FARMLANDS

GRASSLANDS, SHRUBLANDS AND SAVANNAHS

FORESTS

MOUNTAINS

RESTORING LIFE TO THE LAND

The Role of Sustainable Land Management in Ecosystem Restoration

United Nations Convention to Combat Desertification

WOCAT

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

FRESHWATERS

URBAN AREAS

PEATLANDS

OCEANS AND COASTS

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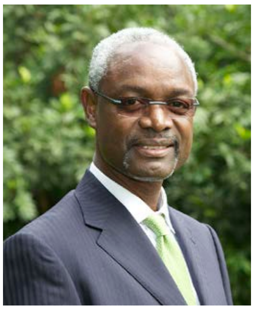
ABBREVIATIONS

CBD	Convention on Biological Diversity
CC	climate change
CSA	climate-smart agriculture
DRR	disaster risk reduction
EA	ecosystem approach
EBA	ecosystem-based adaptation
Eco-DRR	ecosystem-based disaster risk reduction
ELD	Economics of Land Degradation Initiative
ER	ecosystem restoration
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
LD	land degradation
LDN	land degradation neutrality
LUT	land use type
NbS	nature-based solutions
OM	organic matter
R2R	ridge to reef
SDG	Sustainable Development Goal
SLM	sustainable land management
UNCCD	United Nations Convention to Combat Desertification
UNDER	United Nations Decade on Ecosystem Restoration
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UPA	urban and peri-urban agriculture
WH	water harvesting
WOCAT	World Overview of Conservation Approaches and Technologies

FOREWORD



Ibrahim Thiaw
Executive Secretary
of the UNCCD

I'm delighted that the UNCCD has collaborated with WOCAT to author this publication.

As we enter the UN Decade on Ecosystem Restoration, it has a vital role to play: to make clear that sustainable land and water management, based on sound agro-ecological principles must be at the heart of land restoration efforts.

Healthy and functional ecosystems are the basis of all life on earth. We know that humanity is totally dependent on the natural world and the land we live on.

Yet throughout the world, ecosystems are under intense pressure – from climate change, and from people. Our unsustainable consumption and production patterns are indirectly driving land use changes that not only impact biodiversity, but also increase the risks of pathogen spillovers and new zoonotic infectious diseases. To achieve the necessary transformative change, ecosystem restoration efforts on a massive scale are required. And this will be necessary across all ecosystems – in peatlands, mountains, forests – if our efforts are to bear fruit.

This publication outlines some of the tools we have at our disposal to protect and restore nature, bolster ecosystems, and achieve land degradation neutrality. By giving concrete examples of best practice, I hope it can serve as a knowledge tool and call to action.

Restoring our ecosystems and managing land sustainable can benefit nature and people, enhancing food and water security, drawing down carbon into soil, laying the foundation for biodiversity, reducing vulnerability to natural disasters and contributing to healthier air quality.

The COVID-19 pandemic has shown that when political will, collective action, and sustained investment come together – we can make a difference. We can build back, better. We can do this in a responsible way that is focused on both people and nature simultaneously. And if our policies are well aligned and sustainable land management is incentivized, we can effectively mobilize the millions of people who depend on the land to lead the way.

That's why this publication is so vital, and so timely. We hope it can be a source of inspiration, a catalogue of best practice, and a catalyst to spread the effective implementation of sustainable land management practices in land restoration, to benefit us all.

Ibrahim Thiaw
Executive Secretary of the UNCCD

PREFACE

The UN Decade on Ecosystem Restoration (UNDER) 2021-2030, declared on 1 March 2019 by the UN General Assembly, aims to massively scale up the restoration of degraded and destroyed ecosystems as a proven measure to fight climate change (through mitigation and adaptation), enhance food security, water supply and biodiversity, while managing associated risks of conflict and migration. The UNDER focuses on balancing ecological, social and developmental priorities in landscapes where different forms of land use interact, with the aim of fostering long-term resilience.[1] As the world grapples with the legacy of COVID-19, functional ecosystems are essential in our efforts to "build back better" and help avoid future emergence of infectious diseases.

Sustainable land management (SLM) is key to restoration of terrestrial ecosystems: it is at the core of maintaining, or re-establishing, life in the land. This publication sets out to explain the role of SLM, and how we can draw on existing good practices to bring restoration efforts to scale – in the context of achieving a land degradation neutral world by 2030. WOCAT, the World Overview of Approaches and Technologies,[2] has built up, over a quarter of a century ago, a Global SLM Database,[3] which is acknowledged by the UN Convention to Combat Desertification (UNCCD)[4] as being the main source of SLM experience worldwide. The database provides access to field-proven good practices. It is the basis for learning, sharing experience and stimulating implementation between land users and specialists – researchers and advisers – who are at the heart of successful SLM.

This publication, a joint production between UNCCD and WOCAT, seeks to show how experience in implementing sustainable land management practices feeds directly into ecosystem restoration and maintenance: explicit objectives of the UNDER. It serves also as a reminder that SLM brings a raft of other social, economic and environmental benefits alongside its contribution to ecosystem restoration. In the pages that follow, it is demonstrated in what ways SLM experience can help to provide solutions to problems that the UNDER seeks to address – and this is illustrated by presenting a series of on-the-ground "good practices" as evidence.

TAKE AWAY MESSAGES

1. Sustainable land management (SLM) has a central role to play in all the eight ecosystem types of the UNDER, through combatting land degradation at farm and landscape level. It simultaneously generates multiple co-benefits including climate change mitigation and adaptation, resilience and disaster risk reduction, better hydrological function, improved biodiversity - and enhanced production. SLM directly benefits livelihoods.
2. Through SLM, land degradation can be avoided, reduced and/or reversed, contributing to all the land degradation neutrality commitments made by countries. While some SLM practices may specifically target one of the three "response hierarchy" categories (avoid, reduce, reverse), many practices are relevant to two or even all three.
3. SLM can only have a significant impact on ecosystem restoration, however, when it spreads widely, covering a critical mass of land and people, and when the practices introduced are maintained and adapted over time. A combination of SLM practices is required to benefit ecosystems as a whole.
4. The Global SLM Database describes, in standardized and consistent detail, over 2,000 SLM practices from more than 130 countries. Socio-economic and environmental benefits are also recorded. Some ecosystems (especially farmlands, grasslands and forests) are covered by many more entries than others, but this ever-expanding, quality-controlled database is the primary global source of SLM documentation. Multiple good practices are available, and ready to be upscaled.
5. **FARMLANDS** are served by the widest variety of SLM options. Some have their origins in tradition, but others are recent, innovative and constantly evolving to meet the needs of farmers. SLM practices are vital to protect this highly vulnerable ecosystem. However, all actors must work together to create impact at landscape scale: both on-site and off-site.
6. **GRASSLANDS, SHRUBLANDS AND SAVANNAHS** span a broad diversity of settings. These are ecosystems, however, that are often overlooked despite their importance. SLM practices are developing rapidly for extensive semi-arid rangelands where, as well as degradation, resource tenure and invasive species are two specific challenges.
7. **FORESTS** are in the public eye – with dramatic images of degradation stemming from deforestation. Protection of forest areas is only a partial answer: there is growing experience of successful community management. Furthermore, productive agroforestry systems can effectively mimic forests and forest function.
8. **MOUNTAINS** comprise a mosaic of land uses. This means that SLM practices from virtually all the other ecosystems will find relevant niches – in the mountains' farmlands, grasslands, forests and peatlands. A broad range of interventions helps protect these "water towers" with their special biodiversity habitats.
9. **FRESHWATERS** can be protected by multiple SLM practices to ensure supplies for people, animals and farming. Degradation of both water quality and flow regimes is a worry. Upstream-downstream linkages are key: what happens on-site has a very clear and direct impact off-site. Several SLM practices support both freshwaters as well as other ecosystems, especially those associated with catchment protection.
10. **URBAN AREAS** comprise a relatively new focus for SLM. However, there are many transferable technologies. Some relate to urban and peri-urban agriculture, whether vegetable growing or even dairy cow systems. Others focus on "green and blue corridors" of trees, parks and ponds for ecosystem repair and social well-being.
11. **PEATLANDS** are the most uniform of the ecosystems, but despite their paramount carbon storage and hydrological significance, they are often ignored. The priority is clear: protection and restoration by keeping peatlands wet and undisturbed. In some locations, sustainable use – paludiculture – may be appropriate.
12. **OCEANS AND COASTS** may at first appear outside the remit of SLM. But there are specific practices that focus on mangrove forests, and coastal dunes. A "Ridge to Reef" transect approach keeps rivers and their estuaries clean, requiring a raft of SLM practices that are applicable from mountains through to the sea.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1. INTRODUCTION

The UN Decade on Ecosystem Restoration (UNDER) has placed ecosystems firmly in the spotlight for the next ten years. Action must now follow the initial publicity, the stated strategies and the firm intentions. The UNCCD has sought, since its inception, to combat the desertification, land degradation and drought that are at the heart of terrestrial ecosystem deterioration. Article 2 of the Convention states that achieving the objective of combating desertification and mitigating drought "will involve long-term integrated strategies that [focus] on improved productivity of land, and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions, in particular at the community level." In 2015, the country Parties of the UNCCD were invited to establish voluntary land degradation neutrality (LDN) targets in light of target 15.3 of the 2030 Agenda for sustainable development, and to date, 127 countries are pursuing a no-net-loss approach to addressing land degradation.

The antidote to land degradation – and vehicle to achieve LDN – is sustainable land management (SLM), and SLM is perhaps the most powerful tool we have to help achieve the UNDER objectives. Twenty-five years of experiences, documented in WOCAT's Global SLM Database, provides tried and tested practices, and crucially, the ways and means of putting these into use – and upscaling them.

Section 2 of this publication begins by exploring what ecosystem restoration actually means. The UNDER defines restoration as encompassing the full continuum of responses, with its stated aim to prevent, halt and reverse the degradation of ecosystems. One important point needs to be underlined: the UNDER considers "conserving the ecosystems that are still intact" as part and parcel of restoration. This opens up a broad interpretation of ecosystem restoration, and brings a wider selection of SLM practices into the picture. Land degradation is briefly summarized in terms of what it means, how far it extends and its impacts on people and their livelihoods. Sustainable land management is then examined, and there is a brief discussion of associated terms covering a family of approaches that are closely related.

Section 3 first looks briefly at the typology of ecosystems. It shows that categorization is not always based on land use. Nevertheless, the UNDER typology is closely related to that used by WOCAT. This section provides the heart of the publication by demonstrating how SLM has a role to play in all of the eight ecosystems. It introduces each ecosystem and provides a short analysis of where, and in what ways, SLM can help in restoration. The section then takes four good practices, from various countries, to illustrate where SLM can contribute to each ecosystem. WOCAT's Global SLM Database has directly provided the large majority of cases: 28 out of 32. Others have been contributed by WOCAT's partners.

Section 4 addresses the topic of uptake: based on the UNDER's strategy, it attempts to answer the question of how SLM can be spread more widely, in order to have an impact at watershed, landscape and ecosystem scales. It considers on-site benefits, which accrue mainly to the land users, and off-site impacts, which affect people downstream and downwind. The importance, and role, of gender is examined.

Finally, a conclusion presents some general points followed by specific observations for each of the eight ecosystems. These do not take the form of recommendations, but are relevant for policy formulation and decisions-makers – and for a broader readership too. It is hoped the observations will create a basis to explore the topics, and individual ecosystems or particular SLM practices in more detail.

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2. ECOSYSTEM RESTORATION AND SUSTAINABLE LAND MANAGEMENT: BUILDING BACK BETTER

2.1 Ecosystem Restoration

Healthy and functional ecosystems are the basis of life on earth. Whether on land or in the ocean, large or small, their well-being is crucial. However, ecosystems are being increasingly degraded and it is both urgent and essential that restoration is given priority – it is our obligation to "build back better". While definitions of ecosystems rarely specify humankind ("animals", "living organisms" are the terms most commonly seen), it is clear that people are an integral constituent. People – young and old, women and men, rural and urban – through land use change and mismanagement, are implicit in ecosystem degradation. But equally, it is important to acknowledge that they constitute the primary agents of restoration. Humankind suffers, and benefits, according to the state of ecosystems.

The UN Decade on Ecosystem Restoration (UNDER) sets out, in clear and simple terms, what is now required and why.[5]

> *Ecosystem restoration means assisting in the recovery of ecosystems that have been degraded or destroyed, as well as conserving the ecosystems that are still intact. Healthier ecosystems, with richer biodiversity, yield greater benefits such as more fertile soils, bigger yields of timber and fish, and larger stores of greenhouse gases.*
>
> *Restoration can happen in many ways – for example through actively planting or by removing pressures so that nature can recover on its own. It is not always possible – or desirable – to return an ecosystem to its original state. We still need farmland and infrastructure on land that was once forest, for instance, and ecosystems, like societies, need to adapt to a changing climate. Between now and 2030, the restoration of degraded terrestrial and aquatic ecosystems could generate US$ 9 trillion in ecosystem services. Restoration could also remove 13 to 26 gigatons of greenhouse gases from the atmosphere. The economic benefits of such interventions exceed ten times the cost of investment, whereas inaction is at least three times more costly than ecosystem restoration.*

This interpretation of ecosystem restoration differs from conventional, narrower, definitions in that it includes conservation of ecosystems that are still healthy, and the acceptance that ecosystems cannot always be rehabilitated to their natural state.

That broadens the scope for a wide range of strategies to be relevant for the UNDER, with sustainable land management (SLM) being central to them.

As UNDER gets underway at the beginning of 2021, the total global targets on restoration can be aggregated from the pledges countries have made under different conventions and goals. In total, 115 countries have put forward quantitative, area-based commitments close to 1 billion hectares.[6] And UNDER presents an opportunity to “ramp up the number of countries and scale out”.

2.2 Land Degradation

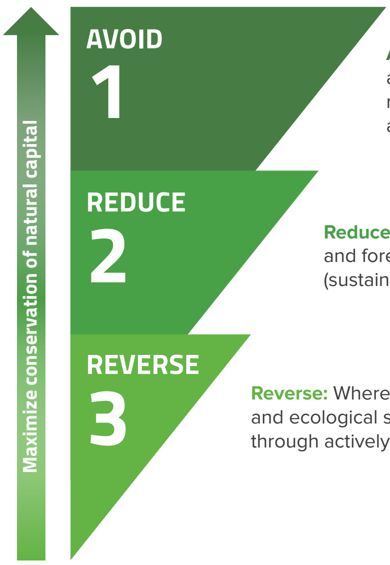
At the heart of ecosystem degradation and destruction – at least terrestrial ecosystems – is human-induced land degradation. It is defined as “degradation of land resources (including soils, water, vegetation, and animals) leading to a reduction in the capacity of the land to provide ecosystem goods and services and assure its functions over a period of time for the beneficiaries of these.”[7] Land degradation is one of the world’s most pressing and pernicious environmental problems, happening at an alarming pace, and it will worsen without rapid remedial action. More than 70 per cent of the globe’s ice-free terrestrial ecosystems have been transformed from their natural state,[8] and 1 in 5 hectares is now considered degraded by countries reporting to the UNCCD.[9] Carbon that is lost from soils and vegetation accounts for almost a quarter of greenhouse gas emissions.[10] Every year, 10 million hectares suffer deforestation.[11] Furthermore, biodiversity is lost – both fauna and flora, above and below ground. Approximately 3.2 billion people are affected by land degradation, especially rural communities, smallholder farmers, and the very poor.[12]

2.3 Land Degradation Neutrality

Land degradation neutrality (LDN), which is integral to SDG target 15.3, is a no-net-loss approach designed to maintain or enhance the land resource base, which is the stock of natural capital associated with land resources and the ecosystem services that flow from them. LDN describes the target of ensuring that land degradation is at least held under control – and land is improved as much as possible. Contributing to achieving LDN by 2030 through national voluntary LDN targets is embraced by the UNCCD 2018-2030 Strategic Framework,[13] which seeks to improve the livelihoods of more than 1.3 billion people, and reduce the impacts of drought on vulnerable populations.

