropolitan municipalities, many district municipalities and authorised local municipalities. |
| **WSAs (Water Services Authorities)** | • Provision of water services within their appointed areas.<br>• Includes metropolitan municipalities, many district municipalities and authorised local municipalities.<br>• May contract out service provision to external water services providers, including water boards. |
| **WSPs (Water Service Providers)** | • Operational water provision and/or sanitation services (as a bulk or retail service). |
| **Trans-Caledon Tunnel Authority** | • A State-Owned Entity responsible for financing and implementing bulk raw water infrastructure projects. |
| **Water Boards** | • Regional or bulk water services providers (sell water to, or accept wastewater from, other water services providers).<br>• As WSPs, the Boards are accountable to WSAs; as organs of state, the Boards are owned, controlled and regulated by DWAF and National Treasury (NT) under the terms of the Water Services Act, 1997 and the Public Finance Management Act, 1999. |
| **Irrigation Boards** | • Predate the NWA. Focus on the management of an irrigation scheme.<br>• Typically established to support the needs of "white" commercial farmer members prior to 1994. |
| **Water User Associations** | • Co-operative associations of water users established under the NWA to undertake water-related activities for the mutual benefit of all its members.<br>• Members co-operate and pool resources to address local water related needs and priorities. |

## 5.2 Government-linked research institutions

The WRC has a vital role in water research by establishing needs and priorities, stimulating and funding research, promoting the transfer of information and technology, and enhancing knowledge and capacity building in the water sector. Although it is a public entity that reports to the DWS, it is a resource for all departments regarding water resources management. The WRC has a Resource Hub where previous reports are available, and the quality of research is maintained through the involvement of a Reference Group during each research project.

SANBI, SANParks and Cape Nature are institutions which have a role to play in gathering first-hand evidence for environmental research. Projects are also presented as reports or spatial data that undergo a rigorous scientific review process and are available for public use.

The ARC drives research and development that promotes agriculture and related industries, ensures natural resource conservation and alleviates poverty. Project outputs are presented as peer-reviewed reports or spatial data, which are mainly available for public use.

## 5.3 Other organisations

Other international and local organisations not linked to government departments have their own interests and needs. An example of this is the World Wildlife Foundation (WWF), which has a large local footprint in South Africa and who works with businesses, farmers and communities to help protect biodiversity. The Nature Conservancy (TNC) is an NGO which has an interest in South Africa and has worked on the Cape Town Water Fund and other funds to improve water security in the region. More localised organisations are focused on community interests such as Meat Naturally, based in Matatiele in the Eastern Cape. Meat Naturally has been working with communities to improve veld management and at the same time improve livelihoods. Coal-Tech and ESKOM are examples of mines that work closely with the WRC and could be potential collaborators.

## 5.4 Implementers

Implementers can be grouped into those that work through government tenders, or those that work through other organisations. Government tenders will have legal constraints which will need to be understood by the implementer. When the government department itself is the implementer, this will also need to adhere to legal constraints. Communities, landowners or dam owners may be incentivised by their own interests and implement projects themselves. Specialist engineering and ecological consultants are usually involved in the on-the-ground activities.

**Table 5-2: Agencies which are mandated and responsible for implementing, or should be involved with, sedimentation management interventions**

