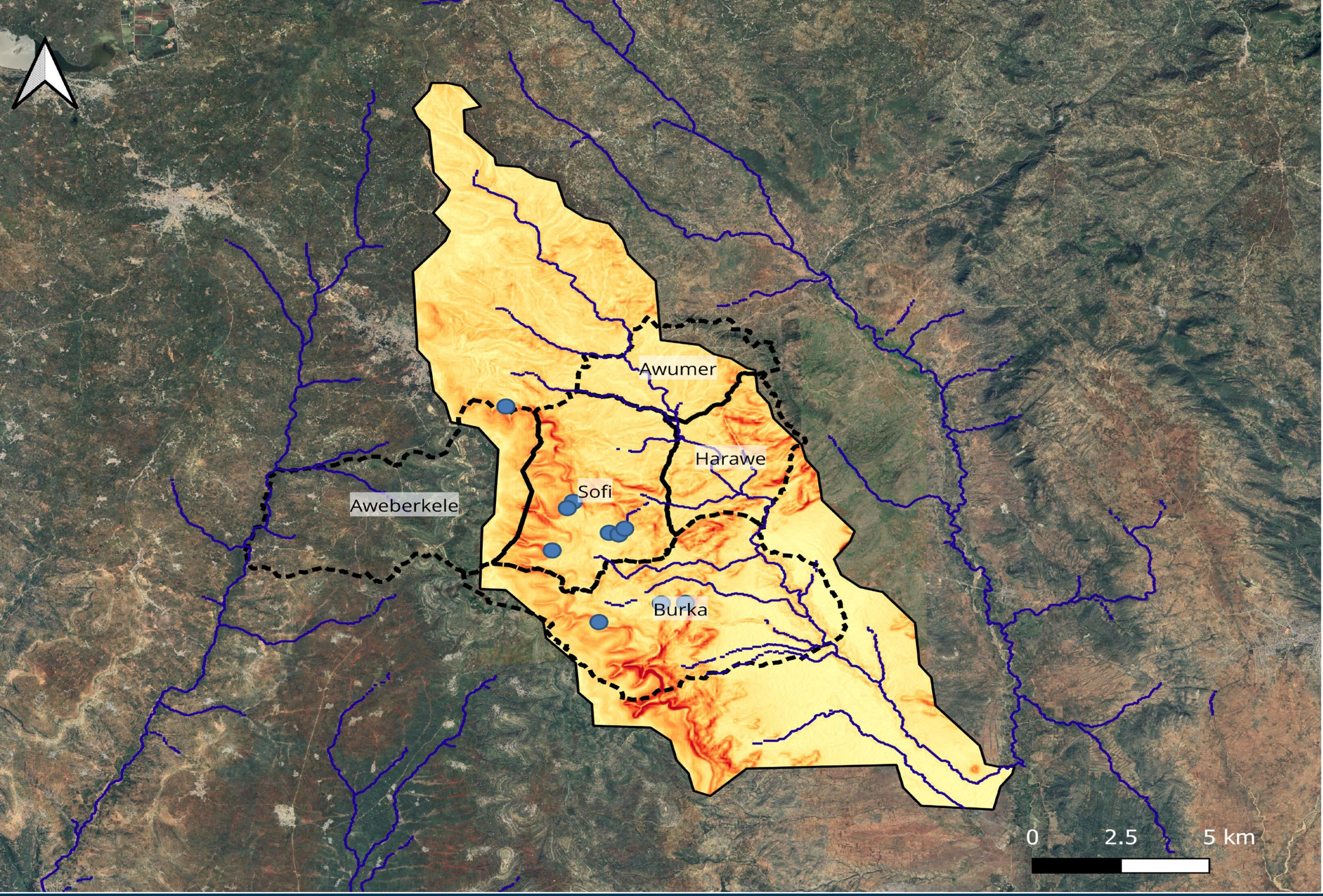

Burqaa Phase II

Catchment Management Guideline Harar-Hakim Gara Catchment

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Executive summary

The BURQAA Initiative Phase I significantly advanced water balancing and socio-economic improvement in the Upper Dabena and Hakim Gara sub-watersheds. The project aimed to compensate for the water consumption of the Bedele and Harar Breweries by implementing soil and water conservation measures that restored degraded lands and improved water retention. These efforts yielded positive results, achieving and even exceeding water-saving targets in the Bedele area while enhancing the local environment and community well-being. Building on this success, the project resumes activities under BURQAA Phase II, expanding focus to the targeted kebeles to further support effective catchment management.

This catchment management guideline aims to enhance water resource management and improve the livelihoods of local communities. Its primary objectives include increasing water retention and availability, improving water quality, minimizing soil loss, boosting agricultural productivity, and fostering cooperation among local government sectors. The guideline outlines a comprehensive implementation framework that encompasses institutional arrangements, capacity-building initiatives, stakeholder collaboration, and risk management strategies. It promotes active community participation in decision-making processes and intervention implementation, facilitating water balancing and livelihood activities. The catchment management plan details the objectives, management strategies, action plans, and monitoring and evaluation processes to ensure sustainable water management and environmental conservation.

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3R	Recharge, Retention and Reuse
BCM	Billion Cubic Metre
BI	BURQAA initiative
CBO	Community Based Organization
MERL	Monitoring, Evaluation, and Learning
NDVI	Normalized Difference Vegetation Index
SWC	Soil and Water Conservation

1 Introduction

1.1 Background

In Ethiopia, water scarcity, land degradation, and the impacts of climate change pose significant challenges, particularly in rural areas where agriculture and community livelihoods are closely tied to natural resources. To address these challenges, localized and practical solutions are essential. Catchment management, which focuses on managing the land and water resources within a specific watershed area, is one such approach that can play a vital role in improving water availability, restoring ecosystems, and enhancing community resilience.

The BURQAA Initiative Phase I, implemented between July 2020 and June 2023, took a significant step in this direction. It aimed to balance water use in the Upper Dabena and Hakim Gara sub-watersheds by compensating for the water consumption of the Bedele and Harar Breweries. Through soil and water conservation measures, degraded lands were restored, and water retention was improved, benefiting both the local environment and community. The project saw positive results, achieving nearly 100% of its water-saving targets in the Bedele area and even exceeding expectations in Harar.

Building on this success, the BURQAA Initiative (BI) Phase II expands these efforts to new areas while focusing on ensuring long-term sustainability. A key element of this phase is the development of a Catchment Management Guideline that is simple, practical, and specifically designed for small-scale implementation at the community level. This guideline will serve as a hands-on tool for local experts to carry out effective catchment management in ways that are directly applicable to the needs of their communities.

1.2 The Need for a Community-Based Catchment Management Guideline

This Catchment Management Guideline provides a straightforward, actionable framework for managing catchments on a small scale. Unlike larger, more complex plans, this guideline is tailored to be easily implemented by local woreda (district) and kebele (community) experts. It focuses on practical, low-cost, and community-driven interventions that can be adopted quickly and effectively by the people living within these catchment areas.

It is designed to be a user-friendly document that offers clear instructions for local actors, including government officials, community groups, and private sector stakeholders, enabling them to carry out sustainable land and water management activities. The guideline draws on the successes and lessons from BURQAA Phase I, ensuring that best practices are scaled up while addressing the unique challenges of the Upper Dabena and Hakim Gara sub-watersheds.

1.3 Purpose and Scope of the Catchment Management Guideline

The purpose of this guideline is to provide a practical, step-by-step framework for effective catchment management at the community level. It aims to empower local experts with the tools and knowledge needed to implement small-scale interventions that improve water availability, restore degraded lands, and enhance the resilience of local ecosystems and livelihoods.

The scope of the guideline includes:

- Practical Water Management Interventions: Simple techniques for enhancing water retention and availability, designed to be implemented with limited resources.
- Soil and Water Conservation: Low-cost measures such as tree planting, check dam construction, and soil bunds construction, which can be easily adopted by communities.
- Community Participation: Emphasis on involving local residents in planning and implementing catchment management activities, ensuring ownership and sustainability.
- Monitoring and Reporting: Basic tools and methods for tracking progress and ensuring accountability, accessible to woreda and kebele-level experts.

This guideline is not a comprehensive catchment management plan, but rather a straightforward tool that offers practical guidance for immediate, small-scale actions. It builds on local knowledge and the experiences of BURQAA Phase I to create simple, implementable solutions for enhancing water security and restoring ecosystems in the project areas.
By providing this resource, the project aims to support local stakeholders in taking a leading role in managing their natural resources, with the ultimate goal of improving both environmental outcomes and community well-being.

2 Catchment Description and Assessment

This section provides a comprehensive overview of the Hakim Gara catchment characteristics, focusing on the assessments conducted during the BURQAA initiative's first phase and the baseline evaluation for its second phase. This chapter aims to highlight the significant challenges faced in this catchment, particularly concerning water scarcity, land degradation, and agricultural practices. A more comprehensive overview is given in Mulugeta et al. (2024),the study conducted during the baseline assessment..

2.1 Catchment Characteristics

Understanding the functioning of the Hakim Gara catchment area is vital for effective water management and resource allocation. This section provides a comprehensive overview of the physical characteristics, hydrology and water resources, land use and land cover, and socio-economic aspects of the catchment, highlighting the interconnectedness of these components and their implications for sustainable water management.

2.1.1 Physical Characteristics

The physical characteristics of the Hakim Gara catchment are derived from a combination of primary and secondary data collection, including literature reviews, existing reports, and satellite remote sensing analysis, supplemented by expert observations in the field. The Harerghe Highlands, located in the eastern part of Ethiopia, are characterized by rugged topography and mountainous landscapes that significantly influence regional geomorphology, soil sequences, ecological zones, and the quantity and quality of plant and animal life (Tamire H., 1981).

In the Hakim Gara catchment, the slope varies significantly, ranging from a minimum of 12% to a maximum of 48% (Mulugeta et al., 2024). The catchment area is dominated by the Hakim Gara plateau, extending from Harar town to Erer, where several springs emerge at the foot of the plateau. The plateau chain stretches for several kilometres, contributing to the drainage flow in the Awumer and Harawe kebeles from opposite sides of the Hakim Gara plateaus.

