Landscape Restoration

– Training Manual

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Table of contents

Introduction 6
1.1. Objective 6
1.2. Why the course material 7
1.3. The process 7
1.4. Target Audience 7
1.5. The structure 7
1.6. The training tools 8

Module 1: Plan and Choose the Most-effective Restoration Strategies 10
1.1. Identification of ecosystem services provided by landscapes. 10
1.1.1. Major ecosystems and ecosystem services in a landscape. 10
1.1.2. Identification, prioritization and mapping of ecosystem services 11
1.2. Socio-economic considerations in forest and landscape restoration 17
1.2.1. Stakeholder engagement 17
1.2.2. Governance and forest landscape restoration 18
1.2.3. Gender and youth 20
1.2.4. Engaging indigenous people 22
1.3. Identification of restoration measures to be placed in a landscape 24
1.3.1. ROAM 24
1.3.1.1. Preparation and planning 24
1.3.1.2. Data collection and analysis 30
1.3.1.3. Results to recommendations 36

Module 2: Selection and implementation of sustainable land management measures 38
2.1. Introduction 38
2.2. General principles for selection and design of SLM measures 38
2.3. SLM measures on cultivated land 41
2.3.1. Alley cropping 41
2.3.2. Bench Terrace 42
2.3.3. Bunds and Fanya Juu (level & Graded) 44
2.3.4. Grass Strip 46
2.4. SLM measures on grassland 46
2.4.1. Controlled grazing 46
2.4.2. Cut and Carry 49
2.4.3. Grassland Improvement 50
2.5. SLM measures on forestland 52
2.5.1. Hillside terrace 52
2.5.2. Micro-basin 53
2.5.3. Tree planting 53
2.5.4. Trench 55
2.6. SLM measures common to all land use types 58
2.6.1. Exclosures 58
2.6.2. Cutoff drain 58
2.6.3. Check-dams 59
2.6.4. Revegetation 61

Module 3: Integrated landscape management 62
3.1. Integrating different SLM measures within a landscape 62
3.2. Integration of physical SLM measures with forage plants and other high value crops 65
3.1.1. Context, benefits and recommended steps 65
3.1.2. Social, environmental, institutional and economic considerations 66
3.1.3. Stakeholders 66
3.1.4. Opportunities, assumptions, costs and timing 67

Module 4: Monitoring and evaluation 68
4.1. Developing the monitoring plan or program in the planning phase 68
4.2. Promoting the participation of key stakeholders 68
4.3. Tools for monitoring and evaluating restoration measures 69
4.3.1. Indicators 69
4.3.2. The FAO monitoring and reporting tool 72
4.3.3. Participatory Monitoring and Evaluation 74
4.3.4. Citizen science 76

Sources of Finance and Financing Mechanisms 77
Conclusion 78

Tables

Table 2. Selected ES and criteria of importance 14
Table 3: Examples of categories of FLR interventions based on three land-use situations 26
Table 4: Guiding questions to identify assessment criteria 27
Table 5: Summary of "preparing and planning" phase (source: IUCN and WRI 2014) 29
Table 6: Diagnosing the key success factors 36
Table 7: Main points of discussion in the validation workshop (source: IUCN and WRI 2014) 37
Table 8: Width of cultivated area on a bench terrace (source: Hurni et al. 2016). 44
Table 9: Design parameters for level and graded bunds and Fanya Juu (Source: Hurni et al. 2016). 45
Table 10: Recommended spacing for grass strips down a slope 46
Table 11: Variables, definition and examples in relation to calculating for controlled grazing. 48
Table 12: Potential conservation practice to improving grassland management 51
Table 13: Examples on the possible dimensions of cutoff drain 59
Table 14: FAO monitoring and reporting tool 73

Figures

Figure 1. The structure or flow of the course. 8
Figure 2: levels in the management of natural resources 11
Figure 3: Steps for rapid ES assessment for site prioritization. 13
Figure 4: Land use land cover map of the central rift valley river basin: a) 2009, b) 2018. 15
Figure 5: Bathymetric maps of Lake Hawassa in 1999 and 2011. 16
Figure 6: Mean monthly water balance of Lake Ziway from 1986 to 2000. 16
Figure 7: Theory U: Collective awareness, strategic approach and collective action 17
Figure 8: Characterizing governance intersections with forest landscape restoration 19
Figure 9: Key elements related to governance along the FLR process (note that only some links are noted here for illustrative purposes). 19
Figure 10: Governance system for Source-to-Sea approach 20
Figure 11: Typical stakeholder groups relevant to a ROAM process 28
Figure 12: Analysis approach as determined by data availability (source: IUCN and WRI 2014). 31
Figure 13: Computing the marginal value of restoration interventions 32
Figure 14: Small dam full of fresh water in Abreha we Atsbeha, Tigray 33
Figure 15: Costs of watershed protection and building new "grey" structure (the example from the united states). 34
Figure 16: Screenshot of the FAO EX-ACT tool (Version 8) 35
Figure 17: The fifteen traditional agroecological zones of Ethiopian highlands. 39
Figure 18: Alley cropping in steep slope 41
Figure 19: Marking a 1.5-meter vertical interval. 43
Figure 20: Marking level or contour lines 43
Figure 21: Marking graded terraces 44
Figure 22: How to select fields for a cut and carry system. 49
Figure 23: A cross-section of hillside terrace 52
Figure 24: Layout of micro-basins in a site 53
Figure 25: Proper planting of a landscape tree. 55
Figure 26: Types of trenches. 56
Figure 27: Schematic diagram of staggered trenches. 57
Figure 28: Check dams in a landscape 60
Figure 29: Land resource planning as part of an integrated land resource decision-making process 62
Figure 30: Human activities and land use determines the sustainability of land resources 63
Figure 31: Various targets for achieving natural resources management goals 64
Figure 32: Links between targets set at different levels 64
Figure 33: Challenges of smallholder farmers 65
Figure 34: Fodder trees planted on the bank of a soil bund (Photo: Wolde Mekuria) 67
Figure 35: The restoration goal wheel and potential indicators 72
Figure 36: The three central elements of monitoring, 74
Figure 37: The four steps of a participatory monitoring and evaluation process. 75
Figure 38: Pathways that citizen science can take to influence natural resource management and environmental protection. 76

1. Introduction

The world's population is growing rapidly, and living standards are improving. These positive developments have a drawback: they also increase competition for water and land resources. Particularly, the demand for water is growing for increased food production, manufacturing and energy production. Climate change intensifies these water challenges through changed precipitation patterns, resulting in too much or too little water, or water of poor quality. In this line, recent predictions indicate that less water may be available, and more droughts may occur in the coming decades. This urges us to ensure productive, multifunctional landscapes – where a mix of trees, forests and agricultural lands co-exist and that support the livelihoods of people, produce raw materials, strengthen biodiversity and maintain the water cycle. Restoring degraded landscapes is therefore becoming increasingly important.

Landscape restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. Forest and landscape restoration addresses restoration at a landscape scale, often encompassing several ecosystems and land uses, as a way of enabling users to achieve trade-offs among conflicting interests and balancing social, cultural, economic and environmental benefits. Restoration is widely acknowledged as a way of reversing degradation processes and increasing the contributions of ecosystems and landscapes to livelihoods, land productivity, environmental services and the resilience of human and natural systems. The term "restoration" covers a wide range of conservation, sustainable management and active restoration practices that increase the quality and diversity of land resources, enhancing ecological integrity and human well-being. Thus, understanding the different benefits of landscape restoration; developing skills in planning, identifying, designing and implementing the most-effective restoration measures as well as acquiring skills in monitoring and evaluating restoration measures is critical to ensuring sustainable management of landscape and scaling up of restoration measures.

1.1. Objective

The primary objectives of these modules are to provide training and practice to capacitate participants to identify and plan the most-effective restoration strategies and methodologies, identify ecosystem services provided by landscapes, design and implement restoration measures while integrating physical, biological and socioeconomic aspects, and monitor and evaluate results.

1.2. Why the course material

The success of the implementation of forest and landscape restoration measures depends on it being designed to fit locally specific factors, including environmental features such as the composition of vegetation, surface- and groundwater flows, soil quality and climate; specific community concerns; and potential uses of the interventions. Therefore, implementation of forest and landscape restoration measures requires the development of a plan that addresses these challenges and that involves all relevant stakeholders, including government, non-governmental organizations (NGOs), private sector actors and local communities as well as identification of ecosystem services provided by landscapes and the most-effective measures to improve or maintain ecosystem services. This training material is designed to provide information that guides the implementation of forest and landscape restoration.

1.3. The process

This training material was prepared based on: (a) action research by the International Water Management Institute (IWMI) and its partners, (b) national and international experience related to forest and landscape restoration, and (c) end users or target audience consultation.

1.4. Target Audience

The training is designed for professionals/practitioners at operational level (i.e., agricultural, sustainable land management and forestry experts, extension workers and development agents, and local communities).

1.5. The structure

This training material is comprising of four modules. The first module presents the different ecosystem services obtained from a landscape, methods/approaches used to identify, prioritize and map ecosystem services, the socio-economic considerations of forest and landscape restoration, and a tool for identifying the most-effective forest and landscape restoration measures. The second module highlights the key components of the design, construction and management of sustainable land management practices on cultivated lands, grasslands and forestlands. The third module discusses the integration of different sustainable land management measures in a landscape. The fourth module summarizes the key components of monitoring and evaluating forest and landscape restoration measures. Figure 1 below provide an overview of the different training modules in the course and how they are linked.

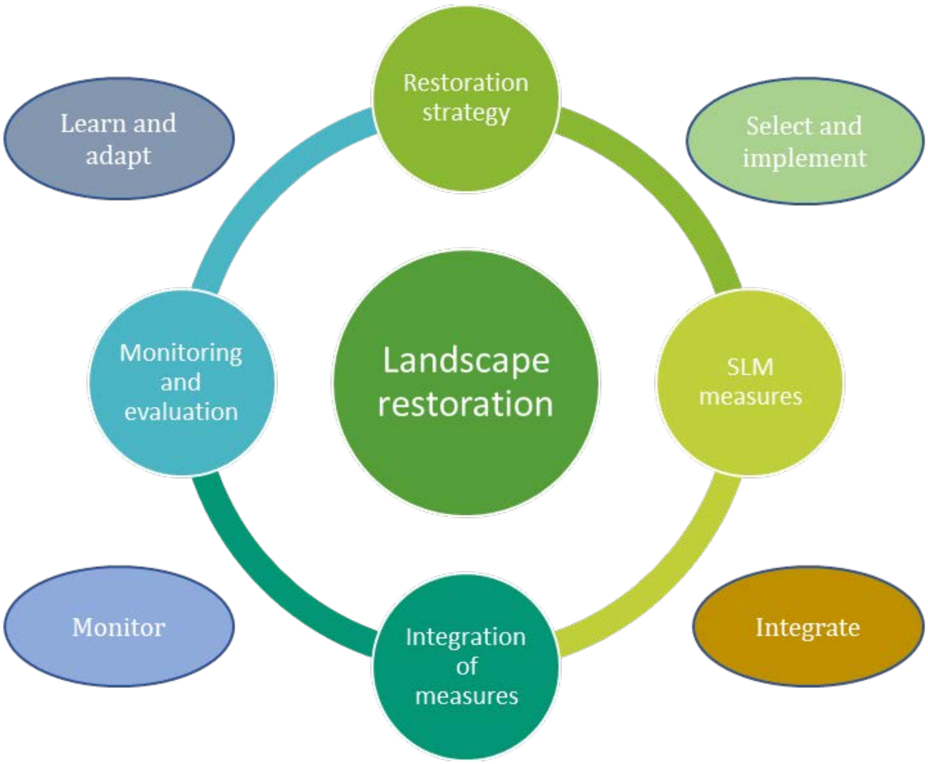


Figure 1. The structure and flow of the course.

1.6. The training tools

This course introduces a few tools and strategies that support forest and landscape restoration including the Restoration Opportunity Assessment Methodology (ROAM), The World Overview of Conservation Approaches and Technologies (WOCAT), The Food and Agriculture Organization of the United Nations (FAO), Forest & Landscape Water-based Ecosystem Services (FL-WES) Tool, and Participatory Monitoring and Evaluation Processes. ROAM provides a flexible and affordable method for countries to rapidly identify and analyze areas that are best suited for forest and landscape restoration and to identify specific priority areas at a national or sub-national level. WOCAT world SLM database, methods and tools helps to spread valuable knowledge in land management, support evidence-based decision-making, and scale up identified good practices, thereby contributing to preventing and reducing land degradation and to restoring degraded land. FAO has also compiled a database of resources related to forest and landscape restoration, including monitoring resources. The course also introduces FAO and World Resource Institute (WRI) guide for practitioners on how to establish a restoration monitoring system. The guide features a step-by-step process for selecting indicators to monitor restoration progress based on specific goals, context, and user needs. Further, the course introduces the FAO EX-Ante carbon balance tool (EX-ACT), which supports to estimate the carbon balance of a program. Finally, the course introduces approaches such as participatory monitoring and evaluation and citizen science to sustain forest and landscape restoration interventions.

Module 1: Plan and Choose the Most-effective Restoration Strategies

1.1 Identification of ecosystem services provided by landscapes.

1.1.1. Major ecosystems and ecosystem services in a landscape.

Although the idea of a "landscape" has different connotations and approaches, it usually includes spatial and temporal dimensions and comprises a variety of different vegetation coverage, many times forming a mosaic or matrix of parcels or patches, whose character is the result of the action and interaction of natural and/or human factors[1]. A landscape includes a wide range of ecosystems including forests, cultivated lands, woodlands, grasslands, wetlands and bushlands and shrublands. The major ecosystems in a landscape provide humans with a range of important provisioning, regulating, supporting and cultural ecosystem services (Table 1).

Table 1. Ecosystem services provided by or derived from major ecosystems in a landscape

Ecosystem services	Benefits to human wellbeing
Provisioning	
Food	Production of fish, fruits, livestock feed, grains, natural food products
Fresh water	Storage and retention of water for domestic, livestock, industrial, hydropower, and agricultural use
Fibre and fuel	Production of logs, building materials, carpentry, fuelwood, peat,
Biochemical	Extraction of medicines (medicinal plants), and other materials from biota.
Genetic materials	Genes for resistance to plant pathogens; ornamental species, etc.
Regulating	
Climate regulation	Source of and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes
Water regulation	Groundwater recharge/discharge, surface water flows
Water purification	Retention, recovery, and removal of excess nutrients and other pollutants
Erosion regulation	Retention of soils and sediments
Hazard regulation	Flood control and storm protection
Pollination	Habitat for pollinators
Cultural	
Spiritual and inspirational	Source of inspiration; many religions attach spiritual and religious values to aspects of lakes, streams, wetland and/or forest ecosystems
Recreational	Opportunities for recreational activities
Aesthetic	Many people find aesthetic value in aspects of different ecosystems
Educational	Opportunities for formal and informal education and training
Supporting	
Soil formation	Sediment retention and accumulation of organic matter (e.g., wetlands and forests ecosystems)
Nutrient cycling	Storage, recycling, processing, and acquisition of nutrients (mainly forest and wetland ecosystem).

1 Roe, M. H. (2007)

Several studies[2] have noted that actors whose actions are influential in a territory and its landscapes often have different priorities with regards to ecosystem services derived from a landscape (Fig. 2). These priorities can be divided into three levels: (1) management practices for self-provisioning, (2) practices for income generation and (3) practices to manage ecosystem services of regional and global interests (Fig. 2). The third level of management activities is the most complex level for rural communities and can turn out to be unsustainable or could even harm rural communities economic and social rights. However, it could also offer key opportunities if the first and second levels are placed as a priority of these initiatives[3].

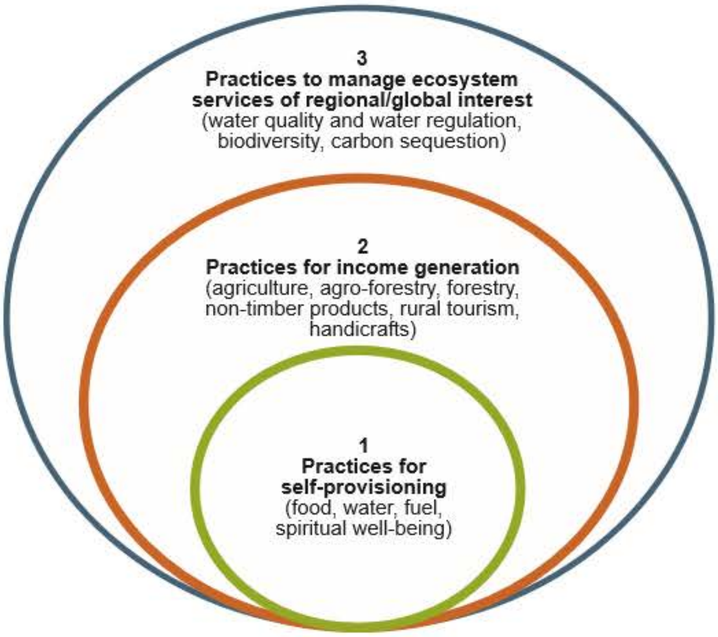


Figure 2: levels in the management of natural resources[4]

1.1.2. Identification, prioritization and mapping of ecosystem services

Ecosystem services (ES)-the benefits that people derive from ecosystems are being increasingly recognized for their contribution to human well-being. In developing countries, such as Ethiopia, people are often directly dependent on these services for their livelihoods. This session of the training focuses on the systematic identification, prioritization and mapping of ecosystem services. This can contribute to:

(i) Informing proper planning and increased contribution of ES to human well-being,
(ii) Ensuring conservation and sustainable management of various services from the landscape,
(iii) Identification of variations in preferences and importance of certain ES by different segments of society. Such analyses will be done through the lens of a socio-ecological system where both social and ecological factors are considered jointly,
(iv) Recognition of synergies between multiple ES while decreasing trade-offs between users, and
(v) Communicate complex information on ecosystem services provided by landscapes across different spatial and temporal scales.

Various tools and approaches have been developed to assess the ES at different spatial and temporal scales. For example, sociocultural values can be assessed with participatory mapping, focus group discussions, household or expert surveys, whereas

[2] Kandel and Cuéllar (2011); Rosa et al. (2003).

[3] Kandel and Cuéllar, 2011

[4] Kandel and Cuéllar 2011; Rosa et al. 2003

economic values can be assessed using cost-benefit analysis. However, this training focuses on one of the frameworks (Fig. 3)[5] developed for rapid spatial assessment of ES that relies on expert and stakeholder consultation and knowledge, available data, and spatial analyses in order to rapidly identify sites providing multiple benefits from ES.

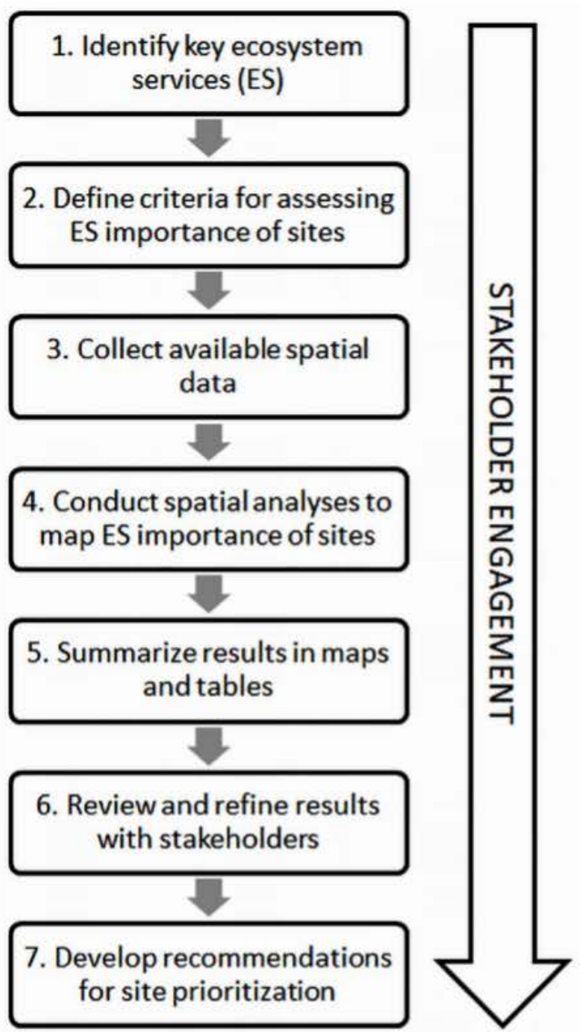


Figure 3: Steps for rapid ES assessment for site prioritization.