LDN is defined as: “A state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems.”[14] The LDN “response hierarchy” of Avoid > Reduce > Reverse land degradation is the overarching principle for LDN implementation, which guides decision-makers in planning interventions to achieve LDN (Figure 1).

Figure 1: The LDN Response Hierarchy



Avoid: Land degradation can be avoided by addressing drivers of degradation and through proactive measures to prevent adverse change in land quality of nondegraded land and confer resilience, via appropriate regulation, planning and management practices.

Reduce: Land degradation can be reduced or mitigated on agricultural and forest land through application of sustainable management practices (sustainable land management, sustainable forest management).

Reverse: Where feasible, some (but rarely all) of the productive potential and ecological services of degraded land can be restored or rehabilitated through actively assisting the recovery of ecosystem functions.

Source: Orr et al., 2017[15]

2.4 Sustainable Land Management

WOCAT defines SLM as: "The use of land resources including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and ensuring their environmental functions."[16] SLM embraces multiple technical alternatives: from structural options such as cross-slope barriers, to agronomic solutions including mulching the soil; from vegetative interventions such as agroforestry to management strategies for grazing and peatland protection. WOCAT identifies 26 different SLM practice groups,[17] each of which is relevant to ecosystem restoration to a greater or lesser extent.

Sustainable land management practices are fundamental to the implementation of the "Ecosystem Approach" as articulated by the UN General Assembly Resolution that established the UNDER.[18] It is also the basis of associated approaches and concepts that promote the preservation, enhancement and restoration of biodiversity, the productivity of land and the resilience of livelihoods and ecosystems – including "nature-based solutions", "ecosystem-based adaptation", and "ecosystem-based disaster risk reduction".[19] This is a family, all closely related, interlinked and often overlapping in their strategies (treating ecosystems as integrated entities) and goals (improved ecosystem services). Their differences lie in subtle divergences in emphasis (Box 1).

SLM underpins these approaches, and the Global SLM Database effectively constitutes a toolbox that provides the ways and means to implement practices under each.

Box 1: Definitions of ecosystem restoration methodologies and approaches

Ecosystem approach: A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.[20]

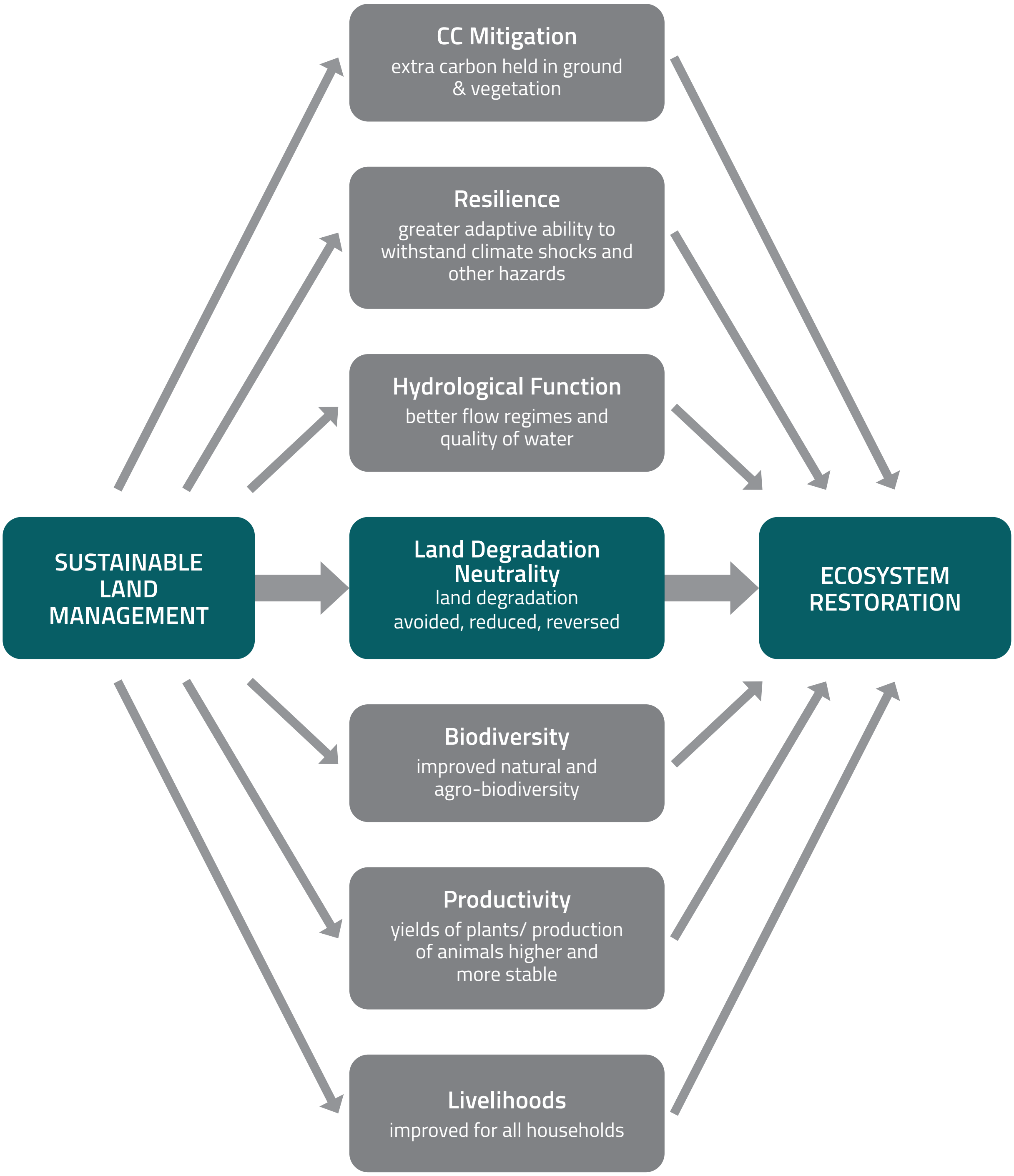
Ecosystem-based disaster risk reduction: The sustainable management, conservation and restoration of ecosystems to provide services that reduce disaster risks by mitigating hazards, and by increasing livelihood resilience.[21]

Ecosystem-based adaptation: The use of biodiversity and ecosystem services as part of an overall adaptation strategy. It includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to the adverse effects of climate change.[22]

Nature-based Solutions: Actions for societal challenges that are inspired by processes and functioning of nature. By developing and implementing solutions that are supported by nature, resilience is achieved while producing societal, environmental and economic benefits. NbS can be functional in various environments including coastal, fresh water, and urban settings.[23]

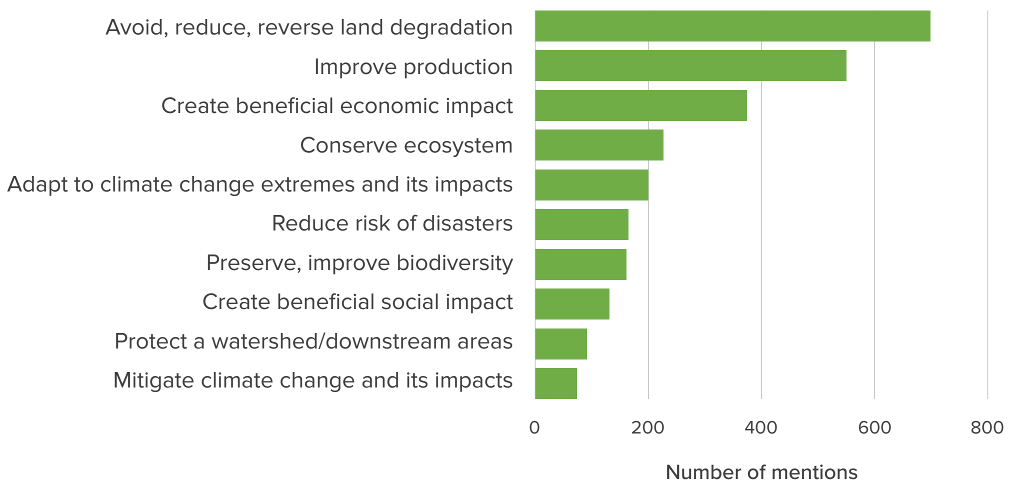
Figure 2 is a simplified visualization of how SLM paves the way to achieve (or exceed) LDN through avoiding degradation where it has not occurred, reducing the risk of it in managed lands, and reversing it where it is occurring still/ has occurred in the past. Simultaneously SLM contributes to mitigation of climate change (through its emphasis on building up organic matter in the soil and vegetation) and climate change adaptation/resilience (through its focus on systems that can buffer variability, shocks and extreme events). SLM also helps improve hydrological function in the land, and supports building back biodiversity into degraded systems. Where applied on productive land, suitable practices can lead to higher and more stable yields. SLM is, thus, the main means of restoring terrestrial ecosystems.

Figure 2: Sustainable land management: the key to ecosystem restoration



One key driver of SLM on productive land is its attractiveness to land users. This is important, because it is land users who will define whether ecosystems are restored or not, and people respond to economic stimuli – or in poorer, developing areas, in ensuring their food and water security. Figure 3, derived from the Global SLM Database, establishes that the main objectives of land users in implementing SLM on productive land are either improving yields or creating beneficial economic impacts (when combined, the largest category) or addressing land degradation (generally with the same aim, albeit longer term) – which can be interpreted as people seeking to improve their livelihoods.

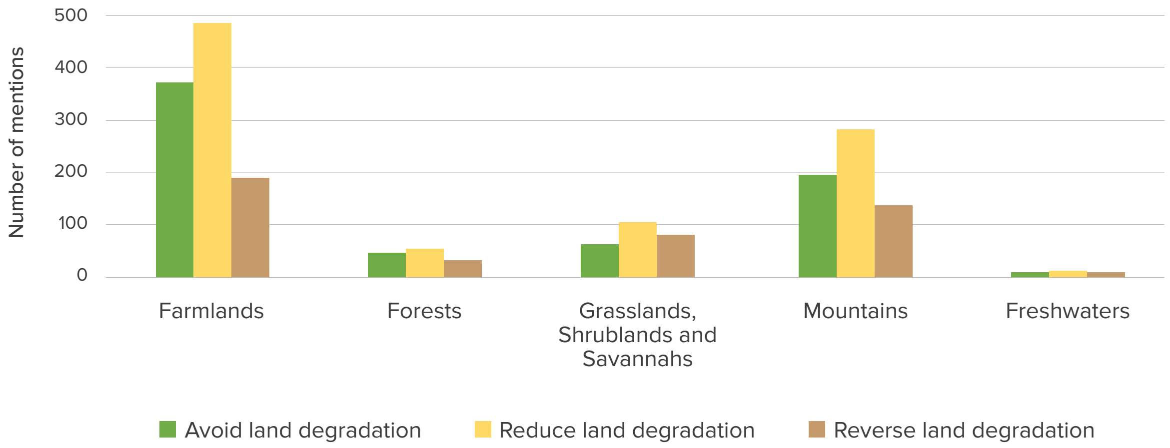
Figure 3: Main purpose for applying SLM from the land user's perspective



Source: Global SLM Database (https://qcat.wocat.net)
Note: derived from 991 entries in the database, of which 772 (78 per cent) cover cropland or grazing land or both.

With respect to LDN there has been an analysis by WOCAT of the database. Of the documented cases of SLM practices implemented, the number primarily targeted at either avoiding, reducing or reversing land degradation were analysed. Figure 4 sets out the results by the UNDER ecosystem type. Reducing land degradation is most common in each ecosystem, and reversing land degradation the least. Nevertheless, it must be recollected that, for the broad definition of ecosystem restoration adopted by UNDER, each of the three LDN response categories are relevant to its overall goal.

Figure 4: LDN Response Hierarchy from entries in Global SLM Database by UNDER ecosystem type



Source: Global SLM Database (https://qcat.wocat.net)

3. SUSTAINABLE LAND MANAGEMENT: ACTION ON THE GROUND

3.1 Ecosystems and Good Practices: An Overview

The UNDER identifies eight different ecosystems: these are:

1. Farmlands
2. Grasslands, Shrublands and Savannahs
3. Forests
4. Mountains
5. Freshwaters
6. Urban Areas
7. Peatlands
8. Oceans and Coasts

One of the ecosystems (Oceans and Coasts) is partially marine and partially terrestrial, while the others are terrestrial. Six of the seven terrestrial ecosystems are characterized by, and named after, dominant land uses/vegetation types. The ecosystem Mountains is an exception.

WOCAT employs land use type (LUT) to characterise landscapes, but when compared and contrasted with the UNDER there is a close – and functionally useful – match. This is true of Farmlands (though WOCAT excludes pastures), Grasslands, Shrublands and Savannahs (where WOCAT places pastures), Forests and Freshwaters.

While Mountains are also covered fully by WOCAT, this is a cross-cutting LUTs, and practices are documented under the other various specific LUTs. The remaining three ecosystems: Urban Areas, Peatlands, and Oceans and Coasts have a much smaller number of entries in the database as they do not focus so firmly on productive land.

It is important to be aware that there is often an intimate interconnection between ecosystems, and various overlaps as well. Thus, many SLM remedies, through their versatility, are relevant to more than one ecosystem: this is evident from Table 1 which summarizes practices from WOCAT experiences and relates these to their actual, and potential roles, in ecosystem restoration. The last column refers to the examples of SLM good practices, which are presented in Section 3.2.