2.1.2 Hydrology and Water Resources

Surface Water

The Harar project site is situated within the Shebelle River Basin, positioned on the water divide between the Wadi Erer watershed to the east and the Wadi Gobele watershed to the west (Acacia Water & MS Consultancy, 2015a). The perennial surface water sources in Harar town and its surrounding areas originate from a few springs emerging from the foot of the Hakim Gara plateau. Four major springs are present, with discharges varying from less than 2 L/s during dry seasons to over 100 L/s in the rainy season (source: Prefeasibility Report Harar Water Supply, 2023). Among these springs, the Sofi, Awubarkale, and Burqaa springs are located at the foot of the Hakim Gara plateau. Unfortunately, during dry seasons, their discharge is insufficient to meet the demands of the Harar town community, limiting usage primarily to residents living nearby and a local brewery.

Ground water

The lithology around Harar Town predominantly consists of high-grade metamorphic rock, which has low groundwater storage and transmission capabilities. Limited sources of groundwater, primarily Mesozoic sandstone and limestone are found at higher elevations. Water supply for groundwater is primarily sourced from the Haseliso and Erer well fields. Farmers have dug several hundreds of hand-dug wells that are wide, unlined, and shallow for small-scale irrigation, making small farmers the main users of groundwater resources in this basin.

Springs

The springs Awurbekele, Sofi, and Burqaa, located at the foot of the Hakim Gara plateau, serve the local community. These springs fulfil domestic water demand and supply water for livestock. During the rainy season, the volume of water from the springs increases due to rainfall percolation, enhancing their water resource availability. Several discharge sampling assessments were conducted during the BURQAA Phase I and in newly added kebeles during Phase II.

2.1.3 Land Use and Land Cover

The land cover in the Harar target area is classified into five categories, with shrublands representing the largest proportion, followed by croplands and grasslands. Built-up areas and open tree cover constitute smaller proportions of the total land use and cover. The areas with high erosion vulnerability on the Hakim Gara plateaus are predominantly covered with shrublands, while lowland intervention sites are primarily dedicated to crop cultivation.

The agricultural practices in the Hakim Gara catchment are largely rainfed and heavily influenced by the limited application of fertilizers, particularly when compared to other agricultural regions in Ethiopia, especially the Ethiopian Highlands. According to Hurni et al. (2015), the net erosion or deposition at the woreda level is estimated to range from 5 to 30 tons per hectare (t/ha). The construction of additional conservation structures on croplands with slopes greater than 8% has the potential to reduce soil erosion rates by 30% to 40%. In the target area, runoff from Harar city drains southeast toward the kebeles, where farmers cultivate a variety of crops, including food crops such as maize and sorghum, as well as cash crops like chat. This combination of land use practices reflects the interconnectedness of ecological conditions, agricultural activities, and water resource management in the Hakim Gara catchment.

2.1.4 Socio-economic Aspects

Agriculture serves as the primary source of income in the Hakim Gara catchment, particularly in rural areas. As of 2022, approximately 85% of the rural population is engaged in the agricultural sector. A thorough socio-economic baseline assessment revealed that agriculture is widely practiced, with the livelihood of the local population heavily dependent on it. Most households hold less than 1.3 hectares of land, usually distributed across nine fields. The assessment also highlighted the disproportionate burden of fuelwood and water gathering, especially impacting women.

Food security in the area is threatened by climate variability and changing rainfall patterns. To improve food security and enhance climate resilience, sustainable water conservation (SWC) interventions are essential. These socio-economic findings underscore the need for targeted interventions to address the pressing issues of water scarcity, land degradation, and agricultural practices within the Hakim Gara catchment.

Table 1. Recommended interventions based on land use and land cover and logistical efficiency

LULC	Legend	Logistical efficiency		
		Market	**Both**	**Reforestation**
Cropland		-Crop rotation or intercropping with oil crops or pulses	-Agro-forestry with marketable fruits and nuts	-Establishing seedling or seed nurseries
Tree cover				-Reforestation with native species and nutritious fruit and nut trees
Grassland		-Cut-and-carry -Area closure -Poultry	-Silvo-pastoral systems	-Extensive silvo-pastoral systems
Shrubland				-Reforestation with native species and nutritious fruit and nut trees

2.2 Catchment Assessment and Analysis

2.2.1 Overview of Baseline Study

Baseline studies are essential for assessing the initial conditions prior to project interventions, enabling a comparison of changes post-implementation. For Hakim Gara, a comprehensive baseline assessment was conducted, involving both primary and secondary data collection methods.

Methods of Data Collection

1. **Primary Data**: Collected through field measurements and surveys, including:
    - Soil moisture assessments at multiple sites (Sofi, Awumar, Harawe) with recorded moisture levels and temperatures. It is expected to dig up to a 30 cm hole. The measurements were taken at between 20 to 30 cm from the ground level. The interventions are mainly stone bunds and terrace construction. Also, the highland parts are protected as an area closure to protect from human and animal interference.
    - Discharge measurements using the velocity-area method, which involved observing water flow in channels and calculating discharge rates (e.g., Sofi, Abawayini, Burqaa).
    - Interviews, focus group discussions, and key informant interviews to gather socio-economic data from the local community.
2. **Secondary Data**: Included remotely sensed data for rainfall and vegetation cover mapping, analyzed using QGIS. This data provides insight into annual rainfall patterns, which vary between 600 to 900 mm/year, and helps to assess vegetation health through the Normalized Difference Vegetation Index (NDVI).

Table 2 Soil moisture sampling and its locations at the old sites (Measurements were taken in December ,2023).

Soil Moisture data – Burqaa Phase I sites					
Intervention Site	Point ID	Location (Lat)	Location (Lon)	Soil moisture (m^3/m^3)	Temp (^{0}c)
Hakim Gara	Sofi1 (Sm_1)	9^0 16'11.82"	42^0 08' 21.26"	0.127	32
	Sofi2 (Sm_2)	9^0 16'06.37"	42^0 08' 20.54"	0.139	33.7
	Sofi3 (Sm_3)	9^0 16'11.8"	42^0 08' 45. 6"	0.135	32.6

Table 3. Soil moisture measurement locations at new proposed intervention sites (December , 2023).

Soil Moisture data – New proposed (Burqaa phase II)					
Intervention Site	Point ID	Location (Lat)	Location (Lon)	Soil moisture (m^3/m^3)	Temp (^{0}c)
Hakim Gara	Awumar	9^0 17' 59.38"	42^0 10' 55.33"	0.062	29.2
	Harawe-1	9^0 15'54.75"	42^0 10' 54.58"	0.067	26.8
	Harawe- 2	9^0 15'53.92"	42^0 10' 50.27"	0.064	24.8

2.2.2 Discharge measurements

Experiments have been conducted. over time, multiple measurements were required at different water levels to draw a relation between water level and discharge, the so-called Q-H curve. The discharge measurements were done through velocity- area method. The flow in the spring channels is just below the springs and it was at low level during the time of field data collection to perform the velocity measurement with the OTT C31 propellor. However, the springs are small and the float method, in this case, was the only available option to collect flow data. A float (leaf, stick, etc.) was placed in the channel, of which the time to travel over a fixed distance was measured, resulting in an average velocity at surface level.

Table 4. Discharge measurements (Date: December 9,2023)

Site	Date Time	Average Velocity (m/s)	Cross section area (m^2)	Q [m^3/s]
Sofi	2023-12-09 10:05	0.0375	0.075	0.0028
Abawayini	2023-12-09 11:18	0.0288	0.056	0.0016
Burqaa	2023-12-09 12:35	0.03921	0.104	0.0041

2.2.3 Data Collection and Baseline Studies

Baseline studies are important to assess the before status of the project work and compare the difference after intervention of project activities. To analyse and collect data, several techniques were applied for primary data and secondary data sources. Primary data were collected during the field data measurements and surveying. Likewise, remotely sensed data of rainfall processing and vegetation cover mapping were done using QGIS. For socio economic surveys: interviews, group discussion and key informant discussion were incorporated.

2.2.4 Stakeholder Mapping

Engaging with local stakeholders is crucial for the success of water resource management initiatives. The presence of local water committees in the kebele is vital for community participation and sustainable management.

Local Water Committee

A local water committee has been established in Hakim Gara, serving as a platform for community members to discuss water management issues, share knowledge, and collaborate on sustainable practices. Their involvement ensures that local needs and perspectives are incorporated into project planning and implementation.

Engagement Strategies

The community engagement strategies include:

- Community Workshops: Organized to educate the community about water conservation practices and the importance of sustainable land management. Regular Meetings: Conducted with the water committee to review progress, address concerns, and adapt strategies as needed. Feedback Mechanisms: Established to allow community members to voice their experiences and suggestions regarding water management practices.

2.2.5 Environmental Impact Assessment (EIA)

The environmental impact assessment in Hakim Gara aimed to evaluate the changes in the ecosystem as a result of interventions and ongoing environmental factors, such as drought and land degradation. The assessment focused on key indicators such as vegetation health, soil moisture status, and land use and cover.

Vegetation Health

Using the Normalized Difference Vegetation Index (NDVI) data from Sentinel-2 satellite imagery, significant fluctuations in vegetation cover greenness were observed. Specifically, data showed a considerable decline in plant health in 2022, attributed to the severe droughts affecting eastern Africa. Despite this, the comparison between intervention sites (e.g., Sofi and Barkele) and reference fields revealed that areas where restoration practices were implemented had higher NDVI scores during the wet season (0.4 to 0.6) compared to control sites, indicating healthier and denser vegetation cover.

Soil Moisture

Baseline soil moisture levels were measured in several locations (Sofi, Awumar, Harawe) on the Hakim Gara plateau, focusing on areas where land restoration efforts (e.g. bund construction and tree planting) had taken place. Measurements showed that:

- Soil moisture varied from 0.127 to 0.139 m^3/m^3 at depths of 10–20 cm in the Sofi intervention sites.
- In new proposed intervention sites (Awumar and Harawe), lower soil moisture was recorded, ranging from 0.062 to 0.067 m^3/m^3. This indicates that soil restoration practices in Phase I improved moisture retention in key areas, leading to better soil health and enhanced vegetation growth.

Water Availability

Hydrological data highlighted the intermittent nature of rivers in the area, with springs being the primary water source during dry seasons. Discharge measurements from springs in Sofi and Abawayini showed low flow rates, which had improved compared to previous years following restoration efforts. This indicates the positive impact of interventions on promoting groundwater recharge and increasing water retention in the landscape.

