The Government of The Kingdom of Lesotho

TECHNOLOGY NEEDS ASSESSMENT REPORT FOR CLIMATE CHANGE ADAPTATION

Technology Action Plan for Adaptation

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Ministry of Environment and Forestry

AGRICULTURE and WATER SECTORS

Contents

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List of acronyms

CA	Conservation Agriculture
CBEWS	Community Based Early Warning System
CBO	Community Based Organisations
COP	Conference of the Parties
CSA	Climate Smart Agriculture
CSAIP	Climate Smart Agriculture Investment Plan
CSR	Corporate Social Responsibility
CRI	Commercialization Readiness Index
DCEWS	Decentralised Community Based Early Warning System
DMA	Disaster Management Authority
DRM	Disaster Risk Management
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EWS	Early Warning System
FAO	Food and Agricultural Organization
GDP	Gross Domestic Products
GIS	Geographical Information System
GM	Genetically Modified
LEWA	Lesotho Electricity and Water Authority
LFNP	Lesotho Food and Nutrition Policy
LMS	Lesotho Meteorological Services
LP	Lerotholi Polytechnic
LZHSR	Lesotho Zero Hunger Strategic Review
MAFS	Ministry of Agriculture and Food Security
NGO	Non-Governmental Organization
NO_2	Nitrogen Dioxide
NUL	National University of Lesotho
PPP	Public Private Partnership
QMRA	Quantitative Microbial Risk Assessment
SMS	Short Message Service
SOP	Standard Operating Procedures
TAP	Technology Action Plan
TNA	Technology Needs Assessment
TRL	Technology Readiness Level
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WASCO	Water and Sewerage Company
WFP	World Food Programme
WMO	World Meteorological Organization

Executive Summary

This Report, the *Technology Action Plan (TAP) Report*, is the third and final report of the activities on which the Kingdom of Lesotho embarked under the Technology Needs Assessment (TNA) Project. The purpose of this *TAP Report* is to document the actions and activities needed in response to the outcomes of a systematic and long process of assessing the obstacles and limitations that are hindering the widespread diffusion and deployment of climate change technologies in Lesotho. Such actions are presented in order to translate the measures (incentives) needed to overcome the barriers that have been identified. They are being put forward as ways of removing the obstacles that are hindering the enabling frameworks in maximizing and enhancing the dissemination of such technologies effectively and steadily in the long path to dealing with climate change in Lesotho. The TAPs presented provide a comprehensive description of the action plans for adaptation technologies, partly based on condensed and edited content from Report no. II, the *Barrier Analysis and Enabling Framework (BA&EF) Report*. of the report is aimed at national policy-makers and stakeholders and national and international donor institutions, as well as investors and other individuals and groups interested in climate change issues.

This TAP Report includes specific project ideas outlining concrete actions that can contribute to meeting the identified ambitions.

A summary of main actions proposed in each sector and the prioritized technologies for Lesotho is provided below for the two sectors, agriculture and water.

TAP for the agriculture sector

Lesotho is predominantly an agriculturally based country. The sector, however, is the most vulnerable to the impacts of climate change. According to climate model projections for the sector, the agricultural productivity will face intense and frequent droughts with elevated temperature regimes in the medium and long term. Thus, Chapter 1 on Agriculture Technology Action Plan, in this report, outlines a brief description of the sector followed by a brief summary of the barriers and enabling measures to the three prioritized agriculture sector technologies. The chapter also identifies ambitions for these technologies in the country. The ambitions for the proposed technologies are:

i) Ambition for Decentralized Community Early Warning Systems (DCEWS)

The target is to establish DCEWS in every district by 2030 starting in six pilot areas supported by upgraded and modernized climate monitoring and forecasting systems. Precise seasonal predictions and proper preparation for various climate hazards including droughts, floods and hailstorms would reduce crop failure by 80% during droughts, reduce livestock mortality and morbidity by 100% during droughts and heavy snow and cold fronts during the winter. This technology belongs to the non-market goods and targets smallholder crop and livestock farmers in rural areas of Lesotho including emerging commercial blocking farmers, fruit producers including semi-commercial to commercial dairy, wool and mohair farmers and poultry farmers throughout Lesotho.

The EWS play a significant role in disaster (or hazard) planning and prevention. The system has four key operational components: (i) Observation, detection, monitoring, analysis, forecasting and development of hazard warning messages; (ii) Assessment of potential risks and integrating risk information into warning messages; (iii) Dissemination of timely, reliable and understandable warning messages to authorities and public at-risk; and finally (iv) Community-based emergency planning, preparedness and training programmes focused on eliciting an effective response to warnings to reduce potential impact on lives and livelihoods.

Some important barriers to the diffusion of this technology include: high cost of construction and operation, limited human and technical resources and capacities, limited research programs available at the national scale. To overcome the above barriers, the following actions are proposed:

a) Improve human capacity of the relevant national institutions involved in early waning issuance, emergency preparedness and response;
b) Increase funding for strengthening technical and institutional capacities of the R&D organizations dealing with multi-hazard monitoring, forecasting and warning services;
c) Improve early warning communication and dissemination system in the country;
d) Enhance the level of cooperation and collaboration with other relevant local and regional research organizations.

ii) Ambition for Conservation Agriculture

The long-term target of conservation agriculture is to transform the tillage system from one dominated almost 99 percent by conventional practices to at least 50 percent CA practices in Lesotho by 2045. However, in the short term, by 2030, the target is to increase the farmers' participation by reducing conventional agricultural by at least 10 percent and to leverage the use of drought tolerant tillage systems to achieve resilient and diversified agricultural sector with improved and sustainable capacity to respond to climate variability and land degradation (Resilience). The Conservation Agriculture systems will be leveraged to scaling-up climate smart agriculture practices and actions to promote adaptation and increased food security achieving zero hunger by 2050.

TAP for the water sector

The water sector in Lesotho relies on precipitation in the form of summer rainfall and snow in the winter to meet the needs and growing demands of the various water-dependent sectors such as agriculture, energy, and industry along with various domestic purposes. Climate change is also expected to have long- term severe impacts on water and food security. The impact will very likely not be uniform in the country, but mainly defined by variations in demographics, agricultural practices and the nature and sustainability of freshwater sources. In this report, Chapter 2 on Water Sector Technology Action Plan outlines a brief description of the sector followed by summary of the barriers and enabling measures to the three prioritized water sector technologies diffusion.

i) Ambition for water reclamation, treatment and reuse

Recent estimate on the total volume of wastewater generated by the domestic, municipal, and industrial sectors in Lesotho is 7.2 million cubic meters. Wastewater in Lesotho is mainly produced from pollution caused by human body's waste products, namely urine and faeces which are carried away by water to form sewerage from domestic and municipal sector as well as the effluent from the industrial sector. In Lesotho, primary treatment type is the dominant wastewater treatment. However, the rapid population increase in the urban areas together with increases of human and industrial activities have brought constraint to wastewater treatment. Water and Sewage Company (WASCO) is the only institution involved in wastewater collection, conveyance, and treatment in the country. After being treated to required standards wastewater is normally disposed into the Mohokare (Caledon) River System. Water reuse is minimal because in the country as it is only used in the industrial sector. However, initiatives are underway to extend use of wastewater to the agriculture sector especially for irrigation purposes.

ii) *Ambition* for rainwater collection from ground surfaces

The TNA process identified rainwater collection from ground surfaces as one of the prioritized climate adaptation technologies for water sector. The technology is already in use in arid and semi-arid areas of Lesotho where seasonal rainfall is the major source of water and a permanent or ephemeral surface water body (such as river or spring) is not present. Rainwater collection from ground water surfaces may take the form of collecting rainwater from ground surfaces utilizing micro-catchments to divert or snow runoff so that it can be stored before it can evaporate to enter watercourses by constructing an earthen or other structure to dam the watercourse and form small reservoirs. Lesotho is investing heavily in water and sanitation through under frameworks of both the Lesotho Highlands Water Projects and the Lowlands Water Supply Schemes. However, the focus of these interventions is either on transfer of water to regional destinations e.g. currently South Africa and in the near future to Botswana. The rural communities only get a trickledown effect of these multinational water projects leaving a greater population of Lesotho in the rural areas exposed to water scarcity which is projected to increase both in the mid and distant periods. Thus, the target for this technology is that by the year 2030, water supply and sanitation services must reach at least 80 percent of the rural population (1.162 million people) and adequate and sustainable supply of potable water. According to the 2016 population census, this makes up approximately 1.162 million people in the rural areas. Furthermore, the target is to provide sanitation services to all the population of Lesotho which is approximately 2.2 million people according to the 2016 population census.

iii) Ambition for boreholes as a drought intervention for domestic water supply

Boreholes play a crucial role as a drought intervention for domestic water supply, particularly in regions prone to water scarcity. During droughts, surface water sources may become unreliable, making it necessary to tap into groundwater reservoirs through boreholes. As a drought intervention for domestic water supply, boreholes can take three major strategies: drilling new boreholes /deepening existing ones; repairing damage boreholes; and /or constructing relief boreholes with restricted used for drought periods only. The target is to drill three monitoring boreholes per each of three main hydrometric catchments of Lesotho especially in southern Lesotho and the Senqu River basin. In addition, take an inventory of all existing community boreholes in the local community councils of Lesotho and drill new ones in at least 80 percent of the electoral division in each community council.

Chapter 1 Technology Action Plan and Project Ideas for the Agriculture Sector

1.1. TAP for Agriculture Sector

1.1.1 Sector overview

Lesotho has prioritized agriculture as one of the key pillars for economic growth (NSDP II) pursuant to inclusive, sustainable growth and private sector-led employment creation because it plays a significant role in Lesotho's economy. Over 70 percent of the country's population lives in rural areas and depends, directly or indirectly, on agriculture for employment and livelihood. The sector has potential to increase food security, reduce rural poverty, and generate both on- and off-farm employment opportunities. According to the Climate Smart Agriculture Investment Plan (World Bank, 2019), main crops include maize, sorghum, and wheat which are planted as monocrops on 85 percent of the country's arable land which comprises 10 percent of Lesotho's total land area. Furthermore, livestock contributes 75% of the total agricultural output, including semi-intensive and intensive production of pigs and poultry, as well as extensive (free range) production of goats and sheep on rangelands in the foothills and highland areas.

Climate change poses major challenges to the development of Lesotho's agricultural sector. Drought, severe frost, excessive rainfall, and pests and disease outbreaks are key production risks leading to average annual losses of US$28 million, corresponding to two percent of Lesotho's GDP (CSAIP, 2018). Lesotho is also a hotspot of severe land degradation. The annual cost of land degradation, attributed to the foregoing impacts of climate change, costs Lesotho an estimated US$57 million per annum, equivalent to 3.6% of the country's GDP (UNCCD, 2018). The agricultural sector is the second largest greenhouse gas (GHG) emitter in the country accounting for 35% of national emissions with the total annual GHG, including emissions from land use, land-use change, and forestry is 1.2 million tons of CO_2 equivalent (tCO_2 eq) (CSAIP, 2018). Within the agricultural sector, livestock overwhelmingly accounts for most emissions at 93.9% of agricultural emissions with cropping accounting for just 6.1 percent of agricultural emissions. Within the livestock subsector, enteric fermentation (53 percent of agricultural emissions) and manure left on pastures (40 percent) are key GHG emitters, while in the crop subsector, savannah burning for agricultural purposes (3 percent) is the largest emitter (CSAIP, 2018). Several policies and strategies, including Vision 2020, National Climate Change Policy (2017), Lesotho Food and Nutrition Policy (2016), and

Lesotho Zero Hunger Strategic Review (LZHSR) accord high priority to scaling up climate-smart practices and actions to promote agricultural adaptation and increased food security, achieving zero hunger by 2030, ensuring access to adequate food and healthy diets all year round, ending malnutrition, doubling smallholder productivity and incomes, and eliminating food loss and waste (Table 1).

Table 1. Descriptions of key agricultural policy initiatives in Lesotho

Policy	Date	Summary
Agricultural Subsidy Policy	2003	Provides for subsidy on agricultural inputs especially seeds, fertilizers and tillage
Irrigation Policy	2002	Key objectives include increasing the area under sustainable irrigation, ensuring equitable access for women and youth, and optimizing government investment in irrigation development. The focus is on enhancing smallholder productivity and promoting high-value agriculture to substitute imports and increase exports.
Range Resource Management Policy	2014	The policy aims to combat land and vegetation degradation through effective strategies and improved legislation. The ultimate goal is to achieve sustainable development and management of rangeland resources, enhancing biodiversity, productivity, and livelihoods in Lesotho
National Seed Policy	2016	The goal of the policy is to promote, develop and regulate the seed sub-sector in order to ensure availability, accessibility and affordability of safe and high-quality seed to all stakeholders for increased food and nutrition security, household income, wealth creation and higher export earnings.
National Climate Change Policy	2017	The mission is to enhance climate resilience and improve the well-being of Basotho through active stakeholder participation in adaptation, risk reduction, and sustainable development initiatives. The policy aims to develop processes and strategies that effectively address climate change impacts across various sectors.
Lesotho Food and Nutrition Policy 2016-2025	2016	The LFNP outlines strategic objectives to integrate nutrition services into health care and prevent malnutrition transmission. Institutionalizing maternity care and promoting nutritional support are key components of the policy. The LFNP aims to facilitate coordination among various stakeholders to avoid duplication and ensure efficient use of resources. Establishing nutrition positions in key ministries is essential for integrating nutrition into broader development agendas.
Soil and Water Conservation Policy	2021	The Soil and Water Conservation Policy aims to implement integrated watershed management and engage relevant stakeholders. Climate-proofing strategies are essential to ensure the resilience of soil and water conservation efforts.

Keeping in view the above stated projected climate change impacts on the agriculture sector, the first step of the TNA project identified and prioritized the following three climate change adaptation technologies in the agriculture sector: a) Decentralized community-run early warning systems; b) Rainwater harvesting; and c) Conservation Agriculture.

1.1.2 Action Plan for Decentralised Community Based Early Warning Systems

1.1.2.1 Introduction

The United Nations Office for Disaster Risk Reduction (UNISDR) defines a warning system as a set of capabilities needed for the timely and meaningful generation and dissemination of alert information to individuals, communities and organizations at risk for optimal preparedness and response and at the appropriate time to reduce the likelihood of injury and death. Early warning and timely response play a major role in reducing the vulnerability and mortality caused by disasters and in enhancing the resilience of communities. A decentralized community-based early warning system (DCEWS) is a localized approach to disaster risk management that empowers communities to actively participate in the detection, communication, and response to potential hazards (Pham et al., 2024). These systems are designed to be people-centred, integrating local knowledge and resources to enhance preparedness and resilience against natural disasters and their effectiveness relies heavily on community engagement, ownership, and the integration of both local and technical expertise.

The choice of this technology has also been motivated by the potential for the provision of precise and effective information through identified institutions that allows the farming community, development agents and government officials to prepare for effective response to slow on set disasters including drought to avoid or reduce risks (UNEP 2012). Annual economic losses caused by weather-related natural disasters have increased in recent times in Lesotho. The tendency for increased frequency of climate extremes is expected to continue in the future. As a result, drought is highly likely to occur more frequently, bringing risks for cropping and livestock agriculture.

1.1.2.2 Ambition for the TAP

The target is to establish decentralized community based early warning systems (DCEWS) in every district by 2030 starting with CBEWS in six pilot areas supported by upgraded and modernized climate monitoring and forecasting systems. Precise seasonal predictions and proper preparation for various climate hazards including droughts, floods and hailstorms would reduce crop failure by 80% during droughts, reduce livestock mortality and morbidity by 100% during droughts and heavy snow and cold fronts during the winter. This technology belongs to the non-market goods and targets smallholder crop and livestock farmers in rural areas of Lesotho including emerging commercial blocking farmers, fruit producers including semi-commercial to commercial dairy, wool and mohair farmers and poultry farmers throughout Lesotho.

Gender issues

Integrating gender into DCEWS for climate change adaptation in the agricultural sector involves recognizing and addressing gender-specific roles, responsibilities, and barriers. This integration is crucial for enhancing community resilience and ensuring equitable access to resources and decision-making processes. First, enabling factors for gender integration must be addressed because effective integration requires fostering local agency and gender equality, since gender equity considerations are crucial for climate resilience (Tye et al., 2023). Secondly, women's leadership and collectives in community management, particularly in commons, enhance resilience. Therefore, it is necessary to empower women to facilitate collective efforts for resource conservation, despite limited participation in formal decision-making is often limited. Thirdly, it is important to recognize and address the fact that structural inequalities limit women's access to resources and services, affecting their ability to adapt to climate change. Addressing these barriers is essential for creating resilient food systems (Bryan et al., 2024). Furthermore, gender-sensitive information dissemination is imperative hence the need to provide gender-sensitive climate information as means to enhance their adaptive capacity. It also critical to build gender-sensitive information-sharing networks to address gender differences in information access. In general, women rely on close-knit networks for information, while men access broader networks. Thus, balancing these networks is vital for equitable information dissemination and climate adaptation (Friedman et al., 2022).

1.1.2.3 Actions and activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

The identified barriers were organized in the order of cause-effect relations, with the main barrier at the centre and the direct causes below it and direct effects above. Overall, two categories were prioritized. These entailed the following specific barriers: High costs of implementation in the context of mountainous terrain in Lesotho with deep ragged valleys increasing the cost of the grid access. Thus, the upfront expenses for acquiring and setting up advanced monitoring technologies, and sensor networks can be substantial, creating a barrier for Lesotho given its limited financial resources. Subsequently, the operation and management costs including security and data retrieval costs are high and compounded by a sparse electrical grid especially within the remote rural locations. Thus, sustaining and updating monitoring systems require large and continuous investments. Furthermore, Government of Lesotho faces limited budgets to environmental initiatives, and climate change monitoring competes with other pressing economic priorities. This limitation in funding creates a significant impediment to the establishment and maintenance of comprehensive monitoring.

Implementing advanced monitoring systems in Lesotho is hindered by technical complexities, including interoperability issues, data integration challenges, and the need for albeit unaffordable specialized technical expertise at LMS and other government institutions where the direct use of climate information services is imperative. Furthermore, Lesotho lacks the necessary technical know-how to effectively operate and maintain sophisticated climate monitoring technologies. This capacity gap impedes the successful implementation of these systems and renders the country dependent on cross-border data sharing and international cooperation. Barriers related to data sovereignty, privacy concerns, and geopolitical tensions hinder collaborative efforts in implementing integrated systems.

Actions selected for inclusion in the DCEWS

Four actions have been selected for inclusion in the DCEWS.

Action 1 Capacity Building: The thrust is to improve technical capacity, specifically of human resources, of concerned national institutions involved in early warning issuance, emergency preparedness and response management. Currently, this capacity is located at the Lesotho Meteorological Services *albeit* in terms of the technical generation of forecasts. The comprehensive capacity building for implementation of functional EWS is a critical need across the board but more so at community level because people are not familiar with the intervention.

Action 2 Ensure Financial Capacity: The idea is to **i**ncrease and ensure dedicated funding for strengthening of organization dealing with multi-hazard monitoring, forecasting and warning services. The technology requires key investments in both equipment and systems. This action is meant to ensure provision of adequate funding for setting up of the requisite implementation systems.

Action 3 Communications and Dissemination: These action is meant to improve early warning communication and dissemination systems in the country and domesticate them at the community level. Currently, communities are passive recipients while in a DCEWS, communities and households are co-creators of messages, their communication and dissemination.

Action 4 Coordination and collaboration: The action entails enhancing and improving coordination and collaboration with other relevant regional and international institutions to support the capacity of Lesotho. Currently, the country leverages this collaboration to make up for the gaps in the capacity of the national systems. This collaboration must be strengthened.

Table 2 summaries activities identified for implementation of the four selected actions.

Table 2. Activities identified for implementation of selected actions

Activities identified for implementation of selected actions	
Action 1	Conduct continuous cycles of need-based trainings for professional staff of meteorological, climate change and disaster risk management (DRM) related national institutions.
	Conduct quality risk assessments to generate new and credible location-based risk data and information mentors to facilitate knowledge transfer and skill development.
	Training and staff development through specialized training workshops
	Strengthen modelling approaches by working closely with WMO and other regional and international meteorological networks to reduce uncertainty in climate projections
Action 2	To increase budgetary allocations for EWS relevant departments to build their capacity
	Establish new meteorological observatories in hazard prone districts
	Installation of 100 new automatic weather stations network including its communication system
	Up-gradation/ automation of 50 existing observatories
	Establish flash flood forecasting and warning system at 10 vulnerable areas
	Installation of weather surveillance readers at strategic locations in the country for monitoring and forewarning disastrous weather events
Action 3	Identify and engage the existing active community groups to participate in emergence preparation drills
	Dedicate funding for resources and training of the volunteer groups
	Engage media particularly social media networks and platform to create awareness on disasters
Action 4	Promote transfer of knowledge through building research collaborations among experts at regional and international meteorological research institutions
	Collaborate and communicate with local, national and regional initiatives to share data, expertise and information to improve credibility of new information

Actions to be implemented as project ideas

Four set of actions have been identified for inclusion in the implementation of the TAP. This is an attempt to break the implementation into operations phases or tasks because the TAP is a composite technology where the actions cannot be treated as mutually exclusive to deliver the system. Thus, all four actions must be considered in developing a project idea to be implemented. Firstly, Action 1 seeks to build capacity to empower local communities to anticipate and respond to climate-related risks, thereby safeguarding agricultural productivity and livelihoods. This approach not only mitigates the impacts of climate change but also fosters community engagement and ownership, which are crucial for the sustainability of adaptation initiatives. Capacity development programs have been shown to improve the resilience of rural farming communities by promoting sustainable farming techniques and technologies (Landicho and Ramirez, 2023). In particular, DCEWS can effectively integrate local knowledge with scientific forecasts, improving the accuracy and relevance of climate risk information.

Secondly, Action 2 addresses the financial barriers anticipated in the implementation of the TAP. As indicated in the description of the action above, the idea is ensure viability and address financial feasibility within the constraints and barriers of the national institutions dealing with multi-hazard monitoring, forecasting and warning services. Since the technology requires substantial investments in both equipment and systems, it is imperative to ensure provision of adequate funding for setting up of the requisite implementation systems.

Thirdly, Action 3 deals with communication and dissemination of key EWS messages. This is crucial for enhancing adaptive capacity and ensuring effective disaster preparedness. Effective communication structures are essential for the timely release and uptake of early warning information, which is particularly important in agriculture where decisions are time-sensitive and impact livelihoods. By focusing on communication, projects can ensure that early warning information is tailored to the needs of farmers and other stakeholders, thereby improving trust and uptake of the information. For instance, tailoring drought warning content to agricultural decision-making enhances trust and uptake among farmers (Calvel et al., 2020) because translating scientific data into actionable information for local communities helps mitigate food security challenges by enhancing adaptive capacity (Firoz et al., 2021). For example, local knowledge can be effectively communicated through community radios, bridging gaps between local communities and external stakeholders (Shivakoti et al., 2021). Effective dissemination methods, such as SMS or WhatsApp with confirmation messages, improve awareness and reaction to natural hazards in disaster-prone areas coupled with the use of multiple dissemination channels, including mobile applications, enhances the reach and effectiveness of early warning systems.

Finally, Action 4 seeks to enhance and improve coordination and collaboration amongst key stakeholders both locally, regionally and internationally to leverage the requisite technical support to make up for the gaps in the capacity of the national systems. This collaboration must be strengthened.

Gender issues

DCEWS can significantly contribute to achieving gender outcomes by integrating gender-sensitive approaches and empowering women in disaster risk reduction efforts. These systems can enhance women's roles and address gender-specific vulnerabilities, leading to more equitable and effective disaster risk management. This kind of community-based adaptation programs have shown that including women in decision-making processes and teaching them adaptive practices can enhance their adaptive capacity and access to economic assets (Duus and Montag, 2022). Elsewhere, participatory action research demonstrated that women-led disaster risk management groups can effectively address local hazards, empowering women and building their capacity (Ruszczyk et al., 2020). This is so because gender mainstreaming in disaster risk reduction ensures that the unique needs and vulnerabilities of women are considered, reducing their susceptibility to disasters. Finally, training women in disaster risk preparedness and management equips them with necessary skills, challenging the stereotype of women as the weaker sex and enabling them to contribute effectively to disaster risk management (Jayarathne, 2014).

1.1.2.4 Stakeholders and Timeline for implementation of the TAP

Overview of stakeholders for implementation of the TAP

Successful implementation relies on the active involvement and collaboration of various stakeholders outlined below.

Community members: Provide local knowledge about historical hazards, vulnerabilities, and existing coping mechanisms; Monitor local conditions, report anomalies, and respond to warnings; Participate in training, drills, and awareness programs to enhance community readiness; and offer insights and feedback on the effectiveness of the EWS, helping to improve and adapt the system.

Local authorities: Encourage participation in the EWS and act as a bridge between the community and external stakeholders; Help make decisions related to the implementation and operation of the EWS, ensuring that it aligns with local customs and practices; and build community trust in the EWS by endorsing the system and promoting its benefits.

Local government authorities: Provide the necessary regulatory framework and policies to support the EWS implementation; Coordinate between different stakeholders, including NGOs, private sector, and community members, to ensure smooth implementation; Allocate resources, such as funding, technical support, and infrastructure, to support the EWS; Integrate the EWS into local disaster management plans and coordinate emergency responses when alerts are triggered

Non-governmental organization (NGOs) and community based organizations CBOs): Provide training and education to community members, local leaders, and other stakeholders on EWS operation and disaster preparedness; Assist with the design, setup, and maintenance of the EWS, including the deployment of technology and monitoring tools; Promote awareness about the importance of early warning systems and advocate for community participation and inclusion; Support ongoing monitoring and evaluation efforts to assess the effectiveness of the EWS and suggest improvements.

Governmental agencies: Develop and enforce national policies and frameworks that support the implementation of decentralized EWS; Provide financial resources, technical expertise, and infrastructure support to local governments and communities; Supply critical data, such as meteorological, hydrological, and geological information, to enhance the accuracy of local monitoring and forecasting; Offer training and capacity-building programs for local authorities and technical personnel involved in the EWS.

Hydro-Meteorological agencies: Provide accurate and timely weather forecasts, hydrological data, and other relevant information to inform early warning decisions; Collaborate with local EWS to ensure that national and regional data is effectively integrated and utilized at the community level; Train local stakeholders on how to interpret and use meteorological and hydrological data for decision-making.

Academia and research institutions: Conduct research on local hazards, vulnerabilities, and the effectiveness of early warning systems; Develop innovative technologies and methodologies for community-based EW; Provide technical support in the design, implementation, and evaluation of the EWS; Offer educational programs and resources to build the capacity of local stakeholders in disaster risk reduction and early warning systems.

Private Sector (Technology Providers, Telecommunications Companies, etc.): Technology Supply and maintain the technology infrastructure required for the EWS, such as sensors, communication devices, and data management systems; Develop and offer innovative tools and platforms that enhance the effectiveness of the EWS, such as mobile apps, GIS systems, and data analytics platforms; Participate in EWS initiatives as part of corporate social responsibility programs, providing funding, expertise, or in-kind support.

International organizations and donors: Funding and Resource Mobilization: Provide financial resources and technical assistance to support the implementation and sustainability of the EWS; Offer training programs, workshops, and technical support to enhance the capabilities of local stakeholders; Share global best practices, tools, and methodologies to improve the design and implementation of community-based EWS; Support the monitoring, evaluation, and reporting of EWS effectiveness and impact at the local level.

Media and communication outlets: Use various media channels, such as radio, television, newspapers, and social media, to disseminate early warnings and emergency information to the community; Conduct public awareness campaigns about disaster risks, preparedness measures, and the importance of early warning systems; Provide platforms for the community to share feedback, report issues, and participate in discussions related to the EWS.

Scheduling and sequencing of specific activities

Table 3 provides an indicative scheduling and sequencing of various activities.

Table 3. Scheduling and sequencing of specific activities

Actions	Scale	Time (Years)									
		1	2	3	4	5	6	7	8	9	10
Improve technical capacity, specifically of human resources, of concerned national institutions involved in implementation of DCEWS and issuance of messages, emergency preparedness and response management.	National	■	■	■							
Increase and ensure dedicated funding for strengthening of organizations dealing with multi-hazard monitoring, forecasting and warning services.	National				■	■	■				
Develop skilled communities to run DCEWS	District							■	■	■	
Improve early warning communication and dissemination system in the country	District	■	■	■	■	■	■				
Enhance and improve coordination and collaboration with other relevant regional and international institutions.	Regional							■	■	■	■

Gender issues

Gender norms significantly constrain women's access to agricultural resources, impacting productivity and efficiency. In this project, all interventions will seek to address constraints especially those tending to reinforce inequalities. For example, women face barriers in accessing land, water, seeds, and technology, which are critical for effective EWS. This project will address these barriers to ensure equitable participation. Thus, the whole community approach will be advocated to engage various stakeholders including women and youth in particular to ensure comprehensive risk management. Experience in climate-smart agriculture in Lesotho shows that women, particularly de jure female household heads, are more likely to adopt CSA strategies hence the imperative for gender specific support in EWS.

Furthermore, this project will draw wisdom from gender-equitable approaches in community-based resource management which have shown promise elsewhere (Schwarz et al., 2014). These approaches consider the different roles and goals of men and women, aiming for fair access to opportunities. In addition, gender-transformative approaches, emphasizing integrating gender into research and development to improve food security and income (Schwarz et al., 2014) will be integrated into the project design and implementation.

Gender analysis is crucial in identifying and addressing the specific needs and constraints faced by women in agricultural settings, which can significantly impact the effectiveness of such systems. First, gender norms often limit women's access to critical agricultural resources such as land, water, seeds, and technology. These constraints can hinder women's ability to participate effectively in EWS and agricultural productivity. Thus, interventions must be designed to address these gender-specific barriers, ensuring that women have equal access to resources and decision-making processes (Quisumbing and Pandolfelli, 2008). Secondly, empowerment strategies in agricultural projects often include forming women's groups, providing training, and changing gender norms through community dialogues. These strategies aim to enhance women's control over resources and decision-making, which is essential for their active participation in early warning systems. Hence projects that target multiple domains of empowerment, such as leadership and control over income, are more likely to succeed in empowering women and improving their engagement in community-based systems (Johnson et al., 2017). Finally, gender-sensitive tools, such as gender resource mapping and gender-disaggregated activity calendars, can help identify the specific roles and contributions of women in agriculture. These tools are vital for designing interventions that are inclusive and effective. Thus, integrating gender analysis with participatory rural appraisal methods can enhance community mobilization and ensure that EWS are responsive to the needs of all community members (Thomas-Slayter et al., 1993).

1.1.2.5 Estimation of resources needed for action and activities

Estimation of capacity building needs

Implementing a DCEWS requires capacity building in several key areas to ensure its effectiveness. We envisage that five capacity-building efforts will empower communities to effectively implement, manage, and sustain a DCEWS, ultimately enhancing resilience to disasters.

Firstly, there is need for technical training. This will entail training on the operation, maintenance, and troubleshooting of EWS's hardware and software components. There is need for skills development in data collection, interpretation, and real-time analysis of environmental indicators to identify potential hazards including the training on the use of communication tools and platforms for disseminating warnings to the community effectively. In addition, communities must be engaged with educational activities on the importance and functionality of EWS to ensure community buy-in and participation, on roles and responsibilities within the community to ensure proper functioning during emergencies, incorporating local knowledge and practices into the EWS to enhance its relevance and accuracy.

Secondly, success and sustainability of systems depend on strong institutions. It is thus, critical to provide training on existing policies, regulations, and best practices related to early warning systems, and how to align them with the decentralized approach. This will include provision of skills to coordinate between various stakeholders, including government agencies, NGOs, and community groups. In addition, resource mobilization cannot be overemphasized i.e. capacity to mobilize financial, technical, and human resources, to sustain the system.

Thirdly, training on setting up and using monitoring and evaluation frameworks to assess the effectiveness of the EWS and make necessary adjustments is crucial. Sustainability hinges on developing strategies for the long-term including community ownership, local leadership, and financial mechanisms to also enable the means to scale EWS to other communities considering the specific needs and contexts.

Fourthly, there is need to develop capacity for disaster response and preparedness. Capacity building for the community on how to respond effectively once a warning is issued, including evacuation procedures and first aid is critical. This includes regular drills and simulations to ensure the community is well-prepared and can act quickly in response to early warnings. It is equally critical to training stakeholders on conducting post-event assessments in order to improve the system's future performance.

Estimation of costs of actions and activities

The implementation of this technology requires a major financial investment given the terrain and topography of Lesotho. A set of four (4) corresponding activities for implementation of this TAP were compiled (Section 1.1.2.3)). The TAP will require a total budget of **USD 50.405** million for its implementation. Most of this funding can be sought from international agencies (USD 122,000) either as grants or loans but some costs would need to be borne by the Government of Lesotho (at least in-kind).