1.1.3 Identifying key ES

Specific ES relevant to target area or landscape is identified using a combination of different methods such as literature review, expert workshop, key informant interviews, focus group discussion and transect walk, and field observations.

> *For example, vegetables are an economically important crop in central rift valley and is highly dependent on surface water flows for irrigation; therefore, freshwater ES that support vegetable production is one of the key ES in the central rift valley.*

1.1.4 Define criteria for assessing ES importance of sites

At this stage, most relevant ES are identified and criteria for detailed spatial analyses are developed. Criteria are developed in consultation with stakeholders and experts. Criteria for mapping areas of importance for each ES are developed based on the level of supply of the service, the level of demand for the service, or both. Table 2 summarizes few examples on ES and criteria for importance.

5 Neugarten et al. (2016)

Table 2. Fish for small scale fisheries

ES	Relevance (or why we need to protect an ecosystem in a landscape providing the desired services)
Small scale fisheries	Lake ecosystems in the Rift Valley basin are relatively susceptible to pollution, compared to other lake ecosystems.
Provision of fresh water	Areas providing high levels of water storage (both surface and groundwater), located upstream of areas with high demand for water for domestic consumption (per capita water demand multiplied by population), vegetable production (per hectare water demand multiplied by hectares of vegetables).
Climate mitigation	Forests containing relatively high levels of biomass carbon stock and vulnerable to deforestation, compared to other sites.
Nature tourism	National parks with relatively high numbers of visitors, compared to other parks.

Exercise One

Topic: Ecosystem services and setting criteria for assessing the importance of sites/ecosystems

Activities: Identification of ecosystem services; selecting most relevant ES (e.g., considering the needs of the local communities); defining criteria for importance of sites (see the examples in Table 2)

Type: Group exercise

1.1.5 Data collection, analyses and presentation of results

This step focuses on collecting available data for selected ES for spatial mapping; conducting spatial analyses using different products such as landcover map, population data, and other global and national data, such as data on biomass carbon stock, hydrological flows (such as precipitation and groundwater flows), lakes storage capacity and water levels, national forest cover data, deforestation rate (current and future), people vulnerable to flooding, and park visitation data; and overlaying the different maps and producing a map describing the different ES in a landscape. For example, figures 4, 5, and 6 display land use and land cover (LULC) changes in the Central Rift Valley River Basin (CRVRB), the bathymetric maps of Lake Hawassa, and mean monthly water balance of Lake Ziway, respectively[6],[7].

[6] Mulugeta et al. (2020). In press.
[7] Demelash et al. 2019.

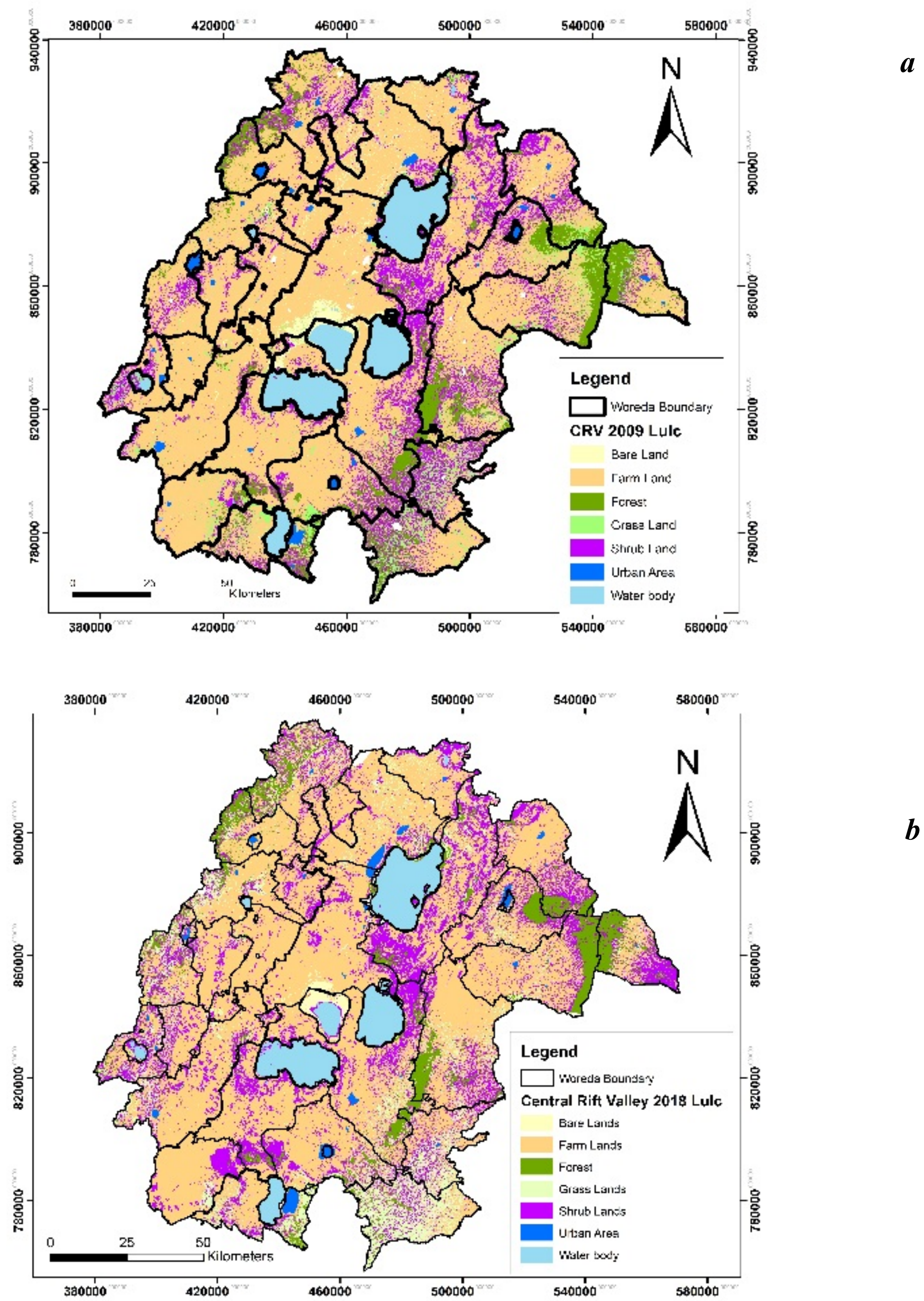


Figure 4: Land use land cover map of the central rift valley river basin: a) 2009, b) 2018[8].

[8] Mekuria et al. 2019. Research report (unpublished).

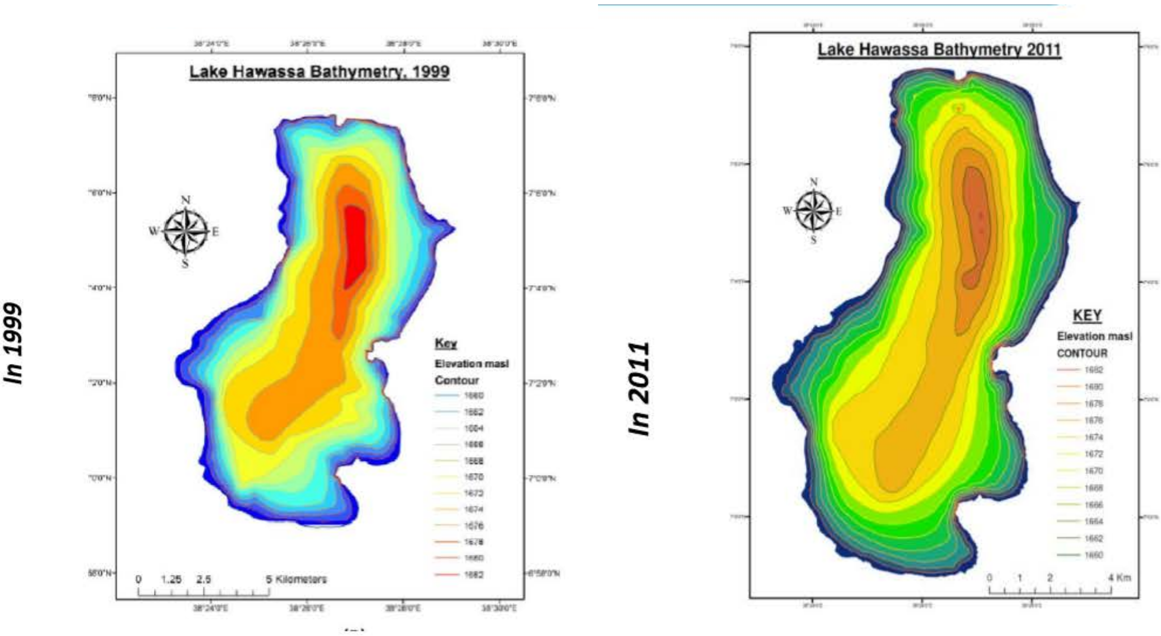


Figure 5: Bathymetric maps of Lake Hawassa in 1999 and 2011.

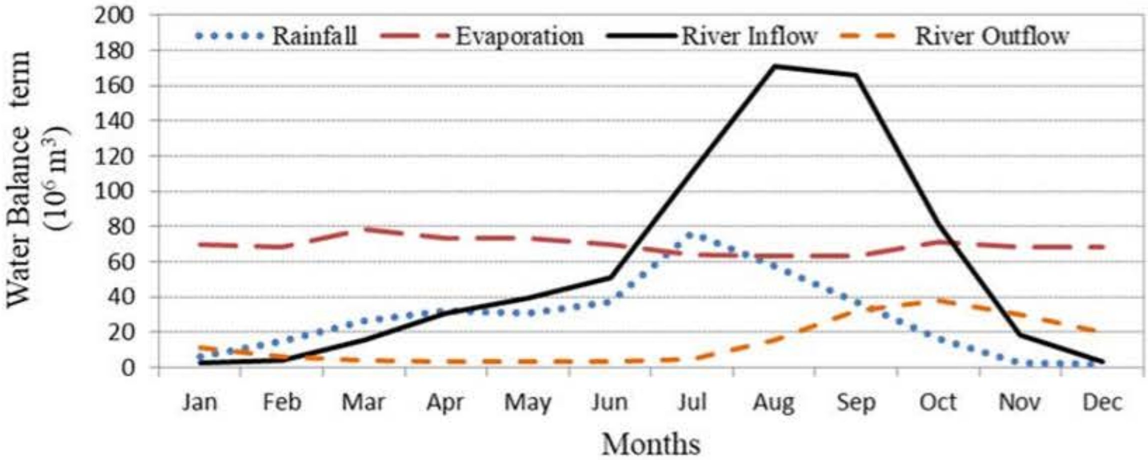


Figure 6: Mean monthly water balance of Lake Ziway from 1986 to 2000.

1.1.6 Review and refine results with stakeholders

This step focuses on presenting the results from the spatial analyses to stakeholders. This activity supports to review the analyses and where possible, validate the maps and other results. For example, foresters are able to verify that sites which the spatial analyses indicated are important for climate mitigation are indeed important based on their own expert knowledge.

1.2 Socio-economic considerations in forest and landscape restoration

1.2.1 Stakeholder engagement

As defined by the IUCN in 2013, landscape restoration is to 'turn barren or degraded areas of land into healthy, fertile, working landscapes where local communities, ecosystems and other stakeholders can cohabit, sustainably'. For restoration of a landscape to happen, alliances between these different stakeholders must be forged based on common understandings of what must and can be done. A theoretical and practical social perspective for this process can be found in the Theory U (Fig. 7). It offers a set of principles and practices for collectively creating the future those stakeholders want to emerge, following the movements of co-initiating, co-sensing, co-strategizing, co-creating, and co-evolving.

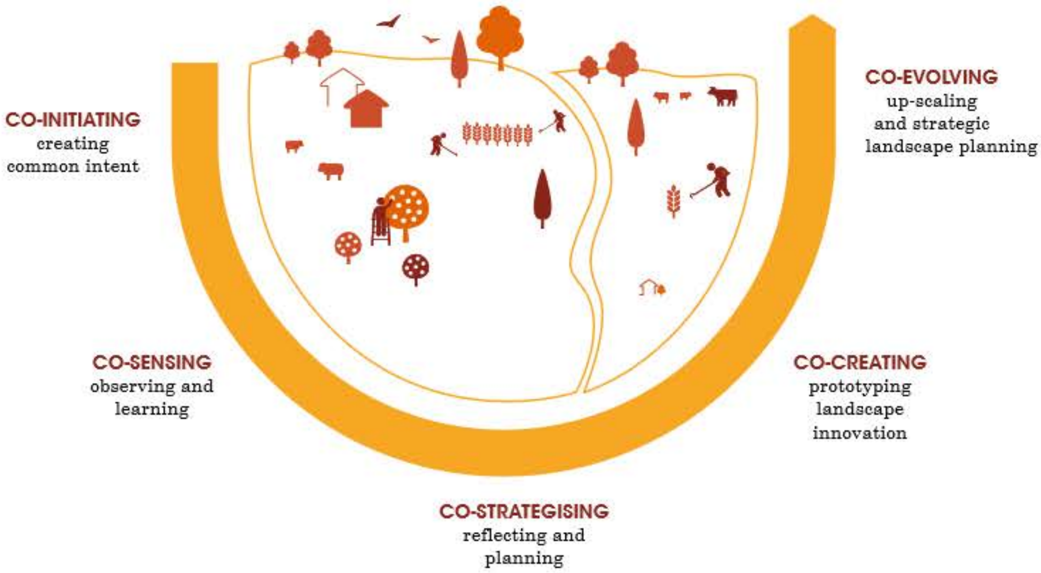


Figure 7: Theory U: Collective awareness, strategic approach and collective action[9]

- Co-initiating –dialogue that identifies issue and the roots of an issue.
- Co-sensing –together the group senses or feels that the issue and its roots need change.
- Co-strategizing –discovering what is in our collective field, our collective way of knowing. The only phase that uses other ways to get in touch with the source besides dialogue.
- Co-creating –developing prototypes to test ideas
- Co-evolving – continuing to test prototypes until they merge into a solution, the continuing to ask: "is it working", "what else can we do", and "who else wants to play"

The learning watershed approach is linked to the Theory U (Fig. 7) in that the learning watershed approach involves examining the interactions among various natural processes and land uses and managing land, water and the wider ecosystem of the watershed in an integrated way. It also supports to undertake interventions using participatory approach and to ensure interaction among different stakeholders. That is, it lays a foundation to exercise the five principles indicated in the Theory U (Fig. 7).

[9] Common land Foundation 2015

1.2.2 Governance and forest landscape restoration

Governance essentially relates to power and decision making. Governance challenges in forest and landscape restoration include: how to reconcile human wellbeing, ecological integrity and economic sustainability? Who decides what to restore? Who pays, and who benefits? Who has got what rights? How are stakeholders engaged? How is capacity build for local stakeholders so that they can be the stewards of the landscape? How are trade-offs negotiated among landscape stakeholders? What policies support or hinder? How are they enforced? How to ensure transparency, clear rules as well as communication? Figures 8 and 9 illustrate the governance intersections and key elements, respectively.

When the system boundary of the landscape approach is a watershed or catchment, the source-to-sea/lake (S2S/L) governance approaches could also be useful (Fig. 10). The S2L approach helps to prioritize and identify intervention strategies that target a key flow threatening the system, such as the example of sediments flows. When the common concern entry point for the landscape approach is water, the S2S/L approach can help identifying key entry points and stakeholders for addressing the water-related issue. The focus on a negotiated and transparent change logic in the landscape approach corresponds to the development of a theory of change for the S2L system based on stakeholder engagement and a transparent diagnosis. Both approaches also emphasize the importance of continued learning and participatory monitoring. The S2L approach can thus add a water and flow lens to the landscape approach.

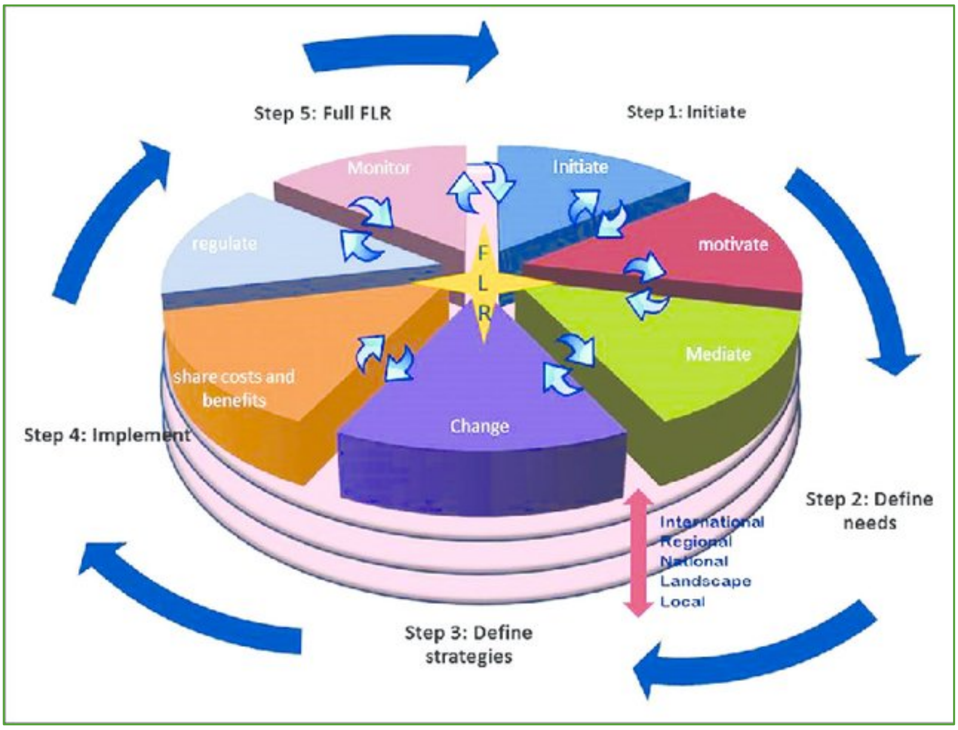


Figure 8: Characterizing governance intersections with forest landscape restoration

Note: The outer arrows illustrate the different steps in an FLR process. The pie chart represents the key governance factors that intersect with FLR, with the whole process being iterative as demonstrated by the 6 pairs of two-way arrows. Finally, all these governance factors operate at different scales.

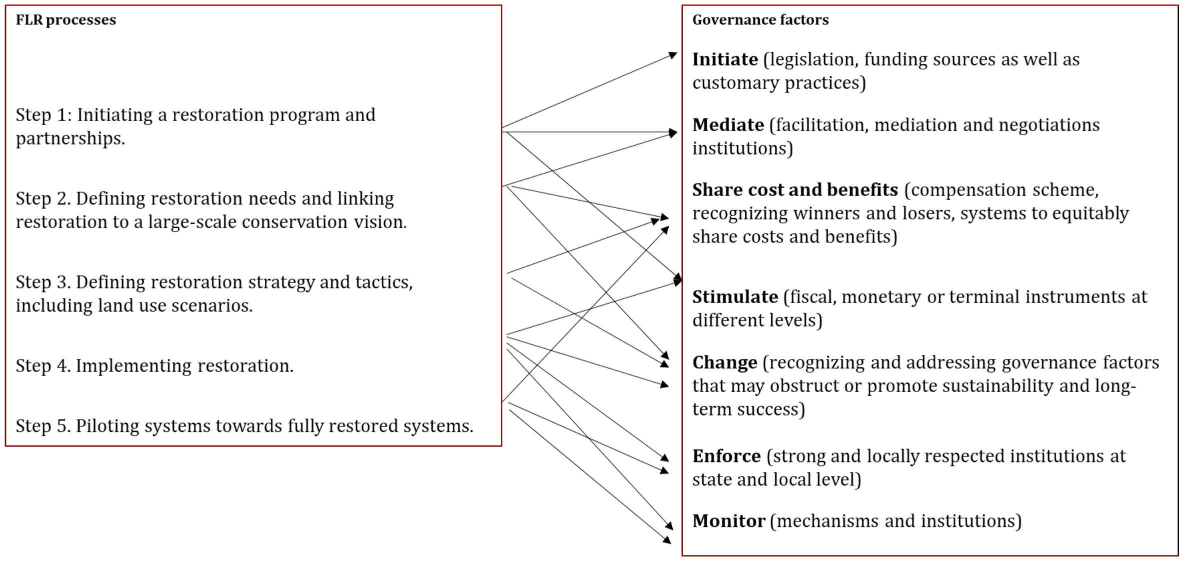


Figure 9: Key elements related to governance along the FLR process (note that only some links are noted here for illustrative purposes)[10].