2.2.6 Socio-economic Impact Assessment

The socio-economic impact assessment analyzed how the environmental interventions in Hakim Gara affected the livelihoods and well-being of local communities, particularly in terms of water access, agricultural productivity, and participation in sustainable land management practices.

Access to Water Resources

The restoration of springs and improved water harvesting practices increased the availability of water for domestic use, irrigation, and livestock watering. Community members reported greater water security, especially during dry periods, as the restored springs produced more consistent water flow compared to pre-intervention conditions. This has alleviated the severe water shortages previously experienced during the dry season.

Agricultural Productivity

Improved soil moisture retention and better land management practices (e.g., tree planting and soil and water conservation bunds) have led to improved agricultural outcomes. Farmers reported better crop yields and more productive grazing lands as a result of the interventions. The increased soil moisture and healthier vegetation have helped mitigate the impacts of drought on agriculture, a critical livelihood for residents. The interventions allow better infiltration of water into the soil profile that is mostly stored as soil moisture and serves to supply crops with water after the rainy season.

Community Participation and Empowerment

The engagement of local communities in the project was a significant factor in its success. Involving community members in restoration activities, such as bund construction and tree planting, fostered a sense of ownership over the interventions. Additionally, the formation of local water committees allowed for more inclusive decision-making, ensuring that water resources are managed equitably and sustainably. The interventions' socio-economic benefits have helped build resilience among local populations, preparing them to better manage water and land resources in the face of climate change.

2.2.7 Hydrological Assessment

The hydrological assessment of Hakim Gara focuses on rainfall patterns, groundwater recharge, surface water availability, and soil moisture dynamics in the area. The primary goal is to evaluate the current water availability and its potential for supporting sustainable land and water management.

Catchment Delineation at sub-catchment

Sub-watershed catchment is important that kebele boundaries when it comes to watershed (catchment management) plan. Usually sub watershed boundaries will not necessarily overlap. The hydrological process of catchment is influenced by physical characteristics within natural boundaries. In general, subsurface water does not flow from one sub catchment to another except underlying complex geology. The following figure shows the delineated watershed targeted to Burqaa initiative in Hakim Gara catchment. The Highlands parts of Hakim Gara have high slopes where bench terraces and protected afforestation are recommended while the lowlands it is possible to implement a water retention structure to enhance water availability. The highland parts are shrublands and easy for implementation of area closure. Subwater selection is the first step to start water availability enhancement activities. Harar city is inside the catchment of the Burqaa phase II and urban watershed planning is required to compliment the practice of IWRM. See the delineated catchment in the following Figure 1.

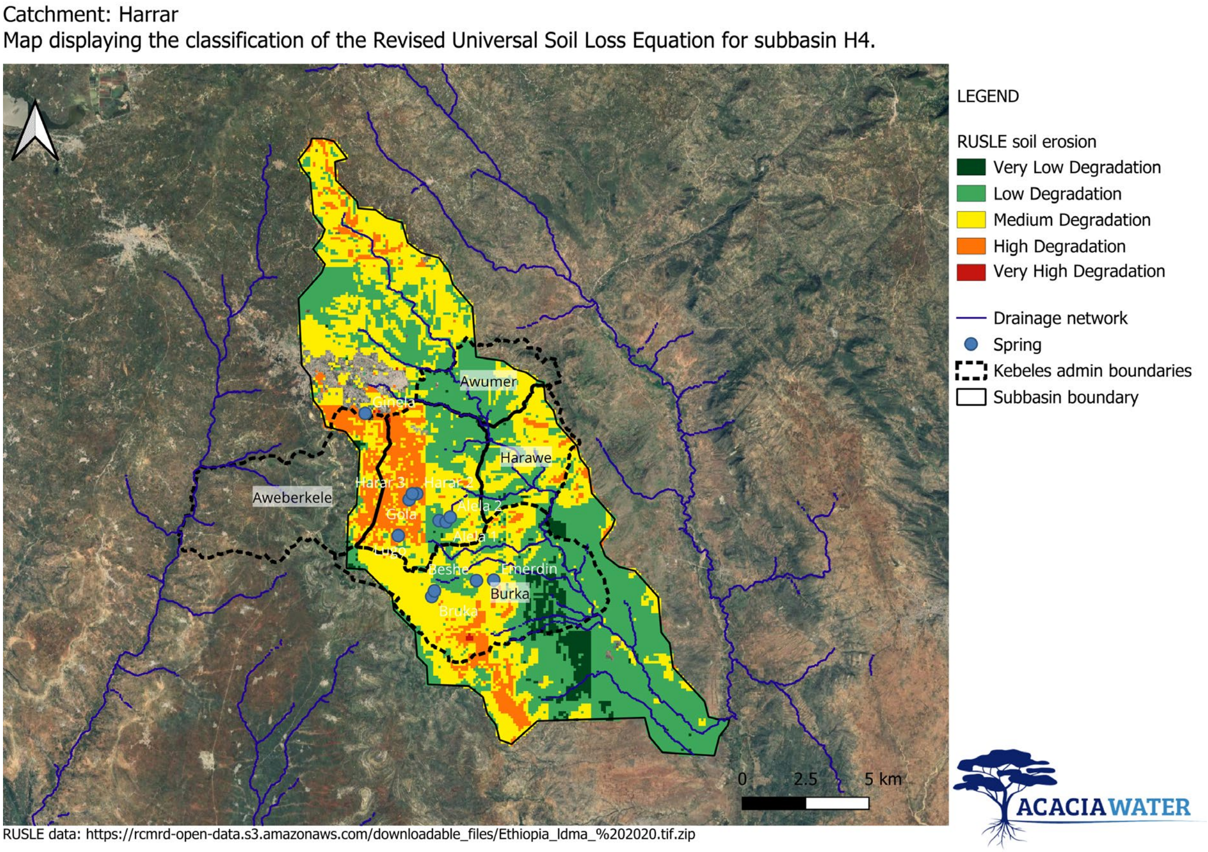

Figure 1 Delineated Hakim Gara catchment with soil erosion vulnerability

Rainfall Analysis

The target area receives annual rainfall ranging from **600 to 900 mm/year**, based on CHIRPS data. However, the natural groundwater recharge to superficial reservoirs that feed the drainage network is limited as evidenced to the absence of perennial rivers. Most of the available groundwater is concentrated in sediment deposits of seasonal river (wadi) beds, inland alluvial valleys, and in deeper sandstone and limestone deposits. The seasonal nature of rainfall and the absence of permanent rivers create significant water scarcity during the dry season.

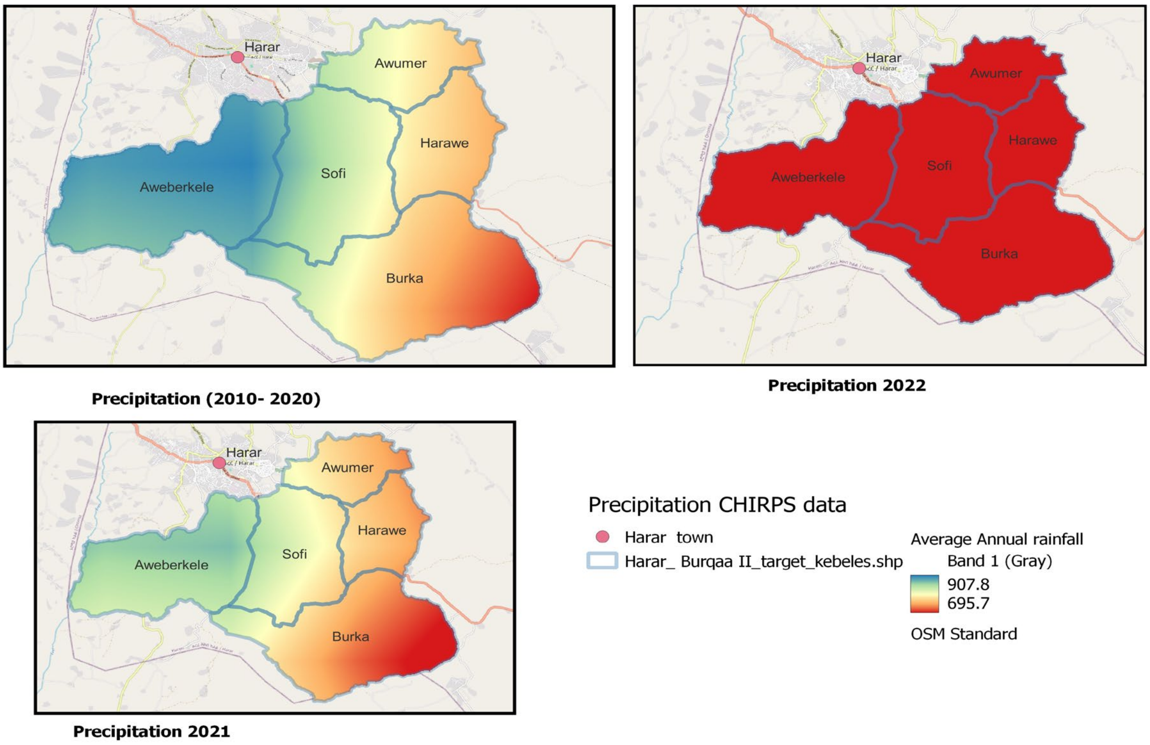

Figure 2. Average annual precipitation data using CHIRPS data (2010-2022)

Key Points:

- **Seasonal Distribution**: Rainfall peaks during the wet season, but water retention in shallow aquifers is insufficient to sustain river baseflows throughout the year.
- **Groundwater Recharge**: Limited recharge capacity due to surface runoff and evaporation, making the groundwater sources vulnerable to depletion during prolonged dry periods.

Surface Water and River Systems

The rivers in Hakim Gara are intermittent, which means they only flow during and shortly after rainfall events. During prolonged droughts, these rivers dry up completely, contributing to water scarcity in the area. Springs located in the region, like those at **Sofi**, **Abawayini**, and **Burqaa**, also show seasonal variability in discharge.

Discharge measurements from various locations show low flow rates, indicating limited surface water availability. Measurements were done using the velocity-area method with tools like the OTT C31 propeller and float method . For instance, the following measurements collected during the dry season by using the floating method.