Gender issues

To implement a gender-responsive capacity-building strategy for DCEWS in agriculture, it is crucial to recognize and address the distinct roles and challenges faced by women in agricultural settings. This approach ensures that both men and women can equally contribute to and benefit from such systems, ultimately enhancing agricultural productivity and resilience. Women are often the primary farmers in many rural areas of Lesotho, yet their contributions are frequently overlooked. In implementing this project, special attention will go towards acknowledging their roles is essential for effective capacity building (Foley, 2009) and integrating programs that address social constraints and enhance resource access for women can lead to more inclusive development outcomes (Weeratunge et al., 2012). In this project, gender-transformative approaches (Schwarz et al., 2014) will be engaged to change the underlying social norms and power dynamics that perpetuate gender inequalities. This will be achieved through targeted training and capacity-building initiatives that empower women and promote gender equity (Hahn and Murthy, 2002). We acknowledge that understanding local gender contexts is crucial for tailoring capacity-building efforts. In particular, the fact that incorporating African feminisms and intersectionality into climate-smart agriculture has shown potential in addressing socio-cultural dynamics that affect gender roles in agriculture (Khoza et al., 2019). Thus, in this project, implementation strategies will consider intra-household power relations and access to resources, which significantly influence women's ability to participate in and benefit from agricultural innovations.

The integration of gender analysis into budget lines and activities is crucial for ensuring equitable and effective implementation. This involves understanding and addressing gender disparities that affect participation and outcomes in agricultural systems. Gender analysis helps identify disparities in access to resources, decision-making, and benefits between men and women in agricultural settings. This understanding is essential for designing EWS that are inclusive and effective (Moxley, 2022). This project will apply a comprehensive gender analysis to evaluate how budget allocations and activities are influenced by gender dynamics within DCEWS in agricultural contexts. The Harvard Analytical Framework and the Gender Analysis Matrix tools will be used to plan, design, and evaluate the project activities at the community level, ensuring that gender needs are addressed throughout the process (Moxley, 2022).

1.1.2.6 Management Planning

Risk and contingency planning

It is essential to develop comprehensive risk and contingency plans to address potential challenges and ensure system resilience. Thus, to enhance the resilience and effectiveness of a DCEWS, and ensure that it serves its purpose effectively in times of need, it is necessary to address the potential risks and establish robust contingency plans (Table 4).

Table 4. Identified risks and possible contingency plan

Type of risk	Description of risk	Contingency actions
Technical Risks	• **Technology Failure:** Potential breakdowns or malfunctions in the technology used. • **Data Security**: Risks of data breaches or loss of information.	• **Backup Systems:** Implement backup technologies or alternative communication methods (e.g., radio or community networks) to ensure continuity. • **Regular Maintenance**: Schedule regular maintenance checks and updates for all technology components. • **Data Protection:** Establish strong data protection measures, including encryption and secure storage.
Operational Risks	• **Inadequate Training:** Community members may not be properly trained or may lack understanding of the system. • **System Integration Issues:** Problems integrating the EWS with existing local systems or infrastructure.	• **Training Programs**: Develop and implement comprehensive training programs for all users, with refreshers and updates as needed. • **Support Mechanism:** Set up a support system to address technical issues and provide assistance to users. • **Pilot Testing:** Conduct thorough pilot tests and simulations to identify and rectify potential issues before full deployment.

Type of risk	Description of risk	Contingency actions
Social Risks	• **Resistance to Adoption:** Community members or leaders may resist using the system due to scepticism or lack of trust. • **Communication Barriers:** Language or literacy issues that hinder effective communication and understanding of alerts.	• **Engagement Strategies**: Use community engagement strategies to build trust and promote the benefits of the EWS. • **Feedback Mechanisms:** Create channels for feedback and grievances to address concerns and improve the system. • **Localized Solutions:** Ensure that the system is culturally sensitive and adapted to the local context to enhance acceptance.
Environmental Risks	• **Infrastructure Damage**: Disasters could damage communication infrastructure, affecting the EWS's functionality.	• **Infrastructure Resilience**: Strengthen infrastructure to withstand potential damage from disasters. • **Alternative Communication Channels**: Develop alternative communication channels that can be used if primary systems are damaged
Financial Risks	• **Funding Shortfalls:** Insufficient funds for initial implementation or ongoing maintenance.	• **Diversified Funding:** Seek funding from multiple sources, including government grants, NGOs, and community contributions. • **Cost Management:** Develop a budget that includes contingency funds for unexpected expenses.

Next steps

Implementing DCEWS technology is vital for enhancing community resilience to natural disasters and other hazards because it empowers local communities to monitor, predict, and respond to risks in a timely and effective manner. The implementation process requires careful planning, capacity building, and coordination among stakeholders (Table 5).

Table 5. The immediate and critical requirements for implementation of DCEWS

Immediate Needs	Critical Requirement
Step 1: Initial Assessment and Planning	
Hazard and risk assessment	**Actions**: Conduct a comprehensive assessment of the hazards (e.g., floods, droughts, landslides) that the community is exposed to, and evaluate the vulnerability of different groups within the community. Use local knowledge and scientific data to map risks. **Outcome**: A clear understanding of the specific risks the community faces, which informs the design of the EWS.
Stakeholder identification and engagement	**Actions**: Identify and engage key stakeholders, including community members, local leaders, government agencies, NGOs, and technical experts. Establish a steering committee or working group to oversee the project. **Outcome**: A collaborative approach that ensures buy-in from all stakeholders and leverages local knowledge and resources.
Setting objectives and defining scope	**Actions**: Define the specific objectives of the EWS, such as improving disaster preparedness, reducing loss of life and property, and enhancing community resilience. Determine the scope of the system, including the hazards it will address and the geographical area it will cover. **Outcome**: Clear goals and a well-defined scope that guide the design and implementation of the EWS.
Step 2: Capacity Building and Community Training	

Immediate Needs	Critical Requirement
Community education and awareness	**Actions:** Develop and implement training programs to educate community members about the importance of EWS, the hazards they face, and how to respond to warnings. Use workshops, simulations, and public meetings to raise awareness. **Outcome:** An informed and aware community that understands the importance of the EWS and knows how to act on warnings.
Training for local leaders and volunteers	**Actions**: Train local leaders, volunteers, and community-based organizations on the operation and management of the EWS. This includes skills in monitoring hazards, communicating warnings, and coordinating emergency responses. **Outcome**: A cadre of trained local leaders and volunteers who can effectively manage the EWS and lead the community in times of crisis.
Technical training for system operators	**Actions**: Provide specialized training for individuals responsible for operating the technical components of the EWS, such as data collection, analysis, and communication technologies. Ensure they understand the system's functionality and maintenance requirements. **Outcome**: Skilled system operators who can ensure the smooth functioning of the EWS.
Step 3: System Design and Infrastructure Development	
Selection of appropriate technologies	**Actions**: Choose technologies that are suitable for the local context, considering factors like accessibility, cost, ease of use, and reliability. This could include low-cost sensors, mobile apps, community radio, and manual observation networks. **Outcome**: A technology solution that is accessible, affordable, and effective for the community.
Development of monitoring and data collection systems	**Actions**: Set up systems for continuous monitoring of hazards using local observations, sensors, and data from meteorological agencies or other sources. Ensure that data is collected, analysed, and disseminated in a timely manner. **Outcome**: A robust data collection and monitoring system that provides accurate and timely information about emerging hazards.
Communication and dissemination mechanisms	**Actions**: Develop and implement communication strategies for disseminating warnings to the community. This could include SMS alerts, community loudspeakers, local radio broadcasts, and social media platforms. Ensure that messages are clear, actionable, and reach all segments of the community, including the most vulnerable. **Outcome**: An effective communication system that ensures timely dissemination of warnings to all community members.
Infrastructure development	**Actions**: If necessary, build or upgrade infrastructure to support the EWS, such as installing weather stations, flood gauges, or community bulletin boards. Ensure that the infrastructure is resilient to the hazards it monitors. **Outcome**: Physical infrastructure that supports the reliable operation of the EWS.
Step 4: Pilot Testing and Refinement	
Pilot implementation	**Actions**: Implement the EWS on a small scale or in a pilot area to test its effectiveness. Conduct real-time simulations and drills to evaluate how well the system works and how the community responds. **Outcome**: Identification of any issues or weaknesses in the system that need to be addressed before full-scale implementation
Community feedback and system refinement	**Actions**: Gather feedback from community members and other stakeholders on the pilot implementation. Use this feedback to refine the system, making adjustments to the technology, communication strategies, or operational procedures as needed.

Immediate Needs	Critical Requirement
	Outcome: A refined EWS that is better suited to the community's needs and more likely to succeed.
Evaluation and documentation	**Actions**: Evaluate the pilot phase by assessing the system's performance, the community's response, and the overall effectiveness of the EWS. Document lessons learned and best practices. **Outcome**: Comprehensive documentation that can inform the scaling up of the EWS and guide future implementations
Step 5: Full-Scale Implementation and Scaling	
Scaling Up	**Actions:** Based on the success of the pilot phase, scale up the EWS to cover the entire community or region. Ensure that the expanded system is fully operational and that all community members are aware of it. **Outcome**: A fully implemented EWS that serves the entire target population, providing early warnings and enhancing disaster preparedness.
Institutionalization and integration	**Actions**: Integrate the EWS into local disaster management plans and link it with regional or national early warning systems. Work with government agencies and NGOs to institutionalize the system, ensuring its sustainability. **Outcome**: An institutionalized EWS that is embedded in local disaster management frameworks and supported by ongoing resources.
Sustainable financing and resource mobilization	**Actions**: Secure long-term funding and resources to maintain and update the EWS. This could include government funding, donor support, or community-based financing mechanisms. **Outcome**: Financial sustainability that ensures the EWS remains operational and effective over the long term.
Step 6: Monitoring, Evaluation, and Continuous Improvement	
On-going monitoring and evaluation	**Actions**: Establish an M&E framework to continuously track the performance of the EWS. Regularly assess the system's effectiveness, community response, and any challenges encountered. Use this data to make ongoing improvements. **Outcome**: A system that evolves and improves over time, ensuring it remains effective in changing conditions.
Community feedback and adaptation	**Actions**: Create mechanisms for regular community feedback, such as meetings, surveys, or suggestion boxes. Use this feedback to adapt the system to better meet the community's needs. **Outcome**: A responsive EWS that adapts to the changing needs and circumstances of the community.
Knowledge sharing and capacity building	**Actions:** Facilitate ongoing training and capacity building for community members, system operators, and local leaders. Share knowledge and best practices with other communities and regions. **Outcome:** A well-informed community that continuously improves its disaster preparedness and response capabilities.
Step 7: Long-Term Sustainability and Community Ownership	
Community ownership and governance	**Actions:** Encourage community ownership of the EWS by involving local leaders and organizations in its governance. Promote a sense of responsibility and pride in maintaining the system.

Immediate Needs	Critical Requirement
	Outcome: A sustainable EWS that is managed and maintained by the community, with strong local ownership.
Adapting to changing risks	Actions: Regularly review and update the EWS to adapt to new or changing risks, such as emerging climate change impacts. Ensure that the system remains relevant and effective in the face of evolving hazards. Outcome: A resilient and adaptable EWS that continues to protect the community over time.
Linking with broader resilience strategies	**Actions**: Integrate the EWS with broader community resilience strategies, such as climate adaptation, sustainable development, and livelihood enhancement programs. Ensure that the EWS contributes to the overall resilience of the community. **Outcome**: A holistic approach to community resilience, with the EWS playing a key role in protecting lives and livelihoods.

Gender issues

Gender disparities can significantly impact the resilience and adaptive capacity of communities, particularly in agriculture-dependent regions. The identification and mitigation of these issues involve comprehensive gender analyses, stakeholder engagement, and the incorporation of gender-responsive strategies into EWS design and implementation. Gender analyses are essential for understanding the contextual factors contributing to gender disparities. A three-phase process involving community-based gender assessments, workshops to interpret findings, and strategies to incorporate these insights into program activities underlie the identification of gender issues in this project following as used in similar projects (Ridolfi et al., 2019). However, more concerted efforts are needed to assess and track gender dimensions to inform equitable emergency prevention and response (Pepper, 2019). The use of innovative technologies, such as smartphones and digital platforms, can enhance the accessibility and effectiveness of EWS. These technologies will be tailored to improve gender equity by recognizing women and men as active participants in development and resilience-building (Silva et al., 2015).

Effective integration of gender equity in locally led adaptation processes requires enabling factors such as community engagement, capacity building, and policy support. These factors are crucial for fostering local agency, gender equality, and transformative change in the agricultural sector (Tye et al., 2023).

1.1.2.7 Reporting

Table 6. Overview table

Sector	**Agriculture**							
Sub-sector	Food Security and Nutrition							
Technology	Decentralised community based early warning systems							
Ambition	Establishment of decentralized community based early warning systems (DCEWS) in every district by 2030 starting with CBEWS in six pilot areas							
Benefits	Mitigates damage to crops and degradation of land/soil							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame (Yrs)**	**Risks**	**Success criteria**	**Indicators for Monitoring of implementation**	**Budget per activity (US$ x 1000)**
Action 1: Improve technical capacity, specifically of human resources, of concerned national institutions involved in early warning issuance, emergency preparedness and response management.	Conduct continuous cycles of need-based trainings for professional staff of meteorological, climate change and DRM related national institutions.	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	LMS	0-4	Human resources performance risks, lack of funding, poor training quality	Availability of qualified professionals	Training plans and progress reports	70
	Conduct quality risk assessments to generate new and credible location-based risk data and information mentors to facilitate knowledge transfer and skill development.	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	LMS MAFS	0-3	Lack of funding, lack of trained staff	Availability of reliable localised risk information	Risk assessment reports	50
		➢						
	Strengthen modelling approaches by working closely with WMO and other regional and international meteorological networks to reduce uncertainty in climate projections	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	LMS NUL	0-5	Lack of funding and Lack of trained staff	Availability of reliable local climate projections	Collaboration plans and reports	70

Sub-Total for Action 1								**190**
Action 2: Increase and ensure dedicated funding for strengthening of LMS, DMA, media, academia to support functions on multi-hazard monitoring, forecasting and warning services.	To increase budgetary allocations for EWS relevant departments to build their capacity	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	Ministry of Finance	0-5	Low funding	Upgraded functional EWS	Annual budget increments	1, 000
	Establish new meteorological observatories throughout Lesotho starting with southern lowlands and Senqu river valley districts	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	LMS	0-10	Poor maintenance, lack of funding	Expanded network of observatories	Number of new observatories and progress reports	5, 000
	Installation of 100 new automatic weather stations network and communications	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	LMS	0-10	Limited maintenance, lack of funding	Fully functional technology	Number of new automatic weather stations	10, 000
	Up-grade/ automation of existing observatories	➢ National cbudget ➢ Donor funding ➢ UNFCCC funding windows	LMS	0-5	lack of funding	Fully functional technology	Number of upgraded observatories	2, 000
	Establish drought forecasting and early warning system in all 10 districts starting with southern lowlands and Senqu river valley district	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	➢ LMS ➢ MAFS ➢ Ministry of Natural Resources	0-10	Technology/ human performance risk	Fully functional technology	Operational DCEWS established across the country	7, 000
	Create capacity for weather surveillance in vulnerable communities in the country for monitoring and forewarning disastrous weather events	➢ National budget ➢ Donor funding	LMS DMA	0-10	Technology / human performance risks	Fully functional technology	Progress on reports of weather surveillance	5, 000

		➢ UNFCCC funding windows						
Sub-Total for Action 2 Activities								**30,000**
Action 3: Improve decentralization of early warning communication and dissemination systems in the country	Identify and engage the existing active community groups to participate in emergency preparation drills	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	DMA	0-5	Poor training quality, lack of funding	Fully functional community groups	Number of community groups established and operating	70
	Dedicate funding for resources and training of the volunteer groups	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	DMA	0-5	Inadequate funding	Fully trained volunteer groups	Budgetary allocations for volunteers and number of volunteers in action	20
	Engage media particularly social media networks and platforms to create awareness on disasters	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	DMA	0-3	Inapt media campaigns	Fully involved media groups	Social media activity reports	20
Sub-Total for Action 3 Activities								**110**
Action 4: Enhance and improve coordination and collaboration with other relevant regional and international institutions.	Promote transfer of knowledge through building research collaborations among experts at regional and international meteorological research institutions	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	NUL LMS	0-10	Lack of funding , geo-political conditions influencing technology transfers	New collaborative international research initiatives	Memoranda of agreement	50
	Collaborate and communicate with local, national and regional initiatives to share data, expertise and information to improve credibility of new information	➢ National budget ➢ Donor funding ➢ UNFCCC funding windows	NUL LMS	0-5	Lack of funding	Credible risk information	Memoranda of agreement and reports	35

Sub-total for action 4 Activities	**65**
Grand total of all activities	**30, 365**

1.1.2.8 Tracking the implementation status of the DCEWS

Rationale, responsibility and content of TAP tracking

DCEWS in agriculture can be effectively tracked through participatory approaches that involve local communities in the design and implementation processes. This ensures that the systems are contextually appropriate and tailored to the specific needs of agricultural stakeholders. Monitoring can include assessing the accessibility and clarity of risk alerts, the integration of traditional knowledge with scientific data, and the responsiveness of communities to warnings. Regular feedback mechanisms and community engagement are essential for evaluating the effectiveness and adaptability of these systems in enhancing agricultural resilience to climate-related hazards.

These systems leverage local knowledge and technology to enhance preparedness and mitigate risks. However, their implementation status is likely to vary across regions despite potential challenges in terms of community capacity and ownership (Pham et al., 2024). In Africa, early warning systems are crucial for climate-resilient agricultural development. However, they often fall short of their potential due to inadequate communication and decision-making processes. Effective systems require integration with local decision-making to maximize their benefits (Coffey et al., 2015). Decentralized blockchain technology has been proposed to improve the traceability and security of agricultural data. This approach ensures transparency and reduces the risk of data tampering, thereby increasing public trust in the system (Sun, 2024). Despite the successes, there are gaps in community engagement and investment at the grassroots level, which hinder the sustainability of CBEWS. Long-term political and financial commitments are necessary to support these systems (Pham et al., 2024). While DCEWS hold promise for enhancing agricultural resilience, their effectiveness is contingent upon robust community engagement, technological integration, and supportive policy frameworks. Addressing these challenges can lead to more sustainable and impactful systems.

Gender issues

Integrating gender-specific criteria and targets into DCEWS is essential for ensuring equitable and effective disaster risk reduction. Gender-responsive approaches can enhance the inclusivity and effectiveness of these systems by addressing the unique vulnerabilities and capacities of different gender groups. This integration requires a comprehensive understanding of gender dynamics and the development of tailored strategies to address them. Gender mainstreaming and disability inclusion into disaster risk reduction and early warning systems are imperative amidst challenges in understanding root causes of vulnerability. Thus, efforts to integrate gender analysis into food and nutrition security EWS highlight the need for more unified and concerted efforts to track gender dimensions for equitable crisis prevention (Pepper, 2019). In addition, community-based surveillance programs emphasize the importance of participatory approaches and community volunteer engagement, which can be enhanced by gender-specific criteria (Jung et al., 2024). This is critical because the integration of gender equity in disaster EWS can improve resilience by fostering awareness and proactive decision-making, particularly through the use of digital technologies. Despite existing frameworks in Lesotho (Kali, 2018), there is a gap in the practical application of gender-responsive policies in local disaster risk management plans and disability-inclusive early warning and early action. The lack of a defined mechanism for developing DCEWS in sub-Saharan Africa underscores the need for gender-specific criteria to be part of system development parameters (Moisès et al., 2023).

While integrating gender-specific criteria into DCEWS is crucial, it is equally important to address broader systemic issues such as resource allocation and institutional support. These factors can significantly impact the successful implementation of gender-responsive strategies in early warning systems.

1.1.3 Action plan for Conservation Agriculture

1.1.3.1 Introduction

Conservation Agriculture (CA) as a production system is underpinned by a set of three interlinked principles - minimum or no mechanical soil disturbance, permanent soil organic cover, and crop diversification - that are applied simultaneously. These principles can be, and indeed are being, integrated into most rainfed and irrigated production systems to strengthen their ecological sustainability, including arable farming, horticulture, plantation agriculture, agro-forestry and organic farming and integrated crop-livestock systems (FAO, 2011). These practices are promoted in order to reduce erosion, improve soil quality through the gradual build-up of soil carbon and in the long term, improve soil fertility and water infiltration. Other benefits of CA can be decreased labour requirements, increased yields, earlier planting and greater drought tolerance due to improvements in soil physical properties.

While CA provides the best guarantee for carbon sequestration in soils, the level of such sequestration does depend, in addition to minimum soil disturbance, on suitable crop rotations or associations, and on the amount of the biomass from the production system that is retained as surface mulch and also is being incorporated or sequestered into the soil. Thus, the overall reduction in greenhouse gas emission as a result of this would also depend on the careful observation of soil compaction and drainage problems and mineral fertilizer application rates to avoid, for example, NO_2 emissions resulting from anaerobic soil conditions. However, CA as a production system, has the potential to deliver on both sustainability and intensification, and its principles are widely applicable across a range of farming systems.

1.1.3.2 Ambition for the TAP

The long-term target of conservation agriculture is to transform the tillage system from one dominated almost 99 percent by conventional practices to at least 50 percent CA practices in Lesotho by 2045. However, in the short term, by 2030, the target is to grow the farmers' participation by reducing conventional agricultural by at least 10 percent and to leverage the use of drought tolerant tillage systems to achieve a resilient and diversified agricultural sector with improved and sustainable capacity to respond to climate variability and land degradation. The CA systems will be leveraged to scaling-up climate smart agriculture practices and actions to promote adaptation and increased food security achieving zero hunger by 2050.

Gender issues

The implementation of conservation agriculture technology must consider gender dynamics to ensure effective agricultural adaptation. Women play a crucial role in agricultural production and biodiversity conservation, yet they often face barriers that limit their participation and benefits from agricultural technologies. Addressing these gender considerations is essential for achieving sustainable agricultural development and food security. In Lesotho, women are heavily involved in various agricultural activities, including weeding, harvesting, and food processing, which are critical for the conservation of agro-biodiversity. In this project, measures will be taken to address institutional barriers identified in similar situations (e.g. as identified in Squire, 2003) such as limited access to training and decision-making processes, that hinder women's full participation in sustainable agricultural development. Conservation tillage technologies, while gender-neutral in design, can become biased if not implemented with gender-sensitive planning, potentially disadvantaging women (Lubwama, 1999). Thus, in this project, measures will be taken to empower women through education, training, and inclusion in policy-making to enhance their role in agricultural adaptation and environmental conservation. Such measures will explore provision of alternative income sources and adding value to women's agricultural activities to further support their contributions to agro-biodiversity conservation (see for example Abdelali-Martini et al., 2008). Cognizant of the crucial nature of gender considerations, implementation of these technology will explore broader socio-economic factors that affect the adoption of conservation agriculture technologies. These include access to resources, market dynamics, and cultural norms, which can influence both men's and women's roles in agricultural systems.

1.1.3.3 Actions and activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

CA is both management and knowledge intensive and complex to practice, requiring more planning than tillage-based systems. It cannot be reduced to a technology package, adoption requiring both change and adaptation based on experiential learning (Derpsch, 2008; Friedrich & Kassam, 2009). The counter measures to the slow adoption of CA elaborate the necessary conditions for the introduction of CA and transformation of tillage-based systems. The support to foster these necessary conditions must be mobilised at the individual, group, institutional and policy levels within the private, public and civil sectors so that the behaviour patterns of all stakeholders involved in the CA innovation system are mutually reinforcing to induce the development of the sufficient conditions, or the enabling environment, for adoption and spread.

Important constraints prevent wider-scale adoption of CA. Experience has shown that the adoption and spread of CA requires a change in commitment and behaviour of all stakeholders. For farmers, social mechanisms that encourage experimentation, learning and adaptation to local conditions are a prerequisite. For policymakers and institutional leaders, transformation of tillage to CA systems requires that they fully understand the large economic, social and environmental benefits that these systems offer. Such transformations call for sustained policy and institutional support that provides both incentives and ‘motivations’ to encourage farmers to adopt components of CA practices and improve them over time.

Actions selected for inclusion in the TAP

Nine actions have been selected for inclusion in the implementation of Conservation Agriculture as follows:

Action 1: Establish reliable local individual and institutional champions - Local champions play a crucial role in the implementation of CA technologies for climate change adaptation. These individuals or groups act as catalysts within their communities, promoting sustainable agricultural practices and facilitating knowledge transfer. By leveraging their influence and understanding of local contexts, they can effectively drive the adoption of CA practices, which are essential for building climate resilience among smallholder farmers.

Action 2: Develop a dynamic institutional capacity to support CA Adoption - This involves creating robust and adaptable institutions that can support the adoption and scaling of practices, which are essential for enhancing resilience among smallholder farmers. By fostering collaboration among various stakeholders, including farmers, NGOs, academic institutions, and government bodies, a dynamic institutional capacity can facilitate knowledge exchange, resource mobilization, and policy development. This collaborative framework is vital for overcoming the challenges posed by climate change and ensuring sustainable agricultural practices

Action 3: Engagement with and functional participation of farmers – This empowers them to adopt sustainable practices that enhance resilience and productivity. This participatory approach ensures that farmers are not just passive recipients of technology but active contributors to its development and adaptation, leading to more effective and sustainable outcomes.

Action 4: Leverage social capital by embracing the Importance of farmers' organizations - This is a strategic action for implementing CA technologies, which can significantly enhance climate change adaptation. Farmers' organizations facilitate the sharing of knowledge, resources, and support among members, fostering a collaborative environment that is crucial for the successful adoption of CA practices. These organizations act as platforms for innovation, enabling farmers to collectively address challenges and improve resilience to climate change.

Action 6: Collaboration between researchers and extension agents to identify problems and facilitate problem solving - This partnership facilitates the identification of problems and the development of solutions by leveraging diverse expertise and knowledge. Such collaboration is essential because it ensures that the solutions are practical, context-specific, and widely accepted by the farming community.

Action 7: Build a knowledge and learning nexus for CA in the farming, extension and scientist community - This involves creating a collaborative framework that integrates farmers, extension services, and scientists to effectively implement CA technologies. This approach fosters innovation, enhances resilience, and promotes sustainable agricultural practices. By leveraging collective expertise and resources, this nexus can address the multifaceted challenges posed by climate change and improve agricultural productivity and sustainability.

Action 8: Ensure Accessibility and affordability of required inputs and equipment - This approach is particularly important for smallholder farmers who often face financial and logistical barriers to adopting new technologies. By making CA inputs and equipment more accessible and affordable, farmers can more readily transition to sustainable practices that enhance productivity and resilience against climate change.

Action 9: Financing and enabling the inception stages – CA is a pivotal strategy for climate change adaptation, offering a sustainable alternative to conventional farming practices. It enhances resilience by improving soil health, reducing greenhouse gas emissions, and increasing crop productivity. Financing and enabling the inception stages of CA involve integrating technological advancements, fostering innovation systems, and establishing supportive policies.

Activities identified for implementation of selected actions

The following actions and activities underscore the key social, institutional and policy requirements for implementation of TAP through adoption of CA (Table 7).

Table 7. Actions and activity context for implementing conservation agriculture technology

Actions	Activities
Action 1	• Support and promote local champions of CA practice • Establish CA support and advocacy research and development groups

Actions	Activities
	• Promote private sector service providers in equipment and machinery and appropriate inputs and agrochemicals • Establish academic and research links with international agencies and CA champions
Action 2	• Mobilize the support and activity of critical policy and technical institutions • Promote and invest in research and development initiatives for CA • Establish collaborative links to promote advocacy, research and development
Action 3	• Mobilize participation of farmers and farmer collectives • Provide capacity building through training, on-farm demonstrations and experiments • Engage farmers in action research
Action 4	• Promote CA farmer field schools and mentorship • Establish CA support associations
Action 5	• Establish CA education clubs and associations for school going youth • Establish a CA scientific society with publication outlets
Action 6	• Establish collaborative studies between researchers, extension and farmers to effect action research • Train extension agents and farmer on scientific concepts underlying CA practices
Action 7	• Establish long term CA studies for demonstration and experimental research • Organize annual field days and study visits observe farm practices, demonstrations and experiments
Action 8	• Link CA farmers for procurement of inputs in bulk • Establish CA mechanizations associations to leverage economies of scale for procurement of CA mechanical services
Action 9	• Advocate for policy support to lower inception costs of CA for pioneer farmers • Advocate for retargeting of current subsidy policy from conventional agriculture to CA.

Actions to be implemented as project ideas

Conservation agriculture is a basket of technologies and ideally all component practices must be implemented simultaneous or in tandem. Thus, all six actions identified above must form a comprehensive project idea.

Action 1: Establish reliable local individual and institutional champions - These champions can facilitate trust, enhance communication, and mobilize local resources, ensuring that practices like CA are tailored to the specific contexts of smallholder farmers. Their involvement can also address the perceived feasibility and relevance of such practices, ultimately fostering greater community engagement and adoption, which is essential for sustainable agricultural intensification.

Action 2: Develop a dynamic institutional capacity to support CA Adoption - The action enhances the cross-sectoral collaboration necessary for effective implementation. Strong institutions facilitate the sharing of best practices, research, and training, which are essential for addressing food insecurity, biodiversity degradation, and water scarcity. By establishing CA centres of excellence, stakeholders can ensure that agricultural practices are participatory, demand-driven, and tailored to the needs of farmers and service providers, ultimately leading to more sustainable agricultural development.

Action 3: Engagement with and functional participation of farmers - This involvement fosters a deeper understanding of the benefits, such as improved soil quality and profitability, while also addressing barriers like financial constraints and lack of knowledge. By actively participating, farmers can share experiences, identify effective strategies, and contribute to the development of tailored education and financial incentives, ultimately enhancing the resilience of agroecological farming systems and promoting sustainable agricultural practices.

Action 4: Leverage social capital by embracing the Importance of farmers' organizations - The action is needed for the successful implementation of CA, as these organizations enhance risk cognition and facilitate knowledge sharing among farmers. By fostering a collaborative environment, farmers can engage in social learning, which significantly boosts their understanding and acceptance of conservation practices. This collective approach not only improves individual farmers' confidence in adopting new technologies but also amplifies the overall adoption rate, leading to more sustainable agricultural practices and improved soil health in the community.

Action 5: Providing knowledge, education and learning services - The action addresses identified barriers such as lack of knowledge and access to resources. Effective education strategies can enhance farmers' understanding of agroecological practices, thereby increasing their confidence and willingness to adopt multiple conservation methods. Additionally, tailored financial incentives can further motivate farmers to implement these practices, ultimately leading to improved soil quality and profitability, which are key motivations for adoption. This comprehensive approach can facilitate the transition towards more resilient farming systems.

Action 6: Collaboration between researchers and extension agents to identify problems and facilitate problem solving - The action identifies and solves problems in the implementation of conservation agriculture. This partnership leverages the strengths of both parties: researchers generate new agricultural technologies and practices, while extension agents facilitate their adoption among farmers. Such collaboration ensures that innovations are not only scientifically sound but also practically applicable and accessible to farmers.

Action 7: Build a knowledge and learning nexus for CA in the farming, extension and scientist community - Improved understanding of CA principles significantly mediates the adoption of practices like conservation tillage and soil cover. This suggests that fostering collaboration and communication among these groups enhances technical know-how, which is essential for successful adoption. Moreover, integrating private learning experiences with external knowledge sources can strengthen the overall effectiveness of conservation agriculture initiatives, ultimately supporting sustainable agricultural practices.

Action 8: Ensure Accessibility and affordability of required inputs and equipment - This approach not only enhances agricultural productivity but also contributes to environmental sustainability. However, several challenges hinder the widespread adoption of CA in Lesotho. These challenges include high input costs, limited access to credit, and the labour-intensive nature of some CA practices. Addressing these issues is essential to promote CA effectively.

Action 9: Financing and enabling the inception stages - Adequate financial support allows for the acquisition of necessary tools and technologies, training in new methods, and the establishment of infrastructure that promotes soil and water conservation. This initial investment fosters a transition to practices that reduce reliance on chemical inputs, ultimately leading to improved soil health and long-term economic viability for farmers, while also benefiting the surrounding ecosystem.

Gender issues

Implementing CA activities can enhance gender outcomes by empowering women and men through increased household incomes and reduced agricultural costs. Gender-disaggregated analysis revealed that female heads of households and women in male-headed households benefited significantly, enabling them to meet critical household needs and invest in productive assets (Ramirez et al., 2022). Training in conservation agriculture principles fosters collaboration among partners, enhancing women's roles in decision-making and resource management, ultimately leading to improved food security and sustainable livelihoods for both genders.

1.1.3.4 Stakeholders and timeline for implementation of the TAP

Overview of stakeholders for the implementation of the TAP

The implementation of CA technology involves multiple stakeholders, each playing a vital role in ensuring the adoption, sustainability, and success of the practices (Table 8). The aim is to enhance soil health, increase productivity, and improve resilience to climate change through practices like minimal soil disturbance, permanent soil cover, and crop rotations. By identifying and engaging critical stakeholders and clearly defining their roles, the implementation of CA can lead to improved soil health, increased productivity, and enhanced resilience to climate change, ultimately benefiting both farmers and the broader national community.