Table 1: SLM Practices relevant to Ecosystem Restoration – based on WOCAT documentation

SLM PRACTICE GROUPS*	DESCRIPTION (simplified)**	LDN HIERARCHY	MAIN ECOSYSTEMS***	EXAMPLES (Section 3.2: Code = Ecosystem and Practice)
Agroforestry	Mixture oF trees with other plants	Avoid Reduce Reverse	FL/GSS/F/M/ FW/UA/O&C	Dynamic Agroforestry Bolivia (FL.02) Shade-Grown Coffee: Lao PDR (F.03) Indigenous Trees in Rubber: China (M.02)
Cross-Slope Barriers	Bunds/ fences/ terraces/ on contour	Reduce Reverse	FL/GSS/M	Vegetated Bund Ethiopia (FL.03) Rice Terraces: Philippines (M.01)
Forest Plantation Management	Management of planted tree species	Reduce Reverse	F/M/O&C	Mangroves: Philippines (O&C.02) Mound Planting: Bangladesh (O&C.04)
Grazing Land Management	Management of grassland/ bush	Avoid Reduce Reverse	FL/GSS/M/P/ O&C	Range Restoration Iceland (GSS.01) Game Routes: Namibia (GSS.03) Silvo-Pastoralism: Tajikistan (M.04)
Integrated Crop/ Livestock Management	Combination of crops with livestock	Avoid Reduce Reverse	FL/GSS/M	Zero-Grazing + Biogas: Uganda (UA.04)
Integrated Soil Fertility Management	Manure, composts legumes etc. to improve fertility	Avoid Reduce	FL/GSS/M/UA	Green Urban Development: Germany (UA.01)
Improved Ground Cover	Soil surface better protected by mulch, vegetation etc.	Avoid Reduce Reverse	FL/GSS/F/M	Green Cane Trash: Australia (O&C.01)
Irrigation Management	Management of irrigated land and water	Avoid Reduce Reverse	FL/M/UA	Vegetable Production: Cambodia (FL.04)
Minimum Tillage	Reduced ploughing/ soil disturbance	Avoid Reduce	FL	Conservation Agriculture: Tunisia (FL.01)
Natural/ Semi-Natural Forest Management	Improving status of existing forests	Avoid Reduce Reverse	GSS/F/M/ FW/O&C	Forest Fodder: Madagascar (F.02) Riparian Forest: Kenya (F.04) Spring Revival: India (M.03)
Protected Area	No-go areas: livestock/ cropping etc. prohibited	Avoid Reduce Reverse	GSS/F/M/ FW/P/O&C	Sacred Grove: Ghana (F.01) Catchment Protection: Haiti (FW.02)
Rotation	Rotating crops in fields/ and/ or livestock in pastures	Avoid Reduce	FL/GSS/F/M	Rotational Pasture Management: Uzbekistan (GSS.04)
Water Diversion/ Drainage	Safe/creative discharge of water	Avoid Reduce Reverse	FL/GSS/F/M/ FW/UA/P/O&C	Wastewater Recycling: India (UA.03)
Water Harvesting	Collection of runoff for production/ consumption	Avoid Reduce	FL/GSS/F/M/ FW/UA	Vallerani System: Jordan (GSS.02) Water Spreading Weirs: Chad (FW.04) Rooftop Water Harvesting: Nepal (UA.02)
Wetland Management	Methods of managing wetlands, including peatland	Avoid Reduce Reverse	FL/GSS/F/M/ FW/UA/P/O&C	Artificial Wetland: Italy (FW.01) Floating Garden: Bangladesh (FW.03) Paludiculture: Germany (P.01) Peatland Restoration: UK (P.02) Andean Wetlands: (P.03) Managing Peatlands: Indonesia (P.04)
Windbreaks	Barriers of trees to slow wind	Avoid Reduce	FL/GSS/F/M/ O&C	Sand Dunes: Senegal (O&C.03)

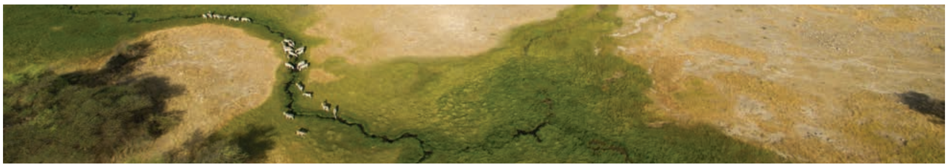
Notes:
* To avoid any implication of hierarchy, these are arranged in alphabetical order
** See WOCAT Glossary, https://www.wocat.net/en/glossary for fuller descriptions
*** FL = Farmlands/ GSS = Grasslands, Shrublands and Savannahs/ F = Forests/ M = Mountains/ FW = Freshwaters/ UA = Urban Areas/ P = Peatlands/ O&C = Ocean and Coasts

3.2. Good Practices in Ecosystem Restoration

The following pages document four on-the-ground SLM practices per ecosystem – sourced from around the world – to give an idea of where, and how, SLM can contribute to restoration. The good practices have been selected, mainly from the Global SLM Database, to demonstrate the very broad range of interventions that are possible, rather than by rank of global importance. The practices are presented in a way that gives a simplified account of the particular intervention: the intention is to draw awareness and stimulate interest in how action supports restoration. The first page under each ecosystem introduces a short analysis of its characteristics, its problems – and how SLM can help in restoration.

FARMLANDS

GRASSLANDS, SHRUBLANDS AND SAVANNAHS



FORESTS

MOUNTAINS

FRESHWATERS

URBAN AREAS

PEATLANDS

OCEANS AND COASTS

1. FARMLANDS

While farmlands cover 37 per cent of the world's surface, croplands make up nearly one-third of that area.[24] And the contribution of croplands to ecosystem degradation is very significant. With the original vegetation stripped away, under many systems of arable farming – rainfed or irrigated – the soil is regularly disturbed and left exposed for long periods. Inappropriate practices damage the land further. While gullies are the most visible form of erosion, it is other processes, less obvious to the eye, that are more damaging to the ecosystem. Surface erosion and nutrient depletion leading to reduced water-holding capacity, diminished biodiversity, and loss of carbon are serious adversities. On irrigated land, salinity is a particular problem. Crop yields suffer. Thus, ecosystems dominated by croplands are a priority for action – for multiple reasons.

Fortunately, many of the interventions that improve and protect the land – preventing soil loss and building up organic matter for example – also bring direct benefits to farmers. This means that land users have an incentive to invest in SLM to improve their own production, while multiple co-benefits to the environment follow (see Figure 2). Production and conservation go together. "Climate-smart agriculture" (CSA) and "good agricultural practices" (GAP) are terms that acknowledge and embrace this co-existence.

Figure 5 is derived from analysis of the Global SLM Database. It examines on-site and off-site benefits of SLM on croplands as viewed by the contributors to good practices. The data is generally based on estimates – though some are derived from measurements. The respondents were asked to assess impacts, on a scale with seven categories from "very negative" to "very positive", against a number of parameters. As expected, the most positive impacts on-site are generally related to production and income, though soil water parameters are also seen as being favourably influenced. Downstream impacts are closely connected to hydrology. The one clear "negative" impact is on workload: SLM practices often require extra labour.

As in all ecosystem restoration, there needs to be a critical mass of action to create substantial impact. Put simply, farmers must act together, not just to help themselves individually on-site, but to create synergies that bring positive impacts and off-site benefits at the larger scale. In this way, the ecosystem at large is the winner. Therefore, while it is essential to identify practices that fit the purpose, it is also crucial to establish how they can be widely adopted and brought to scale. Each of the four good practices: conservation agriculture, cross-slope bunds, agroforestry and organic production that are presented here demonstrate how popularity with farmers can rapidly trigger uptake and propel spread.

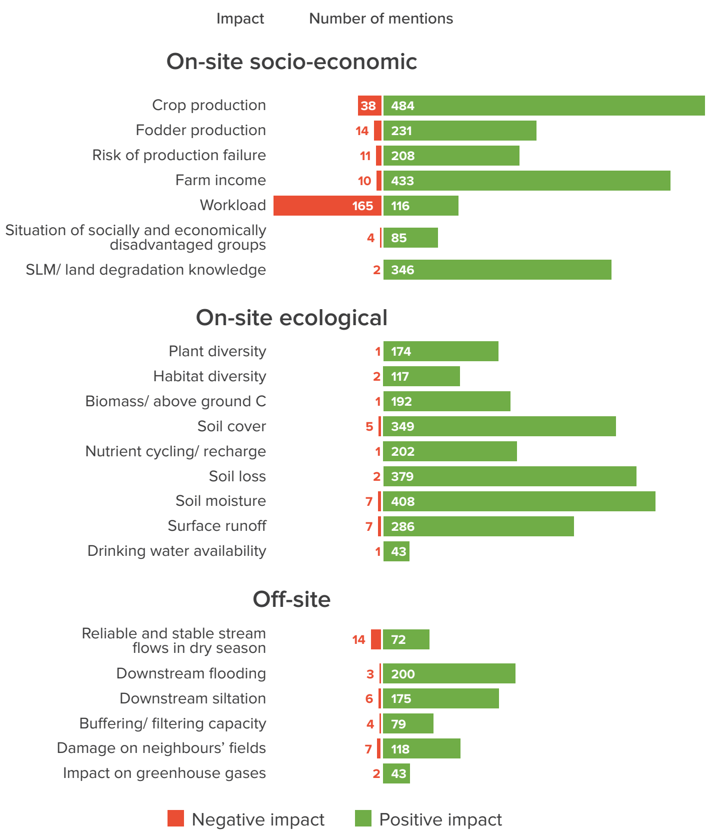
©William Critchley

Agroforestry: Penina Kiulu in Kenya coppicing her *Grevillea robusta* trees.

©Nicole Güdel

Green cover in vineyards, Switzerland.

Figure 5: On-site and off-site impacts of SLM in Farmlands



Source: Analysis of Global SLM Database (https://qcat.wocat.net/)

GOOD PRACTICES IN FARMLANDS

Conservation agriculture, Tunisia

Conservation agriculture (CA) has spread worldwide to over 150 million hectares. Tunisia leads the way in North Africa. CA is based on three principles:

- Minimum mechanical soil disturbance
- Permanent organic cover
- Plant diversification

A key constraint to CA in Africa is the competing demand for crop residues – between mulch and livestock feed. In this pioneering case, grazing of stubble by smallstock is allowed – but for just 30 days post-harvest. Benefits include better soil structure, more soil biodiversity, increased soil carbon, reduced erosion and a more climate resilient system.

https://qcat.wocat.net/en/summary/5457/?as=html
https://qcat.wocat.net/en/summary/3725/?as=html
See also: Kassam et al., 2015[25]

©Donia Mühlematter

"You can really see the difference between my farm and that of my neighbour. Despite the steep slopes, CA has reduced erosion and improved the soil". Conservation agriculture farmer, Abd Rabbou.

©Johanna Jacobi

"Many people come to see our crops: when they see the dynamic agroforestry system they feel obliged to change" Dynamic agroforestry farmers Don Bernabé Ramos and his wife.

Dynamic agroforestry, Bolivia

Mixing trees and crops can be mutually beneficial. There are multiple types of agroforestry – from simple, unplanned mixtures, to sophisticated designs. Dynamic agroforestry is a specific form in which careful pruning and selective weeding enhances the "dynamic development of plant synergies". The system evolves over time as the various strata grow. Species include timber trees, fruits, cacao, sugar cane, pigeon pea and pineapples. Dynamic agroforestry can be highly biodiverse and store high amounts of carbon. Systems can recover degraded land and ensure food security at the same time.

https://qcat.wocat.net/en/summary/5502/?as=html

Vegetated graded bund, Ethiopia

Cross-slope earth bunds or walls are a traditional form of soil and water conservation. Where excess rainfall needs to be discharged safely, one option is to design the bund and adjacent ditch with a small gradient so that it drains laterally to a protected waterway. The bund can be above the ditch or below. Planting the bund with fodder grass and shrubs both stabilizes it and provides a source of fodder. What is particularly important, is that agreement is reached between farmers to construct continuous systems across neighbouring parcels of land - to have an impact at the watershed level.

https://qcat.wocat.net/en/summary/5554/?as=html

©Gizaw Desta

Hedgerows of vegetated graded bunds in the Gosh Learning Watershed.

©Royal University of Agriculture, Cambodia

"Intricately planned" is how Ms Teay Chat describes her farm.

Organic vegetable production, Cambodia

Asia accounts for 9 per cent of global organic production and the area is increasing rapidly. There are environmental benefits from using organic manures and eliminating toxic pesticides. The land is protected, soil organic matter levels increase, and agrobiodiversity improves. In this example, a woman farmer from Cambodia uses organic agriculture that she describes as being "intricately planned". It combines vegetable beds, a pond for irrigation and housed cattle that provide manure. Concoctions of natural products are used for insecticides: a practice that is common in Asia and beyond.

https://qcat.wocat.net/en/summary/4453/?as=html

2. GRASSLANDS, SHRUBLANDS and SAVANNAHS

Grasslands, shrublands and savannahs ("grasslands" in short) are among the most diverse ecosystems on earth, and provide a very wide variety of services – including hydrological regulation and carbon storage: rangelands for example contain more than a third of all terrestrial carbon reserves.[26] Managed by livestock farmers, ranchers and pastoralist herders, grasslands are home to domestic livestock as well as wildlife, and specific flora. They cover vast areas – though they are gradually being reduced in size by demands for cropland and settlements.[27] Grasslands are being degraded in places by mismanagement and "overgrazing", yet many pastoralist herders have few ready alternatives to making full use of the grasslands' resources – without being able to rest land to recuperate.

In the grasslands, management systems and their associated problems are complex. For example, intensive management can reduce biodiversity and pollute waterways; the use of fire in rangelands can be destructive to useful species; disputed tenure may lead to exploitation of resources; and a growing concern is invasion of alien species. In semi-arid areas, a problem throughout is surface erosion when intensive rains fall on denuded soil at the beginning of the wet season.

However, restoration of grasslands can bring benefits to the environment and rewards in terms of production. Whether herders in Asia, ranchers in Australia, or pastoralists in Africa, there are profits through investing in the land. Impact can be achieved, but only if a large area is simultaneously improved by users who agree to implement sustainable practices in the long term. Then pressure on the land can be reduced, conflicts averted, and the spiral of land degradation can be broken.

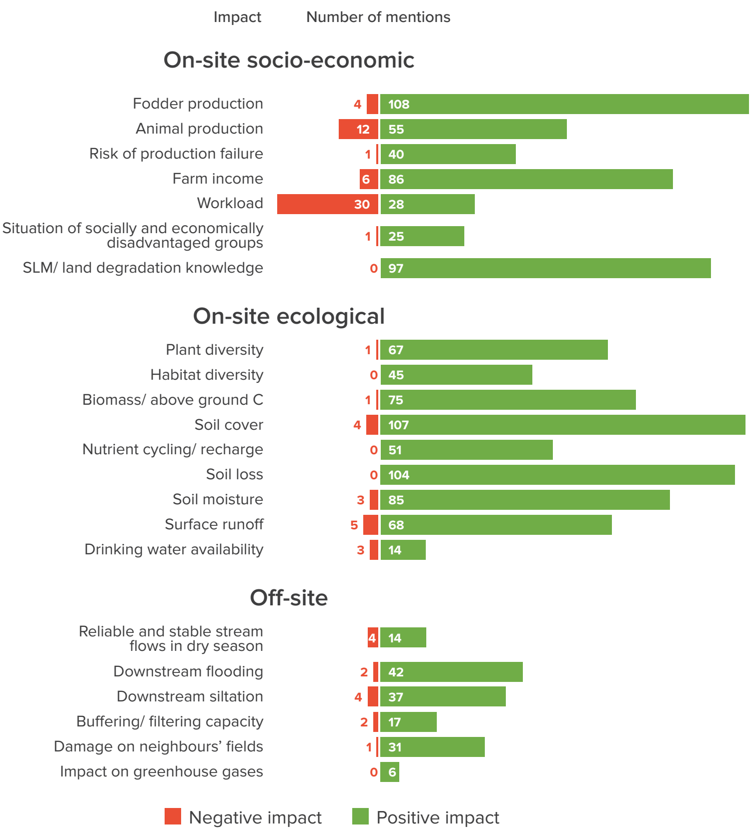
©William Critchley

Successful revegetation of rangeland in Baringo, Kenya.

