UN environment
United Nations Environment Programme

International Resource Panel

United Nations Convention to Combat Desertification

Land Restoration for Achieving the Sustainable Development Goals

An International Resource Panel Think Piece

Sustainable Development Goals

About the International Resource Panel

The International Resource Panel (IRP), a global scientific panel hosted by the United Nations Environment Programme, was created in 2007 to contribute to a better understanding of sustainable development from a natural resources perspective. It provides science-based policy options on how to decouple economic growth from environmental degradation while enhancing human well-being. With more than 20 scientific publications, the work of the panel has shed light on growing environmental challenges related to natural resources, their socio-economic implications and potential new pathways towards their sustainable management.

What is an IRP think piece?

An IRP think piece is a technical or policy paper based on IRP scientific studies and assessments and other relevant literature. It is not a full study and assessment but a collection of science-based reflections, which may catalyze the generation of new scientific knowledge and highlight critical topics to be considered in policy discourse.

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Land Restoration for Achieving the Sustainable Development Goals

AN INTERNATIONAL RESOURCE PANEL THINK PIECE

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Acronyms

ACS	Advanced cook stove
AFR100	African Forest Landscape Restoration Initiative
CCS	Carbon capture and storage
FAO	Food and Agriculture Organization
FLR	Forest Landscape Restoration
GDP	Gross domestic product
GEF	Global Environment Facility
GOM	Government of Malawi
HLPF	High Level Political Forum on Sustainable Development
ICSU	International Council for Science
ICT	Information and communication technologies
IEA	International Energy Agency
ILM	Integrated landscape management
INBAR	International Bamboo and Rattan Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	International Panel on Climate Change
IRENA	International Renewable Energy Agency
IRP	International Resource Panel
IUCN	The International Union for Conservation of Nature
IWRMP	Integrated Water Resources Management Plans
LDN	Land degradation neutrality
LRP	Land restoration program
MBI	Market based instruments
MINERENA	Ministry of National Resources of Rwanda
NGO	Non-government Organization
NRT	Northern Rangelands Trust
PES	Payments for ecosystems services
REDD+	Reducing Emissions from Deforestation and Degradation in Developing Countries
RDP	Reconstruction and Development Programme
ROAM	Restoration Opportunities Assessment Methodology
ROI	Return on investment
RSPO	Roundtable on Sustainable Palm Oil
SANBI	South African Biodiversity Institute
SDG	Sustainable Development Goals
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
URAD	Recovery Units of Degraded Areas and Reduction of Climate Vulnerability
WHO	World Health Organization
WOCAT	World Overview of Conservation Approaches and Technologies
WRI	World Resources Institute

About this think piece

This think piece from the International Resource Panel (IRP) was developed based on IRP scientific studies and assessments including “Unlocking the Sustainable Potential of Land Resources: Evaluation Systems, Strategies and Tools” and other relevant literature. It provides science-based reflections to policymakers, academics and practitioners highlighting the strategic importance of land restoration efforts for the achievement of every single sustainable development goal included in the 2030 Agenda for Sustainable Development. It was prepared under the leadership of Jeffrey Herrick with Tanya Abrahamse (members of the International Resource Panel), Hala Razian (UNEP) and the support of Maria Jose Baptista (UNEP), Simone Retif (UNEP), Moira O’Brien-Malone (UNEP) and written inputs from 27 chapter authors and co-authors listed on the acknowledgements page of this document. Chapter authors responded to an open call from the International Resource Panel to ensure a diverse and interdisciplinary perspective, a first of its kind on this topic.

The final document also benefited significantly from the suggestions of three independent reviewers, and comments from both the UNCCD and UNEP staff.

1

Introduction: Land restoration and the SDGs — the art of the possible

> "Decoupling of resource use and environmental impacts from economic growth and human well-being is a key strategy that can support the achievement of the Sustainable Development Goals ... Achieving decoupling is possible and can deliver net positive gains environmentally, socially, and economically."
>
> — Global Resources Outlook 2019:
> Natural Resources for the Future We Want (International Resource Panel [IRP] 2019; referred to as the GRO report)..

The International Resource Panel's GRO report provides a unique framework for focusing both local and global investments in the SDGs on those activities that promote "improved resource productivity and a relative decoupling of well-being [e.g. SDGs 1-7] from resource use". The "Sustainability Scenario" (IRP 2019), used by the GRO report to support its conclusion that decoupling is possible, is based in part on assumptions about global shifts in population growth and consumption patterns. But it also relies on the potential for significant increases in resource-use efficiency (see *https://www.resourcepanel.org/glossary* for definitions of "decoupling" and related terms).

Matters relating to land are complex and varied, and can be viewed from an array of perspectives including: political, social, economic, productivity, legal, historical, identity, religious and spiritual. These perspectives relate to power, conquest, colonialism, alienation and patriarchy, and include ownership and communal systems, extraction and other user rights and stewardship. Some of the most influential writers, artists and philosophers have written about land over the millennia (box 1.1).

Box 1.1

"I think nobody owns the land until their dead are in it"
— Joan Didion

"What greater grief than the loss of one's native land"
— Euripides

"Awaking on Friday morning, June 20, 1913, the South African native found himself, not actually a slave, but a pariah in the land of his birth." — Sol T Plaatje

"We abuse land because we regard it as a commodity belonging to us". — Aldo Leopold

"This land is your land, this land is my land"
— Woody Guthrie

In this think piece, we recognize that land is one of Earth's most important and limiting resources, that its inefficient and inappropriate use continues to result in degradation, and that degradation does and will have dire consequences on human well-being and the earth systems we depend on. Rather than dwelling on the problem, however, we explore solutions: opportunities to exponentially change the way we engage with this most fundamental resource. The report is driven by the authors' explorations of the inextricable links between land stewardship through restoration and rehabilitation and almost all the Sustainable Development Goals (SDGs) (figure 1.1). It is also consistent with and supports many of the messages included in the United Nations Convention to Combat Desertification (UNCCD) publication, "A natural fix: A joined-up approach delivering the global goals for sustainable development", which focuses explicitly on land degradation neutrality (SDG target 15.3. UNCCD 2016).

We emphasize the importance of both restoration and rehabilitation, and where the term "restoration" is used alone, both are implied. We do not want to draw a philosophical line in the sand, but to make sure we engage with the reality on the ground, which is that we cannot turn back the clock on some of the most degraded land. Restoring degraded land is often more of an inspirational or aspirational concept. In many cases, reverting land to an absolute pristine state is not feasible due to the high diversity of species in nature (including plants, animals and microbes), some of which become extinct during the period of land degradation. In other cases, modification of one or more factors (e.g. climate, slope or soil depth) that determine the land's long-term potential may limit restoration (UNEP International Resource Panel 2016). However, rehabilitation towards restoration aimed at igniting the ability of land to deliver on its ecological services in a sustainable way for human well-being is possible, and there are many such initiatives worldwide.

Figure 1.1. The 17 Sustainable Development Goals. A history of SDG development is *here*

This approach is consistent with the "Scientific Conceptual Framework for Land Degradation Neutrality" published by the UNCCD Science-Policy Interface (Orr et al. 2017; Cowie et al. 2018), which applies definitions established by the Society for Ecological Restoration (McDonald et al. 2016): "Restoration seeks to re-establish the pre-existing biotic integrity, in terms of species composition and community structure, while rehabilitation aims to reinstate ecosystem functionality with a focus on provision of goods and services rather than restoration" (McDonald et al. 2016). "The preferable option in each circumstance depends on the land potential, its land use history, its baseline condition, its potential uses and associated values, and likely impacts of climate change and other shocks and stressors" (Cowie et al. 2018).

The adoption of the SDGs by the United Nations General Assembly on 25 September 2015 has stimulated renewed interest in land restoration and rehabilitation, particularly as a strategy to help achieve SDG 15, "Life on Land" and SDG target 15.3, "Land Degradation Neutrality", both of which have become the focus of much of UNCCD's work.

There are a number of initiatives designed to promote land restoration and rehabilitation, including *Initiative 20x20 for Latin America and the Caribbean*, the *African Forest Landscape Restoration Initiative (AFR100)*, the World Resource Institute's *Global Restoration Initiative*, and the UNCCDs Land Degradation Neutrality fund (*LDN Fund*), an "impact investment fund for land degradation neutrality". A number of other initiatives, while focusing more exclusively on achieving climate change mitigation (SDG 13) through soil carbon sequestration, have a strong focus on sustainable land management, including both restoration and rehabilitation. These include but are by no means limited to *4/1000*, and NGOs such as "*Justdiggit*", which explicitly touts its support for SDGs 1, 2, 5, 6, 8, 15 and 17, in addition to SDG 13 (Climate Action).

These efforts have been guided in part by a number of reports and reviews that have addressed potential benefits of land restoration and rehabilitation to restore ecological function and align these efforts to SDGs other than just SDG 15. The recent Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report "*Land Degradation and Restoration*" shows that at least two-fifths of humanity is impacted negatively by land degradation, and that it is both the driver for biodiversity loss and responsible for intensifying climate change and its impacts, contributing to mass human migration and increased conflict (IPBES 2018). The UNCCD's *"Scientific Conceptual Framework for Land Degradation"* (Orr et al. 2017; Cowie et al. 2018) provides a particularly useful, *peer-reviewed* guide for achieving

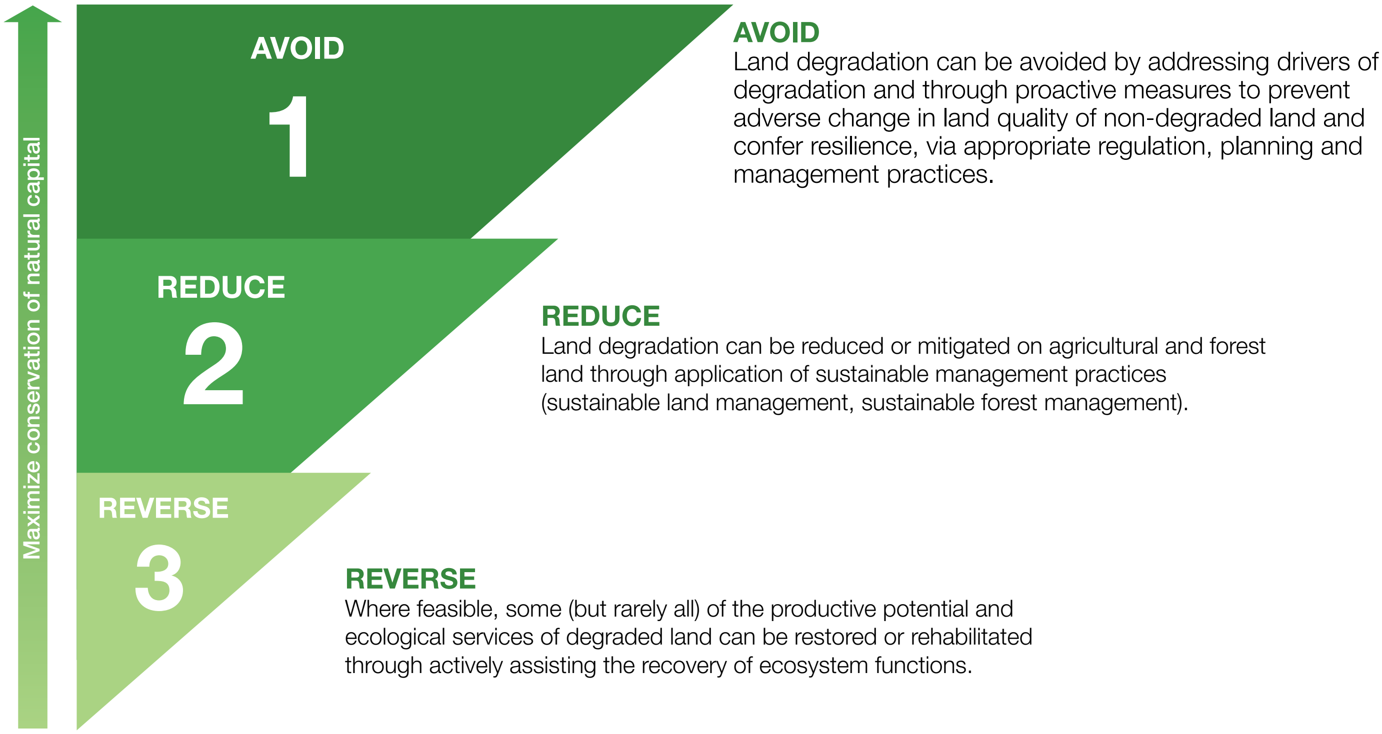

Figure 1.2. The response hierarchy that promotes avoidance over reduction and ultimately reversal (restoration and rehabilitation) of land degradation (from Orr et al. 2017; Cowie et al. 2018).

land degradation neutrality. It includes a response hierarchy that promotes avoidance over reduction and ultimately reversal (restoration and rehabilitation) of land degradation (figure 1.2). This hierarchy is widely accepted among scientists and practitioners. However, it is important to recognize that it may not always be appropriate due the lack of undegraded land, or where the return on investment in reversal (restoration) or reduction is higher than for degradation avoidance.

The aim of this report is to broaden understanding, explore and bring to the fore the links between land restoration and all SDGs, and whenever possible identify knowledge gaps and research needs. In addition, we recognize that the perception of land is complex and varied, and so have purposely sought input from scientists and thinkers in all parts of the world. Here we attempt to explore the potential co-benefits, risks and trade-offs with all SDGs (chapters 3.1 to 3.17) with an international team of authors selected to ensure that developed and developing country perspectives are represented in each chapter. The report begins with a chapter (2) that complements this highly diverse set of perspectives on the individual Goals with a figure designed to stimulate debate through the presentation of an assessment of possible SDG co-benefits. This chapter also explores cross-cutting opportunities through an initial consideration of how emphasizing the co-benefits for one SDG may affect others when planning investments in land restoration and rehabilitation. It builds on the International Science Council's report, A Guide to SDG Interactions: from Science to Implementation (ICSU 2017). The think piece ends with a chapter that explores additional benefits of taking a landscape approach to restoration to help achieve multiple SDGs (chapter 4). It concludes with a brief summary and reflection on the potential value of completing scenario analyses of the type presented in the IRP GRO report that would allow the synergies and trade-offs identified here to be more explicitly quantified.

Finally, we note that this document is inherently aspirational. We have attempted to identify "possible risks, trade-offs and costs of land restoration" in each of the SDG-specific chapters (3.1 to 3.17). We also acknowledge that reaping the benefits will be challenging at best, and in some cases impossible. We hope, however, that the vision and examples will provide inspiration and ideas for leveraging the tremendous opportunities for using land restoration to help achieve each of the SDGs.

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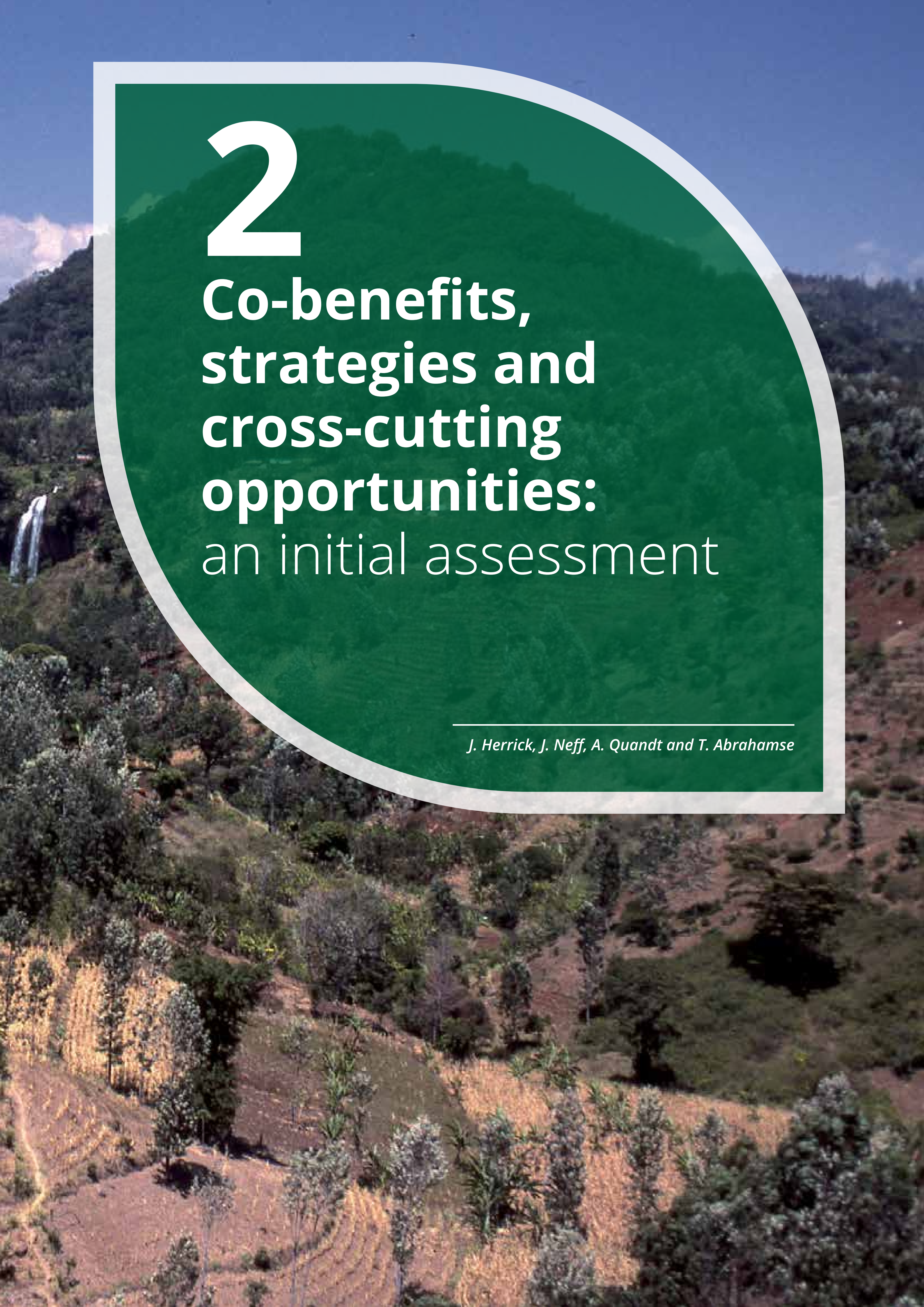

2

Co-benefits, strategies and cross-cutting opportunities: an initial assessment

J. Herrick, J. Neff, A. Quandt and T. Abrahamse

Introduction

In 1938, with war closing in on his adopted home in Europe and soon to engulf much of Asia and parts of Africa, the author Louis Bromfield returned to restore the degraded farm, forest and pas-tureland of his youth in the United States. In 1943, he published Peaceful Valley, a book that addresses many of the co-benefits of land restoration for what would, 72 years later, be articulated as the United Nation's Sustainable Development Goals (SDGs). As the book was published during a period of global conflict, he clearly identified the critical importance of soil for both personal and national security (SDGs 1 and 16):

"There was first of all the soil itself which was the foundation of our own well-being and security, as it was of that of the whole nation…Much of [the soil] was already gone, washed off our hills… The pasture was poor and scrubby and the cattle and sheep got little or no nourishment from it, and in their hunger they had eaten off the young seedlings year after year until there was no new crop of trees coming on to supply the farmer and the nation with timber" (54-55).

He emphasized the connection between farm- and pasture-land restoration and human health (SDG 3).

"We knew, too that poor, worn-out land made not only poor crops and scrubby cattle; it made poor, underdeveloped and malnourished people as well…'Poor land makes poor people' is a saying every American should have printed and hung over his bed" (54-55).

He recognized the connection between land degradation, poverty, and human migration (SDG 1):

"We knew that the greater part of our migratory population in America – one of our most serious economic and social problems – came either from worn-out land or from land that had been converted into factories in the fields" (60).

He recognized the importance of education as he sought to recruit a manager who both was educated and had the ability to learn from his work (SDG 4), though his use of the word "him" reflected common mid-20th century gender roles in the US:

"A good farmer in our times has to know more about more things than a man in any other profession" (51).

He was keenly aware of potential trade-offs as he considered how his decisions about how to restore the land, and manage it in the future, would affect the people he employed and the surrounding communities.

"We sought a way to operate a big farm without dispossessing families…We sought a way of raising the standard of living of all of us on that farm" (60-61).

On March 1 2019, over 75 years after the publication of Peaceful Valley, the United Nations General Assembly declared that 2021 to 2030 would be the United Nations Decade on Ecosystem Restoration, "with the aim of supporting and scaling up efforts to prevent, halt, and reverse the degradation of ecosystems worldwide and raise awareness of the importance of successful ecosystem restoration" (Lebada 2019). The declaration states that the Decade is to be pursued "within existing structures and available resources". While the declaration is referring to the resources necessary to promote the Decade, the reality is that resource limitations will always require a demonstration of the co-benefits for other international goals in order to justify leveraging "existing structures and available resources".

Consistent with both this idea and Bromfield's early vision, this chapter explores the potential co-benefits of both (a) the process of land restoration and rehabilitation, and (b) the restored or rehabilitated land itself for each of the SDGs. The co-benefits of land restoration and rehabilitation are the benefits that accrue to society in addition to the direct positive impacts of land restoration (IPBES 2018a). Examples of co-benefits include improved rural economies, reductions in human migration pressure, and reduced conversion pressure on native landscapes.

The chapter includes the results of an expert survey evaluating the relative extent to which land restoration could provide co-benefits for each of the SDGs, followed by a more general discussion of four strategies for ensuring that land restoration provides co-benefits for multiple SDGs. It focuses on the first strategy: completing holistic and systematic analyses to identify potential synergies and trade-offs between restoration and the SDGs. Consistent with the other chapters in this report, references to restoration include a broad range of outcomes, including those often defined as "rehabilitation" (see chapter 1; McDonald et al. 2016; Orr et al. 2017; Cowie et al. 2018).

EXPERT SURVEY

The results of an expert review of these co-benefits are summarized in the tables below (figure 2.1). They show the predicted relative magnitude of the benefit of land restoration for SDGs 1 to 14 and 16. SDG 15 was omitted as restoration is explicitly addressed in the SDG, and 17 was not included as it focuses on the means of implementation for the other SDGs.

The table is based on a consultation involving the authors of this report, with a total of 26 responses. The authors were asked to separately consider the co-benefits of the restoration process and the resulting restored or rehabilitated land, responding to the question: "To what extent are investments in either the process of restoring or rehabilitating degraded land or the resulting restored or rehabilitated land likely to have co-benefits for each SDG?". This distinguishes it from a similar analysis in the recent IPBES report (IPBES 2018a), and a brief consideration of the positive, neutral, and negative interactions between SDG 2 and SDG 15 in the International Council for Science (ICSU 2017) report, A guide to SDG interactions: from science to implementation (Nilsson et al. 2017). Both the IPBES and ICSU report based their analyses on responses for each target while we asked authors to collectively consider all targets for each SDG.

The median rating was "medium" or higher for all but two of the SDGs (7 and 14) for the restoration process, and for all of the SDGs for the restored land itself. The co-benefits of restored land were also perceived to be "high" or "very high" by at least half of the respondents for six of the SDGs, while the process received a "high" or "very high" rating for just two. The fact that the co-benefits were perceived to be greater for the restored land than for the process of restoration has important implications for how and when these co-benefits are reaped, and how they will be distributed among different populations and generations.

Another important conclusion of this survey is that there is very large variability in experts' understanding of the relative co-benefits of the SDGs. While some of this variability can be attributed to different interpretations of the terms (e.g. "high", "medium") we believe that it also reflects the number and complexity of factors that determine whether co-benefits will be reaped. This is an argument for both further research in this area and very careful consideration and analysis in the design phase for individual projects.

Strategies for ensuring that land restoration provides co-benefits for multiple SDGs

Chapters 3.1 to 3.16 explore potential co-benefits for each SDG in detail. Example targets that may be addressed through the restoration process and the availability of restored land are included at the beginning of each chapter. There are two general conclusions that can be drawn from these tables. The first is that land restoration has the potential to advance an incredibly wide variety of social, economic, and environmental objectives. This is reflected in the fact the authors were able to identify targets for each of the first 16 SDGs that could benefit from land restoration. Second, for most targets we found potential benefits of both the process of restoring the land, and the restored land itself.

Building on the diverse insights articulated by the many contributors to this report, we have identified four strategies that can be used to maximize the identification and leveraging of cross-cutting opportunities involving land restoration or rehabilitation and multiple SDGs. This is based on the "premise that a science-informed analysis of interactions across SDG domains – which is currently lacking – can support more coherent and effective decision-making, and better facilitate follow-up and monitoring of progress" and that "understanding possible trade-offs as well as synergistic relations between the different SDGs is crucial for achieving long-lasting sustainable development outcomes" (ICSU 2017).

The four strategies are: (1) complete holistic and systematic analyses to identify potential synergies and trade-offs, (2) apply a landscape approach to planning and implementation – especially for landscapes with variable land potential, (3) develop targeted solutions, and (4) invest in areas where persistence is likely.

Each of the four strategies must be considered and applied differently at different scales, in addition to considering the diverse social, economic, environmental, cultural and educational contexts. Analyses (strategy 1) completed at the village or watershed level typically have a much more clearly defined group of stakeholders than those completed at the regional or national level. However, these analyses covering smaller areas must struggle with boundaries, particularly when considering the benefits of restoration (see discussion under strategy 2). Conversely, analyses completed at the regional or national level must take care not to overgeneralize to the point that they result in unintended consequences at the local level. This challenge is addressed in part by strategy 3, which explicitly requires the consideration of local contexts in order to target

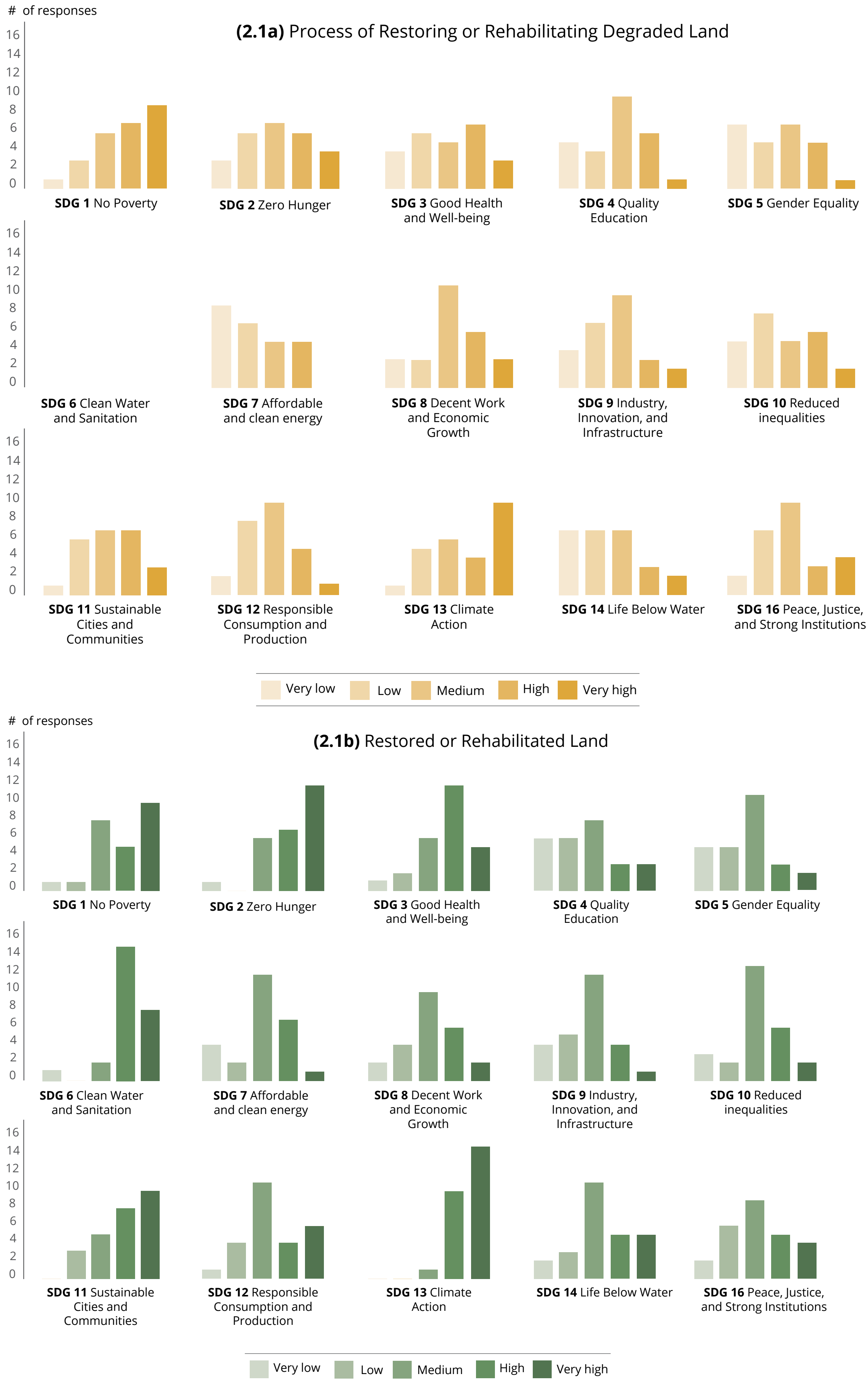

Figure 2.1. Expert responses to the question, "To what extent are investments in either (a) the process of restoring or rehabilitating degraded land or (b) the resulting restored or rehabilitated land likely to have co-benefits for each SDG?"

solutions to where they are likely to have the greatest impact, and strategy 4, which emphasizes the importance of the factors that determine the persistence of restoration investments.

Strategy #1
Complete holistic and systematic analyses to identify potential synergies and trade-offs.

These analyses should occur as early on as possible in the planning process, ideally before any resources are committed. This allows the project design to be optimized to leverage the cross-cutting synergies. It can also lead to the identification of other projects that may have the potential for even higher returns on investment than the one initially proposed.

An early and thorough systematic analysis also enables unintended consequences and trade-offs to be minimized or avoided. In particular, any restoration project that directly or indirectly results in changes to the value, ownership, or control over the use of the land can have wide-ranging impacts on many of the SDGs. These changes can be inadvertently precipitated even by even a seemingly simple project requirement of written documentation of land tenure, which could lead to a re-evaluation of existing, unwritten rules or customs regarding land use.

At a minimum, the systematic analysis should include the following four steps. Wherever possible these steps should be completed using a participatory process engaging both diverse stakeholders and experts. A diversity of perspectives is particularly important at the early "discovery" phase to ensure that all potential co-benefits and trade-offs are included in the analysis. They should also be completed in a landscape (chapter 4) and, to the extent possible, consider the full range of impact, from plot and household to global scales.

Step 1 — Identify the SDG targets that are likely to be directly affected by the activity, either positively or negatively. The highlighted targets listed in figure 2.1 and chapters 3.1 to 3.16 can be used as a starting point. While both focus on positive co-benefits, by identifying potential impact areas they can also be used to determine where further investigation is likely necessary.

Step 2 — Identify the potential indirect co-benefits and trade-offs. For example, increased education (SDG 4) often results in improvements in sanitation (SDG 6). Creating a flowchart or mind map may help with this step.

Step 3 — Describe how these impacts will be generated. This is particularly important when it is possible to achieve a restoration or rehabilitation objective with or without a resulting co-benefit. For example, a monoculture planting may achieve a soil restoration objective (target 15.3) and provide co-benefits for the climate (target 13.3) by improving climate change mitigation capacity through carbon sequestration, but fail to address biodiversity conservation (target 15.5).

Step 4 — Where data are available, the direct (step 1) and indirect (step 3) impacts, both positive and negative, should be quantified. This enables objective comparisons of the total return on investment (ROI) across different land restoration and rehabilitation options, taking into account the benefits for land degradation neutrality (target 15.3) together with the co-benefits and trade-offs for other goals and targets.

EXAMPLE

The following example (figure 2.2) illustrates how this process can equally be applied to issues that are not explicitly addressed by the SDGs, such as human migration. The example describes how a potential sustainable land management or land restoration project, designed to maintain or improve water infiltration and reduce run-off, may affect human migration patterns. It focuses on drylands and seasonally dry regions of the world. This includes many areas in Africa, Mexico and Central America that are experiencing some of the highest rates of human migration. Figure 2.2 shows how land degradation resulting in reduced water infiltration contributes to migration out of an area, while land restoration can potentially facilitate reverse migration. These relationships will be further explored in an upcoming IRP report.