Table 8. Roles of stakeholders involved in the implementation of a conservation agriculture technology

Stakeholder	Roles
Farmers and farmer groups	• **Adoption and Implementation**: Farmers are the primary adopters of CA technologies, responsible for applying CA principles such as reduced tillage, crop rotation, and maintaining soil cover. • **Local Innovators**: Experiment with CA techniques on their farms, adapting practices to local conditions and sharing results with other farmers. • **Peer-to-Peer Learning**: Facilitate the spread of CA practices through farmer field schools, demonstration plots, and informal networks, allowing for the exchange of knowledge and experiences
Local authorities (Chiefs and elected councils)	• Advocacy and Promotion: Support the adoption of CA practices within communities by endorsing the benefits and encouraging participation. • Conflict Resolution: Mediate disputes that may arise over land use, resource allocation, or changes in farming practices associated with CA. • Cultural Integration: Help integrate CA practices into local traditions and farming customs, making them more acceptable and sustainable.
Government ministries with overlapping mandates on agriculture and natural resources	• **Advocacy and Promotion:** Support the adoption of CA practices within communities by endorsing the benefits and encouraging participation. • **Conflict Resolution:** Mediate disputes that may arise over land use, resource allocation, or changes in farming practices associated with CA. • **Cultural Integration:** Help integrate CA practices into local traditions and farming customs, making them more acceptable and sustainable. • Policy Support and Regulation: Develop and enforce policies that promote CA, such as subsidies for CA equipment, regulations that support sustainable land management, and incentives for adoption.

Stakeholder	Roles
	• Coordination and Extension Services: Provide agricultural extension services to educate and support farmers in implementing CA practices. Coordinate efforts between different stakeholders to ensure a cohesive approach to CA. • Resource Allocation: Allocate resources, such as funding, technical support, and infrastructure, to promote CA technologies and practices within the community.
Non-Governmental (NGOs) and Community Based (CBOs) Organizations	• **Capacity Building and Training**: Provide training programs, workshops, and field demonstrations to build farmers' knowledge and skills in CA practices. • **Technical Support**: Offer ongoing technical assistance to farmers, helping them address challenges in implementing CA and optimizing their practices. • **Awareness and Advocacy**: Raise awareness about the benefits of CA through campaigns, community meetings, and educational materials. Advocate for supportive policies and resources at the local and national levels. • **Monitoring and Evaluation**: Monitor the adoption and impact of CA practices, gather data, and provide feedback to farmers and other stakeholders to improve outcomes.
Academic and research institutions	• **Research and Development:** Conduct research on CA practices, including testing new crop varieties, developing improved soil management techniques, and studying the long-term impacts of CA on productivity and sustainability. • **Knowledge Dissemination:** Share research findings with farmers, extension services, and policymakers to inform and improve CA practices. • **Training and Capacity Building:** Offer educational programs and workshops to build the capacity of farmers, extension workers, and other stakeholders in CA principles and practices.
Agricultural extension services	• **Education and Training:** Provide hands-on training and support to farmers in the adoption and implementation of CA practices. This includes demonstrating techniques, offering advice, and troubleshooting challenges. • **Linking Farmers with Resources:** Connect farmers with resources such as seeds, tools, and financial support necessary for adopting CA. • **Monitoring and Feedback:** Regularly visit farms to monitor the progress of CA implementation, gather feedback from farmers, and adjust recommendations as needed.
Private Sector (Input Suppliers, Agro-dealers, Equipment contractors and manufacturers)	• Supply of CA Inputs and Equipment: Provide farmers with access to necessary inputs such as cover crop seeds, organic fertilizers, and CA-specific equipment like no-till planters and direct seeders. • Training and Support: Offer training and technical support on the use of CA technologies and products to ensure farmers maximize the benefits. • Innovation and Development: Develop new products and tools that enhance the effectiveness and ease of CA practices, such as more efficient water management systems or improved crop varieties.
Financial Institutions (Banks, Microfinance Institutions, Cooperatives)	• **Provision of Credit and Financial Products**: Offer loans, credit, and insurance products tailored to the needs of farmers adopting CA practices, helping them manage the initial costs and risks. • **Financial Education**: Provide financial literacy training to help farmers understand and manage the costs and benefits of adopting CA technologies. • **Investment in CA Projects**: Invest in CA initiatives or support farmer cooperatives that promote sustainable agriculture practices.
National Government Agencies	• **Policy and Regulatory Framework:** Develop national policies that promote CA adoption, including subsidies, tax incentives, and regulations that encourage sustainable farming practices. • **National Programs and Initiatives:** Implement national programs that promote CA practices, providing support for research, extension services, and farmer education.

Stakeholder	Roles
	• **Data and Information Sharing:** Provide access to data and information, such as climate projections and soil health assessments, that can help inform CA practices at the local level.
International Organizations and Donors	• **Funding and Resource Mobilization:** Provide financial resources, technical assistance, and capacity-building support to CA projects and initiatives. • **Technical Expertise and Best Practices:** Share global best practices, tools, and methodologies to enhance the effectiveness of CA implementation. • **Monitoring and Evaluation:** Support the monitoring and evaluation of CA projects to assess their impact and sustainability, and to inform future interventions.
Media and Communication Outlets	• **Awareness and Education:** Use various media platforms to raise awareness about CA practices, their benefits, and how they can be adopted. • **Dissemination of Information:** Provide timely information on weather conditions, market prices, and new developments in CA that can help farmers make informed decisions. • **Promotion of Success Stories:** Highlight success stories of farmers who have adopted CA practices, inspiring others to follow suit.

Scheduling and sequencing of specific activities

Table 9 provides an indicative scheduling and sequencing of various activities.

Table 9. Scheduling and sequencing of specific activities

Actions Activities	Scale	Time (Years)									
		1	2	3	4	5	6	7	8	9	10
Action 1: Establish reliable local individual and institutional champions	Local	■	■								
Action 2: Develop a dynamic institutional capacity to support CA Adoption	District			■	■	■					
Action 3: Engagement with and functional participation of farmers	Local					■	■	■			
Action 4: Leverage social capital by embracing the importance of farmers' organizations	National	■	■	■	■						
Action 5: Providing knowledge, education and learning services	National	■	■	■	■	■	■	■	■	■	■
Action 6: Collaboration between researchers and extension agents to identify problems and facilitate problem solving	National	■	■	■	■	■					
Action 7: Build a knowledge and learning nexus for CA in the farming, extension and scientist community	District	■	■	■	■	■	■	■	■	■	■
Action 8: Mobilizing input supply and output marketing sectors for CA	District			■	■	■	■	■	■	■	■
Action 9: Ensure Accessibility and affordability of required inputs and equipment	National	■	■	■							
Action 10: Financing and enabling the inception stages	National	■	■	■	■	■					

Gender Issues

Gender plays a crucial role in the implementation of CA technologies, as it influences access to resources, decision-making, and the overall success of agricultural initiatives. Recognizing and integrating gender considerations into agricultural practices can enhance productivity, sustainability, and food security. Women are often the primary farmers, yet their roles are frequently unrecognized, limiting their access to resources and opportunities necessary for effective agricultural practices (Foley, 2009). Gender roles are culturally defined, affecting control over resources, production, and marketing, which can marginalize women in agricultural research and extension systems (Meinzen-Dick et al., 2011). Thus, research and development systems are more successful when they incorporate gender issues, as women can make unique contributions to productivity and poverty reduction when given the opportunity (Meinzen-Dick et al., 2011). Consequently, neglecting gender issues can hinder potential outputs and welfare, as women's roles in production and food systems are critical for meeting food security goals (Jiggins, 1987). Thus, empowerment actions, such as providing alternative income sources and adding value to women's contributions, are essential for enhancing their role in the conservation and sustainable use of agro-biodiversity (Abdelali-Martini et al., 2008). Implementation of this technology requires a concerted effort to integrate gender perspectives into agricultural policies and practices, ensuring that both men and women can contribute to and benefit from conservation agriculture technologies.

The gender analysis of activities in implementing CA reveals significant insights into how gender roles and dynamics influence adoption. The analysis underscores the importance of considering gender-specific needs and contributions in promoting CA. Studies reveal that women often face more barriers to access extension services, inputs, and credit than men (Dimoso and Mgale, 2023). While both gender categories recognize the benefits of CA, women particularly value the reduced labour requirements and high moisture retention of CA practices (Umar and Umar, 2021). Experiences show that CA technologies offer labour and cost savings, which are particularly beneficial for women who often bear the brunt of agricultural labour. However, challenges such as weed control and skill requirements for machinery operation can disproportionately affect women due to limited access to training (Kumar et al., 2018). Furthermore, women often possess unique knowledge that can enhance CA implementation but face systemic barriers in resource access (Ravera and Rivera-Ferre, 2023).

CA technologies can be gender-neutral if gender-specific barriers are addressed, particularly through joint management of resources (Muriithi et al., 2018). By addressing gender-specific barriers and promoting joint management, CA can be more effectively disseminated and adopted, enhancing food security and agricultural sustainability for all.

1.1.3.5 Estimation of resources needed for action and activities

Estimation of capacity building needs

Implementing CA technologies requires targeted capacity-building efforts across multiple levels and sectors (Table 10). By addressing these capacity-building needs, the successful implementation and sustainability of conservation agriculture technologies can be significantly enhanced.

Table 10. Summary of capacity building needs for implementation of conservation agriculture technology

Skills	Capacity Development
Awareness and Knowledge Dissemination	
Farmers and Agricultural Workers	• Training programs to introduce the principles of CA, including minimal soil disturbance, crop rotation, and permanent soil cover. Practical demonstrations and field days can be crucial.
Extension Agents	• Enhancing the knowledge of agricultural extension workers so they can effectively disseminate CA practices to farmers.
Policymakers and Stakeholders	• Workshops to raise awareness among government officials, NGOs, and other stakeholders about the benefits of CA and the need for supportive policies.
Technical Training	
Farmers	• Hands-on training in the use of CA tools and techniques, such as no-till planters, direct seeders, and crop residue management.
Agricultural Technicians	• Advanced training on CA technologies, soil health assessment, and monitoring, which allows them to offer better support and guidance to farmers.
Research and Development Teams	• Building the capacity of researchers to develop locally adapted CA practices, focusing on soil types, climate conditions, and crop varieties.
Infrastructure and Equipment	
Access to Appropriate Tools	• Ensuring farmers have access to CA-specific tools and machinery, such as no-till drills and planters, and providing training on their maintenance and use.
Infrastructure Development	• Support in building infrastructure, such as storage facilities for crop residues and compost, and water management systems that complement CA practices.
Financial and Business Skills	
Financial Literacy for Farmers	• Training farmers on financial planning, access to credit, and market opportunities to invest in CA technologies.

Skills	Capacity Development
Entrepreneurship	• Encouraging the development of local businesses that can supply CA equipment and services, including training in business management and marketing.
Institutional Support	
Policy Frameworks	• Capacity building for institutions to develop and implement policies that incentivize CA adoption, such as subsidies, tax breaks, or grants.
Monitoring and Evaluation:	• Developing the capacity of local institutions to monitor the adoption and impact of CA practices through data collection and analysis.
Social and Community Engagement	
Community Mobilization	• Training community leaders to advocate for CA practices and organize group activities, such as farmer field schools or cooperative farming initiatives.
Gender and Youth Inclusion	• Ensuring training programs are accessible to women and young people, who are often key players in agricultural activities.
Climate Resilience and Environmental Education	
Sustainable Land Management	• Training on the environmental benefits of CA, such as soil carbon sequestration, water conservation, and biodiversity enhancement.
Climate Adaptation Strategies	• Building capacity to integrate CA into broader climate adaptation strategies, including managing extreme weather events and reducing greenhouse gas emissions.
Research and Knowledge Exchange	
Collaboration with Research Institutions	• Encouraging partnerships between farmers, researchers, and extension services to share knowledge and innovations in CA.
Farmer-Led Research	• Supporting participatory research approaches where farmers contribute to the development and testing of new CA practices
Monitoring and Evaluation Systems	
Impact Assessment	• Building capacity to track the social, economic, and environmental impacts of CA, including changes in crop yields, soil health, and farmer livelihoods.
Data Management	• Training in data collection, analysis, and reporting to inform continuous improvement of CA practices.

Estimations of costs of actions and activities

The CA technology has been piloted for many years in Lesotho with little adoption and spread despite some policy and financial investments from both government of Lesotho, development partners, NGOs and the private sector. However, the level of soil erosion and land degradation in the country prohibits giving up investment for implementation of this technology despite major financial investment for which we have little to show. A set of nine actions and associated activities for implementation of this TAP were compiled (Table 7). The TAP will require a total budget of USD 64.2 million for its implementation. Most of this funding can be sought from international agencies and NGOs, but some costs would need to be borne by the Government of Lesotho (in-kind).

Gender issues

Gender-responsive capacity building for implementing conservation agriculture technology involves tailored training programs that address the specific needs and skills of both male and female farmers. This includes enhancing women's access to knowledge about zero tillage and crop diversification, while also addressing barriers such as limited skills of machine operators. Focus group discussions reveal that understanding the advantages and challenges of CA technologies, such as weed control and seed germination, is crucial hence empowering both genders through targeted education can facilitate better adoption and effective use of CA technologies in sustainable agriculture (Kumar et al., 2018). This approach ensures that training and resources are tailored to the specific roles and responsibilities of women, who often perform critical agricultural tasks. By recognizing and incorporating gender differences, extension programs can enhance the effectiveness of CA technologies, leading to improved adoption rates and sustainable agricultural practices that benefit entire farming households. This strategy promotes equitable participation and empowers women in agricultural development initiatives (Mittal and Rasheed, 2022).

1.1.3.6 Management planning

Risk and contingency planning

Implementing a CA system involves adapting farming practices to enhance sustainability, improve soil health, and increase productivity. However, this transition can face several risks. Developing a robust risk and contingency plan helps mitigate these challenges and ensures the successful implementation of CA and addresses the potential risks and makes robust contingency plans to enhance the likelihood of successful implementation of CA to ensure sustainable farming and environmental health (Table 11).

Table 11. Identified risks and possible contingency plan

Type of risk	Description of risk	Contingency actions
Technical Risks	• **Inadequate Knowledge**: Farmers may lack understanding of CA techniques. • **Soil Suitability**: Soil types may not be suitable for CA practices. • **Equipment Failures**: Specialized equipment required for CA may malfunction.	• **Training Programs:** Implement comprehensive training and extension services to educate farmers on conservation agriculture techniques. • **Soil Assessment:** Conduct thorough soil assessments and tailor practices to soil types to maximize effectiveness.

Type of risk	Description of risk	Contingency actions
		• **Equipment Maintenance:** Establish regular maintenance schedules and have backup equipment available.
Operational Risks	• **Resource Availability:** Lack of access to necessary resources such as cover crops or specific inputs. • **Implementation Challenges:** Difficulties in adopting new practices or integrating them with existing technical and cultural systems.	• **Resource Management:** Secure reliable sources for necessary resources (e.g., cover crops, organic fertilizers) and develop alternative supply chains if needed. • **Adaptation Strategies:** Develop adaptive management strategies to address implementation challenges, including pilot projects and phased adoption.
Social Risks	• **Resistance to Change:** Resistance from farmers and local communities to adopting new practices. • **Training and Education:** Insufficient training and support for farmers.	• **Engagement & Communication:** Develop strategies to engage and communicate with farmers, including demonstrations, workshops, and success stories. • **Support Networks:** Build support networks and farmer groups to share knowledge and experiences.
Environmental Risks	• **Climate Variability:** Changes in climate that affect the suitability of conservation practices. • **Pest and Disease Pressure:** Increased pest or disease pressures that may arise from new practices.	• **Climate Resilience:** Select CA practices that are resilient to local climate conditions and variations. • **Pest Management:** Develop integrated pest management strategies to address potential pest and disease issues
Financial Risks	• **High Initial Costs:** The cost of transitioning to conservation agriculture might be high. • **Economic Viability:** Uncertainty about the economic benefits and returns from conservation practices.	• **Funding Support:** Seek financial support through grants, subsidies, or loans to cover initial transition costs. • **Economic Analysis:** Conduct a detailed economic analysis to demonstrate the long-term benefits of CA and secure buy-in from stakeholders

Next steps

Implementing CA technology involves several critical steps to ensure its successful integration and effectiveness (Table 12). CA focuses on sustainable farming practices that improve soil health, enhance productivity, and reduce environmental impact. To achieve the foregoing ideals of CA, following certain critical steps can expedite effective implementation of the technology, ensuring that it is tailored to local needs, supported by stakeholders, and capable of achieving long-term sustainability and impact.

Table 12. The immediate and critical requirements for implementation of CA

Immediate Need (s)	Critical Requirement
Step 1: Needs Assessment and Planning	
Assess local conditions	• **Soil and Climate Analysis:** Conduct soil tests and climate assessments to determine the suitability of CA practices and technologies.

Immediate Need (s)	Critical Requirement
	• **Farmer Needs**: Identify specific needs and challenges of local farmers to tailor the technology accordingly.
Define objectives	• **Goals Setting:** Establish clear goals for implementing CA such as improving soil health, increasing yield, or reducing erosion. • **Success Metrics:** Define metrics for measuring success, such as soil organic matter, crop yields, and water retention.
Develop a plan	• **Technology Selection:** Choose appropriate CA technologies based on local conditions and goals e.g., no-till equipment, cover crop systems. • **Implementation Strategy:** Develop a detailed plan for deploying the technology, including timelines, resources, and responsibilities.
Step 2: Stakeholder Engagement	
Involve key stakeholders	• **Farmers:** Engage farmers early in the process to understand their perspectives and gain their buy-in. • **Local Authorities:** Work with local government and agricultural agencies to align with regional policies and obtain support.
Create partnerships	• **Technical Experts:** Collaborate with agricultural experts, extension services, and research institutions for technical guidance. • **Funding and Support:** Identify potential funding sources and support organizations to assist with financial and technical resources.
Step 3: Training and Capacity Building	
Develop training programs	• **Education Sessions**: Conduct training sessions for farmers and farm workers on how to use the technology and implement CA protocols. • **Hands-On Demonstrations**: Provide practical demonstrations to show the technology in action and its benefits.
Build local expertise	**Train-the-Trainer**: Train local extension workers and leaders who can provide ongoing support and training within the community.
Step 4: Pilot Testing and Evaluation	
Conduct pilot projects	• **Small-Scale Trials**: Implement the technology on a small scale or in a few test areas to evaluate its effectiveness and address any issues. • **Monitor Results**: Collect data on performance, challenges, and benefits during the pilot phase.
Evaluate and adjust	• **Review Outcomes**: Assess the results of the pilot projects against the success metrics defined earlier. • **Refine Technology**: Make necessary adjustments to the technology or implementation strategy based on feedback and performance.
Step 5: Full-Scale Implementation	
Roll-out Plan	• **Scale Up**: Gradually expand the use of the technology to a broader area based on the success of the pilot phase. • **Resource Allocation**: Ensure that adequate resources (financial, technical, and human) are available for full-scale implementation.
Monitor and support	• **Ongoing Monitoring**: Continuously monitor the performance of the technology and its impact on conservation goals.

Immediate Need (s)	Critical Requirement
	• **Technical Support**: Provide ongoing technical support and troubleshooting to address any issues that arise
Step 6: Documentation and Reporting	
Record keeping	• **Document Processes**: Maintain detailed records of the implementation process, including challenges, solutions, and outcomes. • **Success Stories**: Document and share success stories and case studies to illustrate the benefits and promote adoption.
Reporting	• **Progress Reports**: Prepare regular reports on the progress and impact of the technology for stakeholders and funders. • **Feedback Integration**: Use feedback from stakeholders to continuously improve and adapt the technology and practices.
Step 7: Sustainability and Scaling	
Ensure long-term sustainability	• **Financial Sustainability**: Develop strategies to ensure the ongoing financial sustainability of the technology and practices. • **Local Ownership**: Foster a sense of ownership and responsibility among local farmers and stakeholders to maintain and sustain the practices.
Expand and replicate	• **Scaling Up**: Explore opportunities to scale up the technology to other regions or farming communities with similar conditions. • **Replication Strategies**: Develop strategies for replicating successful implementations in different areas or contexts.

Gender Issues

Gender sensitive strategies aim to ensure equitable participation and benefit-sharing among men and women in agricultural practices. We have recognized that women often face barriers in accessing key resources such as land, machinery, and inputs, which are crucial for adopting CA technologies. This is particularly evident where gendered barriers limit women's participation in CA practices (Wekesah et al., 2019). Furthermore, they tend to be underrepresented in agricultural policy-making and administration, which affects their ability to influence conservation policies and programs. Implementation will seek to address this marginalization which can lead to the neglect of women's perspectives (Samanta, 2022).

We are advocating for the design and implementation of gender-sensitive extension programs that address the specific needs of women in agriculture in order to bridge the knowledge and skill gaps by providing targeted training and resources (Mittal and Rasheed, 2022). Experience shows that understanding gendered practices and perspectives is crucial. Thus, encouraging joint decision-making within households can help balance the labour distribution and ensure both men and women benefit equitably (Sumner et al., 2017). Theoretically CA technologies are perceived as labour-saving, which can reduce the burden on both men and women. This aspect must particularly appeal to women, who often juggle multiple productive and reproductive responsibilities (Kumar et al., 2018; Sumner et al., 2017). However, in Lesotho, the lack of appropriate equipment and knowledge negates the experience especially for women who must do the weeding and digging of planting holes.

1.1.3.7 Reporting

Table 13. Overview table

Sector	**Agriculture**							
Sub-sector	Food Security and Nutrition							
Technology	Conservation Agriculture							
Ambition	The long-term target of conservation agriculture is to transform the tillage system from one dominated almost 99 percent by conventional practices to at least 50 percent CA practices in Lesotho by 2045.							
Benefits	Soil water conservation, soil erosion control, adaptation to climate change with mitigation co-benefits.							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame (Yrs)**	**Risks**	**Success criteria**	**Indicators for Monitoring of implementation**	**Budget per activity (Million US$)**
Action 1: Establish reliable local individual and institutional champions	Support and promote local champions of CA practice	➢ National budget ➢ Donor funding	MAFS, NGOs UN	1-5	Lack of willingness to champion CA due to cultural, social & economic factors	Willing champions available	Local champions successfully practicing CA	2.5
	Establish CA support and advocacy research and development groups	➢ National budget ➢ Donor funding ➢ UN	MAFS NGOs Academia	1-5	Lack of fundin g	CA lobby groups and advocacy agents	Successful fund raising for CA promotion	1.25
	Promote private sector service providers in equipment, machinery, appropriate inputs & agrochemicals	➢ National budget ➢ Donor funding	LMS MAFS DMA	1-10	Low profitability margins on CA equipment sales	An emerging market for CA equipment both manual & tractor mounted	Tractor hire associations purchase and contract CA equipment	2.5
	Establish academic and research links	➢ National budget	NUL NGOs UN agencies	1-5	Low appetite to establish links with	Number of active	Number of active research links	1.25

	with international agencies and CA champions	➢ Donor funding ➢ FAO /WFPs			local researchers	collaborati ve research links		
Sub-total for Action 1 Activities								**7.5**
Action 2: Develop a dynamic institutional capacity to support CA Adoption.	Mobilize the support and activity of critical policy and technical institutions	➢ National budget ➢ Donor funding ➢ UN agencies ➢ NGOs	MAFS UN NGOs	1-5	Low priority for CA	Improved policy environment for CA adoption	Policy incentives for CA adoptions	0.75
	Promote and invest in research and development initiatives for CA	➢ National c budget ➢ Donor funding ➢ FAO /WFP	MAFS Academia	1-10	Lack of financial resources supporting research & development	Availability of CA tools and equipment	Numbers of CA products produced locally	6.25
	Establish collaborative links to promote advocacy, research and development	➢ National budget ➢ Donor funding ➢ FAO /WFP	MAFS Academia FAO /WFP	1-10	Low appetite for CA lobby and advocacy	Number of policies promoting CA	Increase public & private funding for CA	2.5
Sub-Total for Action 2 Activities								**9.5**
Action 3: Engagement with and functional participation of farmers and dissemination systems in the country	Mobilize participation of farmers and farmer collectives	➢ National budget ➢ Donor funding ➢ FAO /WFP	MAFS	1-5	Low adoption rates for CA	Fully functional CA community groups	Increase in CA hectarage driven by farmers and farmer groups	1.25
	Provide capacity building through training, on-farm demonstrations and experiments	➢ National budget ➢ Donor funding ➢ FAO /WFP ➢ NGOs	MAFS	1-5	Inadequate Funding	Increase in on-farms demonstrations and experiments	Farmer driven promotional activities for CA adoption	2.5

	Engage farmers in action research	➢ National budget ➢ Donor funding ➢ FAO /WFP	Academia MAFS	1-10	Lack of funding for research	Number of on-farm experiments and demonstrations for CA	Field day hosted by action research groups	3.75
Sub-Total for Action 3 Activities								**7.5**
Action 4: Leverage social capital by embracing the importance of farmers' organizations	Promote CA farmer field schools and mentorship	➢ National budget ➢ Donor funding ➢ FAO /WFP	NUL MAFS	1-10	Lack of funding	Number of active field schools on CA	Active farmer field schools	2.5
	Establish CA support associations	➢ National budget ➢ Donor funding ➢ WFP /FAO	MAFS NGOs	1-10	Lack of Funding	Active CA groups	Increase CA adoptions	1.25
Action 5: Providing knowledge, education and learning services	Establish CA education clubs and associations for school going youth	➢ National budget ➢ Donor funding ➢ WFP /FAO ➢ NGOs	MAFS NGOs FAO Schools	1-10	Lack of funding supports	Active CA clubs nationally	Club meetings and competitions	2.5
	Establish a CA scientific society with publication outlets	➢ Donor funding ➢ UNFCC C funding windows	Faculty of Agriculture	1-10	Lack of funding	Annual meetings and conferences	Increased research activity on CA	3.75
Sub-Total for Action 5 Activities								**10**
Action 6: Collaboration between researchers and extension agents to identify problems and	Establish collaborative studies between researchers, extension and farmers to effect action research	➢ Donor funding ➢ UNFCC C funding windows ➢ FAO /WFP	Academia MAFS	1-10	Lack of funding	Extension – Research collaborations	Increased support to farmers	5.0

facilitate problem solving	Train extension agents and farmer on scientific concepts underlying CA practices	➢ National budget ➢ Donor funding ➢ FAO /WFP	NUL MAFS	1-10	Lack of funding	Seminars and symposia on CA	Increased knowledge and appreciation of CA	3.75
Sub-Total for Action 6 Activities								**8.75**
Action 7: Build a knowledge and learning nexus for CA in the farming, extension and scientist community	Establish long term CA studies for demonstration and experimental research	➢ Academia ➢ MAFS ➢ FAO / WFP	NUL MAFS	1-10	Land and funding constraints	Number of long-term experiments and demonstration plots	Long term commitments for CA monitoring	12.5
	Organize annual field days and study visits observe farm practices, demonstrations and experiments	➢ MAFS ➢ NGOs ➢ FAO	➢ MAFS ➢ NGOs ➢ FAO	1-10	Lack of funding	Number of field days	Farmer exchange visits	1.25
Sub-Total for Action 7 Activities								**13.75**
Action 8: Ensure Accessibility and affordability of required inputs and equipment	Link CA farmers for procurement of inputs in bulk	➢ National budget ➢ Donor funding ➢ NGOs	MAFS NGOs FAO	1-10	Low participation of farmers	CA based farmer groups	Activity and sustainability of CA farmer groups	1.25
	Establish CA mechanizations associations to leverage economies of scale for procurement of CA mechanical services	➢ National budget ➢ Donor funding	MAFS NGOs FAO	1-10	Low appetite for participation	Number of functional associations	Increased procurement of CA equipment	1.25
Sub-Total for Action 8 Activities								**5.0**
Action 9: Financing and enabling the inception stages	Advocate for policy support to lower inception costs of CA for pioneer farmers	➢ National budget ➢ Donor funding ➢ FAO /WFP	MAFS Academia	1-10	Lack of funding	New policy initiatives	Adoption and use of new policies	1.25

	Advocate for retargeting of current subsidy policy from conventional agriculture to CA.	➢ National budget ➢ Donor funding ➢ FAO /WFP ➢ UNFCCC funding windows	MAFS	1-10	Low political will for CA promotions	Policy debates and engagement	Policy changes	1.0
Sub-Total for Action 9 Activities								**2.25**
Grand Total for all Activities								**64.26**

1.1.3.8 Tracking the implementation status of the TAP

Rationale, responsibility and content of TAP tracking

The proposed national process for tracking the implementation of CA technology involves a comprehensive monitoring and evaluation (M&E) framework, institutional responsibilities, and specific timing and information to be tracked. This process is essential for ensuring the effective adoption and sustainability of CA practices, which aim to enhance agricultural productivity while conserving natural resources. The M&E framework is crucial for assessing the progress and impact of CA technologies. It involves setting specific criteria and indicators to track the implementation and outcomes of CA practices (Yiu et al., 2022). The framework should be designed to capture data on soil health, crop yields, resource use efficiency, and environmental impacts, such as greenhouse gas emissions and biodiversity conservation (Fu et al., 2022; Kundu , 2022).

The Ministry of Agriculture, Food Security and Nutrition (MAFN) will coordinate CA implementation, supported by research institutions, agricultural extension services and NGOs. These institutions are responsible for developing and disseminating CA technologies, providing training to farmers, and facilitating farmer-participatory approaches to refine CA practices. However, collaboration with international organizations and partnerships, such as FAO, WFP as well as NGOs will enhance the capacity for effective M&E and technology transfer. The implementation process will be phased, starting with pilot projects to refine CA practices and gradually scaling up based on lessons learned. Key information to be tracked includes adoption rates, changes in farm income, resource savings, and improvements in soil and water conservation (Shamna et al., 2022). Regular reporting and feedback mechanisms will be established to ensure continuous improvement and adaptation of CA technologies to local conditions (Yiu et al., 2022). While the proposed process emphasizes structured M&E and institutional collaboration, challenges such as socio-economic constraints and the need for policy support must be addressed to facilitate widespread adoption of CA technologies. Thus, understanding sub-national differences and tailoring approaches to specific agro-ecological contexts are also critical for successful implementation.

Gender issues

Integrating gender-specific criteria and targets in CA involves recognizing the distinct roles, needs, and contributions of different genders in the agricultural system. By incorporating gender perspectives, CA can enhance its impact on food security, sustainability, and community well-being. First, gender-disaggregated data collection and analysis is critical because it is essential for understanding the different impacts of CA on men and women. Secondly, it can help to identify gaps and inform gender mainstreaming in agricultural practices, although it is necessary to move beyond economic indicators to address broader empowerment domains (Rodriguez et al., 2024). For example, conducting *ex-ante* and *ex-post* gender-specific impact assessments can reveal differences in how CA affects men and women (Graef et al., 2018). Understanding these differences can guide the development of gender-responsive strategies that address specific challenges faced by each gender, such as labour distribution and access to resources (Kumar et al., 2018).

Finally, building capacity and fostering stakeholder engagement are critical for successful gender integration. Conservation projects that prioritize gender-equitable stakeholder engagement tend to achieve better outcomes and sustainability. Thus, providing technical and financial support, as well as creating a supportive environment, can incentivize gender-focused approaches in conservation projects (Westerman, 2021). While integrating gender-specific criteria in CA is beneficial, it is often perceived as an additional burden rather than a fundamental component. Overcoming this perception requires shifting the dialogue among practitioners to recognize the intrinsic value of gender integration in achieving conservation goals (Westerman, 2021).

1.2 Project ideas for the Agriculture Sector

1.2.1 Brief Summary of the Project Ideas for the Agriculture Sector

The sector selection was based on the recommendations of the NCCP 2017-2027 taken together with the NDC 2020/2021 which identified and prioritized adaptation priorities to drive a climate proof economic agenda. A large proportion of the population ekes their livelihoods and income from the agricultural sector mainly in the crops and livestock sub-sectors. However, climate change already precipitated extreme weather and climate variability manifested by among others prolonged and intense drought, heavy rain, early and late frosts, agricultural production is highly erratic. Therefore, a climate resilient cropping sub-sector was deemed necessary to ensure long-term food and nutrition security for a majority of smallholder farming households. However, pursuant to the NAPA, the prerequisite was to climate proof the sector by addressing climate change imperatives and provide mechanisms to enhance climate change resilience (including water harvesting and storage for irrigation, introduction of improved drought resistant seed varieties and climate change adapted cropping patterns), developing and implementing a functional early warning system for the agriculture sector to identify and mitigate risks and exploit opportunities posed by climate change and practising conservation agriculture.