©VSF Belgium

Transhumance in Niger

Figure 6: On-site and off-site impacts of SLM in Grasslands, Shrublands and Savannahs



Source: Analysis of Global SLM Database (https://qcat.wocat.net/)

Figure 6 is derived from analysis of the Global SLM Database. It examines on-site and off-site benefits of SLM on grasslands as viewed by the contributors to good practices. Compared with croplands, the on-site benefits are more equally divided between production/ income and biophysical parameters. Downstream impacts, once again, are seen to be related mainly to hydrology.

In order to deal with the complexity and diversity of grasslands, solutions are often site-specific. The examples of good practices presented here reflect the widely different challenges and the range of interventions that are being used in areas as far apart as northern Europe, Southern Africa, the Middle East and Central Asia. Nevertheless, there are common denominators – restoring vegetation cover is the most obvious of these.

GOOD PRACTICES IN GRASSLANDS, SHRUBLANDS AND SAVANNAHS

Restoration of degraded rangelands, Iceland

Land degradation in Iceland has been triggered by human activity, and made worse by severe windstorms. Communal user rights increase pressure on the land. Without protective measures, degradation can be devastating. In 1907 the Icelandic Conservation Service was set up: the first of its kind globally. One specific intervention has proved effective in increasing grass cover. It is based on nurturing "islands" of remnant grass patches. These are treated with manure, as well as receiving some inorganic fertilizer. They act as seed banks for natural spread of grass. Over 900 km^2 have been treated.

https://qcat.wocat.net/en/summary/5786/?as=html
https://www.wocat.net/documents/1015/DEF_Iceland_WOCAT_Policy_Brief.pdf

©Thorunn Petursdottir

Manure is used to cover the surface of grass remnant patches to encourage growth and seed production.

©Mira Haddad

"We have hope that our land can be productive again... we can see now birds, animals, and bees ... we need to tell others to do the same." Spokesperson of the local community.

Vallerani System, Jordan

The "Vallerani System" is a mechanized way of constructing micro-basins to rapidly re-vegetate a large area through water harvesting. A tractor pulls a specially designed "Delfino" plough. In Jordan, the basins created are 4.5 m x 0.5 m and 0.3 m deep. They are spaced 0.5 m to 1 m apart along the contour with 7 m (approx.) catchments feeding the basins with runoff. Local shrubs planted in the basins are thriving. First trialled in Niger, the system is currently being used in Burkina Faso where it can cover 20 hectares in one day. Since inception in 1988, it is estimated that 260,000 to 280,000 ha have been treated globally.

Jordan: https://qcat.wocat.net/en/summary/5860/?as=html
Burkina-Faso: https://qcat.wocat.net/en/summary/4430/?as=html
See also https://www.vallerani.com and Critchley et al, 1992[28]

Restoring game migration routes, Namibia

The NamibRand Nature reserve covers 215,000 ha in south-western Namibia. Established by a group of large-scale farmers, its aim is to create a nature reserve facilitating seasonal migratory routes for game, embedded in a healthy ecosystem. Traditionally, the San people and later the Nama used the area seasonally. Then, the area was settled by ranchers who erected fences, and these became barriers to game. The new initiative removes fences, controls invasive alien plants and reintroduces game species. While the reserve welcomes a limited number of tourists, it also hosts researchers – and school pupils for educational visits.

https://qcat.wocat.net/en/summary/4106/?as=html

©NamibRand Nature Reserve

"We have removed hundreds of kilometres of fences and seen a big increase in wildlife. Before there were just a few and many would get stuck in the fences and die." Jackie Vlees.

©U. Nazarkulov

A flock of sheep in a designated area near the village pasture in the Bukhara region.

Rotational pasture management in desert areas, Uzbekistan

With the collapse of the Soviet regime, land tenure and land management rules collapsed in Uzbekistan. As a result, grasslands became overgrazed due to private exploitation - and new grazing arrangements were needed. A rotational system, founded on traditional methods, has helped to stabilize the ecosystem on degraded lands. It is based on three paddocks, each a one-third segment of a circle of 3,900 hectares, served by a central water point. Based on a sustainable pasture-use plan, the livestock stocking rate is controlled, to ensure the regeneration of vegetation, pasture improvement and sustainable use.

https://qcat.wocat.net/en/summary/5474/?as=html

©William Critchley

Farmer-managed natural regeneration. Restoring biodiverse parkland in Burkina Faso.

©William Critchley

An Oyamel (*Abies religiosa*) forest in Mexico – essential for Monarch Butterfly hibernation.

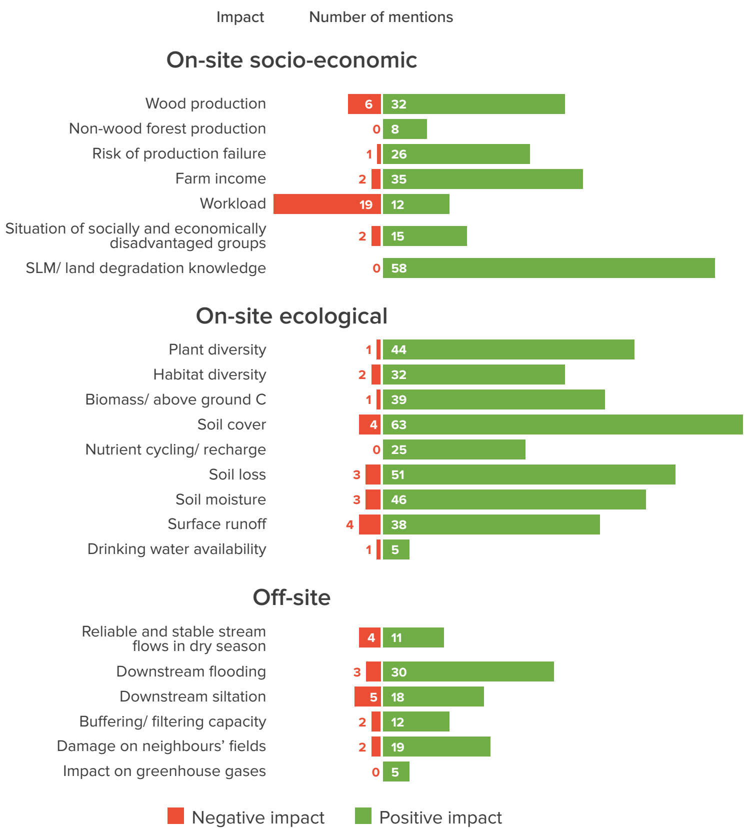
3. FORESTS

Of all the terrestrial ecosystems that are being degraded, it is forests that have captured the public's attention the most. Images of tropical hardwood trees being felled are commonplace, alongside smouldering clearings. These send powerful messages of forest degradation. The consequences, including sediment-laden rivers, mud slides across roads, and eroded hillsides are visible and compelling. But while the rate of decline of net forest loss has slowed in the last decade (from 7.8 million ha per year in the 1990s to 4.7 million ha in the 2010s, mainly thanks to tree planting in temperate zones),[29] highly biodiverse tropical forests are under continued threat: that is where most of the environmentally damaging deforestation is taking place. Massive amounts of carbon are lost to the atmosphere, exacerbating climate change, and significantly the uniquely rich biodiversity is being harmed.

Ninety per cent of those living in extreme poverty are at least partially dependent on forests for their livelihoods and 880 million people use fuelwood or charcoal to cook their daily meals.[30] The use of non-timber forest products is well recognized as being an important part of livelihoods. Forests are said to act as "green pharmacies": in developing countries many medicinal drugs are derived from local plants.

Perhaps even more than other ecosystems, forests differ enormously: from monoculture plantations in the far north to species-rich tropical rainforests. Their location matters, too. For example, riparian forests guarding streams and rivers are immensely important for protecting banks from erosion, filtering sediment as it flows to watercourses, and harbouring abundant biodiversity.

Figure 7: On-site and off-site impacts of SLM in Forests



Source: Analysis of Global SLM Database (https://qcat.wocat.net/)

Figure 7 is derived from analysis of the Global SLM Database. It examines on-site and off-site benefits of SLM in forests as viewed by the contributors to good practices. Compared with croplands and grasslands, the on-site benefits are skewed less towards production/ income - and more clearly in favour of improved hydrology, biomass production, soil health, biodiversity and better knowledge. Downstream impacts once again are related mainly to improved hydrological regimes.

SLM remedies are diverse. In some cases, reducing land degradation – even reversing it – can be driven by local production interests. Good practices highlighted here testify to the ways this can be achieved. One focuses on community management, based on cultural values; another shows how a key indigenous species can be propagated; a third shopwindows a system that "mimics forest" and yet produces coffee. Finally, a riverbank has been protected productively with perennial plants by a farmer. One key lesson is that forest ecosystem restoration is not simply a matter of establishing and policing exclusion areas: there are more creative methods too.

GOOD PRACTICES IN FORESTS

Sacred groves, Ghana

Sacred groves comprise islands of original forest, protected by the traditional authorities through a system of taboos and restrictions. It is believed they are home to ancestral spirits. In the Yiworga area of Northern Ghana, a sacred grove of around 14 ha is even richer in biodiversity than natural forest of the area. Limited use is allowed: beehives are permitted and medicinal herbs are harvested. There are parallels in other countries. In Ethiopia, many churches are surrounded by islands of pristine forest remnants. Localized environmental benefits are apparent, but importantly sacred groves – and similar protected forest remnants – act as seed banks of indigenous species.

https://qcat.wocat.net/en/unccd/view/unccd_175/

©William Critchley

Sacred groves in northern Ghana are islands of rich, indigenous biodiversity providing in-situ seed banks.

©Johanna Götter

"We will have abundant cattle because the samata trees will increase." Mrs Bienvenue Razanamalala (pointing), President of the local Women's Association.

Propagation of a forest fodder tree, Madagascar

Euphorbia stenoclada or "samata" is an indigenous constituent of Madagascar's unique and threatened "spiny forest". Here, forest ecosystem degradation is of global significance because of the high level of endemic species. Samata is vulnerable to habitat loss and increasing privatization of land. This directly impacts on livelihoods, as livestock are dependent on samata (amongst other species) for long periods of the year. Propagation through growing cuttings in nurseries, planting them out and protecting them – and training land users – is benefitting local communities because the long-term provision of supplementary fodder is then guaranteed, reducing pressure on natural vegetation.

https://qcat.wocat.net/en/summary/4842/?as=html
https://vimeo.com/222340296

Shade-Grown Coffee, Lao People's Democratic Republic

Coffee is originally a forest species, and when the first commercial plantations were created, tall shade trees were planted amongst the coffee. In Lao PDR, workers on coffee estates have taken knowledge of coffee husbandry back home with them. They have developed an agroforestry system where coffee is planted under existing tall trees in degraded forest. These innovators are careful not to over-shade: 50-60 per cent sunlight is required for optimal production. Manure is added to the soil to improved fertility. The end result is coffee produced in a system that imitates natural forest.

https://qcat.wocat.net/en/summary/4819/?as=html

©National Agriculture and Forestry Research Institute (NAFRI), Lao PDR

"I have found the coffee trees are healthier...production and income have increased because of the soil fertility and extra moisture." Mr. Thong, farmer, Attapue province, Lao PDR.

©Hanspeter Liniger

"I plant napier grass along the river to help protecting the riparian zone." Peter Gitimu, Kenya.

Riparian Forest Protection, Kenya

Riparian forests are hotspots of degradation, yet perform an essential protective function along riverbanks. But farmers often exploit the rich alluvial soil by cultivating to the very edge of the river: the riparian forest is sacrificed for short-term gain. This cultivated strip can be rapidly eroded into the river. In Kenya, a farmer's own successful actions comprise a combination of building a protective bund, and then planting this with trees which are harvested for fruits and poles, and napier grass which is cut for cattle fodder. This vegetation is not the original riparian forest, nor so biodiverse, but it is simultaneously perennial, productive and protective.

https://qcat.wocat.net/en/summary/4771/?as=html
https://vimeo.com/97404494

4. MOUNTAINS

Mountains are not an ecosystem in the sense of a dominant land use type: they are an amalgam of croplands, grasslands, forests, peatlands, waterbodies and settlements – as well as bare lands and naked rock. "Mountainscapes" are mosaics – but are classed as an ecosystem because of their special characteristics. By definition, the land is sloping and vulnerable to surface erosion as well as mass wasting, accessibility is often poor, and altitude puts a constraint on production. Road networks in steep landscapes are notorious for causing landslips. Mountains are particularly important in their crucial role as "water towers", being the source of streams and river that flow, in some cases, thousands of miles to the sea. They harbour unique biodiversity too with 50 per cent of the world's biodiversity hot spots.[31] Mountains constitute 27 per cent of the global land surface and in 2017, were home to 1.1 billion people: some 15 per cent of the world's population.[32] Natural hazards affect half of the people living in mountains. One in two mountain dwellers in developing areas are calorie and protein deprived. It is also significant that mountains in all continents attract significant numbers of tourists – and this is a source of income but simultaneously can led to localized degradation.

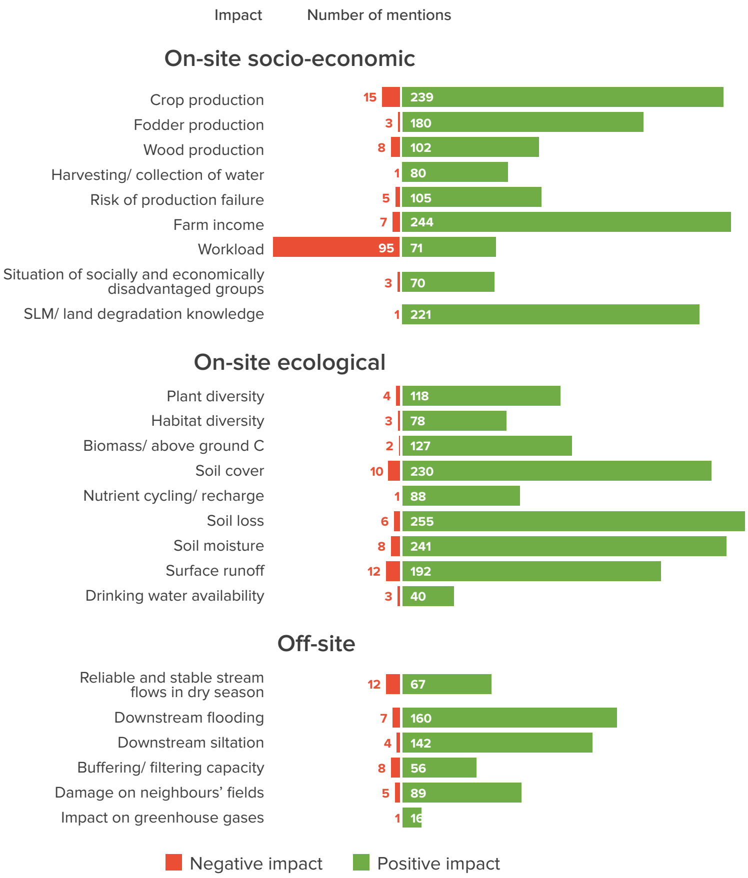
©William Critchley

©William Critchley

The High Atlas in Morocco: a remote "mountainscape" providing agriculture-based livelihoods for thousands of families.