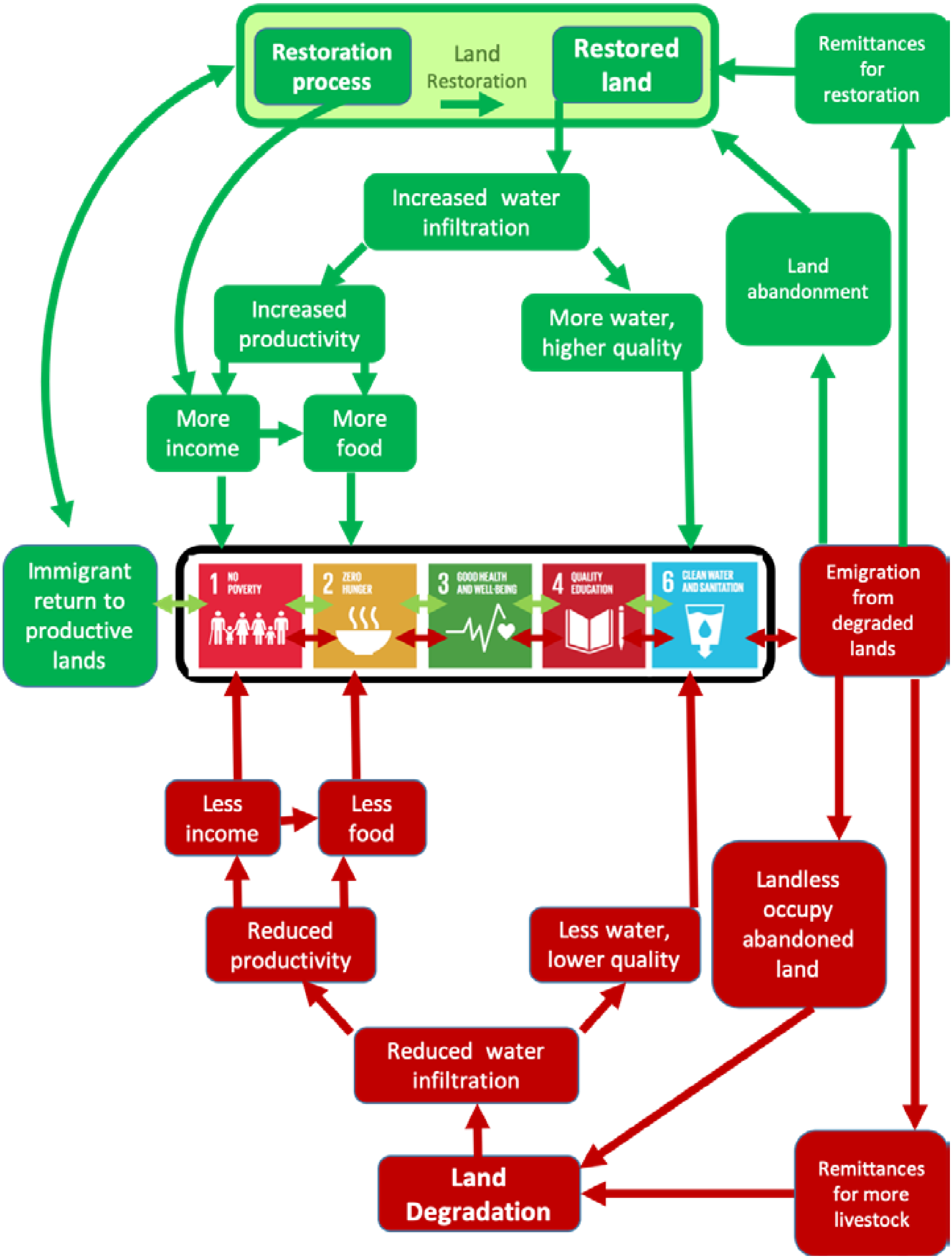

Figure 2.2. Impacts of land degradation (red, below, negative impacts) and restoration (green, above, positive impacts) on human migration through the synergistic effects of resulting changes in soil water infiltration on five of the SDGs.

EXAMPLE STEP 1

For simplicity, we have identified just five SDGs for which direct effects are likely to be significant.

Poverty (SDG 1 – Chapter 3.1) is addressed directly by investments in the restoration process, providing income (targets 1.1 and 1.2). The restored land can also reduce the exposure of poor and vulnerable populations to "exposure and vulnerability to climate-related extreme events" (target 1.5), as increased infiltration during extreme events ensures that soil water will be available to crops during subsequent dry periods, while the corresponding reduced run-off reduces flooding of urban areas.

Hunger (SDG 2 – Chapter 3.2) is directly addressed for subsistence farmers and pastoralists, while others also benefit from a larger and more stable food supply (target 2.1), increasing productivity (target 2.2) as more water is available for crop production. The restoration or rehabilitation process can also be designed to include "sustainable food production systems and implement resilient agricultural practices" (target 2.4).

Good health and well-being (SDG 3 – Chapter 3.3) benefits from improved nutrition, depending on the type of crop. This is particularly important for targets 3.1, 3.2 and 3.4. Improved air quality resulting from reduced wind erosion from restored lands also has health benefits. Mental health and well-being (target 3.4) can also benefit from activities and income generation associated with the restoration process, and from a resulting greener, more diverse environment.

Quality education (SDG 4 – Chapter 3.4) can be increased by the restoration process, as both students (target 4.1) and adults (targets 4.3 and 4.4) learn new skills. Innovative management practices are often taught, and math and reading skills (target 4.6) can be promoted in a practical context. Technology is increasingly used to both plan and monitor restoration projects (e.g. Kimiti et al. 2017), providing additional educational opportunities.

Finally, clean water and sanitation (SDG 6 – Chapter 3.6) benefit directly. Water that soaks into the soil can recharge groundwater reserves, while lower run-off reduces the risk of flooding and the corresponding overloading of stormwater and sewer systems. Target 6.6 explicitly states "protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes".

EXAMPLE STEP 2

Synergies emerging from improvements in these five SDGs alone are likely to be significant, as there are clear synergies among all of them. One example is the cascading benefits of clean water and sanitation (SDG 6), which support good health (SDG 3) through reduced disease. A healthier population can work more consistently, providing more income (SDG 1) for food (SDG 2). Similarly, healthy students are able to better focus on their education (SDG 4). In addition to health benefits, access to safe and reliable water supplies has also been shown to reduce poverty by freeing up time for other activities (e.g. Larson et al. 2006).

The analysis of synergies must also include risks and trade-offs, both among the SDGs and relative to other desired outcomes. For human migration, this includes both the positive and sometimes negative impacts of remittances, such as where they are used to invest in livestock beyond the land's carrying capacity (figure 2.3).

EXAMPLE STEP 3

A brief explanation of how improved soil hydrology is related to each of the SDGs is included in step 1 above (figure 2.2). A technical understanding of how the potential for restoration to improve hydrology varies spatially, is necessary to predict the extent to which these co-benefits may (or may not) be realized. This technical analysis is often omitted in favour of anecdotal "success" stories. Universal extrapolation of these success stories without an understanding of land potential results in wasted resources and missed opportunities at best, and increased degradation at worst (UNEP 2016; Showers 2005). We have included box 2.1 to illustrate the importance of this type of analysis.

EXAMPLE STEP 4

A quantitative analysis of co-benefits for this example would necessarily focus on those SDGs where (a) data are available, and (b) results from the previous three steps indicate that there is likely to be a significant impact, using the relationships identified in Figure 2.2. A quantitative analysis of this case could include information about increase in income, increased numbers of students in school, water quality analysis, reduced numbers of migrants and incidents of hunger and/or malnutrition.

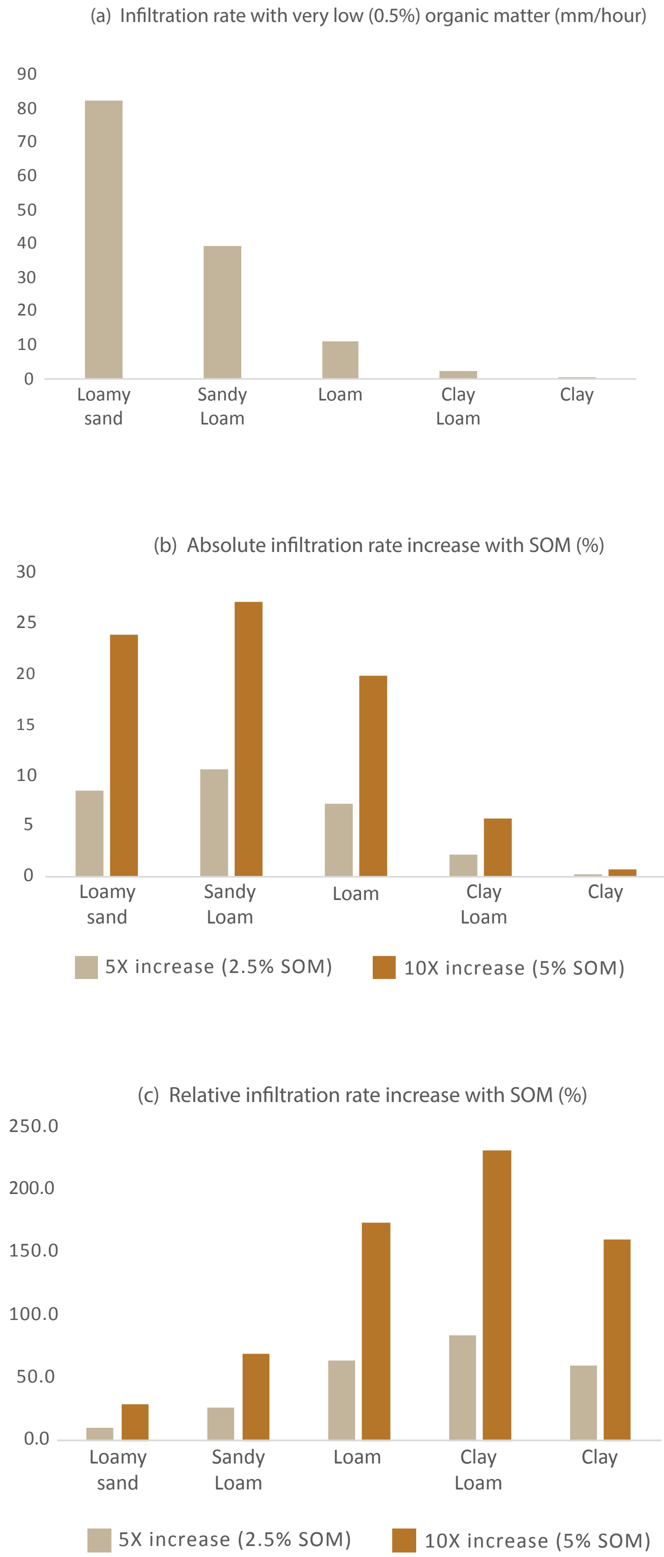

Figure 2.3. Soil compaction and removal of soil-protecting crop residues and tree litter caused by increased livestock populations (funded with remittances from migrants to the US) threaten to diminish or eliminate benefits of the Quesungual agroforestry system in Honduras. In the absence of livestock this agroforestry system often improves soil health (Ayarza et al. 2010; Fonte et al. 2010; Herrick et al. 2007).

Figure 2.4. Effects of soil texture (sand, loam and clay content (a)), and 5X (light brown) and 10X (dark brown) changes in soil organic matter (b and c) on water infiltration rates into the soil. Intense rainstorms commonly exceed 50mm/hour for minutes to hours, easily exceeding the infiltration capacity of soils with moderate to high clay and/or low soil organic matter. Data from Saxton and Rawls (2006; *http://hydrolab.arsusda.gov/soilwater/Index.htm*)

Box 2.1. Soil variability across fields, landscapes and continents controls land degradation and restoration effects on water infiltration and run-off

Land degradation affects, and usually reduces, water infiltration into the soil by (i) reducing vegetation cover that slows the movement of water across the soil, (ii) exposing less permeable soil layers at the surface through erosion, and (iii) degrading soil structure including through the loss of soil organic matter. The first and third types of degradation are typically reversible in human timeframes, while the second is not.

Understanding soil variability can help identify areas where land degradation avoidance is most critical (i.e. those soils that are vulnerable to the second type of degradation – figure 2.4a). For example, soils that are highly vulnerable to relatively permanent reductions in infiltration rates are those with a relatively sandy layer over a layer with more clay. Loss through erosion of a sandy loam exposing a clay loam below will on average reduce infiltration rates by 95 per cent, from 50mm/hour to 5mm/hour (figure 2.4a). These types of soils are common throughout much of East Africa, while in parts of Southern Africa, much of the land is covered by sandy soils that change very little with depth. Rainfall intensities regularly exceed 50mm/hour in most areas of the world, and run-off and flooding are more likely to occur when rainfall intensity exceeds the infiltration rate. This is particularly important as the frequency of intense storms is likely to increase with climate change (IPCC 2018).

Understanding soil variability can also help predict where both soil organic matter (figures 2.4b and c) and vegetation restoration are likely to significantly improve infiltration. Soil organic matter is increased by vegetation inputs, and particular types of vegetation (e.g. grasses) are particularly effective at both slowing the movement of water across the soil, so it has more time to infiltrate, and rapidly improving soil structure including creating stable channels that move water deep into the soil. Different soils support different types of vegetation and affect the extent to which increased soil organic matter is likely to increase infiltration (UNEP 2016).

Implementing a restoration program based on an understanding of soil variability requires first acquiring the best available soil map. Soil maps are constantly being updated, and different soil maps are often more accurate in different countries, and even within countries. Once a restoration investment has been defined for an area, the soils should be verified on-site (e.g. using a tool like the LandPKS app (Herrick et al. 2016)).

Strategy #2
Apply a landscape approach to planning and implementation – especially in landscapes with variable land potential.

This strategy is extensively discussed in chapter 4, "Landscape approach to using restoration to help achieve multiple SDGs". The previous IRP report "Unlocking the Sustainable Potential of Land Resources" (UNEP 2016) provides guidance on how to determine land potential.

One particularly important and largely unsolved challenge, which is not fully addressed by either the current or previous IRP report, is how to ensure that those bearing the costs of restoration also receive its benefits. This is particularly challenging where the costs and benefits are disconnected by time, space, or both (Fremier et al. 2013). Temporal disconnections are nearly universal for the benefits of the restored or rehabilitated land, due to time required for restoration. Temporal disconnections may be minimized for some SDGs, such as poverty (SDG 1) and education (SDG 4), by considering how restoration is pursued, ensuring that the restoration process is designed in a way that optimizes co-benefits. For example, educational benefits (SDG 4) can be increased both by training local populations to complete the work, and by ensuring that this training is designed to provide more broadly relevant knowledge and skills. SDG 1 can be simultaneously addressed if the work prioritizes the poor for employment and is designed to support the creation of local businesses rather than relying on outside contractors.

Some of the most innovative approaches to addressing spatial disconnections are being developed using ecosystem service markets (IPBES 2018b). These allow individuals and groups in other locations to pay for restoration through a direct payment for a service, such as the provision of high-quality water from agriculture-dominated watersheds to urban areas (Postel et al. 2005). Certification programs which allow producers to charge a premium for sustainably managing their land can also play a role, though the net economic benefits are not always as significant as they might appear (Blackman and Rivera 2011) due to a number of factors, including transaction costs such as monitoring.

Certification approaches are, however, limited by the temporal disconnections addressed above. This limitation is starting to be addressed through programs that reward producers for beginning the process of shifting their management. In the United States of America, a Certified Transitional Program was developed, noting that, "certification of farms in transition for technical support and supply-chain recognition can be a key aspect of encouraging increased domestic organic production" (Organic Trade Association 2017). This type of approach could be integrated with some of the strategies described in chapter 4 to reward farmers who are actively restoring their land with a premium for produce from that land, or even from other land that they manage, particularly if the degraded land must be taken out of production to be restored.

Strategy # 3
Develop targeted solutions

The landscape strategy provides just one example of how an understanding of diversity can help target interventions where they are likely to yield the highest return on investment. The same logic can be applied to innovation. In the past, the contribution of biological research to restoration and rehabilitation has been primarily through breeding programs that resulted in plants that could simultaneously stabilize degraded soil while contributing nitrogen. New approaches now provide new opportunities to develop targeted solutions involving soil microbes. For example, microbes that are adapted to remediate contaminated soils in environments where pollutants might otherwise persist for decades (Tripathi et al. 2017). Methods for stimulating the development of soil biological crusts to initially stabilize soils in arid regions are also being developed. These too are generally tailored for specific parts of the landscape.

Strategy #4
Invest in areas where persistence is likely.

Perhaps the greatest challenge for targeting restoration and rehabilitation in a rapidly changing world is determining where these interventions are most likely to have persistent benefits. Planners are beginning to understand the importance of taking climate change into consideration when deciding what types of agroecological systems to promote. However, there is often little consideration of how socioeconomic pressures may affect land use and management in the future. Identifying areas where interventions are most, and least, likely to have a long-term impact is as, if not more, important as determining where the greatest short-term responses are likely to occur (Herrick et al. 2019). This type of analysis is particularly important where restoration is likely to increase the value of the land, or where the value of the land is already changing, for example due to new roads. This illustrates the value and importance of looking at what is planned to address other SDGs before initiating one designed to support SDG 15.3.

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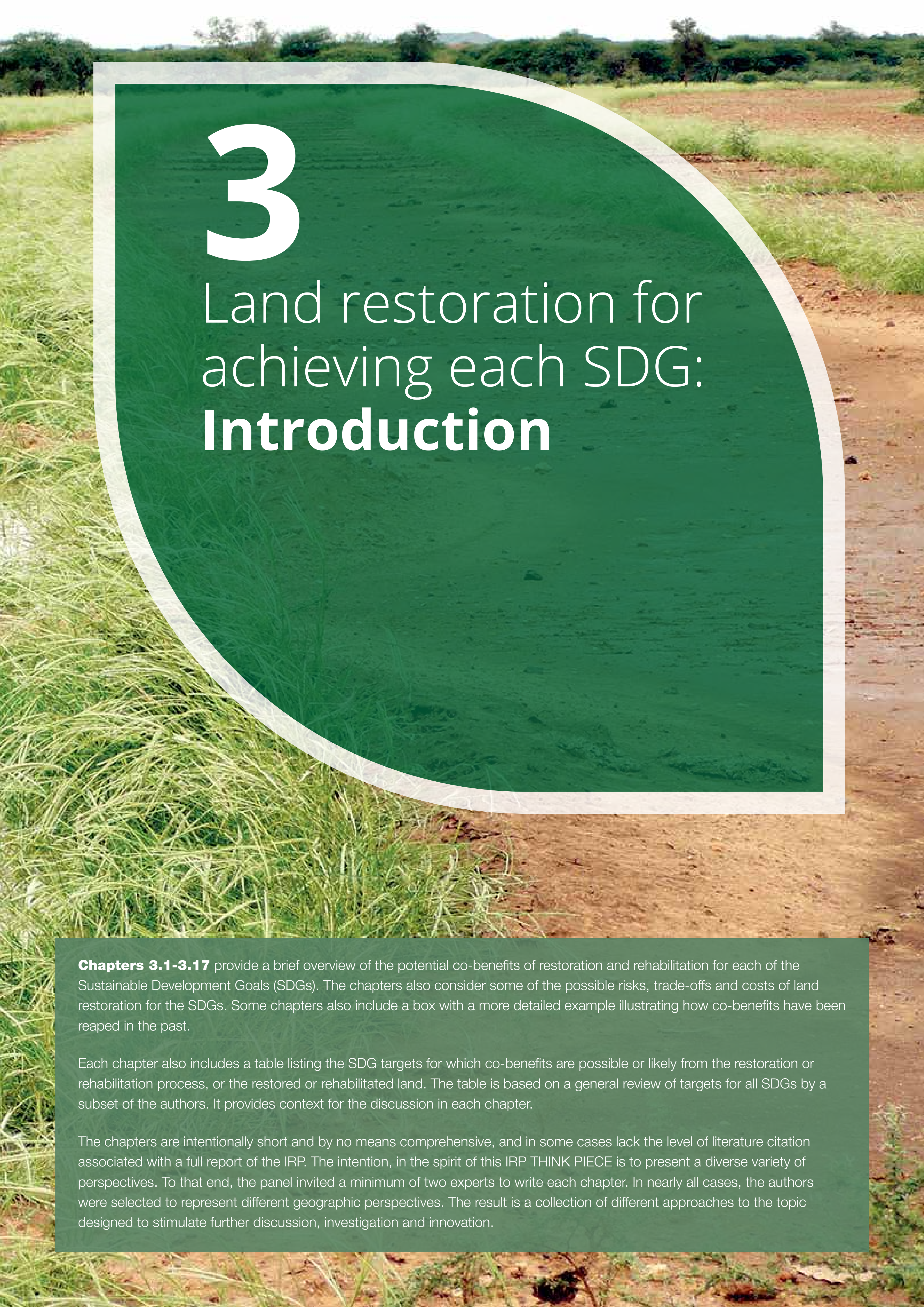

3 Land restoration for achieving each SDG: **Introduction**

Chapters 3.1-3.17 provide a brief overview of the potential co-benefits of restoration and rehabilitation for each of the Sustainable Development Goals (SDGs). The chapters also consider some of the possible risks, trade-offs and costs of land restoration for the SDGs. Some chapters also include a box with a more detailed example illustrating how co-benefits have been reaped in the past.

Each chapter also includes a table listing the SDG targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. The table is based on a general review of targets for all SDGs by a subset of the authors. It provides context for the discussion in each chapter.

The chapters are intentionally short and by no means comprehensive, and in some cases lack the level of literature citation associated with a full report of the IRP. The intention, in the spirit of this IRP THINK PIECE is to present a diverse variety of perspectives. To that end, the panel invited a minimum of two experts to write each chapter. In nearly all cases, the authors were selected to represent different geographic perspectives. The result is a collection of different approaches to the topic designed to stimulate further discussion, investigation and innovation.

3.1 Land restoration for achieving SDG 1: End poverty in all its forms everywhere

A. A. Kaudia and A. Singh

Summary

Land degradation affects an estimated 24% of the global land area (Plieninger and Gaertner 2011), negatively impacting the well-being of at least 3.2 billion people (IPBES 2018). Land restoration can promote poverty eradication in two ways. First, restoration activities can provide employment. Second, the restored land can support increased production of food and materials for habitation and inputs for industry and energy production. It can also help protect and improve infrastructure and increase the quality and quantity of freshwater supplies. The poor often depend nearly entirely on productive land as the basis for their livelihoods and well-being. This heavy dependence on land is often due to lack of options, particularly for the 3 billion people who live on less than USD 2.50 a day (Steiner 2018). Continuous use of land for agriculture, livestock production or mining without sound management reduces productivity and cyclically enhances poverty. Eradicating poverty therefore requires that land and associated soils and water be sustainably managed. This is a win-win strategy that ensures the restoration of degraded land and improved livelihoods. This is because vulnerable communities are the most affected by environmental degradation, which in turn contributes to increased poverty levels. Trade-offs, costs and strategies for achieving sustainable land management for poverty eradication should be considered in a nexus and systems context when undertaking land and landscape restoration initiatives.

1 NO POVERTY

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day	X	
TARGET 1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	X	
TARGET 1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	X	X
TARGET 1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters		X

Table 3.1.1. Examples of Sustainable Development Goal (SDG) 1 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or from the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG1: No Poverty

Land restoration addresses poverty eradication in two ways (figure 3.1.1; Shixiong 2017). First, restoration activities generate employments, thus improving the socioeconomic conditions of the poor (Abhilash et al. 2016). Second, the restored land supports increased future production as well as improved ecosystem services such as better water and air quality.

Poverty manifests itself in various forms. On the one hand, there is absolute poverty, which is a continuous state of dehumanizing depravation of basic life-supporting goods and services derived from the natural environment. On the other hand, there is temporary poverty, which is typical in agrarian communities, where during harvest season most households are able to meet their life supporting needs through selling surplus farm produce to afford relative luxury food items like fish and meat, school fees, and health care. They relapse to near absolute poverty after exhausting their farm produce surplus. Poverty also manifests itself in terms of a scarcity of basic needs such as energy, safe drinking water, access to healthcare and nutritious food. The restoration of degraded landscapes including forests, agricultural fields, wetlands and mainland marine ecosystems has proved critical to poverty eradication. Importantly, land restoration activities help to increase soil fertility, thus enhancing crop production and reducing malnutrition.

Figure 3.1.1. Conceptual figure showing possible ways that land restoration may reduce poverty and improve the livelihoods of the poor.

The productivity of a landscape and quality of life of the poor are inextricably linked. Indeed, for some of the rural poor, forests, scrubland and riparian ecosystems are the main source of life-supporting goods and services: they are sources of wood fuel, drinking water, medicinal plants and food, and improve air quality (MINIRENA et al. 2014). In dry parts of Africa, drought-tolerant fruit trees are life-saving sources of food during dry spells (Chivandi et al. 2015). Higher water quality in rivers is often due to reduced silt-loads associated with well-managed watersheds. This reduces the cost of treating water for city water supplies and the incidence of water-related diseases. For example, an estimated yearly saving of USD 300 million on the cost of treating the New York City water supply illustrates the value of well-managed watersheds in providing water security (Abel et al. 2017).

Forests, scrubland and riparian ecosystems are the main source of energy for cooking and households and in institutions such as boarding schools and hospitals, as over 70 per cent of Africa's population still depends on wood fuel. Industrial reliance on wood fuel includes much of the energy for flue-curing tobacco and tea leaves in Kenya (figure 3.1.2a).

While solely restoring degraded land can result in several improvements, further improvements can be made by introducing promising new crop species that are adapted to degraded land early in the restoration process (figure 3.1.2b; Singh et al. 2018).

Possible risks, trade-offs and costs of land restoration for SDG1: No Poverty

Risks of failure and trade-offs with other SDGs depend on a number of factors, including the methods used to plan and implement restoration projects. Restoration based on planting trees and other types of vegetation such as ground cover-plants, as well as natural regeneration, is prone to risks associated with change in rainfall incidence and intensity (Madsen et al. 2016; Yan et al. 2017). Other risks include the potential for introduced species becoming invasive weeds. Examples include mesquite (Prosopis juliflora) and water hyacinth (Eichhornia crassipes) in Kenya. Invasive species usually result in a loss of native biodiversity and can have a number of other negative impacts on ecosystem services (Muturi et al. 2013; Mironga et al. 2014). If species and site matching are not done carefully, there is a risk of introducing species with limited potential for improving quality of land. Trade-offs are inevitable in restoration because it is necessary to make choices about the type of action. Restoring degraded forestland could involve the eviction of settled communities, which could create conflict between the government and inhabitants of

Figure 3.1.2. (a) Manifestation of energy poverty: children out of school to fetch firewood, (b) Basella is a promising crop species for degraded land (Singh et al. 2018)

such forests, as indicated by the 2017 victory of the Ogiek people against the government of Kenya (*en.african-court.org*).

Costs of restoring land depend on, among other factors: topography, extent of degradation, prevailing government policy, scale of operation, objectives and the entity undertaking the work. Quantification of restoration costs has been limited. Assessments based on cost-benefit analysis and determining the return on investment (ROI), such as the case of Rwanda (MINERENA 2014) and Malawi (GOM 2017) suggest that overall, the aggregate public and private benefits accrued exceed the restoration costs.

Specific strategies for maximizing benefits of land restoration for SDG1: No Poverty

Strategies to maximize the benefits of land restoration for poverty eradication should include measures to ensure that restoration activities based on small-scale subsistence action will minimize risks associated with the relapse of actors' practices that have contributed to land degradation. These degrading practices include annual crop cultivation with crop residue removal, particularly on erodible land. This is aggravated by risks associated with climate change, to which such poor people are highly vulnerable. An assessment of the probability of relapse is an important part of the planning process and can be used to decide where to prioritize investments (Herrick et al. 2019).

An overarching condition for the effective restoration of land hinges on policy and political will. This is illustrated by the impact of global and regional commitments such as the Bonn Challenge, through which 350 million hectares of degraded land is to be restored globally by 2030 *(http://www.bonnchallenge.org/content/restoration-options*), and the African Forest Landscape Restoration Initiative (AFR100), through which by 20 June 2018, 25 African countries have committed to contributing to the target of restoring 100 million hectares of land by 2030 based on nationally-determined restoration potential, taking into account national policies and circumstances.

Maximizing benefits of land restoration for the poor requires a value-chain and nexus-driven approach to restoration. This is because restoration should improve the provision of all goods and services that the poor derive from nature. Overwhelming evidence indicates that, beyond national action, restored communal and private lands provide a key safety net and foundation for the resilience of the poor (Reed et al. 2015). Farmers undertaking farmer-managed natural regeneration (Haglund et al. 2011) of on-farm vegetation, the active growing of trees through agroforestry, the establishment of woodlots, or practicing sustainable land management practices with consequent increase in land productivity, are more resilient to shocks from natural disasters triggered by climate change. Some rely on trees as insurance stocks and sell them for urgent needs, such as paying school fees, covering medical costs and alleviating household cooking energy.

Another documented example of the co-benefits of sustainable land management and restoration for poverty eradication is the agricultural land technology programs that have been implemented in mountainous areas, such as the Loess Plateau in China and the denuded uplands in the Philippines, where these technologies both conserve soil and enhance farm incomes (Malla 2014).

Box 3.1.1. Bamboo and agroforestry for land restoration supports poverty alleviation

Woody plants are widely used for remediation as they provide multipurpose benefits for the poor. For example, planting bamboo both enhances land vitality and supplements the income of local people. These benefits were documented in Anji, China, where bamboo shoots were valued at approximately USD 2 billion per year (INBAR 2018). In Tanzania, bamboo-related enterprises generated an estimated extra USD 200 every month for each household and created jobs for nearly 1000 villagers (FAO and INBAR 2018). Therefore, large-scale bamboo cultivation can serve as a link between environmental restoration and poverty alleviation, fulfilling the targets of SDG 1.

China, Ethiopia, Cameroon, Viet Nam, India, Madagascar, Ghana, the Philippines and Kenya are other countries that have successfully incorporated the use of bamboo for land restoration (FAO and INBAR 2018). Peprah et al. (2014) demonstrated the ability of bamboo to restore degraded lands in Ghana, reporting overall survival rates of 95 per cent and rapid foliage growth converting degraded sites into green landscapes.

Another successful example of plant-based land restoration is agroforestry. Agroforestry is often suitable for landscape restoration because it can improve soil properties, resulting in increased soil fertility and erosion and improved water availability to plants. Agroforestry can improve rural livelihoods by providing a variety of products, including food, fodder, fibre and wood. This enhances food and nutritional security, generates income and alleviates poverty (Djanibekov et al. 2016). Selecting appropriate species for the local soil and climate conditions is critical for the success of agroforestry systems. For example, Lu et al. (2017) and Bohre and Chaubey (2014) recommend very different sets of species for subtropical forest restoration in Southwest China, and land restoration of Northern Coalfield Limitedin Singrauli, Uttar Pradesh, India, respectively.

The use of bioenergy plants for degraded land restoration is gaining worldwide attention as it provides multiple benefits in the form of firewood, biodiesel, bioethanol, charcoal, plywood, paper, pulp, and so on. (Tripathi et al. 2017). Commercial utilization of these end products also helps in fostering a bio-based economy and reducing poverty by providing a market for products that can often be produced on both degraded and restored land.

Caution is advised, however, as monocultures of any species can result in unintended and often negative consequences for many ecosystems. Those services related to biodiversity are the most obviously affected, but monocultures also effectively limit the number and type of products that can be generated from a particular piece of land. Their management is often highly mechanized, which may result in fewer opportunities for poverty reduction. This is a clear illustration of following a process like the one described in strategy 1 in chapter 2.