Consequently, two project ideas have been identified for the agriculture sector based on the two complementary technologies i.e. DCEWS and CA. These two technologies are pivotal in achieving the transfer, diffusion, and deployment of adaptation technologies in agriculture. CA enhances the resilience of agricultural systems, making them more adaptable to climate change, which can be complemented by decentralized community-based early warning systems. These systems facilitate timely information dissemination regarding climate risks, enabling farmers to implement CA practices effectively. A monitoring system can collect and analyse climate data to identify early warning signs of climate change impacts on agriculture. It can help assess the risks associated with changing temperature patterns, precipitation levels, and extreme weather events. By understanding the potential risks, farmers can take proactive measures to adapt their agricultural practices accordingly. By integrating CA with early warning technologies, farmers can optimize resource use, improve crop management, and respond proactively to environmental changes. This synergy fosters the transfer and diffusion of adaptation technologies, ensuring that agricultural practices are sustainable and aligned with local needs, ultimately contributing to food security and resource conservation.

1.2.2 Project idea for Decentralized Community-based Early Warning System

Background

The idea is to develop a model DCEWS to support and climate proof the agriculture sector. The Sendai Framework for Disaster Risk Reduction 2015-2030 highlights the significant role of communities in the development and implementation of EWS and emphasizes the importance of developing multi-hazard, multisectoral forecasting and EWS that are people-centred through participatory processes and tailored to meet the social and cultural needs of users, including gender considerations. Lesotho sought to domesticate the Sendai protocols through a series of strategic documents including the National Early Warning Strategy and Action Plan 2020. This requires an effective EWS that helps communities prepare and take early action to avoid or limit the impact of hazards. Thus, DCEWS for agriculture can offer several adaptation benefits in the context of climate change as it allows communities to develop EWS tailored to their specific agricultural and climatic conditions. This means that the system can account for local vulnerabilities, crop types, farming practices, and the socio-economic context. By having localized information, farmers can receive accurate and relevant alerts about impending climate-related risks, enabling them to take timely actions. Overall, a DCEWS for agriculture strengthens local resilience, fosters community engagement, and enables targeted adaptation actions. By combining scientific data with local knowledge, it enables the capacity of farmers to adapt to changing climate conditions and ultimately builds sustainable and climate-resilient agricultural systems.

Objectives

Primary Objective of the project is to establish a DCEWS that enhances agricultural adaptation to climate change. More specifically, the project seeks to: a) develop and implement localized EWS that provide timely and accurate climate and weather information to farmers; b) build community capacity in climate risk management and decision-making; c) strengthen linkages between DCEWS and national meteorological services; d) promote the adoption of climate-resilient agricultural practices based on early warnings; and e) foster community ownership and sustainability of EWS.

Project outputs

a) **Increased Climate Resilience**: Farmers and communities are better equipped to anticipate and respond to climate risks, leading to reduced crop losses and improved food security.

b) **Empowered Communities:** Enhanced local capacity to manage climate risks through the use of DCEWS.

c) **Improved Agricultural Productivity:** Adoption of CSA practices based on timely and accurate weather information, resulting in higher and more stable crop yields.

d) **Sustainable Systems:** A DCEWS that continues to operate and evolve beyond the project’s lifecycle, supported by local governance and community participation.

Sustainable development context

The Government of Lesotho has already updated the National Strategy for Disaster Risk Reduction (NSDRR) in which early warning is recognized as one of its priority actions. Thus, this National Early Warning Strategic Action Plan (NEWSAP) has been developed as a complementary document to the NSDRR. If early warning on disaster risks is disseminated, communities, disaster management workers and committees concerned will be able to work for timely prevention of, preparedness for and response to disasters. The EWS contributes to the reduction of economic loss as it helps communities minimize the loss of people's belongings, properties and their livelihoods as well. Thus, this project concept establishes the relationship to the country's sustainable development priorities. The EWS II project is intending to pilot this concept in six priority sub-catchments of the Integrated Catchment Management program. Thus, this proposed project concept seeks to make a deliberate effort to build on and continue such interventions.

Project Deliverables

Implementing DCEWS in the agriculture sector offers numerous benefits and deliverables, particularly in enhancing resilience and adaptation to climate-induced challenges. These systems leverage local knowledge and technology to provide timely and accurate information, which is crucial for disaster preparedness and response. By integrating community participation and advanced technologies, DCEWS can significantly improve agricultural productivity and sustainability through enhanced disaster preparedness, increased resilience and adaptation and technology integration and efficiency.

Project scope and implementation

The implementation of DCEWS for agriculture involves integrating technology and local knowledge to enhance adaptation strategies. Such systems aim to provide timely alerts and actionable information to farmers, helping them mitigate the impacts of climate-induced disasters. The project scope includes developing platforms that cater to specific agricultural needs, utilizing both technological advancements and community engagement enhancing their adaptive capacity and resilience. The scope areas are feasible for implementation within the technological and cultural capability of Lesotho especially because it dove-tails into existing EWS initiatives both as strategic policy initiatives and specific interventions.

Project activities

In order to deliver a comprehensive DCEWS envisioned here, the set of actions identified above will be effected in five critical tasks envisaged as a framework of project activities.

a) Task 1: Needs Assessment and System Design
b) Task 2: Development and Deployment of the EWS
c) Task 3: Capacity Building and Training
d) Task 4: Community Engagement and Awareness
e) Task 5: Monitoring, Evaluation, and Sustainability

Timeline: The project concept envisioned will roll out over a 10-year period

Budget requirements:

a) **Estimated budget:** US$15 million
b) Funding sources:

- **Global Climate Funds**: Initiatives like the Green Climate Fund (GCF) and the Global Environment Facility (GEF) provide financial resources for projects that enhance climate resilience, including early warning systems.
- **International Development Agencies**: Organizations such as the World Bank and the United Nations Development Programme (UNDP) often fund projects aimed at improving agricultural resilience and disaster risk reduction.
- **Regional Cooperation**: Cross-border collaborations can attract funding from regional bodies like the African Union which support initiatives that address shared climate challenges.

Measurement/Evaluation

The evaluation of DCEWS involves assessing their effectiveness in empowering communities to prepare for and respond to hazards. Success is measured through various metrics, including community engagement, system responsiveness, and integration with local governance. These systems aim to enhance local capacity and ensure timely dissemination of warnings, ultimately reducing risk and improving community resilience.

Possible Complications/Challenges

These systems aim to empower communities to better prepare for climate-related hazards, but their effectiveness is often limited by several factors. Key challenges include insufficient community capacity, lack of ownership, and inadequate long-term political and financial commitment from governments. Additionally, environmental challenges exacerbated by climate change pose significant obstacles to sustainable agriculture and the effectiveness of early warning systems.

Responsibilities and Coordination

- **Meteorological Services**: Provide weather data, forecasting tools, and technical support for the EWS.
- **Local Government Councils**: Facilitate community engagement, support training initiatives, and integrate the EWS into local disaster management plans.
- **NGOs/CSOs**: Collaborate on community mobilization, capacity building, and advocacy for climate adaptation.
- **Private Sector**: Engage in the provision of technology solutions (e.g., mobile platforms, weather stations) and possible funding or in-kind contributions.
- **Communities**: Actively participate in the design, implementation, and maintenance of the EWS, ensuring it meets local needs and priorities.

1.2.3 Project idea for Conservation Agriculture

Background

The concept here proposes a CA based project in Lesotho. CA is generally defined as a set of management practices that minimize soil disturbance, incorporate legumes through rotations or intercropping, and maintain crop residues on the soil surface. These practices are promoted in order to reduce erosion, improve soil quality through the gradual build-up of soil carbon and in the long term, improve soil fertility and water infiltration. Other benefits of CA can be decreased labour requirements, increased yields, earlier planting and greater drought tolerance due to improvements in soil physical properties. The foregoing definition and descriptions embraces national aspirations for upholding agriculture as one of four engines of development in the National Strategic Development Plan. The National Food Security Policy of 2005 recognized and advocated CA as one of the key strategies for achievement of food security and reduction of soil erosion and land degradation. The Land Degradation Neutrality assessment (UNCCD, 2018) portrayed a high trade-off cost to national economic development with the cost of land degradation exceeding US$57 million per annum. The CA based project has the potential to arrest the spate of soil erosion and land degradation, stabilize the food security situation through increased soil productivity and crop yields.

Objectives

The primary objective of the project to implement and promote CA as a strategy for climate change adaptation and the sustainable management of land resources. The specific objectives are to:

a) Reduce land degradation and restore soil fertility through conservation agriculture practices.
b) Enhance the climate resilience of farming systems by improving water management, soil health, and biodiversity.
c) Increase agricultural productivity and food security in climate-vulnerable areas.
d) Build the capacity of farmers and extension workers in conservation agriculture techniques.
e) Foster community and policy support for the widespread adoption of conservation agriculture.

Project outputs

a) **Improved Soil Health and Reduced Land Degradation:** Enhanced soil fertility, reduced erosion, and improved water retention in project areas.
b) **Increased Agricultural Productivity:** Higher and more stable crop yields, contributing to improved food security and livelihoods.
c) **Enhanced Climate Resilience:** Farming systems better equipped to cope with climate variability and extremes, reducing the risk of crop failure.
d) **Empowered Communities:** Strengthened local capacity to implement and sustain conservation agriculture practices.

Supportive Policies

CA is supported by the Food Security Policy and Strategic Guidelines of 2005, National Climate Change Policy of 2017 complimented by the Soil and Water Consecration Policy of 2021 taken together with the Climate Smart Agriculture Strategic Investment plan of 2018.

Sustainable development context

The National priorities of Lesotho is food and nutrition security and achieving zero hunger through conservation of cropping soils and increasing their productivity. CA has been piloted with mixed results in Lesotho. It is therefore not a new development. However, given its potential for conservation, restoration and reclamation of Lesotho's cropping land resources.

Project Deliverables

The implementation of CA technology for climate change adaptation in the agriculture sector involves several key deliverables. These deliverables are crucial for enhancing agricultural productivity while mitigating the adverse effects of climate change. CA practices such as reduced tillage, continuous cover, and crop rotation form the foundation of these efforts, aiming to improve soil health and increase resilience against climate variability. The following sections outline the primary deliverables in this context.

a) Development of climate-resilient crops through biotechnology and advanced genetics to enhance agricultural efficiency and sustainability.
b) Machinery breakthroughs and automation to support the adoption of CA practices, reducing labor and increasing precision in farming operations.
c) Implementation of sustainable soil management practices to improve soil organic matter, reduce soil disturbance, and enhance soil infiltration and groundwater recharge capacity.
d) Adoption of water-smart strategies and water-efficient irrigation systems to maintain proper soil-water balance and conserve water resources.
e) Transformation of agricultural soils into carbon sinks through no-tillage techniques and the return of diverse crop biomass to the soil.
f) Reduction in fossil energy use and greenhouse gas emissions by minimizing agricultural operations and optimizing input use.
g) Enhancement of soil fertility, nutrient dynamics, and overall soil quality through CA practices, which also help in reducing production costs and sustaining yields.

While conservation agriculture offers significant benefits for climate change adaptation, challenges remain in its widespread adoption. These include bridging gaps between research, industry, farmers, and governments to ensure the effective dissemination and implementation of CA technologies.

Project scope and implementation

CA is a pivotal technology for climate change adaptation in the agricultural sector, offering a sustainable approach to enhance resilience and productivity. CA practices, such as reduced tillage, continuous cover, and crop rotation, are designed to improve soil health and increase agroecosystem resilience, thereby mitigating the adverse effects of climate change. These practices not only help in adapting to climate variability but also contribute to climate change mitigation by enhancing soil organic carbon sequestration, which is crucial for reducing greenhouse gas emissions. Despite the benefits, there are technical and socio-economic barriers to the adoption of CA, such as the need for more stringent policy measures and effective extension services to educate farmers. Addressing these challenges through interdisciplinary approaches and policy frameworks is essential for maximizing the benefits of CA in the agricultural sector.

Project activities

Six project tasks are envisaged as a framework of project activities.

a) Task 1 Baseline Assessment and Site Selection
b) Task 2: Training and Capacity Building
c) Task 3: Implementation of Conservation Agriculture Practices
d) Task 4: Monitoring, Evaluation, and Adaptive Management
e) Task 5: Community Engagement and Awareness
f) Task 6: Policy Advocacy and Scaling Up

Timelines: The project is envisaged to roll out over a 10-year period.

Budget/Resource requirements

a) **Estimated budget:** US$64.25 million
b) **Funding sources:**

- **Global Climate Funds**: Initiatives like the Green Climate Fund (GCF) and the Global Environment Facility (GEF) provide financial resources for projects that enhance climate resilience, including early warning systems.

- **International Development Agencies**: Organizations such as the World Bank, United Nations Development Programme (UNDP), FAO and WFP often fund projects aimed at improving agricultural resilience and disaster risk reduction.

Measurement/Evaluation

The implementation of CA technology for climate change adaptation in the agriculture sector involves tangible evaluations of accomplishments and success measurements through various metrics. These include economic profitability, environmental performance, soil quality, and adoption rates. The success of CA is measured by its ability to enhance carbon sequestration, improve soil health, and increase agricultural productivity while being economically viable for farmers.

Possible Complications/Challenges

The implementation of CA faces several challenges and complications, despite its potential benefits for sustainable farming. These challenges are multifaceted, involving technical, socio-economic, and cultural barriers that hinder widespread adoption. Understanding these challenges is crucial for developing strategies to promote CA effectively. Addressing these barriers through policy support, education, and technology development is imperative.

Responsibilities and Coordination

- **Local Governments**: Support site selection, policy advocacy, and integration of CA into local agricultural strategies.
- **NGOs/CSOs**: Collaborate on community mobilization, training, and scaling up CA practices.
- **Agricultural Research Institutions**: Provide technical expertise, conduct research on best practices, and support monitoring and evaluation efforts.
- **Private Sector**: Engage in providing tools, inputs, and market access for products grown using CA practices.

Chapter 2 Technology Action Plan and Project Ideas for the Water Sector

2.1 TAP for Water Sector

2.1.1 Sector overview

Lesotho has a population of approximately 2.2 million people with about 75% living in rural areas. Despite the ample water resources and revenues generated by the water sector, more than 40% of the population does not have adequate access to water and sanitation services. This is attributed to various challenges related to uneven distribution of water resources, population settlement patterns and sector planning and management. Water contributes to the Gross Domestic Product (GDP) of Lesotho's economy in terms of royalty payments for the transfer of water to South Africa, hydro-electric energy generation, value of irrigated crops produced, domestic and commercial water, investment in water infrastructure and government expenditure in the water sector.

The Environment Act of 2008, affects environmental management of water and land resources while the National Environmental Policy of 1998 provides the framework for water policy development in the country. The policy recognizes periodic prolonged drought and scarcity of water for agriculture and pollution of land and water courses, and advocates providing access to portable water for all people. The legislative framework for water resources management is the Water and Sanitation Policy of 2007 and Water Act of 2008 which was enacted to revise the Water Resources Act of 1978. The 1978 Act stipulated the requirements for obtaining a permit for any water use other than for domestic purposes, and specified that domestic water use takes priority over other uses. Further legislation relevant to water resources is dispersed in several orders and acts administered by different departments.

The fundamental principle in Lesotho must be domestic water supply, power generation and irrigation water demand. However, the Lesotho Water and Sanitation Policy of 2007 has focused almost exclusively on the domestic and industrial water supply aspects. 97 % of the urban population has access to improved water services compared to only 80 % of the rural population while only 44 % (50 % for urban and 34 % for rural) of Basotho are using improved sanitation facilities (Population Census, 2016). The Lesotho Water and Sanitation Policy (2007) emphasises increasing service coverage and ensuring a sustainable water sector and underlines adequate and sustainable supply of potable water and sanitation services to all of the population of Lesotho as a priority.

Greenhouse gas emissions in the water sector are a significant concern, particularly in the context of achieving carbon neutrality. The emissions are categorized into three scopes: Scope 1, which includes direct emissions such as methane (CH_4) and nitrous oxide (N_2O) from wastewater treatment; Scope 2, which involves indirect emissions from electricity consumption possibly from South Africa through Eskom services; and Scope 3, which covers other indirect emissions like those from the production of water infrastructure. Thus, the water sector faces significant challenges in reducing greenhouse gas emissions, particularly Scope 1 emissions. These emissions are complex and site-specific, with a lack of reliable emission factors and limited experience in direct measurement. The sector must adopt a low-carbon management model, focusing on both reducing grid-energy consumption (Scope 2 emissions) and effectively managing biological emissions through improved measurement, modelling, and mitigation strategies. This requires a comprehensive understanding of the pathways and influencing factors of these emissions.

Community water supply programmes are instrumental in achieving the goal of ‘safe’ water for all. Women, a principal target group of these programmes, are to be benefited with greater convenience, enhanced socio-cultural opportunities and better health for themselves and their families, provided through improved water facilities. Water supply programmes largely consist of three essential components, namely: technology, people and institutions (Singh et al., 2005). Although such programmes are intended to benefit women members of local communities, scant attention is paid to the impacts of the socio-cultural context of the community on these programmes. In regions of water scarcity small-scale collection infrastructure can contribute greatly to the volume of freshwater available for human use. This is especially true in such as the southern lowlands and Senqu river valley in Lesotho which receive between 450 – 500 mm per annum resulting in ephemeral stream flow patterns. This technology entails two broad categories: i) Collecting rainfall from ground surfaces utilizing “micro-catchments” to divert or slow runoff so that it can be stored before it can evaporate or enter watercourses; and ii) Collecting flows from a river, stream or other natural watercourse i.e. floodwater harvesting by constructing earthen or other structures to dam the watercourse and form “small reservoirs.”

2.1.2 Action Plan for Water Reclamation, Treatment and Reuse

2.1.2.1 Introduction

Water reclamation, treatment, and reuse involve the processes of collecting, treating, and repurposing wastewater for beneficial uses, such as irrigation, industrial processes, and even potable water supply. Typical wastewater treatment schemes incorporate multiple levels of physical, biological, and chemical treatment in order to ensure that water discharged to the environment does not pose a significant risk of adverse environmental or health impacts.

Treated wastewater is usually discharged to surface water which is often used by a water source for a water utility downstream. This approach is justified as a climate change adaptation technology because it alleviates pressure on freshwater resources, particularly in drought-prone areas like the southern lowlands of Lesotho with annual precipitation below 550 mm and the rain shadow areas of the Senqu River valley with annual average precipitation below 500 mm hence climate and socio-economic changes threaten water availability. Implementing water reuse technologies enhances resilience against water scarcity, although it is essential to further promote and improve these systems to fully address future water deficits.

Analysis indicates that while water reuse technologies can significantly improve water management in drought-prone areas, their implementation alone is insufficient to fully address the challenges posed by climate change and socio-economic pressures. Cost implications include maintenance and energy consumption, which must be balanced against the benefits of enhanced water availability for agricultural, industrial, and drinking purposes. Additionally, environmental flow constraints may limit operational flexibility, highlighting the need for integrated approaches that consider economic, environmental, and social factors to optimize the benefits of water reclamation and reuse. Recent estimate on the total volume of wastewater generated by the domestic, municipal, and industrial sectors in Lesotho is 7.2 million cubic meters. Wastewater in Lesotho is mainly produced from pollution caused by human body's waste products, namely urine and faeces which are carried away by water to form sewerage from domestic and municipal sector as well as the effluent from the industrial sector.

2.1.2.2 Ambition for the TAP

Recent estimate on the total volume of wastewater generated by the domestic, municipal, and industrial sectors in Lesotho is 7.2 million cubic meters (Lekhooana, 2022). Wastewater in Lesotho is mainly produced from pollution caused by human waste products especially sewerage from domestic and municipal sectors as well as effluent from the industrial sector. In Lesotho, the primary treatment type is the dominant wastewater treatment from urban areas and industrial activities have brought constraint to wastewater treatment. The Lesotho Water and Sewage Company (WASCO) is the only institution involved in wastewater collection, conveyance, and treatment in the country. After being treated to required standards, wastewater is normally disposed into the Mohokare river system. Water reuse is minimal because in the country as it is only used in the industrial sector. However, the target is to reclaim, treat and reuse a minimum of 20 percent of treated wastewater for industrial use and agriculture.

Gender issues

Women face gender-specific challenges deeply rooted in societal structures, policy frameworks, and operational practices within the water management sector. Firstly, they often have limited access to decision-making processes in water management projects. This exclusion is a significant barrier to their active participation and contribution to water reclamation and treatment initiatives (Sari et al., 2024; Yesubabu et al., 2024). Secondly, societal norms and patriarchal structures often marginalize women, limiting their opportunities to engage in water management roles. Thus, gender-responsive policies are necessary to empower women and ensure their voices are heard in water management decisions (Sari et al., 2024). Thirdly, they face operational challenges, such as disrespectful behaviour and safety concerns, particularly during water collection and management activities. These issues are exacerbated in regions with water scarcity. In rural communities, during drought, women are at risk of abuse and harassment because of the distances they travel in search of water (Davis et al., 2024) hence the need for gender-sensitive local water management practices are emphasized to mitigate these risks and ensure safe and equitable access to water resources (Shayamunda et al., 2023).

2.1.2.3 Actions and activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

The identified barriers were organized in the order of cause-effect relations, with the main problem/barrier at the centre and the direct causes below it and direct effects above. Overall, two categories of barriers were prioritized: financial and non-financial barriers. However, the two-entail institutional and organizational capacities, and information awareness barriers. Addressing these economic and financial barriers requires innovative funding mechanisms, and a recognition of the long-term benefits of effective climate change adaptation and resilience. The financial barriers entail high operational and maintenance costs. Thus, providing financial support through subsidies or grants can help offset the initial capital costs of implementing water reuse technologies, encouraging widespread adoption. Hence offering tax credits or deductions for investments in water reuse infrastructure can stimulate private sector participation and attract capital to fund projects. Implementing fair and transparent user fees or tariffs for water services, including water reuse, ensures that the costs are appropriately distributed among users, supporting project sustainability.

On the non-financial side, barriers include public perception and acceptance hence, implementing educational initiatives and awareness campaigns to inform the public about the safety and benefits of water reuse can address concerns and build acceptance. Moreover, launching pilot or demonstration projects can showcase the effectiveness and safety of water reuse technologies, helping to build confidence and trust among stakeholders. Actively involving local communities in the decision-making process, seeking their input, and addressing their concerns can contribute to the successful implementation of water reuse initiatives.

Finally, a lack of water quality standards and regulations. Adopt a risk-based approach to setting water quality standards and regulations for recycled water that assesses potential risks to human health, environmental quality, and public safety based on scientific evidence, risk assessments, and exposure pathways. Establish risk-based targets, guidelines, and performance criteria that prioritize protection of public health while allowing for beneficial reuse of recycled water. Thus, it is critical to develop health-based water quality standards and guidelines for recycled water that establish maximum contaminant levels (MCLs) or action levels for priority pollutants, pathogens, and chemical constituents of concern based on their toxicological properties, exposure pathways, and health effects. Align water quality standards with established drinking water guidelines, public health benchmarks, and international best practices to ensure protection of human health.

Actions selected for inclusion in the TAP

Three actions were selected for implementation water reclamation, treatment and reuse. These are:

Action 1: Develop and implement financial incentives on water reclamation, treatment and reuse - Developing financial incentives for water reclamation, treatment, and reuse is essential to stimulate public interest and investment in these technologies, particularly in regions facing water scarcity. Such incentives can enhance perceived value and utilization intentions, addressing the imbalance between reclaimed water supply and demand. Experience indicates that subsidies, when optimally calibrated, can significantly influence public inclination towards reclaimed water, while information disclosure supervision can mitigate diminishing returns from subsidies, ultimately fostering a sustainable water resource management strategy.

Action 2: Develop water quality standards and regulations - Developing water quality standards and regulations is essential for ensuring the safety and effectiveness of water reclamation, treatment, and reuse technologies, particularly in the context of climate change adaptation. These standards help mitigate risks associated with contaminants, protect public health, and maintain environmental integrity. By establishing clear guidelines, stakeholders can enhance the reliability of water reuse systems, promote user confidence, and facilitate the integration of these technologies into existing water management practices. This regulatory framework supports sustainable water resource management, especially in drought-prone areas where water scarcity is exacerbated by climate and socio-economic changes.

Action 3: Capacity building, education and public awareness - Capacity building, education, and public awareness are essential for implementing water reclamation, treatment, and reuse technologies as they enhance community understanding of climate impacts and foster proactive engagement in adaptation strategies. These elements empower individuals to recognize the importance of sustainable water management, address local climate challenges, and promote collective action. Targeted educational interventions can improve adaptive capacity by aligning technological solutions with socio-cultural contexts, ensuring that communities are equipped to effectively utilize these technologies and contribute to resilience against climate change impacts in the water sector.

Activities identified for implementation of selected actions

Table 14 summarises the actions and activities selected for implementation of the technology.

Table 14. Actions and corresponding activities for water reclamation, treatment and reuse

Actions	**Activities for Action Implementation**
Action 1	1.1 Conduct economic valuation studies to quantify the economic benefits and cost savings associated with water reuse, including reduced water supply costs, avoided wastewater treatment expenses, and enhanced water security.

Actions	Activities for Action Implementation
	1.2 Provide financial support through subsidies or grants can help offset the initial capital costs of implementing water reuse technologies, encouraging widespread adoption. 1.3 Establish financial mechanisms that offer low-interest loans for water reuse projects can make funding more accessible and cost-effective for both public and private entities. 1.4 Implement fair and transparent user fees or tariffs for water services, including water reuse. 1.5 Establish water trading systems or markets can create economic incentives for efficient water use, including water reuse, by allowing entities to buy and sell water rights. 1.6 Increase government budget allocations and investment commitments for water reuse initiatives by prioritizing water reuse projects in national development plans, sectoral budgets, and infrastructure investment programs. 1.7 Encourage local governments, municipalities, and regional authorities to allocate resources and establish dedicated funds for water reuse infrastructure development and implementation. 1.8 Mobilize community contributions, voluntary contributions, and in-kind support from water users, community groups, and stakeholders to co-finance water reuse projects and demonstrate local ownership and commitment.
Action 2	2.1 Engage in meaningful public consultation, stakeholder engagement, and community outreach efforts to solicit input, address concerns, and build public trust and confidence in water reuse projects. 2.2 Create technical guidelines for measuring and monitoring water quality, including sampling methods, laboratory procedures, and data analysis. 2.3 Develop regulatory instruments, such as permits, licenses, and enforcement mechanisms, to ensure compliance with the standards. 2.4 Provide training and resources to regulatory agencies, industries, and other stakeholders to ensure they understand and can comply with the new standards. 2.5 Invest in infrastructure and technology for monitoring and enforcing water quality standards, such as laboratories and monitoring stations.
Action 3	3.1 Conduct assessments to determine the knowledge gaps, skills shortages, and specific educational needs of the target community. 3.2 Create educational materials, such as manuals and guides. 3.3 Establish partnerships with educational institutions, NGOs, community organizations, and other relevant entities to leverage expertise and resources. 3.4 Develop train-the-trainer programs to create a multiplier effect, enabling trained individuals to educate others. 3.5 Carry out public awareness campaigns.

Actions to be implemented as Project Ideas

Action 1: Develop and implement financial incentives on water reclamation, treatment and reuse - Developing financial incentives for water reclamation, treatment, and reuse is crucial for promoting sustainable water management under climate change, as it encourages investment in necessary infrastructure and technology. These incentives can lower the cost of reclaimed water, making it competitive with traditional sources, thus enhancing its adoption among farmers and consumers. Additionally, they can facilitate the construction of purification facilities and distribution systems, ultimately reducing water stress in vulnerable regions. This approach not only addresses immediate water scarcity but also supports long-term resilience in agricultural production and food security.

Action 2: Develop water quality standards and regulations - Developing water quality standards and regulations is essential for ensuring the safety and effectiveness of water reclamation, treatment, and reuse processes, particularly in the context of climate change adaptation. These standards help to address the varying qualities of industrial and urban wastewater, which may contain heavy metals, organic loads, and pathogens. By establishing clear guidelines, stakeholders can minimize health risks, enhance public trust, and promote sustainable water management practices, ultimately maximizing the benefits of treated wastewater while safeguarding environmental and human health.

Action 3: Capacity building, education and public awareness - Developing project ideas for capacity building, education, and public awareness is essential for effectively implementing water reclamation, treatment, and reuse as it fosters understanding and acceptance among stakeholders. This knowledge enhances collaboration between sectors, ensuring that water reuse strategies are integrated into broader water management practices. Additionally, informed communities are more likely to support and participate in initiatives that address water scarcity, ultimately leading to improved water productivity and resilience against climate change impacts. Such initiatives can also facilitate the negotiation of water swaps, maximizing the benefits of reclaimed water use.

Gender issues

Implementing water reclamation, treatment, and reuse activities can significantly contribute to achieving gender outcomes by addressing water scarcity and promoting gender equality in water management. These activities can alleviate the burden of water collection, which predominantly falls on women, and empower them through active participation in water management processes. By integrating gender perspectives into water reclamation projects, these initiatives can foster more equitable access to water resources and decision-making roles. While water reclamation and reuse activities offer significant potential for achieving gender outcomes, challenges remain. Women's limited access to decision-making processes and the need for more inclusive policies are critical issues that must be addressed to ensure the long-term sustainability and success of these initiatives.

2.1.2.4 Stakeholders and Timeline for implementation of water reclamation, treatment and reuse

Overview of Stakeholders for the implementation of the TAP

Implementing wastewater reuse involves various stakeholders, each with specific roles critical to the success of the project (Table 15). Each of these stakeholders must collaborate effectively to overcome technical, regulatory, financial, and social challenges in implementing wastewater reuse.

Table 15. Stakeholders in the implementation of water reclamation, treatment and reuse

Stakeholder	Roles
Central government agencies	They set the regulatory framework, policies, and standards for wastewater treatment and reuse. They may also provide funding or incentives and are responsible for monitoring and enforcement to ensure compliance with environmental and public health standards.
Local municipalities and council	Often responsible for the actual operation and maintenance of wastewater treatment facilities. They manage the distribution of reclaimed water and ensure that it meets local needs, such as for irrigation, industrial use, or groundwater recharge.
Department of Environment	Oversee the environmental impact of wastewater reuse projects, ensuring that ecosystems are protected. They may also conduct environmental assessments and monitor the quality of treated wastewater.
WASCO	Operate and manage the infrastructure for wastewater treatment and distribution. They are responsible for ensuring the reliability and quality of the reclaimed water supply.
Engineering and Consulting Firms	Provide technical expertise in the design, construction, and optimization of wastewater treatment and reuse systems. They conduct feasibility studies, design systems, and offer solutions to maximize efficiency and sustainability.
Agricultural Sector	One of the primary users of reclaimed water, particularly for irrigation. Farmers and agricultural businesses play a key role in determining the demand for and the application of treated wastewater in agriculture.
Industrial Sector	Industries may use reclaimed water for processes that do not require potable water, such as cooling, washing, or manufacturing. They help in reducing the demand for freshwater resources.
Public Health Sector	Ensure that the use of reclaimed water does not pose risks to human health. They establish guidelines for safe reuse practices and monitor potential health impacts.
Community and Public Stakeholders	Public acceptance and support are crucial for the success of wastewater reuse projects. Community members and local organizations can influence decision-making and ensure that their concerns, particularly related to safety and environmental impact, are addressed.
Research Institutions and Academia	Conduct research to advance technology and best practices in wastewater treatment and reuse. They may also provide data, analysis, and training to support stakeholders in implementing effective systems.
Non-Governmental Organizations	Advocate for sustainable water management practices, including wastewater reuse. NGOs may also be involved in public education, policy advocacy, and monitoring the environmental and social impacts of reuse projects.
Financial Institutions	Provide funding or financing options for the development of wastewater reuse infrastructure. They may also be involved in assessing the economic feasibility and risk of projects.

Scheduling and sequencing of specific activities

Table 16 outlines the sequence and timing of specific activities, as well as the nature and scale of the activity.

