THE ECONOMICS OF
LAND DEGRADATION

The Value of Land

Prosperous lands and positive rewards through sustainable land management

www.eld-initiative.org

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Foreword

In too many daily decisions, the difference between price and value is ignored. We have, for example, consistently under-valued finite natural resources like the land. The price of land on the global market is often far below its real value to society. As a result of these economic signals, we have extracted too much from the land and degraded this most precious of assets to a dangerous extent. Worldwide, 52 per cent of land used for agriculture is moderately or severely affected by land and soil degradation. The phenomenon is widespread and occurs in all regions. Ecosystem service losses from land degradation cost up to USD 10.6 trillion per year or USD 870 to 1,450 per person within the same time. Everyone on earth suffers indirectly – globally, 1.4 billion people are directly impacted by land degradation.

Increasing our understanding of the true economic value of land to society and aligning our policy to that new reality will be critical. With the population of the world forecast to expand to at least 9.7 billion people by 2050, pressures on food, water and energy supply will mount. With growing competition over a declining resource base, compounded by the accelerating impacts of a changing climate, instability and even conflict will accelerate. Going far beyond traditional environmental or agricultural considerations, difficult trade-offs and access to finite natural resources are set to be key strategic policy issues in the coming decades. Failure to understand what we get from the land means the price to be paid in terms of future uncertainty and vulnerability will be huge. The report highlights that ELD has estimated lost value from land use change and land degradation at 10 to 17 percent of current global GDP annually.

The ELD Initiative has demonstrated however that sustainable land management (SLM) can be profitable at all scales and within a relatively short time horizon. A concerted effort to scale up SLM would certainly help achieve a number of the critical post-2015 Sustainable Development Goals, as well as supporting the G7 commitment to aim to lift 500 million people in developing countries out of hunger and malnutrition by 2030. The continued availability of productive land and soil would also offer significant co-benefits measurable in economic terms. An ELD study conducted across 42 countries in Africa found that taking action on soil erosion over 105 million hectares would save up to USD 62.4 billion in net present value over the next 15 years.

Adopting sustainable land management could deliver up to USD 1.4 trillion in increased crop production. Cost-effective carbon storage, whereby carbon stocks in land and soil are enhanced, can create value up to USD 480 billion and increase food and water security. SLM measures increase the resilience of people and ecosystems to food price volatility or to climate shocks with significant economic implications such as drought and flood. Supporting SLM can thus make significant contributions to climate change adaptation and mitigation and, ultimately, to the goal of United Nations Framework Convention on Climate Change (UNFCCC) to keep the increase in global average temperature below 2 °C.

To deliver on these opportunities, this ELD report calls for bold policy decisions. Supporting economic, enabling and institutional conditions will be needed for the uptake of SLM. From subsidy reform to the elimination of perverse incentives and the development of new markets for different ecosystem services, ELD partners believe robust economic valuation methodologies will help decision makers take the decisions that are urgently needed for the benefit of their communities. Those that do take action will leverage the huge opportunities that exist, such as securing high rates of return on investment from ecosystem rehabilitation and restoration, for example. This is not something that the public sector can do alone. Stakeholder engagement and partnerships should be fostered and investments by the private sector encouraged. Partnerships for the land and investments in the future health of the planet are economically rewarding across all sectors.

With these combined efforts by the ELD network of partners, we want to make a contribution to the global understanding of the value of land and improve awareness of the economic case for sustainable land management in preventing loss of natural capital, preserving ecosystem services, combatting climate change and addressing food, energy, and water security.

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About the ELD Initiative

The Economics of Land Degradation (ELD) Initiative is an international collaboration that provides a global assessment of the economics of land degradation, and highlights the benefits of sustainable land management. Working with a team of scientists, practitioners, policy-/decision-makers, and all interested stakeholders, the Initiative endeavours to provide a scientifically robust, politically relevant, and socio-economically considerate approach that is economically viable and rewarding. Ensuring the implementation of more sustainable land management is of critical importance considering the vast environmental and socio-economic challenges we are collectively facing – from food, energy, and water security and malnutrition, to climate change, a burgeoning global population, and reduction in biodiversity, ecosystems, and ecosystem services.

Understanding the cost of inaction and benefits of action are important in order for stakeholders to be able to make sound, informed decisions about the amount and type of investments in land they make. Even though techniques for sustainable land management are known, many barriers remain and the financial and economic aspects are often put forward as primary obstacles. If the full value of land is not understood by all stakeholders, it may not be sustainable managed, leaving future generations with diminished choices and options to secure human and environmental well-being. A better understanding of the economic value of land will also help correct the imbalance that can occur between the financial value of land and its economic value. For instance, land speculation and land grabbing are often separated from the actual economic value that can be obtained from land and its provisioning services. This divergence is likely to widen as land scarcity increases and land becomes increasingly seen as a 'commodity'. Economic values can provide a common language to help entities decide between alternative land uses, set up new markets related to environmental quality, and reach the goal of land degradation neutrality. It should also be noted that the resulting economic incentives must take place within an enabling environment that includes the removal of cultural, environmental, legal, social, and technical barriers, and also consider the need for equitable distribution of the benefits of land amongst all stakeholders. Though there is a wide variety of possible methods, valuations, and approaches that may be available or appropriate, the ELD Initiative promotes the use of the total economic value, achieved through cost-benefit analyses, as this can provide broad and cohesive understanding of the economics of land degradation. It is a method that is generally accepted by governments and others as a decision-making tool, and is supported here because applying other tools may require a fundamental change existing systems. To this end, the ELD Initiative operates under the following vision and mission statement, with a structure outlined in the organigram:

ELD Initiative: Vision

To transform global understanding of the value of land and to create awareness of the economic case for sustainable land management in preventing loss of natural capital, preserving ecosystem services, combatting climate change, and in addressing food, energy, and water security.

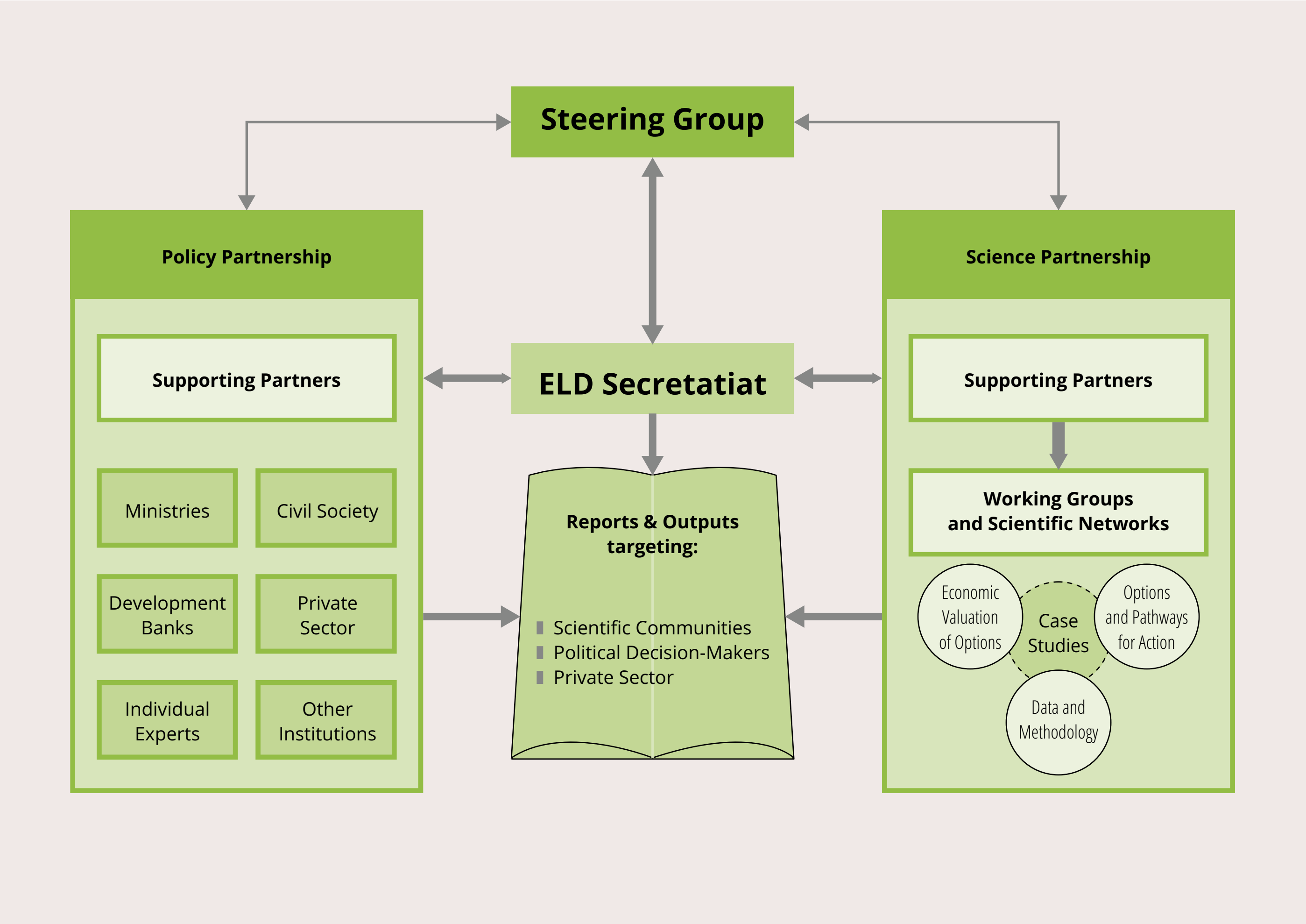
ELD Initiative: Mission Statement

Through an open inter-disciplinary partnership:

- We develop a holistic framework for the consideration of the economic values of land in political decision-making processes;
- We compile and build a compelling economic case for benefits derived from the sustainable management of land and soil on a global and local scale;
- We estimate the economic benefits derived from adopting sustainable land management practices and compare them to the costs of these practices;

- We sharpen awareness of the value of land and related ecosystem services;
- We will propose effective solutions, policies and activities to reduce land degradation, mitigate climate change and deliver food, energy, and water security worldwide

Economics of Land Degradation (ELD) Initative Governance Structure



Acronyms and abbreviations

CBA	Cost benefit analysis
DLDD	Desertification, land degradation, and drought
DPSIR	Driver-pressure-state-impact-response framework
ESV	Ecosystem service values
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
LDN	Land degradation neutrality
GDP	Gross domestic product
GEF	Global Environment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GM	Global Mechanism of the UNCCD
HANPP	Human appropriation of net primary productivity
LAC	Latin America and the Caribbean
MCDA	Multi-criteria decision analysis
MDG	Millennium Development Goals
MOOC	Massive Open Online Course
NAP	National action plan
NDVI	Normalized Difference Vegetation Index
NGO	Non-governmental organisation
NPP	Net primary production
NPV	Net present value
OSLO	Offering Sustainable Land use Options Consortium
PES	Payment for ecosystem services
PPP	Purchasing power parity
SDG	Sustainable Development Goals
SLM	Sustainable land management
TEV	Total Economic Value
UK	United Kingdom
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
USD	United States Dollar
USA	United States of America
USPED	Unit Stream-Power based Erosion Deposition
WBCSD	World Business Council on Sustainable Development
WOCAT	World Overview of Conservation Approaches and Techniques
WTO	World Trade Organization

* *Editor's note: Acronyms and abbreviations are used interchangeably across the document with their fuller counterpart, dependent on context and language.*

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CHAPTER

01 Introduction

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Introduction

All human life ultimately depends on land including the soil and water found there. From land, food is grown, on it protective shelters are raised, and through and across it the fresh water we drink is purified and delivered. Land provides humans with the means to live, and from the first steps tread upon it, has been a patient provider of vital resources. But at the start of the 21st century, our lands are no longer able to keep up with the pressures placed on its limited resources. Increasing misuse and demands for its goods are resulting in rapidly intensifying desertification and land degradation globally – an issue of growing importance for all people and at all scales. Burgeoning populations with shifting demographics and distributions are increasing the demands on land to produce food, energy, water, resources, and livelihoods. Environmental shifts induced through stressors (e.g., climate change) and dissolution of ecosystem stability are further decreasing the ability of land to respond resiliently to natural or anthropogenic pressures.

60 per cent of the Earth's land surface is managed, and approximately 60 per cent of that is agricultural land use[1,2]. Estimates of the extent of land degradation vary, but approximately one third of the world's arable land is thought to have been affected by degradation and desertification to date[3], indicating that it is widespread, on the rise, and occurring in all land cover types and agro-ecologies[4], and especially so in drylands[3,5]. Many degrading practices can be linked to the 'tragedy of the commons'[6] in which the demands of individual interest take precedence over shared, sustainable use of land resources, leading to its overexploitation[i]. Land degradation jeopardises ecosystem services globally, including agricultural products, clean air, fresh water, disturbance regulation, climate regulation, recreational opportunities, and fertile soils[7,8,9,10]. Novel estimates from the ELD Initiative of the global loss of ecosystem service values (ESV) place the cost between USD 6.3 and 10.6 trillion

[i] It is worthwhile to note that communal management can actually be more sustainable (McAfee & Miller, 2012[55]), such as in the traditional Hima system of the Arabic world. In the Hima system, there are protected areas of pasture that are shared amongst individual pastoralists, but also left to fallow with an understanding that this is beneficial for the greater good, even though temporary setbacks due to lack of access are endured. The ELD Initiative has also supported research on the economic rewards of the Hima system (see Myint & Westerberg, 2015[18]).

annually (see *Chapter 3a*). These effects of land degradation and desertification are distributed unevenly throughout human populations[5,11] and often impact the most vulnerable – the rural poor. This population regularly depends on land for their sustenance and livelihoods, and the ramifications of degradation affect them most deeply because of this intimate relationship[12]. An ELD Initiative study on the spatial and economic distribution of the rural poor in the context of land degradation found that over a third of this marginalised population – up to 1.4 billion people – live in less favoured agricultural land and areas[13]. However, having access to an understanding of the full economic benefits and receiving equitable distribution of rewards gained by all of society through their land stewardship, and especially when implementing sustainable land management, is key in resolving many of the issues this population faces.

In light of these types of considerations, using objective metrics like economic values provides a way for different stakeholders to compare the trade-offs of alternative future options or scenarios and thus deliberate on land issues from an equally informed position. Considering land issues from the perspective of the economic values that nature provides involves measuring and valuing all of the benefits of land and land-based ecosystems and the services they provide, including what losses are incurred when they are degraded. Combining this information with a thorough understanding of the economic drivers of land degradation, stakeholder needs, and sustainable land management approaches – practices that ensure renewable, resilient and rewarding land uses, and which are becoming increasingly available and accessible – can support better decision-making. And indeed, awareness on the value of nature and the economic losses of its services that result when it is degraded is reaching public consciousness, with a wave of articles and media outlets discussing the value of ecosystem services (e.g., *'The staggeringly large benefits of conserving nature'*, in The Washington Post[14]).

The economics of land degradation

Land has long been valued solely for the market price of crops, or similar commodity-based market values. The services that ecosystems provide are now understood to include not only those that have market values (e.g., charcoal, minerals, crops), but also those which have non-market values that also contribute to our economy and social well-being, albeit in less direct ways (e.g., water filtration, provision of clean air, nutrient cycling). These are all collectively known as ecosystem services, and are categorised as provisioning, regulating, supporting, and cultural services (see *Box 1.1*). Including non-market valuation is critical to inform decisions on resolving the issues of desertification and land degradation through economic tools, as many of these values take place outside of the current market values, and thus land valuations. Land degradation is defined by the United Nations Convention to Combat Desertification (UNCCD) as 'a reduction or loss of the biologic or economic productivity and complexity of rain-fed cropland,

BOX 1.1

Ecosystem services and examples

(adapted from ELD Scientific Interim Report, 2013[12])

Provisioning	Food, freshwater, fibre, timber, fuel, fodder, minerals, building materials, genetic resources, medicinal resources
Supporting	Primary production, soil formation, nutrient cycling, species habitat, maintenance of genetic diversity
Regulating	Climate regulation, moderation of extreme events, pollution purification, nutrient cycling, erosion prevention, maintenance of soil fertility, pollination
Cultural	Spiritual and aesthetic benefits, educational opportunities, recreation, tourism, hunting

N.B. These are discussed in more detail in Chapter 2

TABLE 1.1

Examples of land degradation impacts and economic opportunities
(examples sourced from UNCCD, 2012[15]; Low, 2013[11])

	Impacts	Economic opportunities
Direct	Loss of ecosystem services, decreases in biodiversity, soil fertility, nutrient depletion, carbon sequestration capacity, animal fodder, wood production, groundwater recharge, grazing, hunting opportunities, tourism, lowered agricultural productivity, etc., increases in salinisation, alkalisation, waterlogging, soil erosion, soil compaction, etc.	Consistent and/or increased supply of goods, stabilised markets, novel markets (i.e., carbon storage), increased access to a stabilised labour force, increased crop production and productivity, etc.
Indirect (including off-site)	Increases in dust storms, changes in stream flow and reliability of irrigation water flow, lowered drinking water quality, siltation of water systems (rivers, dams, lakes, reefs), rural poverty, food insecurity and malnutrition, respiratory diseases (from dust storms), food/water-borne diseases (from lowered water quality and poor hygiene), infectious diseases (from population migration), conflict over natural resources, forced migrations, public unrest, contributions to/decreased resilience against climate change, etc.	Investments into prevention, mitigation, and adaptation (e.g., new conservation or irrigation technologies), etc.

irrigated cropland or range, pasture, forest, and woodland'[15]. Here, as in previous ELD reports (e.g., the ELD Initiative Scientific Interim Report, 2013), it is referred to as *the reduction in the economic value of ecosystem services and goods of land, as a result of human activities or natural biophysical causes.*

As desertification and land degradation have negative impacts on land and land-based ecosystems, much of the economic focus on land degradation to date has been on the costs resulting from these issues (of inaction, as well as action). The estimations of both direct and indirect costs (see *Table 1.1*) are often imprecise, based mainly on biophysical information on land degradation and its impacts, singular – instead of multiple – estimates of impact costs, unvalued non-market costs, and variation in estimation methods[11], and this is an even more pronounced issue in indirect costs. However, assessments of the economics of land degradation to date have shown that the costs of action are lower than the costs of inaction, or 'business-as-usual'[16], which demonstrates the value of taking action towards sustainable land management.

Moreover, it is also necessary to move beyond a focus on the costs of inaction and action. Stakeholders frequently fail to see the full economic value of land inclusive of market and non-market values, and so increased efforts should be made to capture the direct and indirect values of land and land-based ecosystems towards a comprehensive understanding of their full value. Dryland ecosystems are rich sources of flora and fauna biodiversity – organisms that are already adapted to harsh environments and will be increasingly valuable in mitigating risks, for example, of unpredictable weather patterns expected to bring flood and droughts[17]. An emphasis on these types of long-term economic benefits and the benefits of action is needed to encourage awareness and investments into sustainable land management scenarios for the long term benefit of human society. Performing cost-benefit analyses (CBAs) on various potential land management options which include 'business-as-usual' scenarios, improved productivity, and alternative livelihoods scenarios[ii,12], and clearly identifying the economic benefits of sustainable land management provides a path forward. Comprehensive CBAs, in addition to other economic valuations and methods, provide clear economic incentives for land users, businesses, and policy-/decision-makers to look beyond short-term gains and see the fuller picture of future rewards.

[ii] *When creating potential scenarios to value through cost-benefit analyses, it is important to identify scenarios that are likely to be implemented based on the contextual framework, as well its ability to be reflexively maintained and adapted going forward. This is discussed further in Chapter 2 and 5.*

Sustainable land management

Sustainable land management practices are those that serve to maintain ecological resilience[iii] and the stability of ecosystem services indefinitely, while providing sustenance and diverse livelihoods for humans. It does not refer to a single method or practice, but is rather a portfolio of possible technologies, practices, and approaches to land management that are implementable at the local scale. It further involves all relevant and affected stakeholders and their needs in a participatory manner, and is supported by the broader cultural, economic, environmental, legal, political, technical, and social framework and environment. It needs to be adaptive and work with iterative feedback, as the context for sustainable land management is constantly shifting with changing environments, populations, and demands. The ELD Initiative has supported a number of case studies that have explored a variety of sustainable land management scenarios in the context of cost-benefit analyses (see *www.eld-initiative.org* for publications), tailored with a focus on specific geographic regions (*Table 1.2*). For example, one study analysed the benefits of large-scale rangeland restoration using the traditional communal management approach of the Hima system in Jordan[18], while another performed cost benefit analyses for intercropping *Acacia senegal*, a high quality gum arabic producing tree, with sorghum, a primary staple crop in Sudan[19]. Both of these, and other ELD Initiative case studies further demonstrate how considerations for implementing sustainable land management and scenarios based on them must also take place in an enabling environment, discussed next.

Enabling environments and other considerations

As the ELD case studies and others demonstrate, it is critical to create and understand the enabling frameworks and environments that reward sustainable land management practices. Further, these practices must be practical to implement by local stakeholders and be capable of being scaled up to national and even regional or global scales. Without a full enabling environment, efforts to implement sustainable land management practices may not be successful, even with sound economic evidence. For example, governments may introduce policies that turn out to be unsuccessful though the information existed to select a successful choice, or even unwittingly lead to degrading land practices (e.g., implementing schemes that have positive local impact, but negative national impact, or subsiding fertiliser use without considering the full economic or environmental effects of low-cost fertiliser)[11]. Instead of relying on corrective actions that fail to consider the broader framework, governments could promote approaches like the "payment for ecosystem services" (PES) schemes, which reward conservation efforts through mechanisms that compensate land users financially (see *Case study 6.2* in *Chapter 6*; Pagiola, 2008[20]; Pereira, 2010[21]). As another example, certain laws may favour the passing of land titles through men or even openly deny them to women. This discourages women from investing time into sustainable practices for land that they do not have rights to and may even be evicted from. These types of laws can be revisited with economic evidence which shows that there are increased rates of return when women have land rights[iv,22], and changed to reflect the more rewarding nature of revised legal frameworks. An example of a novel and enabling legal environment created and driven by indigenous traditions, capacity, and cultural considerations can be seen in *Case study 1.1*. As these examples show, an enabling environment must be created in order to fully and successfully implement sustainable land management practices, and have to consider the full context of the particular scale, area, and environment.

A thorough understanding of the total economic value (TEV) of land, complemented with an understanding of the drivers of land degradation and the enabling environment required, can inform the development of policies and incentives to identify and support positive, rewarding scenarios. Economic incentives and mechanisms reward land users for potential losses incurred in switching to sustainable management, and should operate in an environment that includes consideration for the finances. When enabling conditions are absent, sound economic arguments can be used to build support for the removal of other cultural, environmental, legal, political, social, and technical barriers, to create economically viable opportunities for sustainable land management.

iii *Ecological resilience is defined as the capacity of an ecosystem to respond to disturbances by resisting and recovering from damage*

iv *It is also important to keep in mind, that since sustainable land management approaches tend to have a higher rate of adaptation when they are innovated at the local level, that scaling up and out must be focused on the "method" as opposed to the actual technology itself*[5].

CASE STUDY 1.1

Creating an enabling legal environment for land rights: The Tsilhqot'in Nation in British Columbia

(adapted from Kopecky, 2015[27])

> **You have to look forward for your new generation and bring your history with you.**
>
> *Chief William*

The Tsilhqot'in are a First Nations tribe based in British Columbia, on the western coast of Canada. The land is known for harsh winters and low ecological carrying capacity, which has led to the acquisition of large swathes of land by the Tsilhqot'in throughout their history, and whom are sustained by a combination of hunting and fishing, as well as cattle ranching.

After the colonisation of Canada, there was a varied process of treaties signed between indigenous tribes and the Canadian government. Following a series of laws that largely prevented indigenous people from making land claims from 1927 to 1951, in 1982 the Canadian government enshrined "aboriginal and treaty rights" within the Constitution. In most situations, this meant that traditional territory was divided up, with the largest portions going to the government, and smaller parcels of land going to the First Nations people, with the exception that they could use some of the ceded lands for traditional purposes (hunting, fishing, etc.). Access to ceded lands has and is increasingly becoming threatened by industrial expansion, especially in the resource rich region of British Columbia, and many First Nations people also argue that they have been given less than 3 to 5 per cent of what they claim as traditional territory.

Despite these enshrined rights, in 1992, forest companies began making moves to set up logging operations in the traditional territory of the Tsilhqot'in people in British Columbia, In response, the Tsilhqot'in set up blockades at forest access bridges, resulting in a two month stand-off until the government openly supported the Tsilhqot'in's three year old Nemiah Declaration which forbade commercial logging, mining, road building, and construction in the region.

Following this, the Tsilhqot'in commissioned a sustainable-forestry plan to identify a feasible approach to sustainable land management in their territory. In their scenarios, they identified an upper sustainable limit of 30,000 cubic metres of timber harvesting annually. However, British Columbia responded with a plan to remove 1.8 million cubic metres over the next five years. Negotiations ensued for a while before 1.1 million cubic metres was settled on. When put to a vote before the Tsilhqot'in people, they resoundingly turned it down, however, the Minister of Forestry began issuing logging permits for the region anyway, despite their opposition.

The Tsilhqot'in were not satisfied with this approach, nor the loss of environmental or economic benefits associated with it. As Tsilhqot'in Chief Roger William was quoted, "Our vision, is we, as Tsilhqot'in people, want to make decision in all the Tsilhqot'in territory. We want to get revenues from all the Tsilhqot'in territory." Thus, rather than argue under the modern treaty process, they chose to go through the court system and create a *novel enabling legal environment*. It took ten years for the case to go to court, and another twelve years before it would be resolved.

After nearly three decades, on June 26, 2014, the Supreme Court ruled that the Tsilhqot'in Nation held the title for almost 2,000 square kilometres – just over 40 per cent – of their traditional territory, (as opposed to the 3 to 5 per cent they would have gotten through treaty negotiations). This set legal precedence for what "Aboriginal title" meant, and also created an enabling legal environment for land rights that reflected the traditions and history of indigenous people and their relationship to the land. This paves the way for other indigenous tribes to argue for land rights, and in doing so, to sustainably manage the land and reap the economic and environmental benefits in traditional manners. As Chief William said, "You have to look forward for your new generation and bring your history with you".

These efforts towards the economic valuation of sustainable land management scenarios and practices are taking place with consideration of the wider issues related to land. In particular, land and its productivity relate to the Sustainable Development Goals (SDGs) of the United Nations in their post-2015 Development Agenda (discussed in more detail later in this chapter). This relates to the following goals, to: 1) end poverty, 2) end hunger and achieve food security and improved nutrition through sustainable agriculture, 3) ensure healthy lives, 6) ensure availability and sustainable management of water and sanitation, 13) act to combat climate change, and particularly, 15) protect, restore and promote sustainable use of terrestrial ecosystems (see *Figure 1.1*).

Other widespread considerations that should be included when developing economically viable scenarios to enact sustainable land management practices are climate change, poverty, gender, and land rights (the links between climate change and land degradation is discussed more in-depth later in this chapter). Poverty is a crucial factor to consider in sustainable land management as the relationship between low income land users and land degradation is often linked in a feedback loop[5,13]. The type of relationship depends on the framework the land users are operating in, but can often take place with negative impacts on the land (though not always, see Malik & Nazli, 1998[23]). Gender is another issue of disparity, especially in rural areas where more and more women are running households and managing the use of natural resources. Less than 20 per cent of agricultural land is held by women globally[24], but many lack or are denied rights to the land, despite the fact that women who have ownership of land can earn more money, which they often spend on caring for family members in higher proportions than men do, leading to improved food security and reduced poverty[22]. Land rights overall are also a crucial point to consider. For example, as many forests in the developing world (up to 50 per cent) have insecure tenure which can drive degradation. Clear and secure land rights create incentives that enhance security, economic growth, and sustainable development, and can increase productivity, health, and food security[24].

The issue of timescales must also be considered in creating sustainable land management practices with economic considerations. With families looking to provide for their basic needs over the course of the next year (or even months or days), local governments concerned about elections over the next couple of years, and businesses focused on their plan for the next several years, it is often difficult to sell the idea of reaping long-term benefits from sustainable land management against short-term concerns and interests[5], as it usually requires at least 5–10 years, and potentially up to 20 to reap full rewards[25], but also to realise the full losses of degrading practices. However, even if land users are aware of the longer-term impact of their actions, they may have more pressing matters at hand when considering their trade-offs and future actions. For instance, during ELD Initiative stakeholder consultations in Kenya, local women noted that they were aware that their practice of harvesting and burning trees for charcoal was unsustainable, but that they needed to provide sustenance and income for their families immediately[26]. Thus, in developing scenarios for CBAs, the realities of timescales that stakeholders and land users face is a critical component for consideration.

Moving forward, it is clear that economic incentives for sustainable land management, as identified through CBAs of sustainable land management should not be considered as the only solution to desertification and land degradation. It is one part of a larger, holistic approach that supports sustainable land management at all scales, and must necessarily integrate these other considerations in order to be successful. This method is also being considered in other fields, for example, the Convention on Biodiversity's Ecosystem Approach (*www.cbd.int/ecosystem*). Some institutions and initiatives that tackle these other frameworks, issues, and considerations are presented in *Appendix 1*.

The Economics of Land Degradation (ELD) Initiative

Even with increasing knowledge on the biophysical contexts of land degradation (e.g., mapping the extent of occurrence[4,28,29]), it has been known for some time that there is a significant knowledge gap about environmental and economic benefits generated from the adoption of sustainable land management technologies at local, national, and global scales[30]. A recent UNCCD background document[31] specifically noted that the economic data on desertification and land degradation was lacking, possibly resulting in limited development investments and decision-making at all levels. This was further recognised and formalised by the UNCCD Conference of Parties (COP) 12 agreement in 2013[v].