- **Sofi Spring**: Flow rate of **0.0028 m^3/s**.
- **Abawayini Spring**: Flow rate of **0.0016 m^3/s**.
- **Burqaa Spring**: Flow rate of **0.0041 m^3/s**.

These results highlight the reduced flow capacity in the springs during dry seasons, further emphasizing the need for improved water management interventions. Moreover, the interventions shall promote high infiltration to support maximum water yield at the springs.

Soil Moisture and Land Restoration

Soil moisture levels were recorded at multiple locations across the plateau, both in old and new kebeles (e.g., **Sofi**, **Awumar**, and **Harawe**). These measurements provide insights into the effectiveness of land restoration efforts and water conservation techniques.

Findings:

- At **Sofi 3**, soil moisture increased from **0.078 m³/m³** at 5 cm depth to **0.135 m³/m³** at 15 cm depth, indicating improved moisture retention with depth.
- In other areas, such as **Awumar** and **Harawe**, soil moisture levels were lower (around **0.062 to 0.067 m³/m³**), suggesting drier conditions and the need for enhanced restoration practices. Also, note that the soil measurements were collected during the dry season.

These variations in soil moisture indicate the effectiveness of conservation interventions, such as bund construction and tree plantations, but also point to areas where further action is required for further analysis.

Impacts of Water Scarcity on Agriculture and Livelihoods

The limited availability of surface and groundwater in Hakim Gara directly affects agricultural productivity and domestic water supply. The seasonal nature of water resources has led to:

- **Reduced agricultural yields** due to water shortages during critical growing periods.
- **Decreased plant health**, as observed in the NDVI analysis, particularly during drought years like 2022, where vegetation health declined significantly.

The hydrological assessment aimed to understand water availability and quality in Hakim Gara, focusing on rainfall patterns, groundwater recharge, and surface water dynamics.

2.2.8 Key Pressure and Challenges

Population growth, soil infertility through land degradation, water availability and supply put pressure on the living conditions of the community. Particularly, deforestation and unsustainable land management (USLM) with hydro meteorological risks causes exposure to the challenges. Even though the influence of climate change is worldwide, in water scarce regions like upper the Hakim Gara catchment end results can disastrous if mitigation or adaptation interventions are not considered.

The following water related challenges are observed in Hakim Gara catchment:

- **Land Degradation & Soil Erosion**: Deforestation and unsustainable land management practices cause soil erosion, increased overland flow and erratic flooding, reducing soil moisture storage opportunities and agricultural productivity.
- **Water Scarcity**: Limited rainfall and lower groundwater recharge lead to severe water shortages, especially during the dry season.
- **Low Management Capacity**: The community struggles with inadequate infrastructure, maintenance skills, and awareness for sustainable water and land management.
- **Water Pollution**: Urban waste disposal pollutes surface and groundwater, affecting health and agricultural production.
- **Lack of soil conservation and Water Harvesting Technology**: Limited access to water harvesting and efficient agricultural techniques for soil conservation restrict resource utilization.
- **Climate Change Vulnerability**: Unpredictable rainfall and prolonged droughts worsen water scarcity and land degradation.

3 Management Objectives and Strategies

Effective catchment management requires clear objectives and strategies that align with the overall goal of improving water availability, reducing land degradation, and enhancing the livelihoods of the community. The management objectives in this guideline focus on promoting sustainable use of water resources, improving soil and land conditions, and ensuring active community participation.

3.1 Criteria/Indicators for Sustainable Water Resource Management

Effective water resource management relies on a range of criteria and indicators that ensure the sustainability of water practices and the health of the catchment area. Monitoring these indicators helps evaluate the success of various interventions and guide future strategies. Key criteria include water availability during dry seasons, water quality, soil erosion, agricultural productivity, the functionality of local water management committees, and collaboration among different sectors.

To assess water availability, indicators such as water storage levels, baseflow measurements, and water usage efficiency are used. Improved water quality is monitored through chemical and microbial contaminant levels, as well as sediment load. Soil erosion and sedimentation are evaluated by measuring erosion rates, sediment accumulation, and soil stability. Increased agricultural production is gauged by monitoring crop yields, food security, and income levels. The effectiveness of local water management committees and sectoral collaboration is assessed through committee activity, community engagement, capacity building, joint initiatives, information sharing, and policy alignment. The table below contains the identified indicators and a detailed description.

Table 5. Criteria and Indicators for Monitoring Summary Table

Criterion	Indicator	Description
More Water Availability During Dry Seasons	Water Storage Levels	Monitor levels in reservoirs, ponds, and wells to assess water availability during dry periods.
	Baseflow Measurements	Observe baseflow recession in streams and rivers to gauge groundwater recharge status and sustained water flow.
	Water Usage Efficiency	Measure water used per unit of agricultural production to evaluate water use practices.
Improved Water Quality and Reduced Pollution	Chemical Contaminant Levels	Measure harmful chemicals (e.g., nitrates, phosphates, fluoride) in water bodies to assess pollution control.
	Microbial Contaminants	Test for pathogens and bacteria to ensure water safety and reduce health risks.
	Sediment Load	Assess sediment concentrations and turbidity to evaluate sediment control measures. Create sediment

		rating curves from simultaneous discharge – sediment concentration measurements.
Reduced Soil Erosion and Sedimentation	Erosion Rates	Measure soil loss rates with erosion pins or sediment traps to evaluate erosion control practices.
	Sediment Accumulation	Observe sediment build-up in water bodies and reservoirs to assess sediment control efforts.
	Soil Stability	Evaluate soil stability and monitor for gully formation to determine erosion control effectiveness.
Increased Agricultural Production	Crop Yields	Measure the quantity and quality of crops to assess the impact of water and soil management.
	Food Security	Evaluate local food security and reduced reliance on external sources to reflect agricultural success.
	Income Levels	Monitor changes in agricultural income to assess economic benefits of improved management practices.
Functioning of Local Water Management Committees	Committee Activity	Track meeting frequency and decision-making to evaluate committee effectiveness and engagement.
	Community Engagement	Assess community involvement and feedback to evaluate local governance effectiveness.
	Capacity Building	Monitor training sessions and workshops for committee members to gauge capacity building efforts.
Effective Collaboration Between Agriculture, Water, and Environmental Offices	Joint Initiatives	Track collaborative projects and initiatives to assess integrated management efforts.
	Information Sharing	Evaluate the frequency and quality of information exchange between sectors for cooperation.
	Policy Alignment	Review the alignment of policies across sectors to assess coherence and effectiveness.

3.2 Strategies for Sustainable Water Management

To achieve the desired management objectives, a combination of strategies is needed that address the specific challenges within the catchment. The following strategies offer practical solutions for improving water availability, reducing land degradation, and promoting resilience to climate change.

A. Water Resource Management: Efficient Use and Conservation Techniques

Water efficiency can be enhanced through various practices, such as **rainwater harvesting**, which collects and stores rainwater for dry periods. Techniques like **building small check dams**, **retention ponds**, and **infiltration trenches** help manage overland flow and surface runoff. Efficient use of soil conservation systems like **mulching** can reduce overland flow water loss in the wet season and improve productivity, especially in agriculture.

Rainwater harvesting is especially effective in arid and semi-arid regions, where annual rainfall averages between 200-800mm. It serves communities where traditional water sources are unavailable, helping to improve vegetative cover and resource conservation. The method involves gathering rainwater from rooftops, rocky or other low-permeability surfaces, channeling it into

storage reservoirs, and thereby providing a reliable water supply for domestic, agricultural, and livestock purposes.
Rooftop rainwater harvesting offers an affordable, decentralized accessible solution for both urban and rural settings. Schools, churches, and offices can also utilize their large roof surfaces to capture rainwater, which is particularly valuable when managed properly to meet community needs. When properly executed, the quality of the harvested water can be considered high, with low salinity and low needs for treatment.

B. Soil and Land Management: Soil Conservation Practices

Terracing and **contour plowing** are effective methods to reduce soil erosion on sloped lands. Contour plowing aligns furrows with the natural curves of the land, reducing water flow, preventing soil loss, and improving infiltration and groundwater recharge. It helps maintain soil fertility by acting as a natural barrier to erosion. To further prevent soil degradation, **gully rehabilitation** measures such as **check dams** and **vegetation planting** can stabilize land and reduce gully expansion. Studies in Northwestern Ethiopia show that these methods can significantly reduce gully depth and soil loss, enhancing landscape stability.
Moreover, introducing **cover crops** and **grass strips** helps stabilize soil and reduces sediment runoff into water bodies. These practices improve soil health, water quality, and reduce pollution, making them essential for agricultural sustainability. Cover crops like cereal rye and crimson clover provide year-round ground cover, preventing soil erosion and enhancing water retention.

C. Biodiversity Conservation: Protecting Habitats and Species

Conserving critical habitats such as wetlands, riverbanks, and forests is crucial to maintaining biodiversity and ecosystem services within catchment areas. Establishing **buffer zones** around water bodies reduces pollution and provides a habitat for local wildlife.
Promoting the planting of **indigenous trees** and shrubs supports local biodiversity while also preventing soil erosion. **Agroforestry**, which integrates tree planting with farming activities, enhances soil structure, water retention, and overall ecosystem resilience. Trees like ***Acacia***, ***Grevillea robusta***, and ***Moringa oleifera*** are commonly used for such purposes, contributing to both environmental and community well-being.

D. Climate Change Adaptation: Building Resilience

To build resilience against climate change, adopting **climate-resilient agricultural practices** is essential. Drought-resistant crops and varieties with deep root systems can improve productivity in challenging environments. These crops require less water and are better suited to withstand extreme weather conditions.
Flood protection structures like **levees** and **retention ponds** are also vital to managing flood risks. Levees prevent water overflow, while retention ponds slow down stormwater release, reducing the risk of erosion and flooding. In addition, these structures can serve as wildlife habitats and enhance the aesthetic value of communities. The adoption of **early warning systems** is critical for disaster preparedness. Communities can use these systems to anticipate and respond effectively to extreme weather events, minimizing damage and safeguarding lives and livelihoods. Current monitoring equipment has the capability of sending warning alarms through SMS messages when water levels exceed a set emergency level.