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3.2 **Land restoration for achieving SDG 2:** End hunger, achieve food security and improved nutrition and promote sustainable agriculture

P.C. Abhilash, S. A. Edrisi and J.L. Chotte

Summary

Globally, more than 2.5 billion people depend directly on agriculture for their livelihoods (Steiner 2018). Biomass productivity has declined on approximately 23 per cent of Earth's land area (Van der Esch et al. 2017). The proportion is even higher (36 per cent) for cropland, forest and pasture systems (Van der Esch et al. 2017). Others have estimated that 30 per cent of arable lands are already degraded (Le et al. 2016; Tripathi et al. 2017). Land degradation significantly affects food availability and distribution and constitutes a key driver of food insecurity and hunger in different parts of the world (Foley et al. 2011; Nkonya et al. 2016). Restoration of productive agricultural land and forests can help safeguard livelihoods and strengthen economic well-being, particularly for the significant proportion of the 3 billion people who live on less than USD 2.50 a day (Steiner 2018) who depend directly on crop and forest products. The process of land restoration can address hunger by increasing incomes and providing the rural poor with access to the knowledge and resources necessary to sustain production increases on their land. The restored and rehabilitated land has even greater benefits as it can support increased food production.

2 ZERO HUNGER

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round		X
TARGET 2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons		X
TARGET 2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	X	X
TARGET 2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	X	X
TARGET 2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed	X	X

Table 3.2.1. Examples of Sustainable Development Goal (SDG) 2 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 2: Zero Hunger

Land restoration and rehabilitation could provide co-benefits for all five of the primary targets for SDG 2. Land restoration and sustainable land management practices can increase food security by increasing short-term agricultural productivity, while also safeguarding regulating services, such as pollination, pest control, soil protection and fertility, nutrient cycling, and hydrological services on which both short-term and long-term productivity depend (Foley et al. 2011; Tilman et al. 2011; Bommarco et al. 2013; Bossio et al. 2010; Stavi et al. 2015; Tripathi et al. 2017). Restored land can support the production of more, and more nutritious food for the poor, addressing the first three targets (table 3.2.1). By improving "land and soil quality", restoration and rehabilitation can also increase resilience (Abhilash et al. 2016; Edrisi and Abhilash 2016; Dubey et al. 2019) and "strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters" (target 2.4).

While co-benefits for the first four targets would be derived primarily from the rehabilitation of agricultural lands, target 2.5 could also benefit from the restoration of natural ecosystems, as the "genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species" is conserved. The process of restoration also has a number of potential co-benefits, particularly for targets 2.3 to 2.5. Cultivation of currently underutilized food crops can also be important for averting hunger. These crops include species rich in vitamins and other minerals such as pearl millet (Pennisetum glaucum), amaranth (apseudo cereal - Amaranth cruentus), winged bean (Psophocarpus tetragonolobus), sword bean (Canavalia gladiata), Indian spinach (Basella rubra), Amaranth leafy vegetable (Amaranthus viridis) and ground cherry (Physalis angulata) (Singh et al. 2018a; 2018b). Many of these species are also legumes, which can contribute to restoration with nitrogen fixation. Breeding programs can benefit from the integration of local knowledge by involving local communities and families, especially with the help of women and children, community health practitioners, diet specialists, and local NGOs. If appropriately structured, their involvement can also help "promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge" (target 2.5) while the subsequent diversification of cropping systems can "help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality" (target 2.4).

Poverty can also be effectively addressed by avoiding and reducing land degradation, and eliminating or limiting its negative impacts. Resource-conserving agricultural practices like conservation agriculture (e.g. minimum or zero tillage) and agroforestry have been shown to minimize the risk of run-off and soil erosion (Palm et al. 2014; Dubey et al. 2019), water pollution, and increase soil water holding capacity and thus escalating the water use efficiency and cultivated crops productivity (Bossio et al. 2010; Palm et al. 2014). Organic farming has significantly increased during recent decades accounting for 37.5 million hectares of land in 2012 with the largest share in Australia (32 per cent), Europe (30 per cent), South America (18 per cent) and Asian countries such as India, China, Japan, and Indonesia (20 per cent) (Willer et al. 2014). Sustainable agricultural approaches have improved the average crop yields by 79 per cent on 3 per cent of farmland in developing countries (IPBES 2018).

Possible risks, trade-offs and costs of land restoration for SDG 2: Zero Hunger

Dudley et al. (2005) highlighted a potential mismatch between social and ecological aims for eco-system restoration. Projects reviewed either prioritized design for social or economic needs that failed to effectively address broader ecological impacts or focused on narrow conservation targets without considering the people's needs. Historically, indigenous peoples and traditional farmers often established diverse and locally adapted agroforestry systems. This resulted in community food security, conserving biodiversity and socio-ecological resilience (Altieri 2004; Parrotta et al. 2015). A review of studies of these systems can help to identify possible trade-offs between the benefits (e.g. increased resilience) of a more diverse agroecosystem, and changes in production of staple crops.

A related trade-off is short-term vs. long-term production. Land must often be taken out of production for one or more years (e.g. to establish a soil-improving cover crop). While the total 10 or 20 year yields of the restored soil may exceed those that would have been realized without restoration, it is of little consequence to the farmer who must continue to feed their family during the first few years when production is eliminated, while the costs of restoration (e.g. in cover crop seed and labour) are highest.

Specific strategies for maximizing the benefits of land restoration for SDG 2: Zero Hunger

The challenges described above can often be addressed by taking a landscape approach (chapter 4). Taking landscape variability into account when planning restoration and rehabilitation allows many of the trade-offs for hunger to be avoided, while maximizing the potential co-benefits.

Trade-offs can be avoided by ensuring that activities that require taking land out of production are implemented in a way that ensures that everyone who depends on the land is still able to produce food. This can occur by temporarily providing access to land in another part of the landscape, or by intensifying production on one part of the farmer's land while taking another part out of production. This approach is widely applied on rangelands where grass banks are established, and rest-rotation grazing systems are applied.

Co-benefits can be maximized by targeting restoration investments where the return is likely to be highest (Herrick et al. 2019). For example, deep loamy soils generally respond more quickly, especially in drylands, because they have higher water holding capacity, supporting production during dry spells. The timely adoption of various adaptive and resilient land management strategies including critical resource conserving practices (i.e. practices for conserving biodiversity, water, soil organic carbon) based on indigenous and local knowledge are imperative for maximizing the benefits of land restoration for the SDGs.

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3.3 **Land restoration for achieving SDG 3:** Ensure healthy lives and promote well-being for all at all ages

M.S. Fennessy and P. Sarkar

Summary

Land restoration is vital to the health and well-being of all people. Restoration to reverse the impacts of land degradation can improve human health by providing high quality and sustainable supplies of food and water. It can also reduce the incidence and transmission of disease. As a result, land restoration is critical to reaching Sustainable Development Goal (SDG) 3 to ensure healthy lives and promote human well-being. Avoiding land degradation and restoring degraded lands has direct and indirect benefits related not only to food, water, and energy security, but also to good physical and even mental health.

3 GOOD HEALTH AND WELL-BEING

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births		✖
TARGET 3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births		✖
TARGET 3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases		✖
TARGET 3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	✖	✖
TARGET 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination		✖

Table 3.3.1. Examples of SDG 3 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 3: Good health and well-being

Land restoration and rehabilitation help achieve SDG 3 both through improved ecosystem services generated by restored lands and through the process of restoration itself. Healthy lives and well-being require safe and sufficient food and water supplies and clean air. Land degradation currently undermines the well-being of an estimated 3.2 billion people by limiting one or more of these factors (IPBES 2018). The restoration of degraded land can contribute to food security by providing a diversity of healthy foods and products (Daily et al. 1997). Each year, 12 million hectares of land capable of producing 20 million tons of grain are lost due to drought and desertification (UNCCD 2016). Restoration of forests and agroforestry systems can improve small landowners' food security through crop diversification, reduced soil erosion, increased water availability and improved pollination. Therefore, land restoration contributes to poverty reduction and securing livelihoods. Restored ecosystems also increase pollinator diversity, which contributes to maintaining plant diversity at local and regional scales and improves the quality and stability of crop yields. Pollinators are required by a number of food crops, many of which have relatively high nutrient densities including numerous fruits and vegetables (Potts et al. 2016). The restoration of forests and wetlands, including riparian zones and floodplains, which cumulatively supply an estimated 75 per cent of the world's freshwater, can mitigate flooding and increase water security (IPBES 2018).

Land restoration may reduce soil borne pathogens that cause human diseases such as anthrax, parasitic helminths (worms), and vector-borne diseases. Intact ecosystems provide a dilution effect that may reduce the number of hosts for vector borne diseases (Aronson et al. 2016; van den Bosch and Depledge 2015).

Restored coastal forests and mangroves help protect fisheries and reduce the impacts of natural disasters by absorbing dangerous storm surges. This reduces loss of life and helps mitigate the significant public health crises that often follow natural disasters (Noji 2005).

The process of land restoration, particularly in urban and peri-urban areas, provides a unique opportunity to contribute positively to human health and well-being. Outdoor physical activity and engagement with nature

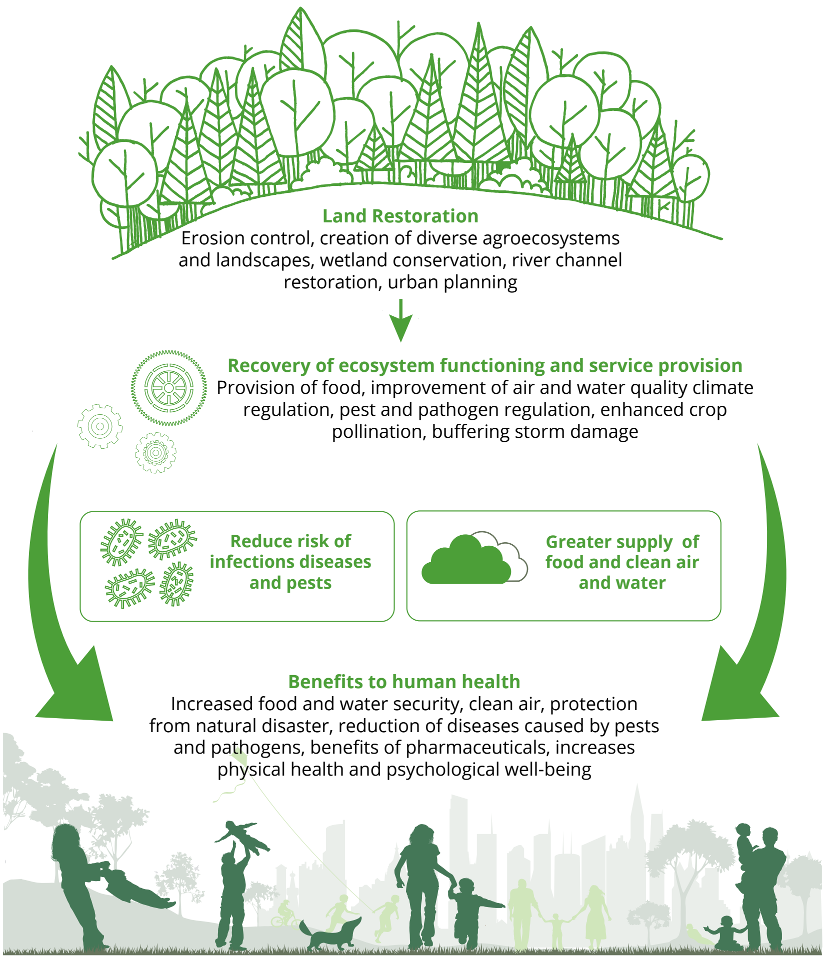

Figure 3.3.1. Human health and well-being are enhanced, both as a co-benefit of the ecosystem services provided by restored and sustainably managed land, and in many cases through the process of restoring the land (adapted and broadened from a figure in Wall et al. 2015 that highlights the importance of soil biodiversity).

Figure 3.3.2. Nalini Nadkarni (right) interviews an inmate (left) about the experience of viewing nature videos. Photo credit: Benj Drummond (*https://unews.utah.edu/nature-imagery-calms-prisoners/*).

have been shown to provide a variety of physical and mental health benefits, including improved child cognitive development (Pretty et al. 2007; Pretty et al 2011; Barton et al. 2009; Aronson et al. 2016). The proximity of restored areas to urban areas can facilitate the achievement of these co-benefits. Even in some of the harshest environments, such as a solitary confinement cellblock in a maximum-security prison, viewing images of natural landscapes by inmates, who are otherwise deprived of access to nature (e.g. glaciers, forests and waterfalls), reduced tension and helped defuse anger *(https://unews.utah.edu/nature-imagery-calms-prisoners/)*. Inmates who viewed nature videos several times a week committed 26 per cent fewer violent acts than their peers (Nadkarni et al. 2017).

Possible risks, trade-offs and costs of land restoration for SDG 3: Good health and well-being

Humans are sustained by the flow of ecosystem goods and services. However, risks associated with restoration to support human health and well-being are related to many factors, including the effectiveness of restoration actions, which depends on how well they address the drivers (biophysical, social, economic, and political) that cause land degradation. Effective restoration can stabilize ecosystem functions, diversify livelihoods, raise incomes, and reduce gender inequities (Adams et al. 2016). Policies or incentives that maximize one or a few ecosystem services can lead to unbalanced outcomes with negative impacts on communities, for example in rural households that are more dependent on natural resources for subsistence and livelihoods (Richardson 2010). Trade-offs that exist between agricultural production and sustaining biodiversity can be managed though landsharing and sparing practices that balance intensive land use with management that protects portions of the landscape and conserves biodiversity (Phalan et al. 2011).

The upfront costs of implementing land restoration practices may present a trade-off if the financial benefits of restoration are delayed and those funds are diverted from other uses that support well-being (Lamb et al. 2005). However, the overall economic benefits of restoration projects have been shown to exceed their costs. A recent UNDP report found that in 42 of the poorest African countries, the benefit of land restoration and conservation for the poor in terms of agricultural productivity is between 3 and 26 times greater than the cost of inaction (UNDP 2018). Programs to halt and reverse current trends of land degradation could generate an estimated USD 1.4 trillion per year of economic benefits (IPBES 2018; UNDP 2018). In these assessments, non-material and cultural values must also be considered because many non-economic values are not amenable to trade-offs (Winthrop 2014).

Another possible risk or trade-off is a temporary or permanent reduction in the provision of one or more ecosystem services during and possibly after the intervention. This is a particular concern in areas currently under cultivation where agricultural production cannot be sustained. While it is easy for those with alternative food sources to cite degradation-associated production declines over time as a justification for restoration of rangeland or forest ecosystems, both the short- and long-term caloric and other needs of the current land managers must be met through a holistic approach. In diverse areas, this can often be achieved through targeted intensification in more resilient parts of the landscape (see chapter 4), while in other areas a regional or even international strategy may be necessary.

Specific strategies for maximizing the benefits of land restoration for SDG 3: Good health and well-being

To achieve SDG 3, an integrated approach to land restoration is required that accounts for multiple goals related to food, air, water, and disease control, while prioritizing strategies that increase human health and well-being during the time the restoration process takes place. All are simultaneously dependent on healthy land, making a multiple benefit focus necessary to sustain soils, biodiversity and human health that address many of the SDGs (Wall et al. 2015). Effective restoration depends on policies that support the development and implementation of practices adapted to local conditions and their economic and policy environments. This may include infrastructure investments, and incentives for better land management and regulation (Vlek et al. 2017).

In urban and peri-urban areas, exposure to natural landscapes and green space improves psychological health by relieving stress, fostering positive emotions and improved attention and cognition (Tzoulas et al. 2007). The restoration of green infrastructure, or a network of protected land including parks, street trees, gardens, green walls, riverbanks, and wetlands provides benefits to physical and mental health, for example by promoting exercise (Shanahan et al. 2015), which can reduce the risk of diabetes, obesity, some cancers, osteoporosis, as well as psychological disorders (Sallis et al. 2012). Proximity is important; land restoration that increases access to areas for physical activity is associated with, for example, lower obesity rates (Gordon-Larson et al. 2006). There are also demonstrated links between tree cover and self-reported health (Kardan et al. 2015) including a natural experiment where a sudden reduction in tree cover reduced health scores (Donovan et al. 2013). Strategies to incorporate street trees in urban areas are effective; urban trees cool local temperatures and mitigate heat stress by providing shade and evaporative cooling. A 10 per cent increase in tree canopy cover has been shown to decrease ambient temperatures by 34oC (Gill et al. 2007). Trees can also reduce particulates in the air, providing substantial health benefits. For instance, urban forests in Mexico City lowered particulate matter (PM10 m2yr) by 2 per cent and ozone by 1 per cent (Baumgardner et al. 2012). Because urbanization is rapid in many regions, policies that incorporate green space in urban settings will help achieve SDG 3.

Strategic land restoration of coastal ecosystems in urban environments can reduce risks from hazardous and extreme events. For example, damages from hurricane "Superstorm Sandy", which hit the east coast of the US in 2012, were reduced by USD 625 million due to the presence of coastal wetlands. Shoreline management in the region now includes restoring salt marshes as an alternative or accompaniment to 'hard' infrastructure (Grimm ***et al***. 2016).

Figure 3.3.3. Mangrove replication in Sri Lanka. Photo credit: Seacology/Sudeesa *https://www.seacology.org/project/sri-lanka-mangrove-conservation-project/*

Box 3.3.1: Mangrove restoration in Sri Lanka

Forest restoration can benefit human well-being by supplying clean water, reducing soil erosion, sequestering carbon, supporting biodiversity and food supplies, and providing biofuels and forest products. When they are restored along coastlines, they can also reduce disaster risk. As extreme weather events such as storms and flooding increase in frequency, restoration of coastal mangrove forests can increase climate resilience by buffering populations from storm surges, which reduces wave damage and floods, and stabilizes shorelines and water supplies.

Substantial mangrove restoration efforts are underway in Sri Lanka through a partnership between Sri Lankan and US NGOs (Seacology and Sudeesa, respectively). Sri Lanka seeks to become the first nation to protect all its mangrove lands through a combination of protecting 8,815 hectares and restoring 3,880 hectares. Nurseries have been established to supply mangrove propagules for planting in coastal lands that once supported dense mangrove forests, many of which were lost due to commercial shrimp farming. A mangrove education centre (the Seacology-Sudeesa Mangrove Museum) was built and is anticipated to attract over 20,000 visitors per year to learn about the value of mangroves. Both the nurseries and museum provide jobs for local people. The project costs are estimated to be about USD 4 million over five years.

Mangrove restoration provides a habitat for a wealth of species, which increases fish and shellfish production and creates livelihood opportunities and poverty reduction. Mangroves are critical nurseries for fish species in tropical and subtropical areas, and the fisheries support social stability and benefit both small-scale and commercial fisheries. Economic valuations are uncommon, but the value of the fishery supported by mangroves in Sri Lanka was estimated to be USD 754 per hectare per year (Huchinson et al. 2014).

An important part of this project is the establishment of a training and a microfinance program to support business start-ups by women in local communities who then protect the mangrove forests. Thousands of loans have been granted to open small businesses or expand existing ones. These microloans have been used to start or expand restaurants, bakeries, and improve fish drying operations.

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3.4
Land restoration for achieving SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

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Summary

Sustainable Development Goal (SDG) 4 aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". Education is systematic, formal and non-formal training and instruction designed to impart knowledge and develop skills. Land restoration promotes inclusive and equitable education by increasing incomes and decreasing household labour requirements, both of which provide households with the money and time to educate their children. Through integrated educational programmes, such as environmental education, land restoration can promote sustainable land practices. Land restoration can also contribute to inclusive education through its contribution to gender equality (Broeckhoven 2015).

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and Goal-4 effective learning outcomes	✖	
TARGET 4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university	✖	
TARGET 4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	✖	✖
TARGET 4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy	✖	
TARGET 4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development	✖	✖

Table 3.4.1. Specific SDG 4 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 4: Quality education

Healthy and productive landscapes and the vital benefits they provide can address the challenges of migration, land degradation, food insecurity, and conflict over natural resources, all of which impact access to quality education (Besseau et al. 2018). The specific co-benefits of land restoration for SDG 4 include: (a) improving food security and physical safety through increased production and decreased conflict over natural resources, which can lead to more effective learning environments, (b) integrating environmental education programs into land restoration efforts, which can provide the knowledge and skills to promote long-term sustainable land management, (c) decreasing the need for children to work instead of attending school through more productive agricultural and ecological landscapes, (d) increasing productivity, which can increase incomes, meaning that more money is available for education both for primary and secondary students, and for quality teacher training to produce more qualified and trained teachers. Often children are not in school because they must work, and sub-Saharan Africa has the lowest primary education enrolment rate at only 41 per cent (UN 2018). Furthermore, girls are four times more likely to be out of school than boys from the same background (Their World 2017). Land restoration efforts can address these geographic and gender inequalities if they include an education component as part of employment.

Possible risks, trade-offs and costs of land restoration for SDG 4: Quality education

While land restoration can and does have positive impacts on SDG 4, there are risks, trade-offs, and costs. First, while increased ecosystem and agricultural productivity can decrease the need for children to work, in certain contexts it could increase the need for both on-farm and off-farm labor. For example, if the household can significantly increase agricultural productivity, this may also increase the need for on-farm labour in order to plant, harvest and sell the increasing amounts of crops. Furthermore, while improved access to ecosystem services can lessen the labour and time requirements for collecting products (fuelwood, fodder, construction materials, etc.), it could have the opposite effect if those products become commercial products. Children may then need to collect products not only for household consumption, but also for sale, increasing their workload. Lastly, increased incomes from restored land will not necessarily go towards education, and increased government budgets will not necessarily improve access to education, particularly where

Figure 3.4.1. The benefits of land restoration for achieving quality education.

the government is corrupt. At the household level, those funds could go towards many other household needs, depending on the cultural context and importance placed on education.

Specific strategies for maximizing the benefits of land restoration for SDG 4: Quality education

Land degradation is already impacting the well-being of at least 3.2 billion people globally and costing more than 10 per cent of the annual global gross production in lost ecosystem services (IPBES 2018). Worldwide, two billion hectares of land are currently degraded. If this land were to be restored, the annual economic benefits are estimated at USD 84 billion (Wu 2017). These economic benefits of land restoration are critical for maximizing the benefits of land restoration for SDG 4. Improving livelihoods and income means more money available for education – both within the household and within the national government. This is illustrated in the Tanzanian case study in table 3.4.2, where restoration provided significant increase in both on-farm income and off-farm income through the collection of important natural resource products such as firewood, construction materials, and herbs that are variously used as traditional medicine. Approximately 36 per cent of households reported using this income for education. At larger scales, an increased budget for national or state governments can result in more money for building schools and providing quality teacher training. More schools can result in easier access to educational facilities, particularly within rural communities in developing countries. Furthermore, higher government budgetary allocation to education can lead to low-cost or free higher education (colleges, universities, etc.). In summary, land restoration could be used to achieve economic growth as well as achieve environmental development, thus helping to achieve the SDGs including SDG 4.

Second, land restoration can decrease the need for children, particularly girls, to work instead of attending school. As seen in table 3.4.2, land restoration can reduce the amount of time girls spend collecting fuelwood, water, and fodder. This gained time can instead be devoted to educational opportunities. Furthermore, land restoration leading to more productive agricultural systems can decrease the need for children to work to provide a household income. If a household can increase its on-farm income, this decreases the need for children to spend time on other income-generating activities. Therefore, land restoration policies should explicitly maximize the benefits of improved ecosystem services and agricultural productivity in order to decrease child labour needs.

Third, enhancing environmental education programs globally and integrating environmental education into land restoration can address SDG 4. Environmental education aims to induce behavioural change at a personal, societal, and global level, arising from the opportunity to gain awareness of the environment and identify and solve environmental problems (Jacobson et al. 2006). Environmental education that increases environmental awareness and stewardship is critical for promoting sustainable development and improving the capacity to address environmental challenges, such as land degradation.

Fourth, land restoration can contribute to SDG 4 by mitigating the negative impacts of degraded land on the educational sector through the destruction of educational infrastructure and disruption of education cycles due to conflict over natural resources and food insecurity. Quality and inclusive education is difficult to achieve where there is conflict. Security is one of the most basic human needs, and without security and peace, formal education cannot be a priority. The same is true with households' food security. Education cannot be a priority where households' food requirements are not met. Furthermore, both the short- and long-term health impacts of malnourishment and undernourishment would impact the educational performance as well as the overall cognitive development of a child (Kar et al. 2008). Therefore, land restoration efforts have the potential to improve food security and promote peaceful coexistence, and thus could have significant impacts on access to education. This addresses SDG target 4.5 by decreasing the vulnerability of children by providing a safer environment for healthy childhood growth and development.

Box 3.4.1: Shinyanga, Tanzania Land Restoration Program (LRP)

Shinyanga, located in northern Tanzania, is one of the poorest regions in Tanzania. Many people in Shinyanga depend on livestock and subsistence farming for their livelihoods (Barrow et al. 1988; Maro 1995; Mlenge 2005). The region has poorly distributed annual rainfall of 600 to 800 mm and the vegetation consists of Miombo and Acacia woodlands. Prior to the 1980s, woodlands were cleared to create land for agriculture leading to the loss of environmental goods and services. In response to these environmental challenges, in 1986 the Government of Tanzania started the Shinyanga Land Restoration Program (LRP) (Barrow et al. 1988) to enhance the resilience of the overall ecosystem through the use of enclosures and fodder reserves with foreign support from the Government of Norway. Since the start of the projects, the LRP has contributed economically to the households and communities in Shinyanga. The percentage of households whose economic well-being has improved as a consequence of benefits from LRP is as high as 64 per cent (Table 3.4.2).

Table 3.4.2. The benefits derived from land restoration in Tanzania. These benefits can improve incomes, which can be used for education, as well as reduce the workload of young people that often keeps them from attending school.

Issue	Outcome
Economic value of land restoration	$14 per month per person
Average value of 16 natural resource products used per annum.	Per household: USD 1,200 p.a. Per village: USD 700,000 p.a. Per district: USD 89,620,000 p.a.
Reduction in time for collecting certain natural resources.	Fuelwood: 2 to 6 hours Pole: 1 to 5 hours Thatch: 1 to 6 hours Water: 1 to 2 hours Fodder: 3 to 6 hours
Percentages of households using products for various reasons in seven districts (average and whole range).	Education: 36% (10 - 61%) Diversify nutrition: 22% (7-55%) Fodder and forage: 21% (10-37%) Medicinals (over 30 spp): 14% (5-36%) Fuelwood: 61% (54-63%)

Adapted from: Monela et al. 2005; Otsyina et al. 2008

The total monthly value of benefits from LRP per person in the Shinyanga Region is estimated at USD 14 – a higher value than the national average (USD 8.50) consumption per person per month in the rural areas of Tanzania.

The products from woodland restoration (Ngitili) were mostly harvested and the proceeds used by households to diversify the economic base or improve the access of households to socio-economic services. For instance, Monela et al. 2005 found that the proceeds from Ngitili contributed USD 22.90 and USD 8.90 to the households' educational and health services respectively. Specifically, Monela et al. 2004 found that proceeds from Ngitili were used by many households to support their children's education and these households have been categorized as the most innovative beneficiaries of Ngitili.

The LRP provides a specific, local example of the economic benefits of land restoration and how they can contribute to SDG 4. Table 3.4.3 provides a broader overview of the estimated economic benefits of land restoration for three different ecosystems in Tanzania. These added economic benefits can be felt at both the household and government levels, leading to increased money for school fees, educational infrastructure, teacher training, and scholarships.

Table 3.4.3. The potential economic benefits of land restoration for selected ecosystems in Tanzania (Groot et al. 2013).

	Temperate	Woodlands	Grasslands
Potential value added per ha per year (in USD, 2007)	1.437	983	1.765
Potential value added, Total per year (in million USD, 2007)	651.1	111.1	727.0

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3.5 Land restoration for achieving SDG 5: Achieve gender equality and empower all women and girls

A. Ganguli and M.J. Kamar

Summary

Degraded landscapes with reduced ecosystem services place social, economic, and ecological strain on agroecosystems. When ecosystem services are improved through restoration and rehabilitation, gender equity and women's empowerment (Sustainable Development Goal [SDG] 5) is often directly enhanced through increased food and nutrition security (Mollier et al. 2017). Specific SDG 5 targets that can be addressed through land restoration include equal participation in decision-making (target 5.5), equal rights to resources (target 5.A), and enhanced use of enabling technology (target 5.B). Realizing benefits requires careful planning based on a strong understanding of how gender currently affects women's access to economic resources, their participation in decision-making processes, and current patterns of land tenure. As gender is a cross-cutting theme in the 2030 Agenda and across the SDGs, it is also explored in other chapters.

5 GENDER EQUALITY

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 5.1 End all forms of discrimination against all women and girls everywhere	✖	✖
TARGET 5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life	✖	✖
TARGET 5.A Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws	✖	
TARGET 5.B Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women	✖	

Table 3.5.1. Examples of SDG 5 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 5: Gender equality

Women, especially in developing nations, represent a critical portion of the agricultural production and land management workforce and are often responsible for meeting the basic nutritional needs of their families (Agarwal 2018). Consequently, they have much to gain from the increased productivity of restored lands, and in addition to their labour, often have knowledge that can be used to increase the success of restoration projects. In addition to increasing food and nutrition security, economic security is also improved when degraded land is restored. This in turn facilitates economic empowerment, which raises the standard of living and quality of life for communities.

Equitable participation in restoration initiatives through gender mainstreaming efforts where men and women participate in all aspects of the process fosters greater individual and community buy-in, which has been shown to have a positive influence on efficiency and effectiveness of restoration projects (Broeckhoven and Cliquet 2015).

Possible risks, trade-offs and costs of land restoration for SDG 5: Gender equality

Gender equality is heterogeneous and highly location-specific, which makes its role in achieving sustainable agriculture and specific SDG targets complicated (Mollier et al. 2017). Gender roles and social norms in developing nations (Catacutan and Villamor 2016; Agarwal 2018) can reduce empowerment and limit the role women play in fostering land restoration. For example, women often have much lower access to land, credit, technology, and knowledge of new practices due to lower access to extension programming (Catacutan and Villamor 2016; Agarwal 2018). As a result, women in rural communities may lose interest in land restoration because of legal and cultural barriers to land rights and ownership (Forsythe et al. 2015) where they do not have a voice or are not in decision-making positions. Restoration can also be expensive, the value often taking considerable time to be felt, which may limit the adoption rate of women especially in economically disadvantaged rural areas. Gender roles in some developing countries may lead to female management decisions regarding land use that may be at cross-purposes with restoration goals (Catacutan and Villamor 2016). For example, decision-making simulation exercises have demonstrated that women may choose to shift land use to more profitable crops rather than management that would support restoration goals linked to numerous ecosystem services (Catacutan and Villamor 2016).

Specific strategies for maximizing the benefits of land restoration for SDG 5: Gender equality

Maximizing benefits of land restoration for gender equality is crucial for long-term land management practices that result in degradation avoidance. Because women's and men's environmental knowledge and priorities for restoration often differ, it is important that both women and men are recognized as right holders and legitimate stakeholders who can exercise their voice and influence in changes to the environment. Methodological frameworks that support SDG 5, such as those created by the UN-REDD Programme, can assist in the design, implementation, and assessment of restoration programs (Eggerts 2017). This gender-responsive approach promotes adapting programs to increase their effectiveness, inclusiveness, and sustainability. To aid the assessment of programs achieving SDG 5, the Gender and Inclusion Toolbox (Jost et al. 2014) provides an additional resource

Figure 3.5.1. Members of the Leparua Woman's group in Northern Kenya collecting native seed for use in restoration projects in community conservancies (Photo credit: David Kimiti).

Figure 3.5.2. Technological training delivered to women and men in how to use land potential assessment tools for restoration planning (Photo credit: David Kimiti).

on how to conduct gender-sensitive and socially inclusive research.

Strategies that can be employed to maximize benefits of land restoration include ensuring gender inclusivity in the identification, development, and implementation of land restoration. The Restoration Opportunities Assessment Methodology (ROAM), developed by the International Union for Conservation of Nature (IUCN) and the World Resources Institute (WRI), highlights how gender-responsive methods can be used in restoration planning (IUCN 2017). This gender-responsive restoration document presents guidelines that support achieving SDG 5 in three phases, marked by preparation and planning, data collection and analysis, and forming policy recommendations from results. The specific gender-responsive strategies suggested in ROAM include gender analysis, inclusion in decision-making, improved rights, new partnerships and alliances, indicator development, data collection, increased dialogue, responsive policies, and the exchange of knowledge. Whereas ROAM is intended for large-scale planning efforts to identify restoration potential within countries or regions, Forest Landscape Restoration (FLR) is an implementation process designed for individual on-ground projects.