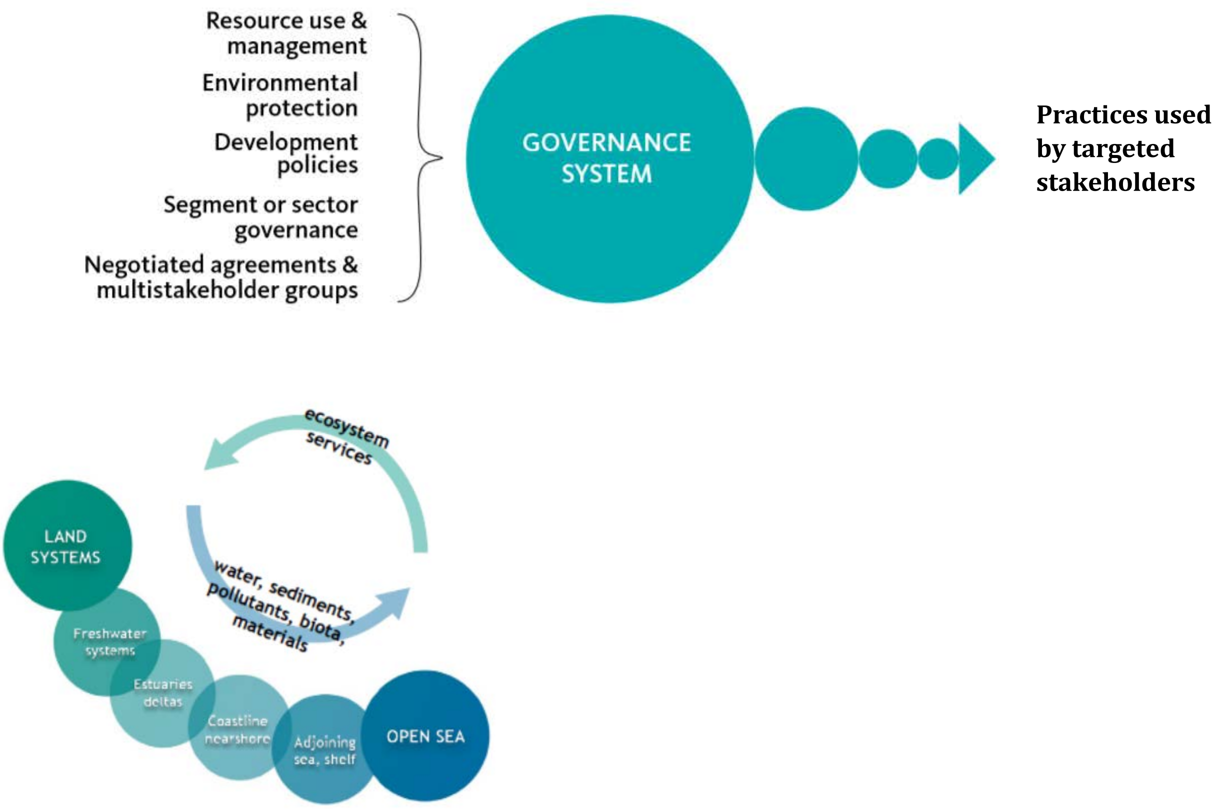


Figure 10: Governance system for Source-to-Sea approach[11]

10 Vallauri et al. 2005.

11 Mathews, R. E., Tengberg, A., Sjödin, J., & Liss-Lymer, B. (2019). Implementing the source-to-Sea approach: A guide for practitioners. SIWI, Stockholm.

1.2.3 Gender and youth

Gender issues are important at all stages of landscape restoration. They should be considered not in isolation, but as an integral part of each stage in the development process: in needs assessments, planning, implementation, monitoring and evaluation of landscape restoration activities. Involving the youth in landscape approaches is also important due to the need to create opportunities for income and employment in rural areas.

Needs assessment

While assessing needs:

- Discover which resources are available in the community, and who has access and control over them.
- Find out who makes various decision in the community, and how. This helps you approach the right people for each decision.
- Identify the different preferences of men, women, children and youth.

Planning

During the planning stage of forest and landscape restoration initiatives, men and women should be equally represented. Encourage all members of the community to be involved in making decision; not just providing information or agreeing to what was proposed. At this stage,

- Try to create an atmosphere that encourage women and youth to participate in planning. That means forming the right grouping for discussion and consider if specific discussion groups for women, men and youth are needed. Find out when in the year and at what times of day women, men and children can attend meetings or do land management work.
- Help the community develop a plan based on the needs of the different members of the community, not biased to any gender or age.
- Try to anticipate the negative impacts of a proposed activity on men, women and children.

Implementation

At this stage, mainly focus on making sure that there are equal numbers of men and women in the group. If women are not free to participate in a mixed group, help them form women-only groups.

Monitoring and evaluation

Monitoring involves gathering and analyzing information as an activity is happening to make adjustment. Evaluation means checking the impact of the activity after it is implemented. In both monitoring and evaluation, data should be gathered on men and women separately, so that they can be compared. Collect information that ensures:

- Men, women and youth are involved in all activities – both in planning and implementing new activities and maintaining existing ones.
- Both men, women and youth participate in management and decision making.
- Benefits are equally distributed to all men, women and youth.
- Project activities met the needs of men, women and youth.
- Projects do not produce unintended negative effects, such as additional workloads, on women and girls.
- Men, women and youth have equitable access to essential inputs.
- The extra time needed to contribute to the activity does not affect the other responsibilities women have.
- The activity improves both women's and youth access to and control over resources.

1.2.4 Engaging indigenous people

It has been recognized that indigenous peoples need to be at the centre of all development, policymaking and planning that affects their lives including forest and landscape restoration initiatives. This is to be achieved by government and civil society's full support of[12]:

- Full and effective participation of indigenous peoples; and
- Indigenous peoples right to free, prior and informed consent.

The engagement of indigenous people or partnerships between government, private sectors, civil societies and indigenous people require: the full and effective participation of indigenous peoples; the opportunity for indigenous peoples to identify concerns, prioritize them and propose solutions that are community driven; and respect, and support indigenous peoples' chosen form(s) of representation, including traditional or customary authority structures. While ensuring these, it is important to recognize the cultural diversity that exists within indigenous peoples and between communities. Accordingly, partnerships must be tailored to the specific characteristics of indigenous communities and development programs (e.g., forest and landscape restoration) must also be responsive to the specific needs of individual communities.

To achieve the above indicated requirements for effective engagement of indigenous people, the UN has developed guidelines. These guidelines include mechanisms for representation and engagement; Design, negotiation, implementation, monitoring, and evaluation; and Capacity building.

Mechanisms for representation and engagement

The UN guideline related to representation and engagement stressed that:

- Governments and the private sector should establish transparent and accountable frameworks for engagement, consultation and negotiation with indigenous peoples and communities.
- Indigenous peoples and communities have the right to choose their representatives and the right to specify the decision-making structures through which they engage with other sectors of society.

Design, negotiation, implementation, monitoring, and evaluation

The guideline for design, negotiation, implementation, monitoring and evaluation discusses the importance of:

- Allowing for the full and effective participation of indigenous peoples in the design, negotiation, implementation, monitoring, evaluation and assessment of outcomes.
- Inviting indigenous people to participate in identifying and prioritizing objectives, as well as in establishing targets and benchmarks (in the short and long term);
- Accurate and appropriate reporting by governments on progress in addressing agreed outcomes, with adequate data collection and disaggregation.
- Adopting a long-term approach to planning and funding that focuses on achieving sustainable outcomes and which is responsive to the human rights and changing needs and aspirations of indigenous communities.

Capacity building

The guideline on capacity building highlights:

[12] United Nations 2005: Guidelines for engagement with indigenous peoples. United Nations Workshop – 2005; International Conference on Engaging Communities – Brisbane, Australia.

- The need for governments, the private sector, civil society and international organizations and aid agencies to support efforts to build the capacity of indigenous communities, including in the area of human rights so that they may participate equally and meaningfully in the planning, design, negotiation, implementation, monitoring and evaluation of policies, programs and projects that affect them.
- The need to build the capacity of government officials, the private sector and other non-governmental actors, which includes increasing their knowledge of indigenous peoples and awareness of the human rights-based approach to development so that they are able to effectively engage with indigenous communities.
- The need for human rights education on a systemic basis and at all levels of society.

1.3 Identification of restoration measures to be placed in a landscape

This session of the training presents the Restoration Opportunities Assessment Methodology (ROAM)[13] that helps to: (a) identify and analyze the potential for forest and landscape restoration (FLR), and (b) locate specific areas of opportunity at a national, subnational or landscape level.

1.3.1 ROAM

ROAM involves three major phases: preparation and planning, data collection and analyses, and results to recommendations. The two phases of ROAM: data collection and analyses and results to recommendations could benefit from the preceding section: section 1.1.2. *Identification, prioritization and mapping of ecosystem services*, as this section discusses the methods/approaches for gathering and presenting information on ecosystem services.

1.3.1.1 Preparation and planning

This phase of the assessment includes seven interrelated activities: defining the problem and objective, partnership engagement, defining outputs and scope, stratification of assessment area, identification of FLR options, identification of assessment criteria and indicators, and planning the work.

(i) Defining the problem and forest and landscape restoration (FLR) objectives

At this stage of the assessment, the key issues to be considered include identifying the scale and, boundaries of the area to be restored, key environmental challenges of the target area (e.g., land degradation, soil erosion, siltation of water bodies, water flows, changes in precipitation patterns, deforestation, declining soil productivity, etc.); relate FLR objectives to national, sub-national or sectoral policies and ensure that FLR is relevant to multiple sectors. SIWI's source to Sea approach also suggested to look at upstream-downstream interaction when defining the problems and forest and landscape restoration objectives (see Figure 10).

(ii) Engaging key partners

This activity focus on finding an institutional home for the assessment and establishing the team to coordinate and lead the assessment. This is to ensure credibility and follow-up of the assessment's findings, and close collaboration between different ministries, scientific institutions, landowners and with other partner organizations. Ensuring a trustful collaboration among partner organizations is critical since one institution/organization will not have all the necessary technical or practical expertise required to oversee the assessment (due to the multi-sectoral nature of FLR).

(iii) Defining the outputs and scope of the assessment

[13] IUCN and WRI (2014)

Defining the outputs and scope of the ROAM process will be something of an ongoing process during the early stages of the assessment. It will be a matter for discussion not only within the assessment team but also with other experts and stakeholders during the inception workshop. However it is important for the team to go into the inception workshop with a clear idea of what the assessment can practically deliver, given time and resource constraints, as this will help avoid lengthy, open-ended debate on these fundamental matters or the setting of overly ambitious aims.

Exercise Two

Topic: Preparation and planning
Area of interest: Central Rift Valley
Activities: Statement of objectives of a ROAM, identification institutional home and key stakeholders, forming assessment team and composition and intended outputs.
Type: Group exercise
Materials: Stationery (Markers, charts, ...)

(iv) Stratifying the assessment area

Most countries or landscapes contain significant diversity in terms of the distribution of major physical, ecological and socio-economic features. This activity is mainly important to delineate relatively homogeneous areas or strata in terms of its restoration-relevant characteristics. This process of stratification will be important later, as it will enable the analysis to use the same default values (e.g. population growth rates, labour costs and per hectare productivity) for each sub-area.

The actual criteria used in stratification will be determined by data availability and by the major characteristics of the assessment area, such as topography, hydrology (e.g., water flows, severity of siltation of water bodies), land use and drivers of degradation. As each sub-area should be coherent and distinct from other sub-areas, it is strongly recommended to start with the agroecological basics, such as rainfall, temperature, altitude, major soil types, etc. Other criteria can then be considered, such as: land cover, population density, common natural resource-dependent sectors, and level of demand for specific forest products (surplus/deficit).

(v) Identifying potential FLR options

While doing this activity, most likely you will start with a longer – and quite detailed – list of locally appropriate interventions and during the assessment several of these options will be combined and some will be discarded. After several iterations and consultations with – and feedback from – stakeholders provide the final restoration options. By the end of the process you will probably have a concrete list of between five and fifteen interventions. At this early stage of the process the best way to produce your list of possible interventions is to classify ongoing restoration activities in your area by, for example, those that take place primarily on forest land, agricultural land, and those that take place primarily to protect slopes, rivers, or wetlands (Table 3).

The topics/issues discussed in section: 1.1.2. *Identification, prioritization and mapping of ecosystem services* could be used here as an input for identifying potential FLR options. For example, the identification of ecosystem services important for a community and the ecosystem providing the services (Table 2, page 14) helps to focus in on a particular land use type (Table 3). This in turn supports to facilitate the identification FLR options relevant the land use type.

Table 3: Examples of categories of FLR interventions based on three land-use situations[14]

Current land use	Current land sub-type	General category of FLR options
Forest land	Land without trees, have two options: Degraded forests:	Planted forests and woodlots, or Natural regeneration. Natural regeneration; Silviculture
Agricultural land	Permanently managed land: Intermittently managed land:	Agroforestry Improved fallow
Protective land and buffers	Degraded parks/protected areas Other protective land or buffer	Park/protected land Watershed protection and erosion control

(vi) Identifying criteria and indicators to identify areas to be restored and potential FLR interventions

Beyond the limited number of criteria used to guide stratification, the team will need to identify a broader set of assessment criteria that can be used to analyze FLR potential within each sub-area. Importantly, these criteria should be selected on the basis that they can help assess the core issues of a ROAM process, including the need for FLR, identification of potential FLR options, scope of the assessment, costs and benefits of FLR, and the legal, institutional, policy and financial limitations/opportunities. Table 4 presents some questions, related to these five factors, which can be considered when identifying assessment criteria.

Table 4: Guiding questions to identify assessment criteria.

Layers of analysis	Possible questions to guide selection of assessment criteria
Need for FLR based on existing national priorities	What parts of the area are in need of, or would benefit from, restoration?
Type and **potential** of appropriate FLR interventions (to address needs)	What types of restoration would be most appropriate and most needed? What needs could they help address?
Scope and **availability of land**, by FLR intervention type	What intervention types would be suitable where? What is the overall potential coverage of each intervention type? What types of land tenure regimes are in place? What are the government policies or strategies for these areas? Are landowners and land users interested in restoration? Are there any commercial or community interests in the area? Are there any conflicting interests?
Economic **costs** and **benefits** of potential FLR interventions	How much would these potential interventions cost, overall and by intervention type? What economic benefits could they deliver? To whom? Over what time frame?
Legal, **institutional**, **policy** and **financial** limitations/ opportunities	Which of the existing policy and institutional arrangements are conducive to restoration? Which create barriers to restoration? What financing sources are available or could be secured?

14 IUCN and WRI (2014)

Exercise Three
Topic: Setting criteria and indicators based on the five factors or layers of analyses (see Table 4).
Area of interest: Central Rift Valley
Activities: Defining the focus of the assessment and providing examples of criteria and indicators.
Type: Group exercise
Materials: Stationery (Markers, charts, ...)

(vii) Planning the work

This activity comprises of three sub-activities: identifying data and capacity needs, planning for stakeholder engagement, and organizing the inception workshop. ROAM is explicitly designed to work with existing data, even when these are limited. A more pragmatic approach to address data gaps is the use of Delphi-type surveys. A Delphi survey involves collecting opinions from relevant experts over several iterative rounds with the results of each round given as feedback to the survey participants, allowing them to comment on and refine the collective knowledge of their peers. It is also acceptable to use values generated for other areas with similar characteristics to the assessment area, as long as it is made clear that the analysis is based, in part, on secondary source data. You may also need to look for proxy indicators for some of the criteria you have selected, if directly related data are not available.

Once you have some idea of the kinds of information you will need and how much data is readily available, you can see whether the capacities of the assessment team will need to be supplemented by identifying and calling on additional in-country expertise. For example, you might need to secure the help of national experts to prepare and analyze GIS maps using different series of spatial data (e.g. land cover, land use, etc.).

The key strategic question at this stage is how best to combine the expertise of local and national experts ("best knowledge") with existing datasets, maps and literature ("best science"). A combination of technical expertise, stakeholder engagement and other data sources tends to give the optimal result. The next task for the team is to identify the main stakeholder groups relating to FLR in the assessment area. Stakeholder groups can be categorized in different ways, and for the purposes of this training three types of stakeholder are identified (Fig. 7): Primary (direct) stakeholders – for example landowners, land users, downstream communities; Secondary (indirect) stakeholders (e.g., different government agencies; and Interest groups (e.g., national experts, national and international NGOs).

The assessment team should, if possible, organize an inception workshop to inform key stakeholders of the potential for FLR and engage their interest and involvement in the ROAM process right from the start. This is essential in order to obtain political and professional ownership of the assessment process and commitment to its results. Depending on the scale of the assessment, the workshop will be at a national, subnational or landscape level. Table 5 summarizes the first phase of the ROAM process.

Table 5: Summary of "preparing and planning" phase (source: IUCN and WRI 2014)

Key parameters	Some questions to consider
Define the problem and objectives for FLR in the assessment area	What is the major land-use challenges? How can FLR help address these challenges? How can FLR contribute to national policies on, for example, rural development, timber/pulp/energy production, food and/or water security, natural resource management, conservation?
Engage with key partners	Which institution(s) would be most suitable? Which other institutions should be closely involved? What knowledge and skills are needed on the assessment team? Which in-country individuals can be brought onto the team?
Define the specific outputs of the assessment	What are the desired outcomes from the assessment? What can the assessment realistically deliver?
Define the geographical scope of the assessment	At what scale will the assessment be done (national or sub-national)? Is this feasible, given the resources available?
Stratify the assessment area	What are the main distinguishing features (in terms of restoration- relevant characteristics) between different parts of the assessment area? What are the factors behind this heterogeneity? Can we base the stratification on the area's agroecological zones?
Identify a preliminary list of potential FLR interventions	What kinds of restoration interventions do we know exist or are feasible in the area? Which other kinds of restoration might be possible?
Identify the criteria and indicators of relevance to the assessment	What ecological and socio-economic restoration-relevant factors are we interested in? What spatial data are available on these factors? Are other data available that we could use as proxy indicators?
Identify a preliminary list of the data required to conduct the assessment and compile an inventory of all available data relevant to the exercise	Given the criteria and indicators that have been identified, what data is needed to assess the potential for FLR, and prioritize potential FLR areas (if this is a desired output)? What data is available and where is it? What is its quality and scale? Is the scale appropriate for the scope of the assessment? What major data gaps exist?
Identify capacity within and outside the assessment team	Who has knowledge about the subjects or of specific degraded areas that could assist the assessment team?
Identify which stakeholders need to be involved, how, and when	Who has a stake in restoration? When and how to engage them? Who do we want to keep informed about the progress and findings? What is the best way to inform them (individual meetings, in a workshop setting, via email, in writing, etc.)?
Inception workshop	What do we want out of this workshop? Who should we invite to achieve this?

1.3.1.2 Data collection and analysis

This chapter of the training covers the core phase of ROAM, involving the collection and analysis of data. It presents the five discrete analytical components: stakeholder prioritization of restoration interventions, restoration opportunities mapping, restoration economic modeling and valuation, restoration cost-benefit-carbon modeling, and restoration diagnostic of presence of key success factors.

(i) Stakeholder prioritization of restoration interventions

This component of the analytical phase of ROAM offers a quick and unique opportunity to establish an unbiased and neutral understanding of land-use change. Spatial analysis offers a good snap-shot of the mosaic of land uses across the landscape at one point in time (*please see section 1.1.2, pages 11-16 of this document*), but in order to place that understanding in a broader context of forest and landscape restoration opportunities, local stakeholders and different government agencies will need to be brought into the analytical process.