E. Community Involvement: Engaging Local Stakeholders

Engaging communities in the planning, implementation, and monitoring of water management practices is key to ensuring the sustainability of these initiatives. Community members can participate in activities such as **tree planting**, **clean-ups**, and **monitoring water quality**. Training programs can help locals collect data on key indicators, report issues, and stay informed about the progress of management efforts. Establishing **local water management committees** fosters ownership of water conservation initiatives. These committees can include representatives from different sectors, ensuring a holistic approach to water management. Regular community training on sustainable water and land management practices will further enhance local capacity. Promoting **gender-inclusive strategies** ensures that both men and women play an active role in decision-making processes. This inclusive approach leverages the strengths of all community members, leading to more effective and sustainable outcomes.

4 Action Plan

A holistic and participatory approach shall be employed in the development of the action plan with high consensus of understanding. All efforts should made through genuine involvement, interested member groups and beneficiaries. All stakeholders should be involved to develop a commonly supported strategy and implementation with their clear roles and responsibilities identified. In the action plan clear methodologies were developed to facilitate planning and implementation of the catchment management strategy.

Development of the action plan includes the following steps:

1. Identify your catchment area and define your objectives in a “what to do” list.
2. Define clear methodology and procedures using the check list.
3. Propose a detailed action plan
4. Identify high priority actions using relevant criteria
5. Work on the implementation of the plan and define follow-up actions.

The action plan could be developed based on objectivities with working strategy. The catchment plan strategy was described under **Section 3** of this document (objectives and strategies).

Table 6. Schematic overview of catchment management action plan

Indicator	Criteria	Strategy	Action check list: in Hakim Gara catchment
Water availability During dry seasons	Water level increased after intervention to rehabilitate springs / Enhanced base flow.	Stakeholder participation, preparation of action plan, study, campaigning, resource mobilization, preparation, design and implementation plan, monitoring and operation strategy	Applying soil and water conservation practices, water harvesting structures at the proposed upstream sites. Gully rehabilitation, check dams, infiltration ponds **(High priority)**.
	Water Usage Efficiency improved.	Providing technical training on detection and reduction of water losses, efficient irrigation water application.	Construction of flood water harvesting structures (artificial ponds).
Improved soil moisture	Increased soil moisture	stakeholder consultation, preparation of intervention plan, resource mobilization	Implementation of contour bunds, micro basins (half-moon), mulching, area closure, grass strips (**Very high priority**).
Degraded land rehabilitation	Erosion / sediment transport reduced	Recommendations of 3R interventions, design, planning, stakeholder involvement,	Applying soil and water conservation practices,

		cooperation and implementation techniques.	Gully rehabilitation, check dams.
Improved vegetation cover	Increase Normalized difference vegetation index (NDVI).	Planning, identification of plant types, recommendations of fruit bearing trees, stakeholder participation, collaboration, mobilizing resources and plantation campaign.	Area closure, fruit bearing plantation establishment, improved grass cover or regreening, development of nursery sites.
Level of institutionalization and sustainability	Functionality of CBOs Interactions and engagement, water management and governance	Stakeholder mapping, documentation of institutionalization, planning, communication, responsibilities and involvement	CBOs working in action, Decision making, legal policies and regulations

4.1 Detailed action plans

In case of Hakim Gara catchment, participatory watershed management guideline action plans the following steps are recommended:

Step 1- characterize the watershed overview biophysical components such as cover, vegetation, agricultural practices. Identify if the land use is grazing land, homestead, cultivation land, forest or bare land. Define the scope of intervention whether it is kebele/ woreda or catchment-based implementation plan.

Hakim Gara catchment has a ruggy and hilly topography with coverage. The highland parts are covered by bushes and shrubs while the lowland parts of target areas are covered with chat farm. The area receives a low amount of rainfall and farmers agricultural practice needs support to enhance water availability through soil and water conservation practice. The catchment intervention plan is kebele-based, and the activity considers participatory watershed management. In participatory watershed management the activities and responsibilities are managed at the kebele level

Step 2 - Characterize the socio economic and livelihood aspects of the community, Characterize Hakim Gara socio economic aspects such as demography, income, infrastructures and services. Promote women and youth participation, list down the roles and responsibilities of community members and active participation.

Step 3 - Present the report of the situation analysis about the land degradation, water availability, ecosystem and environment.

- The baseline report of present situation related to objectives should be prepared.
- The traits and opportunities are proposed under this section.
- The biophysical maps and socio-economic data analysis should be compiled and discussed.

Finally, the reports should be presented to the stakeholders for review, analysis and plan for the intervention plan with the activities.

Step 4 - Build a team to create a plan from the bottom up that includes community inputs, in addition to technical aspects. The building team at woreda level should include a Watershed expert (Irrigation expert) and a Soil and Water Conservation expert. Composition of the KWT will include

the (1) Kebele Chairman; (2) Kebele rural development Head; (3) three DAs; (4) one male representative/leader of each community, (5) one female representative/leader of each community (6) one respected and influential person from each community and (7) representative of the youth.
Step 5 - Identification of community watersheds within broader units with team member participation: each of the prioritized critical watersheds can be further subdivided based upon community locations into community based sub-watersheds. The team members shall insure water shed planning, prioritizing, coordinate the interventions work, settle the dispute and provide guidance for the community.
Step 6 - Development action plan. Propose key actions and plan the intervention procedures.
To support the catchment management plan and to identify what are possible measures. it is better to develop 3R suitability mapping to cross check the alternatives.

To support the decision system, integrated and systematic methodology were developed using 3R / water balancing suitability analysis with a consideration of socio-economic aspects. Based on Biophysical controlling factors, intervention measures were proposed for specific target kebeles. Generally, selection of intervention measures is developed as follows:

1. Determine the location of your focus area on the map. This can be a woreda or kebele, a micro catchment, or any other specific area or location. The core team members decide the location and focus area based on different factors under step 1-6.
2. Mapping the area of interest based on biophysical factors that constitute land use, land cover, slope, soil and Agro-climatic zones. In socio economic mapping, the market based (income generating) and reforestation (environment) intervention is considered.
3. Determine and short list possible interventions which are possible and present in your focus area. Often you will find more than one intervention measures within a focus area, and it is better to prioritize the intervention by setting criterions and goals.
4. Look up in the intervention table, to decide which interventions are recommended for water balancing, carbon sequestration and socio-economic activities.

Before decision-making about interventions, the 3R / SWC / water balancing intervention suitability mapping has been developed based on biophysical parameters reclassified based on slope, land use land cover and agroclimatic zones. In Harar target kebeles, the area receives low amount of rainfall considered as a dry agroclimatic zones. The land use and land cover are mostly classified as crop lands and followed by range lands. The top of plateau ridges like Hakim Gara plateau, Awumer and Harawe has rangelands. The legends of suitability mapping shown in tabular format with possible intervention.

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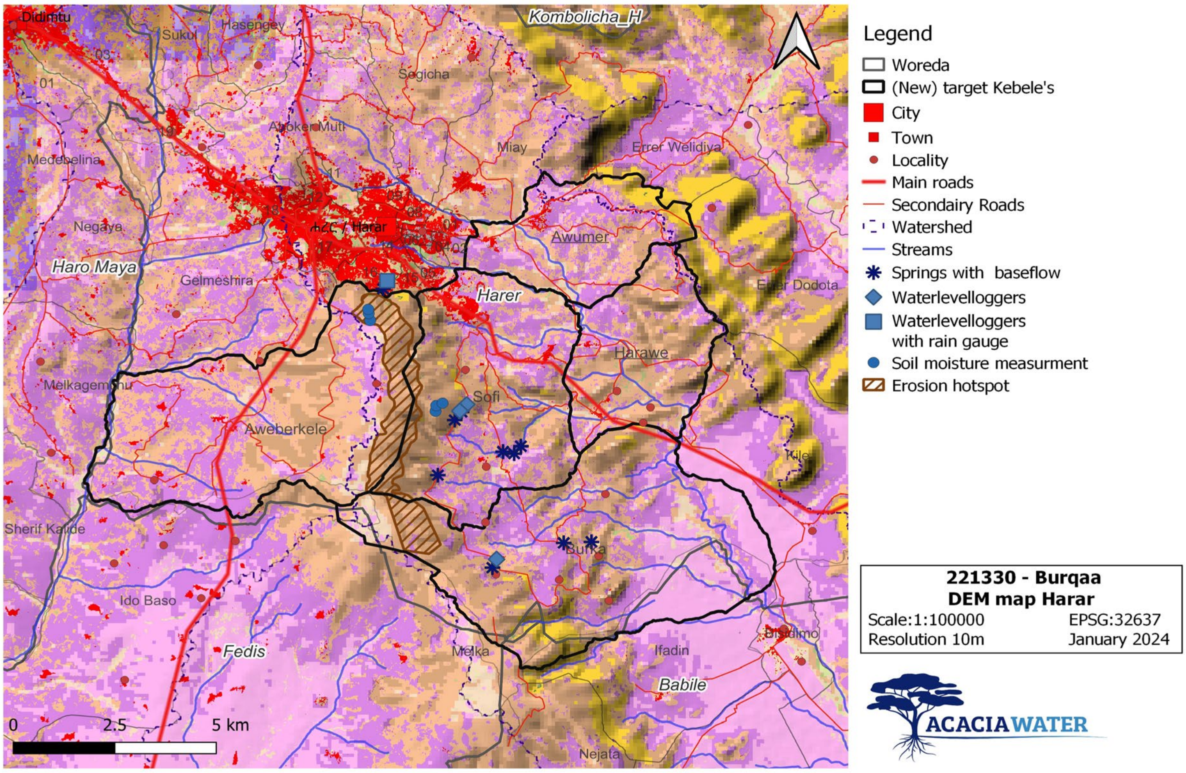


Figure 3. 3R / water balancing intervention suitability map

Next, based on the 3R Suitability mapping the possible intervention measures are depicted in the look up table. 3R suitability mapping proposes possible intervention measures and final decision should be made the core team members of committee. The committee members are expected to present their final decision to stakeholders and community members.

Please, read the map and look up possible intervention measures are shown.

The map shows purple colour – croplands, light yellow – rangelands and red colour - urban areas/ homestead.

Based on Agro-climatic classification, land use and cover, and with topography data possible intervention methods are proposed. This 3R mapping supports the decision-making process by experts, committees and stakeholders. The possible interventions were mapped for Hakim Gara watershed including newly added kebeles in baseline report. Please, refer to the baseline report for further information.