FLR is described as “a planned process that aims to regain ecological integrity and enhance human well-being in deforested landscapes” (Stanturf et al. 2017). Inherent in the process, FLR is aimed at restoring ecological functionality while enhancing human well-being. Because of varying geographical needs, opportunities and constraints, when implemented in conjunction with adaptive forest management principles (Spathelf et al. 2018), FLR allows for local considerations for management based on socioecological knowledge. Using FLR to improve ecosystem services should enhance human well-being. This approach can be used at the landscape scale to help achieve broad international restoration commitments like those set out in the Bonn Challenge. Specific care should be taken that the

SDG 5-enhancing principals used in ROAM are applied throughout all stages of the FLR implementation process. A gender-responsive design and evaluation framework provides specific recommendations for achieving SDG 5 in the context of FLR (Basnett et al. 2017).

At the local level (e.g. restoration sites or projects), strategies that address gender differences in levels or types of education, access to technology, extension and opportunities can be employed to maximize the benefits of restoration projects that target gender equality and women’s empowerment. Women have different natural resource management extension needs than men (Wilmer and Fernández-Giménez 2016) and in increasingly rural areas, gender-specific extension and education programs play a key role in increasing women’s empowerment (Catacutan and Villamor 2016; Mbile et al. 2018; Sell and Minot 2018).

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3.6 Land restoration for achieving SDG 6: Ensure availability and sustainable management of water and sanitation for all

A.C. Flores-Díaz and M.S. Fennessy

Summary

An adequate supply of high-quality water has high economic and social values and is central to the well-being of human populations (Gleick 2014). Recent Sustainable Development Goal (SDG) reports (UN DESA 2016, 2017 and 2018) indicate progress in water access. However, many problems remain. For instance, 60 per cent of the world's population lacks proper sanitation. Water pollution and the loss of wetlands and forest continue, aggravating water stress for 2 billion people. This also has consequences for wildlife and biodiversity, particularly coral reefs and amphibians, which are among the most threatened groups. As a result of the tight linkages between land management and the water cycle, restoration of degraded lands improves water supplies (Bossio et al. 2009). Land restoration efforts indicate it is possible to reverse trends in forest and wetland loss and improve water quality and quantity at both the local and regional scales. Integrated Water Resources Management Plans (IWRMPs) can provide a framework for considering the possible benefits and costs for other SDGs of restoration projects designed to improve water quality and availability (SDG Reports UN DESA 2016, 2017 and 2018).

6 CLEAN WATER AND SANITATION

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally		✖
TARGET 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity		✖
TARGET 6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate		✖
TARGET 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes		✖
TARGET 6.A By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	✖	
TARGET 6.B Support and strengthen the participation of local communities in improving water and sanitation management	✖	

Table 3.5.1. Examples of SDG 6 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all of the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 6: Clean water and sanitation

Water availability is critical for human life, health, and food, as well as energy production, causing a direct, strong impact on well-being. Land restoration efforts, including those targeting land-water interfaces, are essential for the improvement of water resources, with benefits for both people and wildlife. Reversing forest loss can relieve water stress and stabilize water flows for local and regional environments in the medium and long term (IPBES 2018).

Wetland restoration can also lead to improved water quality (by removing sediment, nutrients and metals) and stabilized water flows by storing water and reducing downstream flooding (Mitsch and Gosselink 2015). Restoration that focuses on riparian zones and floodplains can reduce (a) nutrient loads to streams and wetlands that reach the coast causing dead zones; (b) fecal bacteria loads that generate waterborne diseases, leaving 1.8 billion people exposed to fecal contamination (SDG 2016); and (c) sediment loads carrying chemicals in surface waters, reducing water suitability for human consumption, irrigation and nature, and threatening aquatic species, including amphibians, 5:1 in comparison with terrestrial species (Nilsson and Svedmark 2002). Agricultural practices that conserve resources such as organic farming, conservation agriculture (e.g. minimum or zero tillage), and agroforestry are another means to reduce run-off and soil erosion (Palm et al. 2014). Restoration practices that increase vegetation and water retention on the landscape can also mitigate the effects of climate change. For instance, local daytime temperatures may be reduced by decreasing surface albedo, which decreases the amount of solar energy (heat) absorbed by the earth's surface (Foley et al. 2003), and through evaporation, which dissipates large amounts of solar energy. In contrast, in cleared and de-watered landscapes, most solar energy is converted to heat, which can significantly increase local temperatures (Pokorny et al. 2010).

The restoration of degraded lands along with improvements in water-use efficiency (e.g. in agriculture) can reverse many of the trends associated with impacts to freshwater and the services it provides (Postel 2000). Restoration success depends on the degree to which the stressors,

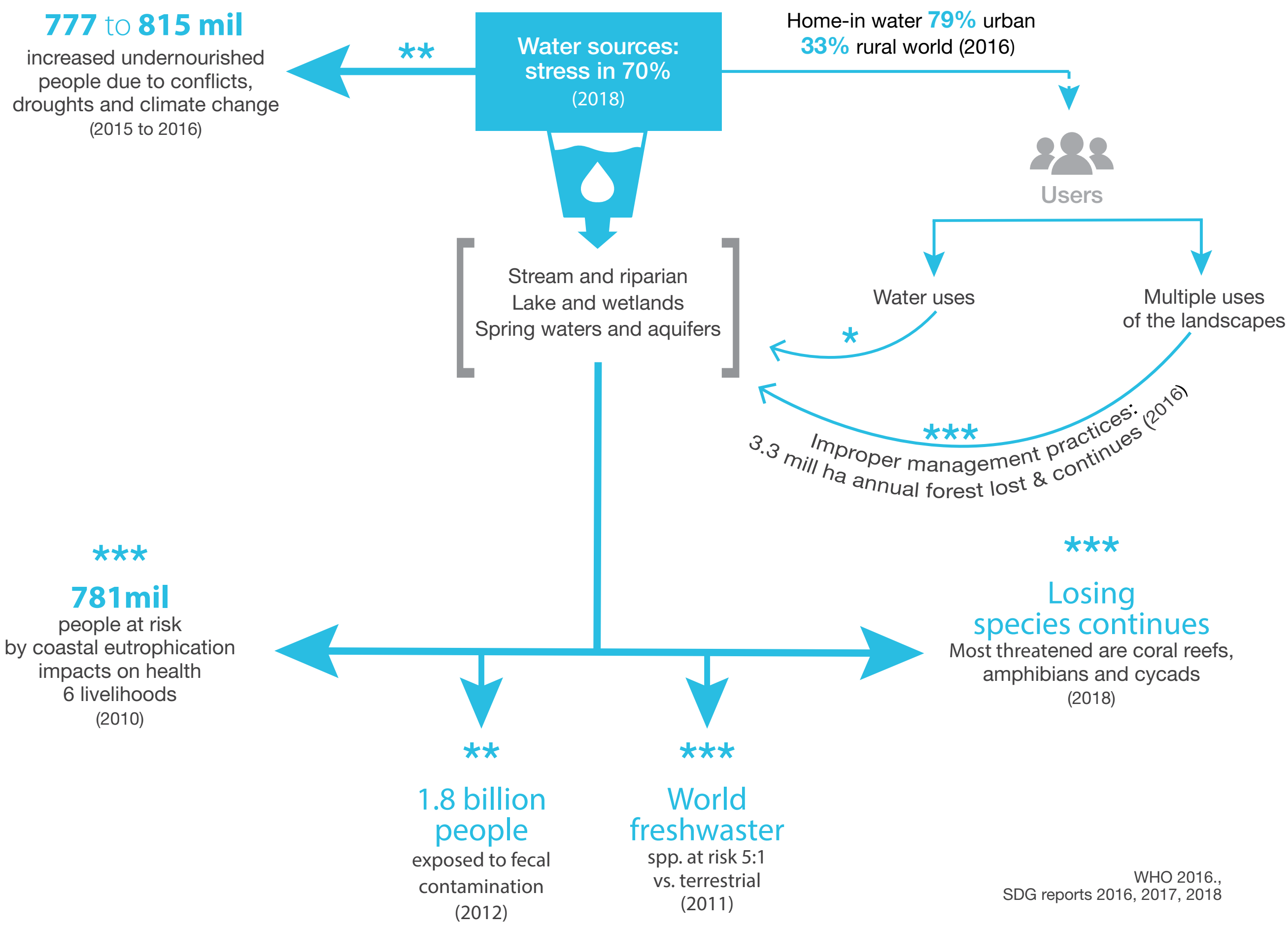

Figure 3.6.1. The cycling components uses and impacts of water resources on diverse territories and peoples (Sources: WHO 2016; Nilsson and Svedmark, 2002; SDG Report 2016, 2017, and 2018). Bold lines indicate warnings and/or problems caused by the lack of proper land-water management and sanitation. Asterisks indicate the relative contribution of land restoration in solving the problem.

which cause degradation, are addressed. Restoration of degraded agricultural lands (including flood plains and riparian zones) can reduce nutrient and sediment run-off that leads to eutrophication and algal blooms in inland and coastal waters (Mitsch et al. 2001). With restoration of agricultural lands, soils can be “re-carbonized” by increasing organic matter content, allowing water to soak in and be held in the soil (Gnacadja 2013), thus sustaining water supplies.

Given that the water cycle includes multiple components and routes that water takes across the landscape, sustainable management of water means sustainable management of the land. In this sense, water security is a prerequisite for food security. A major risk for food production systems, particularly in arid and semi-arid regions that rely heavily on irrigation, is the degradation of water resources, such as declining aquifer levels and groundwater pollution (FAO 2011). Without restoration, the risks of unsustainable production practices, excess fertilization and water pollution (e.g. nitrogen leaching into surface and groundwater) increase, leading to health problems with substantial societal costs (Vitousek et al. 2009; IPBES 2018).

Restoration projects can also be used to help increase awareness of the benefits of ecosystem health for human health, which can in turn generate more support for restoration. Integrated Water Resources Management Plans (IWRMP) can be used to help identify additional co-benefits of land restoration and rehabilitation (UN DESA 2018).

Possible risks, trade-offs and costs of land restoration for SDG 6: Clean water and sanitation

The primary risk of land restoration is that it may result in the competitive use or redistribution of water resources. Competitive use can occur when irrigation water is required for restoration, or when the restoration of a wetland or riparian system requires water to be diverted from food production or urban or industrial uses.

Redistribution can occur where restoration results in a change in water run-off, infiltration and evapotranspiration patterns in space or time. For example, the restoration of rangeland watersheds can increase infiltration and reduce run-off. While usually viewed positively, run-off reduction can result in less water being captured by downslope dirt “tanks” that are often created to provide seasonal water for livestock. The establishment of deep-rooted species can also result in increased evapotranspiration, reducing the groundwater recharge.

Specific strategies for maximizing the benefits of land restoration for SDG 6: Clean water and sanitation

Much of the understanding about the benefits of restoration is inferred from estimated costs of land degradation. For example, in Mumbai, India, it is estimated that for every 1 per cent decrease in forest cover, turbidity increases by 8.4 per cent. This increases drinking water treatment costs by 1.6 per cent (Singh and Mishra 2014). Payments for ecosystems services (PES) can incentivize landowners to reforest their lands, which increases water security (Lamb et al. 2005). Watershed-scale approaches to restoration are most effective for water supplies. For example, restoring an estimated 10 per cent of the land area of the Mississippi River watershed could reduce nitrogen loads to the Gulf of Mexico by an estimated 40 per cent, improving water quality and fisheries in the Gulf (Mitsch et al. 2001). Local communities’ involvement in restoration and rehabilitation projects generally show stronger results because of the integration of local expertise, and the relevance of local knowledge to the project success (IPBES 2018).

To maximize benefits for SDG 6, land restoration and rehabilitation should focus on:

(1) Water-stressed areas which are causing loss of food production, affecting health, and contributing to increasing undernourishment which grew from 777 to 815 million people in 2015 – 2016 (SDG 2018);

(2) Rural localities, to increase survival for children living in water scarcity or without proper sanitation (WHO 2016), to close the gap between urban and rural populations with regard to clean water supply and sanitation, and to take care of critical lands for cities (i.e. rural people as ecosystem services stewards). One option is to adopt the World Health Organization’s global guidelines on sanitation and health to provide basic sanitation to all. Policies that adopt the guidelines are predicted to have benefits such that for each US dollar invested, there will be a nearly six-fold return through lower health costs and increased productivity *(https://www.who.int/news-room/detail/01-10-2018-who-calls-for-increased-investment-to-reach-the-goal-of-a-toilet-for-all)*.

(3) Zones showing declining agricultural productivity (UN DESA 2018), which are important in identifying the watershed level to reduce the sediment and chemical loads reaching water bodies and coasts;

(4) Lotic and lentic wetlands, to improve biogeochemical transformations (i.e. excessive nitrogen and phosphorus), to increase the level of connectivity in the landscape, and to reduce the impacts on inland and coastal fisheries. In many locations, the restoration of riparian zones is particularly important to support biodiversity, reduce downstream flooding and improve water quality.

IWRMPs can provide a framework for considering the possible benefits and costs for other SDGs of restoration projects (UN DESA 2016, 2017 and 2018). These plans help ensure water security, proper sanitation, and balance water among uses and have been implemented in only 48 per cent of the countries (UN DESA 2018). Interestingly, corporate-run water stewardship programs are increasing in response, as businesses realize the risks that water shortages pose to their operations and profitability (Schulte 2018).

IWRMPs provide a valuable framework and participatory process for addressing the possible risks, trade-offs and costs of optimizing restoration projects to address water quality and quantity goals. They also take into account the financial resources (e.g. to improve infrastructure) and data necessary to adaptively manage over time.

Box 3.6.1: Public-Private Water Fund in Costa Rica

Agua Tica is the first public-private water fund initiative in Costa Rica. Its goal is to restore and conserve forests in a critical watershed near the Greater Metropolitan Area of the capital city, San José, in order to achieve water security by maintaining high quality water for downstream users. This area is key to the country's water supply with nearly 60 per cent of its population (2.6 million inhabitants) and 70 per cent of its industry located in the watershed (http://water.nature.org/waterblueprint/city/san_jose_cri/#/c=9:9.69552:-83.85452). As a consequence, demand for water is high as a result of population growth, historic scarcity and changing land use. Before watershed protection, deforestation to establish agriculture and grazing was rapid, and was causing increased erosion and degraded water quality. The water fund project, operated by The Nature Conservancy, Fundecor (a Costa Rican NGO), and other partners, offers protection to inland and riverine forest areas, and native cloud mountain forests (*http://naturalcapitalproject.stanford.edu/why-is-costa-ricas-new-agua-tica-water-fund-special/*).

Agua Tica is based on the premise that preserving water quality and quantity will provide economic, environmental and social benefits. In the 1970s and 80s, this region of Costa Rica had one of the highest rates of deforestation globally (the Natural Capital Project), which led to soil erosion, nutrient run-off and unhealthy water quality. In a payment for ecosystem services scheme, landowners in the watersheds that are the source of water supplies are paid to plant trees, build fences to keep cattle out of riverbeds, and sustainably manage their forests. Funds to support this come from a small tax that all Costa Ricans pay on their water bills (the Natural Capital Project). The anticipated benefits of the project include erosion control to maintain the quality of drinking water supplies, the protection of reservoirs, improved ground water recharge, and improved dry season flows to secure reliable water supplies. Specific activities that contribute to reaching these goals include investment in forest protection, adoption of agricultural best practices, environmental education, and establishment of agroforestry systems, embankment control, and reforestation. A combination of technical- and scientific-based approaches has helped identify where restoration in the watershed will lead to the biggest gains in water quality and quantity (B. Herrera, Fundecor, pers com). The programme is also tracking the mitigation of greenhouse gas releases and biodiversity conservation.

Figure 3.6.2. Aqua Tica Water Fund watershed area. Photo Credit: Manuel Guerrero/Fundecor *(source: http://naturalcapitalproject.stanford.edu/why-is-costa-ricas-new-agua-tica-water-fund-special/)*

Sources for this box:
https://www.fundecor.org/
http://www.naturalcapitalproject.org/why-is-costa-ricas-new-agua-tica-water-fund-special/
http://water.nature.org/waterblueprint/city/san_jose_cri/#/c=9:9.69552:-83.85452
Bernal Herrera-F, Technical Assistant Director, Fundecor, personal communication, January 2019

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3.7 Land restoration for achieving SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

G.P. von Maltitz and A.L. Cowie

Summary

Goal 7 of the Sustainable Development Goals (SDGs) aims to "Ensure access to affordable, reliable, sustainable and modern energy for all". This goal is to be achieved through a combination of the increased use of renewable energy sources (target 7.2) and doubled energy efficiency (target 7.3). Almost all energy sources have a land impact, but the direct footprint of bioenergy is greater than that of wind, solar and fossil fuels. Nevertheless, land restoration, rehabilitation and sustainable land management can greatly enhance the sustainable flow of biomass-derived fuels, whilst also helping to reduce land degradation impacts from the mining of coal, gas and petroleum-based fuels.

7 AFFORDABLE AND CLEAN ENERGY — TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services		✖
TARGET 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	✖	✖

Table 3.7.1. Examples of SDG 7 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all of the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of restoration for SDG 7: Affordable and clean energy

Multiple opportunities exist for restored and rehabilitated land to be used for the production of traditional (wood fuel) and modern bioenergy (biofuels, combined heat and power) to generate renewable energy. Restoration can also restore productivity to areas such as coalfields, oilfields and gas fields degraded during fossil fuel extraction (Ahirwal et al. 2017). Furthermore, degraded sites that are uneconomic to return to productive uses can be targeted for wind and solar energy installations.

To achieve the Paris Agreement's 1.5 oC temperature target will require substantial bioenergy, possibly linked with carbon capture and storage (CCS) within the fuel mix (Fujimori et al. 2016; Sivan and Dooley 2016; UNEP 2016; IPCC 2018). Degraded land has an estimated global potential for the generation of 25 to 90 EJ of energy (Nijsen et al. 2012; Wicke 2011), with Africa's degraded lands having an estimated potential to produce 6 EJ per year of primary bioenergy if all degraded areas were converted to biofuel crops (IRENA 2017). The use of lignocellulosic material through a variety of different conversion technologies (so-called second-generation biofuels) can produce liquid fuels to replace petroleum. For many of the world's poorest populations, access to wood fuels remains their primary energy source, and restoration can greatly increase the sustainable supply of this fuel.

Possible risks, trade-offs and costs of land restoration for SDG 7: Affordable and clean energy

Despite the huge potential for sustainably produced traditional wood fuel (firewood and charcoal) from restored land, even when coupled with improved stove technologies, this fuel seldom meets the WHO (2014) stringent air quality requirements for "clean" fuels (Pope et al. 2017). Use of biomass for modern energy such as biofuels or electricity can greatly increase the percentage of sustainable fuels in the fuel mix, but in developing countries there is still limited evidence that this will provide cheap fuel to the poor.

Rehabilitating degraded areas for the production of bioenergy, especially if this is produced using a monoculture, will result in reduced biodiversity compared to a fully restored area. However, if the biomass is produced from a mix of indigenous species, it may have greater

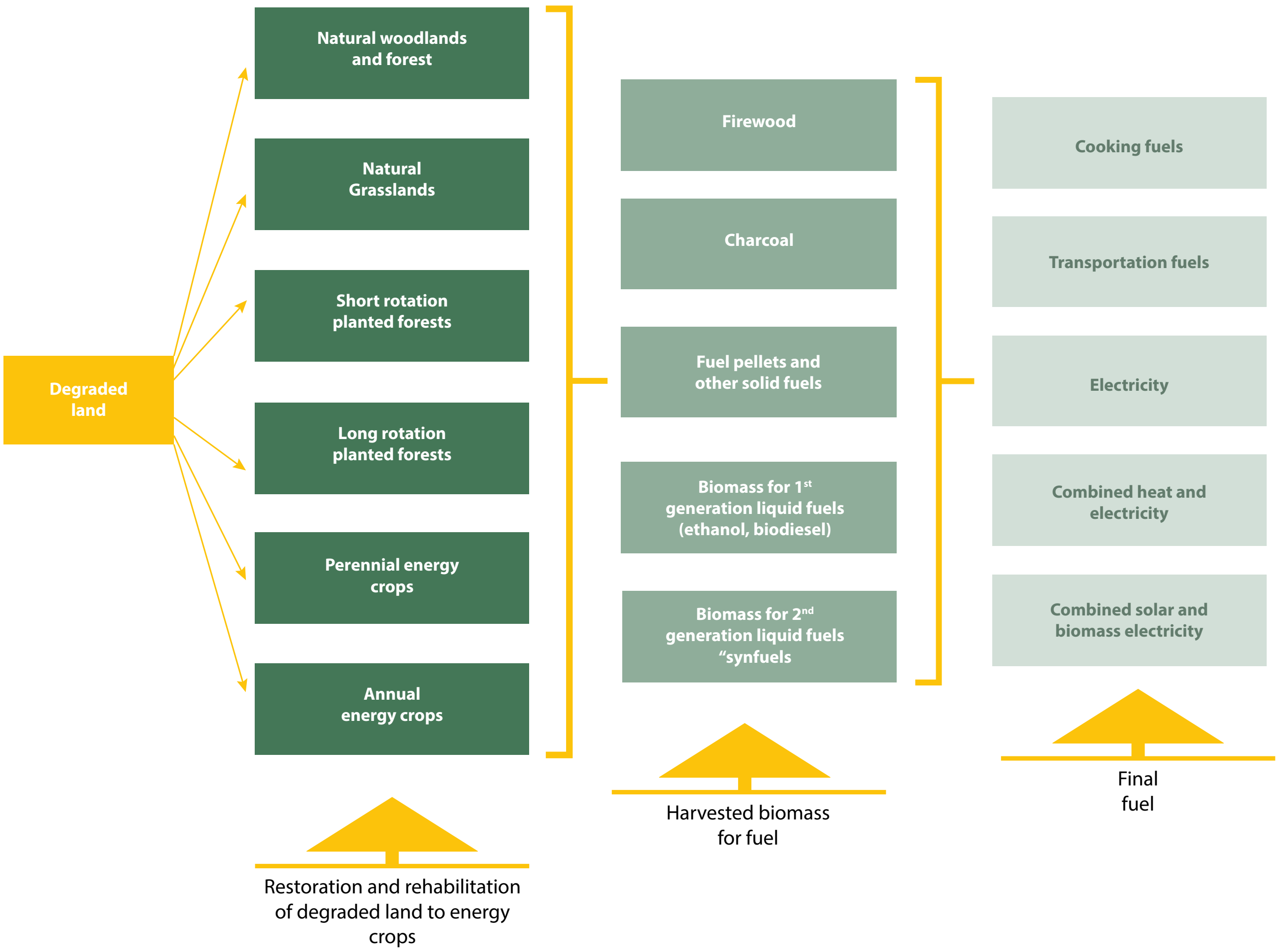

Figure 3.7.1. Illustrates how degraded land can be restored or rehabilitated to a number of different bioenergy crops. These crops can then provide a fuel source that can either be used directly or converted into fuels such as electricity or liquid fuels that can replace petroleum products.

biodiversity than the initial degraded area. Furthermore, literature and biofuel advocates often suggest there are vast areas of available land for biofuel production. However, the analysis of available land does not distinguish between degraded land and other marginal land of naturally low productivity but with important natural biodiversity. Such "marginal land" is often used informally, even if classified as "unused". Restoration and/or rehabilitation can therefore lead to indirect land use change, if farming activities on the degraded land are displaced to remaining natural vegetation (Rosillo-Calle and Johnson 2010). In addition, degraded land might not give the high yields anticipated due to the inherent low productivity of degraded land, and investors might concentrate projects on higher production land, despite degraded land restoration being targeted in the interventions.

Specific strategies for maximizing the benefits of land restoration for SDG 7: Affordable and clean energy

Agroforestry is the practice of growing selected tree species in combination with annual agricultural crops and can be used as a rehabilitation method for degraded land (Borchard et al. 2017; Mehmood et al. 2017). It has a number of benefits for crop production as well as increasing flow of wood or oils as a source of fuel. Agroforestry tends to work best in relatively moist environments, but there are techniques and practices that work in arid environments. An example is the use of the Ana tree (Faidherbia albida), under which some crops grow better than when grown away from the tree, with the tree also providing an important woodfuel source. This agroforestry practice has been used extensively in the Great Green Wall rehabilitation initiative in the Sahara and the Sahel region of Africa (Sinare and Gordon 2015).

Grass species such as Miscanthus (Miscanthus spp.), Switchgrass (Panicum virgatum L.) and Sweet Sorghum (Sorghum bicolor L.) have the potential to produce high biomass yields and could therefore be the basis of lignocellulosic-based biofuel production on previously degraded lands (Mehmood et al. 2017). Miscanthus was shown to grow successfully in areas contaminated with minerals (Fe, Mn, Ti, and Zr) in Ukraine (Pidlisnyuk et al. 2016). Herbaceous biomass crops can provide effective buffers around cropland, reducing pollution of waterways from sediment and nutrients in run-off (Ferrarini et al. 2017). Combining grasslands for bioenergy as a component of an integrated cropland landscape can have multiple benefits including increased biodiversity, reduced erosion and a diversification of livelihood opportunities.

Short rotation woody crops such as poplar, willow and oil mallee can be coppiced after harvest, and cut every two to five years, thereby providing regular production while avoiding frequent soil disturbance. Willow is well-known for its capacity in phytoremediation of soils contaminated with heavy metals, although the residues (e.g. ash) require careful disposal when used for bioenergy.

Restored degraded forests and woodlands can supply flows of renewable woodfuels if managed appropriately. Restoration processes can range from restoring near-natural tree diversity to growing monocultures of trees for short-rotation forestry. Products include firewood, charcoal, and wood chips and pellets. Uses include cooking, space heating in domestic boilers, industrial-scale combined heat and power plants and biofuel production. Despite a huge theoretical potential for biomass-derived energy from restored lands, finding practical ways to make this happen in the short-term are still problematic, especially for developing countries. Technologies such as power production from biomass are well developed, but second-generation biofuel technologies are not widely deployed on a commercial scale. The harvesting and transportation of biomass is costly and modern conversion technologies are capital intensive and expensive to run, making them difficult to establish in impoverished rural areas. Simple technologies such as improved charcoaling therefore remain the most easily exploited options in the short-term and can most directly and cheaply get fuel to the poorest in society (see box 3.7.1) (FAO, 2017b). This might be a sound bridging strategy until more advanced fuels can be economically produced. However, policy reform that promotes truly sustainable firewood and charcoal production is needed in most countries (Liyama et al. 2014). This should target the rehabilitation of degraded lands and include incentives and rules for sustainable forest management and limiting emissions of particulates and greenhouse gases.

In many savanna areas, an increase in tree density and cover (referred to as bush encroachment in Southern Africa) greatly reduces the livestock-carrying capacity. This is degradation due to increased woody biomass, rather than the normal concept of degradation being linked to deforestation. This phenomenon is experienced globally, and is a major problem in Namibia, for example. Land restoration through clearing the bush can result in a biomass source for energy generation (Stafford et al. 2018).

Utilizing degraded land for bioenergy crops will reduce the competition with food production that is anticipated from the expansion of biomass production to deliver the anticipated demand for bioenergy to meet the Paris Agreement target (Fritsche et al. 2017; Kline et al. 2017).

Bioenergy has a key role in facilitating the expansion of other renewables and thus supporting SDG 7. Because biomass can be transported and stored (e.g. in the form of pellets or biomethane), bioenergy is a dispatchable energy source, able to supply baseload, and provide grid stability and security (Matek and Gawell 2015), and thus support the increased use of intermittent renewable energy sources, especially solar and wind (Fritsche et al. 2017). Biomass could, for instance, be used in a hybrid concentrated solar power (CSP) biomass plant, helping to balance the load as well as creating multiple job opportunities (Soria et al. 2015). Thus, the rehabilitation of degraded land to supply biomass for energy can indirectly support other renewable energy sources, enhancing energy access beyond the direct contribution of bioenergy generated. However, any use of biomass for fuel must be balanced with opportunities to sequester more carbon in both above- and below-ground biomass (Griscom et al. 2017).

Box 3.7.1: Meeting clean fuel targets using wood fuels

Woody biomass is the oldest form of renewable energy and can be produced sustainably from restored land, including through the use of agroforestry systems. Of the global renewable energy sources, 77 per cent came from bioenergy in the early 21st century, of which 87 per cent was woody biomass from trees and shrubs (IEA 2009). Woody biomass can also be sustainably produced from restored woodlands and forests, bringing much needed income into deeply rural areas. Although there is a global push for advanced cooking fuels such as electricity and LPG, woodfuels (firewood and charcoal) are still the main fuel for three billion people and wood fuel is likely to remain a primary fuel for many in the medium-term (GIZ 2014). About 94 per cent of Africa's rural dwellers and 73 per cent of urban dwellers rely on wood fuels as their main energy source (IEA 2014). Charcoal is the predominant cooking fuel in many of Africa's large cities, even in situations where there is access to grid electricity, and its use as a fuel seems to be increasing rather than decreasing (Mudombi et al. 2018). As the FAO (2017a and 2017b) points out, charcoal is a fuel of choice for many middle-income households. Even when households have access to electricity, charcoal may still dominate the cooking fuels used. Advanced wood fuel stoves can greatly reduce health impacts associated with biomass burning compared to traditional stoves. However, most still fail to reach the annual average kitchen particulate matter (PM2.5) 10µg/m3 recommended by World Bank (2014), nor the intermediate target of 35µg/m^3.

Charcoal production is often linked to deforestation, but there is growing evidence that in many situations it can be sustainably produced (FAO 2017a). Charcoal is an estimated USD 8 billion industry in Africa alone (World Bank 2011). It also tends to be a less polluting energy source (from a human health perspective) than firewood, especially if used in improved stoves. Improved stoves can also greatly reduce air pollution, especially if lit outdoors and only brought into the kitchen when actually cooking. Gasification stoves, sometimes with solar fans to force airflow (referred to as advanced cook stoves ACS), and/or the use of outside chimneys can reduce emissions to near WHO levels (Roth 2013). Despite low acceptance of relatively costly improved stoves in rural areas where fuel is free, in urban areas were fuel is typically purchased, the cost savings from reduced fuel use can easily justify the purchase of the stoves, an example being the high uptake of relatively expensive stoves in Kenya.

Figure 3.7.2. An example of a fan-driven, forced-draft ACS that produces very low PM2.5 emissions

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3.8 Land restoration for achieving SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

E. Primmer and V. Sudoi

Summary

Economic growth depends on healthy ecosystems that provide food, fibre, fuel and clean water. Restoration generates jobs and economic activity both directly and indirectly, through planning and operational activities that directly contribute to restoration as well as services, information, financing and governance supporting the operational activities. A primary challenge is the distribution of benefits over time and among groups and individuals in society and different ecosystem services. For example, the benefits of restored agricultural land are different from those provided by a restored forest ecosystem. A number of strategies are identified that may increase the co-benefits of restoration for economic growth, including focusing on fragile and marginalized rural economies. Competitive payments and market-like mechanisms can be complemented with mandatory compensation, and offset policies that shift the costs and responsibility for restoration onto the private sector actors, causing degradation.

8 DECENT WORK AND ECONOMIC GROWTH

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries	✕	✕
TARGET 8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors	✕	✕
TARGET 8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services	✕	✕
TARGET 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead		✕
TARGET 8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	✕	✕
TARGET 8.6 By 2020, substantially reduce the proportion of youth not in employment, education or training	✕	
TARGET 8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms	✕	✕
TARGET 8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products		✕
TARGET 8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all	✕	

Table 3.8.1. Examples of SDG 8 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all of the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 8: Decent work and economic growth

Restoration and rehabilitation, coupled with avoidance of land degradation, represent investments in long-term economic opportunities, growth and resilience. Governments and organizations leading the operationalization of the global commitments to combat desertification (UNCCD) and address climate change (UNFCCC) increasingly recognize the long-term economic benefits of land restoration. There is a growing awareness in particular of the local growth and employment benefits that land restoration can provide. The REDD and REDD+ mechanisms have provided an important testbed for assessing the local to global distribution of economic costs and benefits of restoration with a focus on climate change. REDD+ has shown that, with appropriate governance, it is possible to implement large-scale restoration projects with an equitable distribution of economic benefits.