The ELD Initiative and its partners have been working to close this gap between economic understanding and applications, and sustainable land management. It uses the common language of economics to emphasise the total economic value of all land and land-based ecosystems, and to highlight the economic benefits of sustainable land management. The Initiative's goal is to find an integrated economic approach that considers the multitude of variables and impacts that land management decisions can have on the terrestrial environment and its people, particularly for policy-/decision-makers. This approach is global and aims to make the economics of land degradation an integral part of policy strategies and decision-making by increasing the political and public awareness of the costs and benefits of land and land-based ecosystems. The ELD Initiative approach and methodology enables the economic assessment of current and future scenarios and land-use practices, allowing decision-makers, practitioners, and investors to see the trade-offs associated with such, and highlighting the benefits of sustainable land management with sound data and evidence.

v *See www.eld-initiative.org/index.php?id=25 for more information*

vi *See section on 'Limitations of the economic assessment approach' in Chapter 2*

As part of these efforts, the Initiative has a number of products to support this, including the provision, warehousing, and dissemination of knowledge on the topic through a variety of reports, briefs, and academic publications. As mentioned, the Initiative has also conducted a number of regional and global case studies (see *Table 1.2*), and has provided scientific knowledge, management, and networks to other researchers and institutions globally. Further, the Initiative has supported the efforts of three working groups in the areas of *Data and Methodology, Economic Valuations and Scenarios,* and *Options and Pathways to Action* in producing robust scientific outputs, and supporting capacity building where it has been identified as a priority. ELD stakeholder consultations have also taken place in many countries (see *Chapter 5*). To fully understand what is needed on-the-ground to perform thorough CBAs – or other methodologies where this approach is not feasible[vi] – further consultations are planned in other regions to help create sustainable policies, encourage sustainable investments, and put sustainable land management practices into place. The ELD Initiative also provides free, accessible e-learning courses, face-to-face training, and workshops on these approaches, and endeavours to maintain an accessible knowledge base for all, and which can be accessed online at *www.eld-initiative.org*.

Knowledge Management Strategies

The ELD Initiative is a large global network of scientists, academics, business leaders, politicians, decision-makers and other relevant stakeholders, with expertise ranging from ecosystem services to economics, stakeholder participation, communications, and many related topics.

TABLE 1.2

An overview of past ELD Initiative case studies

Title	Focus	Region
Land degradation, less favored lands and the rural poor: A spatial and economic analysis (2014)	Determining the spatial distribution of global rural populations on less favoured agricultural land and in less favoured agricultural areas from 2000–2010, and the spatial distribution of global rural populations on degrading and improving agricultural land from 2000–2010, and to analyse how these spatial distributions affect poverty in developing countries	Global
Assessing the socio-economic and environmental dimensions of land degradation: A case study in Botswana's Kalahari (2014)	Applying a multi-criteria decision analysis (MCDA) approach used to identify key ecosystem service trade-offs associated with four different land uses in Botswana's Kalahari rangelands (note that an MCDA took place in lieu of an intended cost-benefit analyses due to temporal constraints)	Botswana
Soil degradation and sustainable land management in the rainfed agricultural areas of Ethiopia: An assessment of the economic implications (2015)	Performing a spatially explicit economic scenario-based assessment of the extent of land degradation (soil erosion by water) and the costs and benefits of sustainable land management measures in areas of the Ethiopian highlands with rainfed cultivation	Ethiopia
An economic valuation of sustainable land management through agroforestry in eastern Sudan (2015)	A scenario based analysis of the economics of agroforestry in Gedaref state, based on the integration of *Acacia senegal* – a high producing gum arabic tree- with sorghum, a primary staple crop.	Eastern Sudan
An economic valuation of agroforestry and land restoration in the Kelka forest, Mali (2015)	Performing an ex-ante cost benefit analysis of large-scale agroforestry and reforestation in the Kelka forest to inform decision-makers about the value and importance of changing current land use practices in this degrading area	Mali
An economic valuation of a large-scale rangeland restoration project through the Hima system in Jordan (2015)	Performing an ex-ante cost-benefit analysis of large-scale rangeland restoration through the Hima system (a traditional Arabic pastoralist rangeland management regimes based on communal sharing) within the Zarqa River Basin in Jordan	Jordan
The economics of land degradation: Benefits of action outweigh the costs of action in Africa (In print, 2015)	A regional study estimating the benefits of action and costs of inaction based on crop productivity and top soil loss across 42 countries in Africa	Africa

All case studies are available at: www.eld-initiative.org

Capturing and making this intellectual capital accessible is one goal of the ELD Initiative, and will contribute to the achievement of land degradation neutrality globally (see *Box 1.2*), as demanded in the new SDGs, particularly Goal 15. Hence, knowledge management by the ELD Initiative has and will continue to involve:

- **Knowledge compilation:** the creation of a series of publicly available and disseminated reports targeting the scientific community, private sector, and policy-/decision-makers, as well as case studies, summaries, user guides, and practitioner guides to enable access to the methods, assessments, and research undertaken by the ELD expert network;

- **Knowledge warehousing:** a fully accessible platform that provides all ELD reports, case studies, infographics, and briefs, all other ELD-related publications, an interactive case study database and map, access to a compendium of related resources, and general information on the economics of land degradation;

- **Capacity building:** disseminating knowledge at the user level through a series of free e-learning courses addressing different themes, with publicly available online video seminars and in situ training of decision-makers on ELD approaches;

- **Network development:** liaising openly and encouragingly with all stakeholders and interested parties, providing support and expertise for those interested in undertaking cost-benefit analyses for sustainable land management at any level or in any location, including the preparation of collaborative research for development proposals between institutions working on the economics of land degradation or the economics of sustainable land management; and,

- **Institutional development:** regional hubs that collate and support knowledge management and research in a localised context to better serve stakeholders at a different scale. These hubs are intended to serve as interlinked nodes in the ELD web, and allow for regional knowledge and resources that may be more useful than small-scale or large-scale information.

BOX 1.2

Land degradation neutrality at a glance

(from UNCCD, 2015 (Box 1)[3])

Land degradation neutrality (LDN) was born out of the United Nations Conference on Sustainable Development (Rio+20) and is based on the critical idea that the cost of action is significantly lower than the cost of inaction. At the heart of the land degradation neutrality targets are sustainable land management practices that help to close yield gaps and enhance the resilience of land resources and communities that directly depend on them while avoiding further degradation.

It can be understood as a state where the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases. This can happen within different scales and ecosystems. It can occur naturally or due to better land management. It is really the combination of avoiding or reducing the rate of land degradation and increasing the rate of recovery.

It is essential to maintain a synergistic approach to knowledge management in an area that is paradoxically both as specific and broad as the economics of land degradation, which includes biophysical, cultural, economic, legal, social, and technical factors as necessary considerations for successful action. While not all factors can be included in every assessment due to limitations in time, capacity, capital, etc., developing a robust approach necessarily includes access to a platform of expert knowledge. A prime example of this is the World Overview of Conservation Technologies and Approaches (WOCAT) database, which hosts information on sustainable land management technology, mapping, and approaches (*www.wocat.net/en/knowledge-base.html*). The ELD Initiative has also developed and maintains a RefWorks database, which contains relevant case studies and academic publications (*www.refworks.com*)[vii]. *Appendix 1* has more information about broader ELD collaborations, networks, and complementary initiatives, and *Appendix 2* has a listing of organisations and databases that relate to land management institutionally and socio-economically.

vii *Group code: RWMcMasterU, Login: unu-inweh, Password: inweh*

Linking to global agendas

The ELD Initiative also maintains a balanced perspective on parallel global concerns about the trajectory of anthropogenically induced trends and impact on land, which can be interlinked with endeavours to increase efficiency and outputs. Large-scale efforts that the ELD Initiative specifically endeavours to synergistically match its outputs with include the SDGs and the United Nations Framework Convention on Climate Change (UNFCCC).

ELD and Sustainable Development Goals

The SDGs are a set of intergovernmental global goals that aim to focus progress and action towards the world's most pressing concerns, and build on the Millennium Development Goals (MDGs). The SDGs were finalised at the United Nations General Assembly (UNGA) in September 2015. *The Future We Want* was the guiding outcome document from the Rio 20+ Convention held in Brazil in 2012, intended to create an "inclusive and transparent intergovernmental process on SDGs that is open to all stakeholders with a view to developing global sustainable development goals to be agreed by the UNGA."[32] It identifies the need to 'promote an economically, socially, and environmentally sustainable future for our planet and for present and future generations', inclusive of mainstreaming and identifying the interlinkages of sustainable development at all levels, with stakeholders considered equal in driving this growth[33]. Based on this vision, there are 17 SDGs that have been ratified.

The SDGs include seminal targets for addressing poverty, hunger, equality (gender, income, opportunities, education, etc.), climate change, sustainable resource use, etc. Through its ongoing efforts to secure sustainable land management and land degradation neutral world, the ELD Initiative supports, amongst others, to Goal 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.*

Many other organisations support the ratification of Goal 15, including the UNCCD, which has also called for the goal of achieving land degradation neutrality by 2030 as critical in reaching other international commitments to climate change adaptation and mitigation, conservation of biodiversity and forests, alleviating rural poverty and hunger, ensuring long-term food security, and building resilience to drought and water stress[34]. Aiming to sustainably use these critical natural resources also includes the need to protect the key ecosystem services that land and land-based ecosystems provide, including the production of food, feed, fibre, and fuel, carbon sequestration, nutrient cycling, water regulation, etc.

As the Executive Secretary of the UNCCD, Monique Barbut, recently noted, " … The proposed SDGs are ambitious – as they should be. They have the seeds to turn us into better [land] users than any other generation before us. But only if we are bold enough to adopt sustainable land use practices, to accord land rights, and to restore degraded land to meet future growth."[35]

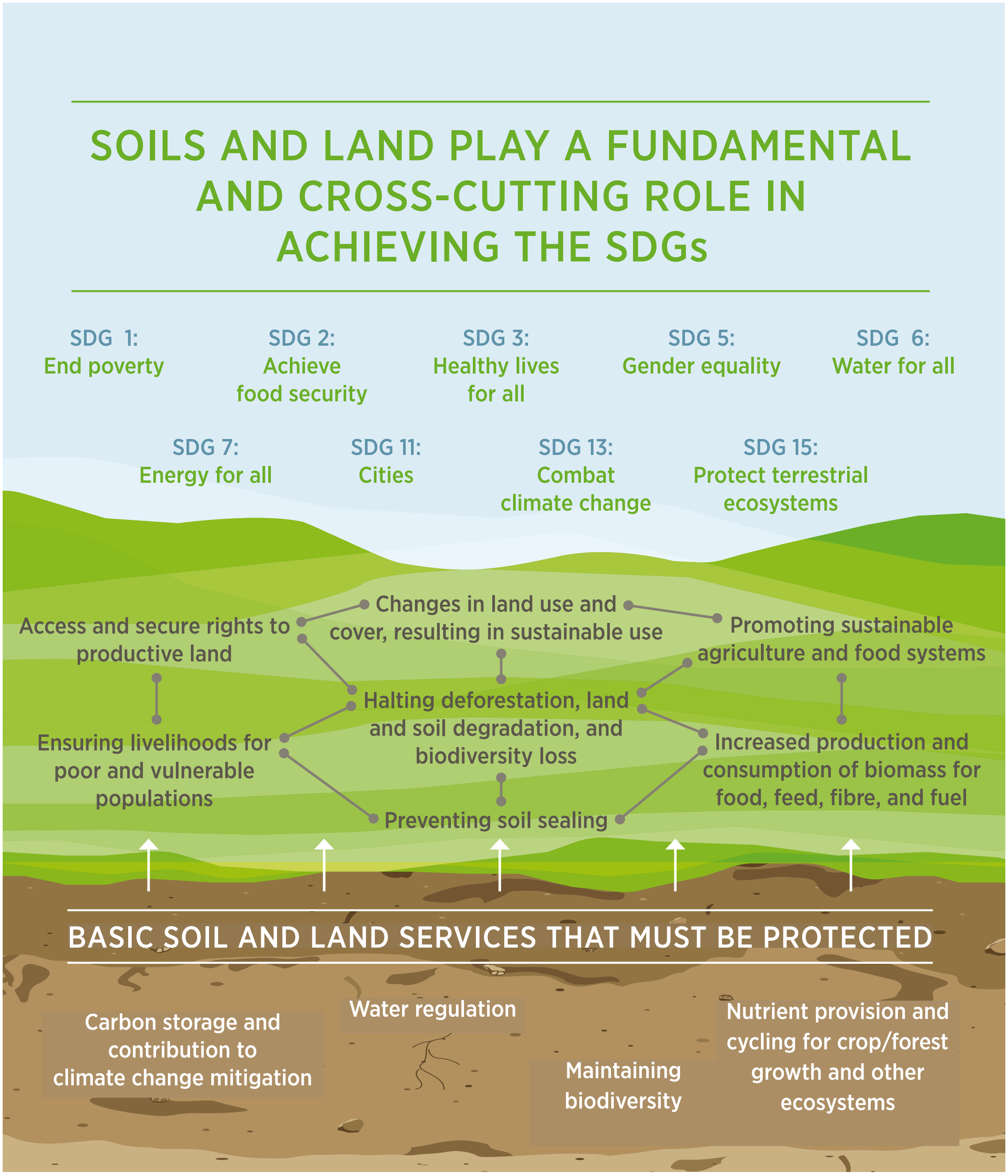
Other entities have rallied around different land issues in regards to the SDGs, further bolstering and demonstrating the need and demand for global action on land degradation and restoration. For example, 16 organisations worked collaboratively to prepare a technical briefing on securing land rights in the post-2015 agenda for SDGs[36], a move endorsed also by the World Resources Institute[37]. The ELD Initiative supports these parallel efforts as complementary and necessary to its own work in securing sustainable land management through economic tools and approaches.

It is clear that connections to and dependence upon land as well as soils are present throughout numerous SDGs, and addressing many of these goals will thus require commitments to the sustainable use of land and land-based ecosystems. The Institute for Advanced Sustainability Studies (IASS) has identified at least nine other SDGs that will require the support of land and soil in order to reach their targets (see *Figure 1.1*).

Taking into consideration the increasing and often competing demand for natural resources, it is imperative that the global community moves beyond silos of efforts and into an integrated systems approach when addressing the numerous, overlapping issues found within the SDGs[38,39]. Thus, the harmonised activities of the ELD Initiative also support the other SDGs that have impacts and dependence on land and soil resources, by providing resource hubs, scientific knowledge, and economic approaches to sustainable land management through cost benefit analyses and other applicable economic tools, and scalable frameworks to action. The multi-stakeholder, capacity-building, localised approach of the ELD Initiative is mirrored in the calls for holistic frameworks around the SDGs, and again, actions by all players should be coordinated to ensure synergistic, efficient, resilient, and sustainable use and allocation of limited resources and capacity to meet these bold yet necessary global targets.

FIGURE 1.1

Roles and interlinkages of soils and land in the Sustainable Development Goals
(IASS (2015)[38])



ELD and climate change

Climate change is one of the most pressing global issues, and is intrinsically coupled with land degradation. Changes in climatic conditions at local and global levels drive land degradation. For example, increases in drought frequency and intensity causing vegetation and soil loss, extreme weather events (e.g., flash flooding) exacerbating erosion, and the increasing unpredictability of weather patterns contributes to the use of short-term, degrading practices, rather than investments into long-term sustainable management. Other consequences of global warming, including shorter growing seasons leading to decreased agricultural and livestock production, decreased water availability, increased energy demands, rising sea levels, etc., will all place further pressure on land to continue providing services, despite decreasing capacities to do so. Effects from climate change on land cause an annual loss of 12 million hectares, whereas 20 million tons of grain could have been grown instead[40]. These concerns will become more relevant in consideration of the need to feed a global population of 9–10 billion by 2050[41].

At the same time, with decreasing vegetation cover and increased soil erosion, land loses the ability to store carbon in biomass and soils, thus contributing to climate change. After fossil fuel combustion, agriculture and land use changes represent the second largest share of greenhouse gas emissions[42], and along with forestry, is thought to be responsible for 17–31 per cent of anthropogenic emissions[43]. Despite soil being the second largest source of carbon next to the oceans, the historical loss of carbon from agricultural soils globally is 55 gigatons[44].

To date, assessments of greenhouse gas mitigation potential in the context of soils, agriculture, forestry, and other land uses, have not adequately included the impact on other services that land provides, or the complex nature of global issues related to land use[45]. For example, while estimates of the potential of soils to sequester carbon abound, there remains controversy over its realisable potential to mitigate climate change via interventions such as no-tillage and other conservation agricultural practices[46,47,48,49]. Perhaps of equal importance are the multiple functions of soil organic carbon, including water retention and soil biological activity, which contribute to soil fertility but are rarely costed. These estimates need to be included in any attempt at total economic value of interventions and remain key areas in need of further research[50]. Further, the referential Intergovernmental Panel on Climate Change (IPCC) reports have not yet explored all types of land collectively in their role in emissions mitigation[41].

However, sustainable land management presents a significant opportunity to reduce greenhouse gas emissions from land use through reducing deforestation and land degradation, something which has been adequately discussed through the UN programme REDD+ (Reducing Emissions from Deforestation and Forest Degradation, *www.un-redd.org*, see *Box 6.2*). Sustainable land management can create net carbon sequestration in soil and vegetation, and provide renewable, low carbon energy – a salient point for nations to consider in the development of their mitigation portfolios and national action plans[52]. For example, an ELD Initiative study performed in Sudan by IUCN showed that with agroforestry scenarios, there is potential for an additional 10 tonnes of above and below ground $C0_2$-eq. sequestration/ha/yr, with an avoided damage cost to the global society is up to EUR 766/ha[19]. Further, croplands globally can bear a carbon sequestration potential of 0.43 to 0.57 gigatons/yr[52], and enhancing carbon stocks through agricultural soils alone can create potential value on the carbon market from USD 96–480 billion annually[viii]. Adequate management of agricultural and forestry land uses are amongst the lowest-cost actions that can reduce global warming, and most actions are either neutral cost or of positive net profit to society, requiring no substantial capital investment[53]. Sustainable land management planning (e.g., forest landscape restoration) can easily include both mitigation and adaption when they are being developed[54]. As carbon sequestration in soil and plants is likely to reach a plateau over a relatively short time, it can be considered more of a 'stop-gap' to allow time for new low carbon technologies to be developed and put into widespread use. Therefore, long term economic sustainability and viability must consider carbon sequestration along with other income generating possibilities such as PES.

As land use is a critical aspect of any climate change solution, efforts to address either climate change or land degradation should necessarily

viii *Smith et al., 2013[41] reported that the "technical mitigation potential for carbon sequestration in agricultural soils was estimated at 4.8 Gt $C0_2$-eq./yr for 2030, with economic potentials of 1.5, 2.2 and 2.6 Gt $C0_2$ eq./yr at carbon prices of 0–20, 0–50, and 0–100 USD t $C0_2$-eq. respectively."*

include co-delivery of complementary objectives to maximise ongoing efforts in both areas. This will be crucial in countries and communities that lack adaptive capacity, as the effects amplify other issues (poverty, food, water, and energy security, resource conflict, etc.).

The objectives of the UNCCD parallel those of the UNFCCC on the broader issue of climate change, which has discernible and exacerbating effects on degradation. Article 4, Paragraph 2(a) of the UNCCD, and Article 4, Paragraph 1(c) of the UNFCCC support mutual action in dryland areas, and Article 8, Paragraph 1 of the UNCCD additionally seeks to address land degradation and desertification in climate change negotiation and implementation processes[34]. Linking these two issues more explicitly through both UN conventions and the associated efforts of partner institutions, initiatives, and parties, allows for a mutual sharing of resources and momentum while acknowledging the multifaceted approach needed from the global community in order to confront these interlinked and pressing issues.

Addressing these two phenomena and their feedback loops thus requires an approach that considers multiple objectives in setting policies and making decisions around land and climate change. With the support and encouragement of the UNCCD, and in parallel with the efforts of the UNFCCC, the ELD Initiative recognises the interlinked impacts of climate change on land degradation and desertification, and actively seeks to include its economic outlook in this perspective.

The value of land: An overview

Overall the ELD Initiative provides a holistic perspective on solutions to sustainable land management through economically viable and optimal scenarios. In doing so, it is drawing from other disciplinary perspectives and practitioners' knowledge to ensure successful adoption, while creating and maintaining a nexus of knowledge available to anyone. This report, as well as the parallel ELD Initiative reports to the private sector and policy-/decision-makers (also being released in late 2015), serves as a foundation for a collective path forward to increase investments in improved land management and land degradation neutrality, through economic insights and realities, grounded in a comprehensive compendium of knowledge on the topic.

Based on this broader understanding of movements toward corrective actions on a variety of land issues, this report forms the core of the ELD Initiative's knowledge outputs as it pertains to the economics of land degradation and sustainable land management. This report is structured to provide an overview of the economics of land degradation and the benefits of sustainable land management. It describes the setup of the ELD Initiative and its collaborations, networks, and partners, and the role of ELD in international efforts on climate change and the upcoming SDGs, before zooming the lens from the global scale through the regional to the national and local level, and finally connecting the dots to the wider context of collaborations and mutual progress. *Chapter 2* provides a technical overview of the ELD economic tools, approach and methodology, and the economic benefits of sustainable land management. *Chapter 3* addresses the broader global picture through an understanding of the ecosystem services that land provides, with novel global and national scenarios demonstrating the value of land and land-based ecosystems. *Chapter 4* scales the focus down, and looks at regional and national contexts for the economics of land degradation. *Chapter 5* focuses the lens further, and looks at national and local levels, inclusive of the outcomes and identified needs and priorities from ELD Initiative stakeholder consultations held in different countries across the world. *Chapter 6* identifies conditions for success, to provide a context to ensure that sustainable land management processes are actually put into place. Finally, *Chapter 7* concludes with a summary of and recommendations from the ELD Initiative findings and steps forward to a land degradation neutral world, with economics as an empowering tool for sustainable land management.

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CHAPTER

02 Setting the stage for structured economic assessment: The 6+1 step ELD approach

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Introduction

In this report, land degradation corresponds to the reduction in the economic value of land and land-based ecosystem services as a result of anthropogenic activities or natural biophysical evolution. Land degradation can take several forms and is linked to a specific land use – for example, salt-induced land degradation can be a severe problem for agriculture[1]. However, the same land used to build a tourist lodge may not be affected by such degradation from an economic perspective. The drivers of land degradation have been described by Lambin *et al.* 2013[2], and further elaborated by Nkonya *et al.* 2011[3] (*Table 2.1*). Although these drivers affect the level of economic benefits derived from land, the ELD Initiative approach allows for broader consideration of other factors and not just those linked to land degradation. Such an approach attempts to be inclusive of all forms of land use and management with the view to improve livelihoods and well-being through the adoption of more sustainable land management rather than focusing on reducing land degradation itself.

The ELD Initiative draws from existing frameworks, approaches, and methods, and adapts and combines them to include features specific to land management. This establishes a structured and comprehensive economic assessment process referred to as the "6+1 step approach", which aims to provide information relevant to policy-/decision-makers. Variation in land degradation, management, and socio-economic contexts across the globe necessitates a flexible application of the "6+1 step approach". This chapter provides an overview of this, which can be used at different scales and for different scopes.

TABLE 2.1

Drivers related to land degradation and their causes
(from ELD Initiative, 2013[4], adapted from von Braun et al., 2013, Table 1[5])

Driver	Proximate	Underlying	Natural	Anthropogenic
Topography	✔		✔	
Land Cover	✔		✔	✔
Climate	✔		✔	
Soil Erodibility	✔		✔	
Pest and Diseases	✔		✔	
Unsustainable Land Management	✔			✔
Infrastructure Development	✔			✔
Population Density		✔		
Market Access		✔		
Land Tenure		✔		
Poverty		✔		
Agricultural Extension Service Access		✔		
Decentralization		✔		
International Policies		✔		
Non-farm Employment		✔		

Complementary frameworks to structure a comprehensive economic assessment

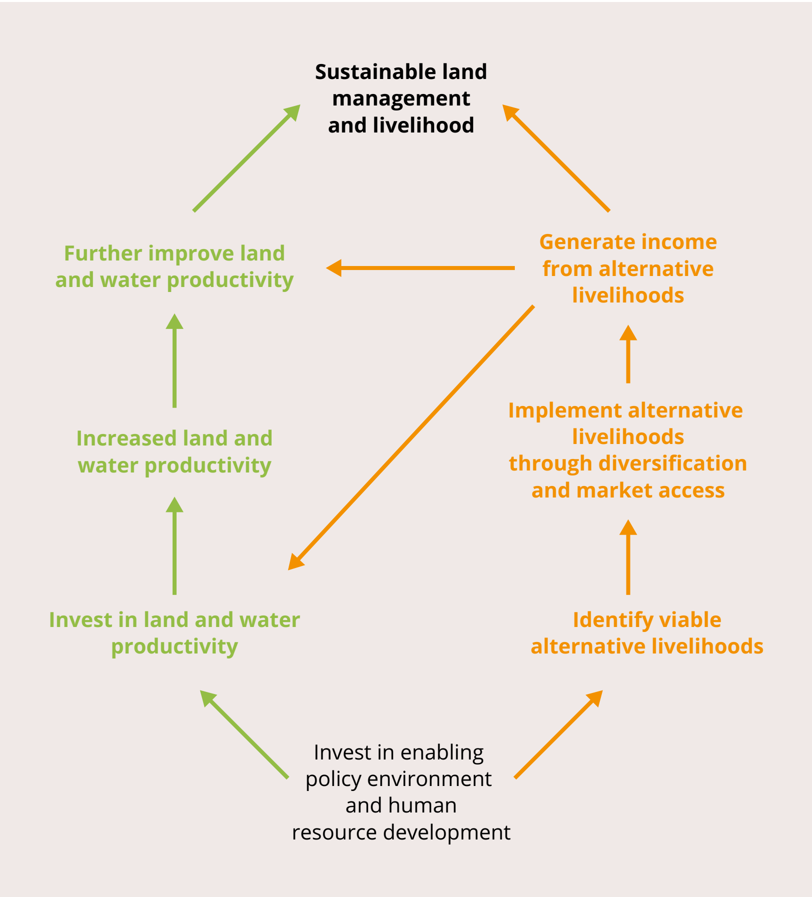
The following frameworks are used to approach and understand different relationships between key concepts as a basic underlying structure for an economic assessment of land degradation and the benefits of sustainable land management. Their primary objective is to help structure the assessment process. These frameworks are are theoretical and general to allow for flexible application at different scales and contexts. Each framework can be combined with a range of different methods for analysis, and choosing a method depends on available capacity and resources, as well as the objective of the assessment itself. Four different frameworks are presented here: impact pathways to sustainable land management, capital asset, ecosystem services, and total economic value frameworks, together with details of how they are combined and how the costs of inaction (or the benefits from action) are valued and compared to the costs of action.

Impact pathways to sustainable land management: a framework for investment into increased productivity and/or alternative livelihoods

Sustainable land management is generally assumed to result in improved land management for current and future generations. Agricultural land that is managed unsustainably could become sustainably managed if demands that increase pressure for high levels of production are reduced, degrading practices are changed to more sustainable ones, or if a land use is changed for an alternative one that reduces pressure (e.g., changing from agriculture to value-added non-agricultural activities such as manufacturing, tourism, etc.). Sustainable land management can be pursued via multiple pathways, employing a range of intervention options. More specifically, there are many ways of ensuring that land management is sustainable, which can be conceptualised as land use **options for action** to be taken by land users themselves (e.g., improved productivity through the use of sustainable technologies, and adoption of alternative livelihoods), and **pathways for action** which focus on the actions taken by 'facilitators' to promote or enhance the adoption of the land use options (e.g., institutional capacity building, regulatory policies, and demand management). Both options and pathways for action need to be combined in order for sustainable land management to be achieved successfully (*Figure 2.1*).

FIGURE 2.1

Pathways to sustainable land management, considering agricultural (green) and alternative livelihoods (orange)
(from ELD Initiative, 2013[4], originally adapted from Adeel & Safriel, 2008[6], sourced from Thomas, 2008, pg. 599[7])



Pathways to sustainable land management and human well-being are depicted in *Figure 2.1*. The left side (green) represents a traditional agricultural/pastoral livelihood where investments are facilitated by enabling policies, regulations, access to agricultural markets and research/extension services, and includes inputs such as agrochemicals, water, and seeds. This pathway is often complemented by alternative livelihood options (e.g., eco-tourism, arts and crafts, and small-scale manufacturing, or through migration and remittances), and is depicted on the right side of *Figure 2.1* (orange). The alternative livelihood options can partially or fully replace the current sources of income. Diversification of activities can help reduce pressures currently exerted on land, and economic assessments can help choose livelihood option(s) and pathway(s) that are most economically desirable. These assessments provide insights that can guide private and public sector investment decisions accordingly, in particular when economic analysis is integrated into policy implementation and design. Both pathways require investments from private and public sectors, training in skills, knowledge, and capacities, and integration of land degradation issues into mainstream government policies to ensure successful adoption of sustainable land management options. Pathways might be influenced by global factors (e.g., prices, actors and discourses) and need to be appropriate to an individual country's national environmental, political, economic, and institutional frameworks and conditions, and typically vary between countries.

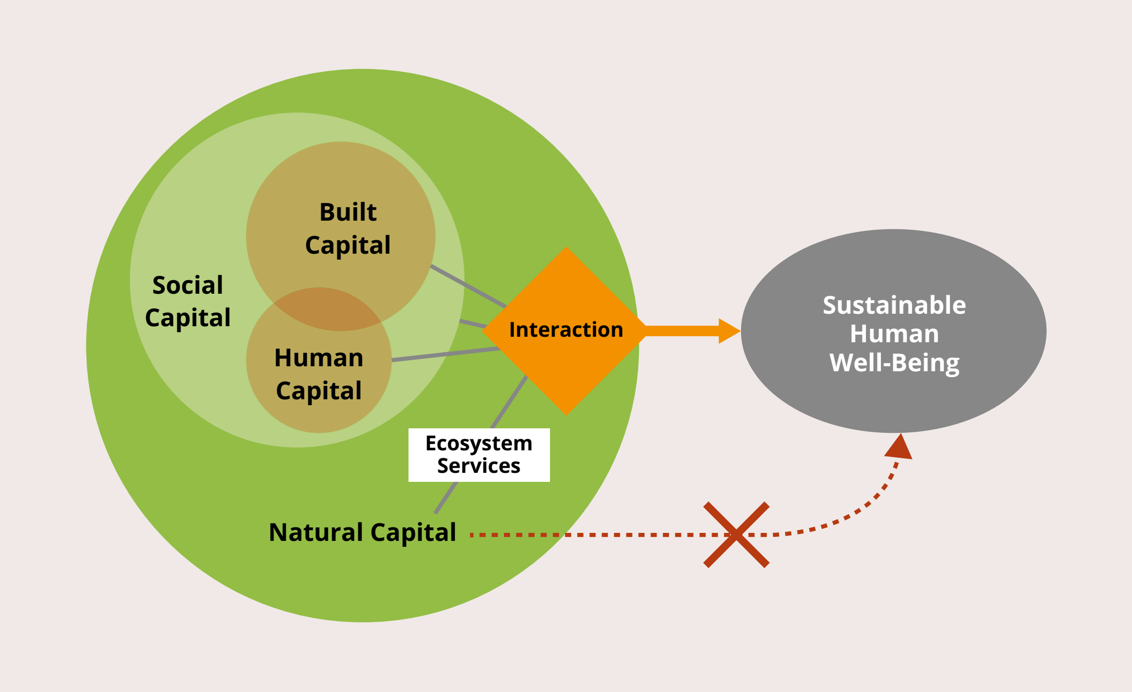
Capital asset framework

The economic approach must be linked to human well-being, which encompasses economic, social, and ecological aspects of development and land management[8]. This is key in adopting a holistic approach, so that the sustainability of land management options is measured by taking into consideration the overall human-environmental

FIGURE 2.2

Interaction between built, social, human, and natural capital required to produce human well-being

(from Costanza et al., 2014[14])



Built and human capital (the economy) are embedded in society (social capital), which is embedded in the rest of nature (natural capital). Ecosystem services are the relative contribution of natural capital to human well-being, they do not flow directly (red arrow)

connection, rather than just focusing on market-driven processes. The following four types of capital assets within the overall human-natural system are necessary in supporting sustainable human well-being (*Figure 2.2*[9,10]):

- **Human capital:** individual people, including their accumulated knowledge and information, physical health, and labour;
- **Built capital:** manufactured goods such as tools, equipment, and buildings;
- **Natural capital:** the natural world (e.g., animals, soils, air, plants, water and minerals) – the stock of natural resources that produce a flow of ecosystem service benefits to human beings and that does not require human agency to be produced or maintained[11,12], and;
- **Social capital:** networks and norms that facilitate cooperative action, including cultures and institutions (e.g., the market and financial system[13]).