Table 16. Scheduling and sequencing of specific activities

Activity	Scale	Time									
		1	2	3	4	5	6	7	8	9	10
1.1 Allocate dedicated funding in the annual budgets, on priority basis for the construction of 100 water reservoirs.	National										
1.2 Advocacy campaign targeting policy makers and legislators for gaining support on funding.	National District										
1.3 Strengthen administrative mechanisms for attracting from donor agencies.	National										
1.4 Provide financial and technical assistance on priority bases to farmers harvesting rainwater.	Local and district										
2.1 Enhance financial support to research and development institutions for enhancing their capacity.	National										
2.2 Arrange prioritization of regions in dire need of rainwater harvesting reservoirs and identification of potential sites.	National, district and local										
2.3 Arrange trainings on need-based manner and skills of researchers though training / workshops and foreign visits.	National										
2.4 Adopt flexible Communication strategy to promote inter agency coordination.	National and district										
2.5 Promote transfer of knowledge (specifically indigenous one) through building research collaborations among experts at regional and international organization working on the same issues.	National										
3.1 Awareness creation on good operation and management practices and change in water use behaviour by organizing campaigns to raise awareness on importance of rainwater harvesting, water saving and efficiency.	National, District and local										
3.2 Ensure participation of local communities in all stages of decision-making process through committees to ensure sustainability of Technology	Local										
3.3 Encourage communities to establish reservoir operator organizations.	Local										
4.1 Develop and implement genderized technology support policy and necessary regulations.	National										
4.2 Develop genderized regulations on the role and responsibilities of stakeholders in management, utilization and operation of rainwater reservoirs.	National										

Gender issues

Gender considerations in the implementation of water reclamation, treatment, and reuse technologies are crucial for ensuring equitable access and benefits for all stakeholders. The integration of gender perspectives in water management is often overlooked, leading to disparities in access and participation. Gender mainstreaming in water management involves recognizing the distinct roles, needs, and priorities of men and women. It is essential to move beyond the assumption that pro-poor projects automatically benefit women, as men and women often have different priorities and access levels to water resources. Efforts to include women in water management have been limited by a lack of understanding of gender as a social construct, rather than equating it solely with women. This has resulted in tokenistic participation without addressing underlying power dynamics (Narain and Goodrich, 2024). In many instances, gender mainstreaming in water resources management has been largely ignored, with unequal participation of men and women. Thus, the existing legal frameworks do not adequately address gender issues, highlighting the need for new policies that promote equal involvement of both genders (Lusuva, 2012).

Stakeholder engagement in water reclamation and reuse technologies often lacks a gender perspective. Workshops in India revealed a conservative approach to wastewater treatment technologies, with limited consideration of gender-specific needs and priorities (Brunner et al., 2023). Effective stakeholder engagement should include both men and women, ensuring that their concerns and priorities are addressed throughout the project cycle. This can be facilitated by using tools and frameworks that incorporate gender perspectives.

A gender analysis reveals that while these technologies offer significant benefits, their implementation can exacerbate existing gender inequalities if not carefully managed. We explored the intersection of gender with water reclamation technologies, highlighting the need for inclusive practices.

2.1.2.5 Estimation of resources needed for action and activities

Estimation of capacity building needs

Capacity building for implementing wastewater reuse projects is essential to ensure that the systems are designed, operated, and maintained effectively and sustainably (Table 17). This involves enhancing the technical, managerial, and institutional capacities of all stakeholders involved, from engineers and operators to community members and policymakers. By addressing these capacity-building needs, stakeholders can implement wastewater reuse projects more effectively, ensuring that they are technically sound, economically viable, socially inclusive, and environmentally sustainable.

Table 17. Capacity building needs for implementation of water reclamation, treatment and reuse

Skills	Capacity Development
Technical Expertise	
Design and engineering	• **Training Needs:** Engineers and technical staff need specialized training in designing and optimizing wastewater treatment and reuse systems. This includes understanding different treatment technologies (e.g., membrane filtration, biological treatment, advanced oxidation), designing for specific end-uses (e.g., agricultural irrigation, industrial processes), and integrating renewable energy sources. • **Outcome:** Improved ability to design systems that are efficient, cost-effective, and tailored to the local context.
Operation and maintenance	• **Training Needs**: Operators require training in the day-to-day management of wastewater reuse systems, including monitoring and adjusting treatment processes, maintaining equipment, troubleshooting issues, and ensuring compliance with quality standards. • **Outcome:** Reliable operation of wastewater reuse facilities, reducing downtime and ensuring consistent water quality.
Water quality testing and monitoring	• Training Needs: Capacity building in water quality testing is critical to ensure that treated wastewater meets the required standards for its intended reuse. This includes training in sampling techniques, laboratory analysis, and interpreting results. • Outcome: Assurance of safe and high-quality reclaimed water for various applications, reducing health and environmental risks.
Regulatory and Institutional Capacity	
Policy and regulatory frameworks	• **Training Needs**: Policymakers and regulatory bodies need training on developing, implementing, and enforcing regulations that support wastewater reuse. This includes understanding international best practices, setting appropriate standards, and designing policies that incentivize reuse. • **Outcome**: A robust legal and regulatory environment that supports and promotes safe and sustainable wastewater reuse.
Institutional Coordination	• **Training Needs**: Training for government agencies, municipalities, and other institutions on effective coordination and collaboration is essential. This includes creating multi-sectoral platforms, streamlining permitting processes, and integrating wastewater reuse into broader water management strategies. • **Outcome:** Improved inter-agency cooperation and more efficient implementation of wastewater reuse projects.
Public-Private Partnerships	• **Training Needs**: Building capacity to develop and manage PPPs can help leverage private sector expertise and investment. Training should focus on contract management, risk sharing, and ensuring equitable and sustainable outcomes. • **Outcome**: Enhanced investment and innovation in wastewater reuse through effective partnerships between public and private sectors.
Community Engagement and Public Awareness	
Awareness and education campaigns	• **Training Needs:** Community leaders, NGOs, and outreach workers need training in designing and implementing education campaigns that raise awareness about the benefits of wastewater reuse, address public concerns, and promote behaviour change. • **Outcome:** Increased public acceptance and support for wastewater reuse projects, leading to higher community participation and long-term sustainability.
Stakeholder consultation and participation	• **Training Needs:** Training in participatory approaches is essential to involve communities in the planning and decision-making processes of wastewater reuse projects. This includes skills in facilitating workshops, gathering feedback, and incorporating local knowledge. • **Outcome:** Projects that are better tailored to local needs and have higher levels of community ownership and support.

Skills	Capacity Development
Gender and social inclusion	• **Training Needs:** Capacity building in gender and social inclusion ensures that wastewater reuse projects benefit all members of the community equitably. This includes training on gender-sensitive approaches, ensuring representation in decision-making, and addressing specific needs of vulnerable groups. • **Outcome**: More inclusive projects that contribute to social equity and empower marginalized groups.
Economic and Financial Management	
Cost benefit analysis and financing	• **Training Needs:** Financial planners and project managers need skills in conducting cost-benefit analyses to evaluate the economic viability of wastewater reuse projects. Training should also cover innovative financing mechanisms, such as green bonds, subsidies, and tariff structures. • **Outcome:** Financially viable projects that attract investment and deliver long-term economic benefits.
Tariff setting and revenue management	• **Training Needs:** Capacity building in setting appropriate tariffs for reclaimed water and managing revenue is crucial to ensure the financial sustainability of the project. This includes understanding the willingness to pay, cost recovery, and equitable pricing models. • **Outcome:** Sustainable financial management of wastewater reuse projects, ensuring affordability and long-term operation.
Resource recovery and circular economy	• **Training Needs:** Training in the principles of the circular economy and resource recovery (e.g., energy, nutrients) from wastewater can enhance the economic and environmental sustainability of reuse projects. • **Outcome:** Enhanced resource efficiency and additional revenue streams from recovered resources.
Environmental and Health Safeguards	
Environmental impact assessment and management	• **Training Needs:** Environmental professionals need skills in conducting EIAs for wastewater reuse projects, identifying potential risks, and developing mitigation strategies. This includes understanding the ecological impacts of reuse and ensuring compliance with environmental regulations. • **Outcome:** Reduced environmental risks and enhanced protection of ecosystems through informed project planning and management.
Public health and risk management	• **Training Needs:** Health professionals and project managers need training in assessing and managing public health risks associated with wastewater reuse, including pathogen control, monitoring, and developing response plans for contamination incidents. • **Outcome:** Safe and healthy reuse practices that protect public health and prevent the spread of waterborne diseases.
Climate resilience and adaptation	• **Training Needs:** Capacity building in climate change adaptation ensures that wastewater reuse projects are resilient to climate variability and contribute to broader water security goals. This includes understanding climate risks and incorporating adaptive measures into project design and operation. • **Outcome:** Climate-resilient wastewater reuse systems that enhance water security in the face of climate change.
Monitoring, Evaluation, and Learning	
Performance monitoring systems	• **Training Needs:** Training in the design and implementation of monitoring systems to track the performance of wastewater reuse projects, including water quality, system efficiency, and user satisfaction. This also includes skills in data collection, analysis, and reporting. • **Outcome:** Continuous improvement in project performance through effective monitoring and feedback mechanisms.
Impact assessment and reporting	• **Training Needs:** Skills in conducting impact assessments to evaluate the social, economic, and environmental outcomes of wastewater reuse projects. Training should cover both qualitative and quantitative methods, as well as effective communication of findings to stakeholders. • **Outcome:** Greater accountability and transparency, leading to improved project outcomes and stakeholder confidence.

Skills	Capacity Development
Learning and knowledge sharing	• **Training Needs:** Encouraging a culture of learning and knowledge sharing among stakeholders, including documenting lessons learned, best practices, and innovations in wastewater reuse. This can be facilitated through workshops, conferences, and online platforms. • **Outcome:** Enhanced innovation, replication of successful models, and continuous improvement in wastewater reuse practices.
Innovation and Technology Transfer	
Adoption of new technologies	• **Training Needs:** Capacity building in the evaluation and adoption of emerging technologies for wastewater treatment and reuse, including decentralized systems, smart sensors, and real-time monitoring tools. • **Outcome:** Adoption of cutting-edge technologies that improve efficiency, reduce costs, and enhance the sustainability of wastewater reuse projects.
Collaboration with academia and research institutions	• **Training Needs:** Strengthening collaboration between implementing agencies and academia /research institutions to facilitate technology transfer, innovation, and adaptation of solutions to local contexts. • **Outcome:** Increased innovation and development of context-specific solutions that enhance the effectiveness of wastewater reuse projects.

Estimate of the costs of actions and activities

The implementation of this technology requires a major financial investment given the terrain and topography of Lesotho. A set of three actions and corresponding activities for implementation of this TAP were compiled (Table 14). The TAP will require a total budget of USD 121 million for its implementation. Most of the funding can be sought from international agencies, but some costs would need to be borne by the Government of Lesotho (in-kind).

Gender issues

To make capacity building in water reclamation and treatment gender-responsive, it is essential to integrate gender considerations into planning, budgeting, and implementation processes. This involves conducting a gender analysis of budget lines and activities to ensure equitable resource allocation and participation. The following outlines key strategies and insights on gender-responsive budgeting and policy implementation.

Gender-responsive budgeting (GRB) is a critical tool for promoting gender equality in public finance. It involves analysing budget allocations to assess their impact on men and women and ensuring that resources are equitably distributed (Singh, 2024). This approach helps differentiate the impacts of public expenditure on men and women, promoting gender equality (Bhul, 2022). This entails planning, implementing, and monitoring gender-responsive activities, contributing to women's empowerment and gender justice (Rahmatia et al., 2023). Women's involvement in water management is crucial, yet often limited by patriarchal structures. It is critical to enhance women's roles in managing water resources, emphasizing the need for gender-friendly strategies at all levels hence empowering women in water management can be achieved by increasing their participation in decision-making processes and recognizing their contributions to environmental sustainability (Sari et al., 2024).

The implementation of gender-responsive planning and budgeting may be hindered by low competence among human resource planners hence training necessity to enhance planners' skills in using Gender Analysis Pathway (GAP) and Gender Budget Statement (GBS) techniques (Sabrina, 2023). Thus, capacity building should focus on improving knowledge and skills related to gender analysis and budgeting, ensuring that gender considerations are integrated into all stages of project development.

2.1.2.6 Management planning

Risks and contingency planning

Table 18 provides a concise breakdown of major risks, their descriptions, and corresponding contingency actions for implementing wastewater reuse projects. By identifying these risks and implementing the corresponding contingency actions, stakeholders can better manage uncertainties and ensure the successful implementation of wastewater reuse projects.

Table 18. Identified risks and possible contingency plan

Type of risk	Description of risk	Contingency actions
Technical risks	➢ **System Failures:** Potential failure of treatment systems to meet required water quality standards. ➢ **Operational Challenges:** Unexpected equipment breakdowns, inefficiencies, or difficulties in system operation.	➢ **Pilot Testing:** Conduct thorough pilot testing of technologies before full-scale implementation. ➢ **Maintenance & Training:** Develop a robust maintenance program and regularly train staff on equipment operation and troubleshooting. ➢ **Spare Parts Inventory:** Maintain an inventory of critical spare parts to reduce downtime.
Financial risks	➢ **Budget Overruns:** Costs exceeding budget due to underestimations or unexpected expenses. ➢ **Funding Shortfalls:** Difficulty in securing sufficient funding or financing for the project.	➢ **Contingency Budget:** Include a contingency budget to cover unforeseen costs. ➢ **Diversified Funding:** Pursue multiple funding sources, including grants, loans, and public-private partnerships (PPPs). ➢ **Phased Development:** Implement the project in phases to align with available resources.
Regulatory and compliance risks	➢ **Delays in Approvals:** Potential delays or challenges in obtaining necessary permits and regulatory approvals.	➢ **Early Engagement:** Engage with regulatory bodies early to align project planning with regulatory requirements.

Type of risk	Description of risk	Contingency actions
	➢ **Regulatory Changes:** Changes in regulations that could impact project design, operation, or costs.	➢ **Flexible Design**: Design systems that can adapt to regulatory changes. ➢ **Continuous Monitoring:** Monitor regulatory developments and adjust project plans as needed.
Environmental risks	➢ **Ecosystem Impact:** Potential negative impacts on local ecosystems, such as water contamination or disruption of natural water flows. ➢ **Climate Vulnerability:** Risks from climate change, such as droughts or floods, affecting water availability and system performance.	➢ **Environmental Assessments:** Conduct thorough environmental impact assessments and implement mitigation strategies. ➢ **Adaptive Design:** Design systems with the flexibility to adapt to varying environmental conditions. ➢ **Monitoring Programs:** Implement ongoing environmental monitoring to detect and address issues early.
Public health risk	➢ **Health Hazards:** Potential contamination or inadequate treatment leading to public health risks. ➢ **Public Resistance:** Concerns or resistance from the public regarding the safety of reclaimed water.	➢ **Strict Protocols:** Adhere to strict treatment and monitoring protocols to ensure water quality. ➢ **Emergency Plans:** Develop and implement emergency response plans for contamination incidents. ➢ **Public Education:** Engage in proactive communication and education campaigns to build public trust and address concerns.
Social and community risk	➢ **Community Opposition:** Potential public opposition due to stigma or misinformation about wastewater reuse. ➢ **Inequity:** Unequal distribution of benefits, leading to social tensions or dissatisfaction.	➢ **Public Outreach:** Conduct extensive community outreach and education to inform the public about the benefits and safety of reuse. ➢ **Equitable Access:** Ensure equitable access to the benefits of reclaimed water across all communities. ➢ **Grievance Mechanisms:** Establish mechanisms for addressing community concerns promptly and effectively.
Operational risks	➢ **Staffing Issues:** Inadequate staffing or lack of skilled personnel to operate and maintain the reuse system. ➢ **Supply Chain Disruptions:** Disruptions in the supply chain for necessary chemicals, parts, or equipment.	➢ **Capacity Building:** Invest in staff training and capacity building for effective system operation. ➢ **Supplier Relationships:** Develop strong relationships with multiple suppliers and maintain a stock of critical supplies. ➢ **Monitoring Systems:** Implement operational monitoring systems to detect and resolve issues quickly.
Political and institutional risks	➢ **Policy Changes:** Changes in political leadership or priorities that reduce support for the project. ➢ **Interagency Conflicts:** Lack of coordination or conflicts among government agencies or stakeholders.	➢ **Broad-Based Support:** Build broad political and institutional support to ensure project continuity. ➢ **Clear Governance:** Establish clear governance structures and interagency agreements to define roles and responsibilities.

Type of risk	Description of risk	Contingency actions
		➢ **Regular Engagement:** Maintain regular communication with stakeholders to address emerging conflicts or issues.
Economic risks	➢ **Economic Downturns:** Economic conditions that could affect funding availability or increase project costs. ➢ **Demand Fluctuations:** Variability in the demand for reclaimed water, affecting revenue stability.	➢ **Flexible Financial Models:** Develop financial models that can adapt to changing economic conditions. ➢ **Demand Diversification:** Expand the uses of reclaimed water to stabilize demand across different sectors. ➢ **Cost-Benefit Analysis:** Perform thorough cost-benefit analysis to justify the project under various economic scenarios.

Next steps

Implementing a wastewater reuse project involves several critical steps to ensure the project is technically feasible, economically viable, and environmentally sustainable. Each step is crucial for the successful implementation of a wastewater reuse project, ensuring that it meets its objectives and contributes positively to water resource management (Table 19).

Table 19. Immediate requirements and Critical Step

Immediate requirements	Critical steps
Needs Assessment and Goal Setting	• **Identify the Purpose**: Determine the specific needs for wastewater reuse (e.g., agricultural irrigation, industrial use, potable reuse). • **Set Clear Objectives**: Establish project goals, including water quality standards, volume requirements, and environmental impact.
Feasibility Study	• **Technical Assessment**: Evaluate the technical feasibility, including the availability and quality of the wastewater, potential treatment technologies, and reuse applications. • **Economic Analysis**: Conduct cost-benefit analysis, including capital, operational, and maintenance costs, as well as potential savings or revenue generation. • **Regulatory Compliance**: Review local, regional, and national regulations governing wastewater reuse and ensure compliance.
Stakeholder engagement	• **Public Consultation**: Engage with the community, local authorities, and other stakeholders to gather input, address concerns, and build support. • **Partnerships**: Identify potential partners, such as municipal bodies, industries, or agricultural groups, who may be involved in or benefit from the project.
Design and engineering	• **System Design**: Develop detailed designs for the collection, treatment, and distribution systems tailored to the intended reuse applications. • **Technology Selection**: Choose appropriate treatment technologies (e.g., filtration, disinfection, advanced oxidation) based on the required water quality. • **Infrastructure Planning**: Plan the necessary infrastructure, including pipelines, storage facilities, and distribution networks.
Environmental Impact Assessment	• **Impact Analysis**: Assess potential environmental impacts, including effects on local ecosystems, groundwater recharge, and water bodies.

Immediate requirements	Critical steps
	• **Mitigation Strategies**: Develop strategies to mitigate adverse impacts, such as safeguarding sensitive habitats or reducing energy consumption.
Regulatory approvals and permitting	• **Permit Acquisition**: Obtain all necessary permits and approvals from relevant authorities, including environmental, construction, and operation permits. • **Compliance Monitoring**: Establish monitoring plans to ensure ongoing compliance with regulations and permits.
Financing and budgeting	• **Funding Sources**: Secure funding from governmental grants, loans, private investments, or public-private partnerships. • **Budget Planning**: Develop a detailed budget covering capital expenditure, operational costs, and contingency funds.
Construction and implementation	• **Contractor Selection**: Hire qualified contractors for construction, installation, and commissioning of the wastewater reuse system. • **Project Management**: Implement a project management plan to oversee construction, ensure timelines are met, and manage any issues that arise. • **Quality Control**: Monitor construction quality to ensure compliance with design specifications and regulatory standards.
Commissioning and testing	• **System Testing**: Conduct initial testing and commissioning of the treatment and distribution systems to ensure they meet design specifications. • **Water Quality Monitoring**: Implement a comprehensive water quality monitoring program to verify that the treated water meets the required standards for its intended use.
Operation and maintenance	• **Operational Plan**: Develop an operational plan that includes regular maintenance schedules, staffing requirements, and emergency procedures. • **Training**: Provide training for operators and maintenance personnel to ensure the system is operated safely and efficiently. • **Monitoring and Reporting**: Continuously monitor system performance and report to regulatory bodies as required.
Public awareness and education	• **Awareness Campaigns**: Educate the public and stakeholders about the benefits, safety, and importance of wastewater reuse. • **User Training**: Provide guidance and training for end-users, particularly in agricultural or industrial settings, on how to safely and effectively use reclaimed water.
Evaluation and optimization	• **Performance Review**: Regularly review system performance, water quality, and user feedback to identify areas for improvement. • **System Optimization**: Implement improvements or upgrades to optimize efficiency, reduce costs, and enhance the sustainability of the project.
Long-term sustainability planning	• **Resilience Planning**: Develop strategies to ensure the long-term sustainability of the project, including climate change adaptation, resource management, and financial sustainability. • **Periodic Review**: Conduct periodic reviews and updates to the system, operations, and regulations to keep pace with technological advancements and changing conditions.

Gender issues

The identification and mitigation of gender issues in the implementation of water reclamation, treatment, and reuse technology require a nuanced understanding of gender dynamics and the integration of gender-responsive strategies. The research highlights the importance of addressing gender disparities in water management, emphasizing the need for inclusive policies and practices that consider the unique roles and challenges faced by women in the sector.

Women are often excluded from decision-making processes in water management, despite being key stakeholders in ensuring water quality and management at the domestic level. This exclusion is rooted in traditional patriarchal structures that limit women's participation and influence (Sari et al., 2024; Caretta and Rothrock, 2021). In most cases, efforts to mainstream gender in water management have been limited by a narrow understanding of gender, often equating it solely with women rather than considering the broader social and power dynamics between genders (Narain and Goodrich, 2024). The neoliberal framing of water as an economic resource can exacerbate gender inequalities, as it often overlooks the complex socio-political dynamics involved in water management (Caretta and Rothrock, 2021).

Gender-responsive policies should be developed to ensure women's participation in water management, recognizing their roles and contributions. This includes creating opportunities for women to engage in decision-making processes and addressing the socio-cultural barriers that hinder their involvement (Sari, 2024; Singh et al., 2009). Thus, educational curricula and training programs should incorporate gender and water relations, focusing on intersectionality and the unique contexts of different regions (Narain and Goodrich, 2024). Development initiatives should not assume that pro-poor projects automatically benefit women but should explicitly address the distinct needs and priorities of both men and women to avoid reinforcing existing inequities. Experiences show that the success of water supply programs depends on understanding the socio-cultural context, including cultural beliefs, social organizational principles, and traditional water technologies. Thus, programs should be re-conceptualized to integrate these aspects, ensuring that they are pragmatic and effective for local communities (Singh et al., 2009). Addressing gender issues in water reclamation and reuse technology requires a comprehensive approach that includes both genders and considers the socio-cultural and economic contexts in which these technologies are implemented.

2.1.2.7 Reporting

Table 20. Overview table

Sector	**Water Resources**							
Sub-sector	Water supply and sanitation							
Technology	Water reclamation, treatment and reuse							
Ambition	The target is to reclaim, treat and reuse a minimum of 20 percent of treated wastewater (Effluent) for industrial use and agriculture.							
Benefits	Diversifying sources of water supplies, reducing wastewater discharge and pollution							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame (Yrs)	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity (Millions)
Action 1 Develop and implement financial incentives on water reclamation, treatment and reuse	Activity 1.1 Conducting economic valuation studies to quantify the economic benefits and cost savings associated with water reuse.	GoL Development Partners	LEWA	1-3	Lack of requisite funding	Economic valuation reports	Recruitment of consultants and commissioning	1.5
	Activity 1.2 Providing financial support through subsidies or grants.	GoL Development Partners	Ministry of Finance and Development Planning	1-5	Lack of requisite funding	Budget allocation and funding agreements	Donor funding agreement; Budget allocation	5.0
	Activity 1.4 Establishing financial mechanisms that offer low-interest loans for water reuse projects	GoL (LEWA)	Ministry of Finance and Development Planning	1-5	No policy development	Policy adoption	Number of project in place	1.5
	Activity 1.5 Implementing fair and transparent user fees or tariffs for water	GoL, LEWA	LEWA	1-10	Lack of policy	Policy implementation	Number of projects in place	1.5

	services, including water reuse.							
	Activity 1.6 Establishing water trading systems or markets can create economic incentives for efficient water use	LEWA	LEWA	1-10	Lack of policy and systems	Regulations and systems put in place	Participation levels	1.5
	Activity 1.8 Increase government budget allocations and investment commitments for water reuse initiatives	GoL Development partners	Ministry of Finance and Developmen t Planning	1-5	Lack of funding	Budget allocation	Annual budget levels	1.5
	Activity 1.9 Encourage local governments and municipalities to allocate resources and establish dedicated funds for water reuse infrastructure development and implementation	GoL Development Partners	Ministry of Local Government	1-10	Lack to commitm ent to decentral ize	Devolution of resources	Devolution of resources	5.0
	Activity 1.10 Mobilize community contributions, voluntary contributions, and in-kind support from water users, community groups, and stakeholders to co-finance water reuse projects.	GoL Development partners	Ministry of local government	1-10	Low communi ty participat ion and co-finance	Community support and co-finance	Community generated funding	5.0

Sub-Total for Action 1 Activities								**9.0**
Action 2 Develop water quality standards and regulations	Activity 2.1 Engage in meaningful public consultation, stakeholder engagement, and community outreach efforts to solicit input, address concerns, and build public trust and confidence in water reuse projects.	Gol Development partners	Ministry of Natural Resources	1-5	Lack funding	Community awareness and support	Municipal participation	3.0
	Activity 2.2 Create technical guidelines for measuring and monitoring water quality, including sampling methods, laboratory procedures, and data analysis.	GoL Development partners	Water Commission	1-5	Lack of funding	Policy and regulatory frameworks	Enforcement of standards	10
	Activity 2.3 Develop regulatory instruments, such as permits, licenses, and enforcement mechanisms, to ensure compliance with the standards.	Gol Development partners	Water Commission	1-10	Lack of legal and policy frameworks for regulation	Development and adoption of regulatory instruments	Enforcement of instruments	10
	Activity 2.4 Provide training and resources to regulatory agencies, industries, and other stakeholders to ensure they understand and	Gol Development partners	DWA	1-5	Lack of funding and legal frameworks	Budget allocation and development of supporting regulations	Training progress reports	10

	can comply with the new standards.							
	Activity 2.5 Invest in infrastructure and technology for monitoring and enforcing water quality standards, such as laboratories and monitoring stations.	GoL Development partners	Water Commission	1-10	Lack of funding	Implementation project reports	Projects funded	50
Subtotal for Action 2 Activities								**83**
Action 3 Capacity building, education and public awareness	Activity 3.1 Conduct assessments to determine the knowledge gaps, skills shortages, and specific educational needs of the target community.	GoL Development partners	Water Commission	1-10	Lack of funding and political will	Active mobilization of implementing entities	Number of projects commissioned	15
	Activity 3.2 Create educational materials, such as manuals and guides.	GoL	Water Commission	1-5	Lack of funding	Reports of trainings conducted	Educational materials developed	3.0
	Activity 3.3 Establish partnerships with educational institutions, NGOs, community organizations, and other relevant entities to leverage expertise and resources.	GoL Development partners	Water Commission	1-5	Lack of funding	Signed MOA and Active collaboration	Activation participation of partner institutions	3.0
	Activity 3.4 Develop train-the-trainer	GoL	Water Commission	1-5	Lack of funding	Number of trainers trained	Training reports	3.0

	programs to create a multiplier effect, enabling trained individuals to educate others.	Development partners						
	Activity 3.5 Carry out public awareness campaigns.	GoL	Water Commission	1-10	Lack of funding	Increased awareness	Number of awareness campaigns	5.0
Sub-Total for Action 3 Activities								**29**
Grand Total of all Activities								**121**

2.1.2.8 Tracking the implementation status of the TAP

Rationale, responsibility and content of TAP tracking

The national process for tracking the implementation of water reclamation, treatment, and reuse involves a complex interplay of institutional responsibilities, timing, and information management. This process is crucial for ensuring that reclaimed water meets quality standards and is used effectively to address water scarcity and environmental challenges. The following outlines the key components of this process being institutional responsibilities and the timing and implementation modalities.

National and international level institutions are responsible for setting standards and guidelines for water reuse. These include health and environmental risk assessments and compliance with local and international legislation (Abou-Shady and El Araby, 2023; Wanner et al., 2023). The technology often requires stringent national regulations and guidelines involving consultation, communication and education to develop effective regulatory structures to ensure safe implementation. In the absence of national regulations, international and regional standards set by respective become de facto regulations to manage reclaimed water for various purposes. Developing a national strategy for water reuse involves adapting frameworks through feedback and learning to effect revolutionary changes in water reuse strategies (Ramaprasad & Syn, 2024). The timing of water reuse projects is influenced by external factors such as climate change and water scarcity, as well as internal factors related to stakeholder behaviour (Wanner et al., 2023). Consequently, the production, distribution, and quality of reclaimed water must meet certain standards, which are monitored by appropriate authorities. Moreover, information on treatment technologies, including primary, secondary, and tertiary processes, is crucial for ensuring the effectiveness of water reuse systems (Abou-Shady and El Araby, 2023). Thus, tracking compliance with existing policy directives and guidelines is essential for the successful implementation of water reuse systems. However, addressing these challenges requires a coordinated effort among stakeholders to develop comprehensive policies and infrastructure to support water reuse initiatives.

Gender issues

Integrating gender-specific criteria and targets into the implementation of water reclamation, treatment, and reuse technology is crucial for ensuring equitable and effective water management. This involves recognizing the distinct roles, needs, and impacts on different genders within water management processes. For instance, gender mainstreaming in water management requires a nuanced understanding of gender as a social construct, not merely equating it with women. It involves recognizing power differences and the intersectionality of gender with other social categories (Narain and Goodrich, 2024). Consequently, projects should avoid generalizations such as "pro-poor is pro-women," which can obscure the distinct challenges faced by different genders. Instead, they should address specific gender-based needs and concerns to prevent reinforcing existing inequities.

Incorporating gender-specific indicators and participatory planning methods can enhance the effectiveness of water management projects. Thus, continuous monitoring and beneficiary-led impact assessments ensure that the projects address the livelihood concerns of women and the rural poor (Gautam and Kuriakose, 2016). Gender considerations should be integrated into all phases of water management modelling, from problem framing to decision support, to reveal and address gendered assumptions that may otherwise be overlooked (Packett et al., 2020).

The integration of environmental, social, and governance criteria in water management can support gender-sensitive approaches by aligning with international standards and attracting investments. This approach emphasizes the importance of social criteria, including gender equity, in achieving sustainable development goals (Huseynov et al., 2024). Toolkits and frameworks can guide the integration of gender perspectives in project design, implementation, and evaluation. These resources help ensure that both male and female stakeholders' concerns and priorities are addressed throughout the project cycle. While integrating gender-specific criteria is essential, it is also important to recognize the broader context of water management. This includes understanding the socio-economic and cultural factors that influence gender roles and access to resources. By addressing these broader issues, water management projects can achieve more sustainable and equitable outcomes.

2.1.3 Action Plan for Boreholes as a Drought Intervention for Domestic Water Supply

2.1.3.1 Introduction

Borehole technology, particularly hand-pumped and motorised boreholes, serves as an effective drought intervention for domestic water supply by accessing deep groundwater, which remains reliable during drought conditions. Experiences shows that hand-pumped boreholes exhibited higher functionality (approximately 75%) compared to motorised boreholes (around 60%) during the 2015-16 drought under conditions similar to Lesotho (MacAllister et al., 2020). Comparatively, shallow boreholes equipped with handpumps are the most reliable, recovering quickly to daily abstraction levels even during extended dry seasons and are less susceptible to contamination by pollutants (MacDonald et al., 2019). Real-time monitoring and proactive maintenance significantly enhanced the functionality of these boreholes, ensuring continuous access to water. A diversified approach utilizing multiple borehole types increases resilience and reduces pressure on individual sources, thereby sustaining water supply during periods of extreme drought.

Selecting boreholes as a drought intervention for domestic water supply offers several advantages, particularly in regions where water scarcity is a pressing issue. Boreholes provide a reliable and sustainable source of groundwater, which is crucial during drought conditions when surface water sources may dry up or become contaminated. This reliability is especially important in rural areas where alternative water sources are limited. Boreholes equipped with handpumps have been shown to recover quickly and maintain water quality even during extended dry seasons, making them a dependable option for communities facing water shortages (MacDonald et al., 2019). Furthermore, the use of boreholes can significantly reduce the time and effort required for water collection, which is critical during droughts when water scarcity can lead to social issues such as gender-based violence and reduced school attendance on the part of the girl child.

Implementing a water management system for boreholes, such as solar-powered IoT-based systems, can enhance their efficiency and sustainability, making them more affordable and easier to maintain (Malinga and Hashe, 2024). Decision-tree analysis and GIS/fuzzy spatial decision support systems can optimize the site selection for boreholes, ensuring high yield and quality while considering economic and technical constraints (Otti and zenwaji, 2019). The implementation of boreholes can alleviate severe water shortages, reduce conflict, and improve health outcomes during droughts (MacDonald et al., 2019).

2.1.3.2 Ambition for the TAP

Boreholes play a crucial role as a drought intervention for domestic water supply, particularly in regions prone to water scarcity. During droughts, surface water sources may become unreliable, making it necessary to tap into groundwater reservoirs through boreholes. As a drought intervention for domestic water supply, boreholes can take three major strategies: drilling new boreholes /deepening existing ones; repairing damage boreholes; and /or constructing relief boreholes with restricted used for drought periods only. The target is to drill three monitoring boreholes per each of three main hydrometric catchments of Lesotho especially in southern Lesotho and the Senqu River basin. In addition, take an inventory of all existing community boreholes in the local community councils of Lesotho and drill new ones in at least 80 percent of the electoral division in each community council. In this regard the target is to introduce at 50 hand pump boreholes/tube well in each community council of the southern lowlands of Lesotho and the Senqu river valley where suitable hydro-geological conditions are available within a period of 10 years.