The key output of this component is a well-defined set of criteria that enables a credible assessment of the need for restoration, the availability and scope of land for restoration, the types and potential of appropriate restoration interventions, the costs and benefits of these restoration options and the presence of key success factors. This has been done in the previous sessions, but stakeholder engagement should include, as appropriate, a review of these criteria and a discussion on any necessary additions and changes. For this component, collecting primary and secondary data are one of the key activities.

(ii) Restoration opportunities mapping

This is a key element of the whole assessment process, involving the analysis of spatial data (*see section 1.1.2, pages 11-16*) and any other restoration-relevant information that the team has been able to acquire (statistical data, technical reports, etc.) and that can be easily mapped. Depending the availability of data, this can be done using two approaches: digital (if large amount of GIS data is available; *see the examples on page 15 &16, Figures 4 &5)* and knowledge (if there is only limited amount of GIS data) mapping approaches. Both approaches have their strengths and weaknesses – digital mapping can be too precise and risks ignoring local realities if the biophysical data indicate that a restoration option is possible, while knowledge mapping captures a richness of undocumented local and technical insights but is not very specific when it comes to landscape-level biophysical constraints. For this reason, assessment teams may prefer to use a combination of these two approaches. This point is illustrated in Figure 12.

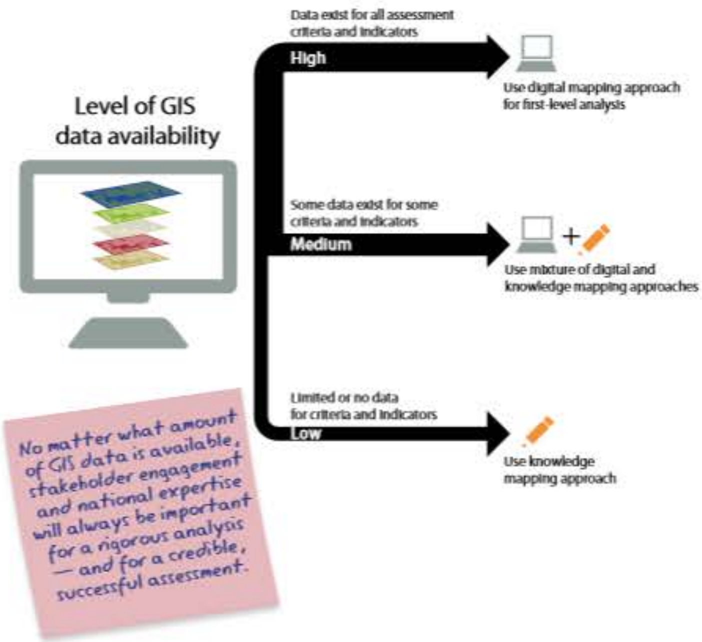


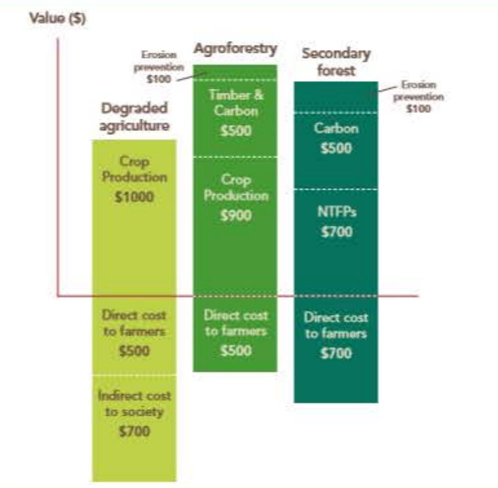
Figure 12: Analysis approach as determined by data availability (source: IUCN and WRI 2014).

(iii) Restoration economic modelling and valuation

While restoration practitioners will ask questions such as where to start and which interventions to use, policy-makers will want to know how much it will cost, who will pay, would public money be better spent elsewhere, and if there is a more cost effective way to deliver the same results. On the other hand, in poor communities, the incentive to extract short-term economic returns from land and natural resources often outweighs perceived benefits from investing in long-term environmental restoration, and related economic and ecosystem returns[16]. Thus, investment in land and natural resource restoration requires a balance between short-term economic returns and longer-term sustainability and environmental goals. The analysis of restoration costs and benefits is therefore a central element of ROAM. The fact that it integrates closely with spatial analysis means that it can offer particularly useful insights for consideration of what constitutes the most supportive policy and institutional framework and it is an essential pre-requisite to the assessment of co-benefits from FLR-driven carbon sequestration and analysis of finance and investment opportunities.

The ROAM approach to analyzing costs and benefits aims to identify how much additional benefit would be expected from a restoration intervention and how much additional cost would be incurred by putting this intervention in place. This type of approach, known as marginal analysis, avoids the need to try to account for all the values in a landscape and all the investments made to sustain those values (Fig. 13).

[16] Mekuria et al. 2020. IWMI Research Report 175.



Land Use	Benefits – Costs	Net Benefit	Marginal Benefit
Degraded Agriculture	$1,000-$1,200	$-200	-
Agroforestry	$1,500-$500	$1,000	$1,200
Secondary forest	$1,400-$700	$700	$900

Figure 13: Computing the marginal value of restoration interventions

(iv) Restoration costs and benefits

Water management benefits and costs

Healthy intact watersheds provide many ecosystem services that are necessary for our social and economic well-being (see Table 1). For example, the experience in the norther highlands of Ethiopia demonstrated that landscape restoration has brought increased fresh water for human and livestock consumption. The interventions implemented in four watersheds in Tigray province, located on the northernmost tip of Ethiopia resulted in large and small dams full of clean water, productive boreholes and even waterfalls (Fig. 14). Many of these services have not been monetized and therefore the economic contributions of healthy intact ecosystems are often under-valued when making land use decisions. However, studies[17] demonstrated that the estimated cost of land degradation associated with LULC change in Ethiopia is about USD 4.3 billion per year. The cost of many interventions to reverse or mitigate land degradation, including the establishment of exclosures, is lower than the cost of inaction by about 4.4 times over a 30-year horizon. This implies that USD 1 spent to rehabilitate degraded lands returns about USD 4.4 to Ethiopia.

[17] Gebreselassie et al. 2016

Figure 14: Small dam full of fresh water in Abreha we Atsbeha, Tigray[18]

Similar experience also exists in the United States where ecosystem services provided by healthy watersheds are difficult to replace and most often very expensive to engineer (Fig. 15). Preventing impairments in healthy watersheds protects valuable ecosystem services that provide economic benefits to society and prevent expensive replacement and restoration costs. Maintaining riparian connectivity and natural processes in the landscape provide a supporting network for ecological integrity, ensuring the sustainable and cost-effective provision of clean water over time. Figure 15 shows that watershed protection is less expensive than building new "grey" infrastructure.

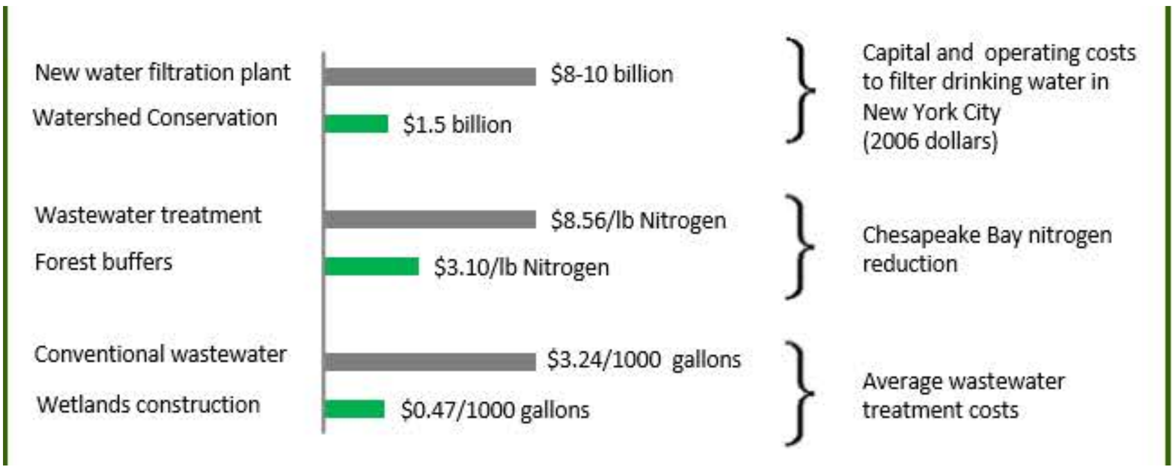


Figure 15: Costs of watershed protection and building new "grey" structure (the example from the united states).

Carbon benefits and costs

[18] http://www.worldagroforestry.org/blog/2016/11/10/water-reward-land-restoration-flows-ethiopias-dry-zone

While the valuation of restoration costs and benefits may have included some consideration of carbon benefits, it is useful to conduct a more thorough analysis of the potential carbon benefits to be achieved through different restoration interventions. Carbon sequestration values can be calculated for each FLR intervention using the FAO EX-Ante carbon balance tool (EX-ACT) (Fig 16). This tool: a) has a set of linked Microsoft excel sheet, b) structured in nine logical topic modules, c) based on land use and management practices, d) equipped with a set of resource (tables, maps, FAO statistical data) that help to populate the tool, e) using IPCC* default values (Tier 1) and/or region specific coefficients (Tier 2), f) comparing the situation without and with project, and g) Adapted to various scales (project, landscapes, region...) (Fig. 16)[19]. It is worth noting that the EX-ACT tool has been approved by donors such as the Green Climate Fund (GEF) and Global Environment Facility (GEF) to calculate carbon benefits of Land Use, Land Use Change and Forestry (LULCF) projects, including restoration projects when applying for funding (see Chapter on Financing).

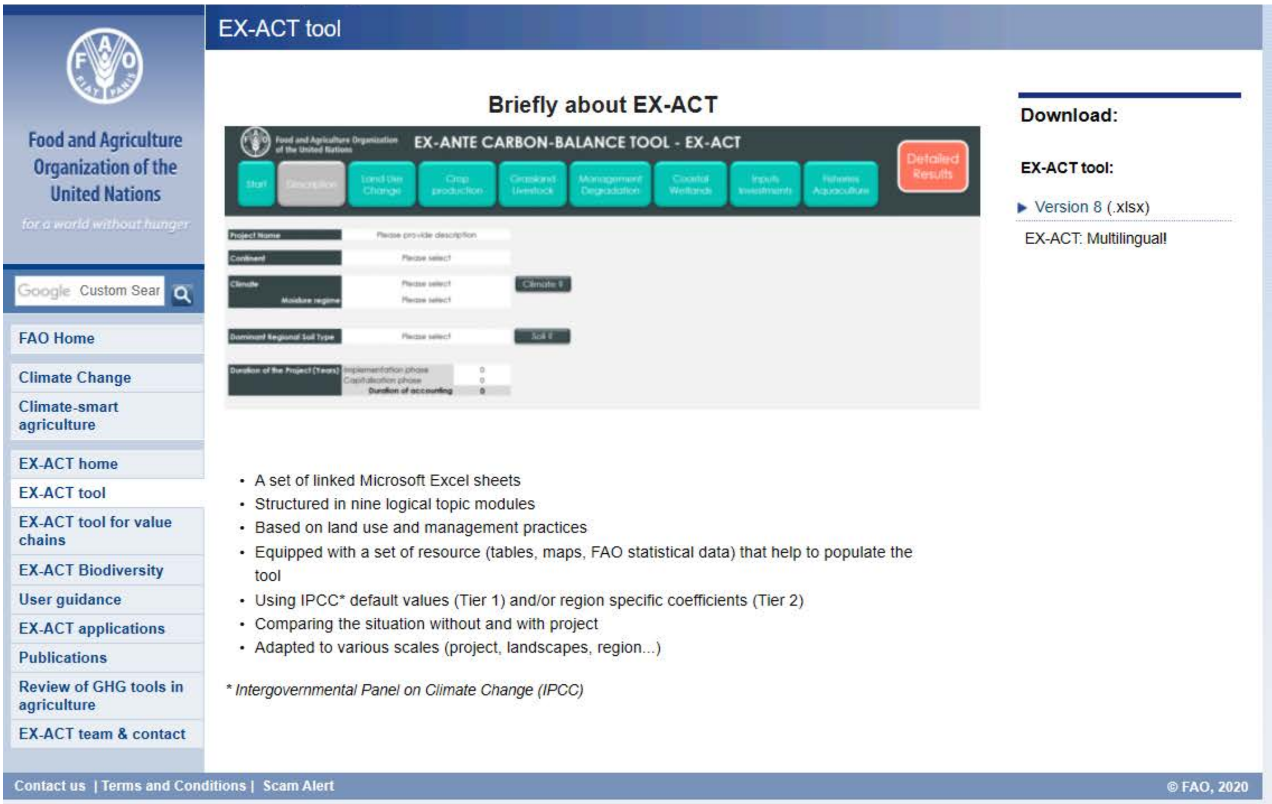


Figure 16: Screenshot of the FAO EX-ACT tool (Version 8).

(v) Restoration diagnostic of presence of key success factors

This component involves a preliminary assessment of the extent to which key success factors are in place in the country or landscape to facilitate restoration at scale. These factors include: the motivations of key actors; the enabling conditions in the country; and the capacity and resources for implementation (Table 6).

[19] FAO 2013

Table 6: Diagnosing the key success factors

Step	1. Select the scope	2. Assess status of key success factors	3. Identify strategies to address missing factors
Activity	Choose the "scope" or boundary within which to apply the diagnosis. The selected scope will be the "candidate landscape".	Systematically evaluate whether or not key success factors for forest landscape restoration are in place for the candidate landscape.	Identify strategies to close gaps in those key success factors that are currently not in place in the candidate landscape.
End product	Candidate landscape for conducting diagnosis	List of missing (partially or entirely) key success factors	Set of strategies
Estimated time	A few days	1-2 weeks	1-2 weeks

1.3.1.3 Results to recommendations

By this stage, the ROAM process has gone through several iterations of data collection and spatial and non-spatial analyses and has generated an overall picture of the opportunities for forest and landscape restoration at the national (or sub-national) or landscape level. But to generate realistic recommendations and lead to concrete follow-up actions, it needs to be presented and discussed with a wider set of stakeholders and experts than have been involved in the work thus far. This final phase of ROAM therefore plays a critical part in ensuring its credibility and impact. The specific aims for this phase of the assessment are to:

- Test the validity and relevance of the assessment results.
- Analyze further the policy and institutional implications of the results.
- Build support for the assessment results among decision-makers; and
- Draft policy and institutional recommendations and plan for next steps.

Organizing the validation workshop is one of the approaches to achieve the above objectives. Main points of discussion in the validation workshop is summarized in Table 7.

Table 7: Main points of discussion in the validation workshop (source: IUCN and WRI 2014)

Elements of assessment	Questions/topics to discuss
Priority FLR interventions identified (i.e. top 5 or 6 interventions)	• Are these the real priorities? • What land uses do they implicate? • Does the potential geographic scale of these interventions make sense? • Which areas or districts might offer potential opportunities for early action on FLR? • How do these priority interventions align with existing plans and programs of key ministries?
Economic analysis (i.e. costs and benefits of priority FLR interventions)	• Do the anticipated returns from the landscape restoration interventions make sense? • How does this compare with the established costs and benefits of other interventions aimed at improving similar categories of land use? • Do those who bear the costs receive a proportionate amount of benefits?
Carbon analysis	• Discuss the carbon benefits from the priority FLR interventions • Do the estimated carbon benefits make sense both at the per ha and national level? • How do the priority interventions relate to national REDD+ strategies?
Water analysis	• Discuss the freshwater benefits from the priority FLR interventions • Do the estimated water benefits make sense both at the per ha and national level? • How do the priority interventions relate to national one WASH program?
Finance/resourcing analysis*	• How can the priority FLR interventions be financed using: o existing investment mechanisms? o new sources of funding? • What are the main financing priorities to promote the FLR interventions?
Policy, legal and institutional analysis*	• What national policies and other measures would stimulate restoration? • What knowledge, tools, capacity and finance are most needed to promote FLR? • How can the demand for restoration be strengthened: o Improved market conditions? o Improved capacity at district level? • Direct payments to landowners? • Awareness raising campaign. • How can coordination across different land-use ministries be improved?

Module 2: Selection and implementation of sustainable land management measures

2.1. Introduction

Sustainable land management (SLM) is defined as the adoption of land use systems that, through appropriate management practices, enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources[20]. SLM includes management of soil, water, vegetation and animal resources. SLM also includes ecological, economic and socio-cultural dimensions.[21] SLM measures for prevention, mitigation and rehabilitation of land degradation and restoration of ecosystem services can be classified into four categories:

- **Agronomic measures** – are measures that improve soil cover (e.g. green cover, mulch), measures that enhance organic matter/soil fertility (e.g. manuring), soil surface treatment (e.g. conservation tillage), and sub-surface treatment (e.g. deep ripping)
- **Vegetative measures** – include plantation/reseeding of tree and shrub species (e.g. live fences, tree crows), grasses and perennial herbaceous plants (e.g. grass strips)
- **Structural measures** – include terraces, bunds, dams, pans, ditches, walls barriers, palisades
- **Management measures** – include change of land use type (e.g. exclosures), change of management/intensity level (e.g. from grazing to cut-and-carry), major change in timing of activities, and control/change of species composition.

Any combinations of the different types of measures are possible and integration of different measures will also be discussed in the module.

2.2. General principles for selection and design of SLM measures

The selection and design of SLM measures consider agroecological zones, severity and extent of erosion damage or risks, the factors causing erosion, as well as the suitability of land to the identified intervention. To support the identification of agroecological zones, Hurni et al. (2016) classified the Ethiopian highlands into fifteen traditional agroecological zones based on altitude and annual rainfall (Fig. 17). Each zone is different for mainly two reasons: rainfall and temperature. SLM measures are different for each zone. Therefore, it is important to know in which zone you are located when you carry out the selection and design of SLM measures. In this classification, 'dry' is defined as having less than 900 mm of annual rainfall. 'Moist' is between 900 mm to 1400 mm, and 'wet' is above 1400 mm of annual rainfall. The main characteristics of each zone are listed in the boxes, including most important crops, traditional SLM measures, soils on slopes, and natural trees.

[20] Liniger et al., 2011
[21] Hurni, 1997)

Figure 17: The fifteen traditional agroecological zones of Ethiopian highlands.

SLM measures are directed at protecting the soil from raindrop impact and hydraulic forces of runoff. The process involves four areas of attention: (a) reduction of raindrop impacts on soil; (b) reduction of overland flows; (c) increase infiltration rate, and (d) slowing runoff velocities. In general, the selection and design of SLM measures depend on many criteria/factors such as:

- Ecological conditions (e.g. climate, soil characteristics)
- Socio-economic conditions (e.g. farm size and system; labor availability and cost, availability of construction materials)
- Production/economic benefits (e.g. agricultural productivity)

- Ecological benefits (e.g. climate adaptation and mitigation, erosion control and water security)
- Socio-cultural benefits
- Off-site benefits (e.g. reduction in siltation of water infrastructure)

WOCAT (World Overview of Conservation Approaches and Technologies; www.wocat.net) provides a global database for SLM practices. WOCAT is also since 2014 the recommended database for reporting on SLM best practices to the United Nations Convention to Combat Desertification (UNCCD). WOCAT has documented a total of 83 technologies and approaches in Ethiopia and also published a book in 2010 with a compilation of sustainable land management technologies and approaches. The database includes measures such as exclosures with ditches and terraces combined with multipurpose grasses or shrubs, as well as participatory approaches, such as local level participatory planning and Learning Watersheds. Below we introduce several SLM measures that are considered suitable for landscape restoration activities in the Rift Valley.

Exercise Four

Topic: Identification the agroecological zone
Area of interest: central rift valley
Activities: Your area is situated in one of these zones. You can find the box which best fits the local conditions of your area. Read the descriptions given in each box. Try to identify the zone in which your area is situated. Try first to find the most suitable agricultural crops listed in the box. If there are still several possibilities, compare the other descriptions as well, and then make your selection. Now, try to find the most suitable box from the figure above.
Type: Group exercise
Materials: Stationery (Markers, charts, ...)