| | | | National | | | | | | | | | | Provincial | | | | | Other | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DWS | DALRRD | DMRE | SANBI | ARC | LandCare | " Working for" programs | SANRAL | Water boards | CMA | DFFE | DALRRD | BRIP | Biodiversity agencies | Provincial Roads | Local municipality | NGO e.g. Meat Naturally | Dam operator | Dam owner (e.g. DWS) | Landowner | Homeowner | NGOs | WUA |
| Source | Improve vegetation cover | Veld management | | | | | | | ❖ | | | ❒ | ◆ | ◆ | | | | | ❖ | | | ❖ | | | |
| | | Conservation agriculture | ❒ | | | | ❖ | ❖ | | | | ❒ | | ◆ | | | | | | | | ❖ | | | |
| | | Rainwater harvesting | | | | | ❖ | | | | | | | ❒ | | | | ◆ | | | | | ❒ | ❖ | |
| | | Agroforestry | ◆ | | | | | ❖ | | | | | ◆ | ❒ | | | | | | | | ❒ | | | |
| | | Natural grassland management | | | | ❖ | | ❖ | | | | | ◆ | | | | | | | | | ❒ | | | |
| | | Wetland rehabilitation | ◆ | | | ❖ | | | | | | ❒ | ◆ | | | | | | | | | | | | |
| | | Clearing of alien invasive plants | ◆ | | | | | | ❖ | | | ❒ | ◆ | | | | | | | | | ❒ | | | |
| | Reduce rill erosion | Contour ridging | | | | | | ❖ | ❖ | | | | ◆ | ❒ | | | | | | | | ❖ | | | |
| | | Vegetation rows | | | | | | ❖ | ❖ | | | | ◆ | ❒ | | | | | | | | ❖ | | | |
| Transfer | Reduce gully erosion | Gully prevention | | | | | | ❖ | ❖ | | | | ◆ | ❒ | | | | | | | | ❖ | | | |
| | | Stone check dams | ◆ | | | | | ❖ | ❖ | | | | | ❒ | | | | | | | | ❖ | | | |
| | | Brushwood check dams | ◆ | | | | | ❖ | ❖ | | | | | ❒ | | | | | | | | ❖ | | | |
| | | Vegetation barriers | ❒ | | | | | ❖ | ❖ | | | | ◆ | ❖ | | | | | | | | | | | |
| | | Gully reshaping | ❒ | | | | | ❖ | ❖ | | | | ◆ | | | | | | | | | ❖ | | | |
| | | Roadside management | | | | | | | | ◆ | | | | | | | ◆ | ◆ | | | | | | | |
| | Reduce riverbank erosion | Re-establish meandering rivers | ◆ | | | | | | | | | ❒ | ◆ | | | | | | | | | | | | |
| | | Stream/riverbank management | ◆ | | | | | | | | | | ◆ | | | | | | | | | | | | ❖ |
| | | Reconnect river and floodplain | ❒ | | | | | | ❖ | | | | ◆ | | | | | | | | | | | | |
| | Trap sediments upstream of dam | Small dams | ❖ | | | | | | | | | | ◆ | | | | | | | | | ❖ | | | |
| | | Vegetation screens | ❖ | | | | | | | | | | ◆ | ❖ | | | | | | | | | | | |
| | | Sabo dams | ❖ | | | | | | | | | | ◆ | | | | | | | | | ❖ | | | |

◆ Mandated

❖ Implementer (if not Mandated)

❒ Other agencies to be involved

| | | | National | | | | | | | | | | Provincial | | | | | | Other | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DWS | DALRRD | DMRE | SANBI | ARC | LandCare | " Working for" programs | SANRAL | Water boards | CMA | DFFE | DALRRD | BRIP | Biodiversity agencies | Provincial Roads | Local municipality | NGO e.g. Meat Naturally | Dam operator | Dam owner (e.g. DWS) | Landowner | Homeowner | NGOs | WUA |
| Sink | Route sediments | Sediment bypass | ❒ | | | | | | | | | | | | | | | | | ❖ | ◆ | | | | |
| | | Sediment pass through | ❒ | | | | | | | | | | | | | | | | | ❖ | ◆ | | | | |
| | Sediment removal | Flushing or sluicing | ❒ | | | | | | | | | | | | | | | | | ❖ | ◆ | | | | ❒ |
| | | Pressure flushing | ❒ | | | | | | | | | | | | | | | | | ❖ | ◆ | | | | |
| | | Empty flushing | ❒ | | | | | | | | | | | | | | | | | ❖ | ◆ | | | | |
| | | Dry excavation | ❒ | | | | | | | | | | ◆ | | | | | | | ❖ | ◆ | | | | |
| | | Dredging | ❒ | | | | | | | | | | ◆[4] | | | | | | | ❖ | ◆ | | | | |
| | Adaptive strategies | Redistribute sediment | ❒ | | | | | | | | | | | | | | | | | | ◆ | | | | |
| | | Reallocate storage | ◆[5] | | | | | | | | | | | | | | | | | | ◆ | | | | |
| | | Modify infrastructure | ◆[6] | | | | | | | | | | | | | | | | | | ◆ | | | | |
| | | Adjust to reduce benefits | ❒ | | | | | | | | | | | | | | | | | | ◆ | | | | |
| | | Repurpose or decommission | ◆[7] | | | | | | | | | | | | | | | | | | ◆ | | | | |

