Good Practices Manual on Biodiverse Forest and Landscape Restoration

Investing in Climate Change Adaptation through Agroecological Landscape Restoration: A Nature-Based Solution for Climate Resilience (Technical Assistance 6539)

October 2023

Cambodia. (photo by Khun Bunnath).

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Deliverable summaries

TA-6539 Investing in Climate Change Adaptation through Agroecological Landscape Restoration: A Nature-Based Solution for Climate Resilience led to the preparation of the following knowledge products:

- KP1 (1): Landscape Restoration Country Profile: Philippines
- KP1 (2): Landscape Restoration Country Profile: Cambodia
- KP3: Business Models to Encourage Private Sector Participation in Sustainable Land and Forest Landscape Management
- KP4 (1): Climate Change Risk and Adaptation Options Assessment – Sangker River Basin, Cambodia
- KP4 (2): Climate Change Risk and Adaptation Options Assessment – Manupali Watershed, Mindanao River Basin, the Philippines
- KP5: Good Practices Manual on Biodiverse Forest and Landscape Restoration
- KP6: Community-based Climate Vulnerability Assessment and Adaptation Planning for Resilient Agroecosystems
- KP7: Applying Advanced Technologies in Support of Landscape Restoration and Climate Change Adaptation
- KP8 (1): User Manual: Sangker River Basin Decision Support System
- KP8 (2): User Manual: Mindanao/Manupali River Basin Decision Support System
- KP8 (3): Admin Manual: Sangker River Basin Decision Support System
- KP8 (4): Admin Manual: Mindanao/Manupali River Basin Decision Support System
- KP9 (1): Restoration plans for demonstration areas in Cambodia and the Philippines
- KP9 (2): Gender and Social Inclusion in the Mindanao River Basin, the Philippines, and the Sangker River Basin, Cambodia
- KP10: Integrating the principles of ecological agriculture into upland farming systems of Manupali Watershed, the Philippines

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Abbreviations

ADB	Asian Development Bank
ANR	Assisted Natural Regeneration
CA	Cambodia Approaches
CBFM	Community-Based Forest Management
CLUP	Comprehensive Land Use Plan
CT	Cambodia Technologies
FSC	Forest Stewardship Council
HCVF	High Conservation Value Forest
IAS	Invasive Alien Species
ICEM	International Centre for Environmental Management
ICRAF	International Centre for Research in Agroforestry (World Agroforestry)
IMO	Indigenous Microorganisms
INREMP	Integrated Natural Resources and Environmental Management Project
IPM	Integrated Pest Management
M&E	Monitoring and Evaluation
MKADC	Mt. Kitanglad Agri-Development Corporation (Philippines)
NGO	Non-Governmental Organization
NPK	Nitrogen-Phosphorus-Potassium
NVS	Natural Vegetative Strips
PA	Philippines Approaches
PT	Philippines Technologies
PVS	Planted Vegetative Strips
SCGFS	Soil Conservation Guided Farming System
SE	Social Enterprise
SLM	Sustainable Land Management
SRI	System of Rice Intensification (Philippines)
SWC	Soil and Water Conservation
SWIP	Small Water Impounding Project (Philippines)
VI	Vertical Interval
WOCAT	World Overview of Conservation Approaches and Technologies

Weights and Measures

%	Percentage
cm	Centimetre
ha	Hectare
m	Meter
m2	square meter

Acknowledgements

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1 Introduction

1.1 The Project

The International Centre for Environmental Management (ICEM) is implementing the Asian Development Bank (ADB) project "Investing in Climate Change Adaptation through Agroecological Landscape Restoration – 1, Climate Change Risk and Adaptation/Restoration Option Assessment in Cambodia, Myanmar, and the Philippines" (53348-001) in collaboration with the International Centre for Research in Agroforestry (ICRAF). The project is currently operating in Cambodia and the Philippines with the goal of developing, evaluating, and promoting climate change adaptation interventions through agroecological landscape restoration. Additionally, the project aims to enhance the capacity of local communities to restore and manage climate-resilient landscapes. The project seeks to achieve its objectives by facilitating knowledge exchange, promoting best practices, and supporting community-driven interventions that promote the restoration and conservation of landscapes. Through these efforts, the project aims to contribute to the long-term sustainability of agricultural systems while also mitigating the negative impacts of climate change on vulnerable communities.

1.2 Pilot Areas in Cambodia and the Philippines

The project assists NGOs and communities in the Samlaut Multiple Use Area (MUA) and its buffer area within the Sangker River Basin of Cambodia and the Manupali watershed in Mindanao, Philippines.

Stung Sangker is part of the western Tonle Sap River basin group that drains much of the northern slopes of the Cardamom Mountains and flows into the Tonle Sap Lake. The river headwaters are located in some of Cambodia's most important protected areas and flow through agricultural and wetlands to the Tonle Sap Biosphere Reserve. The catchments encompass the Battambang Plain, and the extensive wetlands and flooded forest on the western and southern portions of the alluvial plain of the Great Lake. The community forest at Phnom Thor Krao, Otavau commune, is of particular interest. The area includes an extensive tropical rainforest previously designated as a national park that has now been recategorized as Multiple-Use Area (MUA).

Manupali watershed is situated in the southern Philippines island of Mindanao. Manupali is part of the Upper Bukidnon River Basin, upstream of a network of irrigation canals operated by the Bukidnon Irrigation Management Office. The Manupali watershed contributes to the Pulangui reservoir, which supports the largest hydropower facility in Mindanao. It is also part of the Mt Kitanglad Range National Park, one of the few remaining rainforests in the country. The watershed is home to many smallholder farmers willing to participate in restoration activities. ICRAF and ADB have relationships at Manupali, and the watershed is a subject of the ADB Integrated Natural Resources and Environmental Management Project (INREMP), which is close to completion. The project has prepared a Manupali Watershed Management Plan with a 15-year horizon.

1.3 The Purpose of This Manual

This Good Practices Manual aims to give practical guidance for restoring forests and landscapes with biodiversity net gain in the pilot watersheds in Cambodia and the Philippines. This includes the use and regeneration of native tree species, enhancement of ecosystem services, and the identification of benefits for local communities. The manual is designed to support the field staff of the two local NGOs and community members. However, the manual would also be of practical use for those working in areas with similar ecological conditions.

2 Land Use Planning

2.1 The Land Use Goal

The impetus for land use planning arises from the need for change, improved management, or a different pattern of land use driven by changing circumstances. Land use planning aims to create conditions necessary for sustainable, socially and environmentally compatible, socially desirable, and environmentally sound land use. It initiates decision-making processes that consider using and protecting natural resources, which are arrived at through participation and consensus rather than imposition from outside.

The process of land-use planning can be broken down into the following questions:

What is the present situation?

Is change required and desirable? If so:

- **What needs to be changed?**

  Land-use issues and opportunities are identified through discussions with the land users, i.e., the local community, and the study of their needs and the resources of the area.

- **How can the changes be made?**

  After discussions with the community, a range of solutions can be sought to make use of opportunities and solve problems. Different land units will have varying problems and require different interventions.

- **Which option is best?**

  The community and land-use planners select the best options for the whole area and each individual land unit. Negotiation between competing land users may be necessary. The best options are based on forecasts of the outcomes of implementing each alternative.

- **How successful is the plan?**

  Once a land-use plan is in effect, progress should be monitored and the plan amended if necessary.

The objectives of any land use plan are:

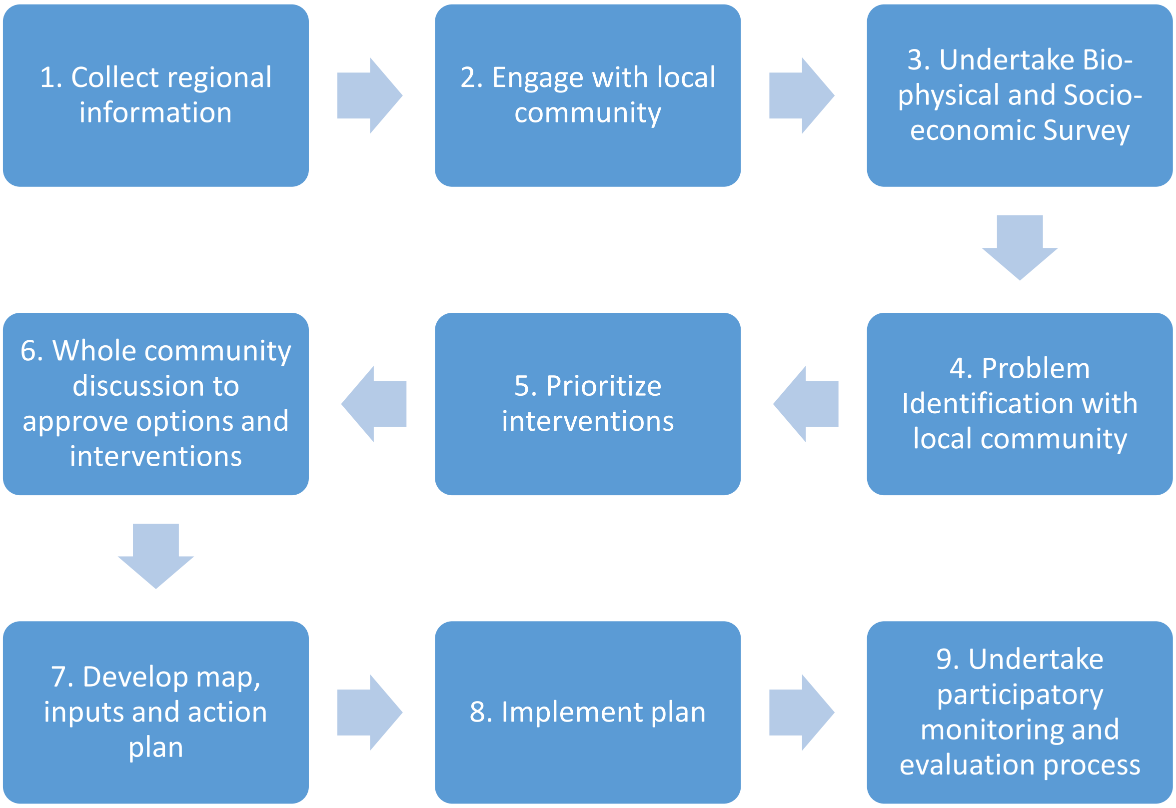
- **Social justice:** Planning should take all sectors of society into account;
- **Long-term sustainability of natural resources:** Land use should correspond to its natural potential;
- **Acceptance and social compatibility:** Any measures taken should be desired, accepted, supported, and carried out by those affected by them. They need to be socially compatible and culturally suitable;
- **Economic efficiency:** Measures should contribute to long-term economic security and improve living conditions and overall economic development;
- **Viability:** Planned measures need to be viable in terms of technology, economy and organization;
- **Poverty alleviation:** Future land use should reduce poverty and improve the living conditions of the affected population.
- **Conflict avoidance:** Land use conflicts should be avoided or settled through mechanisms for conflict resolution.

The project's objectives, to which end the land use planning will be geared, are to achieve biodiversity net gain and enhance ecosystem services through landscape restoration, resulting in improved local livelihoods.

2.2 Land Use Planning Steps

Land use planning involves a series of steps which serve to assemble critical information about the local landscape and community, and develop a land-use plan in collaboration with the community.

Figure 1: Steps to develop and implement a landuse plan in collaboration with local communites



2.2.1 Collect Regional Information

To understand potential issues in the pilot areas, it is recommended to establish contact with the regional administration. In some cases, there may already be existing regional land use plans available. In Cambodia, Commune Land Use Plans are part of decentralized development planning developed by Commune Councils. Similarly, in the Philippines, municipalities (districts) are required to establish Comprehensive Land Use Plans (CLUPs) that demarcate land use zones for forestry, environmental protection, agricultural production, and urban expansion.

2.2.2 Getting Started at Community Level

After understanding potential issues, it's time to engage with the pilot area community to uncover the actual challenges on the ground.

To begin with meet with the community either in a public meeting or initially with the community leaders followed by a public meeting to which all community members are invited. The meeting should introduce the project and its objectives. It is also an opportunity to introduce some of the impacts of land degradation in the watershed, such as low productivity, reduced landholding size, increased drought incidence, flood damage, drying springs, and reduced forest cover.

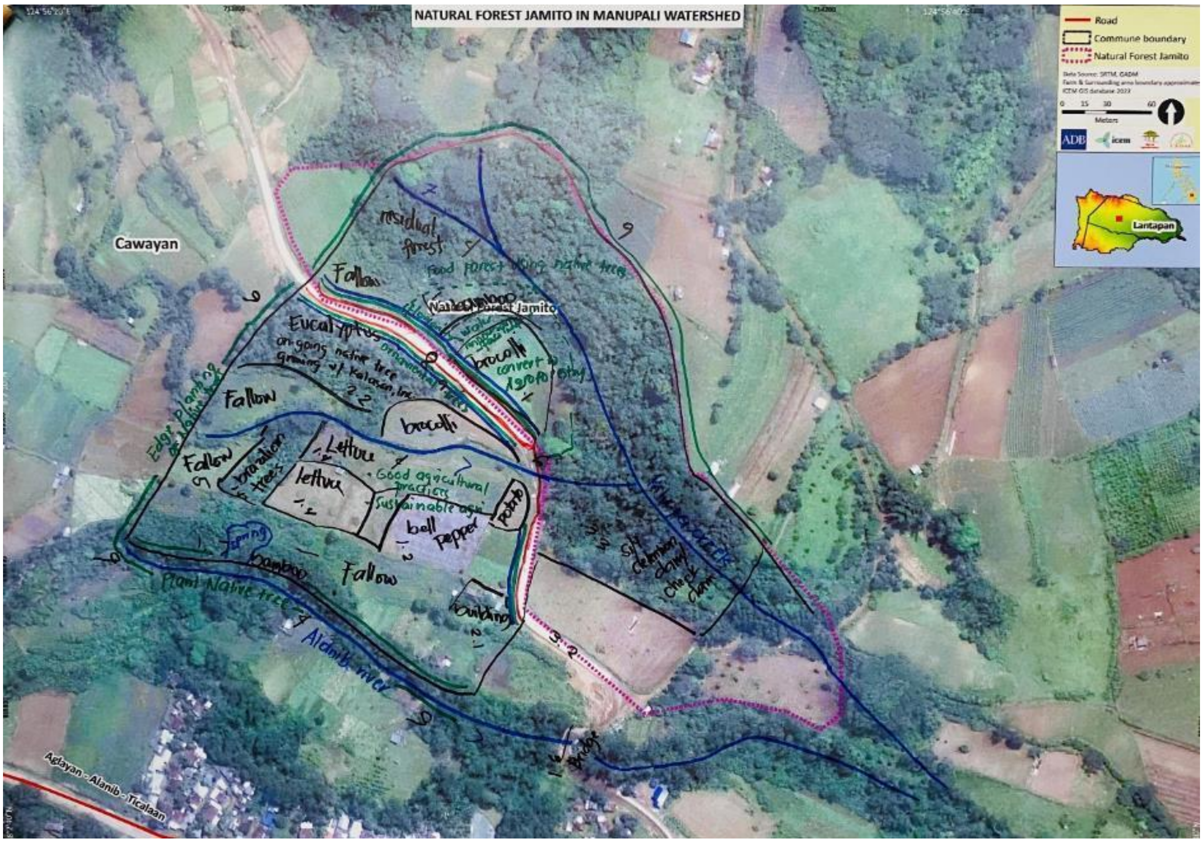
The discussion can then turn to the importance of land use planning in the community/ watershed, including the potential need for improved agronomic practices, soil and water conservation measures, forest regeneration, agroforestry and water harvesting. These discussions will reveal the community's land and resource use issues and provide the impetus to develop plans to address them.