2.3. SLM measures on cultivated land

2.3.1. Alley cropping

Description

Alley cropping is an agroforestry system in which food crops are grown in alleys between rows of hedges. The hedges follow the contour and consist of trees and shrubs such as Leucaena or Pigeon peas. Leguminous perennials are more suitable as they fix nitrogen. Hedges can also be placed on conservation structures. Tree species used in agroforestry in Ethiopia include: Acacia albida, Sesbania and Leucaena, Bamboo. [22]According to WOCAT database, Alley cropping can be applicable in different agroecological zones including moist and wet dega; moist and wet weyna dega; moist and wet kolla, and moist berha. It is suitable for all slope and soil ranges including shallow and degraded soils.

Design and management

Spacing between rows of hedges should not be more than 5 meters. On hedgerows, trees and shrubs can be spaced 25–100 cm apart. When cutting, take care that shrub is cut above lowest split of branches and not below, to support fast regrowth.

[22] Hurni et al. 2016

Alley cropping is applied by individual landholders on their land, and the products are at their own use. Trees are planted in rows of pits along the contour spaced with a vertical interval of up to 5 meters on steep slopes (Fig. 18).

Figure 18: Alley cropping in steep slope[23]

Planting must be narrow in the hedge (every 1 m). Weeding and pruning is required. Grazing between rows of trees only with tied cattle; Cut and Carry is even better. Crop production shifts between trees, leaving a strip fallow after cultivation for about 3–5 years to let the soil regenerate. Use traditional knowledge about soil fertility improvement and tree management. Raising trees requires careful supervision by the farmer who applies alley cropping on his/her land. Grazing should not degrade the grass cover. Crops are allowed only if soil fertility has improved. Crop rotation is a must. Regular cutting of tree branches for mulch and fodder gives the desired benefit.

2.3.2. Bench Terrace

Description

Bench terracing is flat beds constructed by earthen embankments across the slope with cut and fills method and serve as barriers to break slope length and reduce the degree of slope. Bench terrace can be applicable in different agroecological zones including all high dega, all dega, all weyna dega, all kolla, and moist berha. It is suitable for slopes with gradients up to 50% and for all soils including shallow and degraded soils.

Design and management

Bench terraces must be spaced with a vertical interval, which is two-and-a-half times the depth of reworkable soil. If the soil is 1 m deep, the vertical interval is 2.5 m. Figure 14 shows marking 1.5 m vertical interval in the field. Horizontally, level terraces are lined out with the line level as shown in figure 19. Graded terraces are lined out as shown in the figure 20 below. Always start lining out at waterway or river and proceed slightly upslope (1%). Always use the pole with the rope fixed higher up, nearer to the waterway, and the pole with the rope fixed at 1 m, farther away, as shown in Fig. 20. Table 8: Summarizes the width of cultivated area on a bench terrace as determined by slope gradient and soil depth.

Continuous upgrading over 5-20 years is indispensable if terraces are developed from bunds. Stabilization of the riser slope through revegetation is recommended. Cutoff Drain for level terraces and continuous improvement of the ditches below graded terraces is necessary to drain excess runoff during storms. Drainage ditches must be emptied from soil

[23] Hurni et al. 2016

deposited after every heavy storm. This is the duty of the farmer to whom the terraces belong. The terraces must be increased and repaired continually until the situation stabilizes.

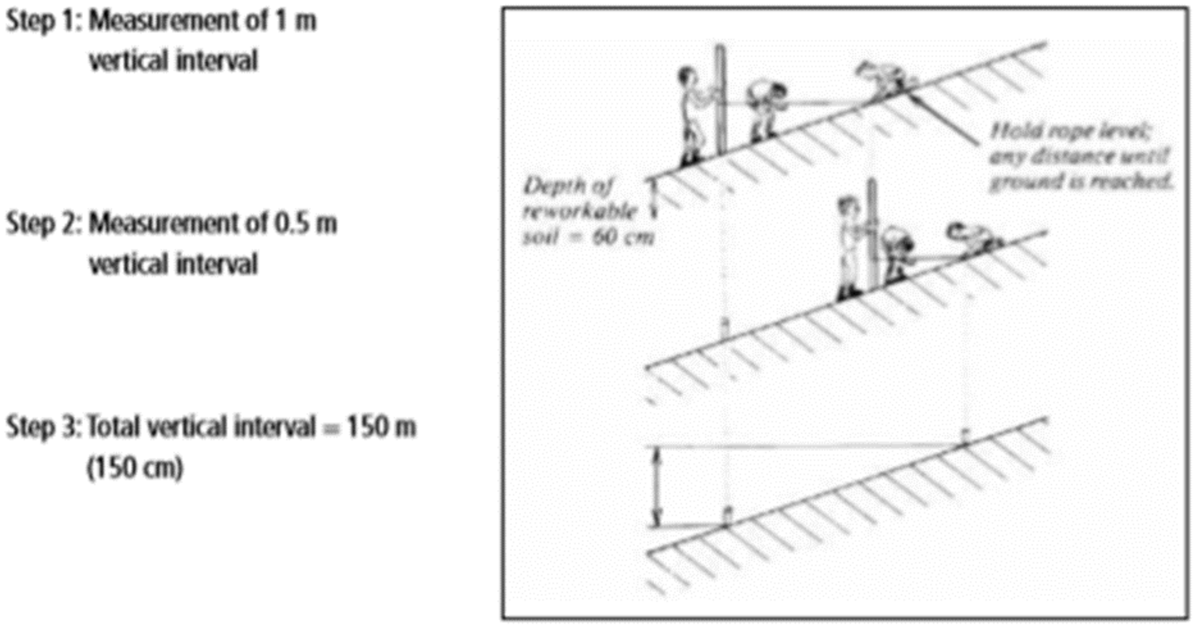


Figure 19: Marking a 1.5-meter vertical interval.

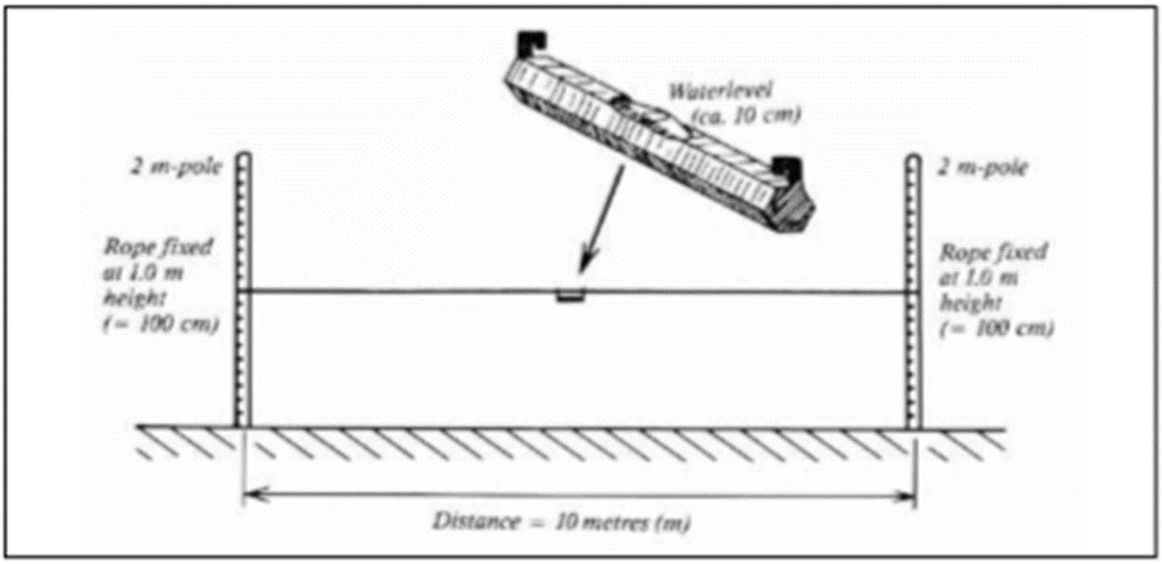


Figure 20: Marking level or contour lines

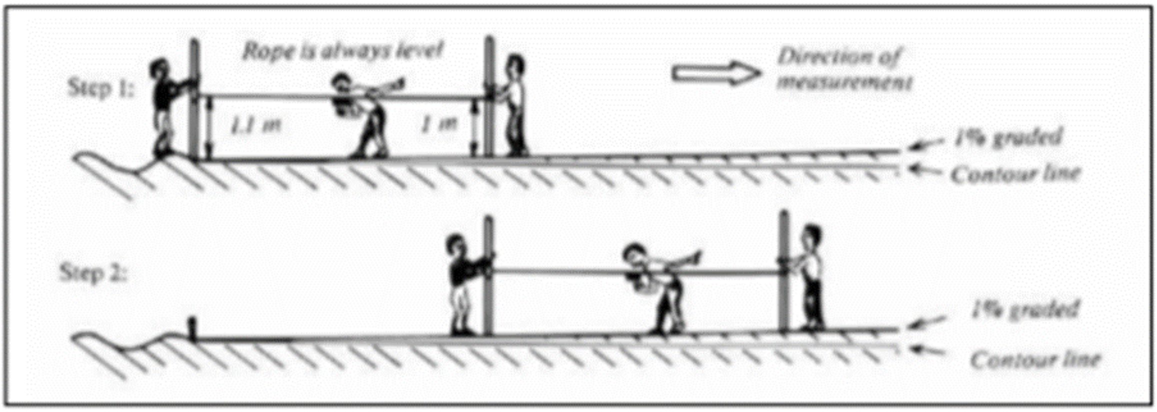


Figure 21: Marking graded terraces

Table 8: Width of cultivated area on a bench terrace (source: Hurni et al. 2016).

Slope gradient (%)	Soil depth (cm)					
	25	50	75	100	125	150
20%	2.8	5.6	8.4	11.3	14.1	16.9
30%	1.8	3.5	5.3	7.1	8.9	10.6
40%	1.3	2.5	3.3	5.0	6.3	7.5
50%	0.9	1.9	2.8	3.8	4.7	6.6

2.3.3. Bunds and Fanya Juu (level & Graded)

Description

WOCAT database on SLM measures indicates that Bunds and Fanya Juu are techniques used in agriculture to collect surface run-off, increase water infiltration and prevent soil erosion. Bunds and Fanya Juu can be applicable in different agroecological zones including all high dega, moist and wet dega, moist and wet weyna dega, moist and wet kolla, and moist berha. They are suitable for slopes with gradients ranges from 3 to 50%; and for all soils in wet agroecological zones, and for clay soils in moist agroecological zones.

Design and management

For the Ethiopian highlands, Table 9 summarizes the specifications for the different kinds of bunds. For graded bunds, no gaps can be provided for ploughing oxen to cross (as for level bunds; i.e., about every 50 m, a gap can be left open to allow oxen pulling ploughs to cross and reach their land) because the graded bund serves as a drainage line which cannot be interrupted. Whenever possible, use and improve traditional waterways in the area where you intend to apply graded bunds. Make the waterways one year before the graded structures to stabilize them before use. If the bunds are long, the basins behind them must be increased towards the waterway, as more and more runoff will have to pass during storms. Revegetation is needed especially on soil bunds in wet areas. Continuous repair during and after heavy storms is indispensable, especially in the first years after construction.

Table 9: Design parameters for level and graded bunds and Fanya Juu (Source: Hurni et al. 2016).

Variable	Bunds		Fanya Juu	
	Level	Graded	Level	Graded
Vertical interval				
For slope < 15%	1 m	1 m	1 m	1 m
For slope > 15%	2.5 * soil depth	2.5 * soil depth	2.5 * soil depth	2.5 * soil depth
Size of ditch				
At the beginning of the ditch				
Depth	50-75 cm	25 cm	1 m	25 cm
Width	100-150 cm	50 cm	2.5 * soil depth	50 cm
When the bund reaches at the waterway or river				
Depth		50 cm		50 cm
Width		100 cm		100 cm

Basic calculations for designing contour bunds

Vertical Interval between bunds (V.I)

*V.I = (s/a + b) * 0.3*

where, S – land slope (%); a and b are constants a = 3 and b =2 for medium and heavy rainfall zones a = 2 and b =2 for low rainfall zones

Horizontal Spacing in between bunds (H.I)

*H.I = V.I/s * 100*

Length of bund per hectare (L.B) = 10000/HI

Exercise Five

Topic: Calculating the vertical interval, horizontal spacing and length of bunds per hectare
Area of interest: central rift valley
Activities: On a 3 per cent land slope calculate the horizontal spacing of bunds in medium rainfall zone and the length of bunds per hectare.
Type: Individual exercise
Materials: Stationery (Markers, charts, ...)

2.3.4 Grass Strip

Description

A grass strip is a ribbon-like band of grass laid out on cultivated land along the contour. They are mainly used to replace physical structures on soil with good infiltration (sandy, silty) found on gentle slopes. Grass strips can be applicable in different agroecological zones including all high dega, moist and wet dega, moist and wet weyna dega, moist and wet kolla, and moist berha. They are suitable for slopes with gradients of less than 15%, and for all soil types.

Design and management

Usually, grass strips are about 1 m wide and spaced at 1 m vertical intervals (e.g., on a 3% slope, grass strip will be 33 m apart). To make a grass strips, make out contour lines at a vertical interval of 1-2 meters or see Table 10. You can sow grass seed, or plant sods from a well-developed grassland nearby. Select a palatable grass species. Cattle must be excluded from this measure all year long to provide for sufficient length of the grasses to slow runoff and retain soil sediment. Grass strips are planted along the contour or along Cutoff Drain

Table 10: Recommended spacing for grass strips down a slope

Slope (%)	Spacing (m)
< 3	>33
3-5	20-33
6-8	13-18
9-11	10-12
12-15	7-9

2.4. SLM measures on grassland

2.4.1. Controlled grazing

Description

Controlled grazing is the management of forage with grazing animals. It limits access to grazing by subdividing pastures with permanent and temporary fences. Controlled grazing can be applicable in different agroecological zones including all high dega, all weyna dega, all kolla and moist berha. It is suitable for well covered rangeland in gentle slope, for all soil types except heavily degraded soils.

Design and management

Controlled grazing is the best method of providing for periodic recovery of grassland. Controlled grazing results in increased amounts of forage harvested by animals; improved forage quality; extended grazing seasons; reduced fertilizer and herbicide applications; reduced labor and feed costs; fewer weeds; and environmentally responsible grazing areas. The maximum number animals allowed varies during the year, being highest after the rainy season when the soil is dry, but low during the rainy season and again especially at the end of the dry season. Therefore, additional fodder must be produced in exclosures, by revegetation and with grassland improvement to overcome shortages in periods of limited access to grassland. Close supervision and active participation of communities in decision making is crucial to sustain the implementation of controlled grazing.

Calculating for controlled grazing

Table 11 summarizes the various parameters; definition and examples of calculating the variables.

Table 11: Variables, definition and examples in relation to calculating for controlled grazing.

Variables	Definition	Example
Stock density	Number of head divided by size of enclosure	One hundred oxen averaging 270 kg each are grazing a 2-hectare enclosure. One hundred oxen times 270 kg equals 27000 kg, or 60 head (450 kg live weight). When divided by 2 hectare, 60 heads equal a stock density of 30 head per hectare.
Stocking rate	Number of head divided by size of grazing area	One hundred oxen averaging 270 kg each are grazing a 16-hectare cell that is divided into 2-hectare enclosures. That equals 60 head (450 kg live weight) divided by 16-hectares for a stocking rate of 3.75 head per hectare.
Rest period	(Number of enclosures times grazing period) minus one grazing period	When grazing 20 enclosures for two days each, the rest period for each enclosure is 40 days minus one grazing period, or 38 days. If the grazing period were one day, the rest period would be 19 days.
Carrying capacity	amount of forage available divided by number of head	a 16-hectare pasture produces an average of 7777 kgs of dry matter (forage less moisture) per hectare per month from March to August. Normal harvest yields 900 kgs per hectare per month. A 270 kg ox will eat approximately 3% of its bodyweight, or 8.1 kgs per day. Dividing 900 kgs by 8.1 kgs equals 111 oxen. Therefore, the carrying capacity is 111 oxen, or 66 animal units per hectare per month.
Residual dry matter	Amount of forage minus amount of forage harvested	A two-hectare enclosure contains 3,500 kgs of dry matter per hectare for a total of 7,000 kgs of dry matter. One hundred oxen will eat 1,800 kgs per day or 3,600 kgs of dry matter in two days. This will leave 3,400 kgs of residual dry mater or 1,700 kgs per hectare. The more-dry matter left, the faster the enclosure will recover.
Profit per hectare	[(Sale weight x price) minus costs] divided by number of hectares	One hundred 270 kgs oxen gain 135 kgs and sell for $75/cwt or $675 each, less a 3% death loss, for a total of $65,475. Each ox costs $450, plus $50 in medicine, fencing and pasture for a total for $50,000. This means a gross profit of $15,475, which, divided by 40 hectares, means $387 gross profit per hectare.

Note: *The difference between stock density and stocking rate: Stock density is the number of animals grazing an enclosure. It is often confused with stocking rate, which is the number of animals on the property. For example, a 500- hectare ranch with 1,000 oxen would have a stocking rate of two oxen per hectare. Dividing the ranch into 20 25-hectare enclosures and putting all the oxen into one enclosure would provide a stock density of 40 oxen per hectare. Strip-grazing each enclosure five times (five 5-hectare strips per enclosure) would give a stock density of 200 oxen per hectare. However, the stocking rate of two oxen per hectare would not change.*

2.4.2. Cut and Carry

Description

Cut and carry, also referred to as zero grazing, is a feeding system where fresh grass is cut daily and fed to housed cows throughout the grazing season. This feeding method is widely practiced by smallholders in many countries and is well suited to small scale dairy production where access to grazing land is in short supply. The primary benefit of cut and carry systems is an improvement in grass utilization, offering potential to increase stocking rates and increase farm output and net margin per hectare. It may be used to provide the complete requirements of cattle kept in a shaded yard or house (zero grazing) or it may be used to supplement grazing. It can be applicable in different agroecological zones including all high dega, all dega, all weyna dega, all kolla and moist berha. It is suitable for all slopes and soil types, except in heavily degraded soils.

Design and management

The design and management of cut and carry requires considering field selection (size, previous use and access; Fig. 22, AHDB 2019); grass (varieties, nutrients) and cutting (growth stage, time of day, machinery)[24].

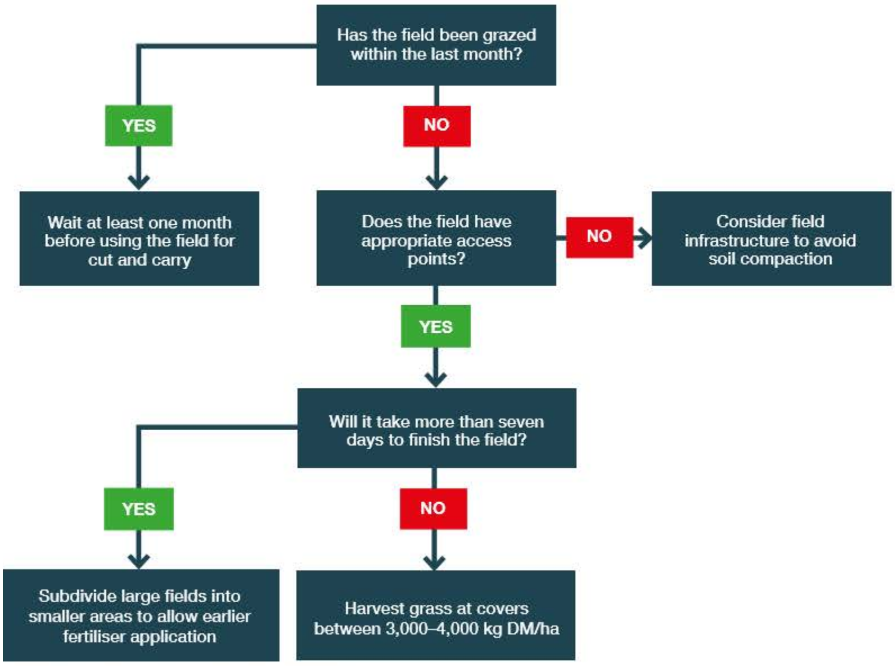


Figure 22: How to select fields for a cut and carry system.

2.4.3. Grassland Improvement

As a landowner or farm operator you face many decisions when managing the resources on your land. When you evaluate options for your grassland or grazing operation, consider implementing some of the conservation practices listed in Table 12 into your grassland/grazing management[25].