Achieving sustainable land management and sustainable economic development requires action undertaken in consideration of all four types of capital. The ELD Initiative focuses on the natural capital element for assessment, but stresses that the other three types of capital are critical to facilitate and enhance the success of any action, and indeed, ecosystem services are the indirect contribution of natural capital to human well-being[14].

Ecosystem service framework

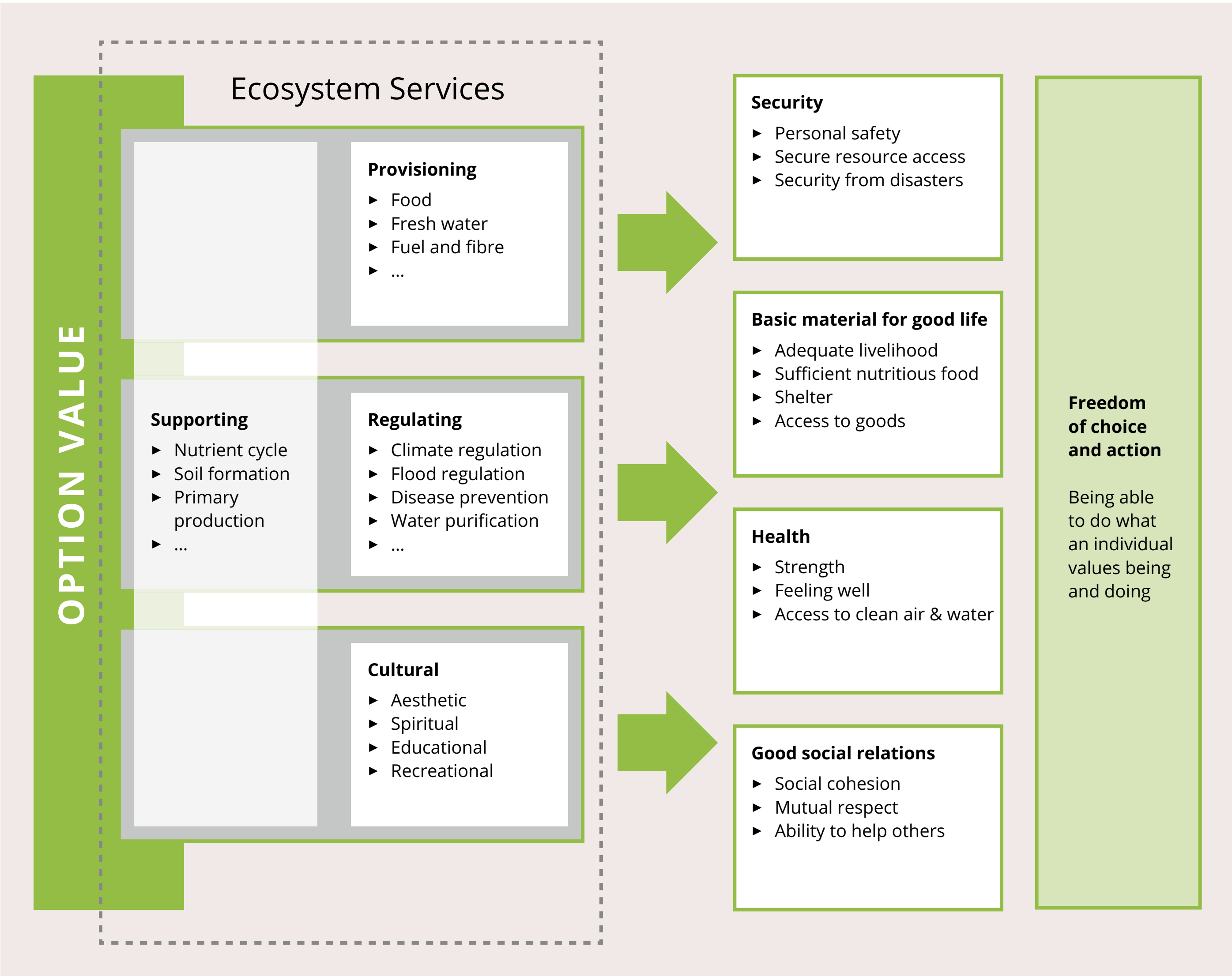
Land provides many different multi-functional services that interact and contribute to human well-being. Each of these services has a (socio-)economic benefit that is of value to society as a whole and goes beyond market values. For example, terrestrial plants are a source of food, building materials, fuel and fibre, while also providing other key services such as regulating the quality of soil, water, and air. Estimating the total economic benefit of land is not easy or straightforward. The ecosystem service framework can facilitate comprehensive ecosystem assessment by dis-aggregating land into broad independent categories (ecosystem services) that can be valued separately (i.e., provisioning, supporting, regulating, and cultural services, see *Figure 2.3*). Land degradation from an economic perspective is the loss or reduction in services provided to society as a whole. The reduction in this natural capital threatens the sustainability of current pathways of exploitation (this is sometimes referred to by economists as the strong sustainability concept).

The ecosystem service framework has several classifications of ecosystem services for a range of purposes[12,15,16,17,18,19,20]. These classifications have been established as guides for comprehensive ecosystem assessments rather than 'blueprints'. The categorisation used by the Millennium Ecosystem Assessment[17] is one of the most popular, and is the basis for classification adopted by the ELD Initiative to identify a complete list of services provided by land that have an economic value to society as a whole. *Figure 2.3* shows the relationship between

FIGURE 2.3

The provision of ecosystem services from natural capital: Linkages between ecosystem services and human well-being

(from ELD Initiative, 2013[4], originally adapted from MEA, 2005, Figure A pg. vi[17])



ecosystem services and well-being, and the flow from ecosystem services to human sustenance and well-being, and ultimately to freedom of choice and action.

There are four general types of ecosystem services[8]:

- **Provisioning services** – natural capital combines with built, human, and social capital to produce food, timber, fibre, water, fuel, minerals, building materials and shelter, biodiversity and genetic resources, or other 'provisioning' benefits. For example, grains delivered to people as food requires tools (built capital), farmers (human capital), and farming communities (social capital) to be produced;

- **Regulating services** – natural capital combines with built, human, and social capital to regulate processes such as climatic events with water flow regulation (e.g., for increased flood or drought control, storm protection), pollution control, decrease in soil erosion, nutrient cycling, human disease regulation, water purification, air quality maintenance, pollination, pest control, and climate control with carbon storage and sequestration. For example, storm protection by coastal wetlands requires built infrastructure, people, and communities to be protected. These services are generally not marketed but have clear value to society;

- **Cultural services** – natural capital combines with built, human, and social capital to produce more material benefits linked to recreation (tourism) and hunting as well as non-material benefits such as spiritual or aesthetic, education, cultural identity, sense of place, or other 'cultural' benefits. For example, production of a recreational benefit requires an attractive natural asset (a mountain), in combination with built infrastructure (road, trail, etc.), human capital (people able to appreciate the mountain experience), and social capital (family, friends, and institutions that make the mountain accessible and safe). Such cultural services would tend to be mostly experienced through tourism or religious practices, and;

- **Supporting services** – these maintain basic ecosystem processes and functions such as soil formation, primary productivity, biogeochemistry, soil formation, and nutrient cycling. They affect human well-being indirectly by maintaining processes necessary for provisioning, regulating, and cultural services. For example, net primary production is an ecosystem function that supports climate control through carbon sequestration and removal from the atmosphere, which combines with built, human, and social capital to provide climate regulation benefits. Some argue that these supporting 'services' should be defined as ecosystem 'functions', since they have not yet clearly interacted with the other three forms of capital to create benefits in terms of increased human well-being, but rather support or underlie such benefits. Supporting ecosystem services can sometimes be used as proxies for benefits when such benefits cannot be easily measured directly.

The ecosystem service framework provides the ELD Initiative with a fairly complete basis for assessment, which can help improve the transparency of the economic estimations and of the mapping of services, increase comparability between scales and sites, and improve communication amongst stakeholders to help them determine the relative merits of different options.

Total Economic Value framework

This framework is set as a guide to facilitate the estimation of the 'total' economic value (TEV) of land and its ecosystem services to society as a whole. Considering the total economic value of land beyond imperfect market values can provide an improved basis for assessment of land value and comparison of land management options for informed decision-making. This is especially important as there is increasing land scarcity due to increased competition for land and between land uses. Similar to the ecosystem service framework, the idea is to deconstruct the total economic value into individual components that can then be summed up together again, while avoiding overlap between these components to prevent double counting.

Total economic value is conceptualised as the sum of use and non-use values (*Figure 2.4*). Use value is the economic value associated with using the land for economically profitable activities and encompasses direct use, indirect use and option values. In the case of land, direct use value stems from direct consumption of land products

FIGURE 2.4

The Total Economic Value concept and existing valuation methods
(from ELD Initiative, 2013[4],originally adapted from Bertram & Rehdanz, 2013, pg. 28[21])

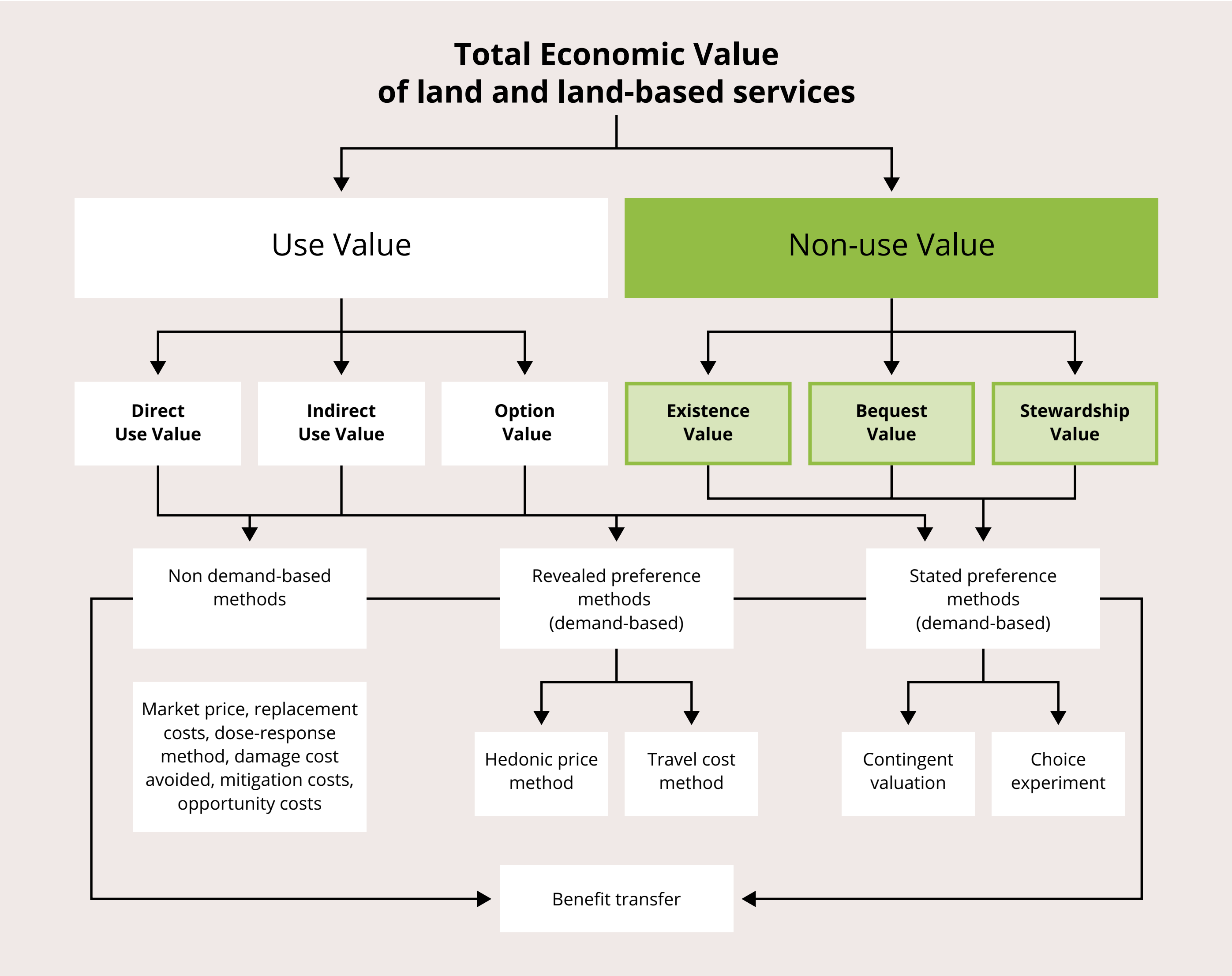


TABLE 2.2

Economic value types typically estimated for ecosystem services
(from ELD Initiative, 2013[4], originally adapted from Quillérou & Thomas, 2012[23])

		Provisioning services	Regulating services	Cultural services	Supporting services
Use value	Direct use	✔	✔	✔	
	Indirect use		✔	✔	✔
	Option	✔	✔	✔	
Non-use value	Existence			✔	
	Bequest				
	Stewardship				

(food, timber, etc.). Indirect value stems from indirect consumption (e.g., pollination leading to production of consumed food). Option value is associated with the option of keeping land use flexible for future direct and indirect uses (e.g., land kept as forest but possibly changed to agricultural uses in the future). This is essentially the economic value allocated to strategies that have been adopted to manage potential threats to profits or livelihoods. It is sometimes considered a use value, but is sometimes considered a non-use value, as it does not correspond to current use but rather to future consumption. Non-use value is the economic value of land that is not associated with consumption, and encompasses existence, bequest, and stewardship values. In the case of land, existence value is the economic value allocated to land simply because it exists. Bequest value is allocated to the possibility of bequeathing land to future generations. Stewardship value is allocated to land kept in good conditions for both direct economic production and the maintenance of surrounding ecosystems.

Combining the ecosystem service and total economic value frameworks

Direct use values encompass mostly provisioning services such as food or timber, and indirect use values are those entities not consumed directly but which indirectly support directly consumed goods such as food and timber (e.g., the values of regulating services – nutrient cycling, water flow regulation, soil erosion prevention, etc.). The ecosystem service and TEV frameworks can be combined together for estimation of the TEV of land. This is the sum of individual cells represented in *Table 2.2* (note: it is possible to increase the level of detail in the table by listing individual ecosystem services rather than their categories). In light of the interconnectivity among the ecosystem service functions, which produce a range of intermediate and final values, caution must be paid in value aggregation so that double-counting is avoided[22]. By measuring marginal changes in values under specified alternatives or scenarios in the socio-ecological system (this can be pursued through cost-benefit analyses, see section on 'economic benefits of sustainable land management'), rather than focusing on ecosystem units in a constant state, risks of double-counting in total economic valuation can be overcome[22].

It is also noted that not all components of the TEV need to or can be estimated for all types of ecosystem services. This is because such economic valuations can be costly to undertake, and there is generally an incentive to obtain the easiest information first. Relevance will depend on the cultural, social, and environmental contexts, as well as the objective(s) of the economic valuation

and assessment. In addition, some types of economic values such as bequest and stewardship values are difficult to estimate because economic numbers are often not seen by individuals as a suitable way to capture such values.

Valuing the costs of inaction or the benefits from action for comparison to the costs of action

The **costs of action** include those associated with investment into land rehabilitation, restoration, or sustainable land management as well as operation of land management activities. They can be associated with a transition that is limited in time (e.g., conversion or switching costs associated with restoration and rehabilitation of land, a change of land management practices or a change of land use), whereas others such as operation costs occur on an ongoing basis. Potential barriers to action stem from investment costs, operation costs, or both. Cost-benefit analysis of land management ideally includes both investment and operation costs for comparison to the economic benefits.

On the benefit side of the cost-benefit analysis, two different types of benefit estimates can be used: costs of inaction or the benefits from action. The **costs of inaction** correspond to the maximum level of benefits that could be obtained from land. This potential may or may not materialise when action is taken, with **actual benefits from action** somewhere between their current level and the costs of inaction[24]. Using costs of inaction may lead to an overestimation of the actual benefits from action, which can create disappointment and frustration when expected levels of benefits do not materialise (*Case study 2.1*). Using costs of inaction also does not allow for consideration of different levels of action. Based on the merits of discussions that have evolved amongst economists, the ELD Initiative tends to give more weight to

CASE STUDY 2.1

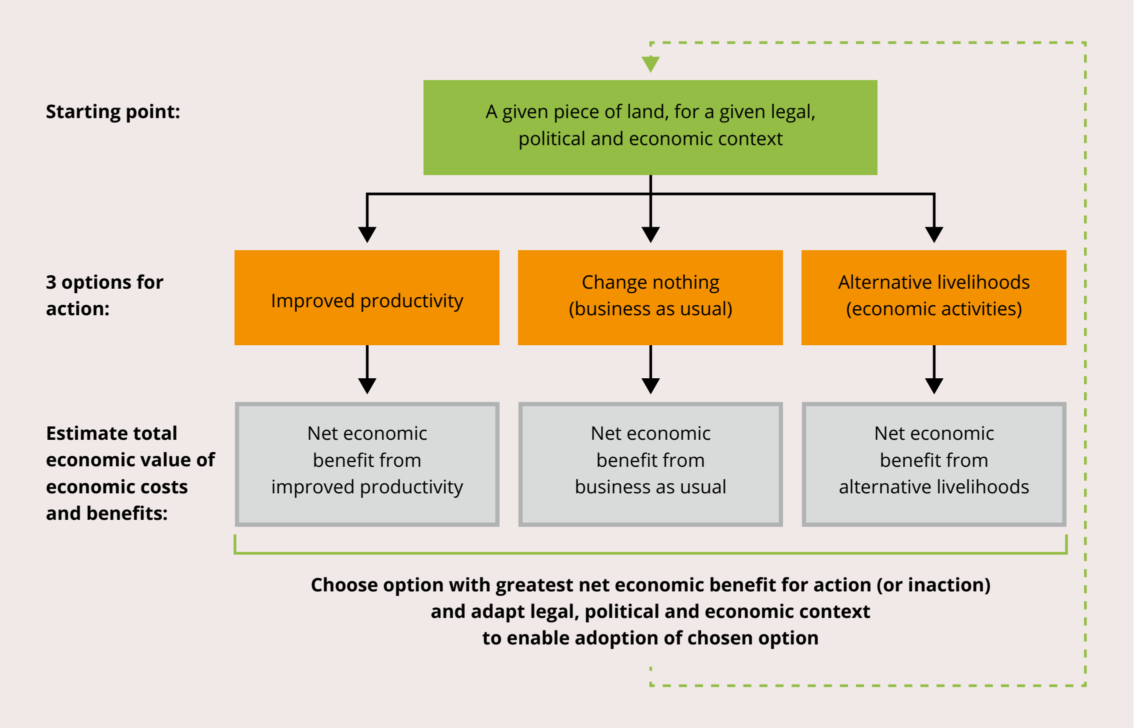
Expected benefits prior to action not translating fully into economic benefits after action

(from ELD Initiative, 2013, pg. 35[4], originally from Kosoy et al., 2007[24])

Three technical studies, including an economic valuation, were conducted in Honduras to inform the provision of a payment scheme for water-related environmental services. The study indicated that the fee charged to fund the payment scheme (aimed at promoting forest conservation) was lower than the opportunity cost (i.e., foregone economic benefits) for upstream landholders in pursuing alternative land uses. The fee accounted only for 3.6 per cent of the estimated willingness to pay of water users. Thus, the valuation study was used to inform policy, but also identified that the necessary budget to be leveraged for such services was not enough. This would lead to under-provision of water-related environmental services, compared to what water users would prefer. Therefore, the expected economic benefits prior to action (estimated based on the valuation study results) could not fully translate into economic benefits after action. The fee charged to water users was instead decided through the voting of representatives from the different urban water sectors. The level of fee to be charged was in this case decided based on political considerations over economic ones.

FIGURE 2.5

A decision-making framework with net economic benefit as a choice criterion (i.e., economic benefits minus costs)
(from ELD Initiative, 2013[4])



the benefits from action rather than the cost of inaction, especially at the local level where more accurate information is needed. This approach is also supported by the Offering Sustainable Land Use Options (OSLO) consortium. However, the costs of inaction are often easier to estimate, especially at the global level, and the ELD Initiative uses both costs of inaction and benefits from action depending on the available data and context.

Multi-level, multi-scale simple decision-making framework

There are three major types of options available to a land manager for land use: change nothing, improve productivity of current land use, or adopt alternative livelihoods. The improved productivity option includes both investment into restoring degraded lands (state) and investment into decreasing the rate of land degradation or even reverse it (process) (*Figure 2.5*). It must be considered that the available options and preferences might vary across different types of land managers (e.g., state, smallholder, private actor, community). When a given piece of land is owned or managed by multiple stakeholders, coordination amongst them is required for a given measure to be agreed upon and implemented.

Alternative livelihoods can be adopted alongside current land use activities to diversify sources of income or even replace current land-based activities. The net economic benefits (i.e., economic benefits minus costs) derived from each of the options should be compared over the same timescale and spatial scale to select the most economically beneficial in time. Once this option has been identified, economic, legal, motivational, political, technical, and social barriers to action may still exist. Such barriers can create perverse incentives fostering land degradation and would need to be removed to provide incentives for action and facilitate the adoption of more sustainable land management. This often goes beyond the range of actions that can be taken by land users and calls upon inputs from institutional capacity, policy-making, law, scientific research, etc. (see *Chapter 6*).

6+1 step approach: six steps drawing from a collection of methodologies (pluralistic) to establish a cost-benefit analysis of possible actions, plus one step to take action

The approaches, frameworks, and methods detailed in previous sections have been integrated into a 6+1 step approach conceptualised by the Global Mechanism of the UNCCD and further developed by Noel & Soussan (2010)[25] for the OSLO Consortium, with each step further disaggregated as required in order to meet the specific objectives of individual studies. The 6+1 steps – defined as the ELD Initiative methodology (ELD Initiative, 2013, pg. 42[4]) – are designed to ensure a thorough knowledge base is established for credible cost-benefit analysis to inform subsequent decision-making processes (*Table 2.3*).

TABLE 2.3

The 6+1 step approach of the ELD Initiative
(adapted and expanded from Noel & Soussan, 2010[25] and ELD Initiative, 2013[4])

1. Inception	Identification of the scope, location, spatial scale, and strategic focus of the study, based on stakeholder consultation. Preparation of background materials on the socio-economic and environmental context of the assessment.
	Methods for: *stakeholder participation (consultation, engagement); systematic review and synthesis of academic and grey literature; selection of relevant existing case studies; extrapolation of existing case studies for global comparison; collection of background socio-economic and environmental data; policy analysis.*
2. Geographical characteristics	Establishment of the geographic and ecological boundaries of the study area identified in Step 1, following an assessment of quantity, spatial distribution, and ecological characteristics of land cover types that are categorised into agro-ecological zones and analysed through a Geographical Information System (GIS).
	Methods for: *stakeholder participation (consultation, engagement); definition and mapping of land covers and agro-ecological zones from the sciences (physical geography, ecology, soil sciences, landscape sciences, etc.).*
3. Types of ecosystem services	For each land cover category identified in Step 2, identification and analysis of stocks and flows of ecosystem services for classification along the four categories of the ecosystem service framework (provisioning, regulating, cultural, and supporting services).
	Methods for: *stakeholder participation (consultation, engagement); identifying different ecosystem stocks and flows (from ecology); categorising ecosystem services into the four categories of the ecosystem service framework.*

4. Roles of ecosystem services and economic valuation	Identification of the role of ecosystem services in the livelihoods of communities living in each land cover area and in overall economic development in the study zone. Estimation of the total economic value of each ecosystem service. **Methods for:** *stakeholder participation (consultation, engagement); identification of available economic data from relevant case studies; data collection and surveys; multi-criteria analysis to identify important ecosystem services; valuation methods for estimation of "missing" economic values (no market price); extrapolation of case studies for global comparison.*
5. Patterns and pressures	Identification of land degradation patterns and drivers, pressures on sustainable management of land resources and drivers of adoption of sustainable land management (including determining the role of property rights and legal systems), and their spatial distribution to inform the establishment of global scenarios. Revision of previous steps if needed, to ensure the assessment is as comprehensive as possible. **Methods for:** *stakeholder participation (consultation, engagement); identification of types of land degradation, patterns, and pressures (from soil sciences, ecology, agricultural sciences, physical geography, etc.); mapping methods (GIS); establishment of global scenarios.*
6. Cost-benefit analysis and decision making	Cost-benefit analysis comparing costs and benefits of an 'action' scenario to that of a 'business-as-usual' scenario to assess whether the proposed land management to net benefits ('action' scenarios include land management changes that can reduce or remove degradation pressures). Mapping of net benefits for identification of the locations for which land management changes are suitable from an economic perspective. This will can help identify 'on-the-ground' actions that are economically desirable. **Methods for:** *stakeholder participation (consultation, engagement); cost benefit analysis with participatory establishment of 'action' scenario and 'business as usual' scenario, choice of discount rate, computation of indicators of economic viability; mapping methods (GIS); estimation of shadow interest rates.* **Tools to facilitate the building of cost-benefit analyses (micro-economic level):** *Toolkit for Ecosystem Service at Site-based Assessment (TESSA); Assessment and Research Infrastructure for Ecosystem Services (ARIES); Corporate Ecosystem Services Review (ESR); Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST); Multi-scale Integrated Models of Ecosystem Services (MIMES); Natura 2000, etc.*

+1. Take action	**Land users:** implement the most economically desirable 'on the ground' option(s) by changing land management practices or land use, at multiple scales and levels.
	Methods for: *stakeholder participation (consultation, outreach, awareness raising, engagement).*
	Private sector: engage in discussions with stakeholders from all sectors directly impacted by changes in ecosystem services to reduce risks associated with a weaker link in the value chain and increasing opportunities for investment in sustainable land management. This requires relevant and suitable impact pathways to be identified, to promote and facilitate actions that can be scaled up and out.
	Methods for: *Stakeholder participation in relation to corporate social responsibility (consultation, outreach, awareness raising, engagement), land materiality screening toolkit, value chain analysis.*
	Policy-/decision-makers: facilitate adoption of most economically desirable option(s) on the ground by adapting the legal, policy, institutional and economic contexts at multiple scales and levels. This requires relevant and suitable impact pathways to be identified, to promote and facilitate actions that can be scaled up and out.
	Methods for: *stakeholder participation (consultation, engagement); identification and social construction of impact pathways (e.g., multi-criteria analysis that identify preferences over possible impact pathways).* **Tools at the macroeconomic level:** *Green accounting using UN System of Environmental-Economic Accounting (SEEA) or using the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) global partnership.*

Details on how each step is performed, with further examples from a range of case studies illustrating the application of the frameworks and various methods, are provided in the ELD Initiative Scientific Interim Report (2013)[4], ELD User Guide (2015)[26], ELD e-learning courses/MOOCs (*www.mooc.eld-initiative.org*), and ELD Initiative Practitioner's Guides (2014, 2015)[27,28].

Economic benefits of sustainable land management

The ELD 6+1 steps approach is grounded on the premise that sustainable land management generates more often than not greater economic benefits than its associated costs. It provides a tool that allows for the assessment of these costs and benefits, with a view to materialise the net benefits of improved land management practices through increased productivity and production, or through the establishment of alternative livelihoods. This section outlines a few examples of studies supported by the ELD Initiative across Africa, Asia, and Latin America.

CASE STUDY 2.2

Step 1 of the ELD approach:
Preparing background materials on socio-economic and environmental contexts: Sundarban Eco-restoration Programme in Bangladesh and India
(sourced from Alam Shain S., Sharma, D., Rajasthan, U., & Sharma, P (Team 'South East Asia-01'), contribution to the 2014 ELD MOOC, available at www.mooc-eld-initiative.org)

Background

The land area of the Sundarbans, including exposed sandbars, occupies 414,259 ha (70 per cent), with water bodies covering 187,413 ha (30 per cent). The Sundarbans are ecologically and economically important at local, national, and even global levels, and the mangrove forest provides both ecological service and goods. Bestowed with scenic beauty and natural resources, it is internationally recognised for its high biodiversity of mangrove flora and fauna both on land and in water. It is also of importance for globally endangered species including the Royal Bengal tiger, Ganges and Irawadi dolphins, estuarine crocodiles, and the critically endangered endemic river terrapin (*Batagur baska*). Further, it is the only mangrove habitat in the world for *Panthera tigris tigris* species. Preserving the health of the Sundarbans ecosystems is a key priority, as the delivery of their highly valued services is threatened by land degradation.