It is essential to emphasize the importance of involving both men and women to seek their views. People should also be made aware of the participatory nature of the project and the fact that land users will be the final decision-makers. Based on practical solutions and local constraints, the measures should be selected in collaboration with land users.

2.2.3 Bio-physical and Socio-economic Survey

Undertaking a bio-physical and socio-economic survey is crucial to gaining a deeper understanding of the watershed and the community residing within it, including their interactions, opportunities, and constraints. The primary objective of this survey is to map the boundaries of the community and watershed and identify the various land units within those boundaries. This will help identify the key issues that need to be addressed and determine the most appropriate measures for landscape restoration. Identifying the land tenure situation within the watershed, including the identification of private (owned or leased), communally owned, and state land, should be sufficient at this stage.

Figure 2.2: Outcome of the participatory mapping exercise, Philippines



The mapping exercise identified existing land uses, potential interventions and natural assets

The two main mapping and surveying methods are participatory mapping and participatory transects. These methods help describe the main bio-physical conditions and community interactions within the watershed and provide information about land resources, opportunities for development, and other significant issues.

Participatory Mapping involves using land user's mental maps of their community to identify resources, assess linkages, and identify social groups and their interactions. For instance, the mapping can reveal interactions between livestock grazers on communal grazing land and the resulting gully erosion of private farmland. The community map can be developed using a Google Maps image base or a sketch map, as illustrated in Figure 2.1 **Transects**, which are walking cross-sections through the community, should be aligned to cross as many different land units or ecosystems as possible. The transect walk should be participatory and include semi-structured interviews with different land user groups, such as farmers, herders, forest managers, and gatherers.

Figure 2.3: Participatory mapping exercises, Cambodia (Left) and Fiji (Right)

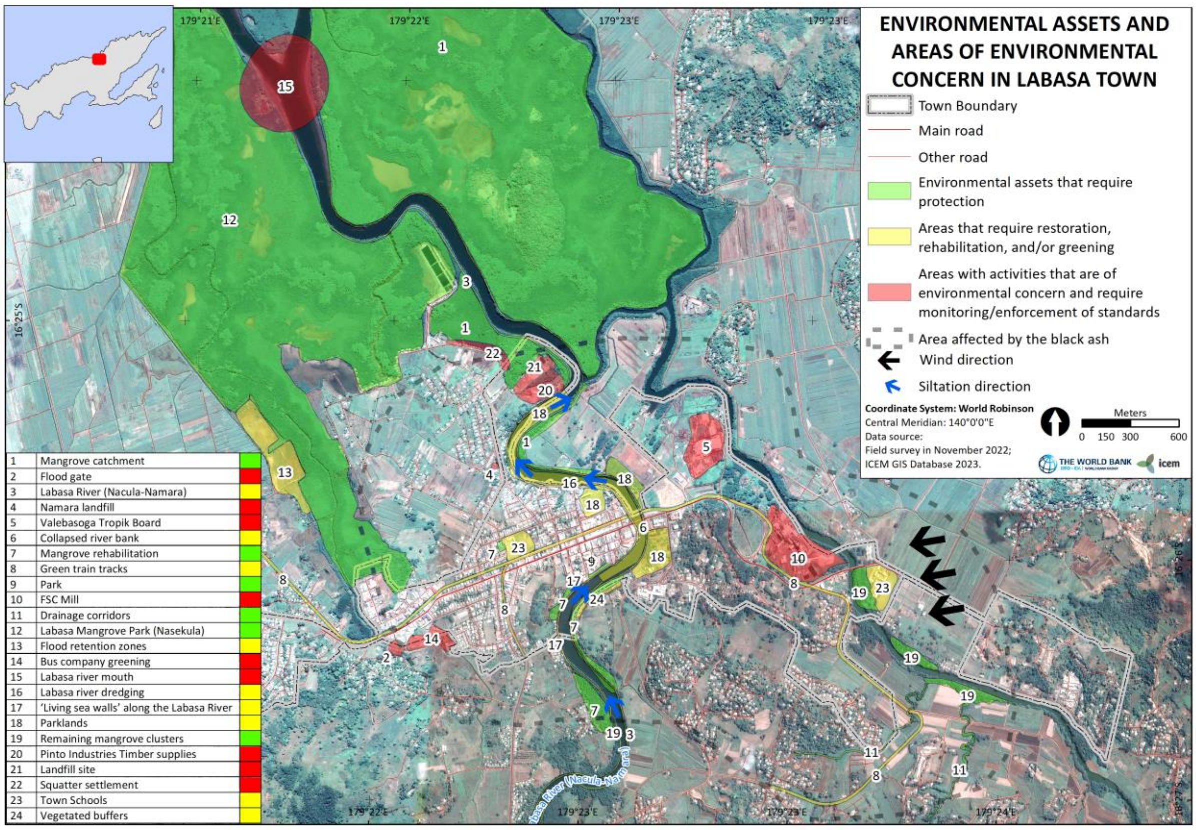
The participatory mapping and transects will involve discussion with as many land users as possible and should stimulate discussion of the issues and potential interventions that may be suitable for each land unit.

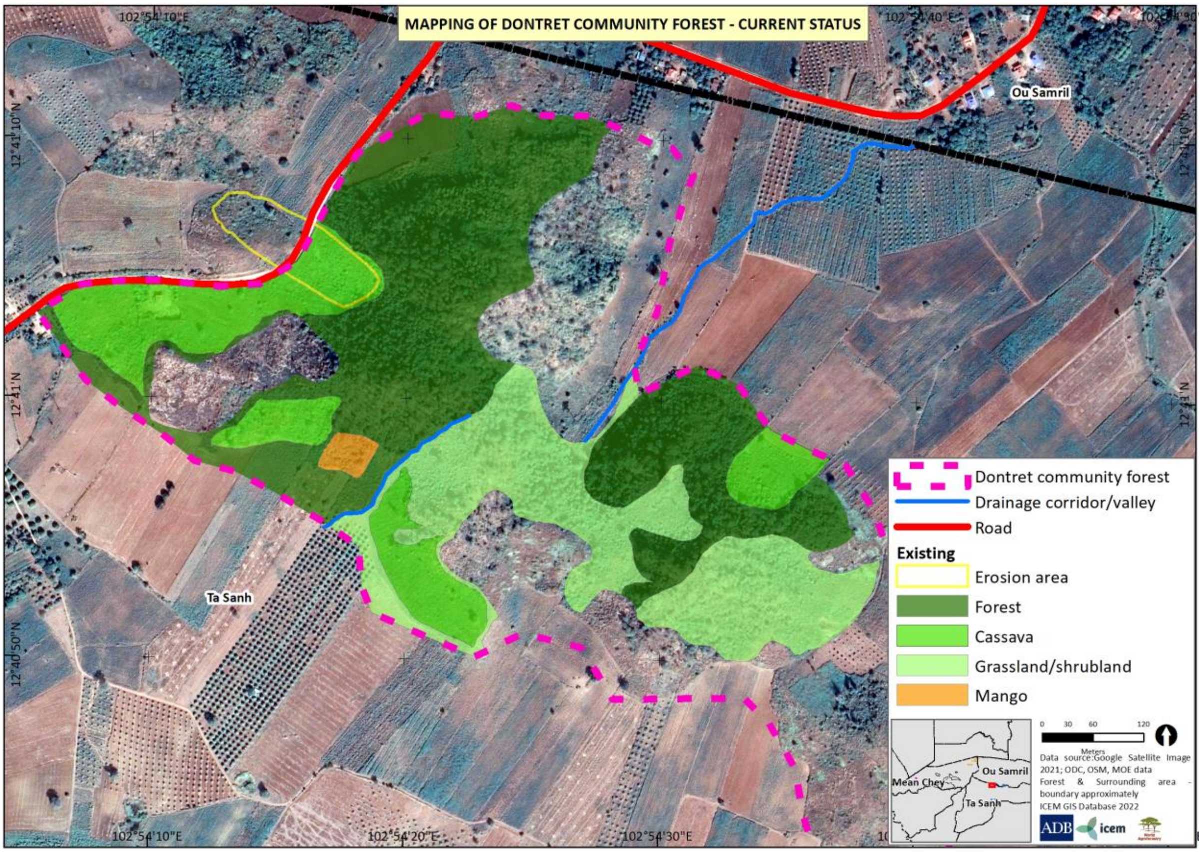
A **Problem Identification** (PI) and ranking exercise will help to identify community needs, strengths and aspirations. The aim is to identify the community's most pressing issues (problems) and their drivers (which may well be outside the community's scope) and to enable a preliminary assessment of potential solutions. Two or more PI exercises should be undertaken based on gender and the interests of different land user groups.

The PI should start with a discussion on the vision for change or how the community would like to see the area and people develop and then proceed to a discussion on the barriers to achieving that vision. The problems need to be defined at this stage so that a solution-oriented approach can be progressed. Problems can be categorized as biological (pest, animal disease, invasive species), physical (waterlogging, landslides), environmental (drought, deforestation, soil erosion), economic (lack of credit), institutional, social and cultural.

The final step is to prepare a detailed bio-physical map on a topographic or high-resolution image (e.g., Google maps) base. Land use, topography, soils, and past erosion initially delineate boundaries and sub-watersheds. For each land use or land unit, the actual conditions in the watershed should be described, including soil, vegetation, drainage, topography, land use, water resources, infrastructure, past and present watershed development activities, and degradation trends (soil erosion, deforestation etc.).

Figure 2.4: Output of participatory mapping workshop, in which key assets and features are marked and identified in Fiji (Top), the Cambodia (bottom





Source: ICEM

The causes of soil erosion can be assessed at this stage and ascribed to land use, farming practices, landscape features, and coping strategies. Examples include cultivation on steep slopes, uncontrolled grazing and deforestation. This will form the basis for designing soil conservation measures and their prioritization.

The results of the biophysical and socio-economic surveys can be combined to produce a community base map to which potential interventions can be added in subsequent steps. The map should be at a scale of around 1:2,000 to 1:5,000 to facilitate presentation and to ensure priority areas are clearly visible.

The next step is to hold a community meeting to present the findings and ensure that the community is on board with the findings, the preliminary solutions, and the priorities for moving forward.

2.2.4 Identification and Prioritization of Interventions

Although many potential interventions may be suitable for implementation in the watershed, it is important to identify a select few that are relatively easy to implement and will begin to show benefits within the project timeframe. These have been highlighted in green in Annex A but other local interventions such as Natural Vegetative Strips (NVS) in the Philippines may also be used.

Annex A shows SLM (Sustainable Land Management) approaches and technologies used in Cambodia and the Philippines as reported by WOCAT (World Overview of Conservation Approaches and Technologies) on their website (https://qcat.wocat.net/en/wocat/). Sustainable Land Management in the context of WOCAT is defined as the use of land resources - including soil, water, vegetation and animals - to produce goods and provide services to meet human needs, while ensuring the long-term productive potential of these resources and sustaining their environmental functions.

Sustainable Land Management technologies are land management practices to control land degradation and enhance productivity and/or other ecosystem services. Sustainable Land Management approaches are the ways and means used to implement an SLM technology, including the stakeholders involved and their roles. Together they are known as SLM Practices.

WOCAT contains 1,247 SLM technologies and 499 SLM approaches, identified by a global network of SLM specialists. WOCAT experts review newly submitted SLM practices, and once any clarifications or modifications are accepted, publish the new SLM as best practice in the WOCAT databses. Annex B contains 33 technologies for Cambodia (Cambodia Technologies (CT) 1-33) and 31 for the Philippines (Philippines Technologies (PT)1-31) and five approaches for Cambodia (Cambodia Approaches (CA) 1-5) and ten for the Philippines (Philippines Approaches (PA) 1-10). Most SLM Practices for the Philippines have been entered into the WOCAT database by the 'Philippine Overview of Conservation Approaches and Technologies' while all SLM Practices for Cambodia have been entered by individuals or projects implying that the Philippines is more advanced than Cambodia in implementing SLM interventions.

Sustainable Land Management approaches, and Soil and Water Conservation interventions can be categorized into six sub-categories (Table 2.1).