The recent biodiversity and ecosystem services (IPBES) report on land-degradation repeats the economic rationale for restoration, stating that the benefits of restoration, including increasing resilience, average 10 times the costs (IPBES 2018). The report highlights the numerous benefits that sustainable ecosystems can provide, from provisioning services, such as food, fibre, fuel and water, to regulating services, such as clean water and a stable climate, all contributing to health, security and peace. Functioning and diverse ecosystems are typically more resilient and provide insurance against extreme weather events, pests and diseases (Green et al. 2016). Restoration generates economic well-being from functioning ecosystems and can mitigate economic losses from degradation (Costanza et al. 2014; Chazdon and Uriarte 2016). Restoration projects can both directly and indirectly increase economic growth and resilience. Promoting land-degradation neutrality under the 2030 Agenda builds on these expectations of multiple benefits which would result in new job opportunities and economic growth, particularly in lower income countries.

The long-term benefits associated with restoration are well documented, and include increased property values and local tax revenues, increased revenues associated with tourism and outdoor recreation, increased fish and game revenues, and avoided costs associated with more resilient ecosystems and the sustainable provision of ecosystem services. Surveys examining willingness to pay for a property nearer a restored environmental asset have shown marginal increases in property value attributable to restoration. Even the protection of land from degradation by removing it from production can sometimes result in economic gains where land conservation results in an increase in tourism and recreation (Sims et al. 2019).

Restoration generates jobs and economic activity, both directly and indirectly. Indeed, the so-called "restoration economy" (BenDor et al. 2015, p. 2) encompasses all of the planning and operational activities that directly contribute to restoration, as well as services, information, financing and governance supporting the operational activities. The employment multipliers of restoration projects have been shown to be well within the range of several other industries, including oil, gas, crop and livestock agriculture, and outdoor recreation (BenDor et al. 2015).

Possible risks, trade-offs and costs of land restoration for SDG 8: Decent work and economic growth

The main challenge for restoration is the distribution of benefits over time and across societal actors. For example, the benefits of restored agricultural ecosystem are different from those provided by a restored forest ecosystem. These evaluations are complicated by long delays between the replanting of forests and the reaping of the benefits. Commonly, the comparison is made between the jobs and economic growth trajectories of current intensive land-use with clearly defined beneficiaries and more diffuse benefits of water retention, soil function or resilience against pests. However, the comparison is also difficult in traditional land-use settings. For a subsistence farmer, a degraded system that is continuing to degrade may provide far greater benefits than restoration, and the time-horizon of decision-making might be particularly short.

Many restoration projects cannot independently generate a positive short-term and sometimes even long-term return on private investment. This leaves them dependent on public sector co-financing or direct payments or subsidies. Public subsidies can be more easily justified where the co-benefits for other SDGs described throughout this report can be identified and, ideally, quantified. Providing employment through the restoration project for farmers and other land managers often represents the most immediate and direct sustainable development benefit. In addition to providing an alternative income, continued stewardship of the restored sites may also provide opportunities for them to identify new opportunities, such as ecotourism or alternative crops or products. In most areas, however, avoiding land-degradation, is by far the most cost-effective way of maintaining ecological, economic and social sustainability with the fewest risks and trade-offs (Paul and Knoke 2015).

Specific strategies for maximizing the benefits of land restoration for SDG 8: Decent work and economic growth

The "restoration economy" has been proposed as a way to both describe and promote the benefits associated with sustainable land use and restoration (BenDor et al. 2015). It is promoted by public and private programs that generate demand for restoration, either as obligations or as opportunities. Indeed, restoration can be promoted through policies that mandate or incentivize investment in restoration (IPBES 2018). Examples include requirements to offset development activities, the investment of public funds in restoration activities, and financial and organizational support for public, public-private and private partnerships at different levels of government. Policies that require or allow for government activities, such as roadbuilding, to be carried out in a more sustainable or restorative manner have also been shown to be effective (IPBES 2018). Foundations, non-profits, corporations and institutions can often justify restoration investments as a way to meet sustainability and social responsibility goals.

Align the development of restoration strategies with the policy objectives of natural resource and land-use. It is important to also consider the long-term and indirect economic benefits and socio-economic impacts of restoration in order to ensure that they are consistent with broader policy objectives. In addition to maximizing co-benefits of restoration, a coherent approach to restoration by governments can help strengthen the case for restoration requirements that impose economic costs on businesses (BenDor et al. 2015). Where restoration requirements are simply framed as regulation and evaluated against the economic opportunities of the development for industry or construction, they are likely to be strongly resisted.

Build restoration initiatives on local economies to ensure sustainability and positive socio-economic impacts of restoration. Important sectors, whose actors need to be engaged and will experience the economic consequences of restoration, include agriculture, forestry and energy. For example, because restoration in many countries focuses on afforestation or reforestation, the restoration economy is tightly coupled with the use of forests for industrial production and fuel. Advancing restoration should be coupled with cost-benefit analyses of these sectors and mobilizing their existing and nascent skills and resources. Forestry represents USD 600 billion of global gross domestic product (GDP). The economic significance of forestry is relatively much higher in low-income countries where forests also contribute significantly to the informal economy. Averaging at 0.9 per cent of global GDP, forestry's contribution to GDP in low-income countries is almost 1.4 per cent, while it is only about 0.1 per cent in high income countries.

Channel public funds to restoration to diversify fragile and marginalized rural economies. Restoration activities and their outcomes can help diversify fragile and marginalized communities in both industrialized and non-industrialized economies. Restoration provides an alternative employment opportunity and can be coupled with the development of new competencies and result in new rural jobs and value chains (Nielsen-Pincus and Moseley 2013). For example, the ecological restoration sector in the USA has been estimated to employ over 125,000 workers and generate an annual output of USD 9.5 billion, in addition to contributing to less directly connected jobs and local spending (BenDor et al. 2015). In arid areas, fire-prone areas and watersheds, restoring local ecosystems can indeed secure a vital lifeline that the rest of the local economy relies on.

Allocate restoration incentives as competitive payments, using market-like mechanisms. REDD+ carbon offsetting programs for forest restoration represent just one of many examples of how outcome-based payments can be used to increase the return on investment. However, an improved understanding of the economic impacts of different payment schemes is needed to support further applications and innovations.

Create policies that shift responsibility for restoration to the private sector actors causing degradation, through a combination of compensation and offsets. A co-benefit of these policies can include the creation of new value chains and business opportunities. (Ten Kate et al. 2004). This type of mechanism can help address counter-arguments that appeal to jobs and economic growth (BenDor et al. 2015). Ecological compensation can be legally required, for example as a part of development permit procedures or following environmental impact assessments. In these obligatory compensations, a so-called mitigation hierarchy requires that avoidance of land-degradation is considered before the residual impact can be offset. Often the aim of offsetting mechanisms is to avoid net loss, which has resulted in critical evaluations of existing offsetting systems that allow land degradation with inadequate offsets. Yet compensation is a way to ensure that land degrading actors address the costs of degradation and restoration. Developing compensation and offset mechanisms can result in new competencies and economic opportunities in the assessment, restoration and trading systems.

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3.9

Land restoration for achieving SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

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Summary

Land restoration and rehabilitation have a large number of clearly and easily identifiable co-benefits for infrastructure and innovation, both of which are necessary to support sustainable industrialization. The development of “quality, reliable, sustainable and resilient infrastructure” (target 9.1) requires ensuring that land is managed and restored to minimize flooding, dust storms and other threats. Land degradation avoidance and restoration activities are widely recognized as key components of infrastructure development projects, including transportation, “to make them sustainable” (target 9.4). Restoration projects also commonly require local research (target 9.5), including civil engineering, to ensure that the practices are appropriate for the specific types of land and climate occurring in each country and region. These projects can also be used to facilitate “access of small-scale industrial and other enterprises…to financial services” (target 9.3) if the contracts and payments are managed appropriately. This helps them to establish a credit record while strengthening the financial service providers. There are also trade-offs, as most industrialization and infrastructure development requires land conversion. These impacts can often be minimized by locating these activities on already degraded land.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all		✖
TARGET 9.3 Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets	✖	
TARGET 9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	✖	
TARGET 9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	✖	
TARGET 9.A Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States	✖	
TARGET 9.B Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities	✖	
TARGET 9.C Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020	✖	

Table 3.9.1. Examples of Sustainable Development Goal (SDG) 9 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 9: Industry, innovation and infrastructure

Industry and infrastructure nearly always involve some impact on the land, requiring restoration, which creates a direct connection between SDGs 9 and 15. At a very basic level, land restoration helps minimize the environmental costs of achieving this SDG. The distribution of these costs is already highly regulated in many countries, as infrastructure project budgets are required to include both minimizing the impacts of developments on the surrounding landscape (e.g. through the construction of water run-off diversion systems along roadways or adding fencing to minimize impacts on wildlife; van der Grift et al. 2013) and restoring a similar amount of land to that which is directly affected. More sophisticated approaches (e.g. Cuperus et al. 1996) attempt to match losses in ecosystem functions through a combination of the size and quality of the restored areas.

Industry and infrastructure are also frequently affected by land degradation through increased frequency and intensity of flooding, the erosion of road- and rail-beds, and the impacts of dust from wind erosion on vehicles and machinery. By maintaining or increasing soil water infiltration rates for example (see figure 2.2 and box 2.1 in chapter 2), water is stored in the soil rather than moving quickly off the land in floods. Land that is restored to explicitly address run-off (e.g. by constructing wetlands or re-establishing mangroves in coastal regions (Danielsen et al. 2005)) can maximize co-benefits for infrastructure.

Increased infiltration and maintenance of ground cover also reduce the siltation of reservoirs, increasing their useful life (Zeleke et al. 2007). This avoids the social, economic and environmental costs of developing new reservoirs, typically in less favourable locations.

Possible risks, trade-offs and costs of land restoration for SDG 9: Industry, innovation and infrastructure

The most common significant trade-off of land restoration for industry, innovation and infrastructure is that the maintenance of restored areas can limit future expansion of industrial enterprises and many types of infrastructure. For example, restored wetlands in a canyon may be inundated by future reservoir development, while investments restoring agricultural land in peri-urban areas may preclude both future industrial development and the re-establishment of native ecosystems (Power 2010).

Specific strategies for maximizing the benefits of land restoration for SDG 9: Industry, innovation and infrastructure

There are at least three types of strategies for maximizing the benefits of land restoration for infrastructure, industry and innovation. The first is to include restoration in the design phase of infrastructure projects. This can often reduce the overall costs of these projects. For example, where watershed restoration reduces run-off intersecting a road, fewer and smaller drains must be installed. Similarly, the restoration of wildlife habitat at some distance from a road, and developing wildlife transportation corridors can reduce the likelihood that animals will cross roads through traffic, reducing the costs of collisions and the need for fencing while preventing genetic isolation of wildlife populations (e.g. Corlatti et al. 2009).

The second strategy is to include infrastructure and industrial development, together with restoration, in broader land use planning efforts. As detailed in a previous International Resource Panel report (UNEP 2016), this can effectively “unlock the sustainable potential of land resources”.

The third strategy focuses on innovation. In most developing countries, the majority of the population is still within one generation of agricultural production, and in some the majority continues to earn part or most of their incomes from farming and/or livestock production. The knowledge associated with these activities provides a strong foundation for developing innovative approaches to land restoration, particularly when integrated with initiatives designed to address other SDGs, such as education (SDG 4).

Box 3.9.1: Applying land restoration to strengthen rural-urban linkages (RUL) as a strategy to reduce poverty and improve environment in the Ethiopian Highlands

One of the biggest challenges for developing successful restoration projects that optimize benefits for multiple SDGs is identifying options for meeting the needs of rapidly expanding urban populations while maintaining or improving rural lands. A 2006 workshop addressed this challenge through an analysis of rural-urban linkages in the Ethiopian highlands. While the workshop did not explicitly address land restoration, it did result in a framework that can be applied to the necessary analysis (Zeleke et al. 2007; figure 3.9.1). The framework includes a livelihood analysis for both urban and rural populations. This can be used to identify key limitations faced by urban populations (e.g. reliable energy supplies) that could be addressed by rural land restoration (e.g. including some sustainable biofuel production – see chapter 3.7). The second component is a flow analysis. This analysis is particularly helpful for identifying potential synergies and trade-offs between land restoration and other SDGs as it breaks down the flow analysis into natural resources, water, labour and, significantly, knowledge and information. Finally, the framework includes a policy and institutional analysis component. This is particularly important when considering infrastructure projects, which often cross a number of national and even international administrative units, where policies may differ widely.

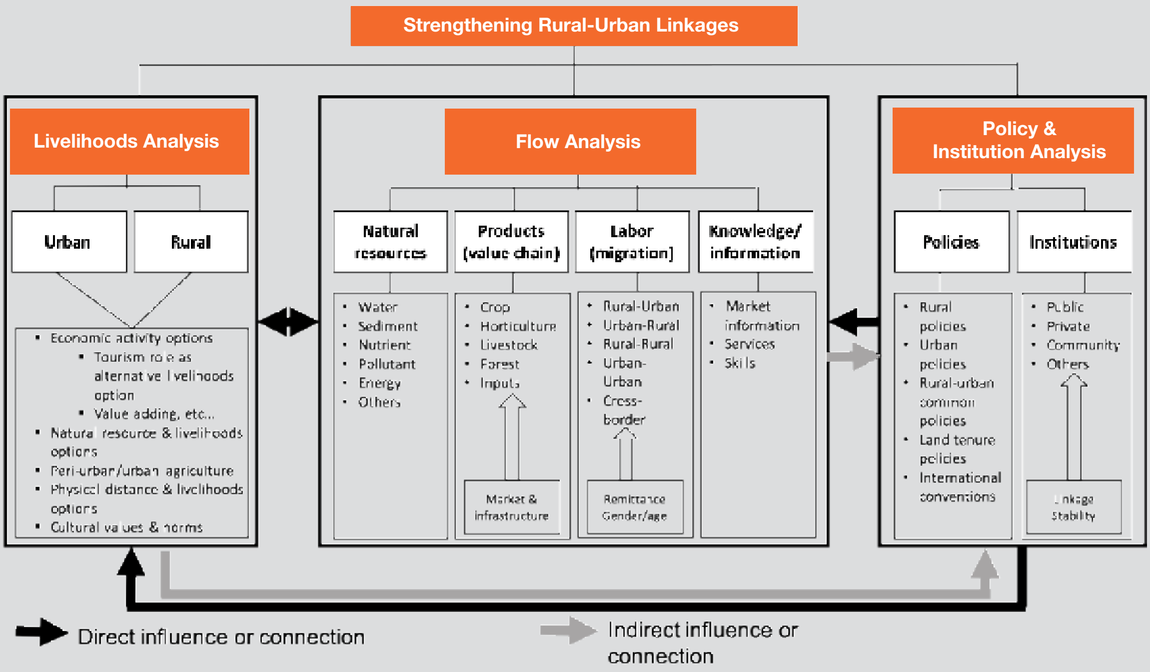

Figure 3.9.1. Conceptual framework for strengthening rural-urban linkages (Zeleke et al. 2007).

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3.10 Land restoration for achieving SDG 10: Reduce inequality within and among countries

A. Quandt and D.W. Kimiti

Summary

Sustainable Development Goal (SDG) 10 states that we must reduce inequality within and among countries. This includes increasing income growth of the bottom 40 per cent, empowering inclusion, ensuring equal opportunity and reducing inequalities, giving less developed countries a voice in international decision-making processes, facilitating responsible migration, and effective monitoring of global financial markets. Inequality is a major challenge for every country, both developing and developed. Inequality can contribute to land degradation, while land restoration can have positive impacts on reducing inequality (figure 3.10.1). Restored land can be more productive, increase incomes, and reduce the need to migrate to new lands. In order to maximize the benefits of land restoration for SDG 10, land-related laws and policies should promote equal ownership rights to land, provide incentives for restoration, promote inclusive decision-making about land resources, and do all of the above in a culturally sensitive way.

10 REDUCED INEQUALITIES — TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average	X	X
TARGET 10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status	X	
TARGET 10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies		X

Table 3.10.1. Examples of SDG 10 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all of the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 10: Reduced inequalities

Inequality is one of the biggest limitations to achieving economic potential. The issues of poverty and land degradation are cyclical, and improving one can positively impact the other. For example, land degradation is often not caused by the ignorance of small-scale land users, such as pastoralists or farmers, but instead tied to larger socioeconomic forces that put people in vulnerable positions, leading to the overuse and degradation of the land (Blaikie 1989). Poor countries are more likely to experience land degradation, and approximately 40 per cent of the world's degraded lands are found in areas with the highest incidence of poverty (Samandari 2017). Thus, land restoration targeting the poorest countries would help to close the income divide between countries by increasing the quality and productivity of the land. Additionally, equal and inclusive land tenure laws promoting sustainable land management and equality in the agricultural sector have the potential to reduce inequality within countries. Lastly, effective land restoration can reduce the need for people to migrate in search of new opportunities. Land degradation and migration can be closely interconnected processes, which are mediated by other social, economic, political, demographic and environmental processes (McLeman 2017).

Land Restoration's Contribution to SDG 10

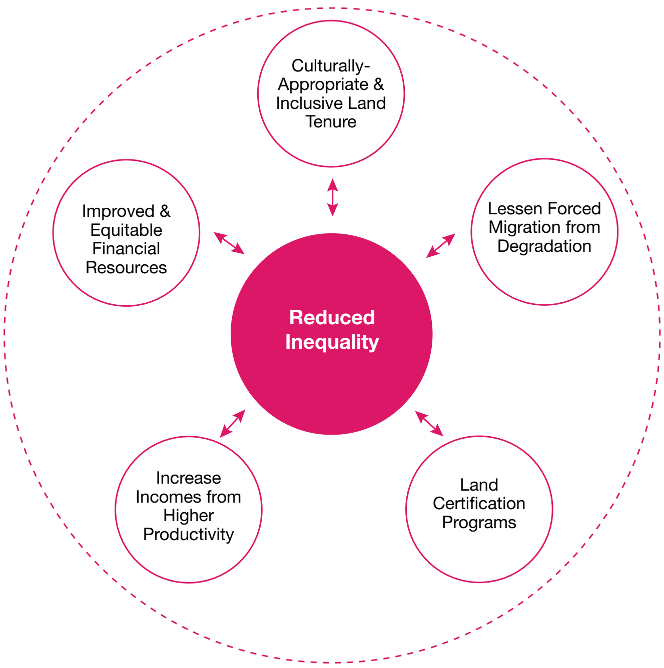

Figure 3.10.1. Co-benefits and strategies for maximizing the contribution of land restoration to SDG 10

Possible risks, trade-offs, and costs of land restoration for SDG 10: Reduced inequalities

There are risks, trade-offs, and costs in promoting land restoration for obtaining SDG 10. For example, wealthy countries have greater resources available for land restoration, thus land restoration in wealthy countries could potentially increase inequality between wealthy and poor countries. Within countries, restored land could be captured by local elites, forcing smallholder farmers to continue farming on degraded lands while the elite profit from the benefits of restored land, thus maintaining or increasing local inequalities. A major trade-off is the issue of migration, which is actually an important part of many livelihood activities. Promoting individual tenure of land for the sake of sustainable management and restoration may actually hinder some livelihoods, including pastoralism. Migration is a key strategy for many households to cope with and adapt to seasonal and ongoing environmental changes. Indeed, the conversion of communal land rights to individual tenure can, in some cases, lead to land degradation and facilitate agricultural land grabs by outside commercial interests (McLeman 2017). However, in other cases, more secure land tenure has shown to create greater incentives for more sustainable land management and land restoration. Thus, the cultural context of land use and livelihoods is critically important for choosing appropriate land tenure policies.

Specific strategies for maximizing the benefits of land restoration for SDG 10: Reduced inequalities

One prominent strategy for maximizing the benefit of land restoration for SDG 10 is through effective, culturally appropriate land tenure laws and policies (figure 3.10.1). Importantly, policies are needed that promote equal ownership and use rights to both men and women, as well as policies that ensure that once land is restored, the benefits accrue equitably to meet the needs and interests of all. Too often, women are left out of policies allowing them equal land ownership and use of natural resources. Along similar lines, land restoration projects must address the specific needs and opportunities of rural women and men, particularly the poorest, to reduce inequalities and stimulate growth. For example, restoration efforts need to take into account the different livelihood preferences of both men and women, not prioritizing one over the other. Gender-responsive land-degradation neutrality policies are imperative at the local, national, regional, and global level. Supporting grassroots-level efforts at land restoration can also lead to positive outcomes for equality and inclusiveness. An excellent example of this is the Green Belt Movement in Kenya, which was founded in 1977 by Nobel

Laureate Wangari Maathai. This grassroots movement began in response to "the needs of rural Kenyan women who reported that their streams were drying up, their food supply was less secure, and they had to walk further and further to get firewood for fuel and fencing" (Samandari 2017). The movement encouraged, trained, and assisted women to take charge of conserving their lands, soils and water, and to demand the state's attention to these problems.

Furthermore, when culturally appropriate, land certification programs can provide secure land tenure rights (figure 3.10.1). Ethiopia's recent land certification program has confirmed previous work that shows that the legal ownership of the land increases investments in, and outputs from, the land (Samandari 2017). These certification programs should aim for inclusiveness.

Ending land-degradation associated with internal or international migration can also reduce inequality (figure 3.10.1). The term "environmental refugees" has been used to describe involuntary migrants caused by environmental issues, land degradation being one issue among many. Therefore, financial resources and policies should help contribute to the land restoration efforts specifically aimed at avoiding involuntary migration, but also to assist "environmental refugees" to relocate to restored or un-degraded lands when necessary.

Lastly, improving and promoting equitable financial services to those dependent on natural resources for their livelihoods can help increase profits for smallholders through reducing the costs of financial transactions and allowing for ease of payments (Figure 3.10.1). For example, according to the United Nations Capital Development Fund (UNCDF) in Kenya, the mobile money service M-Pesa is estimated to have lifted almost 200,000 Kenyans out of poverty and has been effective in improving the economic lives of poor women.

Box 3.10.1: Restoration in Northern Kenya empowers women in pastoral societies

As human populations continue to rise across sub-Saharan Africa, reliance on natural ecosystems continues to rise. This increased pressure on land resources is often coupled with land degradation. In the arid and semi-arid rangelands of Northern Kenya, a perfect storm of disturbance factors has led to degradation across large areas of the landscape, characterized by bare ground prevalence and invasive species encroachment. Most of the pastoral communities in Northern Kenya, specifically the Maasai and Samburu, are patriarchal societies, where the role of women in the community, while important, has been often deemed subservient to the man's role as a warrior or elder, most notably following the cultural intersection between traditional pastoral structures and colonial-era policies (Hodgson 2000). As a result, while males of the tribe traditionally engaged in livestock production activities, women were consigned to household and hunter-gatherer roles. In contemporary Kenya, not much has changed, and Maasai and Samburu women continue to be on average less educated and less likely to be economically empowered than their male counterparts (Gneezy et al. 2009).

As the issue of land degradation emerged as a threat to livelihoods across pastoral lands in Kenya, efforts to rehabilitate these areas gained traction. In Laikipia County, pastoral communities in Tiemamut and Leparua group ranches embarked on reseeding projects aimed at increasing vegetation productivity for livestock. These reseeding projects were set apart from other restoration attempts in the landscape by virtue of them being exclusively initiated, managed, and protected by the women in the community (Mureithi 2012). In Leparua, the women's group supplements their income by getting paid through the Northern Rangelands Trust (NRT) to collect grass seed heads from nearby conservancy grass banks for restoration projects (Figure 3.10.2). Similarly, restoration projects in Westgate and Kalama community conservancies in Samburu County directly employ conservancy women to harvest *Cenchrus ciliaris seed* for use in reseeding projects, as well as for selling on to interested parties. In these conservancies, reseeding programs go hand in hand with mechanical clearing of an invasive tree species, *Acacia reficiens*. Funding for this project through the NRT, the Grevy's Zebra Trust (GZT) and donor agencies is conditional upon all labour distributed fifty-fifty along gender lines. This ensures that not only do women have equal opportunities for earning quick revenue at the beginning of the restoration project, but they are also set up to earn additional continuous revenue once the reseeding project is successful.

Figure 3.10.2. Women from the Leparua women's group collect *Cenchrus ciliaris* seed on Lewa Wildlife Conservancy for use in reseeding projects in NRT community conservancies. (Photo credit: Kieran Avery)

3.11

Land restoration for achieving SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

A.S. Barau, P. Pinho, A.C. Luz and A. Nunes

Summary

Land restoration and rehabilitation in the urban context can help countries attain SDG 11 targets by restoring important ecosystem services in the urban, as well as peri-urban, and rural areas that support urban areas with food, water, energy and raw materials for dwellings and infrastructure. These ecosystem services support a more resilient urban environment. Water, soil and air quality can be improved with land restoration and rehabilitation, reducing environmental risks and impacts, including the urban heat island effect and flash floods. Likewise, land restoration in cities aiming at food production can decrease pressures on rural habitats. However, land restoration and rehabilitation must be planned properly so that their benefits can be distributed equitably, including to the most vulnerable communities. Some innovative policies that promote land restoration and rehabilitation to improve cities can be globally applied, while others must be locally adapted, particularly in developing countries where the negative effects of urbanization are often more serious. Involving local communities in problem assessment and solution implementation can be a pathway to success. Likewise, guaranteeing connectivity between the urban ecosystem and peri-urban areas is mandatory for ecosystem services provisioning and long-term sustainability.

11 SUSTAINABLE CITIES AND COMMUNITIES

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	✖	✖
TARGET 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage		✖
TARGET 11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations		✖
TARGET 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management		✖
TARGET 11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities		✖
TARGET 11.A Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	✖	

Table 3.11.1. SDG 11 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 11: Reduced inequalities

In urban areas, land can often be reclaimed to improve cities' green and blue infrastructure. This can boost biodiversity, which underpins the provision of several ecosystem services within the urban fabric, improving human health and well-being. Green spaces and riverine ecosystems can locally decrease the effects of air, noise, water and soil pollution by providing air- and water-quality regulation (Mexia et al. 2018; Santos et al. 2017; Vieira et al. 2018). Restored urban ecosystems provide microclimate regulation that ameliorate the urban heat island effect (Munzi et al. 2014), and they support flood regulation, avoiding flash floods. If cities' ecosystems are restored taking into consideration local biodiversity and heritage, it can promote the conservation of those values, within and outside the urban area (Pinho et al. 2016). It is established that degradation of urban green infrastructure exacerbates the vulnerability of urban areas to climate change risks and human well-being (Barau et al. 2015). On the other hand, the restoration of urban blue and green infrastructure offers multiple opportunities, which are not limited to lowering emissions and vulnerability to climate change risks (Bai et al. 2018).

The integration of land restoration and rehabilitation in the implementation of existing policies, initiatives and projects may be particularly productive. Examples include SDGs 2, 3, 13, 15, the New Urban Agenda, the Bonn Challenge and others. These initiatives not only support landscape restoration, but they also yield multiple benefits, such as food security, climate change mitigation, ecosystem services and land quality improvement and sustainable housing.

Land restoration and rehabilitation in rural areas can also provide significant co-benefits for cities and human settlements. Direct benefits may include the provision of clean, reliable sources of water by restored watersheds (Santos et al. 2018), or more reliable food supplies through the restoration of degraded agricultural lands. Land restoration and rehabilitation in rural areas can also help make cities more sustainable by reducing the environmental impacts of urban consumption of food, water and energy provided by rural areas.

Possible risks, trade-offs and costs of land restoration for SDG 11: Sustainable cities and communities

While restoring ecosystems in urban areas can increase the provision of ecosystem services, negative impacts on human population health can occur. This includes the increase in pollen-related allergies (Ziello et al. 2012) and the increase in ozone-related risks caused by volatile organic compounds from increased vegetation (Calfapietra et al. 2013). It is also important to highlight that the type and quality of green areas can be related to the social and economic status of neighborhoods (Kabisch and Haase 2014), and the same pattern can be repeated in restoration actions, thus creating unequal distribution of the benefits of restored green areas. Land tenure challenges and conflicts over land may also undermine landscape restoration efforts, particularly in developing countries, as the poor are more likely to lack official land tenure. Land restoration in cities is likely to incur maintenance costs, either for watering plants, especially critical in drylands, and space maintenance, which is more critical in urban areas to avoid the increase of perceived safety risks. Finally, the restoration option, when done top-down, can result in the delivery of services and solutions unwanted by local communities.

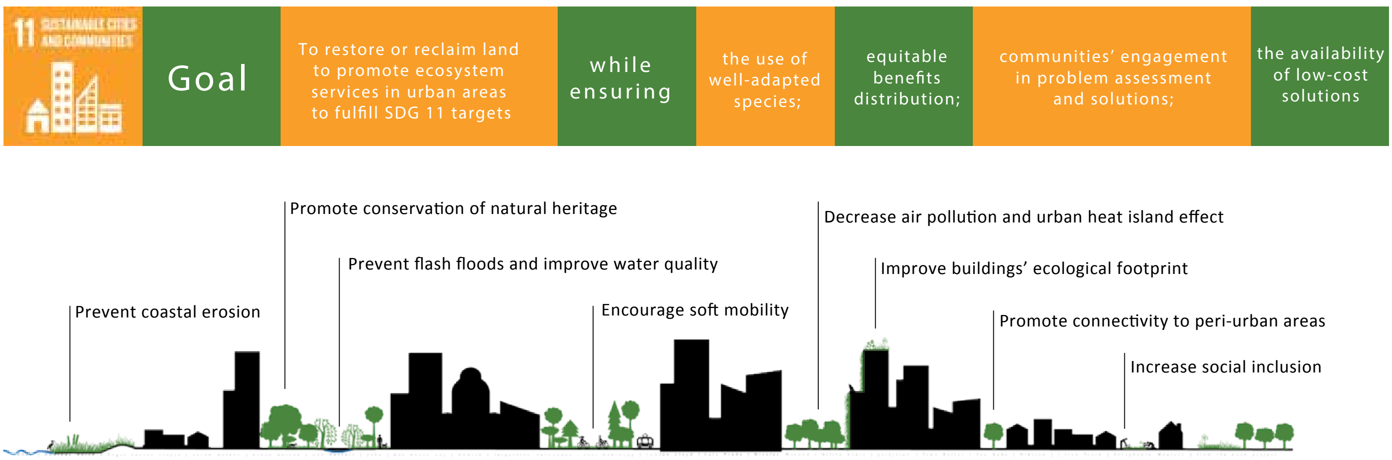

Figure 3.11.1. Land restoration and its rehabilitation can create or promote a wide range of ecosystem services that support SDG 11 targets. If planned with sound ecological and socioeconomic support, land restoration in cities' green spaces and other areas can, for example, prevent coastal erosion and flash floods and decrease the impacts of air pollution and the urban heat island effect.

Specific strategies for maximizing the benefits of land restoration for SDG 11: Sustainable cities and communities

Restoring ecosystems with a single aim (e.g., providing tree cover to provide shade for residents) may incur the problem of creating ecosystems that inadvertently reduce value, either for biodiversity or for people. To overcome this, a focus on ecosystem services at the restoration planning stage should consider multiple functions that can be targeted at the same time and optimize trade-offs between services (Tolvanen and Aronson 2016). For example, improving the diversity of ecosystems within a park and/or providing a more complex vegetation structure can increase green spaces' multifunctionality (Vieira et al. 2018; Mexia et al. 2018). In some cities, participatory approaches can overcome the problems of top-down restoration decisions, implementation and management. For instance, the annual Participatory Budget (https://op.lisboaparticipa.pt/home), conceived by the Lisbon municipality in 2007, results in the proposal and voting of projects by citizens, many of which are directly related to green infrastructure restoration, such as the rehabilitation of the Lisbon Botanical Garden (https://www.ulisboa.pt/patrimonio/jardim-botanico-de-lisboa). To overcome the pitfalls of unequal distribution of ecosystem restoration benefits among city residents, proper planning at the municipal level can ensure that the restored spaces are evenly distributed not only spatially, but also over economic and social strata (Graca et al. 2018).