Major causes of degradation and the main effects

The causes of deforestation and forest degradation in the Sundarban mangrove forests are over-demand, poor forest management, natural disasters, salinity, and sedimentation, and lead to the following issues:

- Reduced flow of water into the mangrove system;
- Extension of non-forestry land use into mangrove forest;
- Straying of tigers into villages along the western boundary;
- Increased demand for timber and fuelwood for local consumption;
- Poaching of tiger, spotted deer, wild boar, marine turtles, horse shoe crab, etc.;
- Uncontrolled collection of prawn seedlings;
- Uncontrolled fishing in the waters of the reserve forests;
- Continuous trampling of river/creek banks by fishermen and prawn seed collectors;
- Chemical pollution through marine paints and hydrocarbons, and;
- Organisational and infrastructure deficiencies.

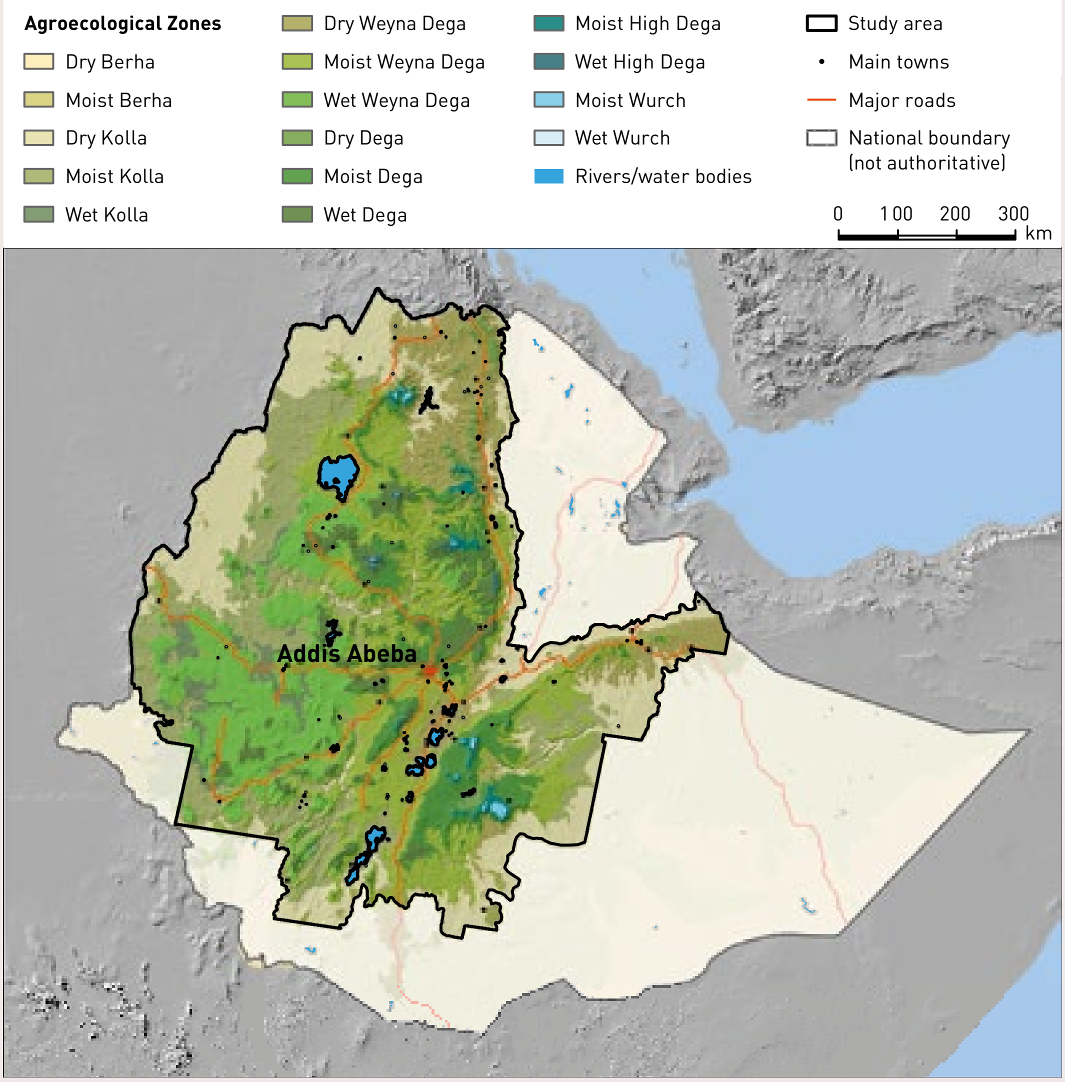
CASE STUDY 2.3

Step 2 of the ELD approach:
Establishing geographic and ecological boundaries in Ethiopia
(adapted from Hurni et al., 2015[29])

The ELD Initiative case study in Ethiopia covers an area of 614,000 km^2, or 54 per cent of the country where rainfed agriculture is practiced. By using Landsat imagery and the Homogenous Image Classification Units approach, a high-resolution land cover map was produced using 50 different land cover types, with types ranging from forest to grassland, cropland to settlement, and bare land to waterbodies (*Figure 2.6*). Multiple information sources were used in creating these classification units, including altitude, terrain, farming system, rainfall pattern, and soil.

FIGURE 2.6

Land cover types of the study area in Ethiopia
(Hurni et al., 2015[29])



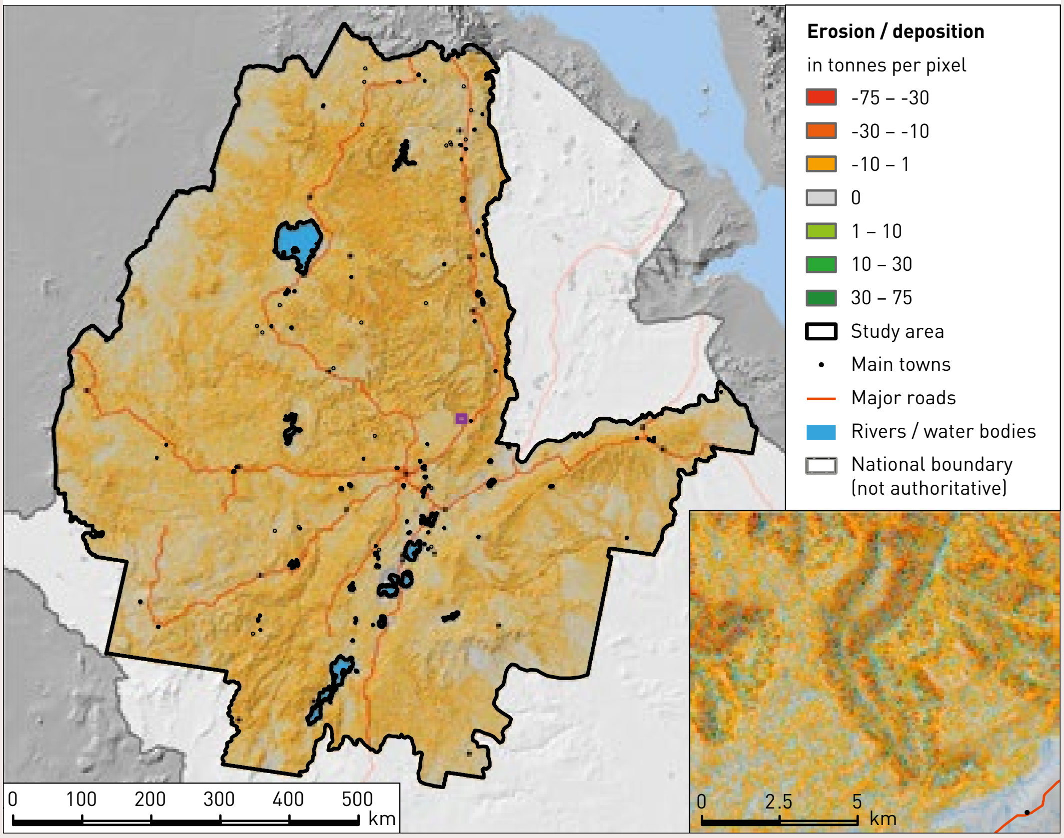
CASE STUDY 2.3

The occurrence of soil and water conservation structures and fertiliser application on cropland in the case study area was modelled, and a database including the information required to model soil erosion and deposition was created. Erosion and deposition estimates were then derived using a United-Stream-Power based Erosion Deposition (USPED) model (*Figure 2.7*), and applied to the landscape to develop visual maps.

The resulting information was also verified with expert opinion, to ensure that the land cover identification as well as estimates of land degradation (soil erosion) and its impacts (deposition) were correct. On this basis, the authors had a firm foundation from which they could develop alternative land management scenarios and compare them in a cost benefit analysis.

FIGURE 2.7

Estimated net erosion / deposition for the study area in Ethiopia
(Hurni et al., 2015[29])



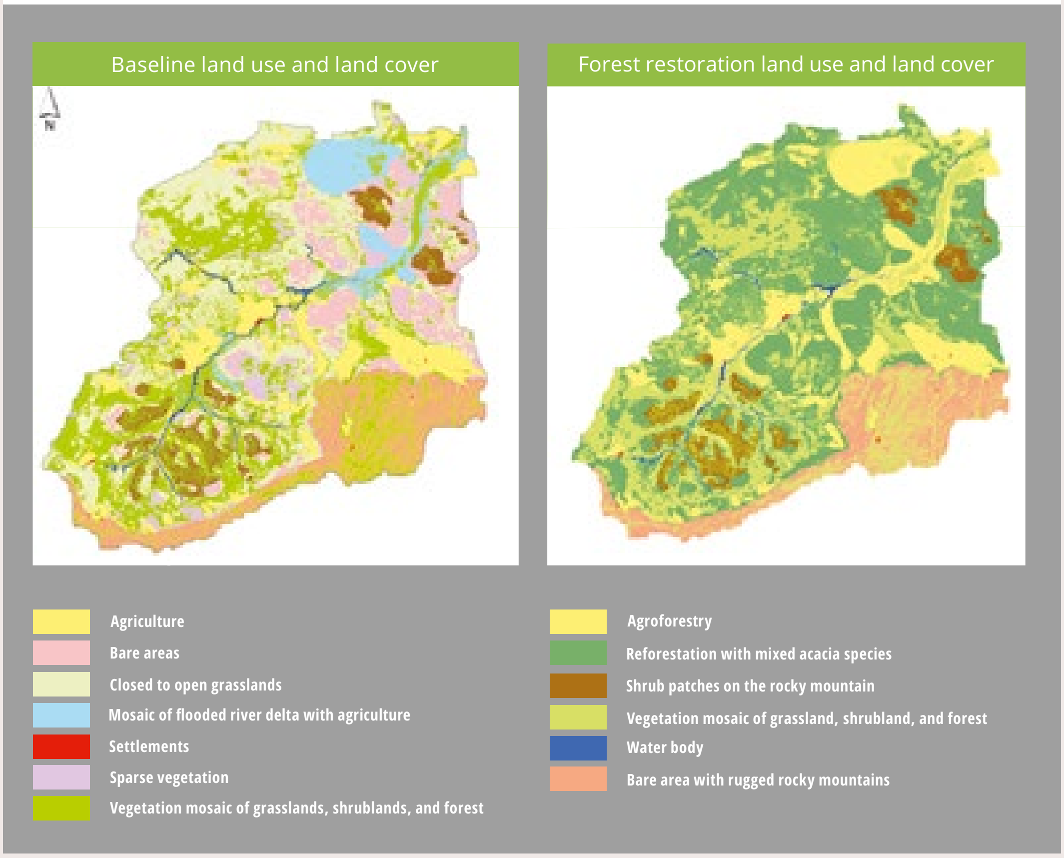
CASE STUDY 2.4

Step 6 of the ELD approach:
Cost-benefit analysis of large-scale agroforestry and reforestation in Mali
(adapted from Sidibé et al., 2014[30])

The ELD Initiative case study in Mali presented an *ex-ante* cost benefit analysis of large-scale agroforestry and reforestation in the Kelka forest. Productivity change, avoided cost, replacement cost, and market prices were used as valuation methods. High-resolution remote sensing techniques, an explicit spatially distributed hydrological model, and a crop growth model were developed to assess the impact of land use change on various ecosystem services (i.e., firewood availability, soil moisture, carbon sequestration, and nitrogen fixation). Two alternative scenarios (i.e., baseline and agroforestry/reforestation) were developed (*Figure 2.8*).

FIGURE 2.8

Land use and land cover map of baseline and reforestation scenarios in Mali
(Sidibé et al., 2014, pg. 14[30])



CASE STUDY 2.4 (CONT)

The study showed that the benefits of large-scale landscape restoration in the study area are significantly higher than the costs of implementing the restoration options, both at the local and global levels, when discounted at 2.5, 5, and 10 per cent for a time horizon of 25 years. Agroforestry provides the highest per hectare return on investment to smallholders: between USD 5.2 to 5.9 of benefits for every USD invested (with a net present value (NPV) ranging between 17.8 and 62 USD/ha/yr). The societal value of the agroforestry and reforestation scenario is notably higher when the global benefits from enhanced carbon sequestration are integrated: up to USD 13.6 of benefits for every USD invested (at a discount rate of 5 per cent), equivalent to a value of 428.8 USD/ha/yr (*Figure 2.9*). However, due to the instability of the market price for carbon, the latter estimates might be subject to variation.

FIGURE 2.9

Net benefits of agroforestry and reforestation scenarios in the Kelka forest watershed, Mopti

(Sidibé et al., 2014, pg. 14[30]*)*

	r = 2.5%	r = 5%	r = 10%
Smallholder farms	NPV USD/ha/yr: 62.2 B-C ratio/ha: 5.8	NPV USD/ha/yr: 55.6 B-C ratio/ha: 5.4	NPV USD/ha/yr: 17.9 B-C ratio/ha: 5.2
Forest community	NPV USD/ha/yr: 72.1 B-C ratio/ha: 3.0	NPV USD/ha/yr: 58.7 B-C ratio/ha: 2.7	NPV USD/ha/yr: 13.8 B-C ratio/ha: 1.7
Global society	NPV USD/ha/yr: 1,405.4 B-C ratio/ha: 49.5	NPV USD/ha/yr: 428.8 B-C ratio/ha: 13.6	NPV USD/ha/yr: 13.6 B-C ratio/ha: 1.7

B = benefits; C = costs

CASE STUDY 2.5

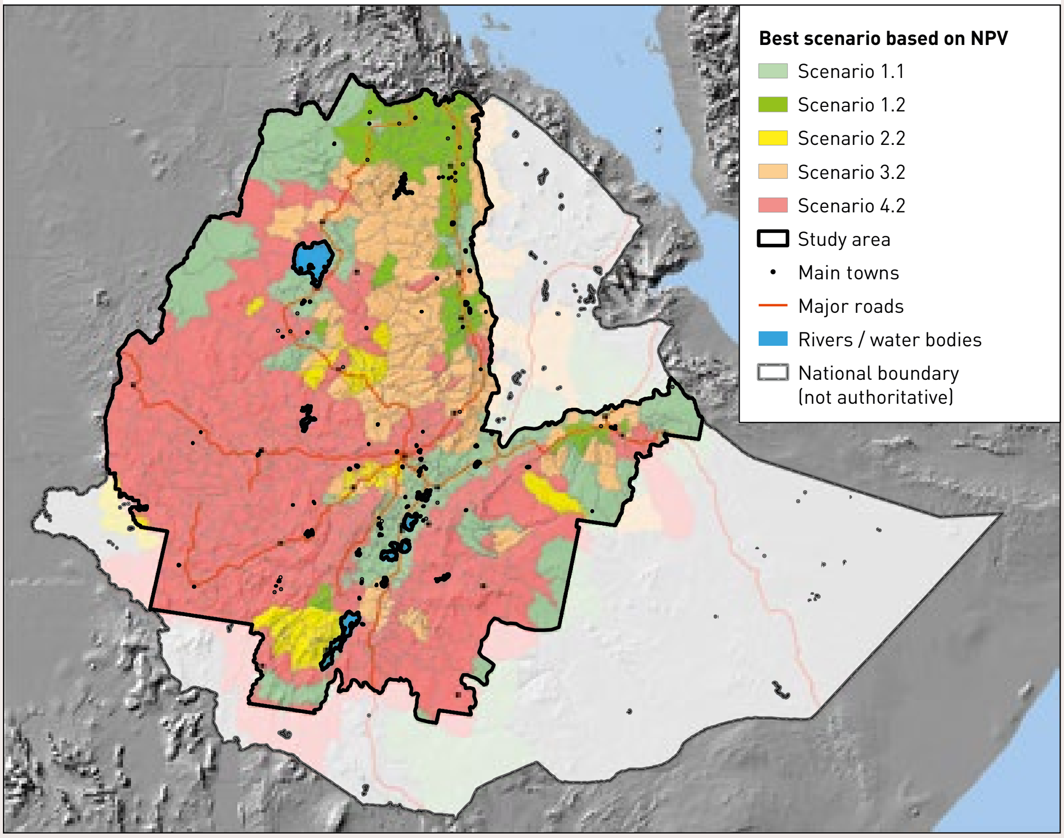
Step 6 of the ELD approach: Cost-benefit analysis: sustainable land management scenarios in the Ethiopian highlands
(adapted from Hurni et al., 2015[29])

In the ELD Initiative case study in Ethiopia outlined in *Case study 2.3*, soil and water conservation structures and fertiliser application on cropland was modelled, and a database created with the information required to model soil erosion and deposition. This allowed for the estimation of crop production and ultimately, the identification of eight scenarios for improved sustainable land management to be used for the cost-benefit analysis. Results show positive net present values under all the scenarios over a 30-year timeframe.

When comparing to business as usual, this indicates the profitability of a farmer to invest in soil and water conservation measures, with a view to increase future financial returns. If all the identified sustainable land management technologies were implemented, crop production was estimated to increase by 10 per cent over 30 years, at a discount rate of 12.5 per cent. A map was produced to help visualise which option would lead to the greatest net economic benefit in different locations (*Figure 2.10*).

FIGURE 2.10

Optimal scenario locations based on net present value (NPV) for different regions in Ethiopia
(Hurni et al., 2015[29])



CASE STUDY 2.6

Benefit-to-cost ratios: Alternatives to current rice and mango production practices in the Piura region of Peru

(from ELD User Guide, 2015, pg. 27[26], originally from Barrionuevo, 2015[31])

This study compares the costs of action to the benefits from action for rice and mango production in the Piura region, both dominating agricultural production in the region.

Rice production in the Piura region is affected by soil salinisation, which reduces crop yields. Two more sustainable land management alternatives are considered for economic assessment and derivation of benefit-to-cost ratios and replacing rice by quinoa production. The first option is costly and not economically attractive. The economic potential of quinoa production is very attractive but depends on demand for quinoa and its market price (*Table 2.4*).

Mango production in the Piura region constitutes 75 per cent of mango exports of Peru. Organic production is seen as helping to reduce soil erosion and salinisation, and improve water retention capacity. Organic mango is in demand and thus the first alternative to current production practices. The second alternative is mango production as part of an agro-forestry system. Both are financially viable but agro-forestry has higher profitability.

TABLE 2.4

Comparison of the net benefits of action and inaction under business-as-usual and improved sustainable land management scenarios

(adapted from Barrionuevo, 2015[31])

			Benefits		Costs		Net benefits	Net benefits of action
			Action	Inaction	Action	Inaction		
Business-as-usual		Rice	N/A	8,522	N/A	6,804	1,717	N/A
		Mango	N/A	10,513	N/A	4,563	5,959	N/A
Sustainable land management	**Rice**	Scenario 1a. horizontal desalination	11,589	N/A	11,304	N/A	285	-1,432
		Scenario 2a. replacing rice by quinoa production	30,000	N/A	10,000	N/A	20,000	18,282
	Mango	Scenario 1b. organic production	8,655	N/A	1,205	N/A	7,450	1,491
		Scenario 2b. production as part of an agro-forestry system	27,049	N/A	2,074	N/A	24,974	19,015

All figures in Peruvian nuevo sol (PEN). Exchange rate PEN/USD = 0.31

Limitations

The various frameworks, approaches and methods outlined in this chapter provide useful tools to perform economic analyses of land management. However, as for any tools, they face a range of limitations.

Limitations of frameworks

The impact pathways for sustainable land management framework outlines the varied pathways to be followed towards the achievement of improved land management and human well-being. While economic assessments can help the identification of the most economically desirable options, sustainable land management requires complementary impact pathways to be established in order to operationalise such options (see *Figure 6.1, Chapter 6*). The framework might provide too narrow a perspective, and a wider range of actions might be needed in order to drive change at a large enough scale. As detailed in *Chapters 5* and *6*, these actions include a range of cultural, economic, environmental, financial, legal, political, technical, and social enabling factors.

The ecosystem service framework emphasises the multiple benefits of ecosystems to humans, but there are ethical considerations raised over its anthropocentric focus[32]. There are a range of non-anthropocentric values – defined as biocentric values – that are not necessarily captured through the concept of ecosystem services which implicitly refer to ecosystem benefits to humans, whether direct or indirect.

Similarly, credibility concerns are raised on the TEV, as it provides a relatively simple framework that might be difficult to operationalise in real life. The value estimated under the TEV is not always translated into prices and real money flows, and it can be perceived as irrelevant, especially for smallholders. The TEV aims to reflect the preferences of society as a whole in the allocation of ecosystem goods and services, including those values that are not normally quantified in monetary terms. This is referred to by economists as the 'economic' value to society as a whole, which may or may not be reflected accurately in market prices or 'financial values". Economic valuation of ecosystems is carried out by humans based on a utilitarian perspective, which assumes that alternative sources of ecosystem service values contribute interchangeably to human welfare[33]. Economic valuation is subject to the same anthropocentric criticism as the ecosystem service framework, added to a concern over the commodification of nature (Monbiot, 2012[34] with response by Costanza *et al.*, 2012[35]).

However, by aggregating individual preferences into a TEV value, this approach assumes that consumer preferences are in line with a shared concept of ecosystem sustainability. Sustainability is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[36] Debates are raised on the varied conceptions of sustainability, which include a 'weak' conception, i.e., different types of capital such as natural versus manufactured which are substitutable towards the generation of human well-being, therefore the key focus must be on their aggregated value[37]. In contrast, a 'strong' conception, i.e., the capacity of natural capital to provide benefits to society, is derived by a complex interaction between a range of biotic and abiotic components. The stock of natural resources must be maintained and enhanced in order to preserve its capacity to deliver these benefits, which cannot be duplicated by manufactured capital[38].

Limitations of the economic assessment approach

Cost-benefit analysis should be used as a guiding tool to compare alternative land use options and scenarios, and identify the most desirable one(s) 'only' from an economic perspective. It should be considered that not everything can be nor should be valued in money, and that a range of non-monetary factors play a role in the identification and design of sustainable land management practices. When a full economic valuation is not an option due to a lack of data, capacity, or social acceptance, alternative valuation approaches can be used. For example, as a result of unpredicted time constraints, multi-criteria decision analysis (MCDA) was used as an alternative to cost-benefit analysis in Botswana's Kalahari to identify key rangeland ecosystem service benefits (i.e., food, fuel, construction material, ground water, genetic diversity, climate regulation, recreation, and spiritual inspiration)[39]. By integrating monetary and non-monetary valuation techniques, with ecological and socio-economic dimensions, the study revealed that while cattle production in the study area provides the largest financial returns to private cattle ranchers, its negative environmental externalities affect all users of communal rangelands, with costs and benefits not distributed fairly. The MCDA approach proved valuable in demonstrating that the policy-driven focus upon intensive commercial food production and ground water extraction in Botswana compromises the delivery of other provisioning ecosystem services (wild food, fuel, construction material and genetic diversity) and cultural services (recreation).

An alternative way of communicating results, instead of the usual indicators of economic desirability (i.e., net present value, internal rate of return, or benefit-to-cost ratio) and one which relates neatly to the concept of sustainability, is to calculate the rate of interest at which we are borrowing natural capital from future generations. A study by Quaas *et al.* 2012[40] looked into overfishing and its related costs across 13 major European fish stocks, and stressed the need to compute return on investments when designing sustainable fishing practices. Through a shadow interest rate analysis (shadow prices differ to market prices as they aim to capture the social returns produced by a unit of privately owned capital over time), the study shows that the economic returns of catch reduction are higher than the ones produced by the current overfishing practices. Catch reduction should therefore be promoted as an investment in natural capital, with a view to increase the fishers income across time.

Limitations of methods

Similarly to the concerns raised on the valuation approach, the choice of methods is not always easy to implement under limited capacity and/or with a limited data context. Also, the suitability of different methods is highly context-specific. An effective engagement of multiple stakeholders able to contribute to the use of multiple methods and implementation of their results is key in this process. The compilation of different types of

knowledge needs good facilitation of exchanges needs to be organised by public decision-makers within a political process in place. The wide variety of methods available can make the users feel lost, therefore a strong guidance is needed to support them in the choice of methods so that they can go beyond their comfort zone. Assessment to inform action need not necessarily be data- and capacity-intensive, as demonstrated in the outputs from the ELD MOOC 2014 (*www.mooc.eld-initiative.org*). Simple assessment does not mean lower quality, as simple yet quality assessments were put together by participants, many of whom had not previously engaged in formal education or had professional experience in this field.

Conclusion

This chapter outlined the range of frameworks, approaches, and tools that can be used to address key land management issues and identify sustainable land management strategies. While it is recognised that there is no blueprint solution to land degradation and that each economic approach faces its own constraints, action must be taken to generate empirical knowledge that can help prevent or reverse land degradation. The ELD 6+1 steps methodological approach for the economic valuation of alternative land use options through cost-benefit analysis was presented, and details on the limitations of such approach were discussed. This approach provides a tool to support policy-/decision-makers with transparent information to adopt economically-sound sustainable land management, through the estimation of the overall economic benefits of addressing land degradation and implementing ecosystem restoration. Such estimates will enable businesses and policy-/decision-makers to test the economic implication of land management decisions, based on a scenario-driven, net economic benefit decision-making framework. The ELD approach recognises that not everything can be valued in money, that a range of non-monetary factors play a role in the identification and design of sustainable land management practices. It also recognises that a comprehensive understanding of land degradation requires the combination of different disciplines, in particular integrating biophysical analysis of the root causes of degradation with socio-economic assessments. By focusing on the economic value of ecosystem services derived from land, and livelihood implications of alternative land use and management strategies, the ELD approach allows for broader consideration of other factors to promote land management and use bringing higher levels of economic benefits and not just those linked to land degradation. *Box 2.1* is an example of how an interlinked system can integrate these values into business models and approaches. By comparing the economic costs of action versus the benefits of action, impacts on human well-being and the long-term effects of decisions, better informed decisions can be made towards the identification and promotion of sustainable land management practices.

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CHAPTER

03

A: The future of ecosystem services: Impacts on ecosystem service values, and global and national scenarios

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Impacts of land cover changes degradation on ecosystem service values

The magnitude of the global economic value of ecosystem services dwarfs the value of the global market economy[1]. Changes to land cover in the past twenty years have reduced the value of the annual flow of ecosystem services by USD 4–20 trillion/yr[2]. However, these losses do not account for reduced ecosystem function and its impact on the value of ecosystem services. Here, human appropriation of net primary productivity (HANPP)[3] was used as a proxy of land degradation to estimate losses of ecosystem services due to land degradation. Two proxy measures of land degradation were used as a measure of impact on ecosystem function; the first is a representation of HANPP derived from population distributions and aggregate national statistics. The second is theoretically derived

from biophysical models and is the ratio of actual net primary productivity (NPP) to potential NPP. Juxtaposition of these measures of land degradation with a map of ecosystem service values (ESV) allows for spatially explicit representation of those lost values that result from land degradation. Resulting estimates of lost ecosystem services is USD 6.3 and 10.6 trillion/yr, using these two approaches respectively. With global gross domestic product (GDP) standing at roughly USD 63 trillion in 2010, all of agriculture represents roughly USD 1.7 trillion (2.8 per cent) of the world's GDP. These estimates of lost ecosystem services represent significantly larger fractions (10–17 per cent) of global GDP. These results demonstrate why the economics of land degradation is more critical than the market value of agricultural products alone.

Introduction

It is becoming increasingly evident that land degradation is expensive, both to local owners and to society in general over multiple time and space scales[1, 2,4,5,6]. The UNCCD recognises this, and at Rio+20 set a target of *zero net land degradation*[7], now referred to as land degradation neutrality (LDN, see *Box 1.2*). The need to restore degraded lands and prevent further degradation is especially important now as the demand for accessible productive land is increasing. These changes are projected to affect mainly tropical regions that are already vulnerable to other stresses, including the increasing unpredictability of rainfall patterns and extreme events as a result of climate change[8,9].

Land degradation, amongst other drivers, is a consequence of poor management of natural capital (soils, water, vegetation, etc.). Better frameworks are needed to: (1) quantify the scale of the problem globally; (2) calculate the cost of 'business as usual'[7], and; (3) assess the benefits of restoration. Visionary farmers and business leaders are becoming aware that ecosystem degradation may affect their bottom line and future prosperity[10], however, they lack the decision-making tools to develop robust and effective solutions. In addition, the prevailing political economy encourages rent-seeking activities in which short-term individual gains are more valued than long societal benefits. Nonetheless, modeling and simulation techniques enable the creation and evaluation of scenarios of alternative futures and other decision-making tools to address these gaps in data and knowledge[11,12,13,14].

In this section, methods to assess the degree of land degradation are investigated, based on its effects on NPP globally. Estimates are then used to derive assessments of the loss of ecosystem service values from land degradation.

Data and methods

Land degradation is a complex phenomenon that manifests in many ways. There have been numerous efforts using a variety of approaches to characterise various facets of land degradation over the last few decades. A recent review of various datasets and the approaches to their development (e.g., expert opinion, satellite derived NPP, biophysical models, and abandoned cropland) has been conducted by Gibbs & Salmon[15]. The GLASOD project (1987–1990) was a global assessment of human-induced soil degradation based primarily on expert opinion[i]. The GLASOD effort separately characterised chemical deterioration, wind erosion susceptibility and damage, physical deterioration, and water erosion severity, into categories of low, medium, high, and very high. An influential 1986 study estimated that humans were directly and indirectly appropriating 31 per cent of the earth's NPP[16]. A subsequent 2001 study arrived at a similar figure of 32 per cent[17].

The Food and Agriculture Organization of the United Nations (FAO) has developed a map of land degradation represented by a loss of NPP. NPP is measured using a Rainfall Use Efficiency (RUE) adjusted Normalized Difference Vegetation Index (NDVI) derived from MODIS satellites as a proxy of measure land degradation[ii,18]. There are many challenges associated with using satellite observations of NDVI as a proxy of NPP because of variability of rainfall and spatially varying agricultural and pastoral practices.