Table 2.1: Sustainable Land Management/ Soil and Water Conservation Interventions by Category

SLM/SWC Category	Description
Physical Soil & Water Conservation	Soil & Stone bunds, Bench Terracing, Hillside Terraces, Conservation Tillage
Flood Control and Improved Drainage	Waterways, cut-off drains, graded bunds
Water Harvesting	Wells, Ponds, Farm dams, Spring development, conservation bench terraces
Soil Fertility Management & Biological Soil Conservation	Compost making, Mulching, contour grass strips, vegetative fencing, intercropping, crop rotation

SLM/SWC Category	Description
Agroforestry, Forage Development & Forestry	Area closure, microbasins, trenches, multi-storey gardening, seed collection
Gully Control	Stone and/or brushwood check dams, gully reshaping/filling/revegetating, sediment storage and overflow soil bunds and dams

Almost all categories are represented in the WOCAT SLM Practices from the Philippines reflecting the diversity of landscapes and the fact that agriculture has been practiced in forested, hilly upper watershed areas for a long time. In contrast the WOCAT SLM Practices from Cambodia are concentrated in the Soil Fertility Management and Biological Soil Conservation category reflecting the fact that most cultivation is on flat or gently sloping land.

The measures to be implemented in the pilot areas can be selected from the SLM Practices outlined in Annex A and Annex B but may be supplemented by additional practices from the whole WOCAT database. The measures selected need to be suitable for the areas' agro-ecology and fit the demands and priorities of the community.

While traditional knowledge can be valuable, it may not always apply to current issues, and newer measures may be more appropriate. However, any measures that are identified need to be agreed upon by the community, as some may be implemented on private farmland (such as natural vegetative strips, grass strips, and boundary planting), while others will require community-level commitment and agreement on future use and benefit sharing, particularly those that involve communal land, such as reforestation, area closure, and gully control.

Care should be taken to address the needs of women, and equal importance should be given to activities that benefit women. Depending on cultural norms, these may be concentrated in activities that save time (such as gathering water) or are around the homestead, such as small woodlots.

If new and untested (in the area) practices are to be promoted, they should be participatory in nature since farmers may be unsure of new land management practices and species and wary of the claimed benefits. Small-scale trials can help to illustrate the benefits of new approaches.

2.2.5 Community Discussion for Approval of Options and Interventions

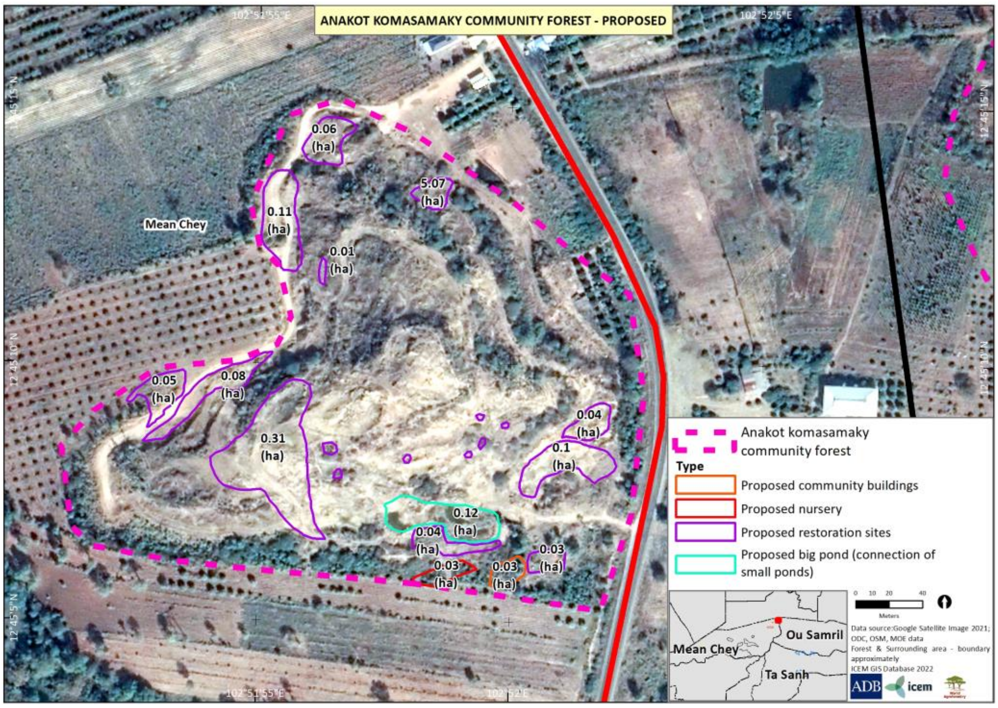
The draft plan is ready for implementation following the selection of suitable interventions. At this stage a whole community discussion is required to achieve consensus on the proposed measures and approve the plan. Following the presentation of the plan, the community should be provided with the opportunity to provide comments and engage in discussion. Valid and helpful suggestions can be incorporated into the plan.

The outcome will be a revised plan with community agreement on the measures/interventions to be implemented, the technical design, required inputs, the schedule of activities, and expected benefits.

2.2.6 Development Map, Inputs and Action Plan

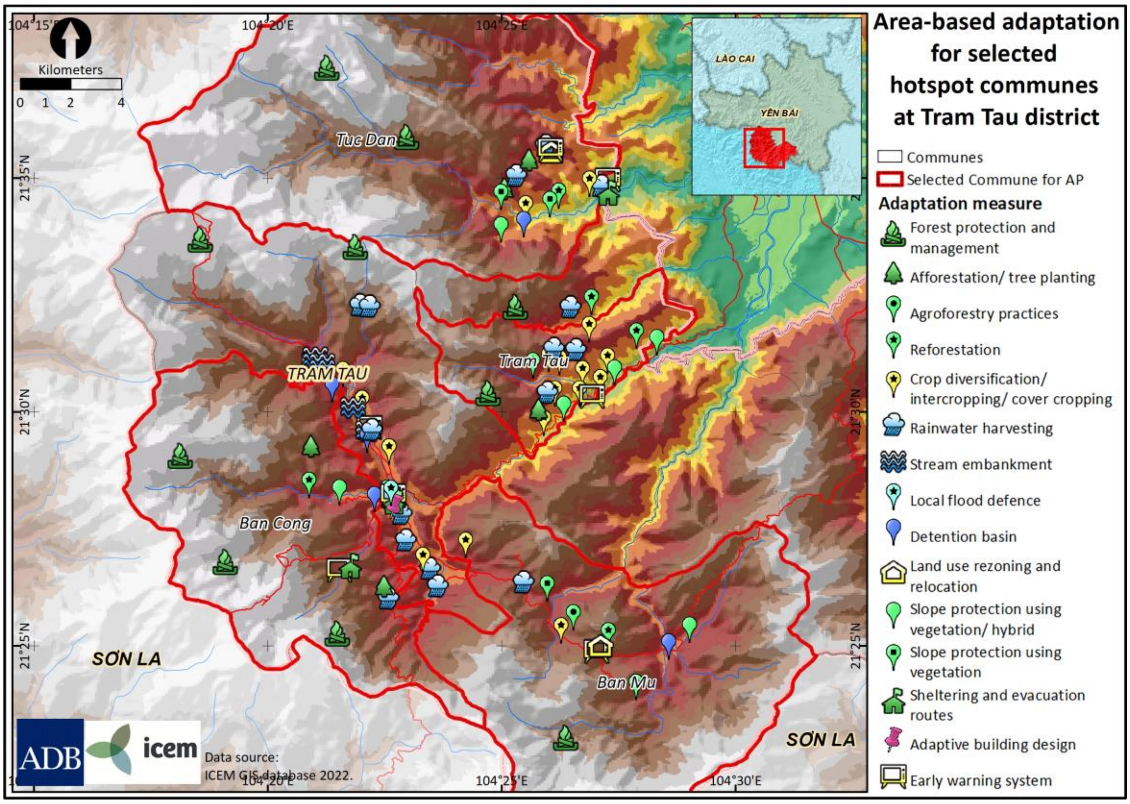
The development map is based on the base map and shows the placement of different development interventions in different land units. An example of a development map is shown in Figure 2.4.

Figure 2.5: Example of a development depicting proposed interventions (Cambodia)



The next task is to estimate the inputs required to implement the planned activities and prepare an action plan showing how long it will take to implement each measure. In watershed development, this can be over a period of years, although in the current project's pilot watersheds all implementation interventions will have to be done simultaneously. Factors that can influence the implementation of measures include the extent (area) of work, specification, slope, soil texture and condition, working patterns, and availability of farmers, tools, and planting materials.

Figure 2.6: Potential adaptation measures for selected comunes in Northern Vietnam



Planting materials are established in nurseries (Section 3.2.3). However, farmers can also be encouraged to produce planting materials on their own land and as part of bund stabilization or vegetative strips if required.

2.2.7 Implementation

The community will form teams to implement the various interventions under the guidance of the NGO. Once implemented, interventions will need careful management and maintenance and can, in time, be expanded or replicated elsewhere if appropriate.

Evidence suggests that development initiatives will not be sustained unless beneficiaries (the community) make some form of resource commitment to support the interventions. Both self-help (the community) and external support (NGOs) translate into commitments to manage, protect and eventually improve the interventions that become assets.

2.2.8 Participatory Monitoring and Evaluation

Participatory M&E is integral to watershed development and requires the identification of indicators against which the progress and success of the project can be measured.

Usually M&E consists of three stages; initially the identification of indicators against which the project's progress can be measured, a baseline evaluation when information regarding the indicators is gathered at the start of implementation and an endline evaluation where information regarding the indicators is gathered to enable an evaluation of project impacts to be made.

Given the short timeframe of the current project it is suggested that only a few easily measurable output, outcome and impact indicators should be identified. An (incomplete) example M&E framework is given in the below table.

	INDICATOR	DESCRIPTION	BASELINE	TARGET	DATA SOURCE	FREQUENCY	RESPONSIBILITY/ REPORTING
IMPACT	Restoration approach and measures used by ADB in future projects	The endline evaluation shows that the approach taken by the project is a success and can be integrated into project planning for future projects	Forest/ landscape restoration not integrated into ADB project planning	Forest/ landscape restoration integrated into ADB project planning for suitable projects	ADB	Endline and Legacy evaluation	ADB
OUTCOMES	Area of tree cover increased in pilot areas	Difference between baseline tree cover area (ha) and tree cover at endline	From imagery Say 12.5ha forested and 10ha deforested	Depends on baseline Say 5ha increase by 2024	Imagery and field visits	Endline	MJP/ ICEM
	Increase in number of farmers/ stakeholders aware of benefits of forest and landscape restoration	Increased awareness of restoration options. Difference between baseline and endline	20% of stakeholders	50% of stakeholders	Stakeholder surveys at baseline and endline	Baseline and Endline	MJP
OUTPUTS	Number of People (m/f) trained in tree planting	Number of people (m/f) attending tree planting training as part of restoration program	Zero	40 male/ 40 female	MJP records	Endline	MJP
	Number of seedlings produced by project nurseries	Output of seedlings by nurseries established by the project	Zero	10,000	Nursery records	Endline but nurseries should keep monthly records	MJP
	Number of leaky dams constructed in watercourses	Number of leaky dams constructed in the CFs and associated watercourses	0	10	MJP & Community records Corroborated by field visit	Endline	MJP/ ICEM
	Number of CFs identified and subject to restoration	The number of CFs with restoration implemented on the ground by the project	0	4	Field visits	Endline	MJP/ ICEM

2.3 Land Units

Step 3 in the land use planning process requires the division of the watershed into different land units that will have their own suite of problems and opportunities for which a number of interventions can then be proposed.

Table 2.2 shows a range of possible land units and interventions. This is by no means definitive and will need to be completed for each pilot watershed.

Table 2.2: Potential Land Units and Interventions

	Land Unit	Examples of Interventions
1	Existing natural ecosystems, including special reference to high biodiversity areas (land and water)	Protection, Community Based Forest Management (CBFM)
2	Production forest, with new plantations marked	Replanting, ANR, CBFM
3	Agroforestry areas, including fruit plantations	Mulching, Intercropping
4	Cultivated Land	Grass strips, NVS/PVS, Composting, Mulching, rotation
5	Pastureland	Reseeding, water harvesting
6	Deforested areas, including areas for planned reforestation	Assisted Natural Regrowth (ANR), Reforestation, enrichment planting
7	Watercourses, wetlands, ponds/lakes	Conservation, management
8	Degraded land (may be part of 2). Include areas of IAS	Area closure, gully rehabilitation, brushwood/stone check dams
9	Disaster risk areas (may be part of 2 and 3)	Area closure, replanting
10	Nurseries: existing and planned	Nursery establishment
11	Houses, roads and other infrastructure	Woodlots, live fencing

3 Land Use Management

3.1 Watershed Management

In watersheds with abundant vegetation, water naturally infiltrates into the ground. However, in degraded landscapes where the soil receives little protection, heavy rainfall is not absorbed and instead strips the surface of topsoil and nutrients as it flows downhill. This process, known as soil erosion, can form gullies that gradually grow over time and can affect roads and other human infrastructure. The combination of moisture and loose soil can also cause landslides in steep areas, and heavy rainfall and degraded soils can cause flooding in lower areas, especially in cases where the natural water absorption capacity has been reduced.

It follows that reforestation and conservation efforts can have the greatest impact in the upper reaches of watersheds. The presence of permanent and rich vegetation in upland areas is essential for protecting the areas downstream. Therefore, planting native varieties of trees and shrubs can be justified even if they do not have an immediate financial return. The benefits of such efforts lie in protecting the environment, reducing soil erosion, and preserving biodiversity.

When deciding where to work, watersheds can be mapped and divided into different levels of hierarchy, such as first-degree (the main watershed), second-degree (sub-watersheds), and third-degree (micro watersheds). Sometimes, a significant portion of erosion in a watershed can be traced to a few micro watersheds. In such cases, it can be easier and more cost-effective to focus restoration efforts on those specific areas instead of trying to cover the entire watershed or sub-watershed.

By using a mix of native species, restoration efforts can also improve biodiversity. To further enhance this factor, it is recommended to plant and protect areas close to water streams, rivers, lakes, and wetlands, as these are crucial habitats for many species. Wetlands and lakes act as sponges during heavy rain, slowing the speed of water and reducing the risk of flooding downstream.