Box 3.11.1. Dune restoration project protects urban coastline in Almada, Lisbon metropolitan area, Portugal

In 2012, after a major coastal storm which destroyed beach-dune support infrastructure, Almada municipality decided to undertake sand fore-dune restoration with the ReDuna project (A). Along 1 km of the Atlantic coast (B), support structures and native species were used (C) to restore the ecosystem. The facilities installed, such as overhanging walkways (C) and signage (A), have enhanced the possibilities of the local population and tourists for interacting with sand dunes and getting to know their value and importance, while reducing trampling (figure 3.11.2). This project is praised by the local population and tourists for providing added aesthetic values and by beach support-structure owners, who were able to keep the economic revenue from the facilities. The functional characteristics of native vegetation, namely, the very long and dense network of root systems, has withstood recent storms (D), further protecting the nearby beach support infrastructure from havoc. Over time, native vegetation and animals have returned, increasing biodiversity and providing resilience to the restored ecosystem.

Figure 3.11.2. Dune restoration in Almada, Portugal: signage (A); support structures and native species used to restore the ecosystem (B); overhanging walkways (C); revegetation has withstood recent storms (D)

Acknowledgments:

CMA - Câmara Municipal de Almada, specifically DIACS (ex. DEGA) for providing photos and information from ReDuna. The ReDuna project is being implemented by Câmara Municipal de Almada, with the APA (Portuguese Environmental Agency) and funded by QREN-European Commission. Pedro Pinho acknowledges H2020/FCT BiodivERsA 32015104 (BioVeins) for funding. Icons from: Abdo, Andreas Reich, Ángel Santos Freyta, Anton Noskov, Anton Noskov, Dan Hetteix, euka, Gan Khoon Lay, Hamish, Jacqueline Fernandes, Joel McKinney, Landan Lloyd, Luis Prado, Nicolas Morand, Nilita Kozin, parkjisun, Time Reiter, You Baba, Mikicon, Icon Track, Stephanie Wauters, from the Noun Project (https://thenounproject.com/).

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3.12

Land restoration for achieving SDG 12: Ensure sustainable consumption and production patterns

K.F. Davis and A. Chhatre

Summary

The production and extraction of agricultural goods, forest products, energy, and minerals alter landscapes and natural systems across the planet and support the livelihoods of billions of people. These land-use decisions are driven in large part by local and distant consumer behaviour and preferences. As the primary SDG linking production and consumption, efforts under SDG 12 have a central role to play in developing land restoration strategies that acknowledge the complexity and interconnectedness of resource availability and demand in order to most effectively target the fundamental drivers of land-use change.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 12.2 By 2030, achieve the sustainable management and efficient use of natural resources	X	X
TARGET 12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment	X	
TARGET 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse		X
TARGET 12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle		X
TARGET 12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	X	X

Table 3.12.1. Examples of SDG 12 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 12: Responsible production and consumption

Efforts at land restoration and avoided degradation can offer a number of benefits toward achieving SDG 12 targets, as highlighted in previous International Resource Panel reports on land (UNEP 2016a; UNEP 2016b; IRP 2019). Forest restoration can stabilize the timing and availability of fresh water for irrigation and increase carbon storage. Through improved soil and nutrient management practices, land restoration can ensure that agricultural fields are not only more productive and profitable, but also more capable of sequestering carbon. As such, promoting efficient and sustainable land use practices can better secure the livelihoods and well-being of those who rely directly on the land, while also realizing climate mitigation benefits. Land restoration and avoided degradation can also indirectly benefit other aspects of consumption and production, including improved air and drinking water quality, increased resilience to climate extremes, lower input costs for farmers, and improved nutrition security.

In addition to the benefits of the restored ecosystem, active restoration efforts – in contrast to passive natural regeneration – have been shown to accelerate the recovery of certain ecosystem functions, especially for areas that are more geographically isolated from pools of species diversity (Molin et al. 2018). Active restoration requires external inputs of energy and labour, such as planting a tree vs. waiting for natural seed dispersal and establishment to occur. While the efficacy of such efforts is context-specific (Gatica-Saavedra et al. 2017; Reid et al. 2018), the selective implementation of active restoration can mean that many of the benefits listed above are realized more quickly. Land restoration initiatives also provide numerous educational opportunities, raising public awareness about the local and distant impacts of their resource consumption choices.

Possible risks, trade-offs and costs of land restoration for SDG 12: Responsible production and consumption

Loopholes and leakage points also abound in land restoration efforts. If not carefully tailored, strategies aimed at avoiding land degradation can simply mean that production is shifted to other places (e.g., Indonesia's oil palm moratorium (Carlson et al. 2012)) or countries (e.g., forest conversation programmes in China and Finland leading to increased timber imports from the Russian Federation (Mayer et al. 2005)) that do not fall under a policy's umbrella, especially if demand for a product is maintained (figure 3.12.1). A number of trade-offs can also occur if land restoration goals are not aligned with sustainable consumption and production. For instance, initiatives that focus too narrowly on land restoration or avoided degradation can compromise food security, especially for subsistence households with fewer alternatives to supplement their diets. Along similar lines, a major concern regarding land restoration efforts is their potential impacts on livelihood options for local communities that rely on the natural resources of the intervention area. Trade-offs with ecosystem services also represent an important unintended consequence of restoration efforts, where the planting of monocultures or the use of non-native, fast-growing tree species can threaten both biodiversity and livelihoods.

Specific strategies for maximizing benefit of land restoration for SDG 12: Responsible production and consumption

Promising strategies to reduce the impact of the consumption of land-based commodities include, but are by no means limited to, the following: (1) selective taxes and subsidies can alter economic advantages away from particular products or practices that are land-intensive; (2) fallowing programmes can prevent farmland degradation, secure farmer incomes against the risk of crop loss, and reduce the use of natural resources in times of scarcity (Wade et al. 2008); (3) certification programmes can better ensure sustainability within supply chains, though the evidence for their efficacy remains limited (box 3.12.1; DeFries et al. 2017). More broadly, recent work argues that efforts to reduce deforestation should target the relatively few companies controlling much of the commodity flow through supply chains. Adoption of zero-gross deforestation policies with immediate implementation and clearly defined and enforceable sanctions may maximize benefits in some cases, provided that these interventions accommodate the goals and priorities of local communities (Garrett et al. 2019).

The co-benefits of land restoration can be increased by addressing the spatial and temporal disconnections between individuals responsible for restoring the land and global consumers who benefit from reducing the environmental impacts of production. This can often generate additional synergies and co-benefits as public outreach and sustainable food labeling can improve individuals' awareness of the environmental impacts of their purchasing decisions (Leach et al. 2016). This awareness may translate into modified consumption patterns as consumers are increasingly concerned about the origins of the products they buy. Reducing losses and waste along supply chains – for instance through improved infrastructure, recycling initiatives, or consumer education

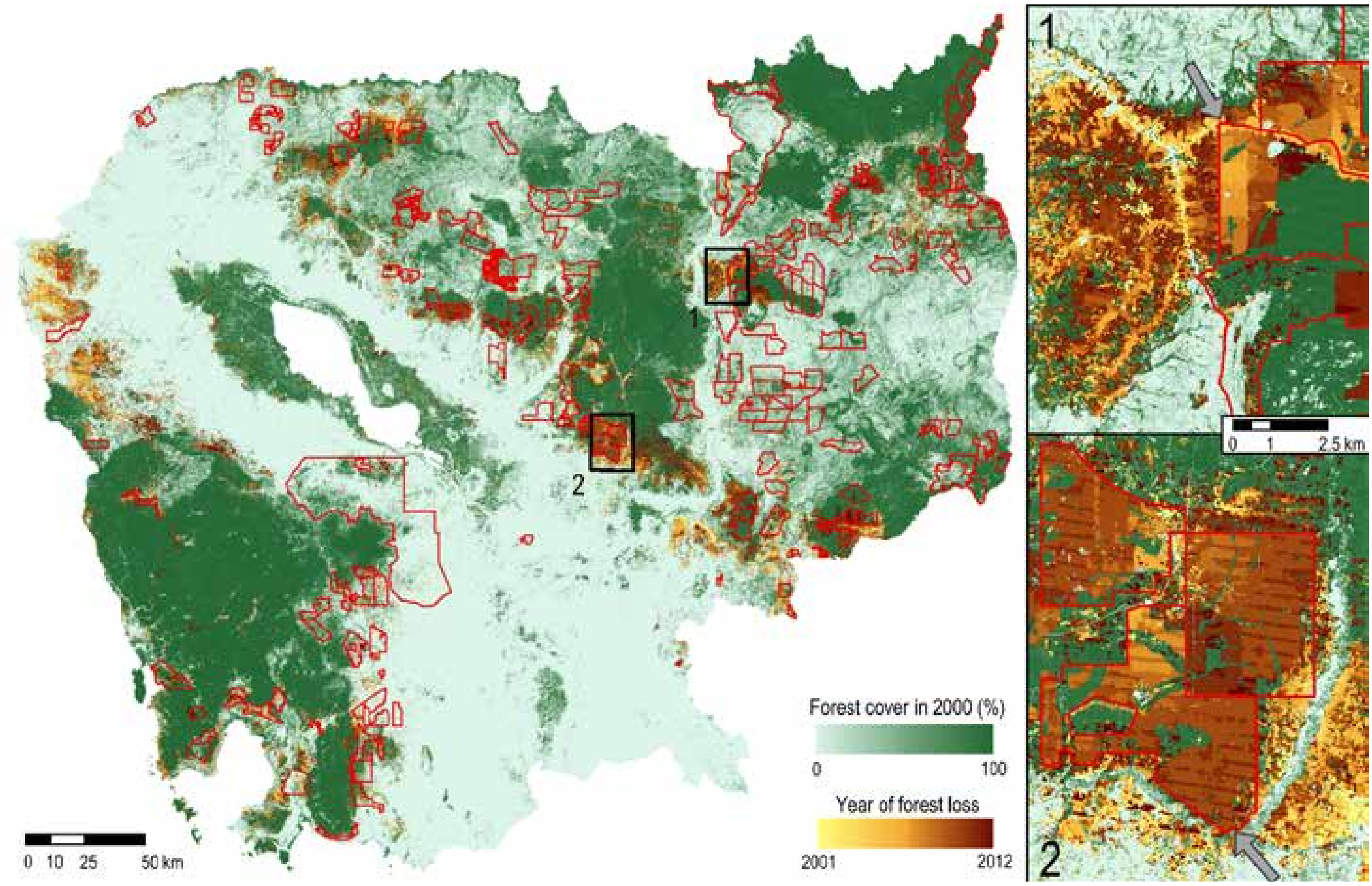

Figure 3.12.1. Deforestation in Cambodia. Since the start of the century, large-scale land investments for rubber and oil palm have accelerated forest loss in Cambodia (Davis et al. 2015). This rapid deforestation has been strongly influenced by distant demand for rubber and palm oil and followed variations in global commodity prices (e.g., Grogan et al. 2018) (image from Davis et al. 2015)

programmes – means that less land and other natural resources will be required to meet consumer demands (Kummu et al. 2012). Similarly, efforts to promote more equitable physical and economic access to products and resources can also minimize inefficient land use. Strategies that account for the influence of distant drivers on land use change are more likely to identify potential leakage points and to realize absolute reductions in degradation (Liu et al. 2013; Meyfroidt et al. 2013). Coupling this perspective with effective and equitable land tenure systems can also ensure that land restoration initiatives are community-driven and complementary to local needs and priorities. These examples and many others can contribute to achieving multiple SDG targets beyond SDG 12.

Figure 3.12.2. Aerial photo of oil palm and the forest in Sentabai village, West Kalimantan, 2017. Photo credit: Nanang Sujana/ CIFOR.

Box 3.12.1. Forest conservation and the achievements and shortcomings of the Roundtable on Sustainable Palm Oil (RSPO)

The RSPO was founded in 2004 to develop a global standard certification process for sustainable palm oil products. The RSPO established a set of environmental and social principles and criteria to guide policy formulation aimed at certifying actors within palm oil supply chains. Central to the RSPO certification process has been the condition that no primary forests or areas of high value in terms of biodiversity or livelihood support should be cleared for oil palm. The RSPO also includes a Remediation and Compensation Procedure (RaCP; RSPO 2019), which explicitly addresses land restoration.

The RSPO is premised on market mechanisms, whereby consumers' willingness to pay for sustainably sourced products (expressed through their purchasing decisions) encourages companies, farmers, and other palm oil supply chain actors to seek certification. Currently 19 per cent of palm oil supply is certified under RSPO.

The effectiveness of RSPO in achieving environmental and social objectives is contingent upon three key aspects: certification, monitoring and enforcement, and consumer interest. Regarding the conditions for certification, one apparent advantage of the RSPO approach is the flexibility it affords policymakers and companies in formalizing the RSPO guiding criteria subject to their specific policy and sociocultural landscapes (and ideally encourages their RSPO participation). On the other hand, this has raised questions about the standardization of the process and the opportunity for leakage into areas not included under each country's definition of "primary forest" or areas of "high conservation value". For instance, in Indonesia – the world's leading producer of palm oil – recent work has shown no significant difference between certified and non-certified concessions across a suite of sustainability metrics (Morgans et al. 2018), and RSPO-certified oil palm concessions have shown limited or no ability to reduce forest loss and fires (Cattau et al. 2016). This and other evidence led to the RSPO's revision of its Principles and Criteria for certification in 2018, where the group imposed an outright ban on the clearing of secondary forests and peatlands as well. Regarding monitoring and enforcement, RSPO requires that growers submit the boundaries of both their certified and non-certified concessions. While this enables the remote monitoring of their compliance, it should be noted that most of the plantations that have received RSPO certification are older concessions with little remaining forest (Carlson et al. 2018). In addition, because RSPO-certified growers are not required to provide information on the areas of high conservation value within their lands, this has prevented remote assessments of their specific conservation (Carlson et al. 2018). Regarding consumer interest in certified products, recent work has shown that while consumer perception of palm oil as "environmentally unfriendly" is relatively high, recognition of the RSPO ecolabel is near zero (Ostfeld et al. 2019). Further, this assumption of consumer willingness to pay for sustainably sourced products has been a major point of criticism of RSPO efforts, as this contrasts with the group's focus on large companies and lack of integration with final consumers and smallholders (von Geibler 2013). This points to the need for a shift away from sole reliance on consumer decisions and towards policies that require full traceability from the supply chains of companies that source palm oil (Ostfeld et al. 2019). In all, the RSPO example highlights the continuing challenge of developing certification programmes that are truly effective in achieving forest conservation while meeting growing global commodity demands. Indeed, the efforts of RSPO have encouraged and informed other similar sustainable certification programmes for beef (e.g., Nepstad et al. 2014), soy (e.g., Garrett et al. 2016), sugarcane (e.g., Smith et al. 2019), and a host of other commodities that can impact tropical forests.

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3.13

Land restoration for achieving SDG 13: Take urgent action to combat climate change and its impacts

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Summary

Land restoration plays a key role in climate change mitigation, as an opportunity to both increase ecosystem resilience and develop local peoples' and governments' capacities to adapt to climate change. Delivering restoration solutions based on appropriate species mix and techniques, combined with assisted regeneration and passive restoration practices, is essential to counteracting soil and biodiversity loss, and to ensuring human well-being. Enhancing plant cover and forest carbon stocks through restoration provides the co-benefit of mitigating carbon emissions and strengthening natural and societal systems' resilience to climate-driven hazards. Hence, to achieve SDG 13, land restoration science and practice should be integrated into climate action policies.

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	✖	✖
TARGET 13.2 Integrate climate change measures into national policies, strategies and planning	✖	
TARGET 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	✖	

Table 3.13.1. Examples of SDG 13 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 13: Climate action

Land restoration provides co-benefits for both climate change mitigation (through increased carbon stocks) and adaptation (because it usually increases ecosystems' resilience to climate-related hazards and natural disasters). This increased resilience results from improved soil biophysical quality (Subhatu et al. 2018; Wolka et al. 2018) and increased biodiversity (Hooper et al. 2005; Cardinale et al. 2012). In many cases, the higher the biological and functional diversity of an ecosystem, and its functional redundancy, the higher its resilience to natural or anthropogenic disturbances (Pillar et al. 2013). Increasing plant cover through restoration improves water infiltration and resilience to flash floods and reduces landslide and soil erosion risks (Sanz et al. 2017).

Increased organic carbon as a result of restoration contributes to both resilience and mitigation. Resilience is supported by enhanced soil health, fertility and water retention capacity. This in turn provides better conditions for further plant establishment. When drought- or fire-adapted species are used, resilience and adaptation to these hazards is also effectively increased. Mitigation is supported by increased carbon stocks (Alkama and Cescatti 2016; Sanz et al. 2017; IPBES 2018). The amount of carbon that could be stored in the soil through "conservation, restoration, and improved land management actions" could generate an estimated "37% of cost-effective CO2 mitigation needed through 2030 for a >66% chance of holding warming to below 2 °C" (Griscom et al. 2017).

Figure 3.13.1. Mixed reforestation of oaks and pines, extensively used as a restoration tool in Mediterranean basin drylands to revert land degradation. In addition to restoration of existing forests, afforestation is sometimes used as a climate adaptation and mitigation strategy (Photo credit: Melanie Köbel).

There is a high level of uncertainty in these types of estimates and the practicalities of achieving this level of carbon sequestration are not trivial, as it requires changes in land use and management by millions of farmers and other land managers throughout the world. However, it remains one of the clearest and more easily quantified co-benefits of land restoration (Paustian et al. 2016).

Multipurpose restoration (e.g., soil protection, biodiversity or non-wood products), as opposed to targeting a single ecosystem service (e.g., wood production), may be an effective climate change adaptation strategy, reducing susceptibility to extreme events, diversifying ecosystem services and income sources to landowners, and increasing overall ecosystems' resilience (Ruiz-Peinado et al. 2017). Restored areas also become "field labs" where we may learn about the best solutions for different climate scenarios and guide adaptive management strategies to deal with climate change.

Possible risks, trade-offs and costs of land restoration for SDG 13: Climate action

Land restoration may pose some risks for tackling climate change and its impacts. One of the main risks is associated with the type of species used in restoration. Exotic species are often selected for restoration plans (Ewel and Putz 2004; Davis et al. 2011), based on the resilience of particular species to one particularly important stressor (e.g., drought - Walther et al. 2009), aesthetic amelioration or fast-growing characteristics (Nunes et al. 2016a). However, such non-native species may compete with native ones (Nunes et al. 2014), or even become invasive, disrupting the stability and affecting the structure and functioning of the "restored" ecosystem (D'Antonio and Meyerson 2002). On the other hand, using species not adapted to future climate conditions may jeopardize restoration success in the medium term, either because they're no longer within their optimum ecological niche (Thuiller et al. 2005) or because of increased susceptibility to pests and diseases (Anderson et al. 2004).

Land restoration may also imply important trade-offs with other ecological or societal goals (ICSU 2017; Dooley et al. 2018; IPBES 2018). Planning restoration to enhance a particular ecosystem service (e.g., restoring forest for carbon sequestration) may increase susceptibility to other climate-related hazards (e.g., fire) (ICSU 2017). In addition, many restoration projects involve high costs, which may be jeopardized due to the long-time scale needed to obtain results and the uncertainty in return (unexpected results) (Nunes et al. 2016b; IPBES 2018), or may exclude poorer countries and people.

Specific strategies for maximizing the benefits of land restoration for SDG13: Climate action

The use of an adequate species mix in land restoration is essential to maximizing its effectiveness in tackling climate change and its impacts. Considering the functional traits of species used in restoration helps planning for resilient systems against disasters (Sterk et al. 2013; Suding et al. 2015; Fiedler et al. 2018). For instance, using drought-adapted and fire-resilient species in areas forecasted to become drier increases restored ecosystems' resilience to such hazards (Sterk et al. 2013). Restoring coastal ecosystems using engineer species for coastal protection, or introducing flood-tolerant species in susceptible areas, proved to be a cost-effective restoration strategy to build resilience (Temmerman et al. 2013). Yet the low commercial availability of native species and varieties used in restoration, particularly in large degraded areas, or cases where growing plants locally is unfeasible may pose some constraints. These limitations call for policies for conservation of locally adapted genetic varieties to maintain the genetic diversity of seeds (Bischoff et al. 2010; Vander Mijnsbrugge et al. 2010), market stimulation to produce and sell native species (Nunes et al. 2016a), and promotion of natural regeneration to complement restoration efforts (Sendzimir et al. 2011; Jones et al. 2018).

Integrating restoration knowledge into climate change policies and planning calls for promoting knowledge exchange and dissemination and demonstration of good practices, particularly in least developed countries more threatened by climate change. Yet uncertainties remain as to how to achieve the best results in restoration (Ockendon et al. 2018). Recovery rates are slow, trajectories often unpredictable, and growing evidence suggests that recovery final stages are the most challenging to achieve (Jones et al. 2018). Thus, we need to include restoration monitoring under the framework of LTSER (long-term socio-ecological research) studies so long-term outcomes can be evaluated. Additionally, funding for long-term restoration monitoring based on indicators of ecosystem functioning is needed (Nunes et al. 2016a) to achieve sustainable and resilient restored areas.

Restored areas are an opportunity to raise awareness of desertification and land degradation problems due to climate-related hazards, and to develop local people's and government's capacity to adapt to climate change. Restored sites may become "field labs" to test and demonstrate land restoration benefits to mitigate and reduce climate change impacts. Examples show how restoring woody vegetation contributed to carbon sequestration (Alvarez and Rubio 2016; Ruiz-Peinado et al. 2017), climate amelioration (Padilla and Pugnaire 2006), reduction of extreme events' impacts, such as local flash floods or landslides (van Dijk and Keenan 2007), or to increased drought resilience by using drought-adapted species (Sendzimir et al. 2011). The dissemination of successful restoration practices for climate change adaptation between countries sharing similar climatic challenges currently or in the future should be promoted.

Learning from local assessments and knowledge may engage and empower local populations into restoration practice, including women and youth, co-creating cost-effective solutions (Dickens and Suding 2013). Planning for multipurpose restoration (e.g., targeting agroforestry multifunctional systems instead of production-focused forests) may be an effective climate change adaptation strategy, increasing landscape heterogeneity and ecosystem resilience, while maximizing different ecosystem services delivery (Ruiz-Peinado et al. 2017; Sanz et al. 2017). Using nature-based local solutions and passive restoration when applicable (i.e., controlling the disturbance factor) may provide low-cost restoration solutions for countries with fewer resources (Weston et al. 2015; Keesstra et al. 2018; Reguero et al. 2018).

The use of indicators of ecosystem functioning in ecosystem monitoring may help us better understand and track the impacts of climate change on biodiversity, working as an early warning of ecosystem change (Matos et al. 2015) and helping adaptive management practices.

Box 3.13.1. AdaptForChange: Learning from past reforestation and afforestation projects

During the last few decades, several reforestation programmes were used for restoration in Europe and worldwide, while afforestation was used to address a variety of objectives, including climate change mitigation, and soil health and stabilization. Many of these projects focused on Mediterranean dryland areas. They were supported by many national and international funding programmes. Their main goal was to reverse land degradation in these desertification-prone areas, contributing to soil and water conservation. In addition, (re)afforestation is also expected to contribute to carbon sequestration, increase biodiversity by providing habitat for different species, and increase resilience (e.g., to prolonged drought), being a major opportunity for climate change mitigation and adaptation. However, the outcomes of past reforestation projects have hardly been evaluated considering all these aspects, being limited, in most cases, to the assessment of post-planting survival. Yet the evaluation of the long-term effects of past reforestation could provide invaluable insights into the most successful restoration strategies to attain multiple goals (soil quality, biodiversity, carbon sequestration, ecosystem resilience, etc.) and maximize ecosystem services delivery, particularly under a climate change scenario.

The project AdaptForChange[1] is aimed at addressing this gap to improve the success of (re)afforestation programmes in semi-arid areas and promote their adaptation to climate change scenarios. It was developed from 2015 to 2016 in Mediterranean semi-arid areas in the southern Iberian Peninsula. It involved the evaluation of 44 (re)afforestation projects with an average age of 20 years (11 to 37 years) based on key Mediterranean tree species (Holm oak, cork oak and stone pine). The projects were distributed along a spatial climatic gradient based on the aridity index (Middleton and Thomas 1992), which ranged from 0.42 to 0.58 (Trabucco and Zomer 2009). This allowed AdaptForChange to evaluate their outcomes under different conditions. Evaluations were supported by field surveys and remote sensing information, which were used to generate ecological indicators of ecosystem functioning (e.g., vegetation cover, structure and diversity, soil organic matter). These parameters were then related to the ability to provide key ecosystem services, namely, forest natural regeneration, productivity, biodiversity, soil quality and resilience to climate change.

The evaluation of past reforestation projects in semi-arid areas enabled the diagnosis of the current status and the drafting of guidelines on the best planning and management strategies to maximize multiple ecosystem services, particularly under a climate change scenario (Nunes et al. 2016b). Mixed (re)afforestation of pines and oaks, used in extensive areas to promote oak establishment, was not beneficial in the medium term (15-20 years) for oak growth (fig. 1), and thus this strategy should be reconsidered. Planning the type of species, tree density and (re)afforestation management on a local scale in a more flexible way, adapted to the climatic and topographic context of the area, may be an effective means of maximizing target ecosystem services (fig. 2). Increasing spatial heterogeneity in reforested areas (e.g., by reducing tree density and including areas devoid of trees where shrubs are left in place) may promote biodiversity and diversification of economic activities (e.g., low-intensity grazing, beekeeping, non-wood products). These measures can help to promote ecosystem resilience and to diversify income sources for the local population under a climate change scenario. See chapter 4 for more information on landscape-scale restoration strategies.

1 AdaptForChange project (2015-2016) was financed by EAA Grants - Programa AdaPT (http://echanges.fc.ul.pt/projetos/adaptforchange/).

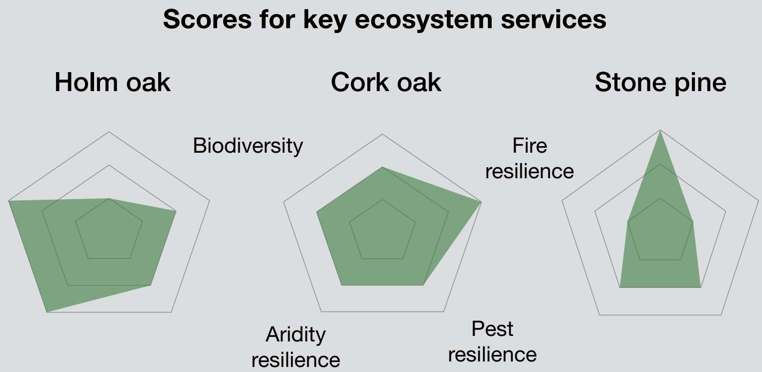

Figure 3.13.2. Scores for key ecosystem services for (re)afforestation projects dominated by Holm oak (Quercus ilex subsp. *rotundifolia*, cork oak (*Quercus suber*) and stone pine (*Pinus pinea*). Modified from Nunes et al. 2016b.

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3.14

Land restoration for achieving SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

S. Fletcher and P. Alvarez-Torres

Summary

SDG 14 asserts the need to sustainably use ocean resources through reducing marine pollution (target 14.1), taking action for the restoration of marine and coastal ecosystems (target 14.2), increasing the area of the ocean under protection (target 14.5) and supporting those whose livelihood is dependent upon coastal and marine systems (targets 14.4, 14.7, 14.B). All terrestrial activities generate implications for the ocean, including through surface run-off, sediment flows, and atmospheric emissions. Land restoration is therefore a key factor in reducing pressures on ocean ecosystems and allowing them to continue providing direct economic, social, and hazard mitigation benefits to coastal communities.

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution		✖
TARGET 14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	✖	✖
TARGET 14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics		✖
TARGET 14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information		✖

Table 3.14.1. Examples of SDG 14 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 14: Life below water

The land and ocean are inextricably linked through numerous natural, economic and social pathways. For example, plastic pollution discharged by rivers affects ocean biodiversity; agricultural and forestry practice on land affects sediment and chemical inflows to coastal waters; and rising demand for urban infrastructure increases the extraction of marine aggregates, including sand and gravel. Coral reefs are particularly vulnerable to land degradation. Consequently, restoration measures are particularly beneficial and can significantly underpin reef-generated societal benefits, including food security, tourism, storm protection, and cultural meaning (Millennium Assessment 2005). These are of substantial economic value. For example, Spalding et al. (2017) estimate that 30 per cent of the world's reefs contribute to the tourism economy, with a total value of nearly USD 36 billion. Mangroves, often adjacent to coral reefs, are important pollution sinks, sediment traps, and nursery areas for many reef fish. These functions enhance the resilience of coral reefs and provide significant natural storm protection for adjacent coastal communities. The restoration of mangroves therefore supports the societal benefits generated by both mangroves and reefs. For example, an assessment following the Indian Ocean tsunami of 2004 indicated that coastal vegetation, including mangroves, helped to provide protection and reduce negative effects on adjacent communities (Danielsen et al. 2005).

Possible risks, trade-offs and costs of land restoration for SDG 14: Life below water

The drivers of mangrove and coral degradation are typically coastal developments, including port construction, tourism infrastructure and the construction of shrimp aquaculture facilities. For example, where mangroves or mudflats are removed to make way for aquaculture ponds or tourism infrastructure, the enhanced sediment inflows smother reef communities and compromise reef function and resilience. This in turn makes reefs more vulnerable to contextual pressures, such as ocean warming, acidification, and pollution. However, both aquaculture and tourism generate significant economic and social benefits and are commonly core elements of national economic planning. Therefore, it is important to recognize that these benefits may be compromised if mangroves are restored. In many instances, the practical opportunities for comprehensive mangrove restoration may be limited, particularly where the mangroves have been replaced by hard engineered structures.

Specific strategies for maximizing the benefits of land restoration for SDG 14: Life below water

Given the transboundary connectivity between land and ocean, area-based governance approaches that enable coordinated land-ocean planning and management, and therefore reconcile the trade-offs between land-based and ocean-based benefits, are needed to maximize the contribution of land restoration to the delivery of SDG 14. Currently, however, it is more common for land planning and ocean planning to be undertaken in isolation, leading to missed opportunities for co-benefits. Integrated coastal management approaches have provided useful initial steps in recognizing the importance of coordination across the land-ocean interface, and many examples of effective integrated coastal management approaches already exist (UNEP 2018a). Yet they seldom incorporate land restoration, and often they are too spatially narrow to incorporate all relevant management considerations.

In contrast, Ridge to Reef governance approaches adopt an ecosystem-based approach in which entire ecosystems are managed in a coordinated manner, ensuring that all relevant influences are considered in the same management and planning framework. These approaches are typically framed around catchments and their adjacent coastal areas to support "healthy and well-managed river basins and coastal areas where people and nature thrive" (IUCN 2017), as well as typically employing land-focused management measures, including restoration, to generate ocean benefits and vice versa.

For example, a Ridge to Reef approach in Grenada used soil conservation and productivity measures in agricultural areas and engaged farmers in forest rehabilitation measures, specifically to improve coral reef health and to enhance conditions in marine protected areas. These measures contributed directly to SDG 14 targets 14.1 (reducing pollution), 14.2 (sustainable ocean management), and 14.5 (coverage of marine protected areas). Notably, this approach was also found to contribute to targets under SDG 1 (ending poverty), SDG 12 (sustainable consumption and production), SDG 13 (climate action), and SDG 15 (terrestrial ecosystem protection). The Ridge to Reef approach, through providing a platform to link land and ocean-based management activities, provided a mechanism for ocean areas to benefit from land restoration activities, whilst deliberately contributing to a range of SDGs, particularly SDG 14. More information about the Ridge to Reef approach in Greneda can be found in UNEP (2018b) and UNDP (online).

Box 3.14.1. Coastal development and coral reef degradation in Hawaii

Waikiki, Hawaii, demonstrates how land-use change and degradation can impinge on coral ecosystems. The image shows how terrestrial habitats that would contribute to the resilience of coral reefs have been replaced by urban and tourism infrastructure. The image also shows how areas of reef have been removed entirely and replaced by recreational marinas, including a channel cut through the reef to enable boats to reach the shore. Although opportunities for coastal habitat and reef restoration appear limited, efforts are being made to reduce the stressors affecting Hawaii's reefs from land-based activities. For example, in May 2018, Hawaii became the first state of the United States of America to pass a law (which will come into effect in January 2021) to ban sunscreens containing oxybenzone and octinoxate, which have been found to be harmful to coral reefs (Coldwell 2018).