Much of the net primary productivity research seeks to determine the human appropriation of such. Imhoff *et al.* made estimates of HANPP using models derived from empirical satellite observations and related statistical data[19,20,21]. Imhoff's representation spatially allocates the HANPP to the location of its consumption. Haberl *et al.* made a similar assessment of HANPP using process models

[i] *Global Assessment of Human-induced Soil Degradation (GLASOD): www.isric.org/data/global-assessment-human-induced-soil-degradation-glasod*

[ii] *Global NPP Loss In The Degrading Areas (1981–2003): www.fao.org/geonetwork/srv/en/metadata.show?id=37055*

and agricultural statistics that were consistent with the estimates of Imhoff *et al.*[3] The Haberl representation spatially allocated the degradation primarily to the agricultural and grazing areas where the land degradation is actually taking place. In some respects, the Haberl representation of land degradation spatially allocates degradation to its actual production location, whereas the Imhoff representation allocates degradation to the spatial location of the consumption of the products that caused the degradation.

Spatially explicit global datasets were sought, that could provide simple and general measures of land degradation to be used as a factor to adjust ESVs on a pixel by pixel basis. The Imhoff data[22] was chosen as a demand-based proxy measure and the Haberl data as a supply-based measure informed by agricultural statistics. The Imhoff data were partially derived from empirical satellite observations of NPP using a time series of Advanced Very High Resolution Radiometer (AVHRR) data.

The Haberl *et al.* databases also lent themselves to this purpose and were easy to access[iii]. These theoretically derived datasets were also used to assess HANPP. They consisted of several datasets including the following:

1) **NPP**: A dynamic global vegetation model which is used to represent potential NPP in terms of $gC/m^2/yr$ [23,24];
2) **NPPact**: an actual NPP layer calculated from harvest statistics in agricultural areas and livestock statistics that are used in grazing areas;
3) **NPPh**: the NPP destroyed during harvest;
4) **NPPt**: the NPP remaining on the land surface after harvest, and;
5) **ΔNPPlc**: the impact of human-induced land conversions such as land cover change, land use change, and soil degradation.

Two representations of land degradation were created that varied in value from 0–100, in which a zero corresponded to 100 per cent degradation and 100 corresponded to no degradation at all. With the Imhoff data, the representation of land degradation was simply 100 – %HANPP (*Figure 3a.1*). The Haberl representation was created using data available at their website (*www.uni-klu.ac.at/socec/inhalt/1191.htm*). A percentage ratio of the data was created and named as *NPPactual* (tnap_all_gcm) and *NPPo* (tn0_all_gsm) (*Figure 3a.2*). Note this is not identical to the measure of HANPP. Perusal of these data show significant differences in that India and China are much more degraded in the Imhoff representation than in the Haberl representation. In addition, the mid-west of the USA and central Canada are much more significantly degraded in the Haberl representation. It should be noted that these differences do not suggest inaccuracy on the part of either dataset. These datasets are representative of two correlated but distinct phenomena (e.g., %HANPP and per cent of potential NPP). Both were chosen because their juxtaposition is an interesting exploration of the separation of production and consumption as it manifests as land degradation.

The third dataset used in this analysis was a representation of ESV based on USD/ha/yr for each type of land cover[2] (*Figure 3a.3*). For this study, only terrestrial values were used, because the representations of land degradation did not include coastal estuaries, coral reefs, and ocean areas. These figures present the data products as they were obtained (i.e., in an unprojected geographic or platte carre equi-rectangular projection). These calculations assume ESVs are a function of areal extent and consequently the analyses have all been converted to their corresponding area. Two representations of the ESV of degraded lands were created via the very simple process of multiplying three raster representations as follows:

ESV_Imhoff_degradation = ESV(Figure 3a.3 * Imhoff Degradation (Figure 3a.1) * Area in Hectares

ESV_Haberl_degradation = ESV(Figure 3a.3 * Haberl Degradation (Figure 3a.2) * Area in Hectares

iii *Haberl database: www.uni-klu.ac.at/socec/inhalt/1191.htm*

FIGURE 3A.1

A representation of land degradation derived from Imhoff data

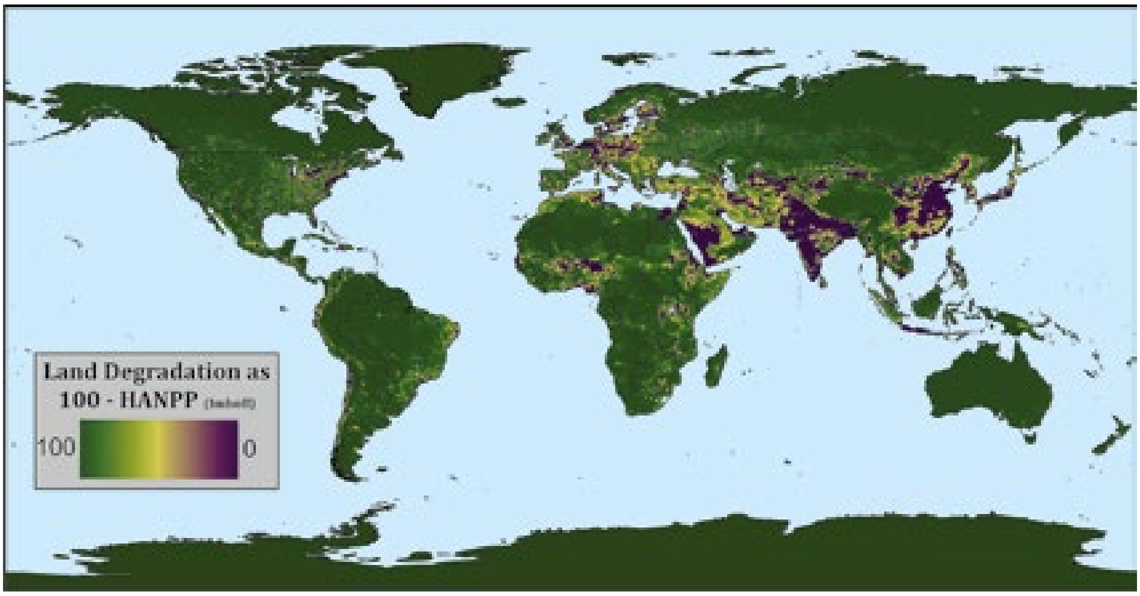


FIGURE 3A.2

A representation of land degradation derived from Haberl data

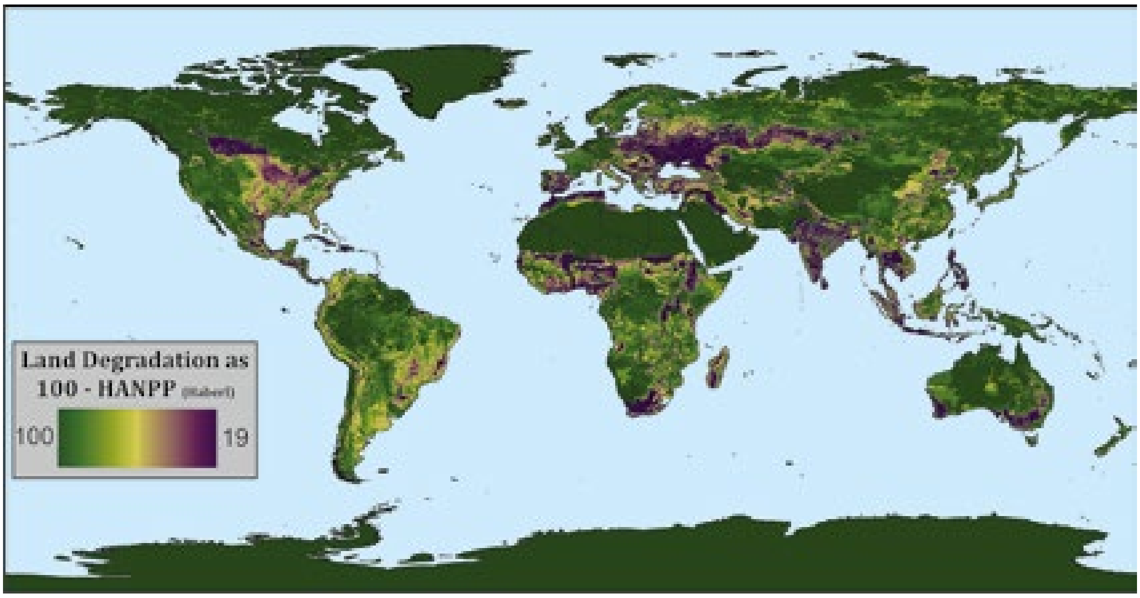
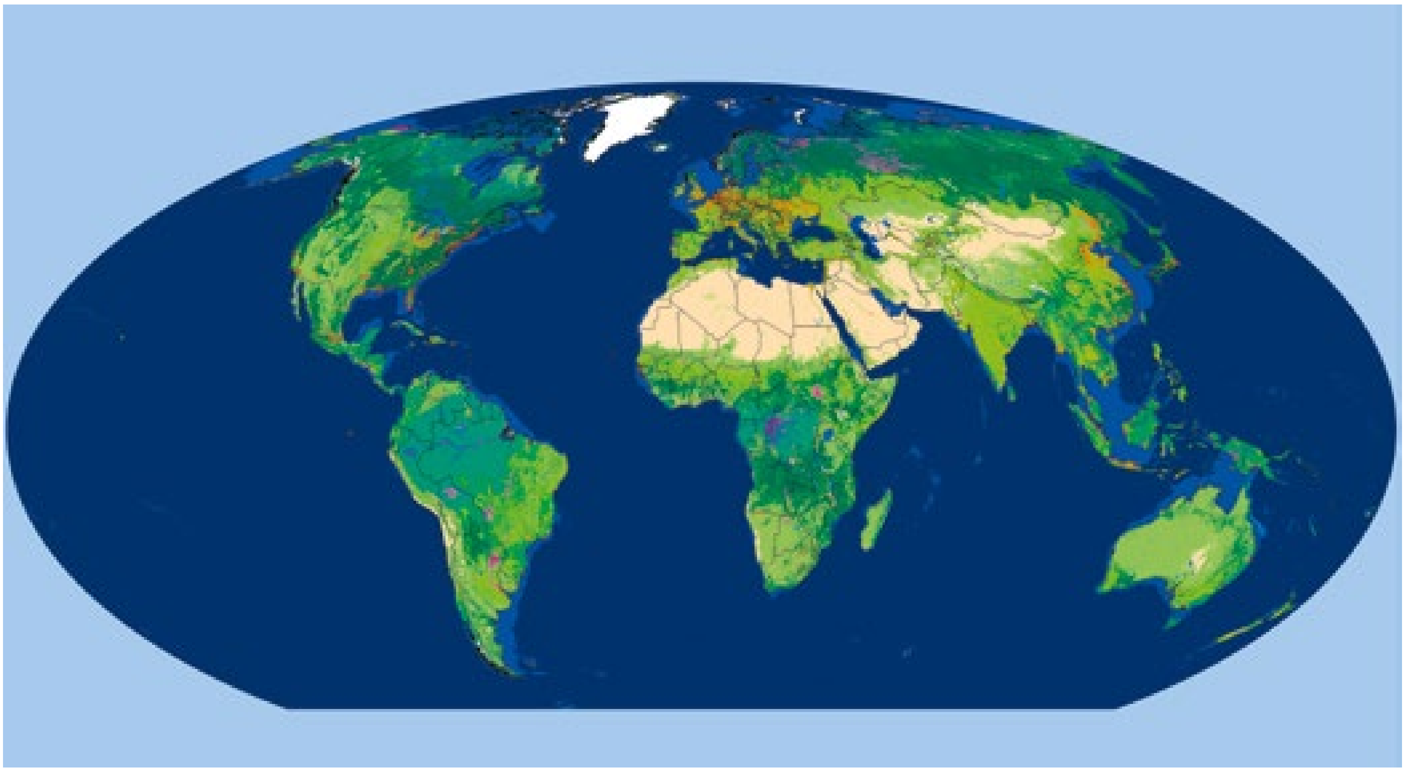


FIGURE 3A.3

Ecosystem service values

(adapted from Costanza et al., 2014[2])



This results in two new spatially explicit representations of ecosystem service values as 'degraded' by the 'Imhoff proxy' and 'Haberl proxy' respectively. The global and national aggregations of these are presented as results. See *Table 4.1* and *4.2*, as well as *Figure 4.1* in *Chapter 4* for similar regional analyses, as well as for per capita and per square kilometre values. The Imhoff representation differs markedly from the Haberl representation. The Imhoff version is really more a map of the location of the driving forces of land degradation, which are a function of population and consumption. The Haberl representation is a more spatially accurate measure of actual land degradation where it takes place; however, it captures agricultural land degradation more effectively than degradation of non-agricultural lands.

Results

The impacts on ecosystem service monetary values that results if proxy measures are linearly proportional to degradation of ecosystem function are found in *Appendix 3*. Globally, the Haberl and Imhoff proxies produce a 9.2 and 15.2 per cent decrease respectively in the global annual value of ecosystem services. Spatial variation between these representations results in some stark differences in their respective impacts on the value of ecosystem services at national levels. In India, the theoretical Haberl derived representation produces an impact that is a 20.3 per cent loss of ESV, whereas with the Imhoff derived representation produces a 72.8 per cent loss. With China, these differences are 6.6 and 45.2 per cent. In the United States, the differences are not as marked, at 8.0 and 16.0 per cent degraded.

At the national level, the spatial patterns of land degradation and their impacts on the loss of ESVs can be similar or dramatically different between the two approaches.

The island continent of Australia provides an example of striking differences. The total value of terrestrial ecosystem services in Australia is roughly USD 3.2 trillion/yr[2]. The Haberl representation of land degradation for Australia includes most of Australia's agricultural areas and even some of the central scrublands whereas the Imhoff representation is much more focused on areas of intense human settlement in and around the capital cities (*Figure 3a.4*). The loss of ESV from the Imhoff and Haberl representations are USD 79 and 224 billion/yr respectively. These values differ by roughly a factor of three. The overall losses presented here represent 2 per cent (Imhoff) and 7 per cent (Haberl) annual loss of ESV. These results are a consequence of the highly urbanised and spatially concentrated population of Australia and the fact that they are a net exporter of food and ecosystem service values. The Haberl representation is likely the best actual measure of actual land degradation whereas the Imhoff representation measures the land degradation associated with the behaviour of the population of Australia.

Nations in and around the Mekong Delta in Southeast Asia diverge from the findings for Australia. The total annual value of ecosystem services for this region is roughly USD 1 trillion/ yr². The overall spatial patterns of degradation for the Haberl and Imhoff representations in the Mekong Delta are more similar because these countries have significant rural populations; however, the Imhoff values tend to show higher levels of degradation than the Haberl values. Here, the Imhoff representation produces a much larger loss of ESV (USD 275 billion/yr) than the Haberl representation (USD 100 billion/yr) (*Figure 3a.5*). In fact, the Imhoff representation produces a larger loss of ecosystem services for all of these nations except for Laos, in which the two numbers are USD

FIGURE 3A.4

Representations of land degradation and land cover for Australia

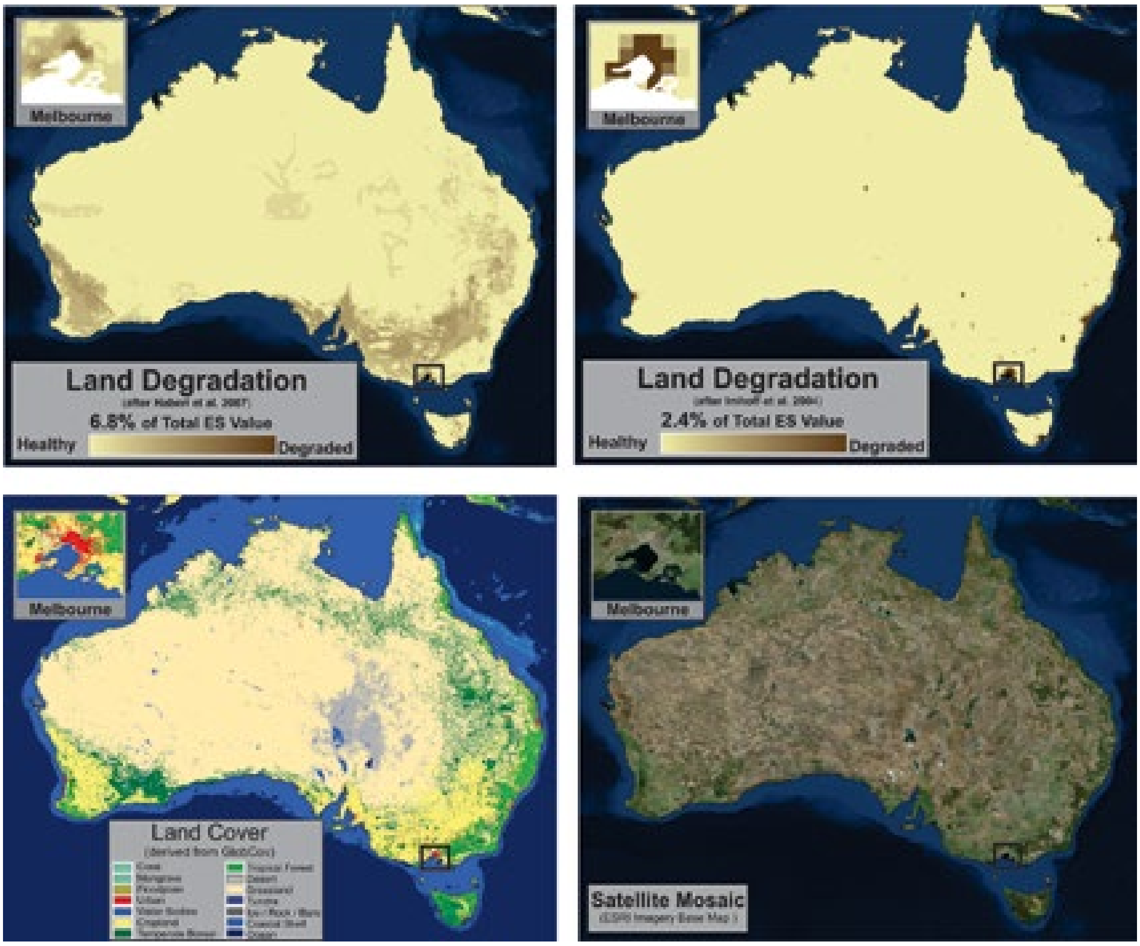
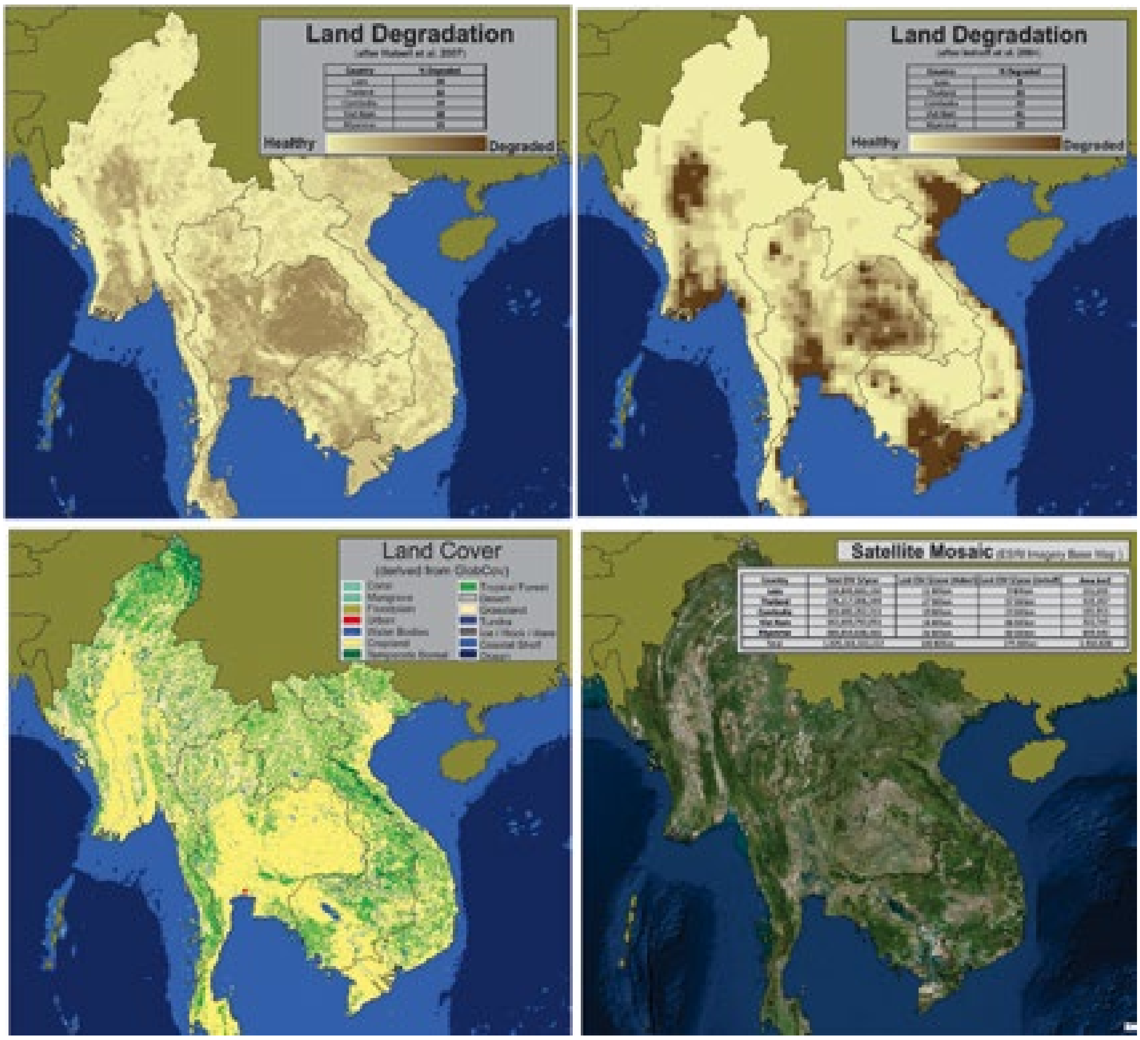


FIGURE 3A.5

Representations of land degradation and land cover for South-east Asia



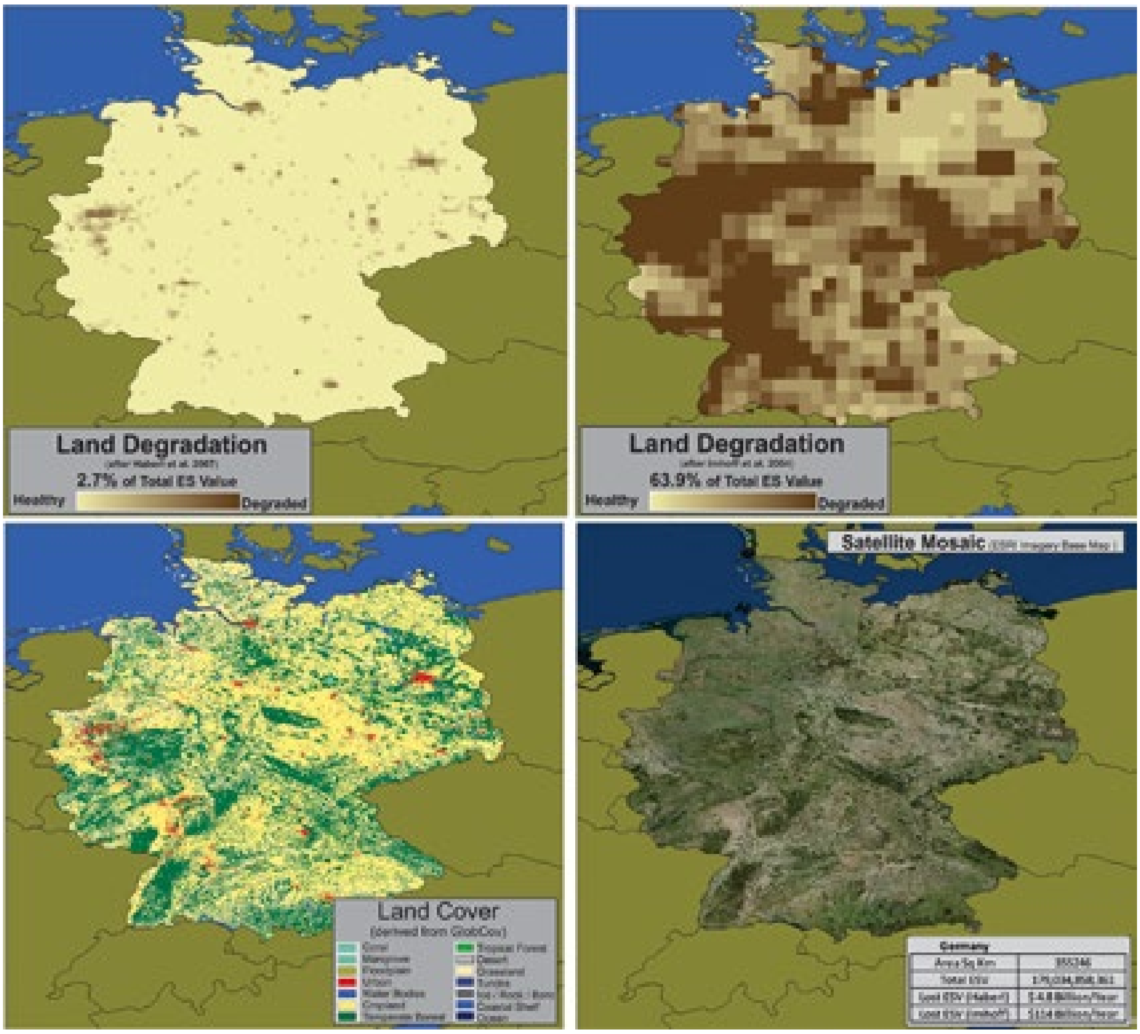
11 and 9 billion/yr respectively. The overall values presented here respectively represent a 27 per cent (Imhoff) and 10 per cent (Haberl) annual loss of ESV. This suggests that this region of the world is in some sort of ecological deficit[25,26].

Germany also provides a striking contrast to the patterns of degradation seen in Australia. In Germany, the Imhoff representation shows land degradation as widespread throughout the nation, while the Haberl representation shows degradation as much more concentrated in and around the urban centers (*Figure 3a.6*). The annual value of ecosystem services from German lands is estimated to be USD 179 billion[2]. Here the empirical Imhoff representation of degradation produces a much larger percentage loss in annual ecosystem service value (64 per cent or USD 114 billion) than the Haberl representation (3 per cent or USD 4.8 billion). Here, the degradation represented in the Imhoff representation is a result of the high levels of consumption characteristic of the population of a western European nation. The Haberl representation is much less extensive and severe, likely as a result of significant soil inputs and a highly regulated agricultural industry.

Bolivia is a nation that appears to have navigated the challenges of land degradation fairly well so far. The annual value of ecosystem services in Bolivia was estimated at USD 1.27 trillion[2]. Here, the Haberl and Imhoff representations of land degradation

FIGURE 3A.6

Representations of land degradation and land cover for Germany



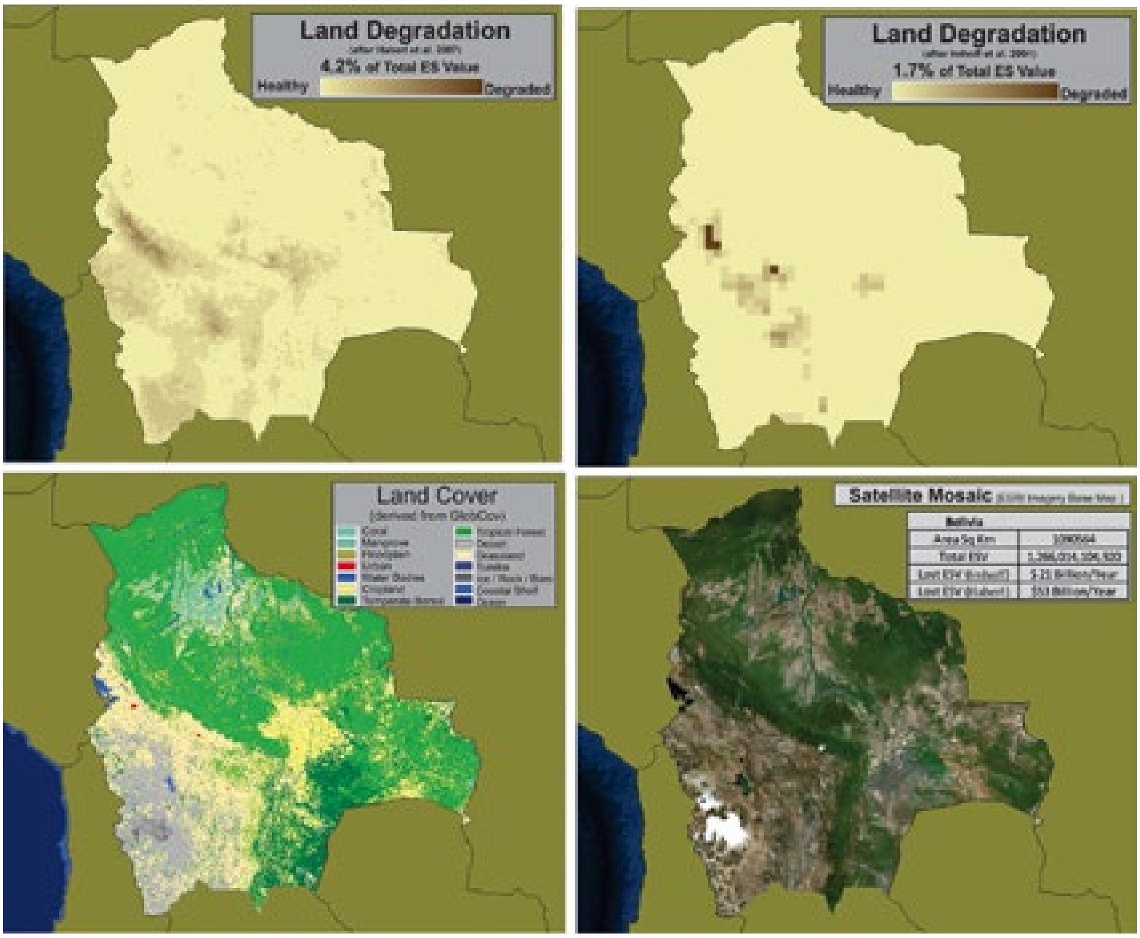
look much the way they did in Australia, in that the degraded areas in the population based Imhoff measure are concentrated in and around human settlements, whereas the agricultural representation derived from Haberl data is more widespread throughout the agricultural areas. The percentage loss of annual ESVs for Bolivia are 4 per cent (USD 53 billion) and 2 per cent (USD 21 billion) from the Imhoff and Haberl versions respectively (see *Figure 3a.7*).