Focusing restoration efforts on specific micro watersheds and protecting areas close to water bodies can maximize the positive impact of reforestation and conservation on the environment and biodiversity.

3.2 Protection

There are many reasons a community will want to preserve land for protection. It might be for ecosystem conservation in lakes and wetlands, with potential economic benefits through ecotourism. In forest areas, the Forest Stewardship Council has defined six categories of high conservation value forests (HCVF)[1] in need of protection from traditional forest exploitation:

1. Species diversity
2. Landscape-level ecosystems
3. Ecosystems and habitats
4. Critical ecosystem services (e.g., provision of water)
5. Community needs (e.g., food from forests)
6. Cultural values (e.g., forests around religious pagodas in Cambodia)

This manual will not detail how to define HCVF areas; however, the local population typically knows which sites are the strongest candidates. In these areas, the community and NGOs should take a precautionary approach to ensure that the conservation value of the HCVF unit is not reduced by, for instance, negative impacts on threatened plants and animals, a reduction in the size of the land, or fragmentation into smaller units. If in doubt, it is better to be cautious and preserve the area or seek

[1] FSC 2020. Intact Forest Landscapes Guidance for Forest Managers.

assistance to study it in greater detail, as damage to ecosystems or habitats can often be difficult or impossible to reverse.

Even though such areas often have no legal protection, they can be conserved as "community-protected areas" or "private protected areas". These areas often have locally defined rules or by-laws, such as only allowing ecotourism or exploiting non-timber forest products (NTFP). Connections between smaller protected areas can be preserved with biological corridors of native vegetation that can run along watercourses, thereby protecting soil, water, and biodiversity.

3.3 Production

3.3.1 Species Selection

This manual follows the ICRAF approach to species selection: **The right tree in the right place for the right purpose.** This means the land user group (community, farmer, firm) should select the forest species based on chosen criteria. In most cases, this will result in a wide selection of species, which increases the number of uses and gives more resilience to climate variations and pests.

It is essential to consider plants' water, soil nutrients, and light requirements. These three factors often vary considerably, even for the same species growing only meters apart. Demand will also vary through a plant's growth cycle. Many forest trees require significant amounts of light and water when young and fast-growing but gradually become more shade tolerant and slower-growing as they mature.

Native species that are already well known, adapted to the environment, and appreciated are particularly recommended. However, species should not be selected against the will of the local population, and the community must be genuinely interested in producing and protecting them during the production cycle. New species should already be proven beneficial, adapted to the country, and planted at a small scale until more local experience is gained. If an exotic species has adapted to local conditions and is valued by the local population, it can be considered as part of the species mix. Always avoid invasive alien species (IAS), however.

Use

- *What will the tree will be used for in the short- and long-term?*

Timber and firewood for local use: Many options exist, including multipurpose species. The local community's experience is the most important selection factor.

Timber for the market: Due to the long production period for trees, it is impossible to know the market price at the moment of final exploitation. It is important to generate bi-products in the short term, such as thinning used for posts or firewood. If the primary purpose is to produce for the market, the first criterion is the current market price, and the second is the price trend in recent years.

Non-timber Forest Products: Besides firewood, trees produce fruit, oils, medicines, and products used for cultural and religious traditions.

Agroforestry species: Many trees improve the soil, especially leguminous species, whose seeds grow in beans. Other suitable agroforestry species are those where the canopy can give a semi-shade to produce agriculture below or trees that provide shade and forage for livestock.

Carbon credits and ecotourism: For these purposes, benefits accrue from the tree's ability to mitigate climate change's impacts or provide more biodiversity. These benefits are only really accrued in the long-term. Local projects typically sell carbon credits through national programs, but there are also local opportunities in the voluntary market, often provided through international NGOs.

Watershed protection: If the primary purpose is the protection of water resources such as a reservoir downstream, prioritize species that protect the soil but do not use too much water. These are often slow-growing small trees and shrubs with a robust root system.

Ecology

- *Is the tree well adapted to local conditions?*

Select the species most adapted to local conditions, typically native and ideally local varieties. People from the local communities, and especially the elderly, will often be able to identify them. As local conditions often vary substantially between sites within the same community or property, it is important to remind communities that adaptation is not always possible. IAS can often be more adaptable than native species and sometimes completely take over and destroy the native ecosystem, often because they have no natural enemies. IAS is a growing problem because people move more than before and because of climate change.

Growth rate and rotation cycle

- *Is the tree growing fast, and how long does it take to be harvested?*

Remember that trees often grow fast in the first years, but the final product may still take several years to develop. Intermediate products are therefore often necessary.

Ease of production

- *Is the species easy to produce and does it have a high survival rate in nurseries and in the field?*

NGOs, government officials, and seed providers can provide information on how to grow and maintain a species and what can be expected. Easy extraction and high seed germination rates are important for community nurseries, together with high seedling survival rates.

Multiple interests

- *Are the interests of different community members considered?*

For community forestry, selecting species through a participatory approach is recommended, as different community members often prioritize different species. For instance, women might prioritize firewood and the protection of water sources and medicinal plants, and community enterprises may want fast-growing commercial species. These interests are not contradictory and can be integrated into a local forest production model. A wider variety of species would give more resilience to climate change, forest pests, and market variations while supporting local households, resulting in more resilient communities.

3.3.2 Seed and Germplasm

Purchased seeds should be certified and handled well. If seeds are collected locally, the seedlings and young trees are often similar to their parents. Seeds should ideally be collected from high-quality mature trees. Some tree species can be directly sown with a high germination rate, while others must be produced in a nursery before being planted.

The principle of hereditary characteristics is also valid for collecting other plant material (germplasm), especially small trees that have germinated close to their mother tree or clones of genetically identical trees that can sprout from the same root system. Collecting and bringing these plants to the nursery or replanting them directly in another field site will save time.

3.3.3 Nursery Production

Keep records: Before starting any nursery activity, establish a nursery book to record everything, including tools and inputs, seedlings produced by species, pests and diseases, mortality rate, seedlings produced and when they leave the nursery, and all costs. Having an accountant or getting support from someone who knows accounting can help avoid financial trouble and conflict in the community.

Nursery area: Although there are many types of forest nurseries, this manual will focus on small community nurseries. To establish a community nursery, the first requirement is to have a permanent source of quality water available throughout the year, from the municipal system, a well, or a natural source.

Figure 3.1: Nursery to support restoration site Cambodia

Other factors to consider are the microclimate, soil and drainage, and an access road for transporting inputs and plants. The land should preferably be flat and with little shade. Sites shouldn't get too hot or windy and shouldn't flood during heavy rains. The quality and depth of soil are essential for bare-root plants, while for other seedlings, it is more important to have quality soil nearby. Agricultural areas that have seen heavy pesticide use should be avoided. Fencing may be necessary, depending on local conditions.

Nursery design: The size of the nursery will vary according to the type of plants produced (bare-root or pots), types of containers, and the number of seedlings. There must be space for seed beds, the transplanting area, raised plant beds, tools, and other inputs. A community nursery can produce up to one hundred thousand seedlings a year. Seedlings can be planted at an average of 100-150 seedlings per square meter depending on container types, plant size and other factors. Even in climates where seedlings take less than a year to grow, a good rule of thumb is to allow for one year from seeding until the plant leaves the nursery when estimating the nursery's production capacity.

A suitable approximate size of the areas provided for plants is 10-20 m for bare-root plants and 5-6 m for potted plants, with a recommended width of 1.20 m. An extra twenty percent more space is required for walkways between plant areas, storage, and other requirements. Walkways require at least 45 cm to allow sufficient space for the wheelbarrow.

Nursery production: Establish nurseries and acquire tools and the main inputs before the nursery season. Ensure that the nursery is equipped with spades, rakes, hoes, saws, machetes, pruning knives, watering cans, water hoses, a wheelbarrow, and a large drum for water. Input materials include soil, sand, organic fertilizer and/or compost, water, wood stakes, strings, and planting pots, bags or root trainer containers. In the past, plastic bags were the cheapest and most common type of planting "pots." Today it is more common to use root trainer containers, that can be used repeatedly. Note that for small community nurseries with few economic resources, it is possible to use alternatives such as bamboo (cut into short tubes) or milk/juice cardboard containers. Bamboo tubes require finer soil material (typically clay) compressed in the bottom. If the roots penetrate the sub-soil, they can be cut before taking the plants to the field.

Planting should be planned to ensure seedlings are ready to take to the field at the beginning of the rainy season. Plants should be large and strong enough to survive in the field. Any delay in the nursery process could be fatal for the plants. On the other hand, the plants should not be too large so as provide problems with transportation. Note that different species have different growth rates as seedlings and will require different times in the nursery.

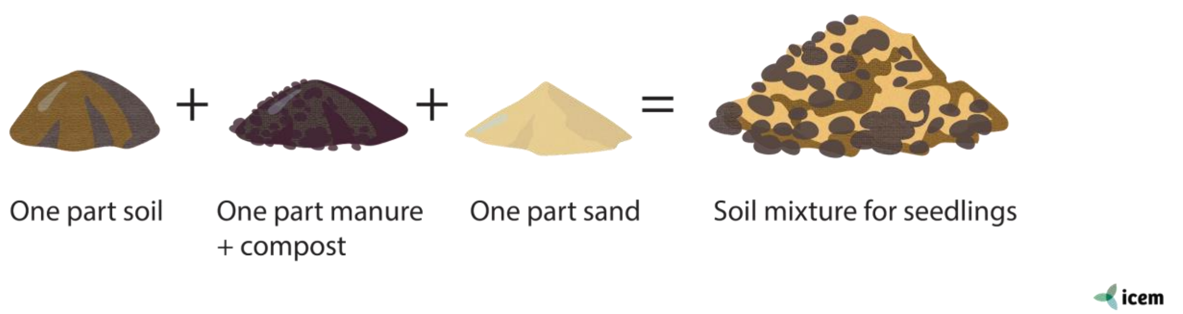
Raised beds: Seeding and seedling beds should be established above ground level to avoid flooding during heavy rains and to protect against fungal diseases. Bricks or stones often surround seedling beds to keep the plants in place.

Type of plants: The advantages of bare-root plants are their light weight and lower production costs. The advantage of plants in pots, bags, and containers is that they bring nutritious soil with them, making field planting less of a shock, leading to higher survival rates.

Some trees can be produced vegetatively as stumps. Branches can be cut from trees and placed in wet soil. When the stump sprouts the first leaves, it has its first roots. Once it has several branches with leaves, cut some of these before bringing the stump to another area for planting. This prevents the plant from transpiring too much water before the roots are settled in the new site.

Soil: Soil should be tested before use. The most important factors are nutrients (especially Nitrogen and Phosphorous) and acidity (pH). When the soil lacks important fertilizer, manure or compost can be added to the soil. Calcium can be added to very acidic soil. Commercial fertilizers might be expensive and are not always available. An argument in favor of natural alternatives such as manure and compost are that they are more suitable for local soil flora and fauna. It is important to add sand to ensure good plant pot drainage.

Figure 3.2: Mixture of Seedling Soil



Source: ICEM

A good mixture will often consist of one part soil, one part manure/compost, and one part sand. The components should be mixed well together before potting. Ensure not to use fresh manure as it will burn the plants. Be sure to mix the components together thoroughly before potting. Fresh manure should be avoided, as it can burn plants. Instead, use manure that has been stored for at least six months.

Where there is a chance that soil contains mold, fungal spores or other potentially harmful organisms soil sterilization can reduce the susceptibility to dampness and other issues. Applying dry heat to the soil for up to 30 minutes (Figure 3.3) can improve the chances of seedling survival

Figure 3.3: Soil preparation, Cambodia

Source: ICEM

Water: It's crucial to provide your plants with the right amount of water for optimal growth. Too little water can lead to weak and slow-growing plants while overwatering can often cause fungal diseases, resulting in high plant mortality rates.

It's important to use clean water with low levels of organic matter, salt content, and minerals such as iron. If available water doesn't meet these criteria, rainwater or water from other sources may be required.

A good rule of thumb is to provide around 20 liters of water per day for each square meter of planting bed. The amount will depend on the temperature, wind, and soil drainage. It's always best to monitor your plants and adjust the watering schedule to ensure they get the appropriate amount of water for healthy growth.

Production process: Some seeds require pre-germination, such as soaking in water or crushing the shell before planting. As requirements vary substantially, it's often best to consult the seed provider or technical advisor. Whether for pot plants or bare-root plants, the prices typically involve seeding in seed beds and re-planting the first young seedlings.

First, spread a generous number of seeds on the top of high-quality soil, followed by a thin layer of soil. The layer should be thin enough that some of the seeds remain exposed. Keep the area shaded and water frequently to prevent the soil from drying out. Once the seeds have germinated and the seedlings are about 5 cm tall, they are ready for transplanting into pots, bags, containers, or the open field in the nursery (for bare-root plants).

To transplant use a wooden stick to make a hole in the soil and put the seedling in carefully, surrounding it with soil but not pressing too hard. Water the seedlings daily until they are established in their new environment. A common practice is to plant multiple seedlings in each pot to ensure at least one plant survives. Another option is to plant seeds directly into pots and then thin out the seedlings once they start to grow. This technique is particularly useful for large seeds.

The time plants require in the nursery will vary depending on the species and variety, soil quality, watering regime, and climate. Even in tropical climates, it can take anywhere from three to nine months before plants are ready for planting in the field.

To ensure optimal growth, provide the seedlings with semi-shade as they grow. This can be achieved using nylon sheets, a frame made from sticks, or banana leaves. Avoid using plastics, if possible. As the seedlings mature, gradually expose the seedlings to more sunlight to speed up growth and acclimatize them to conditions in the field. Once the plants reach a height of about 30 cm, they can be fully exposed to available sunlight.

Pests such as insects and fungus can be fatal to seedlings. While large, industrial-style nurseries often rely on pesticides to combat these , integrated pest management (IPM) is an alternative, more feasible approach, for small nurseries that have various plant species. IPM takes into account whether individual species of insects' harm or benefit the seedlings.

One effective way to control insects and fungal diseases is to monitor plants and remove those affected, so they cannot contaminate the others. The most effective way to avoid fungal infection is to avoid watering too much.