[24] Agriculture and Horticulture Development Board (AHDB) 2019. Cut and carry A best-practice guide.
[25] United States Department of Agriculture, Natural Resources Conservation Service. www.ia.nrcs.usda.gov

Table 12: Potential conservation practice to improving grassland management

Conservation practice	Description	Maintenance
Access control	Limiting the amount of time or the time of year that vehicles and/or livestock have access to water bodies, environmentally sensitive areas or hazardous areas.	Barriers should be periodically inspected, and repairs should be performed as needed.
Brush management	Reducing or eliminating undesirable vegetation to increase the vigor, amount and quality of the desired vegetation present, and increase wildlife habitat.	Spot treatment of individual plants or areas needing re-treatment should be done as needed.
Fence	A constructed barrier to control animal traffic patterns to reduce erosion and control access by grazing animals to permit recovery or stockpiling of vegetation.	Routine inspection should be part of an on-going management program. Inspection of fences in the spring after snowmelt and after storm events is needed to determine if weakness, breaks, or malfunctions have affected the intended use of the fence.
Forage harvest management	Timely cutting and removal of forages for optimized yield, quality, stand life, controlling insects and other pests, and to maintain wildlife habitat.	Before forage harvest, clear fields of debris that could damage machinery. Do not cut forages until dew or rain on leaves has evaporated. Mow most recent seedings ahead of older stands.
Nutrient management	Proper placement of the correct amount of nutrients at the correct stage of plant growth to increase forage production, reduce loss of nutrients to surface or groundwater sources and to increase production and profits.	Equipment needs calibrated to ensure uniform distribution of material at planned rates. Document actual rate nutrients were applied. Changes in animal numbers or feed management will necessitate additional analysis.
Pasture and Hay Planting	Establishing desired native and/or introduced forages to supply forages during normally low production periods, reduce erosion, reduce runoff, improve water quality and increase carbon sequestration.	Inspect and calibrate equipment to insure proper rate, distribution and depth of planting. Growth should be monitored for water stress. Cutting, herbicides or grazing management may be needed to control undesirable plants.
Prescribed Grazing	Managing the harvest of vegetation with grazing animals to maintain or improve the desired plant community and ground water quality, reduce erosion, and improve cover for wildlife.	Monitor data and grazing records on a regular basis to ensure objectives are met, or to make necessary changes in the prescribed grazing plan to meet objectives.
Windbreak/Shelterbelt Establishment	Linear plantings of multiple rows of trees or shrubs established that provide shelter for structures, wildlife, livestock and people, improve air quality, provide noise or visual screens, manage snow deposition, and enhance wildlife.	Control competing vegetation. Protect planting from livestock and wildlife, as needed. Replace dead trees as necessary. Supplemental water may be needed for establishment. Protect plantings from fire with fire breaks. Inspect at least every six months.

2.5. SLM measures on forestland

2.5.1. Hillside terrace

Description

A hillside terrace is a structure along the contour, where a strip of land is levelled for tree planting. Hillside terraces are only applied if there is a strong reason to justify their construction. Hillside terraces are mainly used to prevent damage from flooding below steep slopes. It can be applicable in different agroecological zones including moist high dega, dry and moist dega, dry and moist weyna dega, and dry and wet kolla. It is suitable for slopes gradient ranging from 50 to 100%, and for heavily degraded land.

Design and management

Hillside terraces are up to 1 m wide and constructed at about 2–5 m vertical intervals (Fig. 23).
Hillside terraces used for afforestation need little management except that tree planting must be done carefully at the right location on the terrace and at the right time. Regular weeding around the seedlings supports their stabilization and growth. The community is responsible for hillside terraces on afforestation land. It also organizes the use of the grassland between the terraces.

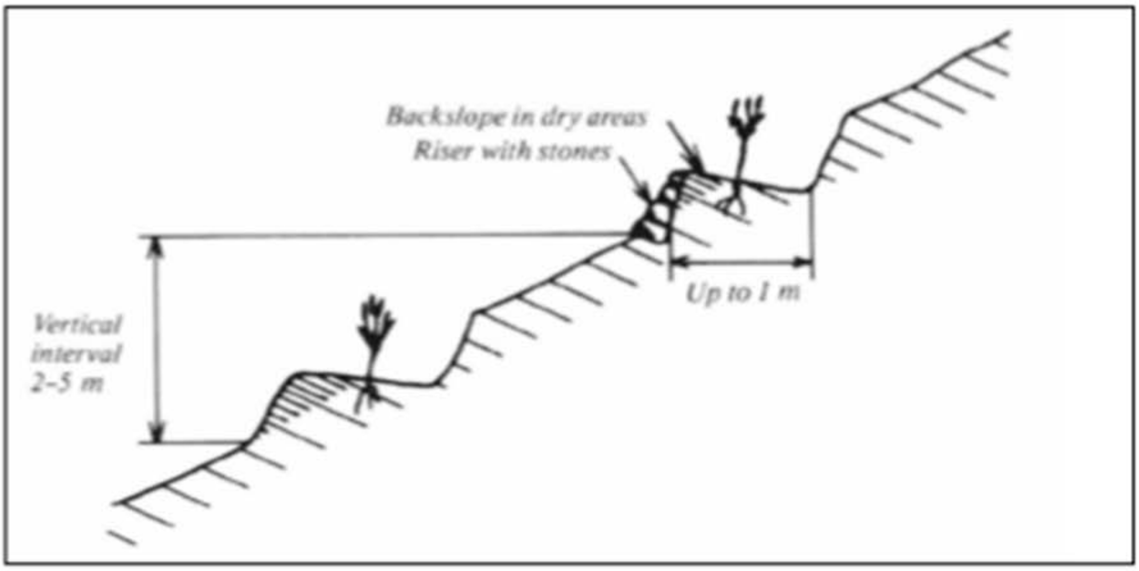


Figure 23: A cross-section of hillside terrace[26]

2.5.2. Micro-basin

Description, design and management
A micro-basin is a small structure with the shape of a half or a full circle, excavated to obtain a small basin for planting a tree (Fig. 24). Micro-basins vary in size according to their designation to conserve water; they are small in moist

[26] *Hurni et al. 2016*

agroecological zones (e.g., 1-meter diameter) and large (e.g., 2m) in dry ones. A micro-basin can be applicable in different agroecological zones including moist high dega, dry and moist dega, dry and moist weyna dega, and dry and wet kolla.

Micro-basins must be carefully lined out on the slope with intermittent placements for runoff control and proper spacing (Fig. 24). The procedures in implementing a micro-basin includes cutting of soil as per site requirement, excavating the earth work in a half moon shape throughout its required length and filling the excavated earth in the upper slope for cultivation. After tree planting, micro-basins require little maintenance but weed control may be needed.

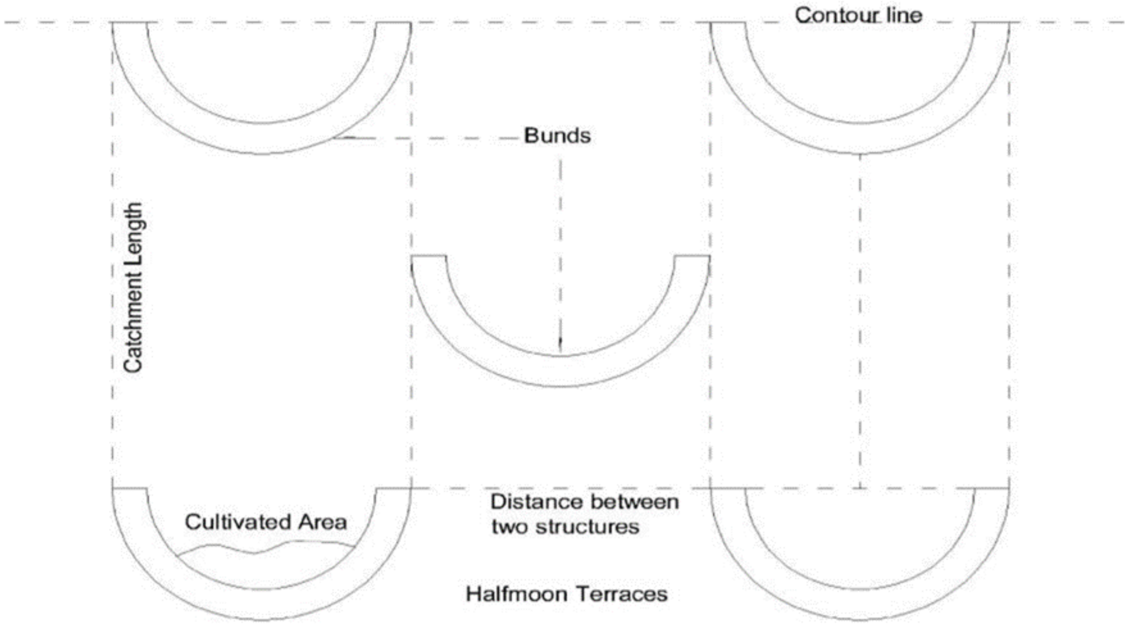


Figure 24: Layout of micro-basins in a site

2.5.3. Tree planting

Description

Tree planting can be applicable in various agroecological zones including all high dega, all dega, all weyna dega, all kolla and moist berha. It involves planning tree planting, tree selection and planting.

Design and management

In designing tree planting, it is important to plan in advance the appropriate location for your tree or group of trees. The below checklist helps you to properly locating a tree (s).

a) Decide what function you would like your tree(s) to accomplish:
- Shade a certain area
- Provide edible fruit
- Provide flowers or aesthetic interest
- Screen or frame specific views

b) Research the tree's mature size (height & width) and ensure that it will not outgrow the location that you have intended. If there is insufficient space to allow the tree to grow full size, choose a different site or a small growing tree species.

c) Tree planting sites should contain adequate soil volumes to allow root growth. For example, each pit has a width of 25 cm, and a depth of 40 cm. Generally, they are spaced 2 m apart, and for eucalyptus trees 5 m.
d) Trees should be located away from overhead and underground utilities.
e) Tree planting sites should allow adequate distance between the tree trunk and the hardscape elements that may be damaged by root development. Determine an adequate distance based on the mature growth characteristics of the tree.

After identifying the appropriate location, the next activity is to select tree species. Tree selection requires a multi-step process. First the beneficiaries need to agree on the purpose of planting tree, whether timber management, firewood production or wildlife habitat. Once the purpose has been agreed upon, identify appropriate tree species and establish a nursery. Finally, prepare a management plan that includes information on nursery establishment and management, planting, harvesting, marketing and different silvicultural practices, before planting trees in a landscape.

Finally, tree planting has to be organized through the concerned community or Kebele Administration, which also has the responsibility for common woodlots. Plants are observed for weed competition and insect damage as they grow. Fodder trees are allowed to grow for two years without pruning. Maintain planted trees for at least 5 years until survival is ensured. Irrigate during short drought periods. Completely exclude cattle from planting site. Supervision of the growth of planted trees is organized by the village or Kebele. Figure 25 displays proper planting of trees in a landscape.

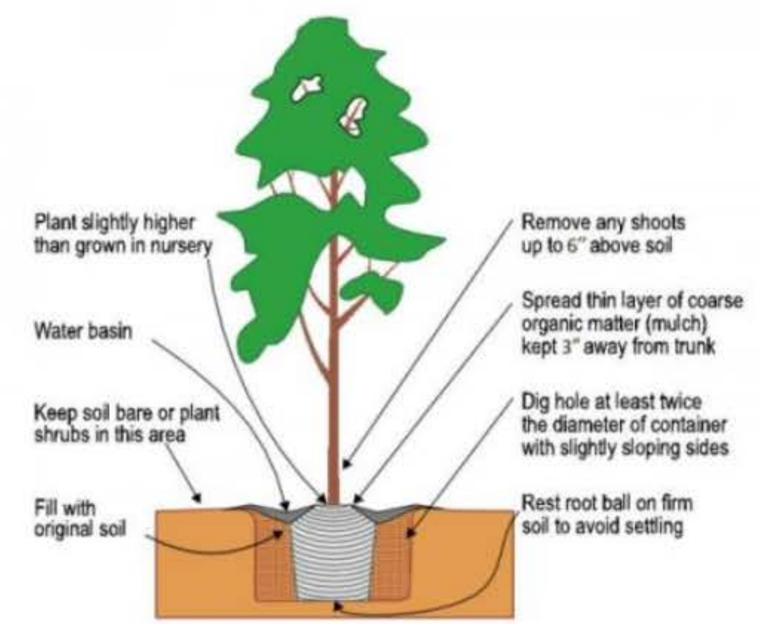


Figure 25: Proper planting of a landscape tree.

2.5.4. Trench

Description

Trenching is one of the major engineering measures for erosion control in non-arable lands and is mainly aimed to slope stabilization and drainage line treatment. Trenches address the problem of soil conservation to act as flow barrier (restricting the flow velocity within the safe limit from soil erosion point of view) and facilitating in-situ water conservation for establishment of vegetation. Trench can be applicable in different agroecological zones including dry and moist dega, dry and moist weyna dega, and dry and wet kolla. It is suitable for all slope ranges and soil types.

Design and management

The trenches are constructed in different geometrical configurations namely contour trenching, continuous trenching, staggered trenching and in line trenching. The selection of trenches depends on the site characteristics and rainfall intensity. Figure 26 shows the schematic diagram of different types of trenches.

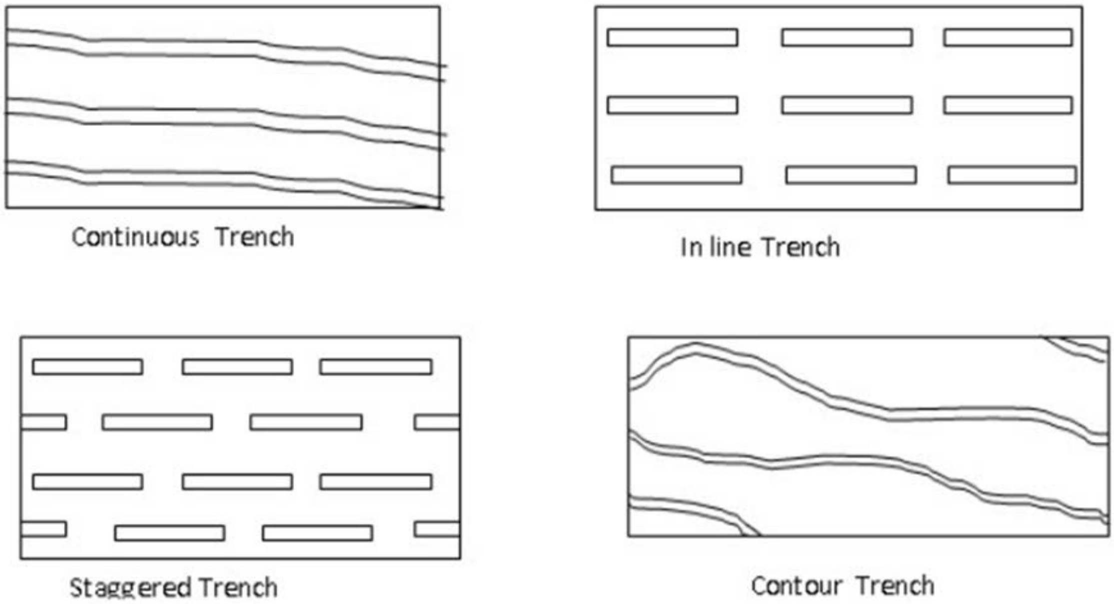


Figure 26: Types of trenches.

Continuous Trenches

These are series of broad channel or embankments constructed at suitable spacing along the graded contours of gentle slopes. They are suitable for the areas having high annual rainfall. This type of trenches are long trenches (as long as 50 m) and have fixed interval (15 -30 meter). In this type of trenches, horizontal intervals are fixed but vertical intervals are varied. These types of trench are easy to construct but there is a problem of inconsistent deposition of soil in the trenches due to varied vertical interval and hence it is difficult to maintain. The cross-sectional area of the trench is usually kept as 0.25 m^2 and depth should not be higher than 0.5 m. The cross section of trenches is kept as square. The life of trench is considered as 5 years. Removal of silts is required in every alternate year under normal rainfall condition and every year under excess rainfall conditions.

In-line Trench

This type of trench addresses the problem of inconsistent deposition of soil. These trenches are maximum 5-meter-long and cross section is similar to continuous trenches. The gap between two in-line trenches should not be more than 2 meters as shown below. This type of trenches has the limitation that it fails to collect runoff flowing between the gaps of two trenches.

Staggered Trenches

The staggered trenching involves the excavation of trenches of shorter length in a row along the contour with interspace between them. These trenches are arranged in straight line (staggered form; Fig. 27). Suitable vertical intervals between the rows are restricted to impound the runoff without overflow. In the alternate row, the trenches are located directly below one another. The trenches in successive rows are thus staggered, with the trenches in the upper row and the interspace in the lower row being directly below each other. The length of the trench and the interspace between the trenches in the same row should be suitably designed such that no long unprotected or uninterrupted slope to cause unexpected runoff or erosion. As the trenches are not continuous, no vertical disposal drain is excavated. The cross-sectional area of these trenches should be designed to collect the runoff expected from intense storms at recurrence intervals of 5-10 years.

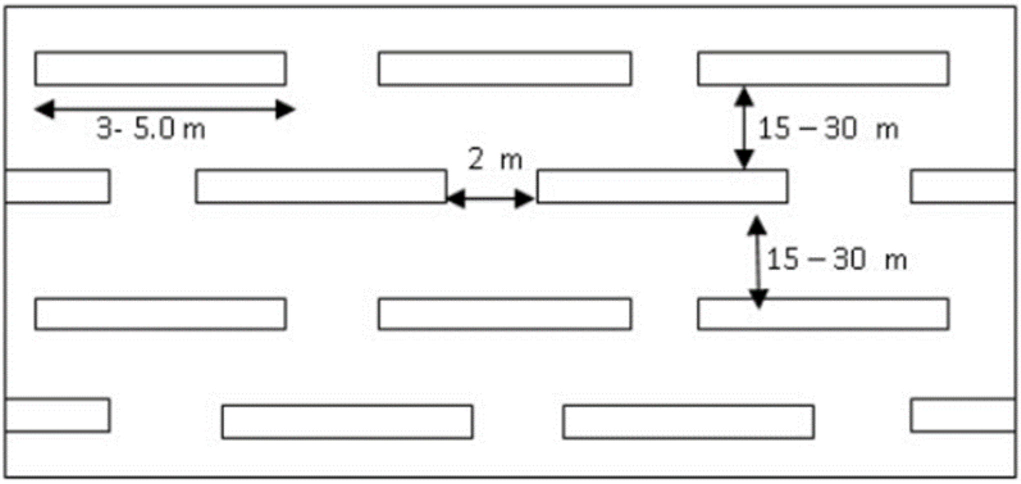


Figure 27: Schematic diagram of staggered trenches.

Contour Trenching

The contour trenches are similar to continuous trench except it follows the prevailing contour of the area. In contour trenches, the horizontal interval is varying unlike continuous trenches. However, vertical interval is fixed usually kept at 3-5 meters. This type of trenches is little difficult to construct but has the advantages over the continuous trenches in terms of consistent soil deposition and hence easy maintenance and less risk of failure.

2.6. SLM measures common to all land use types

2.6.1. Exclosures

Opportunities to expand the use of exclosures in Ethiopia is huge. For example, about 56 million ha (49.6%) of the country is covered by shrubs, grasslands and sparsely vegetated areas distributed across the highlands and lowlands of the country, all of which can be considered as potential areas for exclosures (Ethiopia Land Degradation Neutrality National Report 2015). The report identified about 14.3 million ha of degraded lands in Ethiopia that could be considered as potential locations for exclosures. The Environmental Policy of Ethiopia (1997) encourages the restoration of degraded landscapes through forest development and the establishment of exclosures on eroding and/or eroded hillsides. In this regard, Ethiopia has about 4 million ha of land with a slope of greater than 30%, making them prime candidates for exclosures. Their long-term sustainability may be largely determined by their ability to supply benefits in terms of local livelihoods and incomes, since some exclosures may have net costs, rather than net benefits, for farmers. To ensure the sustainable implementation of exclosures requires:

- Developing proper business plan.
- Integrating income generating activities within exclosure without compromising ecological benefits.
- Strong protection of protected areas.
- Active participation of all stakeholders including local communities.