Gender issues

Gender considerations in the implementation of boreholes as a drought intervention for domestic water supply are crucial for ensuring equitable access and sustainable management. The involvement of women, who are traditionally responsible for water management, is essential for the success of the project. However, several socio-cultural and institutional barriers must be addressed to enhance their participation and benefit from these interventions. Women are often the primary managers of domestic water, responsible for fetching and using water for household needs. Thus, improved access to water sources can significantly enhance their well-being and socio-economic opportunities (Singh et al., 2009).

Despite their central role, women are frequently underrepresented in decision-making processes related to water management. This lack of representation can hinder the effective implementation and sustainability of water projects (Vyas-Doorgapersad, 2013). Moreover, Cultural beliefs and social norms can influence the use and management of new water technologies. The divergence of new water technologies from traditional practices can also pose challenges. Women may be less involved in the operation and maintenance of these technologies, affecting their sustainability (Singh et al., 2009).

Policies promoting gender equality in water management committees must be effectively implemented at the local level. Studies show that gender equality policies, if not well cascaded, will potentially affect community-led monitoring of borehole projects (Joseph and Mwangi, 2022). Development bureaucracies often focus on macro-level technological solutions without considering the socio-cultural contexts that affect women's participation and the sustainability of water projects (Singh, 2006). Thus, incorporating gender-sensitive approaches in water supply programs can enhance women's empowerment and ensure the sustainability of water projects. This includes using gender-disaggregated data and considering socio-cultural contexts in program design (Vyas-Doorgapersad, 2013). Equal and full involvement of women in planning and implementing water projects is essential, particularly in drought-prone areas where their workload is exacerbated by water scarcity (Arku and Arku, 2010). A shift towards gender-based approaches that consider the unique needs and roles of women can lead to more sustainable and equitable water management solutions.

2.1.3.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

The identified barriers were organized in the order of cause-effect relations, with the main problem/barrier at the centre and the direct causes below it and direct effects above. Overall, two categories of barriers were prioritized: financial and non-financial barriers. The former entails high initial costs and maintenance expenses. Thus, providing financial support through government funding or subsidies can help offset these initial costs of borehole drilling, making it more financially viable for communities. Otherwise, there is need to encourage collaborations between public and private entities through PPPs to attract private investment and expertise, leveraging resources for borehole implementation. One way to promote the technology is to offer tax incentives for individuals or businesses investing in boreholes encourages private sector participation and can reduce the overall financial burden.

The latter entails technical challenges and technology transfer. There is need to conduct detailed surveys to assess the feasibility of borehole installation, considering factors like groundwater availability, depth, and quality. Based on the foregoing, choose optimal locations for borehole installation based on geological data and local hydrology to maximize water yield and minimize potential contamination risks by utilising advanced drilling technologies and techniques to penetrate different types of soil and rock formations efficiently. This also entails regularly test the water quality to ensure it meets safety standards for domestic use, addressing concerns about contamination and health risks.

Actions selected for inclusion in the TAP

Action 1: Develop a mechanism for prioritization of areas/sites for installation of boreholes and preparation of a priority list - Developing a mechanism for prioritizing areas for borehole installation is essential to optimize resource allocation, enhance operational efficiency, and minimize costs in well construction projects. By systematically evaluating parameters related to each site, stakeholders can identify high-priority tasks that align with project goals, ensuring timely completion and improved performance metrics. This prioritization facilitates better decision-making, reduces delays, and allows for adaptive management of construction operations, ultimately leading to more effective project development strategies

Action 2: Develop a regulatory framework on ground water extraction that is aligned with, and supports the surface water regulations and strategies - Developing a regulatory framework for groundwater extraction that aligns with surface water regulations is crucial for ensuring sustainable water management. Groundwater and surface water are interconnected resources, and their management must be integrated to prevent over-extraction, contamination, and depletion. A unified regulatory approach can help maintain ecological balance, protect drinking water sources, and support long-term water availability.

Action 3: Reduce costs of groundwater extraction - Reducing costs of groundwater extraction is crucial for sustainable drought intervention strategies, as it ensures that borehole implementation remains economically viable for communities reliant on domestic water supply. High drilling costs can limit access to essential water resources, particularly in regions facing water scarcity. By optimizing borehole locations through predictive modelling and minimizing drilling expenses, communities can enhance their resilience to drought, ensuring reliable access to groundwater while promoting efficient resource management. This approach ultimately supports long-term sustainability and reduces the financial burden on local water management systems.

Action 4: Strengthen technical skills for groundwater extractions, borehole installation and management - Strengthening technical skills for groundwater extraction, borehole installation, and management is crucial for ensuring the sustainability and reliability of water supply systems in drought-prone areas. Enhanced professionalism in these areas minimizes the risk of premature borehole failure, thereby securing safe drinking water and contributing to the achievement of Sustainable Development Goal 6.1. The action will improve knowledge and capacity in drilling practices which leads to better project outcomes, increased stakeholder engagement, and ultimately, more resilient water supply systems in the face of climate challenges.

Action 5: Strengthen institutions for groundwater management - Strengthening institutions for groundwater management is crucial for the effective implementation of boreholes as a drought intervention strategy, as it enhances the capacity to maintain and manage water sources sustainably. Improved local institutions can facilitate better coordination among stakeholders, ensuring equitable access to water and reducing conflicts at waterpoints. Additionally, they can provide necessary financial resources, equipment, and skills for the maintenance of groundwater sources, ultimately leading to increased groundwater recharge and resilience against drought. This integrated approach supports the long-term sustainability of domestic water supply in vulnerable communities.

Activities identified for implementation of selected actions

Table 21 summarises the actions and activities selected for implementation of the technology.

Table 21. Summary of actions and corresponding activities for boreholes as a drought intervention for domestic water supply

Actions	Activities for Action Implementation
Action 1	1.1 Develop an open-source database of groundwater systems: potential information includes groundwater regime, quality, climatic condition, physiographic and drainage aspects 1.2 Formulate a protocol/mechanism 1.3 Preparation of a priority list 1.4 Implement an annual monitoring program for ground water availability/quality and hydrogeology by research institutions and DWA
Action 2	2.1 Coordinate, harmonize, synergize roles and functions of key government departments involved in groundwater/surface water management. 2.2 Develop guidelines for approval of permits for extraction of groundwater resources with an emphasis on a balanced utilization of surface and groundwater. 2.3 Revise existing policies/laws in order to control drilling of boreholes affecting vulnerable aquifers.
Action 3	3.1 Allocate sufficient funds from annual budget 3.2 Develop mechanisms for additional funding from development partners. 3.3 Formulate financial incentives through loan schemes 3.4 Develop partnerships with private sector through incentives to supply required equipment for easy access through business for example set up specialised supply points for subsidised materials and fuel for ground water extraction establishments
Action 4	4.1 Develop courses on hydro geology tailored to groundwater extraction needs for extension workers to increase skills in surveying, delineation, monitoring of ground water resources and maintenance of boreholes' equipment. 4.2 Conduct research/studies to identify locations where ground water extraction is hydro geologically and socio-economically feasible. 4.3 Establish a practical demonstration of model borehole setup and management to enable peer to peer learning.
Action 5	5.1 Strengthen institutional capacity in groundwater management 5.2 Provide recurrent budget support for water user communities for administration of ground water extraction facilities.

Actions	Activities for Action Implementation
	5.3 Secure land tenure rights for areas with potential suitability for groundwater extraction establishment.

Gender issues

The implementation of borehole projects for domestic water supply aims to achieve several key gender outcomes, primarily focusing on enhancing gender equality and empowering women in water management roles. These projects recognize the critical role women play in water management and seek to address gender disparities by promoting their active participation and leadership in water-related activities.

Borehole projects aim to ensure gender equality within management committees, which are crucial for community-led monitoring and maintenance of water projects. The inclusion of women in management roles is essential for the success and sustainability of water projects, as their involvement can lead to more effective monitoring and maintenance practices (Joseph and Mwangi, 2022). Moreover, women's participation in water management is vital for the success of domestic water supply projects and women's exclusion from water management due to traditional norms and top-down approaches can lead to failures (Nguyeni 2018). Thus, women's involvement in water management leads to improved outcomes for both women and the community, highlighting the importance of gender equity in water projects. Finally, borehole projects will significantly impact women's daily lives by reducing the time and effort required for water collection, thereby improving their overall well-being and allowing them to engage in other productive activities (Facanha, 2019).

2.1.3.4 Stakeholders and timeline for implementation of the TAP

Overview of Stakeholders for the implementation of the TAP

Implementing borehole technology as a drought intervention involves multiple stakeholders, each playing critical roles in ensuring the project's success. Each of these stakeholders plays a crucial role in the successful implementation of borehole technology as a drought intervention, ensuring that the project is sustainable, equitable, and effectively addresses the needs of drought-affected communities (Table 22).

Table 22. Roles of stakeholders involved in the implementation of drought intervention for domestic water supply

Stakeholder	Roles
Government agencies: ➢ Water Commission ➢ DWA ➢ Rural Water Supply	• **Policy and Regulation**: Set and enforce regulations governing water extraction, environmental protection, and land use. • **Funding and Resource Allocation**: Provide financial support, allocate land for borehole sites, and ensure equitable distribution of resources. • **Monitoring and Evaluation**: Oversee the implementation process, ensure compliance with environmental standards, and assess the impact of the intervention on the community and environment.
Local Communities including local community councils and chiefs	• **Beneficiaries:** The primary users of the boreholes, relying on them for drinking water, irrigation, and livestock during droughts. • **Participation and Ownership:** Engage in the planning process, provide local knowledge, and contribute labour or other resources to the project. • **Maintenance and Management**: Take responsibility for the ongoing maintenance and operation of the boreholes, often through community-based water committees.
Non-Governmental Organizations	• **Advocacy and Awareness**: Advocate for the needs of drought-affected communities and raise awareness about the importance of sustainable water management. • **Capacity Building**: Provide training and education to local communities on borehole maintenance, water conservation, and sustainable use practices. • **Project Implementation**: Work alongside government and local communities to plan, fund, and construct boreholes, often bringing in technical expertise and additional resources.
Donors and International Organizations	• **Funding**: Provide financial support for borehole projects, often as part of broader drought resilience or humanitarian aid programs. • **Technical Assistance**: Offer expertise in project design, technology selection, and implementation strategies. • **Monitoring and Reporting**: Ensure accountability and transparency in the use of funds, and monitor the project's impact on reducing drought vulnerability.
Private Sector	• **Service Providers**: Companies that supply drilling equipment, pumps, and other necessary technology for borehole construction. • **Consultants and Engineers**: Offer specialized services in borehole site selection, drilling, and water resource assessment. • **Public-Private Partnerships**: Engage in partnerships with governments or NGOs to fund, build, and maintain boreholes, sometimes in exchange for tax incentives or corporate social responsibility (CSR) credits.
Water Resources Management Authorities	• **Regulation and Licensing**: Issue permits for drilling and water extraction, ensuring that borehole projects comply with water use regulations and do not negatively impact local water tables. • **Resource Assessment**: Conduct hydrological surveys to identify suitable locations for boreholes and assess the sustainable yield of aquifers. • **Monitoring Water Quality**: Ensure that the water extracted from boreholes meets safety standards for human consumption and agricultural use.
Local Authorities (Municipal and District Councils	• **Planning and Coordination**: Coordinate borehole projects within their jurisdictions, ensuring alignment with local development plans and the needs of the community.

Stakeholder	Roles
	• **Land Allocation**: Assist in identifying and securing land for borehole sites, often facilitating negotiations with local landowners. • **Community Engagement**: Facilitate communication between the project implementers and the community, addressing concerns and ensuring that local voices are heard.
Environmental Conservation Groups	• **Impact Assessment**: Evaluate the potential environmental impacts of borehole projects, including effects on local ecosystems and groundwater resources. • **Sustainability Advocacy**: Advocate for sustainable water extraction practices and the protection of sensitive ecosystems that may be affected by borehole drilling. • **Rehabilitation Efforts**: Engage in efforts to rehabilitate or restore areas that may be degraded by excessive borehole drilling or overuse of water resources.
Academia and Research Institutions	• **Research and Development**: Conduct research on drought resilience, groundwater management, and the effectiveness of boreholes as a drought intervention. • **Technical Training**: Provide training and education programs for local communities, engineers, and government officials on best practices in borehole technology and water management. • **Data Collection and Analysis**: Gather and analyse data on groundwater levels, climate patterns, and borehole performance to inform ongoing and future interventions.
Media	• **Public Awareness**: Inform the public about the borehole projects, their benefits, and their role in drought resilience. • **Advocacy and Accountability**: Report on the progress of the projects, highlight success stories, and hold stakeholders accountable for any mismanagement or failures.

Scheduling and sequencing of specific activities

Table 23 outlines the scheduling of activities at different scales of implementation over a projected a 10-year period.

Table 23. Scheduling and sequencing of specific activities

Action	Scale	Time (Years)									
		1	2	3	4	5	6	7	8	9	10
1.1 Develop an open-source database of groundwater systems	National	■	■								
1.2 Formulate a protocol/mechanism	National	■									
1.3 Preparation of a priority list	National	■									
1.4 Implement an annual monitoring program	Local		■	■	■	■	■	■	■	■	■
2.1 Coordinate, harmonize, synergize roles and functions of institutions involved in groundwater/surface water management.	National	■	■	■	■	■	■	■	■	■	■
2.2 Develop guidelines for approval of permits for extraction of groundwater resources	National	■									

Action	Scale	Time (Years)									
		1	2	3	4	5	6	7	8	9	10
2.3 Revise existing policies/laws in order to control drilling of boreholes affecting vulnerable aquifers.	National										
3.1 Allocate sufficient funds from annual budget	National										
3.2 Develop mechanisms for additional funding from development partners.	National										
3.3 Formulate financial incentives through loan schemes	National										
3.4 Develop partnerships with private sector through incentives to supply required equipment for easy access through business for example set up specialised supply points for subsidised materials and fuel for ground water extraction establishments	National										
4.1 Develop courses on hydrogeology tailored to groundwater extraction needs for extension workers	National										
4.2 Conduct research/studies to identify locations where ground water extraction is feasible.	National										
4.3 Establish a practical demonstration of model borehole setup and management.	Local										
5.1 Strengthen institutional capacity in groundwater management	National										
5.2 Provide recurrent budget support for water user communities.	National										
5.3 Secure land tenure rights for areas with potential suitability.	Community level										

Gender issues

Gender considerations in the implementation of boreholes as a drought intervention for domestic water supply are crucial for ensuring equitable access and benefits. The integration of gender perspectives in water projects often faces challenges, but it is essential for addressing the distinct needs and priorities of different stakeholders. Gender equality is often inadequately addressed in water projects, with many initiatives failing to move beyond tokenistic mentions of gender issues. This results in reinforcing existing inequities rather than addressing them effectively (Joshi, 2016). A comprehensive review of water projects revealed that many rely on generalized assumptions that pro-poor initiatives automatically benefit both genders equally, which is not always the case. This approach can overlook the specific needs and priorities of women, leading to suboptimal outcomes (Kodama et al., 2016).

The lack of a clear conceptualization of gender in project design leads to poorly defined targets that do not capture the varied lived realities of gendered experiences. This results in either reductionist objectives or vague qualitative statements that are difficult to assess (Robinson et al., 2024). Efforts to mainstream gender in water management have been limited by a narrow understanding of gender, often equating it solely with women. This overlooks the broader social and power dynamics between men and women, as well as differences within women themselves (Narain and Goodrich, 2024). Successful gender mainstreaming requires a context-specific understanding of gender as a social construct shaped by culture. This understanding should inform the development of nuanced gender-inclusion objectives that can be monitored and evaluated effectively (Robinson et al., 2024).

2.1.3.5 Estimation of Resources Needed for Actions and Activities

Estimation of capacity building needs

Capacity building is crucial for the successful implementation and sustainability of borehole technologies as a drought intervention. It involves enhancing the knowledge, skills, and resources of the stakeholders involved in the project, particularly the local communities, to ensure effective management and long-term viability. future interventions. Building capacity in these areas ensures that borehole technology interventions are not only effective in the short term but also sustainable in the long term, empowering communities to manage their water resources independently and resiliently (Table 24).

Table 24. Summary of capacity building needs for implementation of borehole technologies as drought interventions for domestic water supply.

Skills	Capacity Development
Technical skills development	• **Borehole Drilling and Construction**: Training for local technicians and contractors on the technical aspects of borehole drilling, well construction, and the installation of pumps and other equipment. • **Operation and Maintenance**: Building the capacity of local operators and community members to manage the day-to-day operations of boreholes, including monitoring water levels, operating pumps, and performing routine maintenance. • **Water Quality Testing**: Training in water sampling, testing procedures, and interpreting results to ensure the water is safe for consumption and other uses. • **Hydrogeological Assessment**: Developing skills in conducting and interpreting hydrogeological surveys to identify suitable drilling sites and assess groundwater resources.
Community engagement and management	• **Community Mobilization**: Training community leaders and members on how to mobilize and organize community involvement in the project, ensuring that all stakeholders are engaged and their needs are met. • **Formation of Water Committees**: Establishing and training local water committees or user associations to oversee the management, operation, and maintenance of the boreholes. • **Conflict Resolution**: Providing training in conflict resolution techniques to manage disputes that may arise over water access, allocation, or borehole management. • **Awareness and Education Programs**: Educating communities on the importance of sustainable water use, the role of boreholes in drought resilience, and best practices for water conservation

Skills	Capacity Development
Financial management and sustainability	• **Budgeting and Financial Planning**: Training for local managers and water committees on how to develop and manage budgets, including planning for routine maintenance, repairs, and unexpected expenses. • **Fundraising and Resource Mobilization**: Building capacity to identify and secure funding from various sources, including government grants, donor funding, and community contributions. • **User Fee Management**: Training on setting up and managing user fees or water tariffs to generate revenue for the ongoing maintenance and operation of boreholes. • **Financial Transparency and Accountability**: Educating local management teams on the importance of financial transparency, regular audits, and reporting to maintain trust and ensure the proper use of funds.
Institutional strengthening	• **Policy and Regulatory Knowledge**: Training on relevant policies, regulations, and legal requirements related to water resource management, land use, and environmental protection. • **Institutional Coordination**: Building the capacity of local institutions to coordinate with government agencies, NGOs, and other stakeholders involved in the project. • **Monitoring and Evaluation (M&E)**: Developing skills in designing and implementing M&E frameworks to track the performance and impact of the borehole project over time. • **Data Collection and Management**: Training in the collection, analysis, and management of data related to water usage, groundwater levels, and community needs to inform decision-making.
Environmental management and sustainability	• **Sustainable Water Extraction Practices**: Educating communities and local operators on the principles of sustainable water extraction, ensuring that groundwater resources are not depleted. • **Environmental Impact Assessment (EIA)**: Training on how to conduct and use EIAs to assess the potential environmental impacts of borehole projects and develop mitigation strategies. • **Climate Change Adaptation**: Building capacity to understand and respond to the impacts of climate change on water resources, including the development of strategies to adapt borehole operations to changing conditions. • **Ecosystem Conservation**: Educating communities on the importance of protecting local ecosystems, such as wetlands and forests, that contribute to the sustainability of water resources.
Health and safety training	• **Occupational Safety**: Training for drilling crews and operators on safety protocols to prevent accidents and injuries during drilling, construction, and operation. • **Waterborne Disease Prevention**: Educating communities about the risks of waterborne diseases and the importance of maintaining clean and safe water sources. • **Emergency Response**: Building the capacity of local teams to respond to emergencies, such as equipment failures, contamination incidents, or natural disasters that may impact borehole functionality.
Gender and social inclusion	• **Gender Sensitization**: Training on the importance of gender equity in water resource management, ensuring that women, who are often primary water users, have a voice in decision-making processes. • **Inclusive Participation**: Developing strategies to ensure that all segments of the community, including marginalized groups, are included in the planning, implementation, and management of borehole projects. • **Capacity Building for Women**: Providing targeted training for women on technical, financial, and managerial aspects of borehole operations to empower them as key stakeholders in the project.
Information & communication technology skills	• **Data Management Tools**: Training on the use of ICT tools for monitoring borehole performance, water usage, and maintenance schedules. • **Mobile-Based Reporting**: Educating communities and local managers on using mobile technology for real-time reporting and communication, especially in remote areas. • **GIS and Mapping Skills**: Developing skills in Geographic Information Systems (GIS) for mapping borehole locations, monitoring groundwater levels, and planning

Estimations of costs of actions and activities

The implementation of this technology requires a major financial investment given the terrain and topography of Lesotho. A set of five actions and corresponding activities for implementation of this TAP were compiled (Table 21). The TAP will require a total budget of USD 466.5 million for its implementation. Most of these funding can be sought from international agencies, but some costs would need to be borne by the Government of Lesotho (in-kind).

Gender issues

To ensure that capacity building for boreholes as a drought intervention is gender-responsive, it is crucial to integrate gender considerations into both the planning and implementation phases. This involves understanding the unique challenges faced by women and girls in accessing water and ensuring that budget lines and activities reflect these needs. A gender analysis of budget lines and activities can help identify gaps and opportunities for promoting gender equity in water resource management. Engaging women in participatory action research can help identify their specific needs and challenges in water access. Capacity building should include training materials that focus on gender equity in the water sector. These materials should be designed to educate both men and women, fostering an understanding of gender dynamics in water management (Khosla, 2009). Gender-Responsive Budgeting (GRB) tools can be used to ensure that budget allocations in the water sector address gender disparities. This involves aligning budgets with the requirements for achieving women's rights and promoting gender equity (Budlender and Alami, 2006). Finally, a dedicated capacity development framework for the water sector can help identify key determinants for successful interventions. This framework should consider gender as a critical factor in capacity development processes (Jiménez et al., 2024).

2.1.3.6 Management Planning

Risks and Contingency Planning

Implementing borehole technologies as a drought intervention carries various risks that can impact the project's success. By identifying these risks early and planning appropriate contingencies, the implementation of borehole technology can be more resilient, sustainable, and effective in mitigating the impacts of drought. Table 25 outlines the types of risks, their descriptions, and possible contingency plans.

Table 25. Identified risks and possible contingency plan

Type of risk	Description of risk	Contingency actions
Technical risks	Technical failures during drilling or operation, such as equipment malfunction, poor site selection leading to dry or low-yield boreholes, or issues with water quality.	• **Pre-implementation Testing**: Conduct thorough hydrogeological surveys and feasibility studies to identify optimal drilling sites. • **Regular Maintenance**: Implement a routine maintenance schedule to ensure equipment is functioning properly and address any issues before they escalate. • **Backup Equipment**: Have backup drilling equipment and tools on standby to minimize downtime in case of equipment failure. • **Water Quality Monitoring**: Continuously monitor water quality and install necessary filtration or treatment systems if contaminants are detected.
Environmental risks	Negative impacts on local ecosystems, such as depletion of groundwater resources, contamination of water sources, or disruption of habitats.	• **Environmental Impact Assessments (EIAs)**: Conduct thorough EIAs before starting the project to understand potential impacts and develop mitigation strategies. • **Sustainable Water Extraction**: Design extraction plans that do not exceed the recharge rate of the aquifer to prevent over-extraction. • **Regular Monitoring**: Continuously monitor groundwater levels and quality, adjusting extraction rates as needed to avoid long-term depletion or contamination. • **Rehabilitation Programs:** Implement habitat restoration or reforestation programs to offset any environmental damage caused by the borehole project.
Social risks	Conflicts over water resource allocation, community opposition, or inequitable access to borehole water, leading to social unrest or project failure.	• **Stakeholder Engagement**: Engage local communities early in the planning process to ensure their needs and concerns are addressed, fostering a sense of ownership. • **Equitable Access Plans**: Develop access plans that ensure all community members, especially vulnerable groups, have fair access to the water resources. • **Conflict Resolution Mechanisms**: Establish clear, community-based mechanisms for resolving disputes over water use or resource allocation. • **Cultural Sensitivity Training**: Train project staff in cultural sensitivity to ensure that they respect local customs and practices.
Financial risks	Budget overruns, funding shortfalls, or financial mismanagement that could halt the project or lead to incomplete infrastructure.	• **Detailed Budgeting**: Prepare a comprehensive budget that includes contingencies for unexpected costs, with regular financial reviews to track expenditures. • **Diversified Funding:** Secure funding from multiple sources (e.g., government, donors, private sector) to reduce dependency on a single funding stream.

Type of risk	Description of risk	Contingency actions
		• **Cost Control Measures:** Implement strict financial controls and procurement procedures to prevent overspending and ensure transparency. • **Contingency Fund:** Set aside a contingency fund to cover unforeseen expenses or cost overruns.
Regulatory and legal risks	Delays or failures in obtaining necessary permits, non-compliance with local regulations, or legal disputes over land or water rights.	• **Early Regulatory Engagement**: Engage with regulatory authorities early in the project to understand requirements and streamline the permitting process. • **Legal Due Diligence**: Conduct thorough legal assessments to identify potential land or water rights issues and address them before they escalate. • **Compliance Monitoring**: Regularly review project activities to ensure compliance with all relevant regulations and legal requirements. • **Legal Support**: Have legal expertise on hand to manage any disputes or challenges that arise during the project.
Operational risks	Challenges in managing the borehole system, such as inadequate capacity for maintenance, operational inefficiencies, or reliance on external expertise.	• **Capacity Building**: Train local operators and community members in borehole maintenance and operation to ensure sustainability. • **Operational Planning**: Develop detailed operational plans that include standard operating procedures (SOPs) for maintenance and emergency repairs. • **Monitoring Systems**: Implement monitoring systems to track the performance of the borehole and address any operational issues promptly. • **Technical Support Agreements**: Establish agreements with service providers for ongoing technical support and emergency repairs
Political risks	Changes in government policies, political instability, or interference that could disrupt project implementation or sustainability.	• **Government Relations**: Build strong relationships with local and national government bodies to secure their support and minimize political risks. • **Policy Analysis**: Continuously monitor the political environment and assess potential policy changes that could impact the project. • **Contingency Planning for Instability**: Develop contingency plans that include strategies for operating under unstable political conditions, such as securing alternative supply chains or temporary suspensions. • **Community Empowerment**: Empower local communities to manage the boreholes independently, reducing reliance on external political structures.
Health and safety risks	Risks to the health and safety of workers and local communities, such as accidents during drilling, contamination of water supplies, or spread of waterborne diseases.	• **Safety Protocols**: Develop and enforce strict safety protocols during drilling and operational phases, including the use of protective equipment and regular safety training.

Type of risk	Description of risk	Contingency actions
		• **Water Quality Safeguards**: Ensure that all boreholes are properly constructed and regularly tested to prevent contamination and protect public health. • **Health Monitoring**: Monitor the health of local communities for any signs of waterborne diseases and implement quick-response measures if issues arise. • **Emergency Response Plans**: Establish emergency response plans for accidents or health outbreaks, including first aid training and clear communication channels.
Climate risks	Changes in climate patterns, such as prolonged droughts or unexpected heavy rainfall, that could impact borehole functionality or water availability.	• **Climate-Resilient Design**: Design boreholes and related infrastructure to withstand extreme weather events, such as reinforcing structures against floods. • **Adaptive Management**: Implement flexible management strategies that can adjust to changing climate conditions, such as varying water extraction rates based on seasonal availability. • **Diversification of Water Sources**: Develop alternative water sources, such as rainwater harvesting or desalination, to complement borehole supplies during extreme climate conditions. • **Climate Monitoring**: Continuously monitor climate data and forecasts to anticipate and prepare for adverse weather conditions.

Next Steps

Implementing borehole technologies as a drought intervention involves several critical steps to ensure the project is effective, sustainable, and meets the needs of the affected communities (Table 26). By following these critical steps, the implementation of borehole technologies as a drought intervention can be successful, providing reliable and sustainable water sources to communities in need.

Table 26. Immediate requirements and Critical Step

Immediate requirements	Critical steps
Needs assessment and feasibility study	• **Identify the Need**: Assess the severity of drought conditions and the demand for water within the target area, including drinking water, irrigation, and livestock needs. • **Hydrogeological Survey**: Conduct a detailed hydrogeological survey to identify suitable locations for drilling, assess groundwater availability, and estimate sustainable yield. • **Feasibility Study**: Evaluate the technical, economic, social, and environmental feasibility of implementing boreholes, including potential challenges and solutions.
Stakeholder engagement and	• **Stakeholder Identification**: Identify and engage key stakeholders, including local communities, government agencies, NGOs, and private sector partners.

Immediate requirements	Critical steps
community involvement	• **Community Consultation**: Involve local communities in the planning process to ensure the project addresses their needs, incorporates local knowledge, and gains their support. • **Awareness and Education**: Educate the community about the project, the benefits of borehole technology, and the importance of sustainable water management.
Regulatory compliance and permitting	• **Regulatory Review**: Ensure compliance with local, regional, and national regulations governing water extraction, land use, and environmental protection. • **Obtain Permits**: Secure all necessary permits and approvals for drilling, construction, and operation of boreholes. • **Land Acquisition**: If required, acquire land for borehole sites, ensuring that land ownership and rights issues are resolved
Design and Planning	• **Borehole Design**: Develop detailed designs for boreholes, including depth, casing, screens, and pumps, tailored to the specific hydrogeological conditions. • **Infrastructure Planning**: Plan the necessary infrastructure, such as storage tanks, distribution systems, and power sources (e.g., solar panels), to support the boreholes. • **Budgeting and Resource Allocation**: Develop a detailed budget covering all aspects of the project, including drilling, equipment, construction, and ongoing maintenance.
Procurement and contractor selection	• **Tendering Process**: Conduct a transparent tendering process to select qualified contractors for drilling, construction, and supply of equipment. • **Procurement of Materials**: Purchase high-quality materials and equipment, such as drilling rigs, pumps, and piping, ensuring durability and reliability. • **Contract Management**: Establish clear contracts with service providers, including timelines, deliverables, and penalties for non-performance.
Drilling and construction	• **Site Preparation**: Prepare the drilling site, ensuring access for equipment and safety for workers. • **Drilling Operations**: Execute the drilling process, closely monitoring progress to avoid technical issues and ensure alignment with design specifications. • **Well Development**: After drilling, develop the borehole by cleaning and testing it to ensure it is free of debris and contaminants. • **Pump Installation**: Install pumps and other necessary equipment, ensuring they are correctly sized and positioned for optimal performance.
Testing and commissioning	• **Water Quality Testing**: Test the water for contaminants, such as bacteria, chemicals, and heavy metals, to ensure it meets safety standards for its intended use. • **Pump Testing**: Conduct pump tests to determine the borehole's yield and efficiency, adjusting equipment as necessary. • **System Commissioning**: Commission the borehole system, including all associated infrastructure, and verify that it operates as intended.
Operation and maintenance	• **Operation Guidelines**: Develop clear operating procedures, including guidelines for water extraction rates to ensure sustainable use of the borehole. • **Maintenance Schedule**: Establish a routine maintenance schedule, including inspections, cleaning, and repairs, to keep the borehole and equipment in good condition. • **Training and Capacity Building**: Train local operators and community members in borehole operation, maintenance, and management to ensure long-term sustainability.
Monitoring and evaluation	• **Performance Monitoring**: Continuously monitor the performance of the borehole, including water yield, quality, and the condition of the equipment. • **Environmental Monitoring**: Regularly assess the impact of the borehole on local groundwater levels and ecosystems to ensure sustainability.

Immediate requirements	Critical steps
	• **User Feedback**: Gather feedback from the community on the borehole's performance and address any issues or concerns that arise.
Sustainability and community management	• **Community Ownership**: Promote community ownership of the borehole by establishing local water committees or cooperatives to manage and maintain the system. • **Sustainable Practices**: Educate the community on sustainable water use practices to prevent over-extraction and ensure the long-term availability of groundwater. • **Financial Sustainability**: Develop financial mechanisms, such as user fees or community funds, to cover ongoing maintenance and repairs
Impact assessment and reporting	• **Impact Evaluation**: Assess the social, economic, and environmental impacts of the borehole project, including improvements in water access, agricultural productivity, and resilience to drought. • **Reporting**: Document the outcomes of the project, including successes, challenges, and lessons learned, to inform future interventions. • **Continuous Improvement**: Use the findings from the impact assessment to refine and improve future borehole projects, ensuring greater effectiveness and sustainability.

Gender issues

The implementation of boreholes as a drought intervention for domestic water supply has highlighted significant gender issues, which have been identified and addressed through various strategies. These strategies aim to enhance women's participation and address gender inequalities in water resource management.

In drought prone regions like the southern lowlands and Senqu river valley, gender inequality exacerbates the vulnerability of women to drought and water scarcity because they often bear the brunt of water management responsibilities, which are intensified during droughts. The strict patriarchal norms of Basotho culture limit women's participation in decision-making processes related to water management and this restricts their visibility and mobility, further entrenching gender disparities. Women are traditionally seen as domestic water managers, but their roles are constrained by cultural beliefs and social norms, which affect their access to improved water sources (Singh et al., 2009).