3.3.4 Field Plantation

Direct seeding is the most straightforward and cost-effective way to establish a new forest. To do this, remove the vegetation in a small spot (e.g., 30 x 30 cm) and plant multiple seeds, as many will not germinate. The requirements for different species will vary, but it's advisable to plant some seeds just below the surface and others above the surface to be on the safe side. Water each spot thoroughly.

If the direct seeding is in an open field, protect it with some branches to create semi-shade. However, this may not be necessary if there are other trees around. When revisiting the area, ensure the plants have enough light by cutting back grass and providing water from a local source if needed.

Another approach to direct seeding is to prepare plots so that they can grow seeds that fall from nearby trees.

Field planting should take place at the beginning of the rainy season, when the plants have the greatest chances of survival. Some areas have two rainy seasons; however, the general principal is to plant when just before the highest number of rainy days are expected. If the rains do not come it is necessary to water the plants to ensure their early survival.

When transporting the seedlings to the field, ensure they are well watered and don't lose much soil on bumpy roads or dry out in the wind. It's essential to treat the seedlings with care and avoid grabbing them by the stem. Instead, carry them in a box of root trainers or the bag around the soil brought from the nursery.

During planting, dig a hole much larger than the plant's soil and put it back into the hole around it. Remember to remove the bag before planting if it is not biodegradable. The plant should have loose soil below it to ensure the roots can penetrate downwards. Spread out the roots as much as possible, ensuring they are not curled. The soil around the plant should be at the level of the terrain, but in dry areas, the tree can be planted slightly lower, so that water will accumulate around the plant on rainy days.

Figure 3.4: Poster used to illustrate planting process, Cambodia

Source: ICEM

The initial distance between plants varies according to the purpose of the plantation. For normal forest plantations, an area of 3 x 3 m is recommended.

Table 3.1: Planting Distance in the Field, Plants/ha and Examples of Use (ha)

Plant distance	Plants per ha	Examples of use
2 x 2 m	2,500	Timber
2.5 x 2.5 m	1,600	Timber
3 x 3 m	1,111	Multipurpose forestry
4 x 4 m	625	Agroforestry
5 x 5 m	400	Silvopasture

Plants should be protected against direct sunlight and grazing animals. Different materials can be used depending on the threat, such as branches with spines. Another danger is forest fire, especially in the dry season. To mitigate the danger, cut back vegetation near the plants or conduct controlled burning to eliminate debris close to the plants.

3.3.5 Soil and Water Conservation – Assessment of Past Measures

Land degradation and soil erosion in the upper catchment significantly impact water storage and runoff. With reduced storage capacity, the upper basins cannot hold as much water as they did in the past. Furthermore, the likelihood of high-intensity rainfall events caused by climate change requires that water is kept in the upper catchment and released gradually over time, reducing runoff and soil erosion, which can increase flooding downstream and lead to faster sedimentation in reservoirs.

Figure 3.5: Soil erosion on upland slopes, Cambodia

Source: ICEM

Many past interventions to address land degradation and soil erosion failed because they did not consider the needs of land users. It is now widely accepted that the participation of farmers is crucial. Additionally, tangible benefits of interventions such as increased crop yields, improved water availability and reduced erosion need to be realized quickly.

Moreover, it is increasingly recognized that measures to reduce land degradation and soil erosion need to be integrated with livelihood improvements.

In order to combat land degradation and reduce soil erosion Conservation Agriculture (CA) or Conservation Farming (CF) is an increasingly common approach to sustainable agriculture. It is a combination of agricultural methods aimed at optimizing yields and profits while also preventing land degradation. It aims to minimize the decline of soil structure, composition and natural biodiversity.

Conservation farming treats the soil as a living body with emphasis on protecting the topsoil, the upper 20cm of soil, that has the most biological activity and contains much of the nutrients but is also the most prone to erosion. In general conservation farming has three core principles:

- Minimum soil disturbance
- Maintenance of permanent or semi-permanent soil cover
- Crop rotation

These three key principles of conservation farming can be summarized by the following ‘dos’ and ‘don’ts’

Do

- Keep crops and permanent crop residues on the soil surface
- Apply lime and sometimes fertilizer on the surface as necessary
- Practice direct seeding or planting

- Grow multiple crops in a season
- Use specialized equipment for seeding and mulch management

Don't

- Burn crop residues or fallow vegetation
- Prepare land by ploughing or disking (do ridging, subsoiling, ripping, chiseling or no-till instead)
- Monocrop
- Practice uncontrolled grazing

ICRAF promotes Conservation Farming with Trees (CFWT)[2] that takes the principles of conservation farming and combines them with agroforestry. This has two further principles; the judicious integration of trees and good management practices. The integration of trees can complement crop cultivation by using N fixing species, stabilize field boundaries, provide fruits and fodder and provide timber in time. Good management practices may well require training to maximize productivity with information on species selection, seed quality, planting spacing and pest control among others.

Potential adaptation and mitigation options are numerous and varied and include both on-farm and off-farm measures. On farm measures include structural soil and water conservation measures (soil bunds, stone bunds, terraces), biological measures (hedges, cover crops, contour planting), and agronomic measures (minimum tillage, fertilizer use). Off-farm measures include drains, check dams and bank conservation. Other interventions include water harvesting, soil fertility management, agroforestry, forage development, afforestation, area closure, and gully control.

The first step in the land use planning (Section 2.2.1) is the collection of regional information. This should also include the collection of which SLM/SWC practices have been used in each country and region, what is known to work, and what does not to work and why. This information is highly pertinent to what measures may be proposed for each watershed.

3.3.6 Soil and Water Conservation – Potential Measures

Some of the most suitable interventions are presented below. These are primarily biological measures that increase biodiversity and restore the landscape, and they are also relatively low-cost in terms of labor requirements and can be implemented quickly.

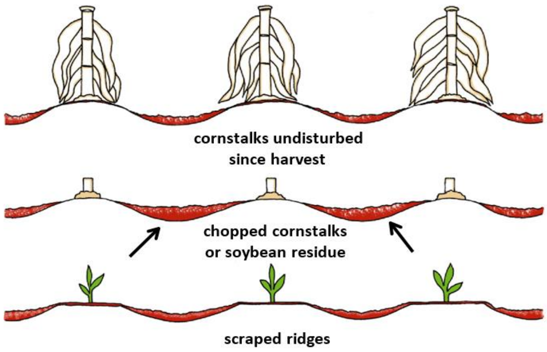
Where an intervention has similarities with an approach or a technology listed on the WOCAT website it is noted below. Annex B contains links to descriptions of each practice. Approaches and Technologies from Cambodia are notated CA1-5 and CT1-33 and PA1-10 and PT1-31 for the Philippines.

Conservation Tillage

Conservation tillage includes reduced and zero tillage. It entails reducing soil manipulation, such as plowing and retaining some crop residue on the soil surface, even during seeding. Keeping the soil surface covered reduces the risk of soil detachment and transport, particularly by heavy rainfall at the start of the rainy season, and soil nutrient and moisture losses are also reduced. The crop residue also enhances organic matter formation, improving water storage and improving nutrient availability. It also reduces labor requirements for land preparation.

[2] Mercado A, Noza Z & Piñion C (2020) Conservation Agriculture with Trees: A Training Manual. World Agroforestry (ICRAF) Philippines.

Figure 3.6: Conservation tillage



Source: Zhu, X., Clements, R., Quezada, A., Torres, J. and Haggar, J., 2011. Technologies for climate change adaptation. Agriculture sector and Lloyd, P. 2019. Switching to no-till? Restore degraded soil first! Farmer's weekly, accessed here: Switching to no-till? Restore degraded soil first! (farmersweekly.co.za)

Reduced tillage means minimal soil surface disruption: only the top 3-4 cm is tilled for crop planting. Zero tillage uses direct planting without any soil disturbance but does require herbicide use. Following harvest, about 20% of the crop residue must be left on the soil to reduce evaporation and protect from erosion.

Conservation tillage is inherent in PA5 Landcare and PA7 Soil Conservation Guided Farm System and in PT1 Contour Straight Block Layout, PT14 Vegetable Terracing and PT26 Conservation Tillage Practices for Corn.

Composting and Mulching

Making compost is a cost-effective soil fertility improvement measure that can also increase water storage in the soil profile and reduce surface runoff and soil erosion. Composting is suitable for high-value crops around homesteads, supplementing artificial fertilizer in cultivated land (particularly if bunded or terraced), and applying around valuable trees.

Compost is produced either in pits or in heaps. Heaps are preferred in higher rainfall areas. Pits or heaps should be sited in the shade, and the number of pits/heaps depends on the amount of plant material available with two as a minimum. An ideal size is 2m wide by 4m long and 1.2-1.5m deep if a pit or 30cm for a heap. The compost should contain layers of plant residue, ash, and manure and be kept moist. Soil should be spread on top of each layer, and bamboo placed in the pit at 2m intervals for aeration.

The pit or heap is left for a month and then turned and mixed into the second pit/heap. The compost should be ready after 3 to 5 months, and the process then repeated and expanded if there is a ready supply of materials.

Mulching is the covering of the soil surface with crop residues (or compost) that protects the soil from raindrop splash erosion and reduces the amount of runoff and soil erosion. It also increases infiltration, prevents crust formation, improves fertility, and reduces evaporation, thus maintaining soil moisture.

Mulching is an effective technique for improving soil quality and conserving moisture around trees and homesteads. A 2-5cm thick mulch on the soil surface helps retain moisture, suppress weeds, and regulate soil temperature. Additionally, vertical mulching is a method where mulch material is placed in furrows along contours every 2-6m, 20cm deep, with about 20cm standing above the soil surface. This method helps to increase water uptake into the soil while reducing runoff and erosion. Vertical mulching is particularly useful in areas with heavy rainfall and steep slopes where erosion is a concern.

The main limitation to composting and mulching is the availability of organic materials and the labor required. Mulching can be combined with area closure, providing a substantial amount of biomass that can be cut and used as mulch.

Composting and mulching are widespread practices. In Cambodia the approaches (A) and technologies (T), identified by WOCAT, described in Annex B, are CA5 Model Farmer, CT5 Mulching with Water Hyacinth, CT7 Use of Rice Husk Biochar, CT13 Compost Application on Rice Fields, CT26 Dry Compost on Paddy and CT33 Coconut Leaf Mulching. In the Philippines see CA8 Conservation farming Village and PT3 Modified Rapid Composting, PT12 Organic Mulching and PT 17 Composting using Indigenous Microorganisms.

Natural vegetative strips (NVS)

Natural vegetative strips (NVS)[3] are live barriers composed of naturally occurring grasses and herbs and are designed to be narrow in size. They have been introduced by Landcare in Mindanao and are likely to be implemented in the Manupali watershed. They may also be suitable for use in the Samlaut watershed.

Contour lines are laid out with an A-frame or through the 'cow's back method' (a cow is used to walk across the slope: it tends to follow the contour, and this is confirmed when its back is seen to be level). The contours are then pegged to serve as an initial guide to plowing.

The 0.3 - 0.5 m wide strips are not ploughed to allow vegetation to establish. Runoff flowing down the slope during heavy rain is slowed and infiltrates when it reaches the vegetative strips. Eroded soil collects on and above the strips, and natural terraces form over time. This leveling is assisted by plowing along the contour between the NVS - through 'tillage erosion' - which also moves soil downslope.

The vegetation on the established NVS needs to be reduced to 5-10 cm before planting crops, and once or twice during the cropping period. The cut material can be applied to the cropping area as mulch, or used as fodder.

NVS is a low-cost technique as no planting material is required, and only minimal labor is necessary for establishment and maintenance. Some farmers had practiced the technology for several years prior to the ICRAF (The World Agroforestry Centre) intervention in 1993. ICRAF realized that farmers preferred NVS to the recommended 'contour barrier hedgerows' of multipurpose trees, which land users viewed as labor intensive. Once farmers were organized into 'Landcare' groups, NVS began to gain wide acceptance.

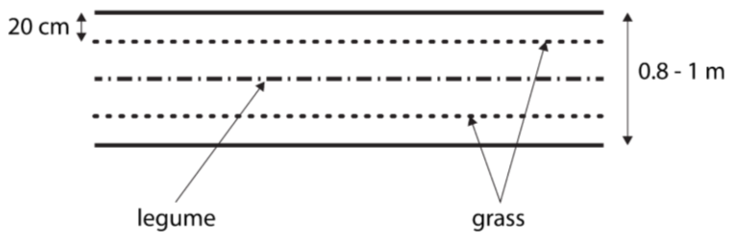
Land users appreciate the technique because it effectively controls soil erosion and prevents loss (through surface runoff) of fertilizers applied to the crop. When establishing the contour lines, or later, some farmers plant fruit, timber trees, bananas, or pineapples on or above the NVS. The trees and other cash perennials provide an additional source of income, at the cost of some shading of the adjacent annual crops.

Grass Strips

Grass strips are also vegetative barriers planted in narrow strips of 0.5-1.5m along the contour. They control erosion on gentle slopes; however, their effectiveness decreases above 5% to 8% slopes. Above 15%, they should be alternated with bunds. Grass strips cause less interference than other measures (such as terraces, bunds and hedgerows), use little arable land, and are much less costly than physical structures.

[3] In WOCAT (Annex B) NVS is integral to PA5 Landcare as well as PT21 NVS and PT23 Planted Vegetative Strips (PVS).

Figure 3.7: Grass Strip Layout



Source: ICEM/ MJP

To effectively suppress weeds and slow down overland water flow, grass species used for live barriers should be perennial and persistent. Ideally, they should also provide good ground cover and be suitable for use as fodder or other materials. These live barriers are established along the contour at 1m vertical intervals. For example, on a 3% slope, the distance between strips should be 33m, while on a 15% slope, it should be 7m. The width of the live barrier strip varies between 0.5 to 1m, with a recommended width of 0.8-1m. The strip is established by broadcasting or planting seeds or cuttings in two to three rows. The middle row can be sown with a legume to improve the nutritive value for livestock. If broadcast, the grass and legume seeds can be mixed for convenience. Planting these live barriers at the onset of the rainy season is best to ensure optimal growth and establishment.