2.6.2. Cutoff drain

Description

Cut-off drains are dug across a slope to intercept surface runoff and carry it safely to an outlet such as a canal or stream. They are used to protect cultivated land, compounds, and roads from uncontrolled runoff, and to divert water from gully heads. They can be applicable in different agroecological zones including all high dega, all dega, all weyna dega, all kolla, and moist berha. It is suitable for slopes ranging from 3 to 50%, and for all soil types.

Design and management

In designing cutoff drain, the gradient of the cutoff drain should not exceed the maximum gradient given. For example, assuming a 70 mm hr^{-1} storm intensity, a poor grassed cutoff drain, a hilly pasture above the drain, clay loam soil, and a freeboard of 20 cm in the drain, the dimensions of the cutoff drain, given for different sizes of the catchment are shown in Table 13. However, in some cases, it will be necessary to follow a natural line instead of a technical one. If the maximum gradient is exceeded, take care about erosion in the drain, improve the grass cover, or apply Check-dam. During heavy storms, the cutoff drains have to be supervised. If overflow occurs, the dimensions must be increased. All farmers that have land below the cutoff drain are responsible for maintenance and repair. For construction, the members of the village or Kebele must cooperate, since everybody benefits from the grassland above the drain. Cutoff drains must be maintained annually or after heavy storms if necessary.

Table 13: Examples on the possible dimensions of cutoff drain

Size of catchment (ha)	Depth of cut of drain (cm)	Width of cut of drain (cm)	Maximum gradient (%)
1	35	50	4.0
2	45	70	2.5
4	55	100	1.5
8	70	140	1.0
16	85	200	0.5
32	115	280	0.4
64	155	400	0.2

2.6.3. Check-dams

Description

Check dams are a small, temporary or permanent dam constructed across a drainage ditch, swale, or channel to lower the speed of concentrated flows for a certain design range of storms events (Fig. 28). They are designed to slow down the movement water down water courses and to promote siltation and the establishment of vegetation. Check dams can easily be built out of rocks and other materials together will act as a filter. Check dams can be applicable in various agroecological zones including all high dega, all dega, all weyna dega, all kolla and moist berha.

Figure 28: Check dams in a landscape

Design and management

Here is a simple method for constructing a check dam:

- Select a site where the gully is relatively narrow.
- Construct a stone weir across the gully, between 10 and 50 cm in height. Ensure that it is slightly slower in the middle than at the other edges.
- Select a pole that is at least 40 cm longer that the stone weir. Cut a piece of geotextile that is long enough to hang over the pole. Both hanging ends should be long enough to reach the bottom of the gully, and to be laid flat for at least 30 cm on the upstream side of the weir.
- Cover the geotextile that is on the bottom of the gully with soil or stones.
- Pack bush against the weir on the upstream side, to improve the filtering effect of the geotextile.
- If the check dam is higher than 20 cm, ensure that there is a bed of stones rocks on the downstream side so that any water that overflows from the dam does not erode the foundations of the check dam.

Check-dams are most effective if a series of them is constructed from the top of the water course or gully, spaced at regular intervals so that the backed up water from each check dam will reach up to the base of the check-dam immediately upstream.

Check dams usually take some time to settle in and become stable features in the landscape. For the first few years it will be important to inspect them before and during the rainy season to ensure that they are filtering the water effectively. If the geotextile breaks before the dam is stabilized by the growth of permanent vegetation, simply replace the geotextile with a new piece and lay in onto the upstream surface of the check dam and secure it with stones or soil.

In order to stop further undercutting of the gully head, and revegetate the gully banks, a reshaping of the gully head and bank is needed. The reshaped gully head and bank has to be protected by grass or a stone riprap. The gully and its immediate surroundings must be closed to animals (area closure for the gully). Gully rehabilitation is a long and cumbersome process and requires permanent supervision until safely established. Gully rehabilitation must be carried out by the group of farmers that have land either in the catchment above the gully, along the sides of the gully, or below the gully. They all have an interest in reducing gullying. Maintenance is needed regularly, with somebody assigned by the community or Kebele Administration to supervise how the gully behaves during the rainy season.

2.6.4. Revegetation

Description

Revegetation is a system of forage establishment on land with an unsatisfactory vegetation cover. Such land may be newly constructed bunds, cutoff drains, waterways or degraded land and gullies. Forage includes grass, legumes and selected trees and bushes. Revegetation can be applicable in different agroecological zones including all high dega, all dega, all weyna dega, all kolla and moist berha. It is suitable for all slope and soil ranges.

Design and management

Three steps are important for revegetation: (a) Exclude all grazing animals throughout the year, Use Cut and Carry instead; (b) Regularly cut the weed which grows during the rainy season, so that grass and legumes can develop and (c) Plant sods of grass and legumes. Such sods can be taken from good natural grassland nearby or from forage nurseries. However, native species will grow best, and are well known to the farmers for their quality and value. Sods are planted about every 25 cm. Every farmer is responsible for regularly maintaining the revegetation on his/her land. The concerned village or Kebele is responsible for revegetation on communal land and in gullies.

Module 3: Integrated landscape management

3.1. Integrating different SLM measures within a landscape

FAO promotes the use of SLM measures across the range of land-use systems – cropping, livestock and forestry – by, on the one hand, reducing further land degradation and, on the other, restoring and rehabilitating degraded lands.[27] Land resource planning (LRP) together with the tools discussed in the above sections of this document are some of the approaches for selecting and putting into practice the optimum SLM options within an integrated landscape management context, supported by the policy and institutional set-up (Fig. 29). As discussed in the above section, the guiding principles are that people and participatory approaches should be at the centre of the process and that governance and enabling policies and institutions should support the achievement of forest and landscape restoration plans.

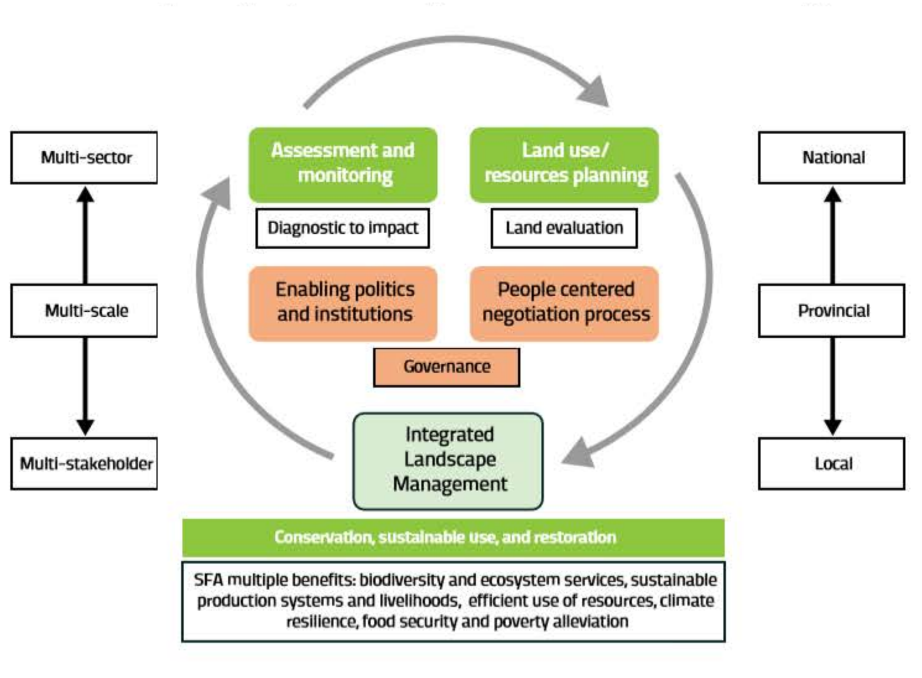


Figure 29: Land resource planning as part of an integrated land resource decision-making process[28]

SLM measures includes a range of complementary measures adapted to the biophysical and socio-economic context for the protection, conservation and sustainable use of resources (e.g. soil, water and biodiversity) and the restoration or rehabilitation of degraded natural resources and their ecosystem functions.[29] Promising SLM options are available to sustain various productive land uses in landscapes (see Module one in this document). More than 2 billion hectares worldwide offer opportunities for restoration through forest and landscape restoration[30], and SLM tools and practices can

[27] FAO 2017.
[28] FAO 2017.
[29] FAO 2017.
[30] UNCCD, 2013

support this task[31]. WOCAT has shown that SLM has the potential to increase yields by 30–170 percent, water-use efficiency by up to 100 percent, and soil organic carbon by 1 percent in degraded soils and by 2–3 percent in non-degraded soils.[32]. The adoption of favorable practices, such as selecting proper land uses or identifying areas of importance (see Module one) and implementing SLM, will enhance sustainability and resilience in the face of change (Fig. 30). Understanding which part of the land resource in a landscape is under threat is vital for selecting and putting into practice the most efficient and affordable solutions. Identifying the most effective SLM measures, therefore, is an entry point to help decision-makers and communities increase the resilience of land-use systems. Tools such as ROAM, help decision-makers adopt appropriate options for the use of land resources based on their natural potential, thereby avoiding unsustainable exploitation and minimizing the risk of further degradation. Such tools also help land users in selecting and putting into practice SLM options that support land and soil restoration in degraded areas.

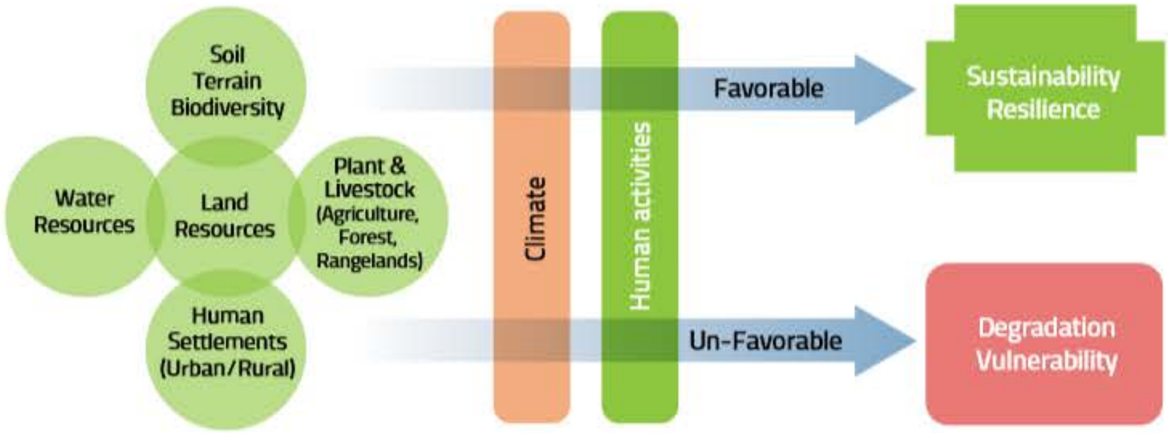


Figure 30: Human activities and land use determines the sustainability of land resources[33]

Integrated landscape management is the basis of natural resource management; it ensures that, by managing the underpinning natural resource base and ecosystem services through a coordinated process across sectors and stakeholders, the full range of societal needs can be met in the short and long terms. For example, Figure 31 illustrates how different natural resources management targets need to be set in managing a landscape. This in turn illustrates the need for integrating different SLM measures to achieve the individual targets and the targets at basin or landscape scale (Figure 31). In this line, it is also advised to evaluate the links between targets and actions at different scales (Fig. 32).

[31] WRI, 2014

[32] WOCAT, 2007; CDE, 2010

[33] FAO 2017.

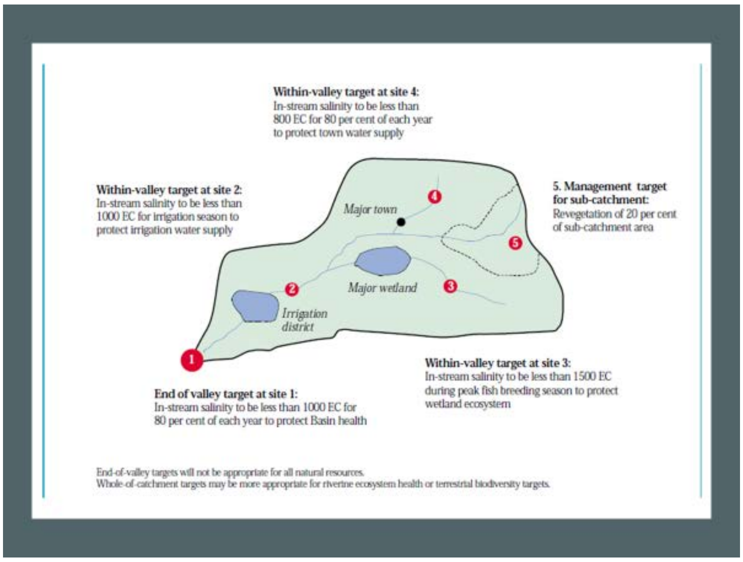


Figure 31: Various targets for achieving natural resources management goals

Figure 32: Links between targets set at different levels

3.2. Integration of physical SLM measures with forage plants and other high value crops

3.2.1. Context, benefits and recommended steps

Like many smallholder farmers in Ethiopia, the farming families of central rift valley are facing three major challenges (Fig. 33)

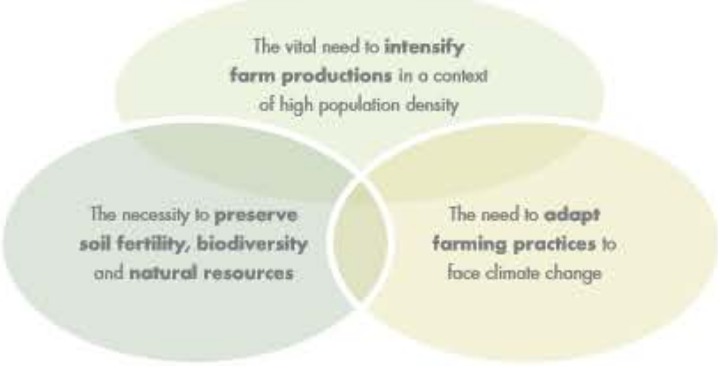


Figure 33: Challenges of smallholder farmers

Constructing physical SLM measures, such as terraces, trenches, and soil and stone bunds, can support the regeneration of native plant species. These can improve the quality and quantity of livestock feed that can be harvested from the exclosure. This, in turn, improves livestock production and increases the benefits obtained by local communities.

In addition, physical SLM measures can be made more effective by integrating them with biological SLM measures, such as by sowing grasses and planting forage and other high value trees on banks of bunds, which can stabilize existing physical SLM measures and contribute to reducing soil erosion, increasing aboveground biomass and carbon as well as improving soil fertility, mainly through nitrogen fixation.

To implement this management option, first construct the physical SLM measures, then plant grasses and other high value trees on the banks of bunds. Other necessary steps include identifying grass varieties and fodder and other high value trees appropriate for the area, raising seedlings of selected plants, sowing grass species and planting fodder and other high value trees.

To help ensure equal benefit sharing and to prevent conflicts, the learning watershed approach can be followed. For example, the community watershed team (CWT) determine the total amount of yield, the total number of beneficiaries, the amount of yield per beneficiary, and the schedule for harvesting and distributing yields.

3.2.2. Social, environmental, institutional and economic considerations

As part of participatory land use planning (*a topic to be covered in course two*), local communities should participate in selecting grass, fodder tree and other high value tree species to be planted on the banks of physical SLM measures. In this line: three elements have been decisive:

- The multiplication of vegetative material by the families themselves in farm-based micro-nurseries.
- The association of grass and legumes forages and other high value trees integrated on ant erosive structures, as well as on unproductive or underused spaces, to address the crucial livestock feeding problems but without competing with traditional crops.
- The involvement of informal institutions to stimulate community ownership, to ensure consistent implementation at the scale of micro watersheds and to address the critical issue of animal open grazing control.

To maximize the benefits, the CWT should work closely with district agricultural offices to decide when to harvest grasses and fodder and other high value trees planted on the banks of for example bunds. The CWT should also consult experts at the district agricultural offices to learn how to manage integrated plant species, including when and how to prune and harvest tree products. Close collaboration between the CWT and experts at district agricultural offices will help ensure better management of integrated grass and tree species and maximize the benefits.

3.2.3. Stakeholders

District agricultural offices and the CWT can be expected to be the lead stakeholders, while local communities, the BoA and NGOs should also participate. District agricultural offices have mandate to raise seedlings of selected plant species and provide seeds of different grass and plant varieties. The CWT is responsible for mobilizing local communities when sowing grasses and/or planting selected trees on the banks of bunds. Local communities can provide free labor to plant forage trees and protect conservation measures from the interference of people and domestic animals. NGOs can be expected to be keen to provide technical and financial support, while the BoA has mandate to coordinate the support provided by local and international NGOs.

3.2.4. Opportunities, assumptions, costs and timing

Information on available grass species and fodder and other high value trees can be obtained from the BoA or from respective district agricultural offices. Facilities for raising seedlings of selected tree species are also available in each district, which could make this option practical and effective.

The costs of implementing this option could be low, as bund stabilization with grass and fodder and other high value trees costs about US$40 per kilometer of bund (i.e., the costs for labor and seed).

This option can be implemented immediately or starting one year after the construction SLM measures (Fig. 34), depending on the availability of resources and other logistics. Results can be expected in the short term.

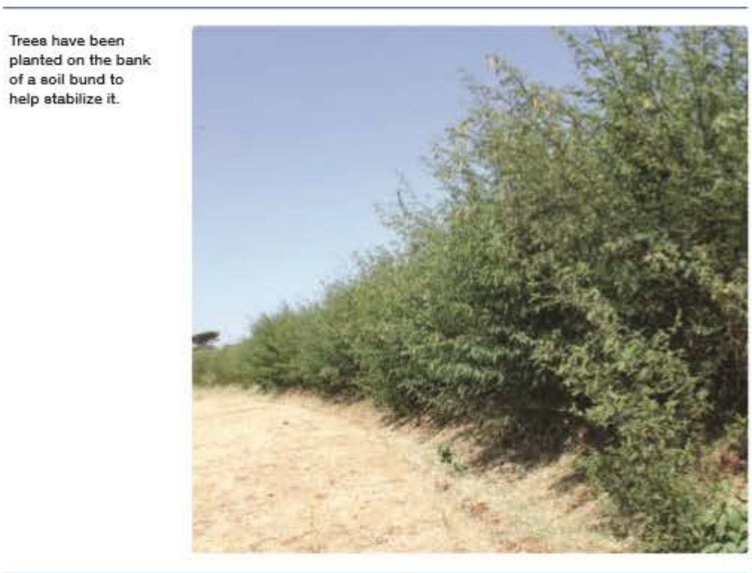


Figure 34: Fodder trees planted on the bank of a soil bund (Photo: Wolde Mekuria).

Exercise Six

Topic: Selection of different SLM measures to be implemented or integrated in a landscape for multiple benefits
Area of interest: Central Rift Valley
Activities: first select a hypothetical landscape within Central Rift Valley and Identify objectives. Then visit/review WOCAT website, and this course document, and select SLM measures appropriate for the landscape and that support achieving planned goals.
Type: Group exercise
Materials: Stationery (Markers, charts, etc.)

Module 4: Monitoring and evaluation

4.1. Developing the monitoring plan or program in the planning phase

Objectives, performance standards, indicators and protocols for monitoring should be incorporated into plans before the start of a restoration initiative. A monitoring plan should be designed and put into action in the planning phase. Monitoring will help determine if a project has achieved its ecological and socioeconomic goals. Indicators are selected as part of baseline studies to measure change related to the identified goals. The choice of indicators will be determined by the availability of monitoring resources and by the level of detail needed. Monitoring should permeate the entire restoration process, from needs assessment, design and implementation, to ongoing adjustments in the light of feedback, to the analysis of intermediate and final results. In order to observe changes or improvements in a given parameter, monitoring should include an assessment of existing ecological and socioeconomic conditions in the proposed area as part of a baseline study, according to which the desired future conditions can be identified.

4.2. Promoting the participation of key stakeholders

All concerned stakeholders should be identified in the planning phase and their diverse interests considered in developing a comprehensive set of issues and parameters to be monitored. A multi-stakeholder monitoring process can be difficult because the various stakeholders may have conflicting objectives, but it is necessary for identifying the right questions to ask and for assessing the extent to which a restoration initiative is meeting desired outcomes and how it is responding to diverse concerns.