Thus, efforts to educate and build the capacity of women are crucial. In the target regions, potential initiatives might include water management counselling and rainwater harvesting systems, which aim to empower women and enhance their role in water management. Moreover, in watershed projects, integrating gender-sensitive participatory approaches is essential. This involves engaging women in planning, design, and implementation stages to ensure their needs and knowledge are considered. The construction of check dams and boreholes has reduced the time women spend fetching water, thereby alleviating some of their burdens and allowing them more time for other activities (Padmaja et al., 2020).

2.1.3.7 Reporting

Table 27. Overview table

Sector	**Water Resources**							
Sub-sector	Water and Sanitation							
Technology	Boreholes as a drought intervention for domestic water supply							
Ambition	Drill three monitoring boreholes per each of three main hydrometric catchments of Lesotho especially in southern Lesotho and the Senqu River basin							
Benefits	Improves access to groundwater for domestic use and for other uses such as watering livestock							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame (Yrs)	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity (US$ million)
Action 1	Activity 1.1 Develop an open-source database of groundwater systems: potential information includes groundwater regime, quality, climatic condition, physiographic and drainage aspects	GoL	DWA	1-10	Lack of funding	GIS based ground water database	District databases	1.0
	Activity 1.2 Formulate a protocol/mechanism	GoL	Water Commission	1-5	Lack skills	Ground water protocol in place	Participatory development of protocol	0.5
	Activity 1.3 Preparation of a priority list	GoL	Water Commission	1-3	Lack of funding	Complete list	Participatory preparation of list	0.5
	Activity 1.4 Implement an annual monitoring program for ground water availability/quality and hydrogeology by research institutions and DWA	GoL Development partners	Water Commission	1-5	Lack of funding	Monitoring programme	Participatory development of programme	2.0
Sub-Total for Action 1 Activities								**4.0**

Action 2	Activity 2.1 Coordinate, harmonize, synergize roles and functions of key government departments involved in groundwater/surface water management.	GoL Develop ment partners	Water Commission	1-5	Lack of policy framewo rk	Regulatory framework	Coordination of water resource agencies	1.5
	Activity 2.2 Develop guidelines for approval of permits for extraction of groundwater resources with an emphasis on a balanced utilization of surface and groundwater.	GoL Develop ment Partners	Water Commission	1-5	Lack of regulator y instrume nts	Regulatory instruments developed	Universal application of instruments	0.5
	Activity 2.3 Revise existing policies/laws in order to control drilling of boreholes affecting vulnerable aquifers.	GoL Develop ment Partners	Water Commission	1-5	Lack of funds	Revised policies and legislation	Participatory policy and legislative review	0.5
Sub-Total for Action 2 Activities								**2.5**
Action 3. Reduce costs of groundwater extraction	Activity 3.1 Allocate sufficient funds from annual budget	GoL	Ministry of Finance and development Planning	1-10	Fiscal constrain ts	Budget increments	Budgetary annual targets met	0.5
	Activity 3.2 Develop mechanisms for additional funding from development partners.	Develop ment Partners	Ministry of Finance and Developmen t Planning	1-5	Low appetite of Develop ment investme nt in water	Increased international funding	Signed funding agreements	0.5
	Activity 3.3 Formulate financial incentives through loan schemes	GoL Develop ment partners	Ministry Finance and Developmen t Planning	1-10	Lack policy framewo rks	Financial incentives in place	New incentive instruments	2.5
	Activity 3.4 Develop partnerships with private sector through incentives to supply required	GoL	Ministry Finance and	1-10	Low appetite on the	Effective partnerships	Import and local	2.5

	equipment for easy access through business for example set up specialised supply points for subsidised materials and fuel for ground water extraction establishments	Develop ment Partners	Developmen t Planning		part of private sector		manufacturing of equipment	
Sub-Total for Action 3 Activities								**6.0**
Action 4.	Activity 4.1 Develop courses on hydro geology tailored to groundwater extraction needs for extension workers to increase skills in surveying, delineation, monitoring of ground water resources and maintenance of boreholes' equipment.	GoL Develop ment Partners	Academia: NUL and LP	1-5	Lack of funding	Approved curriculum	Collaborative development	1.0
	Activity 4.2 Conduct research/studies to identify locations where ground water extraction is hydro geologically and socio-economically feasible.	GoL Develop ment Partners	Academia: NUL, LP	1-10	Lack of funding	Completed research studies	Research collaborations locally and internationally	2.5
	Activity 4.3 Establish a practical demonstration of model borehole setup and management to enable peer to peer learning.	GoL Develop ment Partners	Water Commission	1-10	Lack of funding	Ground water demonstratio n farms	Research results	1.5
Sub-Total for Action 4 Activities								**5.0**
Action 5.	Activity 5.1 Strengthen institutional capacity in groundwater management	GoL Develop ment Partners	Water Commission	1-5	Lack of funding	Water management frameworks in place	Evidence of capacity development	3.0
	Activity 5.2 Provide recurrent budget support for water user communities for administration of ground water extraction facilities.	GoL Develop ment partners	Water Commission	1-10	Lack of funding	Increased budget allocations	Evidence of incremental budget allocations	3.0
	Activity 5.3 Secure land tenure rights for areas with potential suitability for groundwater extraction establishment.	GoL	GoL	1-5	Lack of policy instrume nts	Development of supporting policy frameworks	Inter-Ministerial cooperation on	1.0

							policy development	
Sub-Total for Action 5 Activities								**7.0**
Grand Total								**24.5**

2.1.3.8 Tracking the implementation status of the TAP

Rationale, responsibility and content of TAP tracking

The proposed national process for tracking the implementation of boreholes as a drought intervention for domestic water supply involves several key institutional responsibilities. These responsibilities are crucial for ensuring the sustainability, functionality, and effectiveness of borehole systems in providing reliable water access during drought conditions. Establishing a robust governance framework is essential for effective groundwater management. This includes addressing institutional challenges such as voluntary compliance, administrative responsibility, and conflict resolution mechanisms (Theesfeld, 2010). Policies must ensure adherence to water infrastructure construction standards and empower citizens to hold service providers accountable for failed infrastructure (Kumwenda, 2023).

Continuous monitoring of borehole functionality is critical. Specialized institutions should be established to oversee water service delivery and ensure consistent feedback mechanisms are in place (Turman-Bryant et al., 2019). Implementing a water management system, such as a solar-powered system, can enhance the efficiency and maintainability of boreholes, reducing the risk of contamination and ensuring clean water supply (Malinga and Hashe, 2024). Furthermore, community ownership and responsibility are vital for the sustainability of boreholes. Empowering communities to manage operation and maintenance can improve functionality, although external factors may also affect borehole performance (Kumwenda, 2023). Thus, leadership within community institutions plays a significant role in motivating collective action and ensuring the sustainability of water infrastructure (Ducrot, 2017).

Identifying strategic borehole sites and ensuring they are prioritized during drought conditions can optimize resource allocation. However, discrepancies in usage patterns must be addressed to maximize the utility of these assets. (Turman-Bryant et al., 2019). Thus, coordinated leadership and village governance are crucial for aligning community efforts with national water supply programs (Ducrot, 2017).

Gender issues

Integrating gender-specific criteria and targets in borehole interventions for domestic water supply during droughts is crucial for ensuring equitable access and effective resource management. This approach not only addresses the practical needs of different genders but also enhances the overall sustainability and impact of water supply projects. Gender plays a significant role in water use and management, with women often bearing the primary responsibility for domestic water provision. This necessitates a focus on intra-household dynamics and the unpaid domestic responsibilities typically shouldered by women (Koppen, 2001). Improved domestic water supply can significantly impact gender relations and economic opportunities for women from reliable water access (Sijbesma et al., 2009). Gender mainstreaming in water management involves incorporating gender perspectives at all stages of project development, from problem framing to decision support. This ensures that gendered assumptions are identified and addressed, potentially leading to more inclusive and effective water management models (Packett et al., 2020). Effective water governance during droughts requires understanding local contexts, including gender-specific water demands and usage patterns. In South Africa, a study emphasized the importance of designing implementation plans that consider local gender dynamics to ensure sustainable groundwater management (Lebese, 2017).

Despite the recognized importance of gender integration, many water management projects still lack comprehensive gender analysis. Addressing this gap requires targeted efforts to engage women in decision-making processes and to develop gender-sensitive indicators and evaluation criteria (Kuriakose et al., 2005).

2.1.4 Action plan for rainwater collection from ground surfaces

2.1.4.1 Introduction

The technology of rainwater collection from ground surfaces entails two broad categories: i) collecting rainfall from ground surfaces utilizing micro-catchments to divert or slow runoff so that it can be stored before it can evaporate or enter watercourses; and ii) collecting flows from a river, stream or other natural watercourse i.e. floodwater harvesting by constructing an earthen or other structure to dam the watercourse and form small reservoirs. Micro-catchments are often used to store water as soil moisture for agriculture. Small reservoirs are typically used in areas with seasonal rainfall to ensure that adequate water is available during the dry season. Collection and storage infrastructure can be natural or constructed and can take many forms including: i) Below ground tanks (i.e. cisterns) and excavations (either lined for waterproofing or unlined) into which rainwater is directed from the ground surface.

Subsurface dams are another form of collection/storage infrastructure that can be used to address these same problems. Though they do not technically collect rain from the ground, they serve the same purpose as the above technologies. They have been used in Phamong (Mohale's Hoek) and Mapotu (Mafeteng) where riverbeds are often dry for a portion of the year. They consist of a low-permeability barrier (e.g. concrete) inserted into the ground across a riverbed, blocking the direction of flow. Though a seasonal riverbed may be dry at the surface, subsurface flow often continues throughout the year. Drilling a well on the upstream side of the subsurface dam enables access to water year-round. Subsurface dams cannot be applied everywhere and will only work when the stream is underlain by a shallow impermeable layer such as bedrock or clay. However, they have the advantages over conventional dams e.g. less evaporative loss, superior water quality, and less vector/parasite breeding (Foster and Tuinof, 2004; WHO, 2007). Rainwater collected from the ground surface is typically used for non-potable purposes, including irrigation, general domestic use, and livestock. However, in some regions with seasonal rainfall small reservoirs are commonly used for drinking water supply during the dry season, despite the high turbidity and poor bacteriological quality of the water (Cobbina et al., 2010).

Rainwater harvesting has relatively low storage and maintenance costs, making it an economically viable solution for water scarcity. Its adaptation potential lies in mitigating urban flooding and recharging groundwater, particularly in hilly and urban areas. Environmentally, it conserves water resources and reduces surface runoff, while socially, it empowers communities by providing a sustainable water supply. Additionally, it opens up economic opportunities at the grassroots level, enhancing livelihoods and promoting self-sufficiency in water-scarce regions.

2.1.4.2 Ambition for the TAP

Lesotho is investing heavily in water and sanitation under the frameworks of both the Lesotho Highlands Water Projects and the Lowlands Water Supply Schemes. However, the focus of these interventions is has mainly focused on transfer of water to regional destinations especially in the LHDA treaty. There is hope that the transfer of water to Botswana in the near future will address the deficiencies of the former. The rural communities only get a trickledown effect of these multinational water projects leaving a greater population of Lesotho in the rural areas exposed to water scarcity which is projected to increase both in the mid and distant periods.

Thus, the target for this technology is that by the year 2030, water supply and sanitation services must reach at least 80 percent of the rural population (1.162 million people) and adequate and sustainable supply of potable water. According to the 2016 population census, this makes up approximately 1.162 million people in the rural areas. Furthermore, the target is to provide sanitation services to all the population of Lesotho which is approximately 2.2 million people according to the 2016 population census.

Gender issues

The implementation of rainwater collection from ground surfaces as an adaptation strategy in the water sector must consider gender issues to ensure equitable benefits and participation. Gender mainstreaming in water management can empower women, reduce their burden, and enhance their role in decision-making processes. This approach not only addresses gender inequalities but also improves the overall effectiveness and sustainability of water management initiatives. Implementing this technology as an adaptation strategy must prioritize minimizing the time and distance women and girls travel for water, addressing safety concerns related to water and sanitation facilities, and enhancing women's roles in water governance. Empowering women as water agents can improve their social status and financial security, while also providing them with a platform to influence water policies. However, addressing cost barriers and establishing clear governance structures are essential to ensure equitable access and active participation of women in decision-making processes related to water management.

2.1.4.3 Actions and activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

Addressing economic and financial barriers for rainwater collection technologies requires a combination of supportive policies, financial incentives, and public awareness to promote sustainable and cost-effective water management practices. A number of barriers were identified along with associated measures to address them. The installation of rainwater collection systems involves significant upfront costs for equipment, storage tanks, and distribution infrastructure, which can be a financial barrier. Secondly, ongoing maintenance and operation costs, including repairs and system upkeep, can strain budgets and hinder the economic viability of rainwater collection technologies. Furthermore, insufficient availability of funding, either through government grants, private investments, or community contributions, may impede the widespread adoption of rainwater collection systems. The absence of financial incentives, such as tax breaks or subsidies, may discourage individuals, businesses, or municipalities from investing in rainwater collection infrastructure. In addition, the unpredictability of the long-term economic benefits, such as reduced water bills or savings, may make potential investors hesitant to commit to rainwater collection projects. Water pricing structures that do not account for the true cost of water may undermine the economic rationale for rainwater collection, as the financial benefits may not be fully realized.

Complex or unclear regulations related to rainwater harvesting, including permitting processes and water rights, can create additional costs and uncertainties, acting as economic deterrents. Issues related to land ownership and limited available space for rainwater collection infrastructure can pose economic challenges, particularly in densely populated urban areas. In addition, the lack of awareness or misconceptions about the safety and benefits of rainwater collection may create resistance among individuals or communities, acting as a non-economic barrier. Cultural beliefs and social norms regarding water sources may influence acceptance or reluctance to adopt rainwater collection technologies.

The technical intricacies of rainwater collection systems may pose challenges, especially for individuals or communities with limited technical expertise, acting as a non-economic barrier. Complex or unclear regulations, permitting processes, and zoning restrictions can create non-economic barriers, making it difficult to implement rainwater collection systems. In particular, perceived or actual concerns about water quality, contamination, or health risks associated with collected rainwater may hinder adoption. Insufficient local expertise in designing, installing, and maintaining rainwater collection systems may impede their successful implementation. Lack of community engagement or trust in the reliability and effectiveness of rainwater collection systems can be a non-economic barrier. The foregoing may precipitate resistance to change. Resistance to change or inertia in adopting new water management practices, even if economically viable, can act as a significant non-economic barrier. Thus, the perception that alternative water sources or traditional water supply systems are more reliable may discourage the adoption of rainwater collection technologies.

Actions selected for inclusion in the TAP

Action 1: Provision of government subsidies and tax incentives - Providing financial support through subsidies can help offset the initial costs of installing rainwater collection systems, making them more economically feasible for individuals and businesses. In addition, offering tax credits or deductions for investments in rainwater harvesting infrastructure encourages private individuals and organizations to invest in these technologies. Furthermore, establishing financial mechanisms that offer low-interest loans for rainwater collection projects can make funding more accessible and affordable, facilitating widespread adoption.

Action 2: Develop and introduce water pricing policies - Implementing water pricing structures that reflect the true cost of water can create economic incentives for adopting rainwater collection technologies by highlighting potential cost savings. In addition, encouraging collaboration between public and private entities can attract private investment and expertise, supporting the implementation of rainwater collection projects.

Action 3: Provide capacity building, training incentives and research for development funding - Offering incentives for training programs and capacity building in rainwater harvesting technologies can enhance the skills and knowledge of individuals involved in implementation. In addition, it would go a long way to allay the fears of those who are not convinced with the use of water collected from tanks. Allocating funds for research and development in rainwater collection technologies can drive innovation, reduce costs, and improve overall economic viability. Finally, providing financial incentives for water utilities to integrate rainwater collection into their infrastructure can accelerate the adoption of these technologies in broader water management strategies.

Action 4: Promulgate land use regulations and zoning policies - Advocate for land use regulations, zoning policies, and planning guidelines that recognize and accommodate rainwater harvesting installations as permissible land uses, land improvements, or accessory structures within residential, commercial, or industrial developments. Lobby for zoning code amendments, land use ordinances, or development standards that facilitate rainwater collection projects and streamline permitting processes for landowners. In addition, negotiate easements, land leases, or land use agreements with landowners, property managers, or public agencies to secure access to land for rainwater collection purposes. Establish legal agreements that grant rights-of-way, access privileges, or land use permissions for installing, maintaining, and operating rainwater harvesting infrastructure on private or public lands, ensuring long-term land availability and security.

Activities identified for implementation of selected actions

Table 28. Activities identified for implementation of selected action

Actions	Activities for action implementation
Action 1	**1.1** Providing financial support through subsidies to offset the initial costs of installing rainwater collection systems, making them more economically feasible for individuals and businesses. **1.2** Offer tax credits or deductions for investments in rainwater harvesting infrastructure to encourage private individuals and organizations to invest in these technologies. **1.3** Establishing financial mechanisms offering low-interest loans for rainwater collection projects can make funding more accessible and affordable, facilitating widespread adoption.
Action 2	**2.1** Implement water pricing structures to reflect the true cost of water can create economic incentives for adopting rainwater collection technologies by highlighting potential cost savings. **2.2** Set collaborative platforms between public and private entities can attract private investment and expertise, supporting the implementation of rainwater collection projects.
Action 3	**3.1** Offer incentives for training programs and capacity building in rainwater harvesting technologies can enhance the skills and knowledge of individuals involved in implementation. **3.2** Allocate funds for research and development in rainwater collection technologies can drive innovation, reduce costs, and improve overall economic viability. **3.3** Providing financial incentives for water utilities to integrate rainwater collection into their infrastructure can accelerate the adoption of these technologies in broader water management strategies.
Action 4	**4.1** Advocate for land use regulations, zoning policies, and planning guidelines that recognize and accommodate rainwater harvesting installations as permissible land uses, land improvements, or accessory structures within residential, commercial, or industrial developments. **4.2** Lobby for zoning code amendments, land use ordinances and permitting processes for landowners. **4.3** Facilitate negotiation of easements, land leases, or land use agreements with landowners, property managers, or public agencies to secure access to land for rainwater collection purposes. **4.4** Establish legal agreements that grant rights-of-way, access privileges, or land use permissions for installing, maintaining, and operating rainwater harvesting infrastructure on private or public lands, ensuring long-term land availability and security.

Actions to be implemented as Project Ideas

A set of actions are proposed for implementation as project ideas. These are:

Action 1: Policy development for government subsidies and tax incentives: Selecting policy development for government subsidies and tax incentives as a project idea for implementing rainwater collection from ground surfaces is crucial for enhancing water sector adaptation strategies. Such policies can effectively encourage the adoption of rainwater harvesting systems, which are vital for sustainable water management, especially in regions facing water scarcity and climate change impacts. By providing financial incentives, governments can lower the economic barriers for individuals and businesses to invest in rainwater collection systems, thus promoting widespread adoption and contributing to water conservation efforts.

Action 2: Develop and introduce water pricing policies - Selecting water pricing policies as a project idea for implementing rainwater collection from ground surfaces is crucial for enhancing water management and sustainability. Water pricing serves as an economic tool to promote efficient water use, fund infrastructure development, and encourage behavioural changes among water users. By integrating water pricing with rainwater collection strategies, policymakers can address water scarcity and improve water productivity, especially in agriculture, which is a major water consumer. This approach can lead to more sustainable water use and conservation practices.

Action 3: Provide capacity building, training incentives and research for development funding - Implementing rainwater collection from ground surfaces as an adaptation strategy in the water sector is crucial for addressing water scarcity and climate change challenges. Capacity building, training incentives, and research funding are essential components of this strategy, as they enhance the ability of local communities and institutions to effectively manage and utilize rainwater resources. These elements foster a sustainable approach to water management by empowering stakeholders with the necessary skills, knowledge, and resource.

Action 4: Promulgate land use regulations and zoning Policies - Promulgating land use regulations and zoning policies is crucial for implementing rainwater collection from ground surfaces as an adaptation strategy in the water sector. These regulations help manage urban development, mitigate flood risks, and enhance water ecosystem services. By strategically planning land use, authorities can ensure that rainwater collection systems are effectively integrated into urban infrastructure, thereby improving water management and reducing environmental impacts.

Gender issues

Implementing rainwater collection from ground surface activities can significantly contribute to achieving gender outcomes in the water sector by addressing various socio-economic and cultural barriers faced by women. This approach not only provides water security but also empowers women, enhances their social status, and promotes gender equity. For example, the technology minimizes the time and distance women and girls spend fetching water, allowing them more time for education and economic activities. This reduction in time burden can lead to improved educational opportunities for young girls, as they can attend school more regularly. The proximity of domestic water supply closer to home reduces the risk of sexual harassment and gender-based violence that women face when traveling long distances to fetch water. Thus, safe access to water and sanitation facilities also alleviates psychosocial stress among women (Adeyeye and Bello-Dambatta, 2024).

Finally, this technology has the potential to alleviate the additional work burdens women face in patriarchal structures, fostering equitable power relations. Furthermore, integrating gender perspectives into rainwater management can lead to tailored solutions that address the specific needs of women, ultimately promoting their active involvement in water management and enhancing their socio-economic status within communities.

2.1.4.4 Stakeholders and timeline for implementation of TAP

Overview of Stakeholders for the implementation of the TAP

Implementing rainwater collection from ground surfaces in the water sector involves a complex interplay of stakeholders, each with distinct roles and interests. Effective stakeholder analysis and mapping are crucial for successful implementation. This process involves identifying key players, understanding their influence, and aligning their interests with the project goals. The following is a stakeholder analysis and mapping for rainwater collection systems (Table 29).

Table 29. Stakeholders in the implementation of rainwater collection from ground surfaces

Stakeholder	Key roles
Local Government institutions	Act as context setters and are crucial for policy enforcement and resource allocation. Their motivation is often influenced by economic and social norms, which can either support or hinder implementation.
Technological Experts	Utilize tools like GIS and BIM to design and optimize rainwater harvesting systems, ensuring they are efficient and sustainable
Environmentalists and NGOs	Serve as advocates for sustainable practices and can help transform public opinion to support rainwater harvesting initiatives
Community Members	As end-users, their acceptance and participation are vital. Education and awareness campaigns can convert them into active supporters

The different stakeholders may have conflicting priorities, such as economic efficiency versus environmental sustainability, which can impede progress (Lee et al., 2024). In addition, technological barriers may obtain. For example, implementing advanced systems like GIS technical expertise and resources, which may not be readily available at sub-national levels.

While stakeholder analysis is essential for implementing rainwater collection systems, it is equally important to consider the broader socio-economic and environmental context. This includes addressing potential resistance from stakeholders with conflicting interests and ensuring that technological solutions are accessible and adaptable to local conditions.

Scheduling and sequencing of specific activities

Table 30 shows the scheduling and sequencing of specific activities

Table 30. Scheduling and sequencing of specific activities

Activity	Scale	Time									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1.1 Providing financial support through subsidies to offset the initial costs of installing rainwater collection systems, making them more economically feasible for individuals and businesses.	National	■	■	■	■	■					
1.2 Offer tax credits or deductions for investments in rainwater harvesting infrastructure to encourage private individuals and organizations to invest in these technologies.	National District	■	■	■	■	■	■	■	■	■	■
1.3 Establishing financial mechanisms offering low-interest loans for rainwater collection projects can make funding more accessible and affordable, facilitating widespread adoption	National	■	■	■	■	■					
2.1 Implement water pricing structures to reflect the true cost of water can create economic incentives for adopting rainwater collection technologies by highlighting potential cost savings.	National	■	■	■	■	■	■	■	■	■	■
2.2 Set collaborative platforms between public and private entities can attract private investment and expertise, supporting the implementation of rainwater collection projects.	National, district and local			■	■	■	■	■			
3.1 Offer incentives for training programs and capacity building in rainwater harvesting technologies. This can enhance the skills and knowledge of individuals involved in implementation.	National, District and local	■	■	■	■	■	■	■	■	■	■
3.2 Allocate funds for research and development in rainwater collection technologies can drive innovation, reduce costs, and improve overall economic viability.	Local	■	■	■	■	■	■	■	■		
3.3 Providing financial incentives for water utilities to integrate rainwater collection into their infrastructure can accelerate the adoption of these technologies in broader water management strategies.	Local				■	■	■	■	■		

Activity	Scale	Time									
		1	2	3	4	5	6	7	8	9	10
4.1 Advocate for land use regulations, zoning policies, and planning guidelines that recognize and accommodate rainwater harvesting installations as permissible land uses, land improvements, or accessory structures within residential, commercial, or industrial developments.	National										
4.2 Lobby for zoning code amendments, land use ordinances and permitting processes for landowners.	National										
4.3 Facilitate negotiation of easements, land leases, or land use agreements with landowners, property managers, or public agencies to secure access to land for rainwater collection purposes.	National										
4.4 Establish legal agreements that grant rights-of-way, access privileges, or land use permissions for installing, maintaining, and operating rainwater harvesting infrastructure on private or public lands, ensuring long-term land availability and security.	National										

Gender issues

Gender considerations in the implementation of rainwater collection from ground surfaces in the water sector are crucial for ensuring equitable access and participation. The integration of gender perspectives in water management can empower women, enhance their social status, and improve community water governance. However, challenges such as limited access to decision-making and the burden of water collection persist.

Two key aspects of how gender is accounted for in this context are critical. Firstly, rainwater harvesting initiatives have been shown to empower women by providing them with water and financial security, improving their social acceptance, and enabling them to become key sources of information on water issues in their communities. Experience has shown that (Sharma, 2017). Secondly, gender mainstreaming in water management often fails to alter existing power dynamics, as simply reserving seats for women in decision-making bodies does not change the status quo (Narain and Goodrich, 2024). Thus, women's limited access to decision-making processes and the burden of water collection are significant barriers to their active participation in water management initiatives (Yesubabu et al., 2024). Overall, a nuanced understanding of gender, considering the social and power differences between men and women, is necessary for effective policy and practice. This includes using gender-sensitive data and analytics to inform water management strategies (Narain & Goodrich, 2024). Therefore, innovative water solutions that incorporate gender-sensitive data can optimize water services and empower women to participate in technological development and decision-making.

Women often play a crucial role in water management, yet face significant barriers due to gender inequalities. These barriers include limited access to decision-making processes and the additional burden of water collection. Addressing these issues through gender-sensitive approaches can enhance the effectiveness of rainwater harvesting initiatives and promote gender equity. Women are pivotal in the education and utilization of rainwater, acting as agents of change within their communities. They are instrumental in teaching sustainable environmental practices and managing water resources at the family level. Despite their involvement, women often face challenges such as exclusion from decision-making processes and the burden of water collection, which exacerbates gender inequalities (Yesubabu et al., 2024). A socio-technical approach that combines water provision with women's empowerment has shown success in improving women's social status and financial security, although cost remains a barrier to wider community access (Adeyeye and Bello-Dambatta, 2024).

2.1.4.5 *Estimation of resources needed for action and activities*

Estimation of capacity building needs

Implementing rainwater collection from ground surfaces as a climate change adaptation strategy in the water sector requires comprehensive capacity building across several dimensions. This involves addressing legislative, financial, technical, societal, and governance needs to ensure effective and sustainable implementation. Firstly, establishing a comprehensive regulatory framework is crucial for the successful implementation of rainwater harvesting systems. This includes creating clear guidelines and standards for installation and operation (Peker and İlhan, 2023). To this effect, national legislation, must mandate rainwater harvesting systems and promote supportive legal structures to overcome implementation barriers. To effectively build capacity financial mechanisms are critical. Introducing financial incentives and pricing policies can encourage the adoption and this may involve subsidies, tax breaks, or grants to offset initial installation costs (Peker and İlhan, 2023). In the advent of climate change, investment in non-conventional water resources, including rainwater, is essential to address water scarcity and reduce community water conflicts (Ricart et al., 2021).

To enhance adoption and sustainability, technical standards and innovations are imperative. Developing technical standards for rainwater harvesting systems ensures their efficiency and safety. This includes guidelines for materials used in catchment areas to prevent contamination (Gabriela and Vladimir, 2022). Furthermore, innovations in water treatment technologies, such as solar disinfection, are necessary to make harvested rainwater safe for consumption, especially in rural areas lacking central water systems (Gabriela and Vladimir, 2022). Thus, promoting a cultural shift towards the acceptance and use of the technology H systems is vital. This involves public education and awareness campaigns to highlight the benefits of rainwater as a sustainable water source (Peker and İlhan, 2023). On the other hand, engaging local communities in decision-making processes can enhance the acceptance and effectiveness of RWH systems (Ricart et al., 2021).

Finally, governance and collaborative approaches are critical. Thus, establishing decentralized governance mechanisms that involve all stakeholders, including public and private sectors, is essential for the successful implementation of the rainwater harvesting systems (Peker and İlhan, 2023). Thus, multi-level learning and stakeholder involvement in governance can improve adaptation strategies and ensure the sustainability of water management practices (Gonzales-Iwanciw et al., 2021).

Estimations of costs of actions and activities

The economic viability of a rainwater harvesting system is situational (Ruiz Martínez and Tueros, 2022). In some areas it may not be feasible to implement this system given the going price of water, while in other places the technology is a cheaper source of water compared to national network water, bottled water or other water sources and its implementation proves to be economically feasible in various scenarios such as in residential buildings by saving potable water in schools, where at the same time students are encouraged to become aware of sustainability; in homes and residential buildings. In addition, it reduces greenhouse gas emissions by reducing energy consumption. As a proportion of the implementation expenses of the system, the cost of the tank represents from half (Ruiz Martínez and Tueros, 2022) to 95%, of the total cost (Anchan and Prasad, 2021) while maintenance e.g. replacement of materials may cost up to 50% of the total costs of implementation (Preeti and Rahman, 2021). Gado and El-Agha, 2020) recommend inclusion of recharge wells to increase groundwater performance as an economic solution.

The installation of rainwater collection systems involves significant upfront costs for equipment, storage tanks, and distribution infrastructure estimated at US$5 million for at least 20 installations. Ongoing maintenance and operation costs, including repairs and system upkeep, can strain budgets and hinder the economic viability of rainwater collection technologies and estimated costs are US$3 million.

Gender issues

Capacity building for gender-responsive rainwater collection from ground surfaces involves integrating gender considerations into the design, implementation, and management of rainwater harvesting systems. This approach not only addresses water scarcity but also empowers women and girls by reducing their burden of water collection and enhancing their socio-economic status. The implementation will deploy strategies for achieving gender-responsive capacity building in rainwater collection. The first of these is the empowerment through skill development where training women in technical skills related to rainwater harvesting will be conducted to break social barriers and increase their income. This approach provides women with roles as water agents enhancing their financial security and social acceptance. The second is to facilitate social and political participation. Thus, the strategy involves using the technology as a platform for women to participate in social and political life, contributing to family finances and community decision-making. Mainstreaming gender in this approach will improve health, income, and education, reducing vulnerability and enhancing women's capacity to cope with water scarcity. By decreasing the distance and time required for water collection, rainwater harvesting systems alleviate the physical and social burdens on women and girls, freeing time for education and domestic pursuits. The intention is to address gender-based violence and psychosocial stress associated with unsafe water collection by ensuring safe and accessible water sources (Adeyeye and Bello-Dambatta, 2024).

The gender analysis of budget lines and activities for implementing rainwater collection as a climate change adaptation strategy in the water sector reveals significant insights into how these initiatives can address gender disparities. Rainwater harvesting not only provides a sustainable water source but also empowers women by reducing their time burden and enhancing their social and economic roles. However, the integration of gender-responsive budgeting is crucial to ensure that these benefits are equitably distributed and that women can actively participate in water governance and policy-making.

Rainwater harvesting initiatives have been shown to empower women by reducing the time and distance they need to travel to fetch water, thus allowing them to engage more in social and political life and improve women's financial security and social status, (Adeyeye and Bello-Dambatta, 2024). Finally, gender-responsive budgeting is essential to address gender disparities in climate change adaptation. It ensures that fiscal policies and expenditures are analyzed from a gender perspective, which can mitigate gender-differentiated effects of climate change (Sikhosana et al., 2024).

2.1.4.6 Management planning

Risks and Contingency Planning

Implementing rainwater collection from ground surfaces for climate change in the water sector involves several risks and requires effective contingency plans. The primary risks include water quality issues, system design challenges, and climate variability impacts. Firstly, rainwater collected from ground surfaces can be contaminated with pathogenic microorganisms, making it unsafe for direct human consumption without treatment. This poses a significant public health risk, especially in rural areas where such systems are often implemented to meet basic needs (Gabriela & Vladimir, 2022). Secondly, designing an effective rainwater harvesting system requires careful consideration of local climate conditions and water demand and failure can lead to insufficient water supply, particularly in arid and semi-arid regions where water security is already low. Finally, changes in rainfall patterns due to climate change can affect the reliability of rainwater harvesting systems. This variability can lead to periods of both water scarcity and excess, complicating water management efforts.