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[4] Authorisation from DFFE is required if more than 10 $m^3$ of soil is removed from a water course, including an instream storage dam

[5] Storing of water is a defined water use in the NWA for which an authorisation from DWS is needed if more water is stored than the existing lawful water use as in 1997-1999. Additional abstraction from storage also needs an authorisation from DWS.

[6] Structural changes to dam infrastructure (higher than 5m wall and capacity of more than 50000$m^3$) needs an authorisation from the Dam Safety Office in DWS – even for DWS owned dam infrastructure.

[7] Demolishing of a dam with safety risks as above needs an authorisation from the Dam Safety Office in DWS.

# 6 Conclusions and Recommendations

Water insecurity in South Africa is increasing due to rising demands and climate change impacts. Consequently, South Africa needs to consider new sources of water, but is running out of options for the construction of viable large-scale dams. Against this backdrop, assessing the options and viability for sedimentation prevention and removal is crucially important. These options include both prevention measures (the prevention of silt build-up in dams to avoid storage losses) and management measures (the removal of existing silt from dams so as to create new storage capacity). These interventions will be dam-specific and consider the local catchment context. For example, the interventions proposed for Shongweni Dam, which is known to have lost almost two-thirds of its storage capacity to siltation, will differ from the interventions proposed for Polihali Dam, currently under construction.

In practice, the merits of siltation management relative to other options is likely to be highly context-specific and will differ according to location. Prevention measures such as catchment management generally tend to cost much less than silt removal from dams, although its beneficial impacts (co-benefits) will be more indirect and greater than those of removing silt from dams.

Once the need for silt management is acknowledged, the challenging question of how to pay for the required intervention arises. Various financing options are identified and analysed in this report. These fall under the following general categories:

- Unlock the complementarity between built and ecological infrastructure, using infrastructure budgets to prevent erosion and silt mobilisation. Ensure that bulk infrastructure investments (i) do not make erosion worse, and (ii) are not undermined by erosion and accelerated reservoir siltation (especially given climate change impacts). This should be a matter of “Best Practice”. Additional work required to protect built infrastructure from siltation could be paid for through the Water Resource Infrastructure Charge or the Capital Unit Charge that is already used in water infrastructure development and construction.
- Use the Water Resource Management Charge to invest in ongoing erosion prevention programmes.
- Ensure that private finance (banks, DFIs) insists on silt mitigation and management measures in their financing conditions for built infrastructure or for agricultural development.
- Ensure that the siltation management components of Catchment Management Strategies are aligned, through an agreed and complementary approach to erosion and silt management, with funding for Landcare, “Working for” Programmes, CSI, mine rehabilitation, Meat Naturally and carbon sequestration projects.
- Due to the multiple benefits associated with silt management, special efforts are required to blend financial support from a variety of public and private sources, particularly for siltation management interventions in the source and transfer zones, which have a number of economic, social and environmental co-benefits.

The chance of securing international funding will be increased if the multiple benefits and their beneficiaries have been documented at the catchment scale (typically with a value), and if the institutional capacity is in place to oversee these processes.

The institutional capacity can be strengthened, and the above options will become financially more viable if South Africa’s topsoil and existing reservoir storage capacity are recognised as strategically valuable public assets and both regulation and investment are mobilised to protect this asset.

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