Figure 8 is derived from analysis of the Global SLM Database. It examines on-site and off-site benefits of SLM in mountains as viewed by the contributors to good practices. It is worth noting the very wide range of on-site benefits that can accrue as a result of SLM: the most important positive effects are seen to be on reducing soil loss (unsurprisingly) – and improving production and income (perhaps less expected). Downstream impacts once again are related mainly to hydrology: in their role as "water towers" and sources of rivers, this is of paramount importance.

Figure 8: On-site and off-site impacts of SLM in Mountains



Source: Analysis of Global SLM Database (https://qcat.wocat.net/)

It is evident that mountains pose a particular set of challenges, and many of the solutions are unique. Classifying them as an ecosystem on their own allows the focus they warrant. Livelihoods in the mountains are dependent, in many places, on agriculture. Excluding them from production is not an option. Yet farmland, grasslands – as well as forests and peatlands – are exposed to land degradation, which endangers sustainability of production on-site, and threatens water security downstream. The good practices presented are examples of how people have tackled a cluster of specific problems: cultivation on steep hillsides, drying of springs, overgrazing, and erosion from commodity plantations.[33]

GOOD PRACTICES IN MOUNTAINS

Traditional rice terraces, Philippines

The Ifugao rice terraces in the Philippines have been renowned internationally for over half a century. Intricately constructed, with risers (the walls) being taller than the beds are wide in places, they are on slopes so steep that that they practically define the upper limit of cultivation: 60 per cent. Ingenious irrigation systems nurture the rice crop. These terraces are reputedly over 1,000 years old – and are testimony to people's efforts to grow food in mountain zones. A recent development is the growth in local agro-ecotourism. This supports the farmers to keep the terraces productive and protective of the landscape.

https://qcat.wocat.net/en/summary/5056/?as=html
See also: van Breemen et al, 1970[34]

©William Critchley

Agro-ecotourism: pride in cultural heritage. Roadside stalls bring welcome extra income.

©Gerhard Langenberger

Taking care of an underplanted Taxus mairei seedling in a rubber plantation in the Naban River Watershed National Nature Reserve, Xishuangbanna, China.

Indigenous trees in rubber plantations, China

Rubber is produced from a tree, *Hevea brasiliensis*, which is usually grown in plantations. However, maintaining a weed-free plantation floor with herbicides poses a double threat: from erosion and pollution. A trial, on a mountain slope, is testing interplanting of rubber with selected indigenous trees. The trees, *Parashorea* sp., *Taxus* sp. and *Nyssa* sp. have intrinsic value – while shading the ground and depressing weeds. Runoff is reduced by leaf litter. When the rubber outlives its economic life there is a choice: fell the tallest trees and replant rubber, or remove the rubber and allow the indigenous trees to form a productive plantation.

https://qcat.wocat.net/en/summary/4511/?as=html

Spring revival in the Himalayan foothills, India

In parts of north India, springs have been drying up over the last 30 years. One cause is overuse of the indigenous broadleaf oak, *Quercus leucotrichophora*, for fodder and firewood, leading to ingress of Chir pine (*Pinus rhoxburghii*). The pine is thirsty, and its understorey burns readily, accelerating runoff. However, thanks to innovative individuals and the locally elected forest village committees, efforts are being made to re-establish broadleaf forest. Combined with stone check dams (about 3.5 m long) and a stone wall (about 100 m), local people are making efforts to ensure rainfall infiltrates. There are now positive signs that local springs are recovering.

https://qcat.wocat.net/en/summary/5764/?as=html
https://qcat.wocat.net/en/summary/5950/?as=html
See also: Critchley et al, 2008[35]

©Jaclyn Bandy

"Today we have a big jungle that supports us with water, fodder and wood". Mrs. Saruli, Nakina Village, Uttarakhand, India.

©Malgorzata Conder

Apple trees with the farmer's house in the background.

Silvo-pastoral system, Tajikistan

A forty-hectare farm in Tajikistan was, under Soviet times, subject to strict rules governing use. However, it then became degraded through uncontrolled grazing. In 1991, one farmer improved part of his plot by excluding other people's livestock and by establishing an orchard undergrown with pasture. This six-hectare "silvo-pastoral" system combines a cash crop of fruits (apples, pears and cherries), planted quite widely (7 m x 7 m), with grazing beneath for his mixed livestock. The system yields hay also. The investment was modest at $ 100 per hectare. Though on a small-scale, degraded land has been restored to health.

https://qcat.wocat.net/en/summary/5260/?as=html

5. FRESHWATERS

About 70 per cent of the earth is covered by water, but only 2.5 per cent of that is freshwater. Of the freshwater, 68.9 per cent is in the form of glaciers and snow cover, 30.8 per cent is groundwater, and about 0.3 per cent is in lakes and rivers.[36] Freshwaters supply humankind with multiple goods and services. Water for drinking is most obvious, but water is vital for agriculture, too: for irrigation, processing and livestock consumption. Freshwater supports fisheries, whether in lakes and rivers or through aquaculture. Rivers also provide the energy that is translated into hydroelectric power. Waterbodies help maintain biodiversity – both within the water and along the banks of watercourses. Wetland and peat habitats, with all the services they provide, can only survive if supplied with ample freshwater. Coastal vegetation and even coral reefs themselves, are dependent on rivers delivering good quality water, and flowing to the sea – without all their water being extracted before they reach their destination.

It is clear, therefore, that freshwater degradation is detrimental to the environment - and can be catastrophic. There are numerous ways this can happen. Quantity and stability of supply is contingent on watershed characteristics. When a river catchment is disturbed through land use change, the flow regime become "flashier", with lower baseflows and increasingly devastating floods – exacerbated by climate change. Quality of freshwater is affected by sediment load. Lakes and reservoirs become silted and lose capacity; hydroelectric plant function is impaired. Peatlands and other wetlands are drained and reclaimed for farming – releasing greenhouse gasses and damaging biodiversity. Intensive agriculture can cause eutrophication, when nutrients are washed into watercourses, which then develop algal blooms and deprive fish and other organisms of oxygen. Invasive aquatic plants are a threat.

Figure 9 demonstrates how vulnerable freshwater species are to degraded habitats. The graph incorporates data on the abundance of 323 freshwater species around the world.

The four SLM practices presented are diverse: from holding back water flow in an arid zone to replenish the water table to making use of an invasive weed to support temporary floating gardens; from protecting a village water supply to creating an artificial wetland. But each, in its own way, helps protect freshwaters and their immediate environment.

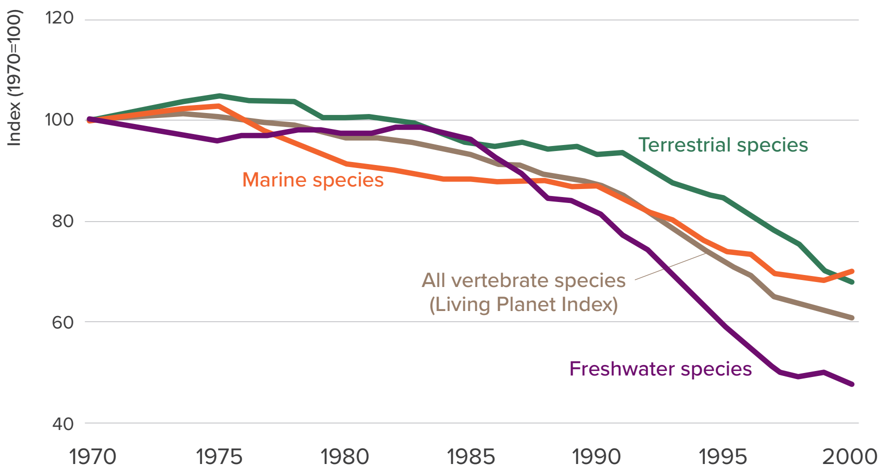
©Hanspeter Liniger

Community-led tourism in the Okavango Delta, Botswana.

©Tim Sophea

On-farm ponds help to alleviate the impact of seasonal droughts, providing irrigation, and are used for small-scale aquaculture in Cambodia.

Figure 9: Decline in biodiversity: Terrestrial, marine and freshwater species



Source: MEA, 2005, cited in Molden et al., 2007[37]

GOOD PRACTICES IN FRESHWATERS

Artificial wetlands, Italy

Wetlands help to purify water. In this case the wetland is artificial: it has been constructed as a "depuration" system for non-point pollution from adjacent cropland. Fertilizers and agrochemicals are washed out of farmland. If they reach fresh waterbodies directly, the result is contamination. This may take the form of eutrophication, where the extra nutrients added to the waterbody cause algal blooms, which deprive the water of oxygen. This is toxic to fish and other aquatic species. The artificial wetland intercepts runoff, and over time, cleans it. Denitrification takes place, sediments are stored, and the wetland itself becomes a mini-haven for biodiversity.

https://qcat.wocat.net/en/summary/4690/?as=html

©Nicola Dal Ferro

Wetland system in the low Venetian plain of Veneto region, Italy.

©Helvetas Haiti

"After planting herbs and trees, there is an increase in vegetation cover: infiltration also increases and there is much more water at the source." Dimenile Désir, source Grand Bois, Morne-à-Brûler, La Vallée de Jacmel, Haiti.

Protecting water supply catchments, Haiti

Water supply at the local level in Haiti is commonly contaminated by bacteria. In order to safeguard spring catchments, three zones are defined. The first is an ellipse-shaped area of 1,000 m² above the spring, which is protected by law as a no-go zone. The second is some 5 ha, reaching upstream. Restrictions apply, including forbidding human defecation. This zone is generally forested. The larger third zone depends on the local community. Generally, this implies use, especially through grazing, with regulations such as no burning. Stone check dams are constructed in gullies. There are direct, and quite rapid, results in the quality of drinking water.

https://qcat.wocat.net/en/summary/1765/?as=html
https://qcat.wocat.net/en/summary/4634/?as=html
See also: Harari et al, 2017[38]

Floating garden, Bangladesh

Floating gardens are fabricated from an invasive plant, the water hyacinth (*Eichhornia crassipes*). They may be reinforced with bamboo. Sizes vary, but gardens are typically about 1.5 m wide x 10 m long, and 1 m thick. They are commonly used in South-Central Bangladesh where land is inundated for around 6 months - the period when the garden floats. The floating gardens are used for vegetable production and/or as nurseries for rice. This traditional practice makes use of a harvested weed, prolongs the growing season, and when a garden begins to rot, can provide organic compost.

https://qcat.wocat.net/en/summary/4373/?as=html
https://vimeo.com/191327210
See also: Harari et al., 2017[39]

©Helvetas Bangladesh

"I have been producing vegetables for two years. I have managed to generate an average monthly income of 500-600 Taka (US$ 6-7)." Mrs. Jaheda Begum.

©Heinz Bender

Aerial view of a water-spreading diversion weir, Chad.

Water-spreading weirs, Chad

Masonry water-spreading weirs have been constructed in the Sahel since 1990. They are an evolution of the permeable rock dams built from loose stone in the 1970s and 1980s. These weirs span the entire width of valleys, holding back water, only allowing it to flow over a spillway and around wings of the weir. The impact is direct, and quick: farm production increases, grazing improves and the water table rises. The weirs range from 100 m to 1 km in length. Costs are high: over US$ 2,000 per hectare directly affected – but the benefits are correspondingly large and long lasting.

https://qcat.wocat.net/en/summary/1537/?as=html

6. URBAN AREAS

Urban areas are rarely thought of as ecosystems in the same way as grasslands or forests – they are constructed rather than natural – but they do combine the common ingredients: a particular dominant land use, unique hydrological flows, and specific biodiversity. Covering less than 1 per cent of the world's land surface, urban areas host approximately 55 per cent of the world's population, and this is expected to increase to 68 per cent by 2050.[40] While only recently acknowledged, there are problems of ecosystem degradation in urban areas that SLM can help to solve.

©Uganda Landcare Network

Farmer Rachel Amol making the most of her quarter hectare of land on the outskirts of Kampala, Uganda

Cities and towns are not just buildings and roads. There are trees, parks and waterbodies – as well as industrial areas and wastelands. Furthermore, there are highly productive patches both within and around the built-up areas. In some countries, the majority of the urban population may be engaged in some form of urban and peri-urban agriculture (UPA) – whether this is vegetable growing in simple containers on verandas or balconies, or tending dairy cows housed in backyards. It is estimated that 130 million urban residents in Africa and 230 million in Latin America engage in agriculture, mainly horticulture, to provide food for their families or to earn income from sales.[41] The global farmed area within "urban agglomerations" is approximated at 60 million hectares.[42] Estimates of the total production from UPA reach as high as 15 to 20 per cent of the world's food.[43] In many developing towns and cities, there is abundant compost material (from waste: though contamination can be a problem), water (from rooftops and hard surfaces) and a hungry population on the doorstep.

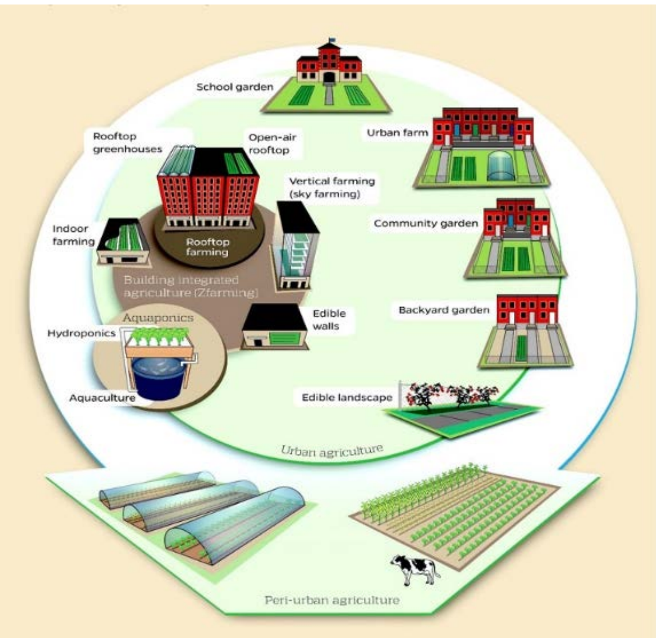
©charkho.blogspot.com

Gujarat, India. Peri-urban agriculture. Vegetables under sprinkler irrigation.

Priorities, according to the FAO, include promoting more sustainable, inclusive and resilient urban and city region food systems; reducing risk to shocks and stresses, such as climate change and pandemics; and ensuring access to green and healthy food environments. There is now a real demand to design resilient and sustainable city region food policies with strong rural-urban linkages.

Figure 10 illustrates the multitude of possible UPA practices in a modern city, and it is by no means exhaustive. In urban areas it is usually space that limits production, thus we see innovative solutions everywhere, with gardens on rooftops, indoors, on walls (including windowsills and balconies) and interspersed in the landscape wherever there is room. Hydroponics and aquaculture are intensive systems, well suited to confined spaces. In developing countries, the themes are equivalent, but an additional enterprise (less so these days, as legislation is tightened) is that of herders guiding livestock through suburban areas to graze and browse opportunistically on roadsides, beside markets and on wasteland. In peri-urban areas, on the fringes of built-up zones in developed and developing countries alike, farming is more organised and consolidated. Irrigation is commonly a feature, and horticulture and intensive livestock systems predominate.