The aforementioned variation between these proxy measures of land degradation warrant some exploration and characterisation. Nations vary significantly in areal extent and human impacts which can distort interpretation of scatterplots in which a point for the small island nation of Samoa has the same influence as the point for China. To test for a measure of consilience between these measures, authors looked at a Log – Log scatterplot of the 'effective area of degraded land' for both the Haberl and Imhoff proxy measures (*Figure 3a.8*).

'Effective area of degraded land' was calculated by simply multiplying the percent degraded layer for each proxy measure (i.e., the Haberl and Imhoff) by the area layer and summing up for each nation or territory. A simple linear scatterplot does show increasing variance with much fewer points at higher values. The essence of this exercise is to simply demonstrate that these two approaches show consilience with one another. Nonetheless,

FIGURE 3A.7

Representations of land degradation and land cover for Bolivia



it was expected to see significant differences between these measures of land degradation because one is spatially allocated to, and based primarily on, agricultural practices and yields (Haberl); whereas, the other is spatially allocated to, and based on, the number and behaviour of the population of the country (Imhoff).

It should also be noted that the differences between these two approaches result in profoundly different measures of 'percentage of land degraded' for the nations of the world. The 'percentage of land degraded' is simply calculated as 'effective area of degraded land' divided by 'total area of land' for each country. This does not adjust or account for the value of the ecosystem services of those lands (e.g., a 50 per cent degraded grassland will count the same as a 50 per cent degraded wetland, etc.) (*Figure 3a.9*).

Discussion and conclusion

Characterising, measuring, and mapping land degradation has long been recognised as a challenging task. Here, authors have presented a simplifying approach to collapse the multivariate phenomena of land degradation into a single spatially varying number. Just as an SAT score and an IQ test both measure intelligence, they do not perfectly correlate nor do they capture all the complexity of what is generally regarded as intelligence. This simplification of land degradation was used to estimate the impact on ecosystem function and convert it into loss of ecosystem service value.

The Haberl and Imhoff datasets were both originally used to estimate HANPP in terms of Pg C/yr (Haberl 15.6 Pg or 24 per cent of NPP, vs. Imhoff

FIGURE 3A.8

Log-log scatterplot of national effective degraded land area

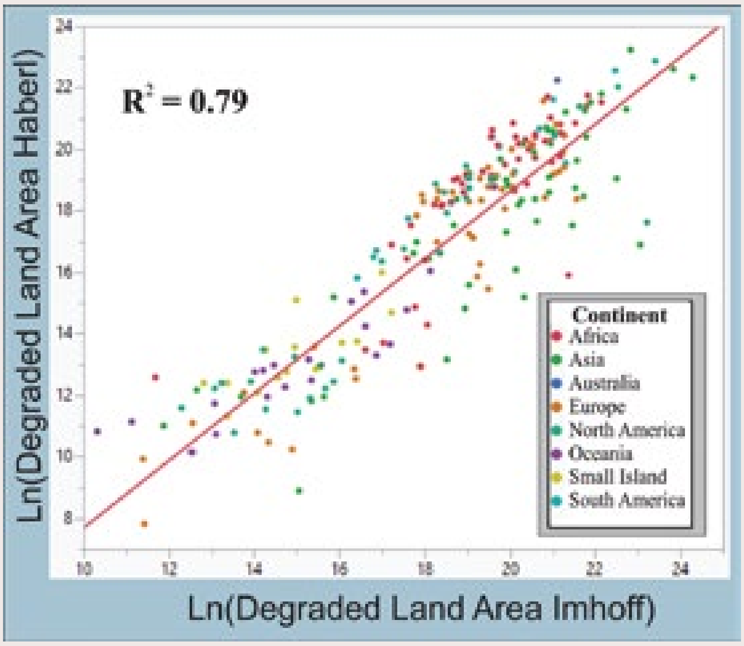
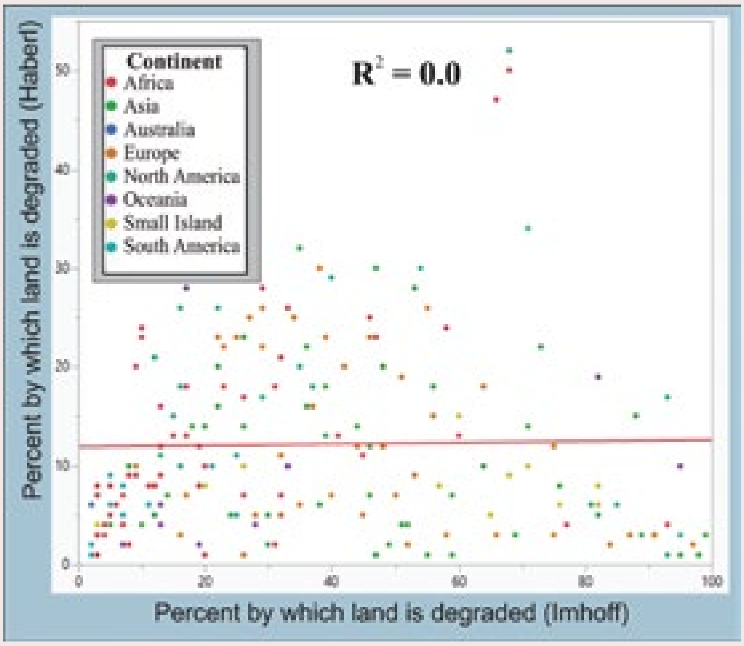


FIGURE 3A.9

Scatterplot of percentage of land degraded for 208 nations



11.5 Pg or 20 per cent of NPP). The Haberl estimate is significantly higher than the Imhoff estimate[3], yet when incorporated into these proxy measures of land degradation, the Haberl representation resulted in a lower global degradation rate of 10 per cent, whereas the Imhoff representation was higher at 20 per cent.

Although they are both a reasonable and useful measure of land degradation, these representations of land degradation do not measure the same thing. The Haberl measure is simply the percentage of potential NPP that is actually taking place (e.g., Actual NPP/Potential NPP), which is representative of the fundamental efficiency of an ecosystem from the perspective of energy transformation via photosynthesis. The Imhoff representation is derived from an allocation of harvest processing and efficiency multipliers applied to national level FAO data from seven categories (vegetal foods, meat, milk, eggs, wood, paper, and fibre) and spatially allocated to a global representation of the population distribution. The Haberl representation is the most valid 'map' of land degradation in terms of spatial patterns; however, the Imhoff representation augments this assessment from the perspective of separating production from consumption. A country that imports food is contributing to land degradation in the agricultural areas of the countries it imports food from.

These representations of land degradation are nonetheless relevant to our understanding of the economics of land degradation. Agricultural lands provide a significant output of ecosystem services not accounted for if only dollar values of agricultural products are included (roughly USD 1.7 trillion/yr, or 2.8 per cent of the global annual GDP). The simplifying assumption was made here that these representations of land degradation can be used as linear factors that reduce ecosystem function and consequently the dollar value of the ecosystem services provided that are not part of agricultural product markets. This approach produces an estimate of lost ecosystem services that result from land degradation of USD 6.3 trillion/yr (Haberl representation) and USD 15.2 trillion/yr (Imhoff representation). The spatial patterns of the Haberl representation are most characteristic of actual land degradation resulting from agriculture and forestry. However, the magnitude of this damage may be better represented by the Imhoff data for several reasons:

1) the Imhoff estimates are likely low because they do not include components of NPP lost due to land transformation;
2) the Imhoff measures are closer to other estimates of HANPP produced by Vitousek *et al.*, 1986[16] and Rojstaczer *et al.*, 2001[17];
3) neither approach captures aspects of land degradation associated with climate change (e.g. melting glaciers that might ultimately disappear and impact land productivity in their watershed), and;
4) other ongoing forms of land degradation are not being accounted for (e.g., the potential extinction of pollinating species that are another serious manifestation of land degradation).

How species extinction interacts with land degradation, which in turn interacts with biogeochemical cycles, are questions raised with respect to 'planetary boundaries'[27].

The earth is a beautiful, complex, and awe-inspiring chunk of natural (and other types of) capital that annually generates ecosystem services valued at more than twice the size of the world's global GDP. In 1997, authors estimated the value of these ecosystem services to be USD 33 trillion/yr[1]. This estimate of the global value of the world's ecosystem services was updated to a value of USD 145 trillion/yr in 2014[2] based on the assumption that the world's land surfaces and associated ecosystems were all functioning at 100 per cent, given the land cover distribution of the earth in 1997. Sadly, the world's land surfaces and associated ecosystems do not have the same distribution they had in 1997 (e.g., roughly half the world's coral reefs are gone) nor are all these ecosystems functioning at 100 per cent. Changes in land cover that have occurred in the last 15 years have resulted in a reduced estimate of the total value of the world's ecosystem services to USD 125 trillion/yr. This represents a loss of roughly USD 20 trillion annually due to land cover change alone. ESV has also been lost as a function of reduced or impaired ecological function. In this chapter, authors prepared a simplified representation of land degradation as a proxy measure of impaired or reduced ecological function to make an estimate of the reduced value

of ecosystem services caused by land degradation using a very simplified average benefits transfer approach. Resulting estimates based on two proxy measures of land degradation are USD 6.3 and 10.6 trillion annually. This suggests that the dollar value of ESV losses from land degradation is roughly 50 to 75 per cent of the dollar value of losses from land cover changes over the last 15 years. These measures of land degradation are mostly associated with changes to agricultural lands around the world. The lower estimate of lost ESV of USD 6.3 trillion/yr is more than five times larger than the entire value of agriculture in the market economy. The ecological economics of land degradation thus indicates that the economics of land degradation is about a lot more than agriculture, and supports the emphasis of the ELD Initiative on total economic valuation inclusive of all land and land-based ecosystem services.

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03 B: The future of ecosystem services: Global and national scenarios

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Introduction

Ecosystem services are a major contributor to sustainable human well-being. Between 1997 and 2011, it has been estimated that the global value of these services has decreased by USD 20 trillion/yr due to land use change[1]. In this chapter, three existing sets of global scenarios[2,3,4] are aggregated to develop and evaluate the future value of global ecosystem services under four alternative land-use scenarios (*Table 3b.1*). The scenarios are a synthesis of prior scenario studies, but are based around the four 'Great Transition Initiative' (GTI) archetypes[5], which provide a range of plausible futures that impact on land and water use and management. This chapter estimates the implications of these scenarios for the value of ecosystem services to 2050. The GTI scenarios are described in more detail later, but in summary are:

1. **Market Forces (MF):** an economic and population growth archetype based on neoliberal free market assumptions;
2. **Fortress World (FW):** an archetype in which nations and the world become fragmented, inequitable, and head towards temporary or permanent social collapse;
3. **Policy Reform (PR):** a continuing economic growth but with discipline/restraint/regulation archetype based on assumptions about the need for government intervention and effective policy, and;
4. **Great Transition (GT):** a transformation archetype based on assumptions about limits to conventional GDP growth and more focus on environmental and social well-being and sustainability.

The value of ecosystem services in these four scenarios were evaluated for the world as a whole and for selected countries and regions, including Kenya, France, Australia, China, United States, and Uruguay, plus a global table. Regional data is also analysed in *Chapter 4*. Results show that under the MF and FW scenarios the value of ecosystem services continues to decline, while in the PR scenario the value is maintained or slightly increased, and in the GT scenario the value is significantly restored.

Global value of ecosystem services

Ecosystems are the life support system of our planet[1,6,7]. However, over the past several decades, the services that they provide (see *Chapter 1*) have been significantly degraded. In 2011, the total value of global ecosystem services were estimated to be USD 125 trillion/yr. This value was estimated to be a decrease of USD 20.2 trillion/yr from 1997 due to land use and management changes[1,6] – a trend which is currently continuing. Interest in ecosystem services in both the research and policy communities is growing rapidly[8,9,10]. This chapter investigates alternative and plausible land-use scenarios which could either accelerate or reverse land degradation, and the resulting value of ecosystem services.

Scenario planning

Scenario analysis or scenario planning is defined as a 'structured process of exploring and evaluating alternative futures'. Scenarios combine influential and uncertain drivers that have low controllability into storylines of the future[11]. Ultimately, the goal of scenario planning is to illustrate the consequences of these drivers and policy options, reveal potential tipping points[12], and inform and improve decisions. Unlike forecasting, projections, and predictions, scenarios explore plausible rather than probable futures[13].

Scenario planning has become an important way to inform decision-making incorporating a whole-system perspective under uncertainty[14,15]. Scenarios have been used at all scales, from individual corporations to communities to global[4]. This chapter uses the highly developed GTI scenarios, and their implications for ecosystem services out to 2050 are estimated.

Methods

Global and national land use change scenarios

The Great Transition Initiative (GTI) scenarios have been worked out in some detail for both the global system and several regions.[i] Brief narrative descriptions of each scenario, extracted from the GTI website, are reproduced here.

Market Forces

The *Market Force* scenario is a story of a market-driven world in the 21st century in which demographic, economic, environmental and technological trends unfold without major surprise relative to unfolding trends. Continuity, globalisation, and convergence are key characteristics of world development – institutions gradually adjust without major ruptures, international economic integration proceeds apace, and the socioeconomic patterns of poor regions converge slowly toward the development model of the rich regions. Despite economic growth, extreme income disparity between rich and poor countries and between the rich and poor within countries remains a critical social trend. Environmental transformation and degradation are a progressively more significant factor in global affairs.

Policy Reform

The *Policy Reform* scenario envisions the emergence of strong political will for taking harmonised and rapid action to ensure a successful transition to a more equitable and environmentally resilient future. Rather than a projection into the future, the *PR* scenario is a normative scenario constructed as a backcast from the future. It is designed to achieve a set of future sustainability goals. The analytical task is to identify plausible development pathways for reaching that end-point. Thus, the *PR* scenario explores the requirements for simultaneously achieving social and environmental sustainability goals under high economic growth conditions similar to those of *Market Forces*.

Fortress World

The *Fortress World* scenario is a variant of a broader class of *Barbarization scenarios*, in the hierarchy of

[i] *www.greattransition.org/explore/scenarios*

the Global Scenario Group[16]. *Barbarization scenarios* envision the grim possibility that the social, economic, and moral underpinnings of civilisation deteriorate, as emerging problems overwhelm the coping capacity of both markets and policy reforms. The *FW* variant of the barbarization story features an authoritarian response to the threat of breakdown. Ensconced in protected enclaves, elites safeguard their privilege by controlling an impoverished majority and managing critical natural resources, while outside the fortress there is repression, environmental destruction, and misery.

Great Transition

The *Great Transition* scenario explores visionary solutions to the sustainability challenge, including new socio-economic arrangements and fundamental changes in values. This scenario depicts a transition to a society that preserves natural systems, provides high levels of welfare through material sufficiency and equitable distribution, and enjoys a strong sense of local solidarity.

Each of these scenarios has implications for land use and management. The interactive web tool, "Futures in Motion" on the GTI website was used to derive estimates of land use change, population, GDP, and other variables for these four future scenarios to the year 2050[ii] (*Table 3b.1*). The GTI scenarios did not, however, include changes in wetlands. These were estimated based on past trends in wetland loss seen between 1997 and 2011 for the MF and FW scenarios[1,6,7], a policy of 'no net loss' for the PR scenario, and an aspirational wetland restoration policy for the GT scenario. These changes are described in more detail later in the section on results.

Unit value change scenarios

The change in global value of ecosystem services in these scenarios was hypothesised to be due to two factors: 1) change in area covered by each ecosystem type; and 2) change in the "unit value" – the aggregate value of all the marketed and non-marketed ecosystem services per ha per year of each ecosystem type due to degradation or restoration (see *Table 3b.2*). These changes relate to how land or water are managed, on average. These effects were separated out by evaluating the scenarios in two ways: a) using the 2011 unit values estimated by Costanza *et al.,* 2014[1] and only changing land use; and b) changing both unit values and land use. Like all estimates at this scale, this is a simplification. But for the purposes of this exercise, authors believed it sufficient. Obviously, much more elaborate and sophisticated modelling and analysis can be done[17], but this is left for future studies.

The unit value changes were based on policy and management assumptions likely to occur in each scenario. For example, in the PR scenario, it was assumed that a slight improvement in policies around the environment and ecosystem services would allow maintenance of the 2011 unit values until 2050, while in FW, unit values would decrease by 20 per cent on average. These percent changes were based roughly on the estimates included in the Bateman *et al.,* 2013[3] study of six future scenarios for the UK. However, they are not intended to be empirically derived, but rather are plausible estimates of the magnitude of change that could occur under each hypothetical scenario. In general, the following was assumed for each of the four scenarios:

1. **Market Forces-Free Enterprise:** decrease in attention to environmental and non-market factors resulting in an average *10 per cent reduction in unit values* from their 2011 levels. This is also in a world where climate change has not been dealt with.
2. **Fortress World-Strong Individualism:** *significant* decrease in attention to environmental and non-market factors resulting in an average *20 per cent reduction in unit values* from their 2011 levels. This is also in a world where climate change has accelerated.
3. **Policy Reform-Coordinated Action:** slight improvement from 2011 policies and management leading to *no significant change in unit values* from their 2011 estimates. This is also in a world where climate change has been moderated.
4. **Great Transition-Community Well-Being:** *significant* increase in attention to environmental and non-market factors resulting in an average *20 per cent increase in unit values* from their 2011 levels. This is also in a world where climate change has been addressed.

[ii] *www.tellus.org/results/results_World.html*

Mapping

Creation of the spatial data layers for the four scenarios was done via a loose coupling with the scenario projection modelling. The modelling of each scenario generated a change in land cover for the following types: Urban, Wetland, Cropland, Forest, Grassland, and Desert. Authors started with a modified version of the GlobCov data product[1] which was used as the original base data. For each scenario, the landcover base was grown or shrunken based on the percentage changes of that landcover scenario projection. All growth and loss were adjacent to the existing original extent of that landcover. The order of precedence for these landcover changes was as follows: Urban, Wetland, Cropland, Forest, Rangeland/Grassland, and Desert. This precedence worked in such a way that all previous landcover transitions are excluded from subsequent conversion (e.g., cropland can not replace urban or wetlands). The results of these models can be presented as tables and as maps for any country or region in the world, and this chapter presents an example of Kenya.

Results and discussion

Global scenarios

Table 3b.2 shows the land area, unit values, and the total annual flow value for each of the biomes. It also shows the total annual ecosystem service flow value for each scenario. The black numbers show values that have remained the same in each scenario as compared to the 2011 values, numbers in red show a decrease, and green numbers show an increase. Using the land use changes for each biome derived from estimates by the Great Transition Initiative shown in *Table 3b.1*[2], the land area of forests (both tropical and temperate/boreal) and grass/rangelands decreased significantly in all scenarios except GT, as compared to 2011 areas. Wetlands (both tidal marshes/mangroves and swamps/floodplains) and ice/rock decreased in the MF and FW scenario, while increased or remained the same in PR and GT. Desert increased in all the scenarios except GT and tundra decreased in all scenarios. Cropland and urban both increased in unit areas in all four scenarios. On the marine

TABLE 3B.1

Future global land use areas and other variables for each of the four scenarios from the GTI website

ELD Scenarios	1997	2011	1. MF	2. FW	3. PR	4. GT
Great Transition Initiative (GTI)			Market Forces	Fortress World	Policy Reform	Great Transition
Costanza *et al.*, 2014			Free Enterprise	Strong Individualism	Coordinated Action	Community Well-Being
Bateman *et al.*, 2013			Focus on Market Growth	Maintain Current Practices	Green and Pleasant Land	Conservation Fully Implemented
Population (e9)	5.9	7	9.08	9.53	8.68	8.08
– Urban pop (e9)	2.75	3.5	6.25	6.57	5.99	5.57
– Rural pop (e9)	3.15	3.5	2.83	2.96	2.69	2.51
Inequality (Richest 10%/Poorest 10%)		16	29.4	53	14.9	7.1
Urban land (e6 ha)	332	350	554	675	490	397
Cropland (e6 ha)	1400	1672	1757	1782	1733	1676
Forest (e6 ha)	4855	4261	3450	3541	3989	4313
Grass/Rangeland (e6 ha)	3898	4418	3991	3696	4219	4483
Desert (e6 ha)	1925	2159	3396	3494	2427	1924

TABLE 3B.2

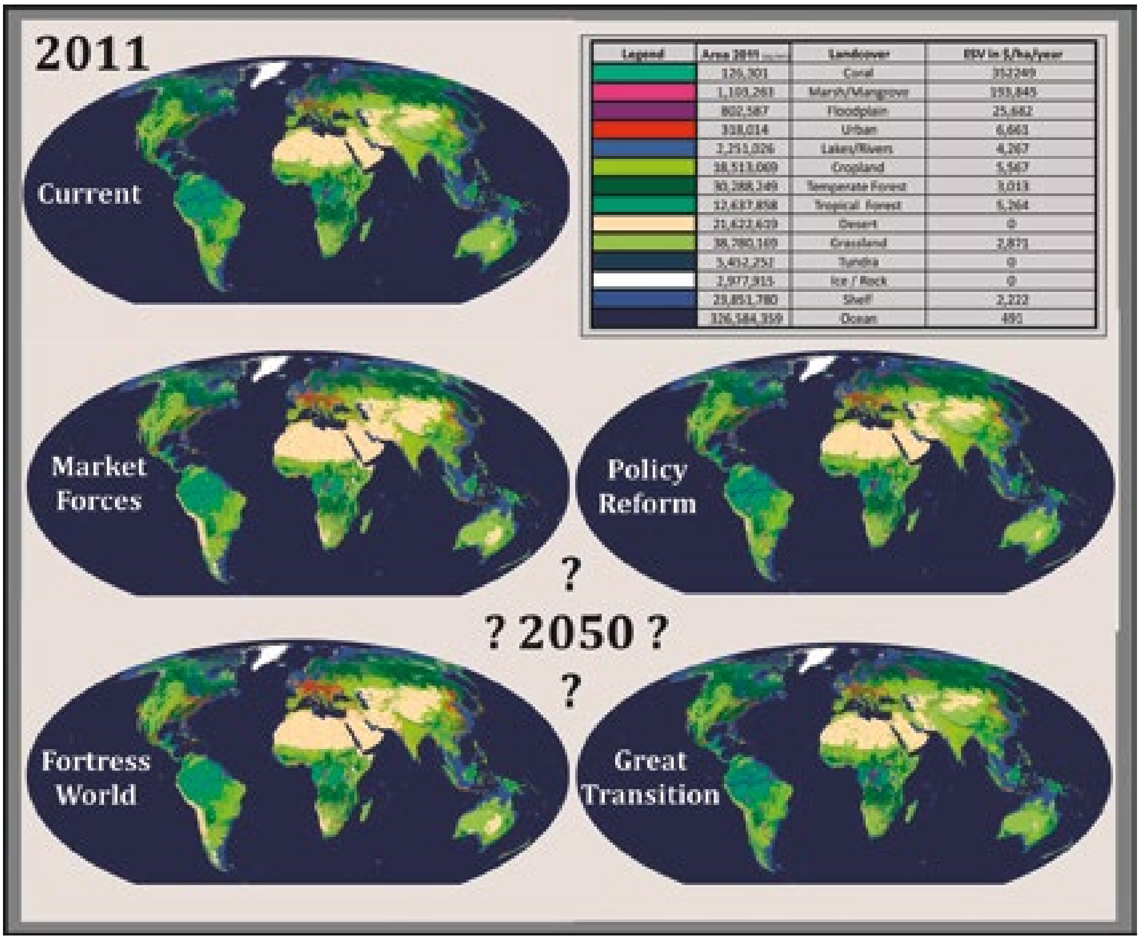
Changes in area, unit values, and aggregate global flow values from 1997 to 2011 and for four future scenarios to the year 2050

Biome	Area (e6 ha)						% Change	-0,1	-0,2	0	0,2	Total Annual Flow of Eco-Services Values (e12 2007$/yr)					
	(e6 ha)		Scenarios to 2050				Unit Values ($2007/ha/yr) ($/ha)	Scenarios to 2050				(e12 $/yr)		Scenarios to 2050			
	1997	2011	1. MF	2. FW	3. PR	4. GT	2011	1. MF	2. FW	3. PR	4. GT	1997	2011	1. MF	2. FW	3. PR	4. GT
Marine	**36.302**	**36.302**	**36.302**	**36.302**	**36.302**	**36.302**	**1.368**	**1.231**	**1.094**	**1.368**	**1.642**	**60,5**	**49,7**	**38,0**	**32,5**	**49,7**	**62,3**
Open Ocean	33.200	33.200	33.200	33.200	33.200	33.200	660	594	528	660	792	21,9	21,9	19,7	17,5	21,9	26,3
Coastal	3.102	3.102	3.102	3.102	3.102	3.102	8.944	8.050	7.155	8.944	10.733	38,6	27,7	18,3	15,0	27,7	36,0
Estuaries	180	180	180	180	180	180	28.916	26.024	23.133	28.916	34.699	5,2	5,2	4,7	4,2	5,2	6,2
Algae Beds/Seagrass	200	234	257	262	234	227	28.916	26.024	23.133	28.916	34.699	5,8	6,8	6,7	6,1	6,8	7,9
Coral Reefs	62	28	5	0	28	35	352.249	317.024	281.799	352.249	422.699	21,7	9,9	1,6	0,0	9,9	14,8
Shelf	2.660	2.660	2.660	2.660	2.660	2.660	2.222	2.000	1.777	2.222	2.666	5,9	5,9	5,3	4,7	5,9	7,1
Terrestrial	**15.323**	**15.323**	**15.323**	**15.323**	**15.323**	**15.323**	**4.901**	**4.411**	**3.921**	**4.901**	**5.881**	**84,5**	**75,1**	**50,4**	**40,7**	**78,3**	**101,7**
Forest	4.855	4.261	3.450	3.541	3.989	4.313	3.800	3.420	3.040	3.800	4.560	19,5	16,2	11,8	10,8	15,2	19,7
Tropical	1.900	1.258	1.019	1.045	1.178	1.273	5.382	4.844	4.306	5.382	6.458	10,2	6,8	4,9	4,5	6,3	8,2
Temperate/Boreal	2.955	3.003	2.432	2.495	2.812	3.039	3.137	2.823	2.510	3.137	3.764	9,3	9,4	6,9	6,3	8,8	11,4
Grass/Rangelands	3.898	4.418	3.991	3.696	4.219	4.483	4.166	3.749	3.333	4.166	4.999	16,2	18,4	15,0	12,3	17,6	22,4
Wetlands	330	188	75	35	225	290	140.174	126.157	112.139	140.174	168.209	36,2	26,4	9,3	4,1	30,2	42,2
Tidal Marsh/Mangroves	165	128	50	25	145	165	193.843	174.459	155.074	193.843	232.612	32,0	24,8	8,7	3,9	28,1	38,4
Swamps/Floodplains	165	60	25	10	80	125	25.681	23.113	20.545	25.681	30.817	4,2	1,5	0,6	0,2	2,1	3,9
Lakes/Rivers	200	200	200	200	200	200	12.512	11.261	10.010	12.512	15.014	2,5	2,5	2,3	2,0	2,5	3,0
Desert	1.925	2.159	3.396	3.494	2.427	1.924	0	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0
Tundra	743	433	300	300	400	400	0	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0
Ice/Rock	1.640	1.640	1.600	1.600	1.640	1.640	0	0	0	0	0	0,0	0,0	0,0	0,0	0,0	0,0
Cropland	1.400	1.672	1.757	1.782	1.733	1.676	5.567	5.010	4.454	5.567	6.680	7,8	9,3	8,8	7,9	9,6	11,2
Urban	332	352	554	675	490	397	6.661	5.995	5.329	6.661	7.993	2,2	2,3	3,3	3,6	3,3	3,2
Total	**51.625**	**51.625**	**51.625**	**51.625**	**51.625**	**51.625**						**145,0**	**124,8**	**88,4**	**73,2**	**128,0**	**164,0**

black values are values that have remained constant, **green** are values that have increased, **red** are values that have decreased from the 2011 values

FIGURE 3B.1

Global land cover 'Base Data', 'Scenario 1 – Market Forces', 'Scenario 2 – Fortress World', 'Scenario 3 – Policy Reform','Scenario 4 – Great Transition'



side, algae beds/seagrass increased in MF and FW, remained the same in PR, and decreased in GT. Coral reef extent decreased in MF and FW, remained the same in PR, and increased in GT. Even though marine systems are not 'land', their functioning is highly influenced by land-based activity, especially coastal systems like coral reefs. The unit values per biome were adjusted from 2011 values as described above. However, the results with unit values, unchanged from 2011 are also shown for comparison (*Figure 3b.3*). The general trends and conclusions are unchanged, only the magnitudes are different.

Putting the land areas and unit values together for each biome, the global total annual flow of ecosystem services values was estimated (*Figure 3b.2*). The total values in both MF and FW were all lower than in 2011, dropping to USD 88.4 and 73.2 trillion/yr respectively, from a 2011 value of USD 124.8 trillion/yr. The values in PR increased a small amount to USD 128 trillion/yr, mostly due to the fact that marine values did not change, forest and grassland/rangelands decreased, and wetlands, croplands, and urban increased. GT, on the other hand, increased to USD 164 trillion/yr.