4.1.1 Setting short-term, medium-term, and long-term goals

Setting goals is mandatory in participatory watershed management to identify if specific objectives are achieved in action. In short-term goals the interventions / SWC measures of achieve the goals with short period of time, e.g. In rainy season of rainfall water. Developing ponds and rehabilitation of small wells for harvesting that used for agricultural and domestic use.

In the medium-term, the intervention could be executed within two or three years. For example, implementation of contour stone / soil bunds in a successive two to three years, with a proper maintenance and operation. The long term includes all interventions and cooperation of all kebele works together by considering water shed as one basic unit. In long-term the cooperation of soil and water conservation practice involves the upstream and downstream relationships all contribution from stakeholders, government, NGO s and community members.

4.2 Priority Actions

Identification of intervention and Priority Setting of Community watersheds with respect to actions are important. The constraints and limitations related to resources like financial and manpower requirements should be settled before implementation action. Priority setting and selection of community watersheds can be conducted in an objective manner by using a combination or all the following parameters listed below:

- Agro-ecological diversity (Biophysical characteristics that constitutes soil condition, rainfall and land use and cover).
- Agriculture potential.
- Watershed landscape approach and sequence (location / orientation in upper reaches of the broader watershed.
- Severity of land degradation.
- Food insecurity and support activities.
- Material availability and cost.

Actions for implementation of interventions are prioritized based on stakeholder discussions and community needs. Proper explanations of why certain actions are prioritized and how they will benefit water and land management must be presented to committee and community for having better understanding about the plan.

In Hakim Gara catchment enhancing water availability is a priority followed by reduction of land degradation. Sustainable land management for agriculture to improve soil moisture and reduction of soil erosion. The top part of Hakim Gara plateau is vulnerable to erosion, therefore stone bunds and agroforestry practices are recommended as intervention measures.

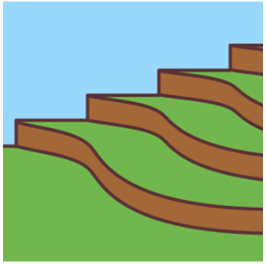
4.3 Implementation

During the implementation of interventions in the catchment, guidance is important according to participatory watershed management. The action plan must support the implementation strategy. Each implementation techniques require the guidelines that could be used a reference or manual.

4.3.1 Participatory catchment management supporting manual

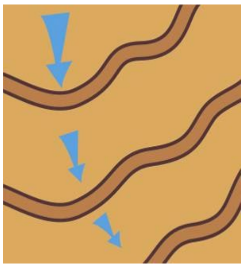
In the Hakim Gara catchment through the Burqaa project, soil and water conservation practices are recommended. The guiding manual has been prepared for the community to implement interventions to the standard. Also, after the implementation has been completed the community is expected to maintain and operate the interventions regularly. The following guiding manual can be used as a reference during the implementation phase:

Terraces



Platforms or benches built along a slope to make hilly areas arable. Terraces usually follow the contour lines of a terrain and might have a gentle slope to allow dewatering.

Contour bunds



Contour bunds and contour trenches prevent soil erosion by intercepting surface water runoff. They are constructed along lines of equal elevation (contour lines) at a right angle to the slope of a plot of land.

Purpose of the interventions

- Reduce surface water flow velocity.
- Enhance infiltration, thereby recharging soil moisture and groundwater.
- Prevent soil erosion and washing out of nutrients.
- Prevent silting of water bodies.
- Construct a level crop field that can be easily worked.

Terraces, contour bunds and trenches should ideally be implemented in combination with other practices of sustainable agriculture, such as agroforestry, farmer managed natural regeneration (FMNR) and sustainable rangeland management.
Terraces, contour bunds and contour trenches are erosion control and water retention measures that can be used on agricultural fields, especially in semi-arid and sub-tropical climates.

Table 7. Terraces and contour bunds implementations guid

	Terraces	**Contour bunds**
Slope	10 - 50% = 1 - 5 m elevation gain for every 10 m horizontal distance	0.5 - 10% = 0.5 - 1 m elevation gain for every 10 m horizontal distance
Soil	More than 1.5 m thick permeable soil, preferably no clay: hard to work and low infiltration	More than 0.5 m thick preferably permeable soil
Gullies	There should be NO, or only small erosion gullies or rills present on the field (<0.5 m deep). Gullies should be filled or intercepted with check dams, so that waterflow during heavy rains does not destroy the terrace / contour bund.	

4.3.2 Roles and Responsibilities

Assignment of roles: who is responsible for each action (local authorities, NGOs, community leaders). Clarification of inter-agency collaboration and coordination. The roles and responsibilities are subdivided among partners and stakeholders. The role and responsibilities of stakeholders in the catchment will be identified and drawn during the workshop together with stakeholders

4.3.3 Construction methods

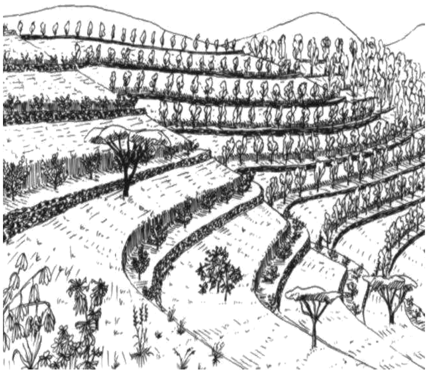
Terraces

- The terrain is dug out upslope and the excavated material is used downslope to create a level platform. The fertile topsoil should be separated and reapplied on the top of the terraces
- The downslope walls are best constructed of stones. They can also be made of soil, reinforced by vegetation such as vetiver grass.
- The walls should be sturdy, well protected from erosion and should not exceed 2 m in height.
- Optionally, every terrace can have a drainage ditch just above the ridge that collects water and channels it to the next step this can be helpful in preventing erosion.
- The platform might have a gentle slope to allow dewatering.

Contour bunds

Can be built of soil and/or stones.

- Are often constructed parallel to an infiltration trench (ditch). The excavated soil from the trench is then placed downslope along the edge of the trench to form the bund (dyke).
- Optional: Build crossties every few meters. These are small earth walls or excavated trenches, perpendicular to the bunds, that subdivide the system into micro catchments and prevent lateral flow along the bund which might cause erosion.
- Plant native grasses, legumes or perennials on the bunds to stabilize them. Apply mulch, especially while the plants develop



© Soil conservation in Ethiopia (CFSCDD 1986)

4.4 Timeline and Milestones for interventions

1. Preliminary desk development of term of references (TOR), maps and conceptual reports requires (2-3) weeks.
2. Field work data collection and reconnaissance survey for illustration of features, delineate and catchment description (3-4) days.
3. Prepare 3R suitability map considering the principles of participatory watershed management. The workload requires (2-3) weeks. Present reports and suitability mapping of the catchment area.
4. Participatory session with planning core team members and present the findings to the community and facilitate the cooperation (within 1 week). During this milestone the inception or minute of discussion by core members prepared. The community members and other stakeholders decide on the minute of discussion for approval. This process will take up to three weeks. The report of approved catchment management intervention report as a deliverable.
5. Summary of reporting of working document, action plan, roles and responsibility on monthly time step.
6. Implementation with a continuous follow up in monitoring to maintain and operate regularly (2- 5) years. Annual or biannual report the status of intervention works those practices through landscape restoration including soil and water conservation practice and afforestation.

5 Implementation Framework

The implementation framework for catchment management is designed to provide a structured and comprehensive approach to sustainably managing water resources. It includes key components such as institutional arrangements, capacity building, stakeholder collaboration, and risk management, all aimed at enhancing coordination and engagement among local stakeholders. By fostering local ownership and integrating training programs, the framework ensures that individuals and organizations are equipped with the necessary skills and knowledge to implement effective management strategies. Additionally, it emphasizes proactive risk management to address potential challenges, enabling communities to adapt to changing environmental conditions and pressures. Ultimately, this framework serves as a vital tool for achieving sustainable water resource management, benefiting both the ecosystem and the local population.

5.1 Institutional Arrangements

The success of small-scale catchment management depends on clear local institutional arrangements that define roles, responsibilities, and collaboration mechanisms at the community level (Table 8).

Table 8. Roles and responsibilities of key stakeholder institutions.

Level	Key Institutions	Roles and Responsibilities
Local Authorities	Village or town-level government units (e.g., councils, local environmental offices)	- Oversee the implementation of the catchment management plan - Provide resources and technical support for water and land management practices - Facilitate enforcement of local rules
Catchment Committee	Representatives from local government, farmers, community leaders, and local NGOs	- Develop and update the catchment management plan - Monitor and assess ongoing management activities - Ensure local stakeholder involvement
Water User Groups	Groups representing farmers, water users, or irrigators within the catchment area	- Maintain water infrastructure - Resolve water use conflicts within the group - Ensure equitable water distribution

The catchment committee should lead local-level decision-making processes, while water user groups handle the on-ground maintenance and management of shared water resources.

5.2 Capacity Building

Capacity Building emphasizes the importance of developing the skills and knowledge of community members, local organizations, and stakeholders. Through training and education initiatives, the framework aims to empower individuals and groups to implement sustainable practices that protect and enhance water resources.
Building the skills and knowledge of local actors is critical to ensure sustainable management. Focus on practical training, peer learning, and access to technical expertise. The aspects are summarized in Table 9.

Table 9. Aspects of capacity building actions.

Capacity Building Activity	Target Group	Key Topics	Implementation Method
Technical Training on Water Management	Local authorities, farmers	- Rainwater harvesting - Water-efficient irrigation - Soil conservation practices (e.g., terracing)	- On-site workshops - Demonstration plots
Community Workshops on Catchment Health	Community members	- Benefits of catchment conservation - Reducing erosion and sedimentation - Protecting water sources	- Community meetings - Educational campaigns
Monitoring and Data Collection Training	Water user groups, catchment committee members	- Monitoring water flow and quality - Tracking land degradation - Managing simple data collection tools	- Practical sessions - Peer-to-peer learning

Ongoing capacity building should emphasize locally relevant practices and rely on collaboration with NGOs or local experts.

5.3 Stakeholder Collaboration

Stakeholder Collaboration is vital for fostering a sense of ownership and shared responsibility among all parties involved in catchment management. By promoting dialogue and cooperation among stakeholders, the framework encourages integrated approaches that consider diverse perspectives and interests.
Collaborative efforts among local stakeholders ensure broad participation and buy-in for catchment management. Stakeholder collaboration aspects are listed in Table 10.