The grass species selected should not be aggressive to adjacent crops or act as weeds. Effective species include Rhodes, Andropogon, Setaria, Phalaris and Vetifer. However, native grass species may be more adaptable to local conditions, promote gains in biodiversity, and be more familiar to land users (Figure 11).

Figure 3.8: River bank restoration with native species, Son La, Vietnam

Source: ICEM/ MJP

The constraints of grass strips are that they do not offer much resistance against erosive early season rainstorms and can be easily damaged by animals.

Grass Strips are similar to CT12 Growing Stylo Grass as Cattle Fodder from Cambodia and PT22 Vetifer Grass System from the Philippines.

Stabilization of farm boundaries

An alternative to grass strips or NVS is stabilizing existing farm boundaries. Crops, grass, shrubs and trees are planted to strengthen the boundaries (particularly soil bunds) against rain, runoff erosion, and cattle trampling and to make the boundary productive for fodder production, fuelwood, timber, or fruit trees.

For fodder production, suitable trees should be planted as seedlings closely spaced (c. 30-60cm apart) in single or staggered double rows, ideally at the start of the rainy season. Nitrogen-fixing trees such as Leucaena leucocephala, Cajanus cajan, and Sesbania sesban are ideal as forage, although local species can also be used. For fuelwood and timber, a single row of seedlings at a spacing of 1-4m is preferred, and fruit trees such as mango, guava, citrus etc. can be planted in combination with other purpose trees. Composting to provide material for establishing the trees.

A limitation is that it does not necessarily follow the contour (although this is not a severe limitation in areas of low slope) and that regular vegetation management is required (pruning, pollarding, thinning) to avoid competition with crops in fields.

Boundary Stabilization is similar to CT8 Multipurpose use of Sugarpalm on Rice Fields from Cambodia and PT11 Contour Farming using Hedgerows and PT22 Vetifer Grass System from the Philippines.

Vegetative Fencing

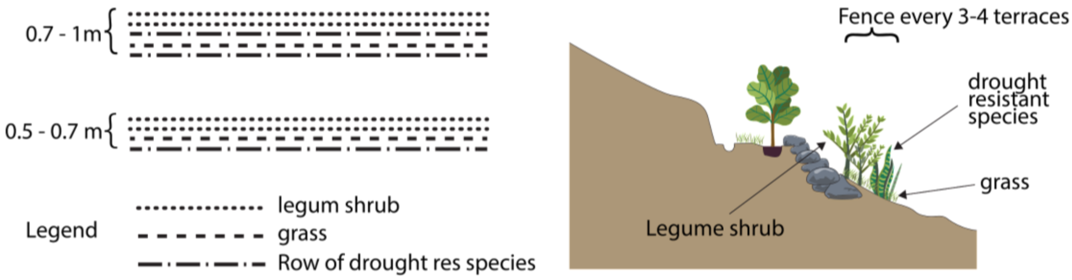
Vegetative fencing is a conservation practice that involves planting materials in rows along with grass and legumes sowed behind these rows. The method is commonly used to protect and enrich reclaimed areas like gullies, farm boundaries, and community assets like ponds. Vegetative fencing helps to control runoff and erosion, and once established, it allows for other valuable trees to be planted behind the fence.

Figure 3.9: Live fencing, here utilizing local bamboo

Source: Savethehills, 2011, accessed here: Visions of Hell: Affordable & effective means of erosion control/slope stabilization (savethehills.blogspot.com)

If established over a large, vegetation fencing can be a useful barrier against runoff and erosion and create 'conservation webs or nets' to trap sediment and moisture, act as windbreaks, and provide some degree of tenure security. The activity can be combined with the treatment of degraded hillsides and area closure by establishing high values trees after the fences have been established.

Figure 3.10: Vegetative Fence Layout and Along Hillside Terrace



Source: ICEM/ MJP

Vegetative Fencing is similar to CT3 Cashew Living Fences from Cambodia and PT8 Live Trellis System, PT 11 Contour Farming using Hedgerows, PT 15 Seed Production of Multipurpose Shrubs/Legumes and PT22 Vetifer Grass System from the Philippines.

Area Closure

Area closure is an agroforestry and forage development technique whereby an area of degraded land is closed to grazing animals and allowed to naturally regenerate or be planted with high-value agroforestry species. The community should directly manage the measure to be effective. Area closure can protect downstream cultivated land from runoff flooding and can contribute to groundwater recharge.

The measure prohibits livestock grazing for 3-5 years, and only limited human interference is allowed until 80% grass cover is achieved. The area can then be planted with multipurpose trees and harvested for fodder or saplings grown for live fences, stabilizing soil bunds and other SWC measures. If severely degraded by gullies, brushwood check dams and live fencing can be established in the area.

Area closure without support measures is a slow recovery process and may not seem beneficial but if combined with agroforestry measures can become an attractive investment.

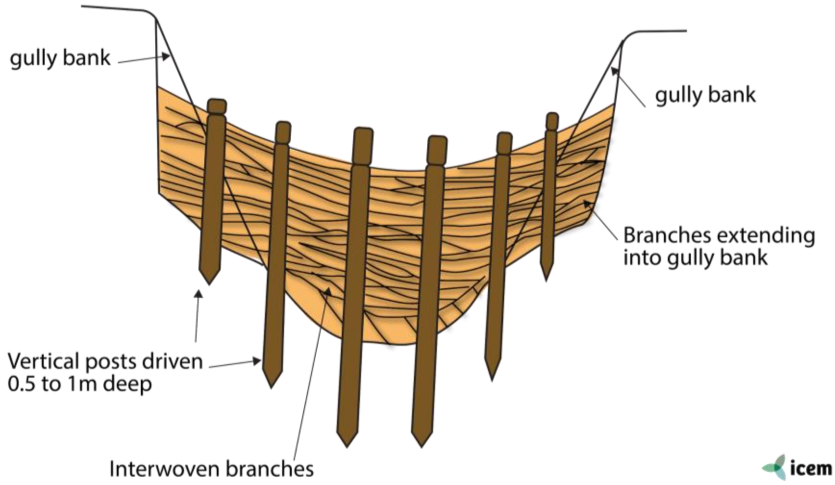
Area closure forms part of a community approach to SLM/SWC and as such is inherent in PA5 Landcare and PA7 Soil Conservation Guided Farm System in the Philippines.

Brushwood check dams

Brushwood check dams are vegetative measures used to stabilize small gullies. Ideally, they are composed of branches, poles/posts, twigs and plant species that can grow from shoot cuttings. The objective of the dam is to retain sediment, slow runoff, and enhance the revegetation of gully areas. The dams are constructed in single or double rows and can also stabilize other conservation structures such as bunds, terraces, and stone check dams.

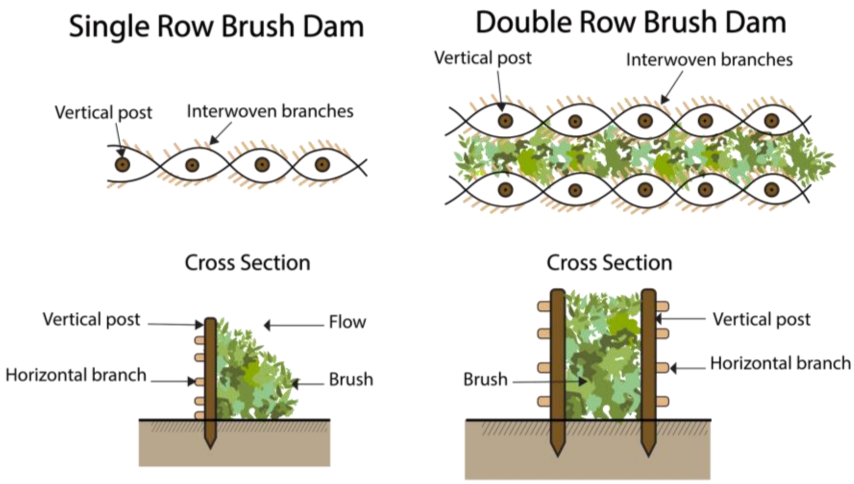
Brushwood dams are suitable for small gullies less than 1.5-2m deep and 2-3m wide. Species with vegetative properties, such as bamboo or Erythrina, are best. The vertical poles are made up of thicker branches (6-10cm) and should be driven into the ground 50-60cm and spaced 30-50cm apart. The height will depend on the depth of the gully, but they should not be more than 1m above the ground.

Figure 3.11: Brushwood check dam



Source: ICEM

Figure 3.12: Brushwood Check dam Layout



Source: ICEM

Once the posts have been driven into the ground, thinner branches are interwoven through the posts to form a wall. Each branch should be pushed 30-50cm into the gully wall.

Spacing down the gully is $S = \left(\frac{Height\ (m) \times 1.2}{Gully\ bed\ slope\ (decimals)}\right) \div 2.5$

If not well established, the dams need constant checking and frequent maintenance during the rainy season.

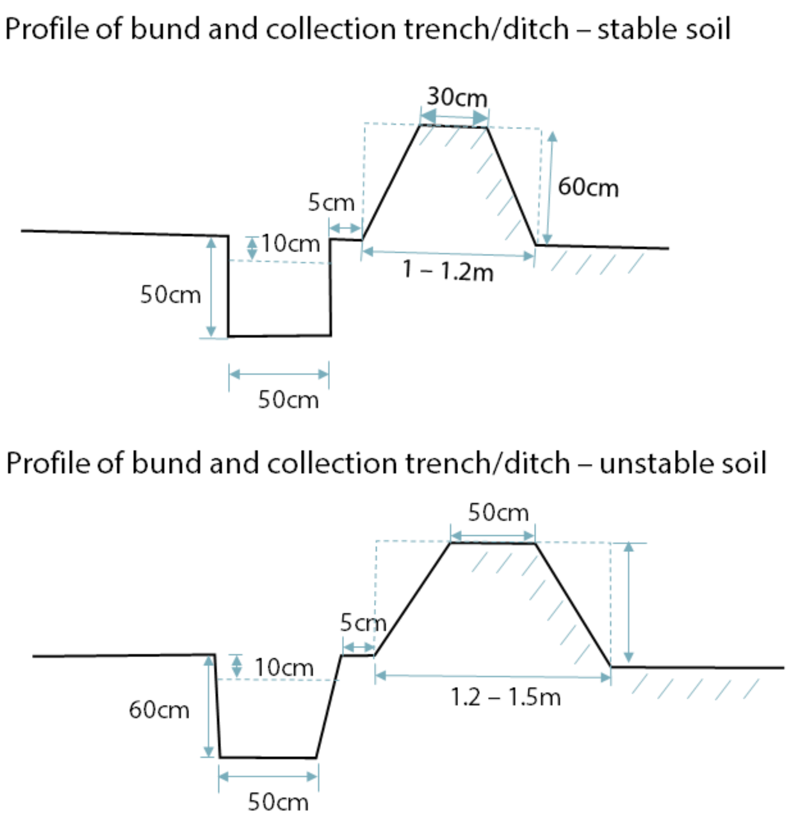
Brushwood check dams are used in PA6 Integrated Soil & Water Conservation Approach and are similar to PT30 Sediment Traps in the Philippines.

Soil bunds

Soil bunds are impermeable structures intended to retain all rainfall, increasing soil moisture and decreasing runoff and soil erosion. They are entry points for further stabilization of cultivated land and can be planted with agroforestry species and fodder crops once established. Level bunds are suitable in drier areas but can also be established in medium-rainfall areas with well-drained soils. In wetter areas graded bunds are required where a slope of 1% against the contour draws excess runoff into natural or constructed waterways. All types of bunds require appreciably higher labor inputs and costs than vegetative measures.

Soil bunds are suitable on cultivated land with slopes greater than 3% and below 15%. They are laid out along the contour using a water line level and dug with the bund's trench upslope. They should be around 60cm high with a base width of 1-1.2m (top width of 30cm) in stable soils and 1.2-1.5m (top width 50cm) in unstable soils). They are usually between 30-60m long on 3-5% slopes.

Figure 3.13: Soil Bunds Layout



Source: ICEM

On slopes of 3-8% the Vertical Interval (VI) is 1-1.5m, on slopes of 8-15% the VI is 1-2m and in exceptional cases of slopes of 15-20% the VI is 1.5-2.5m. However, on steeper slopes the bunds are likely to need stone reinforcement. It is essential to be flexible in laying out the bunds and to respect existing field boundaries and farmers' preferences as much as possible.

Bunds can be integrated with agronomic practices such as contour plowing and composting and can be reinforced with grasses and legumes.

Soil bunds per se are not found in the WOCAT practices but terracing and contouring are mentioned in PA7 Soil Conservation Guided Farm System in the Philippines and stone and rock barriers along the contour are PT16 Rockwall Terracing and PT18 Stone Bunds and Small Basins.

Summary and Conclusion

The aim of this manual has been to give practical guidance for planning and implementing watershed restoration in the pilot watersheds in Cambodia and the Philippines.

As such, it has introduced the concept of land use planning and set out the processes required to achieve optimal and sustainable land uses that are socially acceptable and environmentally sound. This land use planning sets in motion a decision-making process regarding the use and protection of natural resources; decisions that, crucially, have been arrived at by community participation and consensus rather than being imposed from on high.

This land use planning process starts with a community meeting where the community's land and resource use issues are aired, followed by an assessment of the bio-physical and socio-economic conditions, including participatory mapping. This is then followed by the identification and prioritization of potential interventions that leads to a draft plan that is then approved by the community after discussion. This revised plan can then be mapped as a development map and the intervention phase planned for. Implementation is undertaken by the community themselves with local NGO guidance. The interventions, once established, will need management and expansion in time, if appropriate. Lastly, participatory monitoring and evaluation should be planned for.

The implementation of land use planning is discussed in the land use management section, which is divided into watershed management, protection, and production, with the latter forming the greatest part. Watershed management principles state that the upper watershed's forest restoration and conservation measures have the greatest impact and that the most vulnerable and degraded areas should be tackled first. Community areas for protection have been discussed briefly and it is noted that communities tend to know which areas they would like to reserve for protection and that connection between local protected areas can be assured with corridors of native vegetation often along watercourses.