In the light of the foregoing risks, contingency planning is imperative. Thus, implementing simple and cost-effective water treatment technologies, such as solar disinfection and filtration, can mitigate health risks associated with contaminated rainwater (Gabriela & Vladimir, 2022). Secondly, utilizing models to determine optimal tank sizes and system configurations can enhance water security. For instance, the Roof Model helps in designing systems that account for climate change impacts, ensuring a more reliable water supply (Kahinda et al., 2010).

Finally, combining rainwater harvesting with other water supply methods can provide a buffer against climate-induced variability, ensuring a more stable water supply (Jemberie and Melesse, 2021).

Next Steps

Implementing water harvesting from groundwater surfaces requires a strategic approach that considers both immediate requirements and critical steps for successful execution. The process involves selecting suitable sites, designing appropriate structures, and integrating advanced technologies to optimize water collection and storage. The following are immediate requirements and critical steps necessary for the successful implementation of a water harvesting project.

First, identifying suitable locations is crucial. This involves analyzing terrain, weather patterns, and water availability using geospatial technologies like GIS to ensure effective water infiltration and storage (Bhorkar et al., 2023). Thus, it is essential to engage professionals with expertise in water management, geospatial analysis, and hydraulic engineering to design and implement effective water harvesting structures (Mekdaschi and Liniger, 2013). Furthermore, involving local communities and stakeholders in the planning process ensures that the project meets local needs and gains community support.

Secondly, the following critical steps are critical for implantation. Develop detailed designs for water harvesting structures such as check dams, underground dams, and trapezoidal bunds, considering local climatic conditions and crop water requirements (Finkel, 2018). Thus, technology integration is necessary. For example, utilizing advanced modeling systems to simulate precipitation-runoff processes and optimize the design of water harvesting systems (Hamaideh et al., 2017). Finally, establish a robust monitoring system to assess the performance of water harvesting structures and make necessary adjustments to improve efficiency and sustainability (Saha et al., 2024).

Gender issues

The implementation of rainwater collection from ground surfaces is a significant opportunity to address gender issues. This approach not only provides water security but also empowers women by reducing their burden of water collection and enhancing their participation in water governance. However, challenges such as cost barriers and limited access to decision-making processes persist, necessitating a more integrated approach to fully realize gender equity in this context. Rainwater harvesting reduces the time and distance women and girls must travel to fetch water, thereby minimizing their exposure to risks such as harassment and violence.

Access to rainwater harvesting systems can mitigate health challenges by providing safer water sources, reducing the incidence of water-borne diseases among women and girls. Finally, engaging women in co-creating solutions through participatory methods helps tailor water management practices to their specific needs and challenges, fostering gender-responsive strategies.

2.1.4.7 Reporting

Table 31. Overview table

Sector	Water Resources							
Sub-sector	Water and Sanitation							
Technology	Rainwater collection from ground surfaces							
Ambition	At least 64 community council under the local government structure (≈48, 416 households) should have at least one major ground water harvesting infrastructure serving at least 25 percent of the households n in the community councils (290, 500 people). This will be augmented by roof water harvesting structures for at 50 percent of the households (24, 208 households).							
Benefits	Improves water access for irrigation, livestock drinking and domestic water uses							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame (yrs)	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity (US$)
Action 1	**Activity 1.1** Providing financial support through subsidies to offset the initial costs of installing rainwater collection systems, making them more economically feasible for individuals and businesses.	GoL	DWA Water Commission	0-10	Lack of funding	Number of subsidies issued	District databases	1.0 million
	Activity 1.2 Offer tax credits or deductions for investments in rainwater harvesting infrastructure to encourage private individuals and organizations to invest in these technologies.	GoL	Ministry of Finance	0-5	Lack of funding	Tax incentive regulations	Participatory development of protocol	0.1 million
	Activity 1.3 Establishing financial mechanisms offering low-interest loans for rainwater collection projects can make funding more accessible and affordable, facilitating widespread adoption	GoL	Ministry of Finance	0-3	Lack of funding	Loan protocols	Participatory preparation of list	0.1 million
Sub-Total for Action 1 Activities								**1.2 million**
Action 2	**Activity 2.1** Implement water pricing structures to reflect the true cost of water can create economic incentives for adopting rainwater collection technologies by highlighting potential cost savings.	GoL	Water Commission	0-5	Lack of policy	Regulatory framework	Coordination of water resource agencies	0.5 million

	Activity 2.2 Set collaborative platforms between public and private entities can attract private investment and expertise, supporting the implementation of rainwater collection projects.	GoL	Water Commission	0-5	Lack of commitment	Number of active platforms	Platform activity	0.1 million
Sub-Total for Action 2 Activities								**0.6 million**
Action 3.	**Activity 3.1** Offer incentives for training programs and capacity building in rainwater harvesting technologies can enhance the skills and knowledge of individuals involved in implementation.	GoL	DWA	0-10	Fiscal constraints	Budget increments	Budgetary annual targets met	0.5 million
	Activity 3.2 Allocate funds for research and development in rainwater collection technologies can drive innovation, reduce costs, and improve overall economic viability	GoL	Ministry of Finance and Development Planning	0-5	Lack of funding	Increased international funding	Signed funding agreements Research projects	2.0 million
	Activity 3.3 Providing financial incentives for water utilities to integrate rainwater collection into their infrastructure can accelerate the adoption of these technologies in broader water management strategies.	GoL	Ministry Finance and Development Planning	0-10	Lack of funding	Financial incentives in place	New incentive instruments	2.5 million
Sub-Total for Action 3 Activities								**5.0 million**
Action 4.	**Activity 4.**1 Advocate for land use regulations, zoning policies, and planning guidelines that recognize and accommodate rainwater harvesting installations as permissible land uses, land improvements, or accessory structures within residential, commercial, or industrial developments.	GoL	Local government	0-5	Lack of funding	Regulations adopted	Number of leases	0.1 million
	Activity 4.2 Lobby for zoning code amendments, land use ordinances and permitting processes for landowners.	GoL	Local government	0-10	Lack of funding	Zoning protocols	Areas zoned by law	1.5 million
	Activity 4.3 Facilitate negotiation of easements, land leases, or land use agreements with landowners, property managers, or public agencies to secure access to land for rainwater collection purposes.	GoL	Water Commission Local government	0-10	Lack of funding	Number of leases issued	Number of structures build	0.5 million
	Activity 4.4 Establish legal agreements that grant rights-of-way, access privileges, or land use permissions for installing, maintaining, and operating rainwater harvesting infrastructure on private or	GoL	Local government	0-10	Lack of funding	Number of permits issued	Leases issue	0.5 million

	public lands, ensuring long-term land availability and security.							
Sub-Total for Action 5 Activities								**2.6 million**
Grand Total								**9.4 million**

2.1.4.8 Tracking the implementation status of the TAP

Rationale, responsibility and content of TAP tracking

The national process for tracking the implementation of rainwater collection from groundwater surfaces envisions a structured approach that includes institutional responsibilities, timing, and specific information to be tracked. This process is essential to ensure the effective management and conservation of water resources, particularly in regions facing water scarcity. The integration of technology and standardized protocols play a crucial role in this process.

The institutional responsibility of the tracking falls within the domain of three categories of stakeholders. Firstly, government ministries, departments and water boards are responsible for setting guidelines and monitoring compliance with rainwater harvesting systems. Secondly, there will be interdisciplinary teams and resource specialists conducting evaluations to assess the implementation and effectiveness of rainwater harvesting systems. Thirdly, the role of local authorities is critical because local community councils and urban councils /municipalities are tasked with enforcing regulations and providing support for the installation and maintenance of systems.

The implementation will be phased over several fiscal years to allow for gradual adaptation and resource allocation during which regular monitoring will be carried out. Continuous monitoring is essential to track the performance and effectiveness of rainwater harvesting systems. The monitoring will track at least three aspects of the implementation process. Firstly, water quality is critical. Parameters such as microbiological and physico-chemical properties are monitored to ensure the safety and usability of collected rainwater. Secondly, system performance is crucial. Data on the implementation fidelity and effectiveness of systems are collected to identify trends and areas for improvement. Finally, the economic and social impact is necessary. Information on the cost-effectiveness and community acceptance of rainwater harvesting systems is gathered to guide future policy decisions.

While the proposed process provides a comprehensive framework for tracking rainwater collection implementation, challenges remain. Economic constraints and local regulations can significantly influence the degree of system implementation. Additionally, there is a need for more empirical data and research to enhance system efficacy and community acceptance, highlighting the importance of ongoing evaluation and adaptation.

Gender issues

Integrating gender-specific criteria and targets in the implementation of rainwater collection from ground surfaces is crucial for achieving both water security and gender equity. This involves addressing the unique challenges faced by women and ensuring their active participation in water management processes. The integration of gender-specific criteria can enhance the effectiveness of rainwater harvesting projects by ensuring that they are inclusive and equitable. Some gender-specific criteria and targets include a) minimizing Burden on Women and Girls. The project will seek to reduce the time and distance women and girls spend fetching water, which can be achieved by strategically placing rainwater collection systems closer to communities; b) addressing safety and violence. The project will ensure that rainwater collection sites are safe and free from gender-based violence. This includes community monitoring to prevent harassment; c) Ensuring empowerment and participation. The project will seek to empower women to participate in water governance and decision-making processes. This will be facilitated by training women as water agents and involving them in the planning and management of rainwater systems; d) Tracking gender-sensitive indicators. The project will develop and use gender-specific indicators for monitoring and evaluation to track progress and ensure that the needs of women are being met.

The project will also engage gender responsive implementation strategies such as a) Participatory Planning e.g. engaging women in the planning stages of rainwater projects ensures that their needs and perspectives are considered, leading to more effective and sustainable outcomes; b) Data Sharing and Analysis e.g. utilizing gender-sensitive data and analytics to improve the design and implementation of rainwater systems by highlighting gender disparities and informing targeted interventions; and c) Integrated Water Resource Management (IWRM) e.g. incorporating gender perspectives into IWRM to strengthen water management models by revealing gendered assumptions and ensuring diverse stakeholder engagement (Packett et al., 2020).

While integrating gender-specific criteria is essential, it is also important to recognize the broader context of water management. The inclusion of gender in water policies is often limited, and women are frequently seen as passive recipients rather than active participants. Addressing these systemic issues requires a shift in how gender is perceived and integrated into water management frameworks.

2.2 Project ideas for the Water Sector

2.2.1 Brief Summary of the Project Ideas for the Water Sector

The prioritized project ideas for adapting to climate change in the water sector—water reclamation, treatment and reuse, boreholes as a drought intervention, and rainwater collection from ground surfaces—each offer unique benefits and challenges. These interventions are crucial for enhancing water security and resilience in the face of climate change. They interact by collectively contributing to a more sustainable and efficient water management system, addressing both immediate and long-term water needs. For instance, water reclamation and reuse are vital for mitigating water scarcity and enhancing water resource management. This approach is increasingly important globally, with advancements in reuse regulations and risk management playing a significant role in its implementation. Successful reuse of treated water for agriculture, significantly improving water-use efficiency and food production and also contributes to reducing greenhouse gas emissions and is integrated into urban and industrial applications. Boreholes on the other hand provide a reliable water source during droughts, particularly in regions with limited surface water availability. They are thus, essential for maintaining water supply in arid and semi-arid areas. The use of boreholes can be part of a broader strategy that includes water savings and reuse to address climate change impacts. Rainwater harvesting is a strategic solution for enhancing water availability, especially in arid ecosystems. It supports agro-pastoral systems by increasing soil moisture and groundwater recharge. Suitability mapping for rainwater harvesting interventions can optimize the use of rainwater runoff, promoting drought tolerance and ecosystem resilience.

While these interventions are promising, they must be integrated into a coherent strategy that considers economic, social, and environmental factors. Challenges such as installation failures, economic viability, and the need for capacity building must be addressed to ensure their sustainability and effectiveness.

2.2.2 Project idea for water reclamation, treatment and reuse

Background

Water reclamation, treatment, and reuse technology projects are essential components of modern water management strategies, particularly in regions facing water scarcity such as the southern lowlands of Lesotho and the Senqu River Valley. The technology involves the processing of wastewater to produce water suitable for various applications, such as agricultural irrigation, industrial processes, and even potable water supplies.

Objectives

The goal of these projects is to augment water supplies, reduce the burden on freshwater resources, and promote sustainable water use. The specific objectives are:

Measurable outputs

- **Water Quality Improvement**: The effectiveness of treatment technologies is measured by the quality of the reclaimed water, which must meet specific standards for its intended use
- **Volume of Reclaimed Water**: The amount of water reclaimed and reused is a critical metric, indicating the project's impact on water supply augmentation
- **Cost Savings**: Economic analyses often measure the cost savings achieved through reduced water procurement and treatment costs
- **Environmental Impact**: Metrics such as reduced pollutant loads and improved ecosystem health are used to assess environmental benefits.

Relationship to the country’s sustainable development goals

Water reclamation and treatment technologies support SDG 6, which aims to ensure availability and sustainable management of water and sanitation for all and is aligned to the Lesotho Water and Sanitation Policy of 2007. By treating wastewater, these technologies reduce pollution and improve water quality, directly contributing to this goal. The technology also contributes to SDG 12, which focuses on responsible consumption and production, by promoting the reuse of water and reducing the demand for freshwater resources.

Reclaimed water can be used for agricultural irrigation, industrial processes, and even potable purposes, reducing the strain on freshwater resources and providing economic benefits through cost savings and resource efficiency. This is aligned to the Food Security Policy of 2005, the Climate Smart Agriculture Investment Plan of 2018 and the draft National Irrigation Policy of 2022. The implementation of modern wastewater treatment technologies can lead to significant environmental benefits, such as reduced pollution and improved ecosystem health, which are crucial for sustainable development.

Key Deliverables

- **Water Security and Sustainability:** Reclaimed water provides a reliable water source, reducing dependency on freshwater resources and mitigating the impacts of climate change and population growth on water availability.
- **Economic Benefits**: Reuse of treated water can subsidize costs in agriculture and industry, offering a cost-effective solution for irrigation and industrial processes.
- **Environmental Protection:** By treating and reusing wastewater, water pollution is reduced, contributing to healthier ecosystems and improved public healt

Water reclamation is vital for sustainable water management, especially in regions facing severe water scarcity. It supports the circular economy by recycling water resources, thus reducing dependency on freshwater sources and mitigating the impacts of climate change. However, challenges such as public acceptance and infrastructural costs must be addressed to fully realize its potential.

Project scope and possible implementation

The scope of these technologies is broad, encompassing various treatment processes and applications across different sectors. The feasibility of these technologies is influenced by factors such as cost, public perception, and regulatory frameworks.

Project activities

a) **Identification of Water Sources:** Wastewater can originate from diverse sources such as domestic sewage, agricultural runoff, and industrial effluents, each with unique pollutant profiles. Understanding the source is crucial for designing appropriate treatment strategies tailored to the specific contaminants present.

b) **Treatment Technologies:** Treatment processes are typically divided into primary, secondary, and tertiary stages, with advanced technologies like membrane bioreactors and reverse osmosis being employed for high-quality water production. Modern treatment technologies focus on energy efficiency and the removal of emerging contaminants, ensuring the reclaimed water meets the required quality standards for its intended use.

c) **Regulatory Frameworks:** Different regions have established specific guidelines and regulations for water reuse, although a universal standard is lacking. Compliance with these regulations is essential to ensure the sanitary and environmental safety of the reclaimed water.

d) **Reuse Applications:** Reclaimed water can be used for agricultural irrigation, industrial processes, groundwater recharge, and even potable water supplies. The choice of application depends on the quality of the treated water and the specific needs of the region.

Timeline: 10 years

***Budget*:**

Implementing a rainwater collection system from ground surfaces involves several key resource requirements, including materials, infrastructure, operational and maintenance considerations. The total is estimated at US$10 million.

Evaluation

Accomplishment in a water reclamation, treatment, and reuse project can be evaluated through specific metrics such as the volume of water reclaimed, the quality of treated water meeting regulatory standards, and the extent of water reuse in designated applications. Success can also be measured by assessing the project's impact on freshwater resource conservation, cost-effectiveness, public health outcomes, and environmental benefits. Additionally, stakeholder satisfaction and compliance with national and international guidelines will serve as critical indicators of the project's overall effectiveness and sustainability.

Possible challenges

Implementing water reclamation, treatment, and reuse projects faces several challenges, including irregular availability of financial resources, a shortage of skilled personnel for planning, design, and operation, and the lack of effective implementation agencies. Additionally, inadequate institutional structures and the absence of supportive government policies can hinder progress. Societal acceptance is also a critical factor, as public perception can significantly impact the success of these projects. Addressing these challenges is essential for the effective adoption of new technologies in water and wastewater treatment.

Responsibilities and coordination

- **Specialists**: These are technical experts responsible for designing and implementing the water treatment technologies. They ensure that the systems meet the required standards for water quality and safety
- **Continuity Providers**: These stakeholders maintain the ongoing operation and management of the water reuse systems, ensuring reliability and efficiency over time.
- **Program Champions**: Individuals or groups who advocate for the project, securing funding, and support from the community and policymakers.
- **Conveners**: They facilitate collaboration among various stakeholders, including government agencies, private sector partners, and the community, to ensure cohesive project implementation

2.2.3 Project idea for boreholes as drought interventions for domestic water supply

Background

Boreholes serve as a critical intervention for drought relief and climate change adaptation, particularly in regions where water scarcity is exacerbated by climate variability. They provide a reliable source of groundwater, which can be essential for sustaining communities during prolonged dry periods. The implementation of boreholes as a climate adaptation strategy involves several objectives and measurable outputs to ensure their effectiveness and sustainability.

Objectives

- To increase the number of boreholes in drought-prone areas.

- To ensure the equitable distribution of water to vulnerable households during droughts.
- To build community capacity for borehole maintenance and management.

Measurable outputs

- **Water Quality Indicators**: Regular monitoring of chemical and physical parameters, such as salinity and temperature, to assess and maintain water quality.
- **Borehole Yield and Efficiency**: Measurement of water yield from boreholes to evaluate the success of siting and drilling strategies, ensuring that the boreholes meet community water needs.
- **Community Impact**: Assessment of the socio-economic benefits, such as reduced time and energy spent on water collection, and the role of boreholes in alleviating poverty traps in drought-affected areas.

Relationship to the country's sustainable development goals

Boreholes serve as a critical drought intervention technology by providing a reliable source of clean water, which aligns with sustainable development priorities such as ensuring availability and sustainable management of water resources. The implementation of an efficient water management system for boreholes enhances community resilience against water scarcity, directly supporting the mission of improving public health and reducing waterborne diseases. They provide essential water resources in areas where traditional water supply systems are inadequate, thus supporting the achievement of SDGs, particularly SDG 6, which aims to ensure availability and sustainable management of water and sanitation for all. Boreholes contribute to sustainable development by enhancing water accessibility, promoting community-based resource management, and supporting poverty reduction efforts.

Key Deliverables

- **Increased Access to Water**: Boreholes provide a reliable source of water in areas where traditional water sources are insufficient or unavailable.
- **Improved Drought Resilience**: Boreholes, especially when motorized, enhance resilience to drought by providing a consistent water supply.

- **Community Engagement and Accountability**: Effective borehole management systems, such as those powered by solar energy can improve water quality and system maintenance, fostering community ownership and accountability.

The overall importance lies in its capacity to provide reliable access to safe water, thereby mitigating the impacts of drought emergencies, reducing vulnerability, and fostering community resilience in arid regions, ultimately enhancing public health and economic stability.

Project scope and possible implementation

Borehole technologies, particularly those equipped with handpumps, demonstrate significant potential as a drought intervention for domestic water supply in rural areas, as evidenced by their reliability during the El Nino 2015/2016 drought in northern Ethiopia (MacDonald et al., 2019). They consistently recover water levels quickly, maintaining performance even under extended dry conditions, unlike springs and hand-dug wells. The feasibility of implementing boreholes is high, especially in suitable aquifer conditions, making them a strategic choice for enhancing community resilience to drought and ensuring secure drinking water access.

Project activities

- **Site Assessment and Selection:** Conduct hydrogeological surveys to identify suitable sites for borehole drilling; Prioritize locations based on water needs, population density, and aquifer viability.
- **Community Engagement and Mobilization:** Conduct community awareness campaigns on the benefits of boreholes and the importance of groundwater conservation; Form water user committees to manage and oversee borehole use and maintenance.
- **Borehole Drilling and Installation:** Procure drilling equipment and hire specialized contractors; Drill boreholes and install pumping systems, including solar-powered options where feasible; Construct water storage facilities to ensure stable water supply during peak demand periods.
- **Capacity Building and Training**: Train local communities on borehole maintenance, water quality testing, and efficient water use practices; Develop guidelines for borehole management and establish a community-based monitoring system.

- **Monitoring and Evaluation:** Implement a monitoring framework to assess the functionality of boreholes and water quality; Regularly evaluate the project's impact on water accessibility and household resilience to drought.

Timeline: 10 years

Budget

The budget will include costs for hydrogeological surveys, drilling equipment, installation of pumps and storage facilities, community training, and monitoring. The estimated budget is US$24.5 million.

Evaluation

Accomplishment for a borehole technology as a drought intervention project will be evaluated through community participation in routine maintenance activities, as higher engagement correlates with sustainable maintenance outcomes. Success will be measured by the operational longevity of the boreholes, frequency of maintenance activities, and the quality of water supplied. Statistical analysis can be employed to assess differences in maintenance effectiveness across various projects, with specific metrics like user satisfaction and water availability also serving as indicators of project success.

Possible challenges

The implementation of borehole technologies as drought interventions for domestic water supply can face challenges such as inadequate community engagement, leading to poor maintenance and operation practices. Additionally, factors like the distance to water points can hinder access, while the availability of spare parts for repairs can affect sustainability. Payment modalities may also complicate user commitment to the system. Furthermore, insufficient annual maintenance can exacerbate the decline in water supply reliability, ultimately impacting the overall effectiveness of borehole projects in drought-prone areas.

Responsibility and coordination

- **Government Agencies:** Provide technical support, policy guidance, and funding.
- **Community-Based Organizations (CBOs):** Mobilize communities and manage local-level implementation.

- **Non-Governmental Organizations (NGOs):** Offer expertise in water resource management and capacity-building.
- **Private Sector:** Engage in drilling operations, equipment supply, and innovative water solutions.

2.2.4 Project idea for rainwater collection from ground surfaces

Background

Rainwater collection from ground surfaces is a crucial technology for climate change adaptation, addressing water scarcity exacerbated by changing weather patterns. This method involves capturing rainwater that falls on reinforced ground surfaces, such as driveways or paths, and storing it for various uses. The technology not only provides an alternative water source but also helps manage water runoff, reducing urban flooding risks. The main objectives of this technology include enhancing water supply, reducing carbon emissions, and promoting sustainable water management practices. The measurable outputs focus on water collection efficiency, carbon footprint reduction, and the system's impact on local water availability.

Objectives

- **Enhancing Water Supply:** The primary objective is to increase the availability of water for domestic and agricultural use, especially in areas lacking access to centralized water systems. This is achieved by capturing and storing rainwater efficiently.
- **Reducing Carbon Emissions:** Implementing rainwater collection systems can significantly lower carbon emissions compared to traditional water supply methods. For instance, the drain collecting system has been shown to reduce CO_2 emissions by over 87% compared to other systems (Woon et al., 2018).
- **Enhancing ground water recharge:** By integrating rainwater harvesting with infiltration wells optimize water resources and replenish groundwater, contributing to sustainable water management.
- Reducing surface runoff

Measurable Outputs

- **Water Quality Improvement**: The effectiveness of treatment technologies is measured by the quality of the reclaimed water, which must meet specific standards for its intended use.
- **Volume of Reclaimed Water**: The amount of water reclaimed and reused is a critical metric, indicating the project's impact on water supply augmentation.
- **Cost Savings**: Economic analyses often measure the cost savings achieved through reduced water procurement and treatment costs.
- **Environmental Impact**: Metrics such as reduced pollutant loads and improved ecosystem health are used to assess environmental benefits.

Relationship to the country's sustainable development goals

Rainwater harvesting from ground surfaces plays a significant role in advancing Lesotho's sustainable development goals (SDGs), particularly in the context of water security (Lesotho Water Policy and Sanitation Policy of 2007), economic development (National Strategic Development Plan II), and climate adaptation (National Climate Change Policy, 2017). Lesotho's abundant water resources, present a unique opportunity to leverage rainwater harvesting for sustainable development. This practice aligns with several SDGs, including clean water and sanitation, gender equality, and climate action.

Firstly, Lesotho's water resources are crucial for economic development and can be harnessed through rainwater harvesting to improve water security and support economic activities such as agriculture and virtual water trade (Mahlakeng, 2023). Secondly, it can mitigate water scarcity issues, ensuring a reliable water supply for domestic, agricultural, and industrial use, which is essential for sustainable economic growth (Abraham and Priyadarshini, 2024).

Thirdly, it will potentially empower women by reducing the time and effort required to fetch water, thereby promoting gender equity and enabling women to participate more actively in economic and social activities especially enhancing their social status and contributing to gender equality, a key SDG (Adeyeye and Bello-Dambatta, 2024).

Fourthly, the technology promotes climate adaptation and resilience for smallholder farmers in Lesotho, helping them cope with climate variability and change, such as erratic rainfall and droughts (Dick-Sagoe et al., 2022). This is aligned to the Food Security Policy of 2005, the

Climate Smart Agriculture Investment Plan of 2018 and the draft National Irrigation Policy of 2022).

Key Deliverables

- **Enhancing Water Security:** Rainwater harvesting provides a clean and fluoride-free alternative to contaminated groundwater.
- **Mitigating Water Scarcity**: By capturing rainwater, communities can reduce reliance on over-exploited groundwater resources, thus addressing water scarcity issues.
- **Promoting Environmental Sustainability:** Harvested rainwater can be used to recharge aquifers, which helps in maintaining groundwater levels and preventing depletion.
- **Reducing Flooding and Erosion:** Properly managed rainwater harvesting systems can minimize soil erosion and reduce the risk of flooding by controlling surface runoff.
- **Supporting Socio-Economic Development:** Rainwater harvesting initiatives can empower women and marginalized groups by providing them with water security and opportunities for participation in water governance.
- **Agricultural Benefits:** In regions with permeable duplex soils, rainwater harvesting can improve agricultural productivity by providing a reliable water source for irrigation.

Project scope and possible implementation

The scope of these technologies is broad, encompassing various treatment processes and applications across different sectors. The feasibility of these technologies is influenced by factors such as cost, public perception, and regulatory frameworks.

Project activities

a) **Identification of Water Sources:** Wastewater can originate from diverse sources such as domestic sewage, agricultural runoff, and industrial effluents, each with unique pollutant profiles. Understanding the source is crucial for designing appropriate treatment strategies tailored to the specific contaminants present.

b) **Treatment Technologies:** Treatment processes are typically divided into primary, secondary, and tertiary stages, with advanced technologies like membrane bioreactors and reverse osmosis being employed for high-quality water production. Modern treatment technologies focus on energy efficiency and the removal of emerging contaminants, ensuring the reclaimed water meets the required quality standards for its intended use.

c) **Regulatory Frameworks:** Different regions have established specific guidelines and regulations for water reuse, although a universal standard is lacking. Compliance with these regulations is essential to ensure the sanitary and environmental safety of the reclaimed water.

d) **Reuse Applications:** Reclaimed water can be used for agricultural irrigation, industrial processes, groundwater recharge, and even potable water supplies. The choice of application depends on the quality of the treated water and the specific needs of the region.

***Timeline* -** 10 years

Budget

Implementing a rainwater collection system from ground surfaces involves several key resource requirements, including materials, infrastructure, operational and maintenance considerations. The total estimated budget is US$9.4 million

Performance evaluation

Accomplishment in a water reclamation, treatment, and reuse project can be evaluated through specific metrics such as the volume of water reclaimed, the quality of treated water meeting regulatory standards, and the extent of water reuse in designated applications. Success can also be measured by assessing the project's impact on freshwater resource conservation, cost-effectiveness, public health outcomes, and environmental benefits. Additionally, stakeholder satisfaction and compliance with national and international guidelines will serve as critical indicators of the project's overall effectiveness and sustainability.

Possible challenges

Implementing water reclamation, treatment, and reuse projects faces several challenges, including irregular availability of financial resources, a shortage of skilled personnel for planning, design, and operation, and the lack of effective implementation agencies. Additionally, inadequate institutional structures and the absence of supportive government policies can hinder progress. Societal acceptance is also a critical factor, as public perception can significantly impact the success of these projects. Addressing these challenges is essential for the effective adoption of new technologies in water and wastewater treatment.

Responsibilities and coordination

- **Specialists:** These are technical experts responsible for designing and implementing water treatment technologies. They ensure that the systems meet the required standards for water quality and safety
- **Continuity Providers:** These stakeholders maintain the ongoing operation and management of the water reuse systems, ensuring reliability and efficiency over time.
- **Program Champions:** Individuals or groups who advocate for the project, securing funding, and support from the community and policymakers.
- **Conveners:** They facilitate collaboration among various stakeholders, including government agencies, private sector partners, and the community, to ensure cohesive project implementation.

Chapter 3 Cross-Cutting Issues

There are two key sectors in this report i.e. agriculture and water. Two technologies were selected in the agriculture sector being decentralized community based early warning systems and conservation agriculture. In the water sector, on the other hand, three technologies were prioritized i.e. boreholes as drought intervention for domestic water supply, water harvesting from ground water surfaces and water reclamation, treatment and reuse. Cross-cutting issues are challenges or themes that affect multiple sectors and can influence the success or implementation of technologies across those sectors. In the context of the agriculture and water sector technologies prioritized, several cross-cutting issues arise. The following are most relevant in the Lesotho adaptation discourse hence addressing these cross-cutting issues can help ensure the successful implementation and sustainability of the technologies in both the agriculture and water sectors.

a) Climate Change and Environmental Sustainability

The impact of climate change is significant on both agriculture and water resources. In agriculture, it can influence the effectiveness of conservation practices and EWS by altering weather patterns and increasing the frequency of extreme events. Furthermore, changing weather patterns can affect crop yields and the reliability of EWS. In the water sector, climate change can exacerbate water scarcity, affecting the availability and quality of groundwater for boreholes, water harvesting, and reclamation projects. Thus, both sectors need to adopt climate-resilient strategies and sustainable resource management practices to mitigate and adapt to these impacts.

b) Resource Management and Sustainability

Sustainable use of natural resources is critical for both sectors. In agriculture, conservation practices must ensure long-term soil health and productivity. In the water sector, over-extraction of groundwater (e.g., through boreholes) can lead to depletion of water tables, while improper water reclamation and reuse might lead to environmental degradation. Therefore, sustainable management of groundwater resources is essential to prevent depletion and ensure the availability of water for reclamation and reuse. Thus, integrated resource management approaches should be promoted to ensure the sustainable use of water and land resources across both sectors ensuring that the use of water for agricultural and domestic purposes does not compromise future availability.

c) Community Engagement and Capacity Building

The success of DCEWS and water management technologies depends on local community engagement and capacity building. Without community buy-in and understanding, these technologies may not be effectively utilized or maintained. Thus, the success of all selected technologies depends on active community involvement and capacity building. Communities need to be educated and empowered to manage these technologies effectively. Consequently, cross-sectoral efforts should focus on training, awareness programs, and capacity building to ensure communities are well-equipped to implement and maintain these technologies.

d) Policy and Governance

Effective policies and governance structures are crucial for the successful implementation of these technologies. This includes regulations on water rights, land use, and resource management that support both agriculture and water sector initiatives. Thus, coordinated policy frameworks are necessary to align agricultural and water sector goals, ensuring that technologies are implemented in a way that benefits both sectors in order to support and enhance the water, food and energy nexus.

e) Economic and Financial Constraints

The cost of implementing and maintaining these technologies can be a significant barrier. This includes the financial resources required for installing boreholes, water reclamation systems, and technological support to conservation agriculture practices. Identifying funding sources, subsidies, and cost-sharing mechanisms will be critical to overcoming financial constraints and ensuring the long-term viability of these technologies.

f) Technological Integration and Innovation

Integrating technologies across sectors can create synergies that enhance the effectiveness of each technology. For example, data from EWS can inform water management practices, and conservation agriculture can reduce water demand, thereby benefiting water reclamation efforts. Thus, promoting innovation and the integration of technologies across the agriculture and water sectors can lead to more efficient and effective solutions.

g) Infrastructure Development

Strategic and adequate infrastructure is necessary to support the implementation of these technologies. For instance, water harvesting and reclamation require proper storage and distribution systems, while conservation agriculture may require specific tools and equipment. Cross-sectoral planning should ensure that infrastructure development meets the needs of both agriculture and water sectors.

h) Gender and Social Inclusion

Social dynamics, including gender roles, can influence access to and control over resources in both sectors. Women, who are often central to agricultural labour and water collection, may be disproportionately affected by the availability and effectiveness of these technologies. Thus, ensuring that technologies are designed and implemented with a focus on inclusivity can help address social disparities and improve overall effectiveness.

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