Figure 10: Urban and Peri-Urban Agriculture: a typology of the multiple practices possible



Source: FAO-CRFS[45]

SLM initiatives span UPA to increasing the availability of green spaces through urban and peri-urban forestry.[44] Encouraging "green and blue corridors" of parklands and water bodies is a growing theme in urban and peri-urban areas. Functioning well, ecosystems in cities can clean air and water, and help to uplift their inhabitants' feeling of well-being. While there is enormous diversity in practices that enhance urban ecosystems, four are selected here that cover a range of initiatives – from urban gardening in Europe, to wastewater management in India, and from raising dairy cows in Uganda, to rooftop harvesting of water in Nepal. These practices draw attention to the potential that lies in these most complex of ecosystems.

GOOD PRACTICES IN URBAN AREAS

Green urban development, Germany

“Compact Settlement Development” is designed to make efficient use of space in urban areas. Brownfields (former industrial areas) and vacant lots can be converted to “green and blue climate corridors” of parks, ponds and rivers. This addresses temperature and runoff, as well as society’s needs for nature. People also want to cultivate – for fresh food and for recreation. One option is mobile cultivation beds. Vegetables can be grown in a plastic “baker box”, while stacked below is a second box that is gradually filled with compostable waste. In time the lower box is ready itself for cultivation.

https://qcat.wocat.net/en/summary/2603/?as=html
https://qcat.wocat.net/en/summary/4340/?as=html
https://qcat.wocat.net/en/summary/4619/?as=html

©Assenmacher

Mobile cultivation of beds at Moritzplatz in Berlin Kreuzberg.

©ICIMOD

“Rooftop water harvesting made my life easier particularly during 3-4 months of the dry season” A beneficiary from Nepal’s Jhikhu Khola watershed.

Rooftop water harvesting, Nepal

Roofs generate water, and this can be a nuisance in built-up areas. It is not difficult to see the rationale for capturing and utilizing the water – especially where supplies are short. In Nepal’s Jhikhu Khola watershed, ferro-cement water jars of between 500 and 2,000 litres are installed at household level. At only US$ 125 per unit, these durable structures represent very good value. Not only is women’s labour reduced, but the quality of water is improved. The tap of each jar is strategically positioned at 20 cm height: adequate for a container to be placed underneath, but low enough to reduce “dead storage”.

https://qcat.wocat.net/en/summary/4944/?as=html
see also: Mekdaschi-Studer and Liniger, 2013[46]

Wastewater recycling, India

Wastewater is a problem wherever there is human habitation. But it can also be put to creative use. In a densely populated village in northern India, an innovative “water volunteer” has come up with a locally appropriate solution. Where women wash clothes and utensils, drainage water is collected in a tank of 2,000 litres. Mr Rautela, the volunteer, overseas the use of that water for irrigation of people’s kitchen gardens – where vegetables are planted. Each of 14 families receives water, in negotiated rotation, and, depending on the season, one-quarter to one hectare of land can receive vital irrigation supplies.

Source: Brommer and Critchley, 2007[47]

©William Critchley

Mr. Rautela: the “water volunteer” who overseas distribution of wastewater to 14 families for their gardens.

©William Critchley

“I get a substantial amount of manure to fertilize the soil, enabling me to produce vegetables on a small piece of land.” Testimony from an urban farmer.

Zero-grazing and biogas, Uganda

Urban and peri-urban agriculture in the developing world spans vegetable, fruits and livestock. Zero-grazed dairy cows are common in Uganda, even in Kampala. They are fed cut grass, typically *Pennisetum purpureum* (napier grass), which may be grown close-by or brought in by trucks or bicycles. Sorted, green market waste can also be fed. In turn, manure and urine feed small biogas plants. Five cattle are needed for the 25 kg of dung that powers a small unit. The methane produced is used for cooking or providing light. Bio-slurry, which does not smell, is a by-product used to fertilize small vegetable plots.

https://qcat.wocat.net/en/summary/5466/?as=html
https://qcat.wocat.net/en/summary/3371/?as=html

7. PEATLANDS

Of all the ecosystems featured here, peatlands are the least visible, and consequently the most overlooked. Yet their importance is enormous. Around 3 per cent of the world's land surface is composed of peat, and more than 180 countries have peatlands. Peat is un-decomposed organic matter that has built up over time, due to water preventing oxidization. Because of the organic matter that is maintained in peat, carbon is held in the ground. This adds up to massive quantities globally: about twice as much carbon as that held in the world's forests.[48] Healthy peatlands are active: they continue to sequester more carbon, annually, than all other vegetation types combined. Nevertheless, because of the high rate of global degradation, there is a net loss of carbon from peatlands.[49]

The principal threat to peatlands is drainage. Once water is removed, decomposition of the organic material proceeds rapidly. Carbon dioxide is emitted to the atmosphere. Peat's hydrological function of holding and regulating water from rainfall is diminished. Simultaneously, the specific biodiversity of peatland is lost. Dried-out peat then becomes vulnerable to fire, and the loss of carbon is accelerated. In 2015, peat fires in Indonesia brought this particular problem to the world's attention. But peatland degradation continues, less visibly, worldwide: small-scale reclamation for farming, overgrazing, harvesting for compost sold in garden centres, and peat cut for fuel are examples.

Figure 11 illustrates the known global distribution of peatlands. While peatlands are found globally, their distribution is by no means even. In particular, there is a concentration in the far north, throughout the boreal and arctic zones. This has implications with climate change bringing warmer weather, and leads to the strong probability that wild peat fires will increase in these areas - leading to huge greenhouse gas emissions and further peatland degradation.[50]

©Marcus Silvius

Peatland restoration – blocking drainage channels

©William Critchley

Historically, peatlands (left above) were drained to extend farmland (below and right above) in the UK.

Figure 11: Global distribution of peatlands

Known location of peatlands   Countries with known peatlands

Sources: Yu et al., 2010[51]
Map by Levi Westerveld / GRID-Arendal (2017)

SLM can contribute to peatland management, and there are two main routes – as described in the good practices below. The first is simply by stopping and prohibiting drainage, and rewetting where necessary. This restores the peatland's ability to sequester carbon and hold on to stored carbon. The second is by managing peatlands productively through "paludiculture", often associated with re-wetting. This yields harvests from perennial species that tolerate waterlogged soils, such as reeds and tree crops. Controlled grazing (where practiced) can yield livelihood benefits without degrading the underlying peat. In a recent FAO survey, the total global area under paludiculture was estimated at 25 million ha, of which around 64 per cent was used for crops and the remainder for grazing.[52]

GOOD PRACTICES IN PEATLANDS

Managing peatlands for paludiculture, Germany

Peatlands can be utilized, but they must be managed with caution. The key is to keep the peat wet to about 10 cm below the surface. In Saxony-Anhalt, weirs are opened strategically to flood the land. Utilization of peatlands for production is termed paludiculture. This excludes ploughing and is limited to perennial plants. Grazing by specific breeds of cattle is an option. Productive uses include growing trees that tolerate wet conditions such as alder, and reeds for thatching. The process of maintaining the peat for paludiculture is costly: up to US$ 6,000 per hectare, and can only be implemented if subsidized.

https://qcat.wocat.net/en/summary/4614/?as=html

©Norbert Röder

Suckler cow and calf on a re-wetted fen.

©William Critchley

"The work done at Mar and other estates in restoring eroded peatland will hopefully be the forerunner of many larger projects." Mark Nicolson, Mar Estate in Scotland: a partner in the Cairngorms Peatland Restoration Project.

Peatland restoration, United Kingdom

Ten percent of the UK's land area is peatland. The majority is blanket bog which is globally rare. Scotland is home to well over half of the UK's 3 million ha of peatland – and the "Flow Country" in the far north is Europe's largest blanket bog. In 2020, the Scottish government launched a fund of more than UK£ 250 m for a decade of peatland restoration. On-the-ground activities involve local environmental groups, but also include public-private partnerships between the government and estate owners. Actions emphasize rewetting by blocking drainage channels, and restricting burning. Since 2012, more than 25,000 ha are recuperating.

www.iucn-uk-peatlandprogramme.org;
www.nature.scot/climate-change/nature-based-solutions/peatland-action-project

Restoring the High Andean Wetlands

Wetlands of the puna ecoregion on the high plateau of the Andes contain vast areas of peat which yield safe water. Families raise livestock including llama and alpaca. However, overgrazing and mining as well as exploitation for fuel have caused widespread degradation. Problems are similar in Peru and Argentina, where an initiative has been launched by Wetlands International to restore wetland ecosystems. The 7-year programme addresses human and environment needs simultaneously. During the Phase 1 of the programme, pilot activities have helped 270 families, through a participatory process, to improve wetland management and grazing practices on just over 6,500 hectares.

https://lac.wetlands.org/caso/conservando-los-humedales-altoandinos/

©Wetlands International LAC

Restoring grass cover on degraded peatlands.

©Aris Sanjaya, CIFOR.

Participatory-action research in community-based fire prevention and peatland restoration, Indonesia.

Managing peatlands, Indonesia

Indonesia has the third largest area of peat in the world and its problems are severe. Draining peat raises the threat of burning, and the catastrophic fires of 2015 served as a wake-up call. The main drivers of drainage are conversion to agriculture – and particularly, palm oil plantations. A national Peatland Restoration Agency was established in 2016, and tasked with the immediate restoration of 2.4 million hectares. Strategies are based on rewetting and revegetating. Canal blocking is one focus and paludiculture another. But the answers are not simply technical. Dialogue is needed to negotiate trade-offs between environmental and economic objectives.

https://www.cifor.org/publications/pdf_files/infobrief/6449-infobrief.pdf

8. OCEANS AND COASTS

While oceans themselves are outside the mandate of this publication, coasts are certainly within the framework of SLM. The impact of land degradation has a direct impact on coastal land through erosion, and indirectly on mangroves, seagrass meadows and reefs – extremely important to the sea's health and coastal livelihoods.

Along the tropical coast, as noted in the case from the Philippines, mangrove forests are especially prominent, both in their role as protectors against storm surges and filters for sediment - from the sea, and from freshwater flows into the sea. They hold and consolidate the shore against erosion. Mangroves present an illusion from above: they appear to be quite uniform and monotone, but underneath the story is quite different. They form an extremely rich ecosystem of their own, affording protection to multiple marine creatures and breeding grounds for fish and other organisms. They also store large amounts of carbon both above in their vegetation and below ground. Mangroves even provide abundant nectar for pollinators, including bees. Yet mangroves are under threat. They are cut for poles and fuelwood, unsustainably browsed by livestock, and more recently have become victims of plastic waste brought in by river flows.

©William Critchley

A beehive within a mangrove forest: this adds value to mangroves and the bees deter illegal cutting. Eritrea.

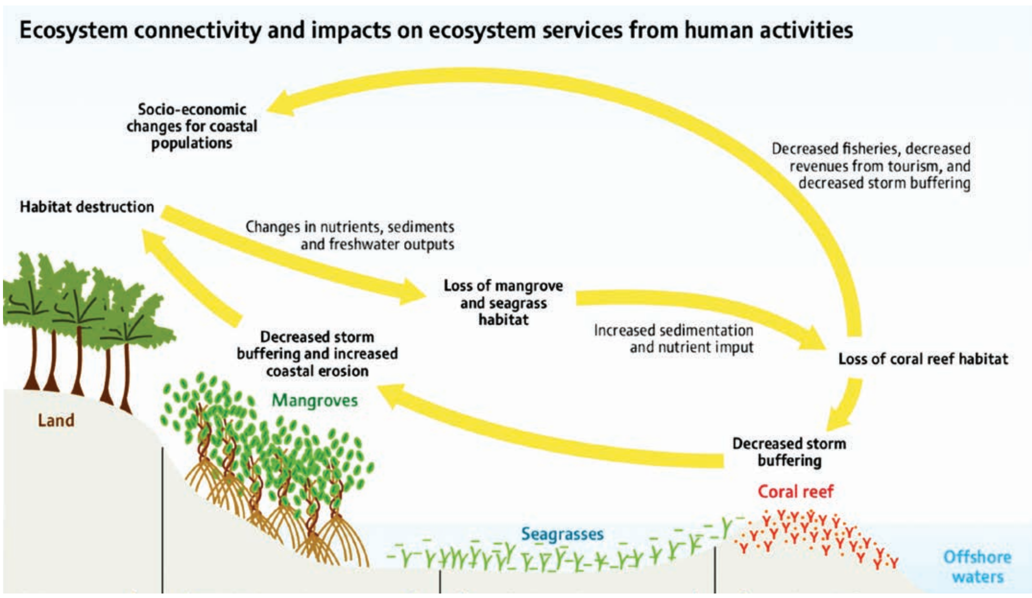
SLM has an important role to play, not just in directly managing mangrove forests, and addressing issues of sand dune stabilisation by tree planting – but by making sure that the river water that reaches the sea is healthy. “Ridge to Reef” (R2R) describes a strategy championed by IUCN that takes a landscape approach. This strategy acknowledges the fact that mangrove forests, seagrass meadows and the reef are affected, not just by coastal factors, but by land management inland – from the most distant points of river basins that supply water to the ocean. While Figure 12 demonstrates negative feedback loops, R2R can break the negative cycle through a sequence of SLM practices along the ecosystem transect from far inland to the sea – with a profound and positive impact on the coast and ocean.

©Fazlay Arafat

Afforestation with mangrove plants to protect land degradation and coastal erosion, Cox's Bazaar, Bangladesh.

The four SLM practices featured look at different zones along the R2R transect. The first example, from Australia, shows how a better system of farming sugar cane can reduce negative impacts on the reef. Two examples, one from Senegal and one from Bangladesh, show afforestation aimed at protection of the coastal strip. The last example describes rehabilitation of a mangrove forest in the Philippines.

Figure 12: Ridge to Reef connectivity: Negative loop that simultaneously demonstrates opportunities for ecosystem restoration through SLM



Source: Silvestri and Kershaw, 2010[53]

GOOD PRACTICES IN OCEANS AND COASTS

Green cane trash blanket, Australia

In Queensland, under conventional production systems, sugar cane was burnt before harvest. However, there were complaints that eroded sediment was reaching the sea and polluting the Great Barrier Reef. A further trigger to change the approach was the difficulty of burning in wet years. So, the cane began to be harvested green, leaving a thick mulch of residues behind. While this made the process slower and more expensive, there were numerous on-site and off-site benefits. The mulched land held moisture much better, soil structure improved – and much less sediment reached the seashore.

https://qcat.wocat.net/en/summary/4357/?as=html
https://qcat.wocat.net/en/summary/3524/?as=html
See also: Liniger and Critchley, 2007[54]

©William Critchley

Trash covering the interlines between the sugar cane.

©Djolly Ma. P. Dinmaling

"They protect us from winds and storm". Local observations about the Banacon Island Mangrove Forest, Bohol Province, Philippines.