Figure 3.14.1. Coastal development in Hawaii.
Photo credit: © John – stock.adobe.com

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3.15

Land restoration for achieving SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

G. Metternicht and G.P. von Maltitz

Summary

Land restoration, together with avoidance and reduction of land degradation, provides both a clear pathway to achieve land degradation neutrality (target 15.3), while providing opportunities to support achievement of the other Sustainable Development Goals. A focus on sustainable management and restoration of the land base is the central tenet of a better and sustainable future, where poverty is reduced, food and water are secured, biodiversity is safeguarded, and sustainable livelihoods are promoted (UNCCD 2017). This chapter recognizes that land restoration is essential for achieving SDG 15 and provides a complementary perspective on benefits for the other SDGs to the one presented in chapter 2.

15 LIFE ON LAND

General co-benefits of land restoration for SDG 15: Life on land

Restoring and rehabilitating land increases soil carbon, fertility and water use efficiency, as well as above- and below-ground biodiversity and productivity. Together, these provide a wide range of benefits to society, including contributing to climate change mitigation and adaptation (Orr et al. 2017). This can also lead to increased flows of food, fibre and fuel, as well as supporting rural livelihoods, potentially improving the well-being of some of the most marginalized communities.

Land restoration can stabilize ecosystem functions, prevent the spread of invasive alien species and enhance the livelihood of local communities living around the project sites. For instance, the South African Working for Water programme (WfW), in addition to removing invasive alien plants, also restores stream flow and biodiversity whilst creating rural job opportunities (Crossman et al. 2016).

Forest and organic soil (wetlands and peatlands) restoration programmes improve water management while also increasing ecosystem services, such as carbon stocks (Locatelli et al. 2015; Willemen et al. 2018).

Strategies to achieve wide-scale land restoration require:

i. The accommodation of multiple functions of landscapes so that restoration ensures the supply of multiple ecosystem services (Crossman et al. 2016). This requires the adoption of integrated, participatory land-use planning approaches that value the multifunctionality of the land, can enhance the protection of biodiversity, and promote ecosystem restoration (Metternicht 2018).

ii. Early engagement with stakeholders (Lovell and Taylor 2013) in a process that accepts the legitimacy of multiple values and acknowledges the concerns of diverse stakeholders is a prerequisite for planning landscapes that contain a mix of land-use interventions (Crossman et al. 2016). It is important that farmers, extension officers and practitioners have a joint understanding of the process and anticipated benefits. This necessitates the incorporation of indigenous peoples and local communities in decision-making processes. These groups can also contribute valuable local knowledge: applying traditional systems of land use and resource management has, in many cases, demonstrated solutions to avoid and reduce land degradation, recover degraded ecosystems, providing multiple societal benefits (IPBES 2018).

iii. Ensure ongoing knowledge-sharing and documentation of good practices, successes and benefits of restoration using platforms such as WOCAT (https://www.wocat.net/en/), (https://www.wocat.net/en/), the Economics of Land Degradation (ELD - https://www.eld-initiative.org/), and the Network for Industrially Co-ordinated Sustainable Land Management in Europe (NICOLE – http://nicole.org/).

iv. It is important to get the right mix of policy incentives, including market-based instruments (MBIs) and traditional command and control instruments, to reward good land management practice and discourage degradation. Global experience suggests MBIs have the capacity to create incentives for restoration and help access additional sources of

Land restoration and/or rehabilitation essential to meet the targets of SDG 15

15.1 Ensure conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services...
15.2 Implement sustainable forest management, halt deforestation, restore degraded forest,...increase afforestation, reforestation.
15.3 Combat desertification, restore degraded land and soil,...and strive to achieve a land degradation-neutral world
15.4 Ensure the conservation of mountain ecosystems, including their biodiversity
15.5 Reduce the degradation of natural habitats, halt the loss of biodiversity...
15.6 Promote fair and equitable sharing of and acess to benefits arising from the utilization of genetic resources...
15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna
15.8 Prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species
15.9 Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction...

Figure 3.15.1. Land restoration and the United Nations SDG of life on land. Source: Authors.

funding and can help reduce barriers to participation and the risk of perverse outcomes (Baumber 2017). Simple incentives encourage landholders to protect or restore ecosystems, including access to credit, payment for ecosystems services, and policies that increase security of land tenure.

v. Target sustainable land management policies toward different revegetation methods, socioeconomic incentives, habitat protection mechanisms, sustainable livelihoods, diversified funding and partnerships, technical support, and green infrastructure development (see Ethiopia case study in box 3.15.1). Land-use plans can provide a detailed analysis for land utilization, promote the most beneficial land-use arrangement and structure, and prioritize land restoration based on local environmental conditions to balance sustainable land use and socioeconomic development. Hence, they enable multiple partners working together at a landscape scale to achieve land rehabilitation/restoration (Metternicht 2018).

Lastly, measures to achieve land degradation neutrality (LDN), including assessment of land potential, can prioritize intervention first on lands where prevention or avoidance of land degradation is possible, followed by land where mitigation through improved land management practices is suited, and lastly, on land suitable for restoration or rehabilitation (Cowie et al. 2018). Avoidance is more cost-effective than restoration.

Adaptive management approaches to landscape-scale rehabilitation policy with a focus on the dynamic interactions between people and their local environment can significantly increase the probability of long-term success (Lü et al. 2012). Conventional approaches to restoration often need to be adapted to the local conditions of drylands, while both policies and investments need support through improved data on existing and potential soil organic carbon (SOC) levels (Laban et al. 2018).

Possible risks, trade-offs and costs of land restoration for SDG 15: Life on land

Trade-offs are inevitable. A careful analysis of socioeconomic and biophysical context and broad-scale participation in planning ensures that the best possible livelihood outcomes are achieved (Potts et al. 2018). Restoration projects need to balance productivity and biodiversity goals together with the targets defined by the other SDGs (Osuna et al. 2019).

Avoidance and reduction of land degradation are more cost-effective than restoration, which varies widely, depending on the technique used and the ecosystem in question (Orr et al. 2017; Chazdon and Uriarte 2016). Land degradation itself often imposes an economic and livelihood cost that is greater than the cost of management efforts that would deter it (Potts et al. 2018). Degradation mitigation and restoration responses are constrained by availability of resources, technologies, knowledge of the system and institutional competencies (Willemen et al. 2018).

Figure 3.15.2. Restoration as a catalyst (modified from Akhtar-Schuster *et al*. 2017)

Policy instruments, including MBIs, carry the risk that the diverse range of ecosystem services and functions provided by restoration activities may be commodified, oversimplified or traded off against environmental degradation at other locations (Baumber 2017).

Unless underlying drivers of degradation are addressed, there is a risk that restored areas will not achieve long-term sustainability. There is a growing realization that many of the drivers of degradation are national or global in nature (Herrick et al. 2019).

Photo credit: Hanspeter

Box 3.15.1. Brazil and Ethiopia: Community-based land restoration to address degradation and enhance livelihoods (SDG 15.1, 15.2, 15.3, 15.5)

Brazil: Land restoration for advancing land degradation neutrality

The semi-arid region of Brazil located in the Caatinga and Minas Gerais (about 858,000 km2) is susceptible to land degradation and is home to 29 per cent of the country's population, including the poorest of the region, with quality of life below the national average. Land degradation intensified by drought is one of the most serious environmental problems of this region, causing significant economic and social damages. The National Policy to Combat Desertification and Mitigate the Effects of Drought (adopted in 2015) recommends that states and municipalities mainstream actions into their public policy to address this problem. To this end, the Department of Sustainable Rural Development and Combating Desertification is working with municipalities of the region in the planning and implementation of the URAD project (Recovery Units of Degraded Areas and Reduction of Climate Vulnerability) through environmental, social, and productivity initiatives underpinned by the mix of six activities: training and capacity building of rural smallholder farmers; rehabilitation and conservation of soils; water and biodiversity; water harvesting; basic sanitation; and energy efficiency. The programme envisages engaging families living in the recovery units in the implementation of actions such as the construction of dams, ecological stoves, beekeeping, and the rehabilitation of riparian forest, so that the community takes ownership of technology to improve quality of life, increase employment and income and food security.

Source: *https://knowledge.unccd.int/knowledge-products-and-pillars/unccd-science-policy-weblog/brazil-sets-novel-model-reverse* and Ministry of Environment, Department of Sustainable Rural Development and Combating Desertification (2017) URAD Project *https://www.indepthnews.net/index.php/the-world/latin-america-the-caribbean/2157-brazil-sets-up-an-innovative-model-to-reverse-land-degradation*

Figure 3.15.3. Recovery of degraded areas under the URAD project occurs through on-ground implementation of activities such as: provision of ecological stoves for sustainable energy use; training courses for small landholder farmers on soil and water conservation; land degradation and its control (Photos credit: Valdemar Rodrigues)

Ethiopia: Integrated approaches for community-based land rehabilitation and restoration of watersheds

The Learning Watershed Initiative is a cross-institutional programme implemented in the basin of Lake Tana (northern Ethiopia) to integrate natural resources conservation, agricultural production, and livelihood improvement through demonstrating best practices and fostering coordinated actions among actors. It uses participatory approaches to engage farmers, extension agents, researchers and policymakers for collaborative planning to design shared objectives, collective decision-making and adaptive learning. A watershed development committee, comprised of a minimum of 30 per cent women, is elected by the community and oversees collective actions. Soil and water conservation measures on cultivated land, as well as severely degraded land, are undertaken via voluntary community free labour investment. Other key components of the initiative include: integrated interventions and implementation strategies that respond to the constraints and needs of people through consensus and stakeholder discussions; linkage of extension and research to promote agricultural technologies; benefit-sharing mechanisms through creating bylaws to advance equitable sharing and utilization arrangements on communal resources; performance assessment and knowledge exchange. Rehabilitation of degraded land includes revegetation of gully areas, construction of bunds, area closure, no free grazing practices, fodder production, integrated homestead development, promotion of farm machinery and improved agricultural technologies.

The Debre Yacob watershed is a case in point of successful implementation; it invested 59,557 person days for construction of 101 km of bunds planted with grass and combination of fodder legumes, which over a five-year period have retained 21,900 cubic metres of sediment. In one instance, a gully rehabilitated area of 4.5 ha has benefited 97 farmers who shared fodder biomass of 20-85 tonne/ha per season.

The application of appropriate sustainable land and water management practices has led to improved biodiversity and regeneration of degraded lands, minimizing soil erosion and increasing productivity. The approach has increased the regulation and provision of ecosystem services such as increase in stream flows, improved diversity of plant species, and fodder and crop productivity.

Source: *http://wlrc-eth.org/project-component/learning-watersheds*

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3.16

Land restoration for achieving SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

I.B. Franco and S.H. Ali

Summary

Land provides the most fundamental resource for nourishment and sustenance for a vast majority of the world's population. When land is degraded and food supply is threatened, human populations often descend to the most basic of instincts to survive and compete over scarce resources. Such a resource rush can lead to further land degradation and a proverbial "tragedy of the commons". Restoring land has the potential for reversing such trends and there has been growing consensus to harness such peace dividends. Disputes over land need to be adjudicated fairly so that a respect for the judicial process can also prevent conflict escalation. Land restoration also provides an opportunity to "enlarge the pie" for dispute resolution pathways and possible solutions out of intractable conflict for professionals in the justice system.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

TARGETS	Restoration or rehabilitation process	Restored or rehabilitated land
TARGET 16.1 Significantly reduce all forms of violence and related death rates everywhere		✖
TARGET 16.4 By 2030, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime	✖	✖
TARGET 16.7 Ensure responsive, inclusive, participatory and representative decision-making at all levels	✖	
TARGET 16.8 Broaden and strengthen the participation of developing countries in the institutions of global governance	✖	

Table 3.16.1. Examples of SDG 16 targets for which co-benefits are possible or likely from the restoration or rehabilitation process, or the restored or rehabilitated land. This table is based on a very general review of targets for all the SDGs and provides context for the discussion below, which focuses on a subset of these targets.

General co-benefits of land restoration for SDG 16: Peace, justice and strong institutions

Fostering fair and equitable sharing of the benefits arising from land restoration and promoting appropriate access to land requires urgent action to end the misuse of land resources in conflict and post-conflict environments. Land restoration can help achieve SDG 16 in several ways. Land degradation resulting from unsustainable land use is not only a main cause of conflict, particularly in resource-rich regions in developing countries, but also a main source of political instability. While the "tragedy of the commons" described by Hardin (1968) refers to negative impacts on the land, the tragedy of resulting conflicts is often of even greater immediate concern.

As the 2018 Caux Dialogue on Land and Security (CDLS 2018) highlighted, land restoration can be used to support conflict prevention and resolution. If adjudicated fairly, it can also assist professionals in the justice system in finding possible solutions and better governance arrangements for land use.

The escalation of conflict has had a significant impact on community assets and livelihoods, particularly in developing countries. The arrival of competitors over land resources is often perceived as a threat to local community assets and livelihoods. A situation that leads to resentment, political instability and, in the worse-case scenario, to intensified armed conflict. In this context, land restoration can be used to equip communities with stronger assets, livelihood options and infrastructure required for positive livelihood transformations (target 16.4). It is only through land restoration that alternative livelihood options can be created, conflict can be prevented and positive dispute resolutions can be successfully obtained for overall sustainability in developing locations (target 16.8).

Dispute resolution pathways have also been heavily impacted by the indirect benefits of land restoration. At times, actors competing over land resources are unable to engage in positive dispute resolution. A case in point are resource regions where governments and the private sector are reluctant to further engage with community groups due to their suspicions of links between locals and illegal groups (Franco and Isabel 2014). This not only aggravates the level of discontent and violence in remote rural areas, but results in unfair dispute resolution processes. Land restoration can open new pathways for dispute resolutions by fostering positive communication and relationships amongst parties involved. It also opens opportunities for dialogue and enables effective communication and community engagement based on trust and accountability to develop governance agreements in the justice system that create value for all parties involved.

Professionals in the justice system have been allocated responsibilities in an attempt to reduce the power of illegitimate actors over land-dispute processes. However, these responsibilities are proving very difficult for professionals to ensure good governance. This situation has hampered the effective allocation of land, thereby diminishing the possibilities of sustaining peace over time. Land resources can often be wasted, misused, or both due to poor governance arrangements in the justice system. Yet efforts need to be made to improve professionals' capacity to contribute to adequate and effective administration of land resources. It can help individuals and organizations in the justice system become more empowered to set the rules for effective land use and act as important mediators and promoters of access to justice for all.

Addressing land restoration issues in alignment with SDG 16 will have the extra benefits of reducing risks, overcoming existing trade-offs in conflict, minimizing costs and fostering sustainable peace in both conflict and post-conflict environments. Other co-benefits such as reduction of violence, child labour, illegal land use, bribery and the fostering of accountability, inclusive participation, stronger institutions and protection of fundamental rights over land are some of the added benefits of land restoration in line with SDG 16.

Possible risks, trade-offs and costs of land restoration for SDG 16: Peace, justice and strong institutions

Implementing land restoration projects in conflict-prone regions can contribute to peace, but it does have risks if not carefully implemented. For example, restoration of

Figure 3.16.1. Community capacity-building and consultation workshop on peace and land use in a mining region in Boyacá, Colombia. Photo credit: I. Franco

land may require temporarily or permanently changing its use, which may benefit some groups over others. This may increase, rather than reduce, factors contributing to violence. Integrating initiatives designed to address SDG 16 with land restoration can help mitigate these risks by helping parties to change values, perceptions and attitudes towards land use and equip underrepresented stakeholders with the skills and capacities to deal with these issues in conflict and post-conflict environments (See figure 3.16.1).

For example, SDG-16-inspired strategies and policies apply to communities to reduce their social and environmental vulnerability and risks caused by land displacement, land degradation or pollution. Land restoration involves detailed scientific knowledge and collaboration amongst key parties. Both might not be readily available or accessible or costly, particularly for affected communities (Sitarz 1993; A/69/700).

The negotiated text for SDG 16 includes policy advice aimed at reducing potential risks associated with various activities, including land restoration and management (Whaites 2016). Promoting the rule of law (target 16.3) and improving governance (targets 16.5-8) can all help reduce the risk that restoration initiatives will inadvertently result in increased conflict (see figure 3.16.2).

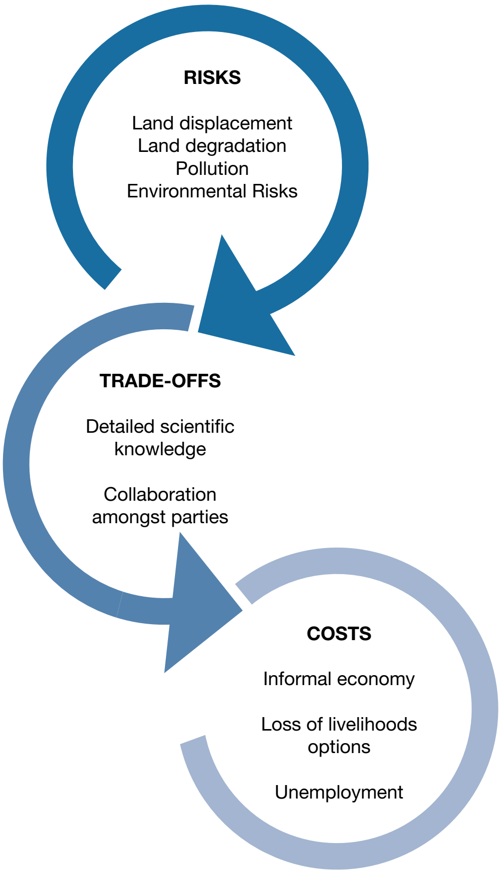

Figure 3.16.2. Risks, trade-offs and costs

Specific strategies for maximizing benefits of land restoration for SDG 16: Peace, justice and strong institutions

Pressured by illegal groups, both in conflict and even in post-conflict environments, some local communities are forced to leave their land behind due to involuntary displacement. In their absence, illegal actors engage in illicit plantations and exploitation of natural resources threatening local livelihoods and biodiversity itself. In those cases where communities resist displacement they often find themselves trapped in conflict, resulting in persecution or, in the worst-case scenario, in death (Franco et al. 2018). Evidence also shows that in some cases, community members are forced to engage in criminal activities as an alternative livelihood option. In countries like Colombia, conflict over land is a sensitive issue, particularly in resource-rich regions where guerrilla and paramilitary groups engage in armed conflict over natural resources (Franco and Isabel 2014). This situation has escalated conflict, compromising new pathways for dispute resolution and hindering professionals' capacity in the justice system to deal effectively with land restoration processes.

Three general strategies stakeholders can apply to address these issues and hopefully foster sustainable peace for all include: (1) carefully organizing how resources are mobilized and allocated to prevent conflict and restore stolen community assets and livelihoods; (2) ensuring that restoration is implemented in ways that open new pathways for dispute resolution; (3) facilitating international support for efforts to increase capacity in the justice system (table 3.16.2).

In conclusion, while not easy, collaboration amongst all parties involved in, or affected by, land restoration can result in positive outcomes for promoting sustainable peace, accountable and inclusive institutions, and justice for all.

Strategy	Description
Mobilization and allocation of resources	Effective mobilization and allocation of resources to implement restoration in ways that replace stolen community assets and livelihood options is the first strategy to prevent the escalation of conflict and achieve SDG 16. This can often be achieved by applying a combination of land restoration alternatives to address both landscape and stakeholder diversity. Restoration practitioners can help communities find alternative livelihood options consistent with community development aspirations. In doing so, they are also compensating locals for the loss of land.
Restoration implementation and new pathways for dispute resolution	The second strategy concerns how restoration can open pathways for dispute resolution. Aware of the impact of conflict on local communities, multiple actors have embarked on dispute resolution mechanisms which are often wasted, misused or both, yet these arrangements represent a potential for change in ways that help achieve SDG 16. If restoration arrangements are fairly shared and agreed amongst all parties involved, it can result in positive relationships, increased accountability, trust and hopefully in sustainable peace for all.
International support for capacity-building in the justice system	The third general strategy focuses on increasing capacity in the justice system. Resource mobilization to build the assets needed to empower professionals accountable for restoration processes is essential in the achievement of peace, justice and stronger institutions. International and domestic actors should enhance global support for efforts to improve capacity, particularly in the context of developing countries.

Table 3.16.2. General strategies for land restoration

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3.17

Land restoration for achieving SDG 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development - observations, challenges and lessons learnt

T. Abrahamse

The achievement of the 2030 Agenda and the SDGs requires a paradigm shift in approaches and perspectives

17 PARTNERSHIPS FOR THE GOALS

Summary

According to the United Nations Environment Assembly (UNEA 2016), sustainable management of natural capital is key to ensuring continued economic development. The question is how to get there. The aim of this chapter is to highlight lessons learnt to influence strategies and approaches for achieving the ambitions of the SDGs and the future we want. Land degradation is a global issue affecting both developed and developing countries. However, approaches to overcome the problem must differ according to national and local planning, research, policy, regulatory and governance strength levels. There is need to take stock of present local and international realities into "refreshed" South-South and South-North partnerships and engagements, as well as identifying new partners that can assist, both directly and indirectly, in the achievement of goals. Key elements of these lessons are motivated by the other chapters in the review and by the author's almost four decades of experience. Three different sets of development assistance and partnerships in southern Africa (box 3.17.1) are provided as brief windows into some of these engagements regarding land and developmental assistance.

Introduction

Africa's share of the world's total amount of uncultivated, arable land according to UNEA 2016, is as high as 65 per cent and so is worth a special mention and is a rich source of lessons learnt. The social, political, economic and geographical, as well as biodiversity and resource richness characteristics, of the continent have driven increased land degradation with a devastating impact on people and sustainable development for the future. Pressure from urbanization, underregulated industrialization, a growing population (particularly youth), increased expectations for a better life and increased IT connectivity, and undergoverned multinational and local mineral, agricultural and biological exploitation exacerbate degradation of air, land and water quality.

Global south commonalities with Africa include poverty, inequality, exclusion from development planning, lack of appropriate capacity building, struggling institutions, governance structures under pressure, economic downturn and lack of investment. Together these deter sustainable management and utilization of natural resources. Yet examples given in this paper in previous chapters, as well as from other sources, from Africa and other developing regions, showcase inspiring efforts and successes in development projects and programmes aimed at land restoration and degradation avoidance.

Challenges and lessons

1. Nature of Poverty

Poverty in many parts of the world is both the cause and effect of land degradation, and so the causes of poverty need to be analyzed carefully. It is clear that poverty not only stems from lack of income or even of resources, though these factors are key. Poverty also stems from lack of inclusion, useable information, marginalization, gross inequality, helplessness and lack of confidence. First-glance analysis and traditional metrics to understand poverty are under question and in many cases generalizations should be avoided.

2. Exacerbating inequality

It is important to pay attention to power differentials and the potential for exacerbating existing inequalities, whether based on gender, class, ethnicity or nationality. Mention is made of this phenomenon in some chapters above. It can be an unintended consequence of narrowly conceived land restoration programmes.

3. The power of funds in scarcity and other factors

The arrival of development assistance in poor underresourced areas in some instances can be detrimental. Existing less-resourced projects wither away, local indigenous knowledge gets subsumed to the better resourced systems, and new power differentials arise. There is an in-built power differential between the givers and takers in development initiatives. Funders crowding in with ready-made tools and impressive PowerPoint presentations and varied project planning and M&E systems can expand that gap. It is important also to take into account the often diverse, complex and time-consuming reporting requirements, particularly for smaller departments and institutions.

4. Showing value

The long-time horizon of land degradation projects and programmes can result in failure, and "bridging" strategies are needed towards a longer-term solution. Long lag time is a challenge for restoration, so it is important to design projects in ways that provide short-term and intermediate benefits. Throughout the project it is important to highlight local economic development links and short- and long-term value of the land in as a compelling way as possible. Making the case from a lived experience perspective is a powerful tool as are comparative and global examples.

5. Language

Nomenclature can be a problem here - over the past four decades better land management has adopted a range of names. This "rose by any other name" syndrome can result in confusion (e.g., restoration, rehabilitation vs. adaptation, land reclamation, adaptive management, climate resilience). Scientists develop new concepts, but politicians and citizens see no difference. A compelling story understood by a broad audience, with a value proposition that shows the economic and social rationale for healthy land in a simplified unified language is a powerful tool. The universally agreed SDGs will help alleviate this issue.

6. Providing certainty

Planning that includes empowering consultation and dialogue has been shown to be key to success. Links with national and local government development goals and key performance indicators (KPIs) or aspirations for sustainable solutions should be made at the initiation of projects and programmes. The chapters above give instances of conflict between degradation avoidance, land restoration and other developmental and investment programmes. Conflicts can be avoided through better understanding and mapping of stakeholders throughout the chain.

Business players are key participants and so stakeholders in global land degradation are particularly risk-averse to policy, planning and regulatory uncertainty. Mining, in general and particularly in sensitive areas such as dunes and wetlands, requires oversight. Oil, gas and coal extraction and open-cast mines are typically abandoned when the resource is depleted. Similarly, agricultural production systems that fail to return organic matter to the soil can also result in degradation of land to the point that it is no longer economically productive, resulting in abandonment. Yet business provides instant jobs, tax revenue, needed communication infrastructure, food security and other investments and thus often presents a conundrum for national development agencies. Engaging positively with business is essential. The long-term vision of sustainability and stability is easier when the business is home grown, less so when the resource extractor is from outside.

Multinationals need to be engaged with at source, at head office and shareholders. Labelling, fair trade and consumer power have been harnessed successfully in some cases and in some instances divestment campaigns and encouraging green-based investment have altered priorities and behaviour patterns.

Local institutions such as the national chambers of mines have a vested interest in longer-term sustainability and stability. The Mining and Biodiversity Guidelines of South Africa is an example where the mining business chamber and a public sector institution worked together to produce an agreed guideline to map areas of mining constraints. Business' need for certainty and understanding costs drove the process, and the guidelines will be the foundation for regulations in the future.

7. Fitting into national and local agendas - regional governance

It is important to take into account local and national planning structures and approaches and build on them rather than recreating the wheel. Development projects promising new approaches and solutions can have "new systems fatigue". It can be more effective to enhance existing initiatives, laws, planning frameworks and systems. Fostering integrated development planning (IDP) at the municipal level that includes land degradation avoidance and land restoration assists in embedding local projects into longer-term plans. In some instances, a regional governance structure that includes all key stakeholders including investors and local government, with a focus on land restoration in a spatial area, has shown success and longevity.

8. Strengthening national institutions and democratizing science and research

Land restoration needs to come out of its shell and work to highlight its central importance to development and the economy. Successful sectors such as mining and tourism thrive because of strong institutions which provide support including R&D, data and information and skills development. Strong national institutions ideally fight for better policies and regulation, provide compelling science and information, and have access to decision-makers. Partnering and supporting national institutions to embed capacities will help to maintain projects long after the funder has gone.

Development cooperation players often arrive with preconceived ideas on what is to be done, and their focus on local projects can provide localized successes and green spots. As with partnering local institutions, a worthwhile investment needs to include research capacities at national and local institutions and citizen levels.

There are indications that successful nations have higher numbers of individuals with science capacity. This capacity can be harnessed for a number of enhancing activities including improved extension services, development of guides and manuals, and improvement of citizen science. Some of these approaches are old but effective in creating jobs. However, they can only be successful if human professional capacity is enhanced. Job creation and capacity building must be an integral part of, and be a KPI for, any project, for these reasons.

9. Access to data, information, knowledge and best practice

The problem often is not that there is not enough data and information, but that it is scattered and in unsuitable forms. Information in the form of remote satellite data, census records from previous development initiatives, national and international institutions archives, etc. do exist. This information can be augmented by information gathered using rapid research approaches.

Sharing of information in a form that is accessible, usable and useful is now made possible by the exponential growth of capacities in the information and communication technologies (ICT) area. Harnessing data from a variety of spheres and "dishing it out" in an understandable form is an important area of investment and partnership. It is important to be respectful of other, including local, information gathering systems, to find synergies and to display information in an accessible way, including through new and popular platforms such as social media and apps and television.

10. Use of financial and legal instruments - incentives, subsidies, offsets

The chapter on SDG 8 recommends competitive payments and market-like mechanisms complemented with mandatory compensation and offset policies to shift responsibility to the parts of the private sector responsible for degradation. This approach has been found to be successful where governance is sophisticated and well-established. While difficult in other systems, the principle is sound but needs thorough investigation, implementation and monitoring to achieve goals.

11. Breaking down silos

There is rarely a quick fix: a 360-degree perspective and analysis of the current context is essential. But the enormity and complexity of the task can overwhelm without focus, so it is important to be clear on priority actions.

Developing creative cooperation partnerships for co-development, co-production and co-communication is difficult but worth the effort for success. Mapping the players and key institutions and players including beneficiaries is a useful exercise. Minimizing destructive competition amongst development players should be seen as a key success factor for rural projects in general. A conscious effort to work across networks, avoiding "ownership" of communities and people by different funders and NGOs and a nexus approach reduces destructive competition for money, skills, and spheres of influence.

12. Use of national fiscal public funds

The demand for housing and better economic opportunities leading to rapid urbanization is a global phenomenon, sometimes exacerbated by migration due to conflict and landlessness. Improving and diversifying the rural economy is easier said than done. The ROI for the private sector to engage has a long unacceptable time horizon and so needs political will to channel public funds. Some successful strategies include focusing on small rural towns and including "soft" issues, such as the development of markets and cooperatives for small-scale farmers and assistance with tourism.

Match funding from national coffers can increase project sustainability, but in many instances there is no ready cash available. In-kind contributions need to be included and valued, including the long-term "knock on" value of a successful initiative. Also, it is important to recognize existing ecological infrastructure as foundational, as well as other natural assets (resource accounting), and of co-equal value to built infrastructure, and be included in evaluation and costing and in performance monitoring.

13. Rethinking human capital development

Land restoration needs high-level and low-level skills. A skills analysis with the local community before starting a project is useful, and building local skills should be an integral part of the plan. Capacity building and enskilling should be a KPI of programme monitoring. Local skills and capacity development will contribute to sustainability and buy-in, and broad skills will assist in employment multipliers, labour mobility and general empowerment. Use of (and funding of) local capacity-building institutions will embed appropriate curriculum development with a life long past the project duration. Improved skills in planning, design, implementation and monitoring, as well new data analysis and informatics tools, will unleash more local solutions for local problems. Fostering relations between participants of different projects can also be used to great effect, as well as South-South cooperation for sharing and learning.

14. Creative use of information technology

Approaches to overcoming land degradation and restoration have their origins before the ICT revolution. A global success has been the spread of mobile telephony. Unfortunately, access to the Internet remains a challenge in terms of data costs and communications infrastructure. However, in many parts of the world, both in the North and the South, ICT has become a major tool for development, whether it be for information for decision-making, banking and remittances (such as M-Pesa), sharing best practice and technologies, etc. The uptake of ICT even in the poorest and most marginalized sectors of society (particularly the youth) has been a game-changer over the past 20 years.

Local innovation can go viral, be copied and give a confidence boost to local innovators. A worthwhile investment would be to ensure that a user group such as traditional healers that harvest plants and small-scale farmers in an area have access to pertinent information through mobile apps and other ICT.

The computing power in handheld devices is phenomenal, and our sector needs to borrow or piggyback on these tools and capacities. In theory, complex data, "boiled down" into useable information can put knowledge - such as from remote sensing, biodiversity occurrence data series, weather and climate - into the hands of ordinary citizens.

15. The power of television and popularization

Another global phenomenon is the mushrooming of TV satellite dishes, even in the poorest areas, which gives unparalleled access into people's homes. Popularization and awareness of environmental issues through popular campaigns and even inserting compelling stories in local "soapies" and novelas is a channel that is underused.