The restoration of productive land for forestry and agriculture has been divided into forest restoration and soil and water conservation on agricultural land.

The manual follows the ICRAF approach to species selection: *The right tree in the right place for the right purpose*. This means that the land user group (community, farmer, firm) should select the forest species to produce based on a number of criteria: proposed use, ecology, growth rate and rotation cycle, ease of production, and to satisfy multiple community interests. This will result in a wide selection of species that gives greater resilience against climate change and pests.

The manual sets out requirements for nursery establishment and production in some detail, including location, design, tool requirements, plant types, planting medium, water requirements, and the production process, including field plantation and planting density.

Potential soil and water conservation measures are numerous and varied with both on-farm and off-farm measures including structural soil and water conservation measures (soil bunds, stone bunds, terraces), biological measures (hedges, cover crops, contour planting) and agronomic measures (minimum tillage, fertilizer use) and off-farm measures including drains, check dams and bank conservation. Other interventions include water harvesting, soil fertility management, agro-forestry, forage development, afforestation, area closure and gully control (if needed).

The principles of Conservation Farming and Conservation Farming with Trees (CFWT) have been set out and a selection of the most suitable, largely biological, measures are presented in more detail including conservation tillage, composting & mulching, natural vegetative strips, grass strips, farm boundary stabilization, vegetative fencing, area closure, brushwood check-dams and soil bunds.

The two annexes present suitable sustainable land management/soil and water conservation interventions by agro-ecology, slope, soil and land use (Annex A) and a list of conservation approaches and technologies from Cambodia and the Philippines (Annex B).

Annex A: Sustainable Land Management/ Soil and Water Conservation Interventions and Suitability by Agroecology, Slope, Soils and Land Use

		Agro-Ecology	Slope	Soil	Land Use	Other
SWC	**Physical Soil & Water Conservation**					
SWC 1	**Level Soil Bunds**	Semi-arid, Arid, also Medium Rainfall	Cultivated 3-15%, Grazing 1-5%	Well drained	Cultivated, Grazing	
SWC 2	**Stone Bunds**	Semi-arid, Arid, also Medium Rainfall, All	5-35%	Deep, well drained, esp. stony	All, degraded, gullies	Recommeded with trenches in moisture-stressed areas & shallow soils
SWC 3	**Stone Faced Soil Bunds**	As above but more suitable in drier areas	3-35%	All, esp. stony	All	Recommeded with trenches in moisture-stressed areas & shallow soils
SWC 4	**Level Fanya Juu**	Most suitable - Medium rainfall. Also upper semi-arid (if gentle slopes & well drained soils)	3-15% (no depressions)	Deep, well drained	Cultivated, grazing if slopes<5%	Combine with tied trenches for max effect in gentle slopes & deeper soils
SWC 5	**Bench Terracing**	Most suitable - Medium rainfall. Also upper semi-arid (if gentle slopes & well drained soils)	12-58%	Deep, well drained	Cultivated, unused hillsides w. slopes 12-58%	Needs waterway to dispose of excess water
SWC 6	**Conservation Tillage**	All	All	All	Cultivated	
SWC 7	**Hillside Terraces**	Semi-arid, Arid, also Medium Rainfall (if deep, well drained soils)	20-50%	Suitable for shallow soils, also deep soils	Degraded, good for tree planting	Need integration with trenches
SWC 8	**Hillside Terraces with Trenches**	Semi-arid, Arid	steep, 20-50%	Shallow, medium depth (suitable in all depths)	Degraded, good for tree planting	Integration w. check dams in depressions and gullies
FCD	**Flood Control and Improved Drainage**					
FCD 1	**Waterways (Veg. & stone paved)**	All but especially moist areas	Veg <10%, Stone <20-25%. Both 1-5ha area			Link to graded bunds & cutoff drains
FCD 2	**Cut off drains**	Moist (med-hi rainfall), Dry to protect investments	<50%	Not vertisols or soils w. high clay content	protects cultivated area	Divert water to cultivation, SS dams or reservoirs
FCD 3	**Graded soil bund**	Wet, high rf areas (esp poorly dr. soils)	3-15% (15-30% exceptional only)	Poorly drained	Cultivated	Tied ridges in terrace channel
FCD 4	**Graded fanya juu**	Wet, high rf areas (esp poorly dr. soils)	3-15%	Deep best, Poorly drained	Cultivated	Uniform terrain best, no depressions, becomes bench terrace in few years, integration w grassed/paved waterways
FCD 5	**Improved surface drainage on vertisols**	All, partic. Moist & waterlogged	<2%	Vertisols & vertic properties		

		Agro-Ecology	Slope	Soil	Land Use	Other
WH	**Water Harvesting**					
WH 1	**Hand-dug wells**					Permeable rock, alluvium along watercourses
WH 2	**Low cost water lifting**	Most suitable if excess runoff or poor infiltration				Lift <7m
WH 3	**Low cost micro ponds**	All except v. dry (<400mm)		NS in sand/sandy loam or vertisols		Suitable if hand-dug wells not possible (W/T too low)
WH 4	**Underground cisterns**			Not sandy or vertic soils		
WH 5	**Percolation pit**	All	Any (need adequate runoff)	Not poorly drained or waterlogged, not high clay, not sodic, need good porosity	Marginal land, gullies	Not shallow water table, not near gorges, not high cattle area
WH 6	**Percolation pond**	All		Not poorly drained or waterlogged, not high clay, not sodic, need good porosity	Marginal land	Not shallow water table, not near gorges, not high cattle area
WH 7	**Farm pond construction**	All	Any (need adequate runoff)			Ideally need max volume for least excavation
WH 8	**Spring development**	All	Any (need adequate runoff)			
WH 9	**Family drip irrigation**	Arid & semi-arid			Any but close to cultivation	
WH 10	**Roof water harvesting**	High rainfall or arid/semi-arid where rain is most accessible water source	Rugged steep terrain (if pond developemnt difficult)			
WH 11	**Farm dam construction**	All				Dependent on geology, needs to be impermeable
WH 12	**River-bed/permeable rack dams**	200-750mm, arid-semi arid	<2% - wide shallow valley beds	All (poor will be improved)		
WH 13	**Small Stone Bunds w.Run-on & Run-off Areas**	Dry, <400mm arid, semi-arid	1-5%	<50cm	marginal, temporary grazing areas, improve fallows in weyna dega areas	Practiced in Sahel
WH 14	**Narrow stone lines along contours**	Arid & semi-arid	1-5%	Permeable to allow infiltration, shallow, stony	Degraded, extensive grazing	Practiced in Sahel
WH 15	**Stone faced/soil/stone bunds w.Run-on & Run-off Areas**	Arid	1-5%	>50cm		
WH 16	**Conservation Bench Terraces**	Semi-arid, Arid, also Medium Rainfall (if deep, well drained soils)	steep, 20-50%			
WH 17	**Tied Ridge**	Semi-arid, Arid, also Medium Rainfall (if deep, well drained soils)	gentle 0-5%		Cultivated	
WH 18	**Zai & Planting Pit system**	Arid & semi-arid	<5%	shallow soils	Restoration of degraded land	Practiced in Sahel
WH 19	**Large Half Moons**	V. arid - Arid <500mm	<5%	>30cm		Common in most drylands worldwide
WH 20	**Diversion Weir**	All				Dependent on geology, needs to have low permeability

		Agro-Ecology	Slope	Soil	Land Use	Other
BSC	**Soil Fertility management & Biological Soil Conservation**					
BSC 1	**Compost making**	All				Pit in v.dry, v. cold and windy areas, heap elsewhere
BSC 2	**Fertilization & Manuring**	All				
BSC 3	**Live Checkdams**	All	Low-med		Gullies & dry river beds	
BSC 4	**Mulching & Crop Residue Mgt.**	All				Integrate with structures on slopes >5%
BSC 5	**Grass strips along contour**	Medium to high rainfall. Poss. Semi-arid, not arid.	<8% (15% alternating w.structural measures)			Not suitable >8% slope on own, need to control free grazing
BSC 6	**Stabilisation of Physical Structures & Farm Boundaries**	All				Requires controlled grazing
BSC 7	**Vegetative Fencing**	All			Currently practiced in cultivated, expand to degraded	Secure land tenure will encourage take up in communal & degraded areas
BSC 8	**Ley Cropping**	All, esp. where land fallowed			Fallow land, >2500m and lower areas where shallow soils left for grazing or planted with undemending crops	From S. Australia. Cut & carry and controlled grazing
BSC 9	**Legume Integration into Cereal Cropping System**	All			Cultivated, Population pressure forces this.	Also can grow irrigated sorghum/maize intercropped with haricot beans
BSC 10	**Intercropping**	All but best 1800-2300m			Cultivated land	Examples, maize, sorghum, cotton and legumes e.g. chickpea, cowpea, bean, green lentil, soya, forage legumes etc
BSC 11	**Crop Rotation**	All			Cultivated land	
BSC 12	**Strip Cropping**	All but <500mm rf need runon-runoff system, 500-700mm rf need SWC above 5% slope	SWC needed >5% in 500-700mm rainfall		Cultivated land	Useful conservation measure if <5% slope

		Agro-Ecology	Slope	Soil	Land Use	Other
AFF	**Agro-Forestry, Forage Development & Forestry**					
AFF 1	**Area Closure**	Most	All - esp. suitable for steep areas unsuitable for other measures	Suitable for shallow, degraded soils	Degraded areas	Best when directly managed by community or interested farmer group and where combined with other soil conservation measures e.g. terraces, trenches, eyebrow basins, pits, multi-purpose trees
AFF 2	**Microbasins**	Med - sl. Low rainfall areas. Not suitable for low rf areas - prefer trenches, eyebrows.	5-50%	Suitable for shallow, stony soils	Degraded areas	Combine with hillside terraces, stone bunds, trenches etc. Also suitable in large gully areas for tree planting
AFF 3	**Eyebrow basins**	Semi-arid - med rf areas w shallow soils	5-100%	shallow but >25cm	Degraded areas	Combine with hillside terraces, stone bunds, trenches etc. Also suitable in large gully areas for tree planting
AFF 4	**Herringbones**	Arid-med rf areas -most effective 500-900mm	Gentle slopes <5%	>50cm, med textured (SL, SCL)	Pastoral areas	Supports growth of different species
AFF 5	**Micro-trenches**	Arid-med rf areas -most effective 600-900mm	3-30%	>50cm	Degraded lands, widespread gullies etc	Better option than microbasins as collect and store more moisture. MTRs more suitable in areas >6-700mm rf.
AFF 6	**Trenches**	Highlands to semi-arid	<100%	>50cm, not too rocky	Degraded lands, gullies, support area closure, improve grazing	
AFF 7	**Improved Pits**	Low-med rf areas 600-700mm	gentle <8%	>50cm	Degraded lands, widespread gullies etc	Similar to micro-trenches, use for cash crops & coffee, combine with other measures
AFF 8	**Multistorey Gardening**	Gen >600mm rf.	<8%	Mod deep 50-100cm		Around homesteads to protect fruit & close to water source
AFF 9	**Seed Collection**	All				Need to use diversified multi-purpose trees
GC	**Gully Control**					
GC 1	**Stone Checkdams**	All		Stony soils	Highly eroded gully areas in all land uses	Large gullies also need catchment treatment
GC 2	**Brushwood checkdams**	All			Small gullies in all land uses, also depressions in soil bunds	Also reinforce bench terraces, SS bunds, roadside gullies etc
GC 3	**Gully Reshaping, filling, revegetation**	All but >600mm rf			Gullies in all land uses esp cultivation	
GC 4	**Sediment storage & Overflow earth dams**	Trad. In drier areas but suitable for all			All gullied areas	Water harvesting & conservation structures that convert large active gullies into productive land. Can be allocated to resource poor farmers
GC 5	**Sediment storage & Overflow soil bunds**	as above		Suitable for sandy loams and SCL where no stones	Med-small gullies 2-3m deep	Water harvesting & conservation structures that convert large active gullies into productive land by encouraging sedimentation

Source: ICEM

Annex B: World Overview of Conservation Approaches and Technologies Sustainable Land Management Practices (Approaches and Technologies) in Cambodia and Philippines

Cambodia

WOCAT SLM Approaches Cambodia	
CA1	[Community Safety Nets - Establishment of rice seed banks at village level]
	A rice (seed) bank is a community safety net system where farmers can get both rice seeds for cultivation and rice for consumption from a communal storage house in order to increase their food security
CA2	[Water user group [Cambodia]]
	A water user group, led by a committee staff, decides about the distribution of the water during the dry season to plant dry season rice.
CA3	[Collection, selection, breeding and dissemination of locally adapted ... [Cambodia]]
	Local genetic rice varieties which are better adapted to changing climatic conditions are collected on farms, tested, described, selected or bred into new varieties and again distributed to farmers with the goal to increase their food security
CA4	[A Safe Vegetable Growers Group in the Svaymeanchey ... [Cambodia]]
	The safe vegetable growers' group was formed by farmers on a voluntary basis and is part of an Agricultural Cooperative. It supports the selling of products through an organized group to buyers.
CA5	[Model farmer [Cambodia]]
	Model farms were introduced by an NGO in order to spread knowledge about SLM (compost, System of Rice Intensification SRI, and other technologies) in the project area
WOCAT SLM Technologies Cambodia	
CT1	[Stabilization of irrigation channels in sandy soils with ... [Cambodia]]
	In sandy areas, old rice bags are filled with sand and piled up as dikes bordering irrigation channels, and Pandanus plants are used to stabilize them on the long term
CT2	[Intercropping of orange trees with mungbean in mountainous ... [Cambodia]]
	Intercropping of mungbean between orange trees improves soil fertility and generates income before the orange trees bear fruit
CT3	[Cashew living fences [Cambodia]]
	Living fences of cashew, reinforced with bamboo and/or barbed wire, are used to keep the cattle off the garden or the rice seedbed
CT4	[Cultivation of organic vegetables to improve the household ... [Cambodia]]
	Cultivation of mixed organic vegetables utilizing natural fertilizers and homemade pesticides so as to reduce expenditure on external agriculture inputs
CT5	[Mulching with water hyacinth (Eichhornia crassipes) after the ... [Cambodia]]
	Water hyacinth (Eichhornia crassipes) is collected during the monsoon floods, attached to poles on the flooded fields, chopped when the water recedes and used as mulch to plant different crops
CT6	[Crop diversification with the application of rotation techniques [Cambodia]]
	Crop diversification is the practice of simultaneously cultivating two or multiple varieties of crops in a given area whilst at the same time applying crop rotation and/or intercropping
CT7	[Production and use of rice husk biochar in ... [Cambodia]]