Table 10. Stakeholder collaboration aspects.

Stakeholder Group	Roles in Collaboration	Methods for Engagement
Farmers and Water Users	- Participate in water conservation and soil management activities - Implement sustainable agricultural practices	- Regular meetings with the catchment committee - Field visits
Local NGOs	- Provide technical expertise and resources - Facilitate community education and capacity-building initiatives	- Partner agreements with local authorities
Local Authorities (Municipal)	- Facilitate legal and financial support - Coordinate local resources and oversee compliance with management plans	- Joint planning and progress review meetings

The **Catchment Committee** plays a central role in fostering ongoing communication and cooperation between stakeholders.

5.4 Risk Management

Risk Management addresses the various challenges that may arise during catchment management. By identifying potential risks and developing strategies for mitigation, the framework aims to enhance resilience and adaptability in the face of changing environmental and socio-economic conditions. The table below shows the specific risks and outlines targeted strategies for mitigating them, along with assigning responsible entities. Risk mitigation strategies and responsibilities are given in Table 11.

Table 11. Risk mitigation aspects.

Risk	Strategy for mitigation	Responsible Entity
High population growth and poverty can increase pressure on water resources.	- Promote alternative livelihoods to reduce pressure on water resources - Improve water use efficiency and conservation	- Local authorities - NGOs
Resistance to change the inherited practices	Conduct community engagement and awareness campaigns - Demonstrate successful practices through pilot projects	- Catchment committee - Local NGOs
Deforestation for agricultural activities and fuelwood collection	- Implement community-led afforestation programs - Promote the use of alternative energy sources such as biogas	- Local communities - Environmental NGOs
sectoral interests and lack of integrated approaches	- Foster intersectoral collaboration and regular communication between stakeholders - Establish catchment coordination mechanisms	- Catchment committee - Water user groups
Change in the rainfall patterns	- Develop rainwater harvesting systems - Implement climate-resilient agricultural practices	- Local authorities - Farmers
Policy changes	- Ensure flexibility in management plans to adapt to policy shifts - Engage policymakers early in catchment planning	- Catchment committee - Policy advisors

6 Monitoring, Evaluation, Learning, and Reporting (MERL)

A thoughtfully crafted Monitoring and Evaluation (M&E) plan acts as a guiding compass for any plan, steering it towards its goals, ensuring accountability, promoting learning, and presenting its impact to stakeholders.

6.1 Monitoring and Evaluation

These indicators must be SMART (specific, measurable, achievable, relevant and time bound), and a baseline record for each indicator should be assessed. Then a target value for each indicator should be defined, with a clear data source to measure it. The frequency of measuring the indicator is an important element to be identified with assigned responsible person or entity to follow up.

Increase Water Availability During Dry Seasons

- Objective: Enhance water retention and availability during periods of low rainfall.
- Indicators (Table 12):
    - Increase in water storage levels in local reservoirs, ponds, and wells.
    - Improved baseflow in streams and rivers during dry months, both in quantity and duration.
    - Water usage efficiency per unit of agricultural production.

Monitoring Strategies:

- Water storage levels: Use sensors and satellite imagery to monitor surface area and water volume changes over time.
- Baseflow measurements: Observe baseflow in streams and rivers to gauge groundwater recharge.
- Water use efficiency: Measure water use per unit of crop production to assess irrigation practices.

Table 12. Water quantity availability assessment criteria

Criterion	Indicator	Monitoring Method
Water Availability	Water storage levels in reservoirs, ponds, wells	Sensors, satellite imagery
Baseflow in streams	Gauge baseflow during dry months	Ground-based flow meters
Water Use Efficiency	Water use per unit of crop production	Flow meters, crop yield analysis

Improve Water Quality and Reduce Pollution

- Objective: Reduce pollutants entering water bodies to provide cleaner water for both communities and ecosystems.
- Indicators (Table 13):
    - Decrease in harmful chemicals (nitrates, phosphates) in water.
    - Reduction in pathogens and microbial contamination.
    - Lower sedimentation and turbidity levels.

Monitoring Strategies:

- Chemical contaminants: Regular testing for nitrates and phosphates.
- Pathogen levels: Use water quality tests for microbial safety.
- Sediment load: Monitor turbidity and suspended solids using sensors and satellite data.

Table 13. Water quality assessment criteria.

Criterion	Indicator	Monitoring Method
Water Quality	Chemical contaminant levels (nitrates, phosphates)	Chemical water tests
Pathogen Levels	Microbial safety testing	Pathogen testing kits
Sediment Load	Turbidity and suspended solids	Turbidity meters, sediment traps

Reduce Soil Erosion and Sedimentation

Aspects for the reduction of erosion and sediment concentrations in surface water are given in Table 14.

- Objective: Reduce soil loss and sediment accumulation in water bodies.
- Indicators:
  - Decreased soil erosion rates.
  - Reduced sediment build-up in reservoirs.
  - Improved soil stability and reduced gully formation.

Monitoring Strategies:

- Soil erosion rates: Use erosion pins or sediment traps.
- Sediment build-up: Conduct sonar surveys or turbidity assessments in reservoirs.
- Soil stability: Evaluate through gully monitoring and vegetation cover assessments.

Table 14. Erosion and sedimentation aspects.

Criterion	Indicator	Monitoring Method
Soil Erosion Control	Soil loss rates	Erosion pins, sediment traps
Sediment Accumulation	Sediment levels in reservoirs	Sonar, turbidity meters
Soil Stability	Gully formation, vegetation health	Soil stability tests, vegetation surveys

Increasing Agricultural Production

Table 15 shows the aspects of agricultural production.

- Objective: Boost agricultural productivity through better water and soil management.
- Indicators:
  - Increase in crop yields.
  - Improved food security.
  - Increased agricultural income levels.

Monitoring Strategies:

- Crop yields: Regular measurements of harvested crops per unit area.
- Food security: Use household surveys and market analysis to assess food availability.
- Income levels: Monitor changes in agricultural income and economic benefits
.

Table 15. Aspects related to agriculture.

Criterion	Indicator	Monitoring Method
Agricultural Production	Crop yields	Harvest records, satellite imagery
Food Security	Household surveys	Community assessments
Agricultural Income	Income monitoring	Financial records, surveys

Strengthen Local Water Management Committees

- Objective: Build the capacity of community-based water management groups.
- Indicators:

- Active committee participation and regular meetings.
- Clear roles and responsibilities within committees.
- Capacity building and training for members.

Monitoring Strategies:

- Committee activity: Track attendance, decision-making, and participation in meetings.
- Capacity building: Document training sessions and skills acquired.

Table 16. Aspects of local water management committees.

Criterion	Indicator	Monitoring Method
Committee Effectiveness	Meeting frequency and participation	Meeting records
Community Involvement	Engagement in decision-making	Surveys, interviews
Capacity Building	Training sessions	Attendance logs, feedback surveys

Promote Cross-Sectoral Collaboration

- Objective: Foster collaboration between local government sectors to align strategies for water, land, and agricultural management.
- Indicators:
  - Joint initiatives between water, land, and agriculture sectors.
  - Information exchange across sectors.
  - Policy alignment and coherence in management strategies.

Monitoring Strategies:

- Collaborative initiatives: Track joint projects and integrated management efforts.
- Information sharing: Document meetings and exchanges between sectors.
- Policy coherence: Review alignment between water, agriculture, and environmental policies.

Table 17. Aspects of promoting cross-sectoral collaboration.

Criterion	Indicator	Monitoring Method
Cross-Sector Collaboration	Joint initiatives and projects	Project documentation
Information Sharing	Meeting frequency	Meeting minutes
Policy Alignment	Coherence in management policies	Policy reviews

Table 18 shown provides a comprehensive framework for monitoring and evaluating the implementation of catchment management strategies. The indicators, baseline, and target are flexible, depending on the specific catchment data available.

Table 18. Monitoring and Evaluation Framework.

Objective	Indicator	Target	Data Source	Collection Method	Frequency	Responsible Person
Ensure increased water retention and availability during periods of low rainfall.	Water Storage Levels	Increased	Local Water Authorities	Water Level Monitoring	Quarterly	Water Resource Officer
	Baseflow Measurements	Increased	Hydrological Monitoring Reports	Streamflow Gauging	Quarterly	Hydrologist
	Water Usage Efficiency	Improved	Water Usage Reports	Field Surveys	Annually	Water Resource Manager

Improved water quality and reduced pollution	Chemical Contaminant Levels	Reduced	Water Quality Testing	Sampling and Lab Analysis	Quarterly	Environmental Specialist
	Microbial Contaminants	Reduced	Water Quality Testing	Sampling and Lab Analysis	Quarterly	Environmental Specialist
	Sediment Load	Reduced	Sediment Surveys	Field Sampling	Annually	Environmental Specialist
Minimize soil loss and prevent sediment from clogging rivers, streams, and reservoirs.	Erosion Rates	Reduced	Soil Erosion Monitoring	Field Surveys	Annually	Soil Scientist
	Sediment Accumulation	Reduced	Sediment Surveys	Field Sampling	Annually	Environmental Specialist
	Soil Stability	Improved	Soil Erosion Monitoring	Field Surveys	Annually	Soil Scientist
Boost agricultural productivity through improved water management and soil conservation.	Crop Yields	Increased	Agricultural Surveys	Field Surveys	Annually	Agricultural Extension Officer
	Food Security	Improved	Household Surveys	Field Surveys	Annually	Agricultural Extension Officer
	Income Levels	Increased	Household Surveys	Field Surveys	Annually	Agricultural Extension Officer
Strengthen the capacity of community-based water management groups to lead local conservation efforts	Committee Activity	Increased	Committee Reports	Meeting Reports	Quarterly	Local Committee Leader
	Community Engagement	Increased	Community Surveys	Surveys and Interviews	Annually	Community Leader
	Capacity Building	Increased	Training Reports	Field Surveys	Annually	Capacity Building Coordinator
Foster cooperation among local government sectors to align water, land, and agriculture strategies	Joint Initiatives	Increased	Government Reports	Meeting Minutes	Biannually	Government Coordinator
	Information Sharing	Increased	Government Reports	Meeting Minutes	Biannually	Government Coordinator
	Policy Alignment	Achieved	Government Reports	Meeting Minutes	Biannually	Government Coordinator

6.2 Evaluation Techniques

The best approach to evaluate the progress and the effectiveness of a project or a plan is to conduct a feedback mechanism during and after the implementation period, this can be through developing list of questions align with the main objectives and the information needs of key stakeholders and conduct a field survey for instance.