A participatory monitoring approach also promotes mutual learning as participants work together to better understand restoration efforts and impacts. Participants can expect to gain a greater understanding of ecological health, the economic and social well-being of local communities, and the interconnections between the environment, the economy and social conditions. They will also gain new perspectives of the restoration initiative and its potential outcomes.

The chronology in achieving target results may differ, but all participants in a monitoring program should have access to the same information so they can develop common understandings of the issues. It may also be necessary for monitoring teams to spend time discussing their perhaps differing understandings of concepts. It is especially important to develop a common definition of what "success" will look like, so that stakeholders are able to share a common vision of what the restoration initiative is seeking to achieve. Once commonly agreed indicators and sources of verification have been defined, tasks and responsibilities (as well as skills and tools) should be identified and agreed among members of the monitoring team.

4.3. Tools for monitoring and evaluating restoration measures

This section of the training focuses on introducing the FAO and AFR100 monitoring and reporting tools as well as participatory monitoring and evaluation approaches for forest and landscape restoration. Monitoring restoration using appropriate tools (e.g., the FAO and AFR100) and following participatory approaches is critical to the continuation of restoration at scale and serves at least the following important purposes:

- To unlock resources.
- To target interventions.
- To manage well.
- To detect progress.
- To learn.
- To adapt.
- To inspire.
- To report.

4.3.1. Ecological Indicators

Monitoring should be focused on progress toward specific goals and objectives that the restoration effort plans to achieve. Indicators help measure how much progress has been achieved. A holistic monitoring system should include indicators that draw on the following:

Socioeconomic. Assessing the health and well-being of people within the context of restoration goals (e.g., food security, access to clean water) can indicate whether the restoration program has achieved success in restoring targeted ecosystem services.

Political. Political will and favorable policy conditions in the form of new or modified laws that enable restoration or simply visible support from politicians can signify progress and sustained commitment to restoration success.

Financial. Understanding the flow and/or sum of investments in restoration activities and financing of restoration initiatives by donors, governments, private sector, and other sources can indicate focus and commitment to restoration.

Biophysical. Assessing the physical change in land use and land cover over time is the most straightforward indicator of whether restoration is effectively taking hold.

Steps for choosing indicators

To set up a restoration monitoring system, it is recommended that stakeholders follow the steps below that guide them through a uniform and efficient approach. These three steps can be used at whatever scale is desired.

Step – 1: At what scale? The scale of the restoration effort to be monitored whether it is national, subnational, local or some other geographic extent is critical context for making all other decisions regarding the monitoring system.

Step -2: Use the framework to help select indicators based on goals. Given the scope and large range of ecosystem types for which restoration will be needed, each restoration effort's specificities need to be carefully considered. Site-specific attributes should be identified at the early planning stage. The three questions that support to select indicators are:

Why restoration?

Identify the main goals of the restoration effort to be monitored. Consult with local communities and key stakeholders to identify what the restoration interventions are aiming to achieve. These goals are the basis for developing indicators and metrics against which to measure success. For example, if some types of restoration interventions are aimed at increasing food security, relevant indicators may be those related to soil fertility or crop yields. Typically, a suite of restoration interventions is implemented in support of integrated landscape management and designed to achieve multiple, interrelated goals.

What vegetation?

Identify in which type of landscape the change is happening. Change in land-use cover remains a common factor that needs to be measured, regardless of the restoration goal. In many types of restoration efforts land-use cover is increased by a combination of trees, and *other vegetation like shrubs, grasses, bamboo, or some type of agroforest system. Different indicators will be needed depending on whether canopy cover or other types of cover are being monitored.*

Which drivers?

Identify the drivers of degradation and loss of ecosystem services in the restoration area. Focusing on drivers of degradation helps identify how to mitigate and adapt to restoration challenges to ensure sustainability of the restoration effort.

Step – 3: With what resources? Take stock of existing monitoring efforts. Reach out across sectors and ministries to learn about any existing monitoring initiatives already taking place. Leveraging existing monitoring frameworks and/or data already collected will streamline the process. This process should also identify compatibility with other commitments and reporting requirements. Other regional and international agreements such as the Sustainable Development Goals, Aichi Targets, Paris Climate Agreement, and UNCCD Land Degradation Neutrality targets may coincide with the goals of the restoration system. It is important to identify shared interests and common elements of data collection, and to integrate any monitoring or reporting efforts for these initiatives to increase efficiency and avoid duplication.

These three steps can be used at any scale to create a streamlined monitoring system. FAO and WRI have created matching indicators and metrics for the national and landscape scale. When answering the question "why restoration," it can be useful to consult the Restoration Goal Wheel (see Figure 35). If the stakeholder's goal is focused on community support, then the indicator recommended would be "people engaged in planning and execution.

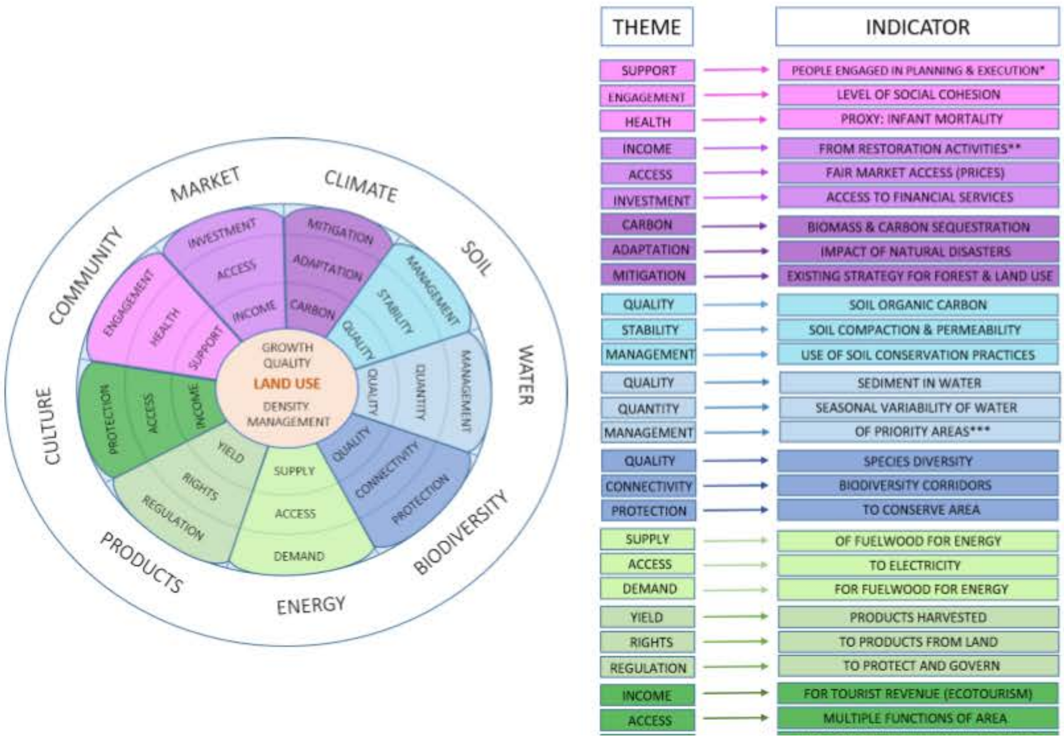


Figure 35: The restoration goal wheel and potential indicators

4.3.2. The FAO monitoring and reporting tool

The FAO's monitoring and reporting tool (Table 14) aims to guide project leaders in designing their projects and implementers in reporting on and tracking the progress of restoration, analyzing the elements of success and failure, and compiling the lessons learned for adaptive management and corrective actions. The tool consists of an easy-to-complete form to be filled out by technical staff. The quantitative components of the tool can also provide "scores", if required, to better measure improvements over time. The form is built around seven categories of information, described below.

Table 14: *FAO monitoring and reporting tool*

Sections	Description
Section I: General information	Users provide a one-stop summary of the restoration initiative's main attributes, such as its location, geographic extent, timeframe and budget. Key stakeholders are identified, along with the nature of their contributions.
Section II: Area description	Users characterize the restoration area according to five criteria: • Climatic conditions, such as rainfall and temperature, wind, extreme weather events and climate-change impacts. • Geomorphological and pedological properties, such as topography, altitude, hydrographic features and soil types. • Ecological features, such as faunal and floral species, biotic interactions, and vegetation structure and cover. • Socioeconomic properties, such as land use, land rights, and income-generating activities; and • The direct causes of degradation, such as poor grazing management, overharvesting and invasive species.
Section III: Objectives	Users state the restoration objectives, actions scope and its contribution to broader initiatives is also described.
Section IV: Supportive governance framework	Users assess the level of support for restoration provided by the governance framework. Stakeholder involvement should be detailed in a table showing roles and responsibilities. Information on local actors and providers of specific actions in capacity development, research, awareness-raising and institutional development can be listed in this section.
Section V: Restoration strategy adopted, planning and implementation	The purpose of this section is to provide details about planned and implemented interventions and measures at the field level. Special attention is given to protection to facilitate natural regeneration and soil and water management measures, as well as plantation-related activities (e.g. site preparation, nursery techniques, the reproduction material used, and post planting measures.
Section VI: Monitoring	Users specify whether a monitoring plan has been developed for the restoration initiative and, if so, they are invited to provide additional information, such as the plan's timeframe, baseline, stakeholders and other aspects (e.g. ecological, social, economic, political and technical).
Section VII: Results and sustainability	This section is intended to provide an indication of the degree of success of the restoration initiative, based on the measurement of processes and activities, with a focus on the following points: • Restoration objectives and outcomes – users are invited to provide an appreciation of the participation, relevance, effectiveness and adequacy of funding of the initiative. • Field restoration results/impacts – e.g. the increase in vegetation cover induced through restoration interventions such as assisted natural regeneration or planting (area, cost/ha, survival rates, timeframe, etc.). • Capacity development: e.g. institutional development and awareness raising (number of people trained, cost, number of participating stakeholders, etc.).

	• Contribution to human well-being. • Impacts on policies (e.g. policy/legislation barriers overcome, policy/ legislation changes). • Environmental impacts. • Sustainability (e.g. in terms of scaling up, ownership by local actors, the institutionalization of results in the long term, funding and capacities). Users identify and assess key problems and recommend ways of overcoming them, as well as key impacts and achievements (e.g. increased resilience, plant diversity, vegetation cover, vegetation quality, and reduced erosion)
Section VIII: Further sources of information	Users provide sources of information and references to relevant supporting documents (e.g. maps, publications, web pages and pictures).

4.3.3. Participatory Monitoring and Evaluation

Participatory monitoring and evaluation (PM&E) is a process through which stakeholders at various levels: (1) engage in monitoring or evaluating a particular project, program or policy, (2) share control over the content, the process and the results of the monitoring and evaluation activity, and (3) engage in taking or identifying corrective actions. PM&E is critical in program planning and achieving sustainability and equity as it supports people[34]: (1) know what works for them and professionals need to learn from people, (2) make contributions of resources (money, materials, labour) for programs, (3) become committed to activities that they have helped develop, (4) can develop skills, knowledge and experience that will aid them in their future work, (5) helps managers and major stakeholders to get regular feedback and early indication of progress, and (6) provide information that is credible and useful, so that lessons learnt can be included into the decision-making process. Figure 36 shows the three central elements of monitoring, whereas Figure 37 displays the four steps of PM&E.

Figure 36: The three central elements of monitoring,

[34] Rifkin and Kangere 2002.

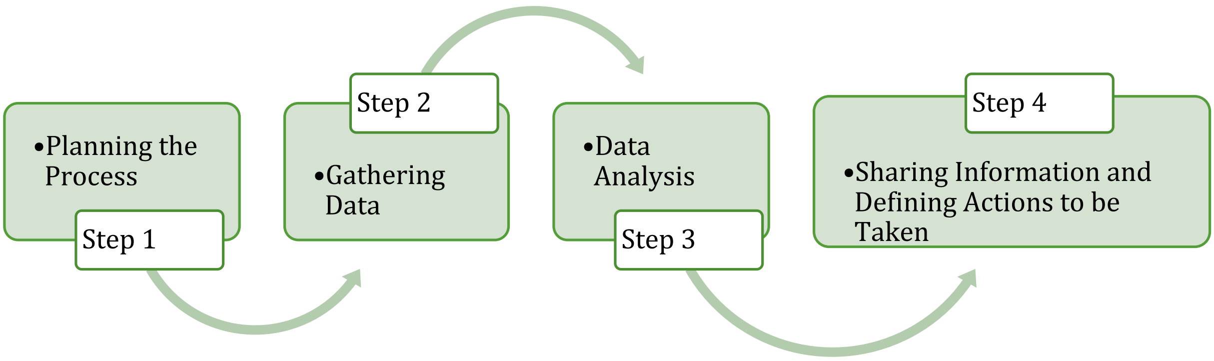


Figure 37: The four steps of a participatory monitoring and evaluation process.

Step 1 of the process includes identification of stakeholder groups, setting objectives and develop indicators. Step 2 is about gathering of data on implementation processes, strategies and results using both quantitative and qualitative methods such as participatory rural appraisal (PRA), transect walk and beneficiary assessment. Step 3 of the PM&E involves various categories of program stakeholders in the critical analysis of successes and constraints and the formulation of conclusions and lessons learned. In step 4, the key activity is sharing the results of preceding M&E activities with other stakeholders and discussing on appropriate actions to be taken based on the findings.

4.3.4. Citizen science

According to McKinley et al. (2015), citizen science is defined as participation by the public in a scientific project. Projects can involve public participation in any or all stages of the scientific process. Projects can involve professional scientists or be entirely designed and implemented by volunteers. However, citizen science is science and should be treated as such in its design, implementation, and evaluation. This same study elaborated that one of the reasons to invest in citizen science in natural resources and environmental protection projects is to better engage the public in helping to make decisions through generating new scientific knowledge and through learning gained from participating in the scientific process (Fig. 38).

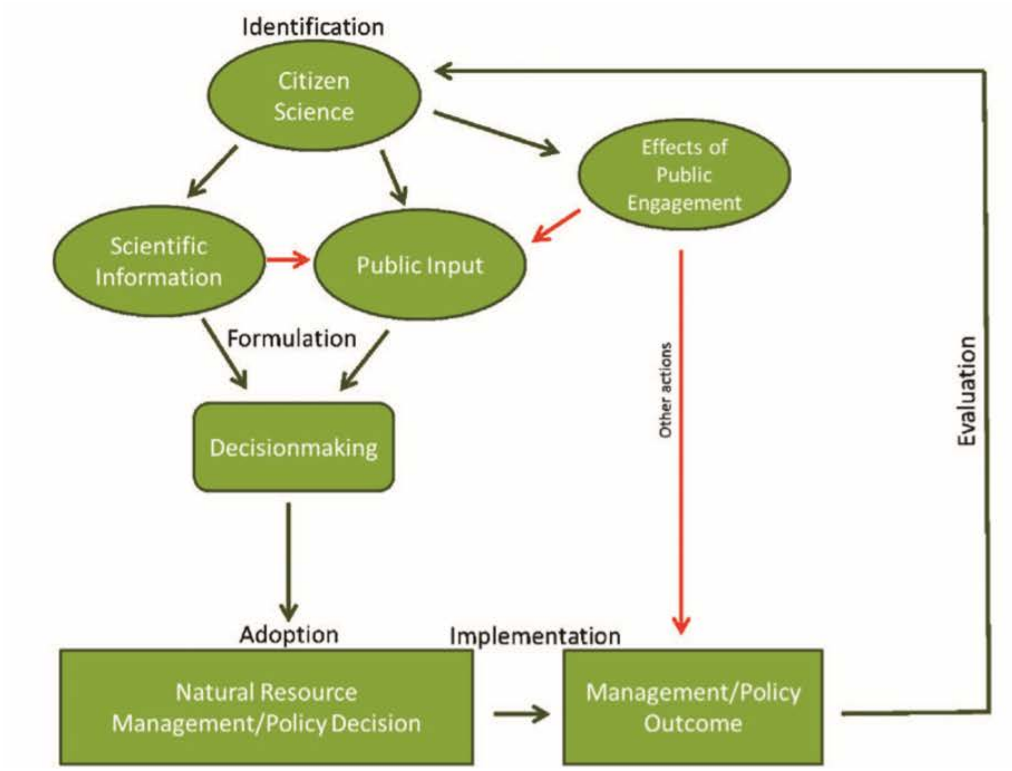


Figure 38: Pathways that citizen science can take to influence natural resource management and environmental protection.

Citizen science can be used in a variety of ways[35], including:

- Monitoring studies assessing patterns, in space and/or time, of one or more ecosystem components.
- Process studies assessing the impacts of factors on ecosystem components or functions (e.g., nutrient and water cycling).
- Opportunistic and observational studies that do not follow a strict design but are often deliberate in the subject and timing of observation.

According to McKinley et al. (2015), citizen science projects can have the following benefits:

- Engage people in decision-making processes
- Promote collaboration
- Bring fresh perspectives into decision-making
- Foster environmental stewardship
- Spread knowledge
- Answer local community questions of concern
- Incorporate local and traditional knowledge into science and management
- Build awareness of an organization's mission
- Improve science literacy and build expertise

Sources of Finance and Financing Mechanisms

Potential sources of finance for forest and landscape restoration measures include NGOs, government agencies and private enterprises. NGOs can provide financial support to local communities in the form of credit or subsidies. Government agencies provide financial support in the form of subsidies or revolving funds for lending through cooperatives or microfinance institutions (MFIs). There are a number of interventions owned by the government, which can provide

35 McKinley et al. (2015)

financing services, such as Food for Work (FFW), Productive Safety Net Program (PSNP), Sustainable Land Management (SLM) programs, Agricultural Growth Program (AGP), Climate Resilience Green Economy (CRGE), Youth Empowerment, and the African Forest Landscape Restoration Initiative (AFR)100 programs. Recently, the Global Mechanism of the UNCCD, in close collaboration with the UNCCD Secretariat, through a global program, established the Impact Investment Fund for Land Degradation Neutrality (otherwise known as the LDN Fund). The LDN fund aims to attract blended financial assistance to support large-scale efforts to restore or rehabilitate degraded land for sustainable and productive use with long-term private sector financing.[36]

In another approach, payments for ecosystem services (PES) initiatives (e.g., reducing emissions from deforestation and forest degradation [REDD+]) and, for example, the Green Climate Fund (GCF) and the Global Environment Facility (GEF) that are financial mechanisms of the UNFCCC, and the UNFCCC and the other Rio Conventions, respectively, may provide financing. In recent years, the need to promote the conservation of natural resources and ecosystems has led to the development of PES schemes that offer incentives to farmers or landowners in exchange for their agreement to manage their land in a particular way, or to maintain ecosystem services.[37]. There are many different mechanisms for PES, including direct cash payment and in-kind payment, and the success in implementing PES is quite variable.[38]
PES could provide an additional revenue stream for forest and landscape restoration measures, as they provide significant ecosystem services, such as watershed protection, soil and biodiversity conservation, carbon sequestration, and the minimization of climatic and financial risks by increasing the resilience of the environment to natural disasters.[39]. The implementation PES mechanisms require more public sector support. However, depending on the scale of the scheme, NGOs can also facilitate PES and are often more suitable. Government agencies and NGOs would need to facilitate PES schemes by supporting activities such as helping local communities generate baseline information against which improvements could be monitored, placing values on ecosystem services, and organizing users into cooperatives. This helps to facilitate the verification and certification of added values.

Conclusions

Restoring degraded landscapes is becoming increasingly important to address the current and future challenges of water resources use and management. To this end, understanding the different benefits of landscape restoration; developing skills in planning, identifying, designing and implementing the most-effective restoration measures as well as acquiring skills in monitoring and evaluating restoration measures is critical to ensuring sustainable and wider adoption of landscape restoration measures. As part of addressing these issues, this course presents theories, approaches and tools for designing restoration strategies, selecting and implementing SLM measures, integrating different SLM measures in a landscape, and tools for monitoring and evaluation for adaptive learning.

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[36] Orr et al. 2017
[37] Nordén 2014; Ferraro and Kiss 2002; Wunder 2005.
[38] Hangrove and Chandler 2004; Asquith et al. 2008
[39] Seyoum et al. 2015

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