Figure 3b.3 compares the difference between total annual ecosystem services value when the unit values are changed for each biome (based on the different priorities embodied in each of the scenarios) and when the values are left at those used in 2011. MF and FW decreased from 2011 values to USD 98.3 and 91.5 trillion/yr, respectively, and PR and GT increased to USD 128 and 136.7 trillion/yr, respectively. The overall pattern remains the

FIGURE 3B.2

Global total annual flow of ecosystem service values

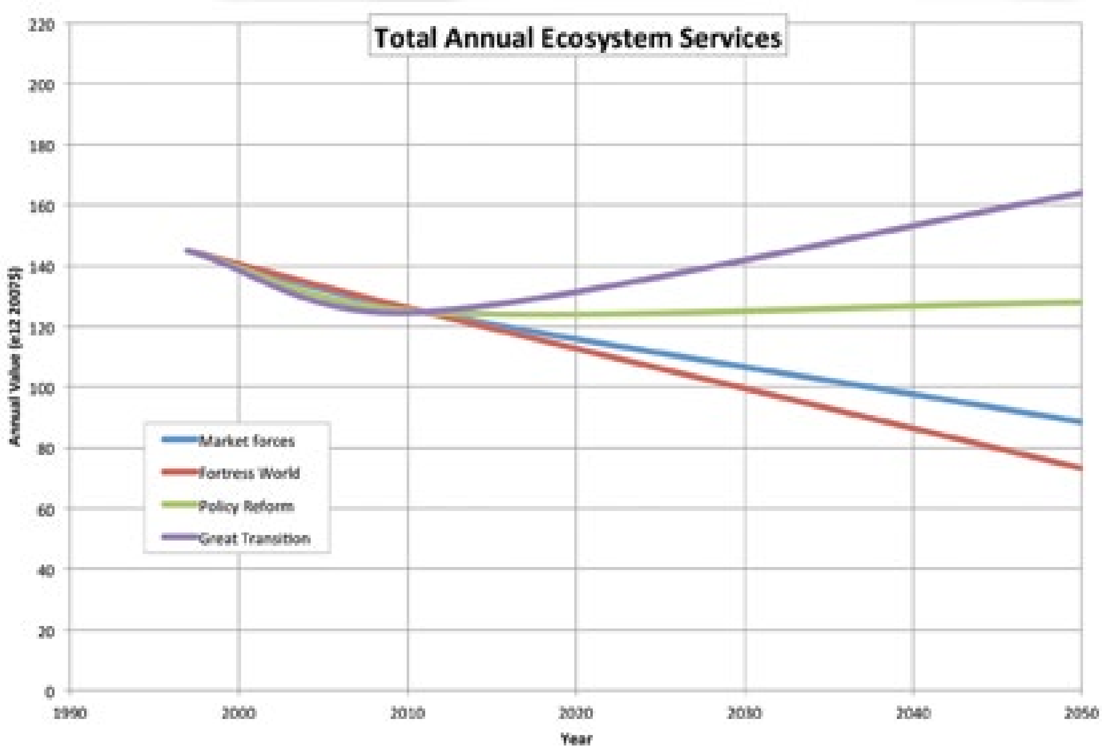


FIGURE 3B.3

Comparison of ecosystem service values

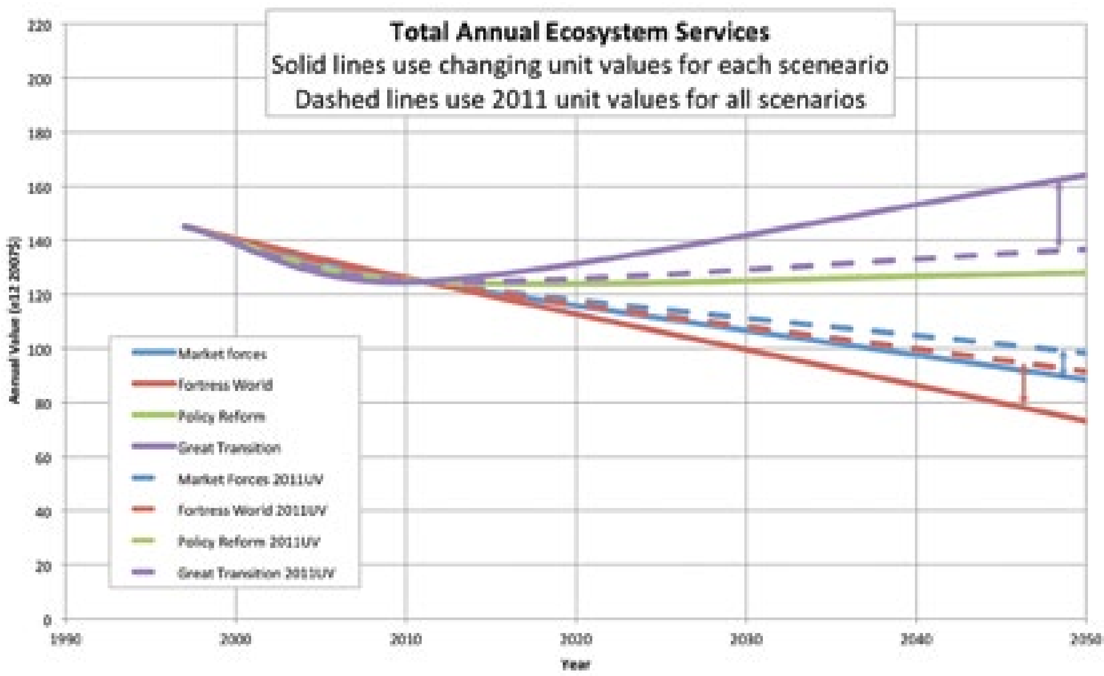
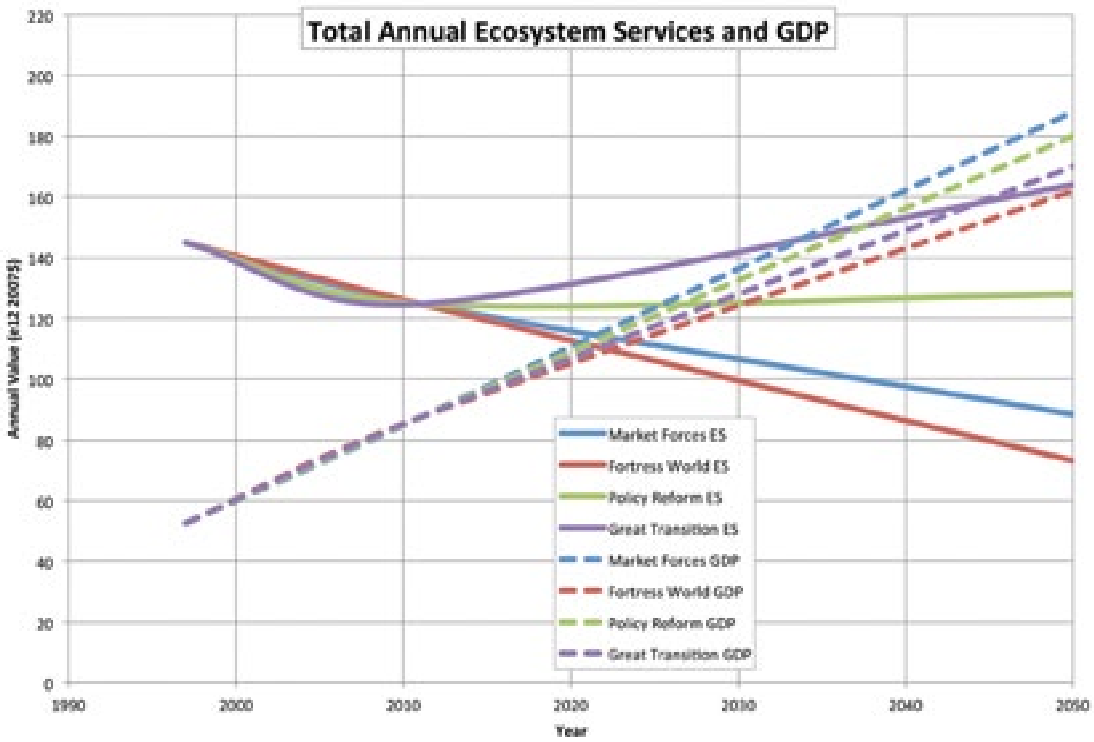


FIGURE 3B.4

The annual value of ecosystem services and GDP for each of the four scenarios



same, but the differences are reduced. This occurs because the changes in unit values amplify the existing changes in area cover of the biomes.

The GDP for each scenario (from the GTI website) is shown in *Figure 3b.4*. MF has the highest GDP as economic growth is the end goal of society in that scenario. PR follows closely behind as it fosters economic growth while simultaneously passing policies to preserve ecosystems and the services they provide. GT comes third because even without the focus on economic growth, the society and economy are healthy and prospering. FW is last since global society is deteriorating, with social, environmental, and economic problems reaching a point of collapse.

Regional scenarios

Using the global model created for the four scenarios, land area changes and impacts on ecosystem services values for any country or region can be looked at individually. The results include maps of land area for each biome, changes to those areas, and the value of ecosystem services for each of the four scenarios within that country or region. They also include a table showing estimations of land area for each biome within each country and the values of their ecosystem services, as done for the global scenarios (*Table 3b.2*). In this report, results for Kenya are shown as an example. However, maps and tables for Australia, China, France, United States, and Uruguay can be found at: *www.eld-initiative.org/index.php?id=122*.

Kenya has a terrestrial land area of 58.5 million ha, which in 2011 was made up of 15 million ha of forest (0.5 million ha tropical and 14 million ha temperate), 35 million ha of grass/rangelands, 0.1 million ha wetlands, 1.1 million ha desert, 6.5 million ha cropland, and 0.2 million ha urban lands. With the four different scenarios, the land use changes in Kenya resembled the pattern of overall global changes. Most of the biomes in MF and FW decreased, except for desert, cropland, and urban. PR saw a similar pattern to MF and FW, except that in this scenario, the area of wetlands increased. In GT, all the biomes increased in area except for desert. The GT scenario involves reversing desertification and investment in restoring other ecosystems (*Table 3b.3*).

TABLE 3B.3

Four transition scenarios and ecosystem service values and flows to 2050, by biome

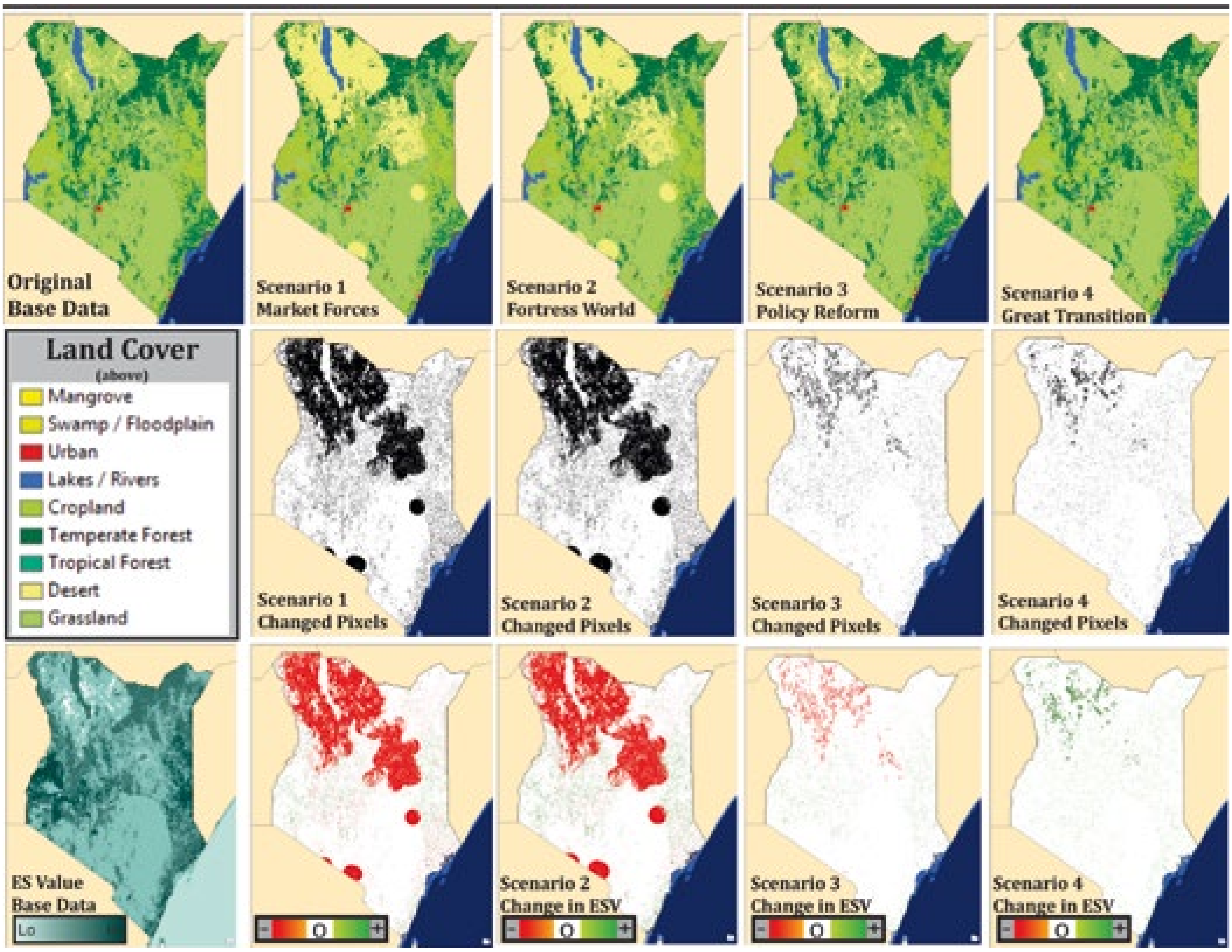
Biome	Area (e6 ha)					% Change	-0,1	-0,2	0	0,2	Total Annual Flow of Eco-Services Values (e12 2007$/yr)				
						Unit Values ($2007/ha/yr)									
	(e6 ha)	Scenarios to 2050				($/ha)	Scenarios to 2050				(e12 $/yr)	Scenarios to 2050			
	2011	1. MF	2. FW	3. PR	4. GT	2011	1. MF	2. FW	3. PR	4. GT	2011	1. MF	2. FW	3. PR	4. GT
Terrestrial	**58,554**	**58,554**	**58,554**	**58,554**	**58,554**	**4,901**	**4,411**	**3,921**	**4,901**	**5,881**	**251.35**	**179.29**	**156.48**	**247.14**	**307.39**
Forest	14,889	11,460	12,263	14,267	15,660	3,800	3,420	3,040	3,800	4,560	47.98	33.18	31.58	45.97	60.48
Tropical	569	410	447	542	567	5,382	4,844	4,306	5,382	6,458	3.06	1.98	1.93	2.92	3.66
Temperate/Boreal	14,320	11,050	11,816	13,725	15,093	3,137	2,823	2,510	3,137	3,764	44.92	31.20	29.65	43.06	56.82
Grass/Rangelands	34,622	24,838	22,899	33,238	34,662	4,166	3,749	3,333	4,166	4,999	144.23	93.13	76.32	138.47	173.28
Wetlands	85.5	12.9	0.1	105.0	146.4	140,174	126,157	112,139	140,174	168,209	6.64	0.81	0.02	6.98	9.80
Tidal Marsh/Mangroves	26.4	3.4	0.1	25.5	26.2	193,843	174,459	155,074	193,843	232,612	5.12	0.59	0.02	4.94	6.09
Swamps/Floodplains	59	10	-	80	120	25,681	23,113	20,545	25,681	30,817	1.52	0.22	0.00	2.04	3.70
Lakes/Rivers	1,206	1,206	1,206	1,206	1,206	12,512	11,261	10,010	12,512	15,014	15.08	13.58	12.07	15.08	18.10
Desert	1,070	13,402	14,073	2,496	79.8	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Tundra	-	-	-	-	-	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Ice/Rock	-	-	-	-	-	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Cropland	6,493	7,298	7,691	6,954	6,576	5,567	5,010	4,454	5,567	6,680	36.15	36.56	34.25	38.71	43.93
Urban	190	339	423	288	225	6,661	5,995	5,329	6,661	7,993	1.26	2.03	2.25	1.92	1.80
Total											**251.35**	**179.29**	**156.48**	**247.14**	**164,0**

The total ecosystem service values for the MF and FW scenarios decrease significantly compared to the 2011 values. FW sees the greatest decrease (of about USD 100 billion), followed closely by MF (USD 70 billion). PR decreases only by about USD 4 billion from the 2011 value, while GT increased by about USD 55 billion (*Table 3b.3*). For comparison, the GDP of Kenya in 2011 was around USD 94 billion.

Figure 3b.4 shows maps of the biome land use changes for each of the four scenarios compared to the 2011 base map. It also shows which pixels changed between the 2011 base map and that scenario. Scenarios MF and FW showed the greatest changes, while PR and GT the least.

FIGURE 3B.5

Maps of biome land use changes for four scenarios in Kenya, compared to 2011



Top row: Maps of the area change of each biome in Kenya for the base map and the four scenarios

Middle row: Maps of the pixels changed between the base map of 2011 and each of the four scenarios. In the MF and FW maps, there are multiple symmetric circular desert areas. These occur because a single desert pixel in the original base map grew symmetrically outwards from all edges of desert

Bottom row: Maps of the change in the value of ecosystem services between the base map of 2011 and each of the four scenario

The large differences in the total annual ecosystem services values between each of the four scenarios shows the kind of impact that land-use decisions can have going forward. A difference of USD 75.6 trillion/yr globally in the value of ecosystem services between the FW and GT can mean life or death for many people, especially those in developing countries[18]. The GT scenario is an ecosystem services restoration scenario. It can reverse the current trends in land degradation and allow for a sustainable and desirable future, and can also address climate change while restoring other critical services, especially those that are important to the poor.

Scenarios are not predictions – they only point out the range of plausible future conditions. They can help policy-/decision-makers deal with uncertainty and design policies to improve the chances of better futures occurring. They can also be used to engage the larger public in thinking about the kind of future they really want. Scenarios can be used as the basis for public opinion surveys to gauge preferences for different futures at the global, regional, national, and local scales[4].

Future work can extend these initial analyses by using landscape scale computer simulation models to help create and evaluate scenarios for ecosystem restoration for comparison with business-as-usual[17]. These approaches hold significant promise for reversing land degradation and building a sustainable and desirable future towards sustainable land management, using comprehensive ecological-economic arguments as an aid for better decision-making.

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04 Regional-level economic valuation of land degradation

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Why are regional-level studies on the economic impacts of land degradation needed?

Most studies on land degradation focus on the global, sub-national, or the local level. However, drivers and impacts of degradation also operate at the regional level – here referred to as the intermediate, macro-geographical level transcending national boundaries[i]. Dust from soil erosion occurring across the Sahara can be carried to the Nile Delta, Mediterranean Sea, and even to Central and South America where it influences air quality and affects cloud development and precipitation patterns[1,2]. In another example, upstream infrastructure developments in one country, such as the construction of dams for hydropower, may seriously affect the livelihoods of downstream dwellers in adjacent countries due to a reduction of water for consumption or increased sedimentation of arable land[3,4]. Alternatively, the contamination of water in wetland ecosystems due to uncontrolled mining endeavors can cause land degradation across the whole ecosystem, thereby affecting several countries[5]. Land degradation driven by unsustainable land use, biophysical constraints or population pressure can also lead to transboundary migration, and eventually create regional conflicts[6,7]. Thus, to establish the full picture of land degradation and economic benefits of sustainable land management, a greater understanding of degradation drivers and impacts at the regional level is needed.

Regional-level economic values of land degradation

Though the need to halt and ideally reverse land degradation across spatial scales is increasingly being understood, policy action driven by economic understanding is constrained by limited information about the economic and financial values of land and land-based ecosystems, its benefits to economic development and societal

[i] *www.unstats.un.org/unsd/methods/m49/m49regin.htm*

wellbeing, and the costs of land degradation[3,8]. To provide for necessary information, the techniques of economic analysis, and in particular cost-benefit analyses are especially well suited[9,10] (see C*hapter 2*).

While still few in number, some regional-level economic analyses of land degradation do exist, and thereby follow different approaches. Relevant valuation studies often focus on either the drivers of degradation, or ways to halt or reverse degradation[11]. The Overseas Development Group[12] recommends the classification of studies on land degradation by: (i) impact on global systems such as the climate; (ii) impact on ecosystem services; (iii) land-related processes such as deforestation or soil erosion; (iv) land-use systems such as agriculture or pastoralism, and; (v) land management-related drivers such as overgrazing or over-intensive cropping. In this section, the ODG classification is used to present a selection of economic valuation studies on land degradation with a regional focus.

Impact on the climate system

In dryland areas with low precipitation, low soil fertility, and high evapotranspiration[13], land management practices are being explored which foster carbon sequestration and increase crop yields at the same time. Carbon sequestration has gained increasing attention in the past years, and is considered an important strategy in mitigating climate change and interlinked combatting land degradation (see *Chapter 1*; Harvey *et al.*, 2014[14]). Agro-forestry systems are particularly promising for sequestering carbon[15,16]. For instance, an ELD Initiative case study[67] analysed the carbon sequestration potential of large-scale sustainable land management scenarios involving agroforestry and reforestation in Mali. Climatic and anthropogenic pressures had resulted in the decline of both forest resources and soil fertility in a Kelka forest. The study authors analyzed the potential of different agroforestry and reforestation measures, and determined associated future costs and benefits. Using different discount rates (2.5, 5, and 10 per cent), and productivity change, avoided cost, replacement cost, and market based valuation methods, they found that over a 25 year time horizon, the benefits of the restoration scenario were continuously higher than the costs of implementing them. Benefits ranged from USD 5.2 to 6 per dollar invested. This included measuring the indirect use of value of carbon sequestration. While the carbon would be sequestered locally, the benefits are enjoyed at regional and global levels. Local populaces with less access to capital to implement sustainable land management scenarios may thus rely on mechanisms implemented at regional and global scales that incentivise projects with important carbon sequestration potential[67]. This is also a key point for regional consideration as these types of catchments and ecosystems, as well as climactic impacts, often exist through and across political boundaries. In another study, assessing the economic viability of agroforestry for both carbon sequestration and the prevention against salinisation in two Australian areas with low to medium rainfall, Flugge & Abadi (2006)[17] found that growing trees for carbon at expected market prices (USD 15/tonCO_2-e) was not an option. Based on a bio-economic optimisation model of farming systems, the authors showed that while increased precipitation fostered sequestration rates, the carbon price would have to be about USD 45/tCO_2-e in the medium-rainfall area, and as high as USD 66/tCO_2-e in the low-rainfall area to be competitive with existing land use practices. These examples demonstrate that sustainable land management can be aligned with existing or newly developing carbon market schemes in principle. However, sustainable land management scenarios need to be designed carefully with respect to regional needs and particularities, and require synergistic trans-boundary approaches to assessing the economics of land degradation and climactic issues simultaneously. More information on climate change and land degradation is available in *Chapter 1*.

Impact on ecosystem services

As *Chapter 3* demonstrated for national and global levels, a particularly useful way of applying regional-scale economic valuation is to analyse the effects of land degradation and restoration on the provision of ecosystem services, with carbon storage and sequestration being one prominent example (see above). The analysis of ecosystem service values (ESV) and trade-offs allows for an objective assessment of potential scenarios for land management, restoration, and protection, which can serve as the basis for dialogue and knowledge exchange across national boundaries.

Applying a cost-benefit analysis to four dryland forest areas stretching across regions in Latin America, Birch *et al.*, 2010[18] evaluated the potential impact of ecological restoration on both the value and provision of multiple ecosystem services. The authors compared the value of a set of ecosystem services under three different restoration scenarios versus 'business as usual', supported by a spatially explicit model of forest dynamics. Results showed that passive restoration (i.e., natural regeneration) was cost-effective for all study areas, whereas active restoration was outweighed by comparably high opportunity costs. Since ESV varied substantially between study areas, the authors stressed the importance of consider the context surrounding ecosystem service provision, as well as the limitations of a benefit transfer[ii] approach to ecosystem service valuation, which can further be useful in determining how to manage land resources across countries that share ecosystems. Schuyt (2005)[3] highlighted the economic consequences of wetland degradation, as well as the importance of these ecosystems for local communities by analyzing different sub-Saharan African wetlands. These wetlands were not only an important source of water and nutrients necessary for biological productivity, but provided a vast array of goods and services with economic value that were crucial for local livelihoods. This included provisioning services such as wood or fish, and cultural values such as scenic beauty for tourism. However, Africa's wetlands were rapidly degrading due to demographic growth and increased demand for resources, but also due to the failure of policy interventions to account for the needs of the multiple stakeholders and claims on the wetlands' water and lands. The economic value of wetlands for local communities should thus be weighed against other wetland uses such as the diversion of water for the purpose of agriculture. Land managers with the capacity to consider regional effects of their projects (e.g., mining, dams) should take into account potentially negative trans-national effects when developing strategies to implement sustainable land management

Impacts of land-related processes

While *Chapter 3* presented novel values of ecosystem service value losses across a number of land uses and scenarios, arguably most studies about land degradation focus on soil erosion, and concomitantly, the depletion or loss of soil nutrients[19,20,66]. On a global scale, the annual loss of 75 billion tons of soil from arable land has been estimated to cost the world about USD 400 billion per year, with the USA alone expected to lose USD 44 billion annually from soil erosion[22]. Biggelaar *et al.*, 2003[23] evaluated the global impact of soil erosion on productivity in terms of crop yields by analysing a dataset of 179 plot-level studies from 37 countries. The authors found that yield declines were two to six times higher in Africa, Asia, Australia, and Latin America, when compared to Europe and North America. Regionally, however, estimates of the economic costs of soil erosion-induced land degradation are limited. Available estimates date back to the 1990's[24,25,26], which, given the on-going spread of land degradation can be considered outdated. On that account, the ELD Initiative commissioned a new estimation of regional-scale costs and benefits of soil erosion on arable land in Africa, which is presented in *Case Study 4.1*.

Impacts of land-use systems

While land degradation is usually the consequence of interacting biophysical and human drivers, overgrazing by livestock is often mentioned as one of the main anthropogenic drivers. As a consequence, pastoralism and transhumance are usually considered as ecologically unsustainable and economically irrational[32]. While this assumption has been largely refuted[33,34], measures to combat land degradation still center on agricultural development, often at the expense of pastoralists[35]. One of the main reasons for the focus on agriculture is a poor understanding of pastoral systems in general, and the economic benefits of pastoralism in particular[32,37]. A policy brief by the IUCN (2006)[37] about the economic importance of drylands in the IGAD[iii] region showed that pastoralism provided a wide range of environmental goods and services not only to consumers within the region, but also on larger scales. Beside the provision of milk, skin, and meat by livestock, pastoralism also contributed to the regulation of carbon levels, nutrients, water, and biodiversity. The average asset value of the goods and services derived annually from dryland ecosystems is estimated to range between 1,500–4,500 USD/ha within each IGAD country. Further, assessing the direct and indirect values

[ii] *Procedure of estimating the value of an ecosystem service in one location by assigning an existing valuation estimate of a similar ecosystem service elsewhere.*

[iii] *Intergovernmental Authority on Development in Eastern Africa, comprising Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda*

CASE STUDY 4.1

Regional estimates on soil erosion for Africa, based on econometric modeling and cost-benefit analysis

(Tilahun et al., (2015, in print): The economics of land degradation: Benefits of action outweigh the costs of action)[50]

Soil nutrient loss on arable land in Africa has been considered highly detrimental to agricultural ecosystems in general, and to cereal production in particular. Given that cereals provide for about 50 per cent of daily calories supply per capita (FAOSTAT) soil nutrient loss on African croplands provides a serious impediment for rural livelihoods and food security[27,28]. However, much of the literature lacks empirical underpinnings on a continental scale which account for the economic costs of inaction against soil nutrient loss (as measured by nitrogen, phosphorous, and potassium) on a continental scale and conversely, the costs and benefits of taking action against further nutrient loss.

To this end, this study undertaken for the ELD Initiative provides a cost-benefit analysis on erosion induced soil nutrient depletion on croplands across 42 African countries. By aligning continental-level, empirically grounded data of a cropland area of 105 million hectares (accounting for 45 per cent of total arable land in Africa) with economic valuation extrapolated over a time span of 15 years (2016–2030), the study seeks to provide a basis for future, informed decision-making for the African region.

Assumptions and Caveats

1. Soil erosion influences the society through its on-site and off-site impacts. The authors considered only on-site impacts;
2. One of the on-site impacts is a reduced flow of various ecosystem services. Since relevant data across all 54 African countries were not available, authors focused on nutrient loss across 42 countries;
3. The loss of nutrients has been defined as the loss in N, P and K, and was assumed to directly cause changes in cereal productivity;
4. Macroeconomic data used in the analysis do not account for spatial variability within a country, and;
5. In conclusion, this estimate is very conservative and would fall in the lower bound.

Methodological approach: Regional-level estimates and cost-benefit analysis

(1) Relationship between nutrient balance and crop productivity

Based on a review of secondary data about the causes of land degradation, as well as on empirical findings of nutrient budgeting in Africa, an econometric model of soil nutrient loss was developed. The model integrated national-level biophysical data (e.g., soil erosion in ton/ha; forest cover in per cent of total land area) as well as national-level economic data (e.g., poverty gap in per cent of the population with an income below the poverty line of 1.25 purchasing power parity (PPP) USD/day). The modeling approach assumed that variations in nutrient depletion rates across the analysed 42 African countries could be explained by variations in biophysical and economic factors.

To estimate crop yield loss, the relationship between soil nutrient balance (*difference between soil nutrient inflows (e.g., fertiliser) and outflows (e.g., crop products)*) and crop production was modeled based on a yield or production function. It was assumed that the variation in cereal crop yields across the study countries could be explained by variations in total nutrient balances in croplands and factor input uses between countries. The results of the two models allowed for the calculation of average crop yield loss per unit of soil nutrient loss for each country (crop seasons 2010–2012). Macroeconomic data were retrieved from FAOSTAT and World Bank databases. 12 different types were considered based on FAOSTAT. Data about the balances of nitrogen, phosphorous, and potassium were derived from Henao & Baanante (1999, 2006)[29,30].

(2) Costs of inaction vs. costs of action

After analysing the effect of soil nutrient loss on crop yields across 42 African countries (see above),

CASE STUDY 4.1

the costs of inaction (i.e., maximum potential benefit of taking action) against soil nutrient loss were estimated in terms the economic value of crop loss due to soil erosion-induced nutrient depletion. The annualised value of crop loss (years 2010–2012) was derived at by multiplying the marginal physical product of soil nutrients by the average market price of a disaggregated set of 12 crop types. Costs of action (in terms of sustainable land management technologies) were estimated following a value transfer approach[31]. Benefits of action depend on the level of efficiency of the type of intervention, and can thus be considered a fraction of the costs of inaction.

(3) Cost benefit analysis

To evaluate the economic profitability of taking action against soil nutrient losses, the net present value (NPV) was taken as a main decision criterion. The NPV is based on assumptions about the discounting period, flows of costs and benefits over this period, and the discount rate. In this study, the NPV was calculated in terms of action against soil nutrient loss over a discounting period of 15 years, based on a real interest rate averaged across the 42 analysed countries. It was assumed that each country would have established erosion controlling sustainable land management structures by the end of the first five years, and that these would be 75 per cent efficient in reducing soil erosion.