	Rice husks as well as empty seeds are pyrolyzed and used as a soil amendment in the rice seed beds and the vegetable gardens
CT8	Multipurpose use of sugar palm grown on rice ... [Cambodia]
	Sugar palms growing on the dykes along the rice fields are used as source of income and have different effects on the growing of the rice, like reducing the wind speed and thus the evaporation and wind erosion
CT9	Crop rotation to promote safe vegetables [Cambodia]
	Crop rotation is a component of integrated pest management (IPM) which can contribute to an improvement in crop production with a standardized and reduced use of chemical fertilizers and pesticides
CT10	Crop rotation between mango trees in combination with ... [Cambodia]
	The rotational intercropping of vegetables between mango trees is a form of agroforestry.
CT11	Irrigation of paddy fields using water-pumping wheels (Norias) [Cambodia]
	Norias are water-pumping wheels made of bamboo which are used to irrigate paddy fields in order to increase the yield
CT12	Growing stylo grass (Stylosanthes guianensis) as cattle fodder ... [Cambodia]
	Stylo grass (Stylosanthes guianensis) is grown under and between mango trees to be used as fodder for cattle
CT13	Compost application on rice fields [Cambodia]
	Manure, leaves and rice straw are gathered in a compost house and the produced compost is applied twice a year to the rice field
CT14	Sandy soil improvement by using natural fertilizer and ... [Cambodia]
	The practice of improving the conditions of a sandy soil by natural fertilizers and liquid compost application increases the crop production, as it leads to a substantial improvement of the soil quality
CT15	Home gardens for consumption and cash crop production [Cambodia]
	Home gardens, containing tree, shrub, herbs, vine, tuber layers as well as poultry, produce food for household consumption as well as an additional income.
CT16	Intercropping of mung bean and banana in the ... [Cambodia]
	Intercropping of mung beans with bananas adds nutrients to the soil, and generates further income while waiting for the yield of the banana trees
CT17	Using slurry from biodigester for soil improvement [Cambodia]
	Biodigester slurry sourced from cow manure is used as an important natural fertilizer for the cultivation of crops.
CT18	Eggplant cultivation technique between lemon trees [Cambodia]
	Eggplant cultivation between lemon trees using restroom and crop residues as a source of soil nutrients instead of being reliant on the use of chemical fertilizers
CT19	Use of plastic mulch combined with a drip ... [Cambodia]
	The cultivation of eggplants by using plastic mulch and a drip irrigation system in order to control weeds, retain soil moisture, save water and reduce labor for maintenance, weeding, watering, and the application of fertilizer for increase production and income
CT20	Intercropping of vegetables to control pests along the ... [Cambodia]
	Cropping by setting up alternative rows of different crops: lettuce, pak choi, escarole, choy sum and morning glory for a reduction in damage from insects.
CT21	Improved orchard with an integrated farming system [Cambodia]

	The integrated farming system (IFS) includes basically the mixture of different farming components like crops, fruit tree cultivation, fish and livestock husbandry on the same farm plot
CT22	Agroforestry: Intercropping of vegetables between orange trees [Cambodia]
	Intercropping of chilies (or other short-term crops) between young orange trees is a type of agro-forestry system
CT23	Intercropping of eggplants between mango trees using rice ... [Cambodia]
	Intercropping of eggplants between mango trees and the application of straw mulching on the plants' roots and the land so as to retain soil moisture by reducing heat-induced evaporation
CT24	On-farm ponds to alleviate the potential impact of ... [Cambodia]
	Digging ponds on farms to harvest rain water used for irrigating crops during drought
CT25	Use of household ponds for garden irrigation and ... [Cambodia]
	Ponds are used at household level to raise fish as well as to irrigate vegetable gardens and rice seedlings
CT26	Using dry compost on paddy rice fields [Cambodia]
	Dry compost is made from raw materials of cow manure, rice straw, rice husks, ash, leaves, waste from kitchen and water for application on paddy rice field to improve soil quality and reduce chemical fertilizers
CT27	Growing vegetables in a net house to ward off ... [Cambodia]
	A net house is a structure that is enclosed by a nylon net (like mosquito nets) which protects vegetables from insects.
CT28	Growing corn using drip irrigation system [Cambodia]
	The cultivation of corn with the use of a drip irrigation system
CT29	Agroforestry: intercropping of pineapple between orange and mango ... [Cambodia]
	The agroforestry practice based on intercropping of pineapple between mango and orange trees helps to maintain soil nutrients
CT30	Adapted System of Rice Intensification (SRI) principles in ... [Cambodia]
	Some points of the System of Rice Intensification (SRI) technology, like the row transplanting of young seedlings and the use of compost are adapted and applied in Kampong Chhnang
CT31	Home Garden (Pomelo, Lemon, Supplementary Crops) [Cambodia]
	This technology involves the cultivation of crops around the house, including pomelos, lemons and other supplementary crops, with solely the application of cattle and chicken manure as fertilizer
CT32	Agroforestry-intercropping of peanut between cashew nut trees in ... [Cambodia]
	Intercropping of annual cropping (peanut) with cashew trees farm aims to fill the free space of land between cashew trees. This kind of crop cover prevents soil erosion and improves soil fertility
CT33	Coconut leaves mulching for winter melon cultivation [Cambodia]
	The use of coconut leaves mulch for winter melon cultivation helps to conserve soil moisture, reduces evaporation, reduces weeds, saves water, preserves the soil from erosion, and increases crop productivity

Philippines

WOCAT SLM Approaches Philippines	
PA1	Assisted Natural Regeneration (ANR) [Philippines]
	A process of rehabilitating degraded forest lands by taking advantage of trees already growing in the area
PA2	Vegetative Approach in Controlling Wind and Water Erosion ... [Philippines]
	Using vegetative approach to stabilize sand dune areas along the coast.
PA3	Community-Based Forest Management [Philippines]
	Community-Based Forest Management (CBFM) refers to the organized efforts to work with communities in and near public forestlands with the intent to protect, rehabilitate, manage, conserve, and utilize the resources in partnership with the Local Government Units (LGUs) and other stakeholders
PA4	Social Enterprise (SE) [Philippines]
	Social Enterprise (SE) aimed to provide social protection among its members and generate additional family income. Above all, this approach will encourage the conservation, preservation and protection of the resources available in the community
PA5	LANDCARE - Claveria Landcare Association (CLCA) [Philippines]
	Associations that help diffuse, at low cost, soil and water conservation technologies among upland farmers to generate income while conserving natural resources
PA6	Integrated Soil and Water Conservation Approach in Improving Biophysical Condition of Mt. Kitanglad Agri-Development Corporation (MKADC) Pineapple Production ... [Philippines]
	Integration of soil and water conservation technologies primarily aim to protect the area from loss of biodiversity and land degradation.
PA7	Soil Conservation Guided Farm System [Philippines]
	Soil Conservation Guided Farming System (SCGFS) is a land use management approach that integrates technologies: terracing, agro-pastoral technology, multi-storey cropping, and contouring within the socio-economic and bio-physical limitations of upland areas for optimum development of soil and water resource in a sustainable manner
PA8	Conservation Farming Village [Philippines]
	A modality in mobilizing resources for sustainable upland development which utilizes a basket of strategies, technologies, and interventions to catalyze the widespread transformation of traditional upland farming systems into resilient and sustainable upland production systems.
PA9	Palayamanan: Climate Change Adaptation Strategy for Lowland Ecosystem [Philippines]
	Synergistic mix of farming ventures implemented by the farm family based on the existing environment and their resources to address food security, income instability, and sustainability
PA10	Woodlot [Philippines]
	Woodlot is a forest management approach which aims the to provide food, wood for fuel, construction and material for woodcarving and to provide a steady source of water for the lower-hilly rice land area
WOCAT SLM Technologies Philippines	
PT1	Contour Straight Block Layout [Philippines]
	It is a package of soil and water conservation technology that integrates contouring, bedding, and blocking
PT2	Compact Farming for Vegetables Production [Philippines]
	Land users are organized into a group or association to undertake jointly activities in the farm which include operation, input procurement, and marketing of produced crops.

PT3	Modified Rapid Composting [Philippines] Modified Rapid Composting is the in-situ decomposition of rice straw using compost fungus activator, Trichoderma harzianum or Effective Microorganism, that helps in utilizing the residual Nitrogen-Phosphorus-Potassium (NPK) from the decomposed rice straw
PT4	Rainfed paddy rice terraces [Philippines] Terraces supporting rainfed paddy rice on steep mountain slopes: these have been in existence for more than a thousand years
PT5	Sweet Potato Relay Cropping [Philippines] A farmer's indigenous practice of growing sweet potato as a relay crop to its main crop of either rice or corn
PT6	Small Farm Reservoir (SFR) [Philippines] The Small Farm Reservoir is an earth dam structure used to trap harvest and store rainfall and water runoff
PT7	Trees as Buffer Zones [Philippines] Trees as buffer zones are vegetative measures established in the area to prevent pest from crossing in between blocks. Further, the technology provides haven for flora and fauna which are endemic in the area
PT8	Highly Diversified Cropping in Live Trellis System [Philippines] Gliricidia sepium locally known as "kakawate" served as live trellis / or anchorage for annual crops (mostly creeping-type vegetables) and erosion control measure.
PT9	Pressing of Cogon Grass (Imperata cylindrica) [Philippines] An indigenous technology of enhancing wildling growth by pressing of cogon grass
PT10	Re-soiling (Pit with manure) [Philippines] Replacing the sand in the planting hole with soil for the proper nourishment of newly planted trees and for better moisture retention and storage
PT11	Contour Farming using hedgerows [Philippines] Contour farming is a technology practiced in sloping areas in which hedgerows are established along the contours and other annual/cash crops are grown in the alleys between the hedges
PT12	Organic Mulching [Philippines] Organic mulching is a practice of applying thin layer of organic materials on the soil surface that decompose over time for the purpose of conserving soil moisture, reducing soil erosion, improving soil fertility, and reducing weed growth
PT13	Small Water Impounding Project (SWIP) [Philippines] Development of micro-catchment for soil and water conservation and for the provision of supplementary irrigation during the dry season
PT14	Vegetable Terracing [Philippines] Vegetable terracing is a technology practiced at which point terraces are established from the contours along mountain slope for crop production
PT15	Seed Production of Multipurpose Shrubs/Legumes [Philippines] Seed production of multipurpose shrubs and legumes, a soil conservation practice in sloping areas wherein flemingia (Flemingia macrophylla) and Indigofera (Indigofera tinctoria) are densely planted along contours
PT16	Rockwall Terracing [Philippines] Rockwall terracing refers to the piling of stones or rocks along contour lines to reduce soil erosion in hilly areas
PT17	Composting using Indigenous Microorganism (IMO) [Philippines]

	Composting is the natural process of decomposition of organic matter by microorganisms under controlled conditions
PT18	Stone bunds and small basins [Philippines]
	Piling of stones and rocks along the contour to control run-off and soil erosion. It is also about the creation of small basins by removing stones and using them as barriers
PT19	Firebreaks/ Greenbreaks [Philippines]
	Gaps in vegetation or other combustible material that act as barriers to prevent and/ or control the spreading of forest fires to other areas
PT20	Multi-Storey Cropping [Philippines]
	Cultivating a mixture of crops with different heights (multi-storey) and growth characteristics which together optimize the use of soil, moisture and space
PT21	Natural Vegetative Strips (NVS) [Philippines]
	Within individual cropland plots, strips of land are marked out on the contour and left not-ploughed in order to form permanent, cross-slope barriers of naturally established grasses and herbs
PT22	Vetiver grass system or Vetiver grass technology [Philippines]
	Vetiver grass used as contour hedgerows in sloping agricultural land used for annual crops
PT23	Planted Vegetative Strips (PVS) [Philippines]
	Planting of economic crops/forages in strips along the contour to control soil loss through erosion
PT24	Ecological engineering for biological pest control in lowland ... [Philippines]
	Ecological engineering in lowland rice agroecosystems by planting of flower strips in rice fields as habitats for beneficial arthropods which control pests
PT25	Residue Incorporation (Corn) [Philippines]
	Incorporation of corn stalks during land preparation for the succeeding crop
PT26	Conservation Tillage Practices for Corn Production [Philippines]
	Conservation Tillage Technology (Zero Tillage) or "Tipid Saka" - A crop production system which focuses on soil conservation and reducing excessive tillage operations, reduces labor and farm inputs while increasing productivity and profitability
PT27	Littuko Growing for Forest Enhancement [Philippines]
	Growing of rattan is done by upland farmers as part of the Community-Based Forest Management (CBFM
PT28	In "situ" Decomposition of Banana Stalk [Philippines]
	Leaving the trunk of a newly harvested banana standing beside a follower plant to provide nutrients and moisture especially during period of drought
PT29	Organic-Based System of Rice Intensification (SRI) [Philippines]
	Intensifying the irrigated rice production while at the same time reducing farm inputs including seeds, fertilizer, and water
PT30	Sediment Traps [Philippines]
	Sediment traps are structures built in the area which includes cascading catchment canal, silt traps and catch basin along perimeter, between pineapple fields and along diversion ditches to collect runoff during rains, preventing and minimizing the eroded soils cascading into natural bodies of water.
PT31	WINDBREAKS [Philippines]
	Planting of herbaceous plants or trees along property boundaries to serve as windbreaks and as sources of fodder and fuel

Cambodia. (photo by Khun Bunnath).

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