Mangrove planting, Philippines

Mangroves perform an essential function in protecting coasts from storm surges and erosion of the coastline. Sediments are captured and a rich, unique ecosystem is established. Mangrove forests are highly biodiverse and act as breeding grounds for fish and other marine creatures. On the island of Banacon, the mangrove "Bakauan" (*Rhizophora* sp.) is highly appreciated. Replanting of degraded mangroves began in 1957. Mangroves are propagated through cigar-shaped "propagules", produced by mature plants. Results have been positive – but community-agreed rules are needed to protect the mangroves from being cut for poles and charcoal.

https://qcat.wocat.net/en/summary/5060/?as=html
https://www.bohol-philippines.com/mangrove-forests.html

Stabilization of wandering sand dunes, Senegal

A belt of casuarina (*Casuarina equisetifolia*) along the coast has proved effective in protecting market gardens of the Niayes coastal zone from sand. Previously, dunes were steadily moving inland. Stretching from St Louis to Dakar, the belt of trees is 200 metres wide. Planting began in the 1970s. Seedlings were spaced on a 2.5 m x 2.5 m grid. A local Forestry Union was created in 1992 to maintain the plantations. Casuarina is an alien species, but grows well and tolerates sandy and salty soils. It has become naturalized in many locations along the coast of Africa.

https://qcat.wocat.net/en/summary/5098/?as=html
De Dakar à Saint-Louis, une forêt de filaos en rempart contre les assauts de la mer (lemonde.fr)

©Julie Zähringer

Casuarina equisetifolia plantation in Lompoul.

©Atike Rohoman

"Cyclones and tidal surges are regular phenomenon here. So, we work with the forest department to create a greenbelt along the coast with more resilient species." Nur Uddin, farmer, Chittagong, Bangladesh.

Accreted river islands for Coastal Protection, Bangladesh

Close to the coastline, sediment is deposited by rivers as they slow, forming islands. Known as "accreted land", this needs to be stabilized with vegetation or the islands will be eroded again. Vegetated and stable, they help to protect the coast against tidal bores and storm surges. Mixed plantations are the most effective, and they accelerate natural succession. To encourage rapid establishment, tree seedlings are planted on mounds with a diameter of 1 m and a height of 60 cm. Raised planting reduces the risk of flooding and increases survival. Species include *Acacia auriculiformis*, *Casuarina equisetifolia* and *Terminalia arjuna*.

https://qcat.wocat.net/en/summary/4732/?as=html


©India, Hanspeter Liniger

4. SCALE AND ACTION: BROADENING THE IMPACT

4.1 From local to ecosystem-wide interventions

SLM technologies, when applied in combination across an entire landscape, can provide an impact on ecosystem restoration much greater than the sum of individual practices implemented locally. There are linkages and dependencies between the different parts of an ecosystem. While localized activities will help to improve livelihoods, and bring forth numerous benefits on-site, it is only through a combination and connection of good SLM practices within a landscape that significant positive impacts can be maintained or recreated at ecosystem level. Thus, a substantial proportion of land within an ecosystem needs to be treated to start releasing the full benefits of restoration. To reach that critical mass, a landscape approach begins with identifying an area large enough to involve multiple land units (e.g., within a watershed), including sectors and jurisdictions/administrative boundaries that are inclusive of different forms of land tenure governance (communal, private and public land: as applicable).[55] This way, there will be greater potential to navigate the inevitable mix of social, economic and environmental trade-offs inherent in land use planning and management. This approach requires full and open access to assessment data – acquired through a mix of scientific measurement and participatory processes. The data includes land potential, land degradation status, socio-economic conditions, and gender dynamics. It also requires the identification of appropriate roles for the various actors who can contribute to transformative change, ideally all working collaboratively to find, and then implement, the optimal mix of land use and management options possible, ecosystem-wide.

Farmland where a large cluster of SLM practices has developed a critical mass – and will have a significant effect on the ecosystem, Cambodia.

4.2 SLM at scale – how to influence decision-making

Local action, leading to ecosystem-wide efforts, needs underpinning and supporting by government, multilateral agencies, public-private partnerships, and other organizations to stimulate restoration processes. Thus mainstreaming/scaling up (institutionalization) is required to bolster and sustain scaling out (wide adoption/ uptake) of good SLM practices over large areas. Without this there will be no catalytic transformation in terms of ecosystem restoration. It is important to co-design mainstreaming and scaling out strategies with multiple stakeholders at different levels in a participatory, inclusive manner: from the local community to the national. Strategies must focus on addressing several key decision-making processes. Table 2 sets out the main processes and some of the related instruments that create opportunities for promoting and realizing SLM at scale. These decision-making processes and related instruments can be employed both at the national and the local level. For instance, at the national level, strategies and related allocation of funds may foster restoration activities, such as for peatland restoration in Scotland (see under Peatlands, Section 3.2). While at the local level, communities may develop their own management plans to regulate resource use in rural spring catchments as in India (see under Mountains, Section 3.2).

Table 2: Key Decision-Making Processes and Related Instruments

DECISION-MAKING PROCESSES	TYPES OF INSTRUMENTS
Policies and regulations	• National development policies • Sectoral policies (e.g., agriculture, economy, environment) • Regulatory instruments (laws, regulations) • National strategies and action plans
Incentives and Financing mechanisms	• Financing frameworks (budget allocations) • Economic and non-economic incentives • Microcredit programmes • Financing mechanisms and funds (e.g., watershed funds) • Certification schemes
Education and awareness-raising	• SLM curricula (e.g., university, higher education) • Training modules for professionals (e.g., advisory services) • Awareness campaigns and material
Land use/territorial planning	• Land use and territorial planning processes at all levels • Budgetary allocations for SLM by administrative units • Information and monitoring systems
Programs and projects	• National and subnational sectoral and cross-sectoral programs and projects (e.g., environment, agriculture, climate change, small business)
Local initiatives	• Local organizations (e.g., producer associations, indigenous organizations) • Local management plans

Source: based on Bastidas Fegan, 2019[56]

Clearly, calculations of costs and benefits of SLM are a key to decision-making. The cost of inaction is greater than the cost of restoration,[57] and around US$ 10 trillion could be lost by 2050 if ecosystem services continue to decline.[58] Every dollar invested in restoration creates up to US$ 30 in economic benefits.[59] The UNDER encourages nations to consider policies that favour ecosystem restoration. However, estimates of costs and benefits (and the way these are expressed) vary considerably, as hard data are scarce. This is unsurprising as it is notoriously difficult to quantify the impacts of land degradation and SLM. Nevertheless, evidence is fundamental to underpin wise investment, and in the example below, the Economics of Land Degradation Initiative provides some persuasive data for African policy makers (Box 2).

Box 2: Reaping economic and environmental benefits from sustainable land management

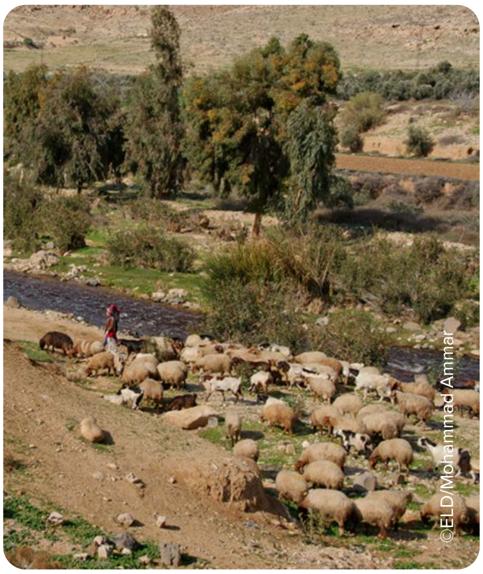
Recent ELD Initiative research undertook a cost-benefit analysis to measure the costs of erosion-induced depletion of soil nutrients on croplands across 42 African countries. It found that nutrient loss costs result in the loss of over 280 million tonnes of cereal ever year. An analysis of the costs of inaction versus the cost of action for controlling soil nutrient loss across the countries found that the benefits of action are about US$ 2.83 trillion in purchasing power parity over the next 15 years, or US$ 71.8 billion annually for all of the countries put together. Conversely, by taking action against soil erosion and resulting nutrient depletion, the total economy of the combined countries could grow at an average rate of 5.31 per cent annually over the 15 year period instead – quite an opportunity economically, environmentally, and socially for any policy-/decision-maker to grasp.

Source: The Economics of Land Degradation Initiative, 2013[60]

Countries must decide where to allocate resources in order to achieve the optimal mix of social, economic and environmental returns. Box 3 gives an example of policy influenced by cost-benefit calculations.

Box 3: Where cost-benefit calculations have changed government policy: Reviving AL-Hima in Jordan

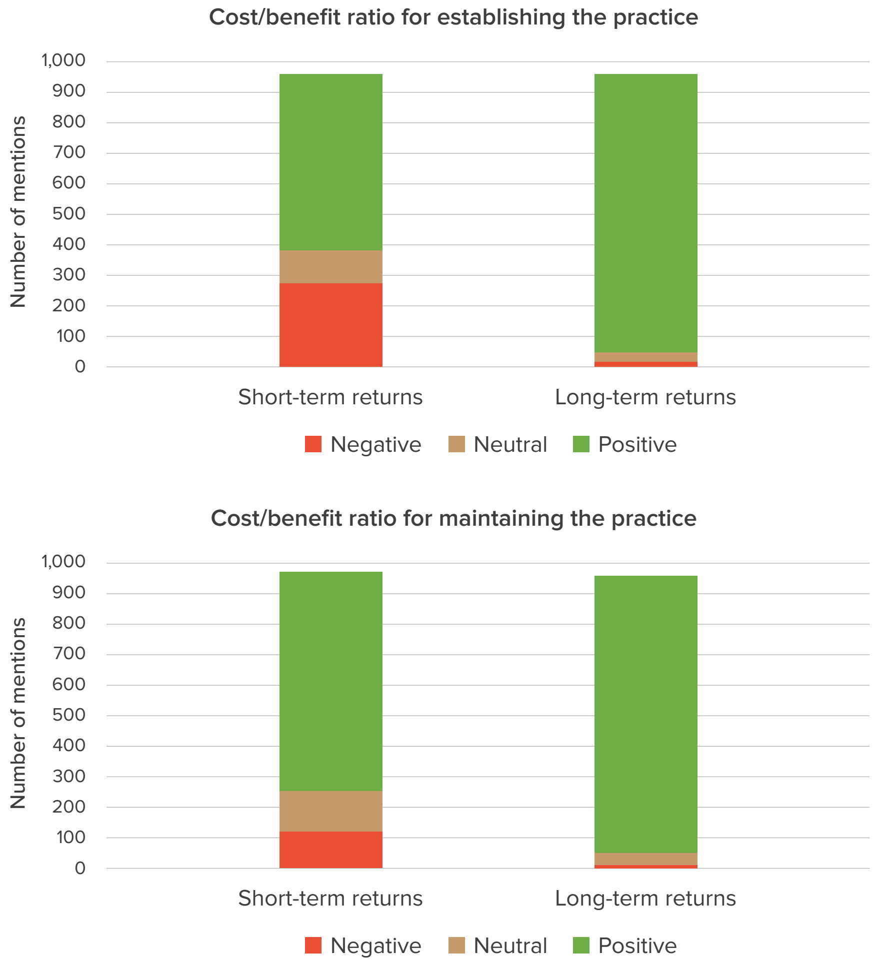
A traditional rangeland management system known as Hima ("protection" in Arabic) involves setting aside specific grazing areas to restore indigenous plant cover. "Social fencing" is one component: this means families agreeing to exclude their livestock voluntarily. Community participation is key at all stages, from problem identification to action. This low-cost approach has improved livestock production, and that alone outweighs the costs of implementation. Yet this is trivial compared to improvements in other ecosystem services. The value of additional groundwater infiltration was found to be 10 times greater than the value of the improved fodder supply, and there were additional benefits of carbon sequestration and reduced sedimentation of downstream reservoirs. Based on this experience, the national Jordanian Rangeland Strategy was revised in 2015.



Source: https://www.eld-initiative.org/en/where-we-work/asia/jordan/

Looking at impact locally, an analysis of the Global SLM Database shows cost: benefit ratios of the SLM practices documented. Covering, mainly, SLM on cropland, grazing land and forest it is based on qualitative estimates by land users implementing the practices in the field, and SLM experts accompanying them (Figure 13).

Figure 13: Perceived benefits of SLM: related to establishment and maintenance costs



Source: Global SLM Database (https://qcat.wocat.net)

Making the change from unsustainable to sustainable practices requires an initial investment. This is particularly so when restoration requires time and effort during an establishment phase that then triggers restoration of biological function in the land. Even so, for the short term, less than a third of all SLM practices documented in the Global SLM Database reported negative returns during the establishment phase, implying that benefits quickly outweigh the costs for most. Often, these costs are connected to machinery and equipment, as well as labour. However, in the long term, investments generally pay off well, and the benefits outweigh the costs for the large majority. Furthermore, the "slightly positive" short-term returns in the establishment phase generally turn, in the long term, to "highly positive" returns. Maintaining the technology after establishment is generally less costly. Box 4 gives an example of how costs and impacts are characterized in the case of the Accreted River Islands for Coastal Protection in Bangladesh (see under Oceans and Coasts, Section 3.2). In this particular case, short term returns are negative, because of the high costs of investment, but in the long term the picture changes and returns are very positive. Note that all of the socio-economic and ecological impacts are judged to be favourable.

Box 4: Costs and selected impacts of the Accreted River Islands for Coastal Protection, Bangladesh

Total establishment costs per hectare: 1420 USD
Annual maintenance costs per hectare: 320 USD

Socio-economic impacts

		1	2	3	4	5	6	7	
Wood production	decreased						✓		increased

Ecological impacts

		1	2	3	4	5	6	7	
Suface runoff	increased					✓			decreased
Evaporation	increased					✓			decreased
Soil cover	reduced					✓			improved
Soil loss	increased					✓			decreased
Soil accumulation	decreased					✓			increased
Soil organic matter/below ground C	decreased					✓			increased
Vegetation cover	decreased						✓		increased
Biomass/above ground C	decreased					✓			increased
Plant diversity	decreased						✓		increased
Beneficial species (predators, earthworms, pollinators)	decreased					✓			increased
Habitat diversity	decreased					✓			increased
Pest/disease control	decreased					✓			increased
Flood impacts	increased					✓			decreased

Benefits compared with establishment costs

		1	2	3	4	5	6	7	
Short-term returns	very negative		✓						very negative
Long-term returns	very negative							✓	very negative

Benefits compared with maintenance costs

		1	2	3	4	5	6	7	
Short-term returns	very negative		✓						very negative
Long-term returns	very negative							✓	very negative

Source: https://qcat.wocat.net/en/summary/4732/?as=html

Economic factors are key determinants of land users' decisions to adopt or reject SLM practices. It is evident that, on productive land, a wide range of existing SLM practices generate direct benefits not only for land users on-site, but off-site benefits mainly accruing to downstream stakeholders as well. High initial investment costs associated with some practices may, however, constitute a barrier to their adoption; short-term support for land users can help to promote these practices where appropriate. As is the case for all start up investments, the broader policy, financial and institutional context can either incentivize the shift to sustainable practices or, sometimes, inadvertently, the opposite. In order to make such investments, land users need to operate in an enabling environment under stable economic conditions as well as being assured of secure tenure and resource-use rights.[61]

4.3 Concerted Action

The UN Decade for Ecosystem Restoration is a call to everybody to help build a #GenerationRestoration. Each of us lives in one of the eight UNDER ecosystems, and makes direct use of one or more - and is dependent upon the services of all. We have a shared responsibility. UNDER proposes, in its strategy, ten "Actions".[62] These actions mirror WOCAT's experience and vision in bringing together SLM stakeholders in its global network, to jointly foster the uptake of SLM practices. Below, the UNDER's strategic actions are clustered and addressed with bullet points that highlight priorities.