Conclusion

SDG 15 is inextricably linked through complex cause-and-effect relationships with all other SDGs and so cannot be engaged with in silos. Many development efforts, led by a range of local, national and international players, impact directly and indirectly on the outcome of this SDG. The capacity for land to play its multipurpose role in a sustainable future requires a 360-degree perspective, with integrated, cooperative and transdisciplinary approaches for data and information management, research, policy, planning and actions. This perspective must include, amongst others, governance, communication, capacity and capabilities, skills, economic imperatives, conflict, political and social matters. Existing policies and institutions need to be built upon, possibly including through the development of a compact amongst all key players to include land degradation avoidance and land restoration in development efforts (see box 3.17.1).

Box 3.17.1. Development assistance and partnerships in southern Africa – a selected review

1. In the mid-1950s, the then-colonial government of Northern Rhodesia created a class of elite master farmers out of a group of Christian Mazezuru farmers from Southern Rhodesia. Ostensibly, they regarded the natives as unable to farm and use the land productively, and it is uncertain what steps were taken to identify and bring these individuals and their families north to take advantage of this initiative. It is uncertain whether incentives were used or whether it was semi-forced cohesion. Land with title was given to these "migrant" farmers in the Mazabuka area south of the capital, Lusaka. These farmers were also given special training, tools and resources to protect and restore degraded land. The training covered a variety of topics, including crop rotation, contour ploughing, and pest and soil protection. In this way, they received separate but similar extension services support as the colonial or settler farmers. By the early 1980s, long after Zambia became independent, the outcomes of this intervention were still seen on the landscape. Unlike surrounding areas, where native dwellers lived on degraded land and soils, these farmers and their families thrived, grew cotton, maize and groundnuts, used improved farming methods and were the highest consumers of hybrid seed, artificial fertilizer and pesticides.

Other countries of the "South" have their own, and in some instances similar, stories (for example, India and the impact of the Green Revolution). However, in Southern Africa it is the colonial legacy of land alienation that has had the longest impact. Through land alienation, colonialists or settlers owned and utilized the major part of the land (Crown land or Trust land in the case of the Rhodesias), carved out to include the best and most fertile lands, and the natives used the rest (communal land or Bantustans in South Africa), without title, often having been forcibly moved there.

2. Two decades later, in the early 1990s, the newly minted South Africa, with the democratic transition under its belt, went from only one international donor prepared to fund a limping state to over 150 donors keen to weigh in with international development cooperation. Strong and experienced international donors with keenness to support the "miracle" transition in an array of areas that they had deemed important for assisting states to succeed. Some donors had supported NGOs off the State's books, and so had hard-earned experience of the country. Others stepped in after the transition with offers of loans, grants and other instruments.

The Reconstruction and Development Programme (RDP) office in the Presidency was responsible for managing this influx of international support. Fortunately, the RDP (which included strategies on land agriculture and the environment) had been extensively consulted throughout the country as part of the ruling party manifesto, and so it was relatively easy to fit the proposals of these donors into the plan for the new South Africa. Those whose proposals did not fit, or who had other ideas about what was needed for success, were not entertained and turned down. The confidence to turn down money is a rare luxury, a once-in-a-lifetime confidence boosted by being the new shiny kids on the block!

3. Another two decades later, in 2015, "donor" relations are very different, as displayed by an example of the Global Environmental Facility (GEF) building on the Critical Ecosystem Partnership Fund (CEPF) experiences and successes. As documented on its website (www.sanbi.org; accessed July 2019): "The South African Biodiversity Institute (SANBI), through the CEPF funded learning network project in the Maputaland- Pondoland-Albany Hotspot (MPAH), developed a set of case studies and lessons learnt based on project experiences within the MPAH. These focused on three themes, including biodiversity stewardship; local government and civil society; and strengthening community conservation across the landscape. The case studies were the achievement of the five-year, US$6 million CEPF investment in the region.

Building on that experience and CEPF investment the Biodiversity and Land Use Project, implemented by SANBI, was initiated in 2015 with funding from the GEF and aimed to support municipalities in effectively regulating land use to ensure biodiversity continues to provide essential ecosystem services. Part of the deliverables included the 'soft' issue of effective and sustaining partnerships. Agreements were signed with the World Wildlife Fund South Africa (WWF-SA), NCT Forestry Co-operative Limited (NCT), the Eastern Cape Parks and Tourism Agency (ECPTA), the Ehlanzeni District Municipality and the uMgungundlovu District Municipality. These agreements aimed at strengthening the uptake of biodiversity priorities into planning and land use management. Through this a workshop for developing biodiversity management plans (BMPs) for a group of traditionally used medicinal plant species was also done showing direct value to local traditional healers as part of the Biodiversity and Land Use Project.

Building even further on this SANBI started yet another programme building on past successes in June 2016 with the development of a five-year GEF-funded project entitled, 'Unlocking Biodiversity Benefits through Development Finance in Critical Catchments'. The GEF 6 project will implement interventions at both national policy and institutional development level, through demonstration initiatives in two catchments. The project is being developed in partnership with the Development Bank of Southern Africa (DBSA) and will secure $7.2 million from 2017–2021".

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4

Integrated landscape approach to using restoration to help achieve multiple SDGs

S.J. Scherr and L. Wertz

The power of land restoration to achieve specific SDGs is clearly demonstrated in chapters 3.1-3.16. Taking a landscape approach to restoration planning and management allows resource managers to achieve many, if not most, of the Goals simultaneously across the same land area. It is, after all, at the level of the landscape where the two principles undergirding the SDGs – indivisibility and inclusivity (A/RES/70/1) – must be put into practice by foresters, farmers, agencies, NGOs, businesses, and civil society. It is in the landscape where land management systems need to find the synergies and balance the trade-offs between development and conservation demands (Mann et al. 2018).

In this chapter, we review the limits of sectoral actions – those that focus on independently achieving a narrow set of objectives (e.g., increasing agricultural productivity or providing clean water) in a part of the landscape. We then show what an integrated landscape approach to restoration planning looks like in practice and provide examples. Finally, we highlight specific strategies and policies for maximizing the effectiveness of landscape approaches to restoration for achieving the SDGs.

Figure 4.1. Conventional planning and policy decisions for natural resources in different parts of a landscape are siloed in different ministries and discussed with different stakeholders. Yet critical ecosystem services, such as water flow and storage, movement of pollinators and wild plant species do not respect these artificial boundaries, nor do many degradation processes, such as soil erosion, nor economic and social flows and interactions. Thus, plans and policies to achieve the SDGs that ignore such interactions lead to major inefficiencies, conflicts, and higher costs.

Limitations of sectoral silos

While holistic approaches to natural resource management and land health are far from new, they differ markedly from the prominent modes of decision-making of the last century and a half. The conventional approaches, which are still widely applied today, commonly emphasize specialization, comparative advantage, and short-term profit-maximization, while delegating responsibility for "nature" to government-controlled land and regulation. In other words, "the typical approach has been to manage different parts of the resource base (e.g. rivers and forests) independently, to meet different sectoral goals (e.g. crop production, watershed protection, production forestry)" (Denier et al. 2015, p 16) as illustrated in figure 4.1.

Since different land uses, and the human economy as a whole, rely on the same finite resource base, decisions made to improve outputs in a single sector, without effective coordination with other sectors, can have negative impacts on the overall availability of resources. In fact, this is exactly what we have seen: overexploitation, land degradation, and race-to-the-bottom competition are hallmarks of industrial society.

For example, in some countries, the rapid expansion of oil palm plantations has improved the output of national economies and lifted many people out of poverty. "However, palm production has also led to high deforestation rates, conversion of peat swamps leading to loss of biodiversity, increased CO_2 emissions and wildfires. It has also had negative impacts on human health and forced migration from affected areas" (Denier et al. 2015). Elsewhere, strategies to revegetate degraded watersheds through extensive plantations of exotic forest species have often undermined both freshwater and terrestrial biodiversity, and farmer and community livelihoods. While agricultural biofuels are a promising energy alternative, in some contexts and without careful design, they may undermine food and water security and biodiversity (Bringezu et al. 2009).

Figure 4.2. An integrated landscape management (ILM) approach encourages resource managers and other stakeholders to work together to sustain a diverse mosaic of land uses and to select land uses and management systems that explicitly contribute to many different SDGs and are consistent with the sustainable potential of different parts of the landscape. In contrast, a sectoral approach tends to frame decisions as trade-offs, neglecting options that contribute to multiple outcomes simultaneously. © EcoAgriculture Partners/Wenceslao Almazan and Louis Wertz 2015

A holistic, integrated landscape-based approach can both ensure that these mistakes are not repeated, while reducing costs and conflicts among individuals and institutions working in a landscape.

What is an integrated landscape approach?

We define landscape as a socio-ecological system with a mosaic of natural and human-modified ecosystems, influenced by distinct ecological, historical, economic and socio-cultural processes and activities. The natural resource base of the landscape must provide more than one, and often many, benefits or ecosystem services, such as food, rural livelihoods and well-being, energy, fibre and building materials, medicines, and biodiversity (Millennium Ecosystem Assessment 2005). Applying a landscape approach to restoration requires applying a process of decision-making and action that is responsive to, inclusive of, and designed by the diverse stakeholders in the landscape. To describe this process, we use the generic term “integrated landscape management” (ILM); many other names are used, depending on the particular entry point for collaborative action (e.g. integrated water resource management, landcare, holistic management, bioregional planning, territorial development, satoyama) (Scherr et al. 2013).

ILM aims for managing the underpinning natural resource base and ecosystem services in a coordinated way so that societal needs can be met in the short and long term (Thaxton et al. 2015).

Five key features characterize ILM, all of which facilitate the achievement of multiple SDGs:

1. Shared or agreed-upon management objectives among stakeholders that encompass multiple benefits from the landscape;

2. Resource management practices that are designed to contribute to multiple objectives;

3. Management of ecological, social, and economic interactions across the landscape for the realization of positive synergies and the mitigation of negative trade-offs;

4. Collaborative, community-engaged planning, management, and monitoring processes; an

5. Reconfiguration of markets and public policies to achieve the full set of landscape objectives (Scherr et al. 2013).

The overall adaptive process of ILM involves five main elements: (1) stakeholder engagement; (2) generating a shared understanding of landscape status relative to its potential, issues and options; (3) collaborative development of a landscape vision and action plan; (4) implementation, including design of interventions, communications, and investment finance; and (5) tracking changes to enable adaptation from lessons learned and evolving landscape conditions (Heiner et al. 2017).

Benefits of an integrated landscape approach for addressing multiple SDGs

Between 2013 and 2017, four surveys of integrated landscape initiatives - in Africa, Latin America and the Caribbean, South and Southeast Asia and Europe - found that generally, "initiatives with larger numbers of objectives, investments, and participating stakeholder groups all reported significantly higher numbers of positive outcomes, suggesting significant value in the core precepts of the integrated landscape management approach" (Estrada-Carmona et al. 2014).

Table 4.1 summarizes the reported impacts of 357 of these initiatives in the developing world and maps them explicitly to eight of the 17 SDGs. The findings demonstrate the practical potential for multi-SDG strategies. A large proportion of the initiatives reported positive impacts across agriculture, ecosystems, livelihood, and institutional dimensions. A multi-institutional review of the potential of ILM as a tool for implementation of the SDGs found examples including 16 of the 17 SDGs (Thaxton et al. 2015).

Applying the five elements of the integrated landscape management process can help ensure that the potential benefits of restoration projects for multiple SDGs are identified and realized.

For example, a cross-sector programme for watershed restoration can spur economic activity, improve agricultural productivity, improve water availability and quality and thus help enhance the health conditions of the entire population. It can also support biodiversity conservation and contribute to climate-change mitigation and adaptation. ILM can also be used to minimize trade-offs associated with land restoration. For example, if certain lands need to be taken out of food production on a temporary or permanent basis in order to achieve restoration objectives, other ecologically healthy or resilient areas of the landscape could be used to ensure secure food supplies and access.

Thus, adopting a landscape approach that systematically considers multiple sectors and diverse stakeholder needs can enhance overall policy and programme coherence and effectiveness.

Dimension	Reported impacts of landspace initiatives	Sub-Saharan Africa (%, n=87)	South and Southeast Asia (%, n=166)	Latin America and Caribbean (%, =104)	Impacts SDG #
Agriculture	*Increased yields*	*40*	*46*	*38*	*2*
	Increased profitability	*29*	*53*	*37*	*1*
	Reduced environmental impacts	*39*	*57*	*56*	*6, 12, 15*
Ecosystems	*Improved biodiversity protection*	*51*	*87*	*66*	*15*
	Improved water quality and regularity	*29*	*52*	*42*	*6*
Institutional	*Greater empowerment of women*	*45*	*83*	*55*	*5, 10, 16*
	Preserved/used indigenous and local knowledge	*37*	*88*	*67*	*10, 16*
Livelihoods	*Improved food security*	*46*	*69*	*42*	*2*
	Higher income for low-income households	*46*	*96*	*52*	*8*

Table 4.1. Reported impacts of 357 integrated landscape initiatives surveyed in 2013-2015 in Latin America, Sub-Saharan Africa and South and Southeast Asia, organized by outcome dimension and mapped to related SDGs. Data synthesized by authors from Estrada-Carmona et al. 2014; Milder et al. 2014; and Zanzanaini et al. 2017.

Benefits of the ILM process for addressing SDGs at local to national scales

The five elements of the ILM process are largely scale-independent and thus can strengthen national and sub-national, as well as local, initiatives designed to maximize the positive impacts of restoration projects on multiple SDGs in at least four ways.

First, ILM can support **alignment of outcomes** across sectors and scales, increase coordination, and help harmonize planning, implementation, and monitoring processes. This approach can make more efficient use of scarce financial resources by reducing redundancies and increasing sustainable development returns on investments through effective planning and decision-making.

Second, well-facilitated ILM can **empower communities** through multi-stakeholder processes and inclusive governance. ILM processes are participatory and collaborative, engaging all stakeholders - including women, youth, mobile communities, indigenous peoples, and other marginalized and vulnerable peoples - in decision-making and management of natural resources, agricultural lands, biological diversity, and culturally important resources. As Mann et al. (2018) note:

> "ILM helps to foster debates about multiple landscape functions, services, and visions among concerned actors and inspires an exploration of a range of land-use options and synergies. It allows heterogeneous actors with different motivations and roles to constructively exchange options for landscape development and hence their visions of sustainable development that have been previously often left outside of decision-making processes."

A third way that ILM supports achievement of SDGs at multiple scales is by involving multiple stakeholder groups in **spatial analysis and planning**. Spatial information about ecosystem services, development, conservation and restoration opportunities, and the interactions between social, economic, and environmental forces shaping land use change is critical to successful land restoration planning.

Many of the processes which determine successful restoration strategies are unseen and difficult to detect, from plants' roots slowing run-off and holding topsoil to encourage groundwater recharge to forest patches that house pollinators and enhance assisted natural regeneration, as well as improving nearby crop yields. Maps of where and how manifestations of these processes occur can be particularly enlightening, showing how decisions about where and what type of restoration practices to employ can "trickle down" to affect many more people in the landscape. Foreseeing and understanding implications of potential trade-offs and making informed decisions about the best restoration practices to deploy constitute an important part of the planning process. Integrated analysis and planning tools are critical to finding acceptable courses of action in the near term, and that will prove sustainable in the long term (Thaxton et al. 2015).

Finally, the **multi-stakeholder partnerships** at the core of integrated landscape management are necessary for translating this information into restoration projects, which typically must be implemented at the landscape scale. ILM provides an integrated, evidence-based, and risk-informed decision-making process that incorporates monitoring and evaluation metrics that reflect cross-sector synergies. In this way, international and national spatial analysis expertise can find its way into on-the-ground implementation of restoration projects in ways that explicitly address multiple SDGs.

Restoration applications in Honduras and Kenya

ILM takes many different forms, as illustrated by two very different applications. Additional applications are described at peoplefoodandnature.org/learning-network/meet-landscapes/.

Caribbean north coast of Honduras

The Solidaridad Network is facilitating the Paisajes Sostenibles (Sustainable Landscapes - PaSos) initiative on the Caribbean north coast of Honduras[2]. The landscape has very high-value forest and coastal biodiversity, but also rapidly expanding agricultural production and population, and has experienced extensive degradation of soil, forest, water and biodiversity. PaSos brought together a broad range of landscape stakeholders, including palm oil, cocoa, and ecotourism companies, indigenous peoples' and community-based organizations, farmer organizations and cooperatives, municipal governments, research institutes and universities, community water associations, and non-profit organizations to restore the landscape in all its dimensions. They shared their understanding of the landscape, defined together a set of landscape ambitions concerning production, environment and human well-being in 2030, and are creating and making commitments to a landscape action plan.

To further refine their initial plans, PaSos-Solidaridad worked with PBL-Netherlands Environmental Assessment Agency and EcoAgriculture Partners to use a set of models

[2] Read more about this initiative here: *https://www.solidaridadnetwork.org/solidaridad-stories/smallholder-oil-palm-production-honduras-model-for-sustainable-livelihoods*

to develop landscape scenarios to 2030 for business as usual (BAU), accelerated agricultural exports (AAEG), and the integrated landscape management plan (ILM) under development. While PaSos' landscape ambitions align with numerous SDGs, the quantitative models focused on projecting outcomes of the three scenarios for the specific SDG targets concerning food security (SDG 2), water (6), biodiversity (14 and 15), and climate change (13). The report concludes that "given the scenario projections on population, climate change and agricultural production, the ILM is the only scenario that has positive outcomes for 3 of the 4 SDGs, or is able to limit degradation, compared to the BAU and AAEG scenarios. This does illustrate the scale of the challenges faced in the landscape, but also the potential value of a process that explicitly encourages and enables stakeholders from multiple sectors to coordinate strategies" (Meijer et al. 2018). When initial scenario runs indicated that even in the ILM scenario some SDG food security targets were not being met, the stakeholders added new activities to the action plan.

Lake Naivasha basin of Kenya

The Lake Naivasha basin in Kenya (figure 4.3) epitomizes a diverse landscape. It is home to major national wildlife parks and bird sanctuaries and private conservation reserves, Kenya's export flower industry, as well as smallholder farmers, pastoralists, and fishers. The basin is home to over 700,000 people living in both rural and urban communities including the fast-growing city of Naivasha. Poor agricultural practices, over-abstraction of water, and uncoordinated resource management have put significant strain on the environmental health of the basin and the floriculture, horticulture, livestock, and tourism industries that support the local economy. When a major drought peaked in 2009, water levels in the lake dropped to alarmingly low levels. The crisis made international headlines, sparking backlash against retail chains in Europe stocking vegetables and especially cut flowers produced in Naivasha greenhouses.

In response, the Imarisha Naivasha Board was created by the national Government with support from the flower industry. Imarisha's role is to coordinate restoration by bringing diverse stakeholders together, including local government, non-governmental organizations, commercial flower growers, small-scale farmers, pastoralists, community groups, and citizens, to develop an integrated basin management plan and cooperate to restore the water catchment area. To this end, Imarisha Naivasha stakeholders developed the Lake Naivasha Basin Integrated Management Plan (2012) and accompanying Sustainable Development Action Plan (2012), laying out the goals of development in the basin and outlining specific objectives to be accomplished in five-year increments. Key actions promoted have included water-use efficiency in agriculture, watershed revegetation, conservation and climate-smart agriculture by smallholders, improved urban wastewater management, improvements for smallholder fishers and pastoralists, water access for grazers, and improving environmental stewardship by nature tourism operators.

By including all stakeholders in the design, interventions have been targeted more strategically and benefits distributed more fairly. The plans explicitly advance SDGs concerning poverty reduction (1), food security (2), water (6), biodiversity (14, 15), and climate (13). Imarisha is also contributing to strong institutions, decent work and economic growth (8), gender equality (5), and responsible consumption and production (12). This has generated broader political and social support for development and conservation plans, in contrast to meagre enthusiasm for previous actions that focused narrowly on water.

Figure 4.3. Settlements on the shores of Lake Naivasha, Kenya. Integrated sustainable development planning has helped improve sanitation and reduced pressure on nearby woodlands. Upstream, well-targeted restoration efforts have reduced flooding and siltation in the basin. Photo credit: © EcoAgriculture Partners/ Louis Wertz 2015.

Conclusions

In planning and implementing solutions to land degradation, we cannot apply the same decision-making processes that led to land degradation in the first place. Integrated landscape management offers a locally determined, context-specific decision-making process that addresses complex and dynamic realities of development and environment. For land restoration to maximize its contributions to the SDGs, policymakers and practitioners will need to utilize holistic, landscape-level approaches to mitigate trade-offs and realize synergies.

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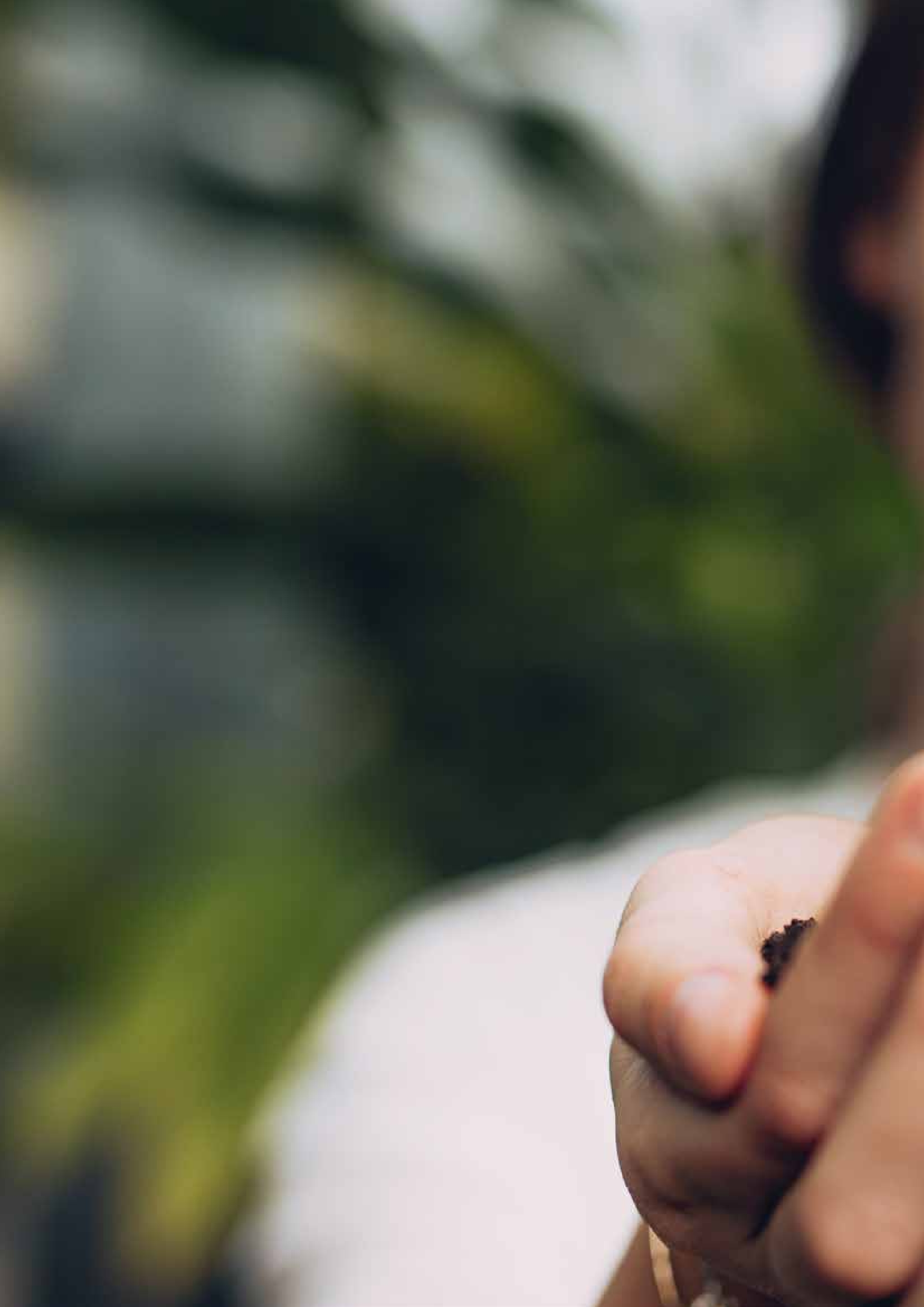

5 Summary and conclusions

Figure 5.1. International students in the Iceland / United Nations University Land Restoration Training Programme work together to learn how to use their hands and a simple mobile phone app to help determine land restoration potential. Photo credit: Hafdís Hanna Ægisdóttir (please note Icelandic letters).

This report builds on the conclusions of the UNCCD Science-Policy Interface that land degradation is usually most effectively - including cost-effectively - addressed hierarchically, beginning with avoiding and reducing degradation of relatively undegraded lands, and then reversing degradation of already degraded lands, through restoration or rehabilitation.

Four major conclusions emerge from the extremely diverse chapters written in response to each of the first sixteen SDGs. A fifth is drawn from chapter 4.

1. Land restoration and rehabilitation can have significant co-benefits for all the SDGs.

While other reports have focused on a subset of the SDGs, this report has intentionally considered all of them, and has done so by inviting a large number of diverse authors to participate in the process. Their observations and conclusions, while by no means comprehensive, paint a picture of opportunity and hope as investments in land restoration rapidly grow across the globe. A summary of their conclusions is that land restoration has co-benefits for all SDGs, indirectly, directly, or both. At the same time, the authors collectively acknowledge that the challenges of restoring land, and of realizing SDG co-benefits, are significant, as evidenced by the variable success of past initiatives.

2. The extent of the restoration co-benefits and the potential risks and trade-offs vary widely among the SDGs and their respective targets.

The review recognizes not only the diversity of co-benefits that restored land and the process of restoring land can provide, but also that the extent that restoration provides these co-benefits also vary widely among SDGs. One significant observation is that the relative benefit of restoration for the general Goal is often perceived to be greater for some of the Goals than for the specific targets. This is because the targets are in many cases more narrowly defined than the Goal. An example is climate change (SDG 13). Land restoration is widely acknowledged to be essential to the goal of combatting “climate change and its impacts”, as stated in the Goal itself. But the targets do not explicitly call for increasing climate-change mitigation (e.g., through increased soil carbon sequestration). In other cases, such as gender (SDG 5), co-benefits are by no means guaranteed: they depend almost entirely on how and by whom restoration work is completed, and who is able to leverage the benefits of the restored land.

3. The co-benefits of the restoration process are often much different than those of the restored land, and often work at different temporal scales.

The relative benefit of each varies among the SDGs. This conclusion has significant implications for how projects that attempt to address land restoration together with one or more other SDGs are both planned and financed: co-benefits of the restoration process (e.g., on poverty through incomes) are realized immediately, while the benefits of the restored land (e.g., on hunger through increased agricultural production) may require years or decades to be realized.

4. Quantitative and qualitative modelling, including scenario development, at local to global scales can help guide future investments.

It is easy to identify potential synergies and co-benefits. It is much more difficult to ensure that they are realized. Informal discussions among the authors revealed widespread frustration with the extent to which development initiatives are developed and implemented independently from each other, resulting in unrealized opportunities to realize co-benefits through synergies at best, and in unnecessary trade-offs at worst. Even projects funded by the same government, government agency, or donor are often uncoordinated. The scenarios included the International Resource Panel's recent Global Resources Outlook (IRP 2019) illustrate the power of developing and applying integrated models to help structure and navigate the incredible number and complexity of interacting factors that determine the extent to which co-benefits of restoration will be realized.

5. An integrated landscape approach, including targeting research and investments, is key to increasing the total return on land restoration investments.

An integrated landscape approach is one that takes into account spatial variability in land potential, and is "responsive to, inclusive of, and designed by the diverse stakeholders" (chapter 4). It can be used to help meet the needs of displaced populations while land is being restored. Furthermore, targeting investments to those parts of the landscape that are most likely to respond, and where recovery is likely to persist, is key to optimizing returns on investments.

Finally, the reflections on SDG 17, Partnerships for the Goals, presented in chapter 3.17 provide a number of practical lessons learned over a lifetime of work in conservation and development. They provide a reminder that while there is much yet to learn, there is also a solid foundation of lessons learned on which we can build together.

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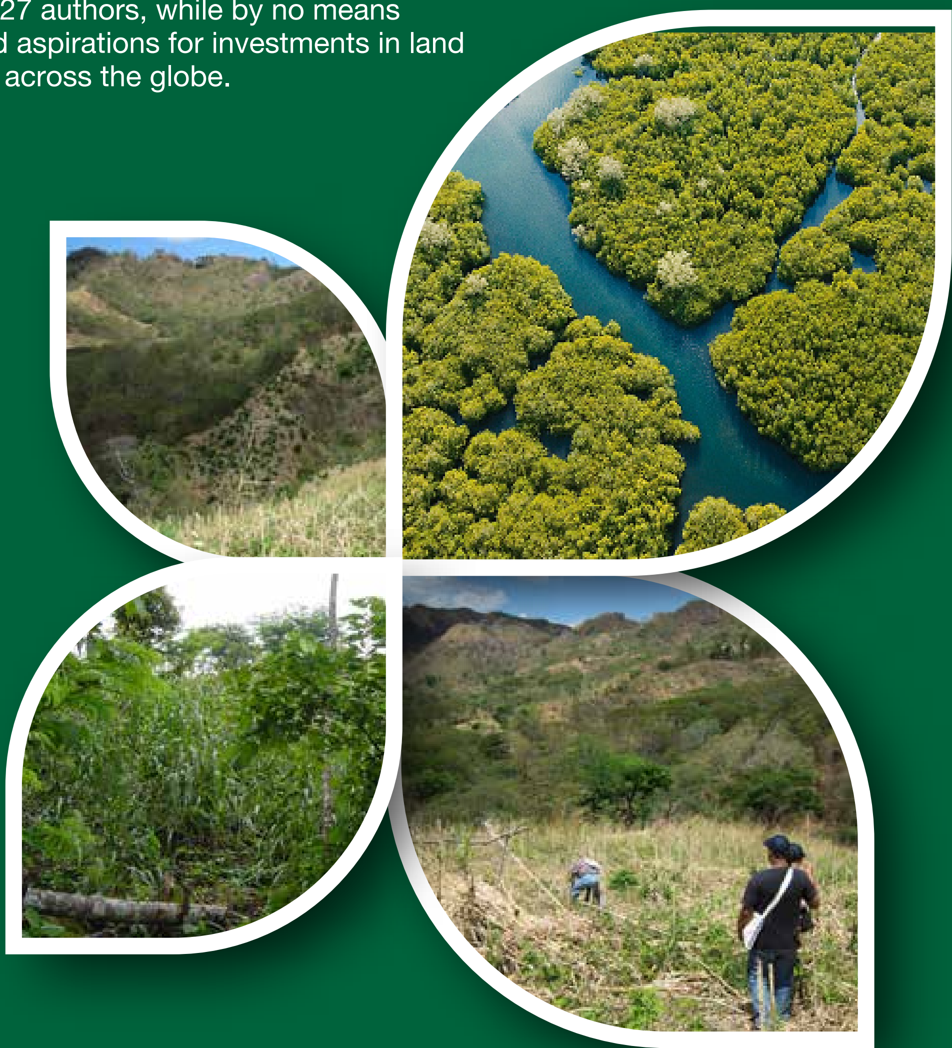
As we approach the final decade before the Sustainable Development Goals (SDG) are to be achieved in 2030 a huge step-up is required on all fronts if the world is to achieve its targets and reverse the climate and species crises. Currently, about a quarter of the world's land is degraded. Land restoration and rehabilitation together represent one of three primary strategies for achieving SDG 15 (Life on Land), and particularly for meeting the land degradation neutrality target under that goal (15.3). This International Resource Panel think piece highlights that both the process of land restoration and rehabilitation, and the restored land, have tremendous potential to help the world limit climate change and achieve its aims for sustainable development. The think piece provides diverse reflections for policymakers, academics and practitioners for the development of strategies to maximize the co-benefits of land restoration and rehabilitation for life on land by highlighting the risks, trade-offs and costs of land restoration and rehabilitation for the achievement of the 2030 Agenda for Sustainable Development and its associated goals. It strongly recommends a systemic analysis, before investment is made, to avoid unintended consequences. The think piece provides a clear strategy to maximize cross-cutting opportunities for land restoration or rehabilitation across multiple SDGs. The observations and conclusions provided by the 27 authors, while by no means exhaustive, provide hope and aspirations for investments in land restoration and rehabilitation across the globe.



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