6.3 Learning aspects

To ensure continuous improvement and resilience in project management, it's essential to capture lessons learned from the implementation of the management plan. Establishing a process for documenting best practices, successes, and challenges faced during the project is crucial. Encouraging knowledge-sharing among stakeholders through workshops, training sessions, and community exchanges fosters a culture of continuous improvement. Integrating these learnings into future management plans and strategies enhances their effectiveness. Additionally, promoting a culture of learning by actively involving local stakeholders in reviewing outcomes and refining approaches based on experiences ensures that the project evolves and adapts effectively.

6.4 Reporting Mechanisms

- Clear guidelines for reporting to stakeholders and decision-makers.
- Frequency of reports and structure (monthly, quarterly, annually, Table 19).

The foundation of effective reporting lies in understanding the diverse needs of stakeholders and decision makers. Effective stakeholder reporting involves delivering the right information, in the right format, at the right time using clear communication strategies that enhance transparency and support informed decision-making.

Create a reporting schedule to keep stakeholders informed. While quarterly or annual reports are standard, some stakeholders may require more frequent updates. Utilize dashboards and reporting tools for easy access to current information. Based on the monitoring and evaluation framework, its preferable to have a quarterly report contains the water storage levels, base flow measures, and the chemical and biological contaminants based on monthly recorded data base, in addition to the community activity which have to be reported quarterly. The table below indicates the frequency of reports for each indicator.

Table 19. Monitoring indicators and corresponding reporting frequencies.

Indicator	Frequency		
	Quarterly	Biannually	Annually
Water Storage Levels	x		
Baseflow Measurements	x		
Water Usage Efficiency			x
Chemical Contaminant Levels	x		
Microbial Contaminants	x		
Sediment Load			x
Erosion Rates			x
Sediment Accumulation			x
Soil Stability			x
Crop Yields			x
Food Security			x
Income Levels			x
Committee Activity	x		
Community Engagement			x
Capacity Building			x

Joint Initiatives	x
Information Sharing	x
Policy Alignment	x

6.5 Adaptive Management

Mechanisms for adjusting strategies are essential for maintaining the effectiveness and resilience of project management. This can be achieved through regular monitoring and evaluation, collecting data on key indicators, and review progress against the set goals to identify areas needing adjustment. in addition to adopt an adaptive management approach, which is a structured, iterative process of robust decision-making in the face of uncertainty, involves making decisions as part of an ongoing process, learning from the outcomes, and adjusting strategies accordingly. Scenario planning is used to anticipate potential future conditions and develop flexible strategies that can be adjusted as conditions change, helping to prepare for various possible futures and make informed decisions. Moreover, versatility in resource allocation to respond to unexpected challenges or opportunities is a clear feature of flexible management style where it is easy to reallocate funds, personnel, or other resources to areas where they are most needed at any given time. While still the regular stakeholder engagement, through community meetings, surveys, and workshops, is crucial for gathering diverse perspectives and insights, ensuring that evolving needs and conditions are understood and addressed.

7 Conclusion and Recommendations

7.1 Summary of Key Points

The key issues for the implementation of improved water management through a catchment management plan are listed below. These include the primary objectives, strategies, and outcomes of the catchment management plan.

The main objectives for the catchment management plan developed in the Burqaa project are:

1. Promoting Sustainable Use of Water Resources by
    a. Implementing water-saving technologies and practices.
    b. Encouraging the use of alternative water sources, such as recycled water.
    c. Educating communities about water conservation techniques.
2. Improving Soil and Land Conditions by
    a. Adopting soil conservation practices like contour ploughing and agroforestry.
    b. Restoring degraded lands through reforestation and controlled grazing.
    c. Monitoring soil health regularly to guide land management practices.
3. Ensuring Active Community Participation:
    a. Involving local communities in decision-making processes.
    b. Providing training and capacity-building programs for community members.

These strategies for water management not only help in achieving the management objectives but also foster a sense of ownership and responsibility among community members.
In the light of these objectives and strategies, some indicators have been specified to highlight crucial aspects of effective water resource management. These ensure the sustainability, and the health of catchment areas and include:
Water Availability During Dry Seasons: This is critical for maintaining agricultural productivity and ensuring water supply for domestic, livestock and industrial use. Techniques like rainwater harvesting on the supply side, and promoting efficient irrigation systems on the demand side, can help manage this.
Water Quality: Regular monitoring of pollutants and maintaining standards for drinking water and agricultural use is essential. This includes managing sources of contamination and implementing purification processes. In addition, training on the correct application of fertilizers and pesticides may help reduce negative impacts.
Soil Erosion: Preventing soil erosion helps maintain the agricultural production capacity of the soil, as well as the quality of water bodies. Practices like afforestation, terracing, and using cover crops can be effective in avoiding soil loss.
Agricultural Productivity: Sustainable farming practices, crop rotation, and the use of more drought-resistant crops can enhance productivity while conserving water.
Functionality of Local Water Management Committees: These committees play a vital role in managing local water resources, resolving conflicts, and implementing policies. Their effectiveness often depends on community involvement and proper training.
Collaboration Among Different Sectors: Integrated water resource management requires cooperation between agricultural, industrial, and urban sectors. This ensures that water use is balanced and sustainable.
Monitoring and evaluation these indicators help in making informed decisions and adapting strategies to changing conditions. Recommendations for Stakeholders:

- ✓ Begin the conversation early with all the stakeholders from the planning phase.

- ✓ Assure the continuity of these conversations during the whole project cycle by agreeing on a regular meeting date as regular communication is key to gaining stakeholder support.
- ✓ Build the trust by being transparent in your objectives and goals, plans, and be strict to the timeline.
- ✓ Stay consistent with your messaging and whenever there is a need to change; be clear about what has changed and why.
- ✓ Some stakeholders want the opportunity to voice their opinions and their needs; therefore, provide multiple ways for stakeholders to share their inputs.
- ✓ Whenever, there is a complain, try connecting with the complaint stakeholder in person rather than relying on their online feedback so that issues can be resolved with limited misunderstandings.
- ✓ Keep your plans flexible and adaptable to assure the sustainability and the long-term success.

Generally, catchment management plan must focus on the reality of biophysical and socio-economic aspects. Even though, the concept of catchment management is similar, one catchment management plan does not fit for other catchments, due to different factors. For example, water scarcity is the main problem in Hakim Gara catchments and land degradation issues in Upper Dabena catchment. The main reason for the difference is rainfall variability and land use and cover condition. Also, socio economic parameters have influence in catchment management plan through stakeholders' participation and involvement in every step of the planning process.

8 Literature

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Table 20. Look up interventions table – Harar target areas – Burqaa Phase II

Biophysical controlling factors				**Recommended water balancing, Agro-forestry, and livelihood improvement interventions**			
Land cover	Agro-Climate	Slope class	Legend	Water balancing interventions		Restoration (Environment)	Income generating activities
				Soil and Water conservation measures (SWC)	Water harvesting/recharging interventions		
Open forest	Dry	Flat (<5%)		-Micro basins (Half-moons) - tie ridges/ grass strips - Zai pits,	-Sand dams (On-stream) -Harvesting surface runoff -Retention ditches	-Reforestation/ Agro-forestry practice -Seedlings - Nursery sites	-Bee hives -Plantation of drought resistant fruit trees; that adaptable to Agro- ecological zone
		Low slope (5-15%)					
		Medium slope (15-30%)		-Gabion check dams (on-stream) -Soil /stone bunds - Bench terraces	-Runoff retention basin - Infiltration ponds		
		High slope (>30%)		Area closure Bench terraces	-		-
	Moist	Flat (<5%)		-Micro basins (half-moons) -Grass strips	-Sand dams (On- stream) -Harvesting surface run off -Roof top water harvesting	-Reforestation/ --Agro-forestry practice -Seedlings - Nursery sites	- Bee hives - Plantation of fruit trees; that adaptable to Agro- ecological zone -Bee hives
		Low slope (5-15%)		-Fanya Juu -Stone/soil bunds			
		Medium slope (15-30%)		-Check dams			
		High slope (>30%)		-Area closure -Bench terraces			-
Croplands and mixed farming	Dry	Flat (<5%)		-Pre-season ploughing -Water conservation tillage -Mulching -Field bunds	-Roof top water harvesting -Construction of artificial pond (Off -stream) -Sand dams (On-stream) -Water retention ponds	-Crop rotation -Low tillage Compost/	- Production of vegetables and crops - Poultry farming - Bee hives
		Low slope (5-15%)					

				-Fanya Juu -Stone/soil bunds		organic manure - seedlings, providing drought resistant crops	
		Medium slope (15-30%)				-	-Bee hives
		High slope (>30%)		-Area closure -Bench terraces		-	-Bee hives
	Moist	Flat (<5%)		-Field bunds -Grass strips -Tie ridges -Fanya Juu -Stone/soil bunds	-Construction of artificial -water retention ponds - Roof top water harvesting	- Improved varieties for seedlings, nursery sites, - Improved and hybrid breedings	- Bee hives - vegetables and food crops - Poultry farming - Cow fattening/ Dairy farm
		Low slope (5-15%)					
		Medium slope (15-30%)				-	
		High slope (>30%)		-Gabion check dams -Area closure			-
Range lands	Dry	Flat (<5%)		-Grass strips -Zai pits -Micro basins	- Sand dams - Infiltration ponds	-	-Cow fattening and dairy farm
		Low slope (5-15%)					-Bee hives -Poultry farming

	Moist	Flat (<5%)		-Micro basins -Stone /soil bunds -Gabion check dams	-Sand dams -Infiltration ponds	-	-Pig farming -Fish farming -Cow fattening -Dairy farming
		Low slope (5-15%)					-Poultry farming
		High slope (>30%) & Leptosols	-	-Bench terraces -Area closure			
Urban area/homesteads				Roof top water harvesting			
Permanent water/ Wetlands				Fish farming, pig farming, wetlands and flood plain protection			
Wurch (elevation > 3,200 masl)			------	Area closure and forestation			

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