A. STRENGTHENING ABILITIES

Empowering a global movement (Action 1), Build up capacity (Action 6) and Build up the next generation (Action 9)

Longevity: the UNDER lasts 10 years and this is an opportunity to create a movement that will last; opportunity to invest in building capacities that will endure; opportunity to involve the next generation and have them participate over a decade.

Building capacity: beyond the confines of a project or programme, investment in long-term capacity building is needed.

Children and youth: awareness raising and education needs to start at an early age (throughout education) so that the next generation grows up with a different understanding of their surroundings, of ecosystems, and the consequences of their own actions.

Create ownership: this ensures committed involvement of multiple stakeholders.

Make use of digitization: use innovative channels for #GenerationRestoration to "connect" through exploiting digitization and the social media.

Building up a #GenerationRestoration in Uganda: Launch of Junior Landcare.

B. STIMULATING ACTION

Set the right incentives (Action 3) and Shift behaviour (Action 5)

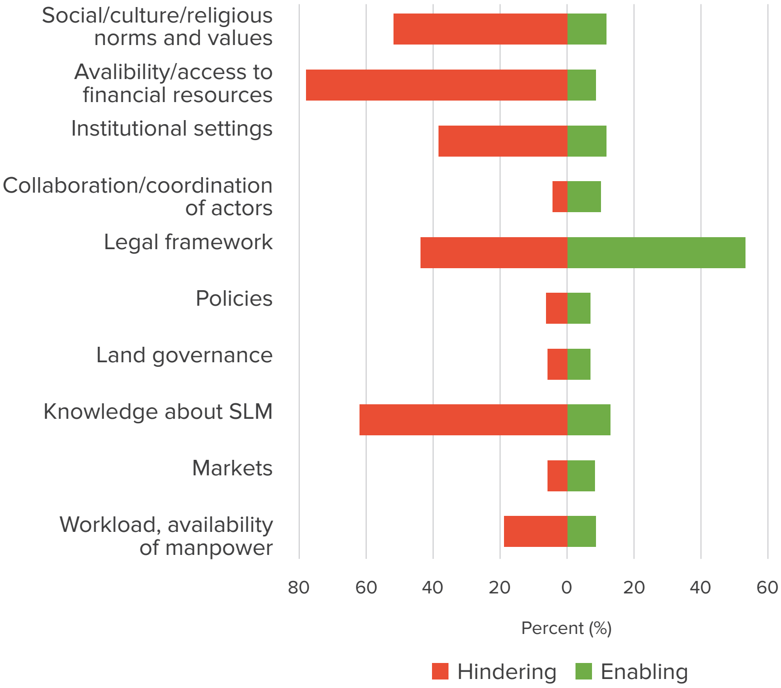
Create visible and felt benefits: people need to understand the opportunities for improving their livelihoods.

Better understanding of behaviour change: "knowing facts" is not enough; we need to be aware of the main factors that lead to behaviour shifts in different contexts.

Assessing enabling and hindering factors: which internal and external factors support behaviour change? Figure 14, derived from the Global SLM Database, sheds some light on this.

Knowledge transfer to land users on the use of an A-frame for establishing contour lines in Tonosí, Provincia de los Santos, Panama.

Figure 14: Analysis of "enabling" and "hindering" factors behind the implementation of SLM



Enabling and hindering conditions for the implementation of SLM show their relative importance over 233 examples. Lack of finance, knowledge and technical support strongly impeded action: these are serious constraints. On the other hand, an enabling legal framework was the top ranking enabling factor.

Source: Global SLM Database (https://qcat.wocat.net)

C. UNDERSTANDING POTENTIAL

Invest in research (Action 6) and Listen and learn (Action 10)

Understand and document good practices: the priority is first to establish, together, what works on the ground – there's no need to re-invent an already rolling wheel. This must then be taken into account to inform policy making.

Co-development of solutions: the key is cooperation between practitioners and researchers to jointly assess the current situation, and agree upon the best options for coordinated action.

Quantify the costs and benefits of restoration: guidance is needed, based on data, to inform choices for evidence-based action.

A group discussion between farmers, extension staff and researchers on the assessment of promising SLM practices in Cambodia.

D. CELEBRATING CHANGE

Celebrate leadership (Action 4) and Celebrate culture of restoration (Action 8)

Champions: they can make all the difference. Charismatic leaders in communities help to create/advance change. The first challenge is to identify them.

Create a movement/culture: people need to identify with a cause and form a culture of restoration.

Create long-term partnerships and alliances: this goes above and beyond projects and programmes with their limited lifespans.

Farmer innovation in Tajikistan: Iskandar Mirzoev and his son, showing how they graft different varieties of pears onto the same tree to investigate which responds better to a changing climate.

E. REMOVING CONSTRAINTS

Finance for restoration on-the-ground (Action 2)

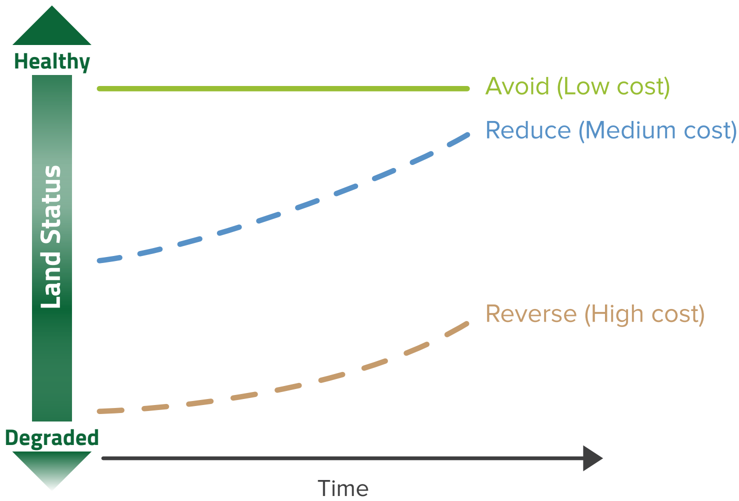
Address finance as a main hindering factor: Figure 14 has shown how important it is to help people help themselves – grants or other incentives are essential to oil the wheels of ecosystem restoration.

Recognise that costs for action differ: It is much cheaper and makes economic sense to focus on avoiding degradation (Box 5). But reduction and restoration are important too: the context determines the priority.

Move beyond project/programme funding: just as long-term partnerships are paramount, so too is long-term funding provision. Only some ecosystem restoration – especially that on directly productive land - pays back quickly.

Construction of a demonstration site for an integrated rice-fish system in Dakchung Province supported through a small grant – collaboration between the National Agriculture and Forestry Research Institute (NAFRI), extension staff and villagers in the South of Lao PDR.

Box 5: Land Degradation and Ecosystem Restoration: Costs of Action



This conceptualisation shows how the cost of avoiding land degradation while the status of the land is still healthy is low compared with the process of reducing degradation. Reversing land degradation is more expensive yet – and takes much longer. The same graph can equally be interpreted as a proxy, in simple and generalised terms, for the costs of ecosystem restoration.

Source: adapted from Linger et al, 2019[63]

F. EMBRACING GENDER

Implicit in UNDER is a gender dimension.

Not all land users are able to adopt, or benefit from, SLM practices equally. Lack of resources is one constraint, limited knowledge or information is another. But gender, too, can be a barrier. Women face various obstacles to restoring their land. For instance, women have the same legal rights as men to own and access land in only 28 countries. Fewer than 20 per cent of land holders worldwide are women. Women constitute only 13 per cent of those making major decisions on farmland. And of 143 economies, 90 per cent have at least one law restricting economic equality for women.[64]

Drip irrigation supporting cauliflower production using water from a soil cement pond, Nepal

Yet their potential importance in ecosystem restoration is enormous. In many poor countries, more than 95 per cent of economically active women work in agriculture. About 70 per cent of rural women in South Asia and more than 60 per cent in Africa are farmers. Women in developing regions affected by desertification, land degradation and drought produce 60–80 per cent of the food. Moreover, women hold essential indigenous knowledge – vital in food production - yet far fewer women than men benefit from technologies developed from this knowledge.[65]

In the Solomon Islands, Apollonia, an innovative farmer, grows watercress for the local market. She ensures that the stream water remains clear and clean for optimal production.

All over the world, in one way or another, gender has an influence on activities, decision making, distribution of benefits, access to resources, and support through capacity building. In addition, complex local norms and cultural conventions make it difficult for women to obtain the same opportunities as men in implementing restoration practices.

Apart from gender equality being a goal in its own right, this is exactly where there is hidden potential to decrease land degradation, achieve LDN and accelerate ecosystem restoration. Closing these gender gaps could create 240 million jobs by 2025 and add US$ 28 trillion (26 per cent) to annual global growth (GDP).[66] Furthermore, overlooking women in restoration initiatives simply means that the priorities and knowledge of half of the population is ignored.[67] As highlighted by the UNCCD's Gender Action Plan, it is important to remember two key points about women and restoration:[68]

- Interventions do not increase women's burden. They decrease it.
- Women not only contribute to, but also benefit from, the interventions.

According to the Global SLM Database, women feature most prominently in practices that (i) improve ground or vegetation cover, (ii) integrate soil fertility as well as pest and disease management, (iii) involve agroforestry and home gardens and (iv) improve energy efficiency (examples in Box 6). These favoured practices – basically seeking to secure fertility, food and energy around the home - provide a clue towards how gender-sensitive ecosystem restoration initiatives can be focused.

Successful restoration relies on the women and men who in turn depend on the landscapes for their livelihoods – and whose rights and well-being must be safeguarded and promoted for restoration to be sustainable and just. Gender-blind restoration efforts are likely to reinforce or even exacerbate pre-existing inequalities.

Box 6: Women taking the lead in SLM practices: examples from the Global SLM Database

Sri Lanka: Individual and contour platforms are established in home gardens to cultivate vanilla as a cash crop and to help control soil erosion. Female farmers have formed their own Vanilla Growers Association and organized training programmes.

https://qcat.wocat.net/en/summary/5757/?as=html
https://qcat.wocat.net/en/summary/5177/?as=html

Ecuador: Family gardens, generally managed by the women of the household, are small spaces where short-cycle vegetables and legumes are grown, in some cases combined with coffee, bananas and fruits. These gardens improve food security through production for family consumption, and yield some income through helping to meet the demand in local markets.

https://qcat.wocat.net/en/summary/3273/?as=html

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5. CONCLUSIONS

Multiple proven sustainable land management practices have been documented and are currently being used in ecosystem restoration. The Global SLM Database, established under WOCAT, describes in standardized and consistent detail more than 2000 SLM practices from over 130 countries. It is continuously growing. The database acts as a toolbox of good practices – ready to be more widely deployed - under a family of closely related ecosystem restoration methodologies, including the "ecosystem approach", "ecosystem-based disaster risk reduction", "ecosystem-based adaptation" and "nature-based solutions". This database is unique and remains the key global source of SLM documentation. It is officially recognized by the UNCCD.

Because ecosystems are, to one extent or another, both cross-cutting and interconnected, SLM applied in one ecosystem has various impacts on others. For example, terracing of crops on mountainsides has a local effect, but an impact also on freshwater flows, in turn influencing grasslands and even the ocean and coast. There are multiple other specific links: peatlands affecting, and being impacted by, freshwater systems; urban areas vulnerable to land degradation on nearby mountains; farmlands benefiting from healthy adjacent forests. Rather than visualizing ecosystems as individual icons representing separate distinct units, a jigsaw may be more appropriate - demonstrating how each is locked into others.

All of the ecosystems have their unique characteristics and needs in terms of SLM. **Farmlands** stand out as a “constructed” ecosystem: their main land use has been fashioned by humankind over the millennia for a particular purpose. They are particularly vulnerable to degradation but equally responsive to myriad SLM practices that improve production. **Grasslands** have also been modified by people and their livestock, and are evolving still: but appropriate SLM is developing in parallel. **Forest** ecosystems may appear to be simple, but forests vary enormously. So do the rates of degradation and the consequences. A reoccurring theme here is potential: for agroforestry, for community management, and protection in specific zones.

“Mountainscape” is a term that sums up the amalgam of land uses in **Mountains**, but also their physiographic and socio-economic characteristics: fortunately, most appropriate SLM remedies can be borrowed from other ecosystems. **Freshwaters** too are improved though multiple, versatile, SLM practices, especially within their catchments. But there are also technologies specific to water bodies. Much the same can be said for **Oceans and Coasts** – where various familiar SLM practices are valuable inland, and made-to-measure interventions can support mangroves and seagrass beds. The “ridge to reef” approach perhaps best epitomizes the importance of acknowledging and addressing ecosystem connectivity.

Peatlands may be the most uniform of the ecosystems, but despite their paramount carbon storage and hydrological significance, they are often ignored and commonly misunderstood. Nevertheless, the answers are relatively simple: “keep peat wet” is the primary message. **Urban areas** comprise a new focus for SLM. With only a tiny proportion of the world’s land surface, they are home to more than half the global population. However, there are many elements that are shared with the natural ecosystems – dominant land use, a particular hydrological regime, and unique biodiversity. Ecosystem degradation is clearly occurring, yet there are many transferable SLM technologies.

Sustainable land management has been demonstrated to play a central role in restoration of all the UNDER ecosystems, through combatting land degradation at both local and landscape level. When effectively implemented, it simultaneously generates multiple environmental co-benefits. On farmlands and grasslands in particular, effective SLM also raises and stabilizes yields of crops and livestock, and thus directly benefits livelihoods. It is the vital link that connects production with restoration.

It is self-evident that SLM can only have a significant impact on ecosystem restoration when it expands over a substantial area. Scaling-out of SLM to ecosystem level requires mainstreaming. This means decision makers at different levels must acknowledge its importance, by working to align social, economic and environmental policies to create an enabling environment for SLM, ensuring land tenure rights are secure, and helping in awareness raising and promotion. Another important barrier that must be overcome is finance. Thus, the judicious use of incentives can help land users overcome the start-up costs of shifting to SLM, and this may be coupled with accessible financing mechanisms designed to trigger and sustain action. The UNDER strategy provides support to #GenerationRestoration: guiding all those actors who are involved, including women and men, the young and the old, who together play the crucial role of bringing SLM to scale.


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About UNCCD

The United Nations Convention to Combat Desertification (UNCCD) is an international agreement on good land stewardship. Through partnerships, the Convention's 197 Parties set up robust systems to manage land degradation and drought promptly and effectively. Good land stewardship based on a sound policy and science helps integrate and accelerate the achievement of the Sustainable Development Goals, builds resilience to climate change and prevents biodiversity loss. Land also plays a key role in the prevention, preparedness, response, and recovery phases of the COVID-19 pandemic, securing rural livelihoods and creating green jobs, supporting community resilience and maintaining the sustainable delivery of ecosystem services.

www.unccd.int

About WOCAT

WOCAT is the global network for Sustainable Land Management (SLM) and hosts the Global Database on SLM Practices in partnership with the United Nations Convention to Combat Desertification (UNCCD). Over the past 28 years, WOCAT and its partners have developed a set of standardized tools and methods for SLM knowledge management and decision support. These are now used in over 50 countries around the globe. The availability of standardized data facilitates comparative analysis across projects, programmes and countries. WOCAT provides a robust basis for evidence-based decision-making in SLM mainstreaming and scaling out to improve production, attain land degradation neutrality, increase climate resilience and help in ecosystem restoration.

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