Results

The depletion of soil nutrients as supporting ecosystem service will cost the 42 analysed countries about 280 million ton of cereals per year. In present value terms, this cost of inaction *is about USD 4.6 trillion PPP over the next 15 years, which is USD 286 billion PPP (USD 127 billion) per year or 12.3 per cent of the average GDP* for 2010–2012 of all the countries in the study.

The present value of costs for establishing and maintaining sustainable land management structures for controlling soil nutrient loss across the countries' croplands as cost of action was estimated at about USD 344 billion PPP with an annuity value of about USD 9.4 billion.

For the 42 countries, the benefits of action *are about USD 2.83 trillion PPP* for the next 15 years, or USD 71.8 billion/yr. Thus, taking action against soil erosion induced nutrient loss from the 105 million hectares of croplands in the 42 countries over the next 15 years will be worth about USD *2.48 trillion PPP or USD 62.4 billion/yr in NPV.*

By taking action against soil erosion induced nutrient depletion in cereal croplands over the next 15 years, the total economy of the 42 countries could grow at an average rate of 5.31 per cent annually compared to 2010–2012 levels. Considering that the annuity value of cost of inaction is 12.3 per cent of the average annual GDP of these 42 countries over the same period, the cumulative cost of inaction, i.e., the maximum benefits of action, is far greater than the cumulative cost of action.

of pastoralism in six countries globally, Rodriguez (2008)[38] concluded that pastoralism contributed substantially to their GDP, ranging from 9 per cent in Ethiopia to as much as 20 per cent in Kyrgyzstan. The ELD Initiative supported a study on the large-scale restoration of rangeland in Jordan by using the Hima system – a system of resource tenure historically practiced across the Arabian Peninsula (see *Chapter 1*). The study found that the benefits of sustainable land management practices as derived from the Hima system outweighed their management and implementation costs[39]. The analyses indicate that pastoralism and traditional livestock management systems are viable economic systems, and can generate a greater flow of ecosystem benefits and economic returns from marginal lands than other land uses such as agriculture.

Management-related drivers of degradation

Land degradation often occurs from unsustainable agricultural practices, which frequently go hand in hand with population pressure and/or the sealing of land by urban and infrastructural development[7]. This set of pressures on land is particularly problematic in the Mediterranean region[iv], which encompasses 22 countries surrounding the Mediterranean Sea[6]. About 31 per

iv *Middle East and Northern Africa (MENA) as well as Southern Europe.*

cent of the region's population is said to suffer from severe land degradation and desertification[40], causing economic costs at a range between EUR 2.7 and 5.1 billion/yr for Egypt alone (3.2 – 6.4 per cent of its GDP), and about EUR 1.5 billion/yr (~3.6 per cent of GDP) for Algeria[41]. With the Mediterranean population likely to more than double by 2020 from 1961, about 7 per cent of the region's agricultural land may be lost, leading to an agricultural amount as little as 0.21 hectare per capita in 2020[6]. To foster food security in the region, sustainable land management will need to be adopted, and more diversified, value-added income sources created[6]. One particular form of unsustainable agriculture is irrigation without drainage management in arid and semi-arid regions, since it can lead to the salinisation of land. Based on a benefit transfer method, Qadir *et al.*, 2014[4] estimated the costs of salt-induced land degradation in irrigated areas at USD 27.3 billion annually due to lost crop production. The authors summarised several cost-benefit analyses for sustainable management alternatives with regard to salt-affected lands, and concluded that the costs of 'no action' on salt-affected lands may result in 15 to 69 per cent losses depending, among others, on the crop grown, the intensity of land degradation, and on-farm soil and water management.

Benefits and weaknesses of regional-scale economic valuation

Benefits of regional-scale economic analyses

The above examples suggest that there are a range of benefits of regional-scale economic valuations. Making the value of ecosystem services and goods, as well as the dangers surrounding their economic (and socio-cultural) loss more explicit is likely to foster the mainstreaming of global problems such as land degradation into regional and national development planning[12]. Due to cost-benefit analyses and total economic valuations of ecosystem services provided by dryland regions and land use systems such as pastoralism, the economic importance of land management practices beyond agriculture can be highlighted. This can help decision-makers and international development agencies to weigh alternative land management options[42,43], in particular for marginal lands, and eventually to consider a policy shift in favor of multiple resource user groups[38,44].

The economic valuation of land degradation is thus a helpful approach to make ecosystem service research operational[18], to target research more specifically to the needs of policy makers[45], and ultimately to improve the implementation of multilateral environmental agreements such as the UNCCD[46]. Based on the same data source in *Chapter 3a/3b* and found in *Appendix 3*, a summary of regional ecosystem service value losses can be found in *Table 4.1.*

Weaknesses with regional-level estimates

Availability and reliability of data

Despite their undoubted benefits, economic valuations across spatial levels are prone to various problems. Since definitions of land degradation or desertification vary, analysts are confronted with a lack of reliable, accurate, and readily available data as well as estimations about the scope and severity of the problem[43,47]. Besides, available data are often fragmented across different disciplines[48]. Particularly problematic for regional-level valuations is the fact that national-level data about land usage or land cover types are rarely disaggregated to allow for calculations of particular yield estimates, pastoral-specific figures, or management interventions such as fertiliser use[38,49,50]. Finally, the currently fractured knowledge database is often combined with procedural and structural barriers that hamper the exchange of information across spatial scales[51,52].

Spatial variation

While regional-level estimates of the costs and benefits of land degradation are helpful to raise awareness of the problem among policy makers, they are less suited to derive recommendations for specific policy action at the sub-national level unless they are spatially explicit. An ELD Initiative study performed in Ethiopia found high spatial variation in the distribution of benefits, and thus the optimal scenarios for implementing cost-effective sustainable land management practices[53]. This finding was mirrored in the study of Birch *et al.*, 2010[18] on dryland forest regeneration. The study revealed substantial spatial variation in ecosystem service values across the analysed sites, which, if not accounted for, might lead to overly narrow management

TABLE 4.1

Regional ecosystem service value losses from land degradation
(based on the Haberl and Imhoff models (see Chapter 3), and the data found in Appendix 3 and 4)

Region	Model	per person	per sq km
Africa	Haberl model	1,164	43,826
	Imhoff model	1,517	57,092
Eastern Africa	Haberl model	928	51,996
	Imhoff model	1,553	87,015
Middle Africa	Haberl model	1,455	31,658
	Imhoff model	1,393	30,319
Northern Africa	Haberl model	1,074	28,323
	Imhoff model	935	24,640
Southern Africa	Haberl model	2,208	50,830
	Imhoff model	1,240	28,554
Western Africa	Haberl model	1,160	66,516
	Imhoff model	1,945	111,551

Region	Model	per person	per sq km
Americas	Haberl model	1,686	39,634
	Imhoff model	2,126	49,981
Caribbean	Haberl model	863	165,422
	Imhoff model	1,200	229,948
Central America	Haberl model	854	57,883
	Imhoff model	1,067	72,308
South America	Haberl model	2,198	51,438
	Imhoff model	1,891	44,256
Northern America	Haberl model	1,581	26,428
	Imhoff model	3,007	50,267
Latin America and the Caribbean**	Haberl model	1,746	53,462
	Imhoff model	1,622	49,682

Region	Model	per person	per sq km
Asia	Haberl model	908	124,191
	Imhoff model	1,641	224,434
Central Asia	Haberl model	1,847	29,888
	Imhoff model	3,734	60,424
Eastern Asia	Haberl model	155	21,208
	Imhoff model	992	135,481
South-eastern Asia	Haberl model	836	118,738
	Imhoff model	1,203	170,746
Southern Asia	Haberl model	248	65,490
	Imhoff model	998	263,406
Western Asia	Haberl model	10,213	561,088
	Imhoff model	10,775	592,016

Region	Model	per person	per sq km
Europe	Haberl model	2,211	72,206
	Imhoff model	2,570	83,934
Eastern Europe	Haberl model	4,500	71,050
	Imhoff model	3,085	48,719
Northern Europe	Haberl model	1,763	102,393
	Imhoff model	5,305	308,156
Southern Europe	Haberl model	766	90,862
	Imhoff model	1,356	160,916
Western Europe	Haberl model	120	21,087
	Imhoff model	1,306	229,989

Region	Model	per person	per sq km
Oceania	Haberl model	6,616	29,623
	Imhoff model	3,740	16,746
Australia and New Zealand	Haberl model	8,087	28,899
	Imhoff model	3,312	11,835
Melanesia	Haberl model	2,232	39,881
	Imhoff model	4,847	86,620
Micronesia	Haberl model	2,227	851,024
	Imhoff model	13,972	5,340,272

Region	Model	per person	per sq km
World	Haberl model	867	46,365
	Imhoff model	1,438	76,910

Haberl model (yellow rows)
Imhoff model (orange rows)

*** summation of Central America, South America, and Caribbean*

TABLE 4.2

Percentage change in the value of land from land degradation
(based on the Haberl and Imhoff models, data found in Appendix 3)

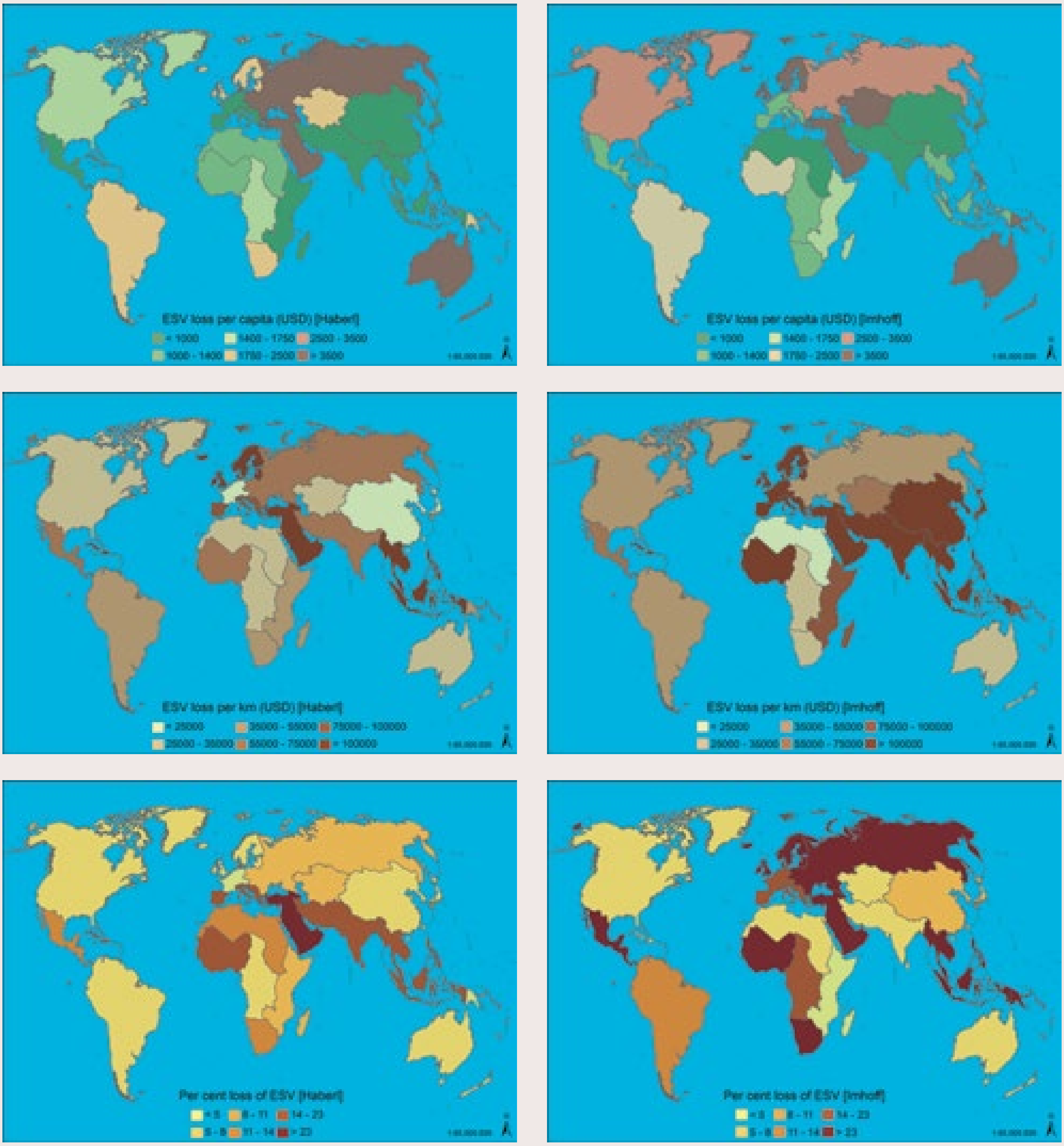
	Haberl model	Imhoff model
World	9.13	15.14
Africa	11.55	15.04
Eastern Africa	11.37	19.02
Middle Africa	5.84	5.59
Northern Africa	14.33	12.46
Southern Africa	11.70	6.57
Western Africa	19.29	32.35
Americas	6.95	8.77
Caribbean	23.18	32.22
Central America	12.30	15.36
South America	6.53	5.62
Northern America	6.62	12.58
Latin America**	7.14	6.64
Asia	28.38	51.28
Central Asia	9.81	19.83
Eastern Asia	6.64	42.42
South-eastern Asia	16.72	24.04
Southern Asia	16.86	67.82
Western Asia	83.96	88.59
Europe	8.93	10.38
Eastern Europe	8.75	6.00
Northern Europe	8.18	24.63
Southern Europe	20.08	35.56
Western Europe	4.44	48.42
Oceania	6.53	3.69
Australia and New Zealand	6.75	2.77
Melanesia	4.74	10.31
Micronesia	13.57	85.17

*** summation of Central America. South America. and Caribbean*

FIGURE 4.1

Regional maps of ecosystem service value losses per capita and per km^2, and land value changes

Haberl model **Imhoff model**



The first four maps are ecosystem service value losses (ESV) in USD for the Haberl and Imhoff models per capita (first row) and square kilometre (second row), and the last two maps are percentage losses in land value as a result of degradation by both models. Data is found in Chapter 3a and 3b, and Appendix 3 and 4. As explained in Chapter 3, the Haberl model essentially shows where land degradation is actually occuring, and the Imhoff model shows where consumption of degradation-causing products occurs.

actions. Spatially explicit (cost-benefit) analyses, in turn, would allow management interventions to be targeted more effectively since areas with the greatest potential benefits per unit cost could be identified[18]. Similarly, Bai *et al.*, 2008[42] found that global and transnational data needed validation on the ground because by relying on national statistics or spatial data alone, researchers would risk to substantially over- or under-estimate a given problem.

Different approaches and perceptions

Another problem related to regional-level economic valuations is the multiplicity of valuation tools currently applied, which hampers the comparability of results across spatial scales and studies. Moreover, ecosystem values largely depend on the perception as valuable to society[54], which however is composed of different stakeholder groups with varying individual perceptions, constraints and interests[12,55]. Economic valuations that rely on marketable ecosystem services alone and do not account for potential differences across stakeholder groups risk prioritising one group of beneficiaries over the other, thereby eventually exacerbating the fragile situation of already marginalised groups[56,57,58].

Contextual factors and regional particularities

Drylands and agro-ecosystems are dynamic and complex human-environment systems[13] with land degradation being subject to a multiplicity of interacting drivers. Therefore, regional-level economic valuations should not be taken as blueprints for policy intervention unless contextual factors and regional particularities are also considered[59]. For instance, several studies showed that the impact of soil erosion on crop yields is highly site-specific, with the resilience and sensitivity exhibited by soil, but also rainfall, largely determining the productivity of land[12,60,61]. To be effective, decision-making thus needs to consider the complexity of local land management systems[62], biophysical processes, potential local constraints to the adoption of suggested land use alternatives (e.g., individual capabilities, financial constraints, tenure regimes), as well as potential impacts of policy action on the economic benefits of ecosystem services.

How to substantiate regional-level economic analyses for policy implementation

Regional-level economic valuations and cost-benefit analyses are helpful to underline the importance of policy action against land degradation from an economic point of view, but are often less well suited to provide for specific policy recommendations. To this end, valuation approaches are critical which take account of multiple ecosystem services and land user groups, as well as of spatial variation and social-ecological interlinkages[38,43]. The 6+1 approach, as suggested by the ELD Initiative and discussed in *Chapter 2*, is a particularly promising tool in this regard. To improve the comparability of economic estimations across countries, regional-scale economic models could build on global databases such as FAOSTAT or WOCAT (*www.wocat.org*).

To foster the translation of regional-level economic valuation approaches into policy action against land degradation, strategic alliances between field practitioners, researchers from different disciplines, and policy-/decision-makers across countries are crucial[38,63]. Transnational multi-stakeholder collaboration can foster the exchange of best-practice examples of sustainable land usage[12]; improve data access and reliability[64]; and help to tackle regional-level drivers of land degradation – for instance, those related to unsustainable land management. Likewise, cooperation can nurture the setup of monitoring and early warning systems for transboundary events resulting from land degradation (e.g., dust storms[2]), and the design of coherent policies for the development of a regional infrastructure that accounts for potentially harmful effects on the environment[10,65].

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CHAPTER

05 Stakeholder engagement and perspectives at national and sub-national scales

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Stakeholder engagement

Sustainable land management is an important cross-cutting issue of concern to a range of different stakeholders. Stakeholders are defined as those who can influence and/or are affected by a particular decision or action[1]. Stakeholders in sustainable land management include: local communities; district/county, national, regional, and international policy-makers; and the highly diverse private sector, ranging from small scale firms to transnational companies[2]. The impacts of land management challenges further span a wide variety of policy sectors and scientific disciplines[3,4]. This diversity requires effective integration of perspectives in order to deliver sustainable land management actions that are feasible to implement[5], and which also consider and serve the varied needs and scales of operation of different stakeholders.

Stakeholder engagement is important for a number of reasons. The development of economic valuation tools alone does not mean that those tools and methodologies will be used and translate into avoided degradation and improved land management practices. They need to be relevant and legitimate to the end users, as well as accessible and compatible with the available datasets, capacities, and resources. Engaging stakeholders in the ELD Initiative process invites them into the ELD space, allows them the chance to shape the process in a way that makes it practical, and creates an opportunity to significantly enhance the reach and impact of the ELD Initiative. Further, engaging with end users throughout the process of the ELD Initiative helps to ensure that the developed products meet the needs of those whose decisions have a bearing on the sustainability of land management.

Thus, this chapter focuses on stakeholder engagement at a range of scales, and provides examples of how it has been done through the ELD Initiative. Such a multi-scale approach is vital in

the international framework of land degradation neutrality (LDN, see *Chapter 1*). Although LDN needs to be achieved at the global scale, it is through the aggregate effects of local actions that progress will be made towards the LDN target[6]. Recognising this, stakeholder engagement in the ELD Initiative process has taken place from the local to the international level. Engagement activities have encompassed national and sub-national multi-stakeholder consultations and workshops, regional consultations, and attendance at international multi-stakeholder conferences and meetings, some of which were hosted as part of ELD Initiative funded case studies. The engagement mechanisms were tailored to the needs of the different stakeholders and their scales of operation, and thus enabled two-way dialogue and knowledge exchange[7] rather than encouraging top-down, instructional narratives. This allowed team members to capture perspectives from a range of land managers and land use decision-makers across different parts of the world, whom experience different land degradation challenges in a variety of governance contexts.

The ELD stakeholder consultations had the specific objectives to:

1. Introduce the concept of total economic valuation of land to sustainable land management stakeholders;
2. Understand how the ELD valuation approach can function and fit within specific country/regional contexts;
3. Generate feedback from stakeholders on economic valuation approaches in general, and on challenges/opportunities of their possible application in the country/region;
4. Provide recommendations to help guide the development of appropriate valuation tools and documentation;
5. Establish networks of sustainable land management stakeholders/practitioners;
6. Identify existing gaps in terms of knowledge, related tools and their application, and;
7. Ensure the ELD Initiative and wider global sustainable land management community is aware of the challenges to the implementation of sustainable land management (including land rights/tenure issues, etc.).

TABLE 5.1

Summary of ELD stakeholder engagement during 2013–2015

Scale	Location and dates	Type of engagement	Stakeholder groups involved	Number of participants
International	Bonn, Germany, March, 2014	ELD Private Sector Workshop	civil society, international organisations, international donor agencies, private sector, scientists,	43
	San Jose, Costa Rica, September, 2014	Ecosystem Services Partnership conference	civil society, government, scientists	400
Regional	Nairobi, Kenya January, 2014	ELD Africa Hub workshop	international donor agencies, scientists	20
	Amman, Jordan, May, 2014	ELD case study workshop	civil society, international donor agencies, local community members, government, scientists, private sector,	50
	Santiago, Chile, November, 2014	Regional workshop	international donor agencies, government, scientists	22
National	Lima, Peru, September, 2013	ELD case study workshop	civil society, government, scientists	60
	Nairobi, Kenya, April, 2014	Multi-stakeholder consultation	civil society, government, private sector, scientists	27
	Gaborone, Botswana, July, 2014	ELD case study workshop	civil society, government, international agencies, scientists	24
	Khartoum, Sudan, September, 2014	Multi-stakeholder consultation	civil society, government, international donor agencies, scientists	37
	Moshi, Tanzania, October, 2014	Multi-stakeholder consultation	civil society, government, international donor agencies, scientists	34
	Manila and Los Banos, Philippines, February, 2015	Multi-stakeholder consultation	civil society, government, private sector, scientists	24
	Vientiane, Laos, February, 2015	Individual stakeholder consultations	civil society, government, private sector, scientists	8
Sub-national	Piura, Peru, July–August, 2013	ELD case study workshops	civil society, government, private sector (farmers), scientists	100
	Narok County, Kenya, April, 2014	Multi-stakeholder consultation	civil society, government, private sector (farmers), scientists	32
	North Kordofan, Sudan, September, 2014	Multi-stakeholder consultation	community members, farmers local government,	57

The stakeholder engagement that took place within the ELD Initiative spanned several scales and regions of the world, including Africa, Latin America and the Caribbean, Asia, and the Middle East, over the period 2013–2015: (*Table 5.1*).

Several illustrative examples of these engagement activities are outlined below, with more detail on the context and outcomes of each. These examples provide models and suggestions for how stakeholder engagement for sustainable land management can take place across different cultural, social, economic, political, and environmental contexts.

Regional consultation: Latin America and the Caribbean

A regional workshop was held in Santiago at the Economic Commission for Latin America and the Caribbean (ECLAC). Participating stakeholders were from Mexico, El Salvador, Peru, Chile, Argentina, and Brazil. Stakeholders from other parts of the world but working in the region were also present, including: French cooperation, International Research for Development (IRD), the University of Sassari (Italy), the Stockholm Environment Institute (Kenya), and the University of Leeds (UK). The aim of the workshop was to discuss possibilities to link a major regional endeavour, the AridasLAC initiative, with the ELD Initiative through the formation of a Latin American and Caribbean (LAC) regional hub. The main objectives of the AridasLAC initiative were identified as:

1) producing a dryland outlook for LAC countries focusing on the economic and social processes and impacts of desertification, land degradation, and drought (DLDD);
2) linking scientific approaches with knowledge and actions on the ground with a view to address DLDD, and;
3) providing high-level (Ph.D.) training to field officers to build local capacity and knowledge.

The workshop started with presentations on the AridasLAC and ELD Initiative. Discussions followed on the links and possibilities for synergies to strengthen activities, taking into account resourcing opportunities for a regional hub through collaboration between French cooperation, IRD and the European Commission, together with the ELD Initiative. Capacity building in the use of economic tools for assessing land degradation and drought was identified as a particularly urgent need for the region. The University of Sassari, universities of the northeast of Brazil, the University of Leeds, and the National Councils of Science and Technology from Argentina and Mexico identified the opportunity to develop training courses for policy-/decision-makers to address key skills gaps. The ELD e-learning MOOC was also identified as a useful tool for capacity development. Participants agreed on the importance of focusing on the economic and social impacts of land degradation and drought and stressed the urgency to move towards sustainable land management.

National workshop: Botswana

A workshop was held at the University of Botswana, Gaborone, attended by 24 stakeholders. The objectives of the workshop were to:

1) disseminate the key findings from an ELD-commissioned Botswana rangelands case study which utilised a multi-criteria decision analysis (MCDA) approach;
2) stimulate discussion and gain stakeholder feedback on the findings, and;
3) identify urgent gaps within policy with a view to informing future planning.

Results from the case study were presented (see Favretto *et al.*, 2014[8]; Dougill *et al.*, 2014[9]). Participants then worked in small groups to discuss the approach used in the ELD case study, in order to identify the demand for economic analysis to inform policy-/decision-making, opportunities for policy change, and how policy-makers can better incentivise sustainable land management in Botswana (i.e., which economic mechanisms can be used). Each group then presented the outcomes from their discussions for further comment and feedback.

Stakeholders agreed that MCDA approach can provide valuable input to policy-/decision-making. They emphasised the need for multi-level analyses to capture different stakeholders' values and perspectives, with MCDA being identified as a particularly useful approach for analyses where other data sources are lacking and where inputs from different stakeholders are needed. It was agreed that:

- Involvement of all stakeholders is crucial in advancing policy;
- Stakeholders should be involved from the local up to the national level;
- Capacity building is required for both policy-makers and local people on the ways in which competing land uses can take place at the same time, and;
- There may be valuable lessons to be learned from nearby countries such as Namibia, where community-based natural resource management and cross-sectoral approaches are showing positive results when it comes to balancing multiple stakeholder demands on land.

Sub-national consultation: Narok County, Kenya

The sub-national multi-stakeholder consultation in Narok County forged a collaborative effort between the county and the ELD Initiative with the goal of fighting land degradation at the local scale. Stakeholders in attendance included key government entities at the county level, farmers, women's groups, and scientists. The consultation began with an introduction by the County Commissioner, after which the ELD Initiative was presented, and then discussions around sustainable land management and economic considerations for Narok County ensued.

When different stakeholder demands collide in a specific area, it often leads to the decrease of available and accessible land areas, which concentrates pressures onto any remaining land. In the absence of sustainable land management, this concentration of pressures and demands can lead to land degradation. A key barrier to sustainable land management identified by stakeholders in this consultation was strong pressure on land availability from domestic Kenyan investors from outside of Narok County, as well as different land uses within the county that are leading to land use conflict. Lack of sustainable livelihoods was also identified as a challenge, especially for women: one of the attendees from the women's groups noted that, in the absence of other income-generating opportunities, they resorted to charcoal making because they needed income for food, school fees, and health expenses. The group further highlighted that economic benefits, trade-offs, and costs need to be better identified in order to inform their land use decision-making and management practices. A detailed summary of this consultation can be found in the "Report on the ELD Kenya Consultations" document, provided by UNDP/SEI[10].

TABLE 5.2

Summary of stakeholder recommendations to policy-/decision-makers

Markets for different ecosystem services need to be developed and enhanced
The commitment of political leaders to policy development must be increased
Enhanced coordination and implementation of existing policies is needed
It is necessary to involve the private sector in the adoption of SLM, especially those desiring to invest in land, and land managers
Sub-national institutions must be reinforced
Local level institutions should be established, such that PES can be enacted
Empirical evidence should be used in policy development on SLM
Harmonised policies must be developed to use across sectors in dealing with land, ultimately resulting in better coordination of policy mainstreaming of land issues
Strategies need to take into account cultural implications that impact livelihoods
Development frameworks need to mainstream land degradation issues

TABLE 5.3

Summary of stakeholder recommendations to the ELD Initiative

1. Methods
ELD needs to respond to country level demands relating to different stakeholders (e.g., concrete sustainable livelihood options, mitigation of violence over natural resources, etc.)
Multi-criteria decision analyses are needed in areas where data is lacking and could be incorporated into the ELD approach
Deeper knowledge of SLM implementation options is required
ELD needs to be built on already existing data, processes and structures, specifically engaging national experts and decision makers working in relevant areas (e.g., land management, economics, GIS)
ELD needs to provide real alternatives to unsustainable livelihood practices
ELD needs to provide evidence and empirical information to inform policy
Social and economic impacts must be evaluated in order to support policy-/decision-makers
Repeated stakeholder demands for PES could serve as an entry point for ELD country level engagement

2. Networking and multi-scale, multi-stakeholder, multi-sector involvement
Social dialogue is needed at both the country and local level. ELD networks can feed into existing networks such as the National Coordinating Bodies established at the country level in support of implementation of National Action Plans (NAPs) to combat desertification. This dialogue should extend to the local (village) level, allowing the provision of additional inputs and feedback to national platforms, with the goal of ensuring two-way communication
Involvement of private sector in adoption of SLM
National level group of ELD champions should be built
Partnerships should be fostered between government, civil society, private sector, international, and regional actors

3. Training and capacity building
Targeted capacity building on SLM is needed. This could be explored in collaboration with existing initiatives/ programs* (e.g., Soil Leadership Academy (SLA), UNDP, GIZ)

4. Communications and information
Tailor communications to meet different stakeholders' needs
Ensure communication flows are two way and iterative
Information must be made more accessible to all stakeholders
Projects that have been successful in addressing SLM using participatory methodologies, even though small in scale, should be used as models for up-scaling

* *See Chapter 7 for a list of complementary land initiatives*

Stakeholder needs and expectations from the ELD Initiative

As indicated earlier, the main goal of the *Options and Pathways for Policy Outreach* Working Group (authors of this chapter and instrumental in carrying out the stakeholder consultations) is to integrate stakeholder groups and policy-/decision-makers in the ELD Initiative at all stages of the process to ensure that the outcomes are based in real-time demand and needs at all times. *Table 5.2* and *5.3* respectively summarises the key stakeholder recommendations to policy-/decision-makers and the ELD Initiative, driven by the identified needs and approaches from the ELD stakeholder consultations.

Policy pathways: Entry points for action

The drivers and effects of land degradation cross-cut a wide range of sectors, including agriculture, environment, forestry, water, and energy, as well as education, health, and development. Land degradation is also linked to sustainable development concerns including climate change, biodiversity loss, poverty, health, food, water, and energy insecurity, and human displacement[11]. Each of these sectors provides possible entry points for SLM actions. Ultimately however, movement towards SLM requires a multi-sector approach at national and sub-national levels. This section explores issues of national planning, resource allocation, and implementation. It focuses on the experiences of the Philippines and Chile and explores the potential of the ELD approach to identify policy pathways. It then identifies entry points for actions.

The Philippines

The Philippines is comprised of more than 7,100 islands. Their primary national resources include minerals, cropland, forests, and coastal and marine resources, which collectively make up approximately 36 per cent of the nation's wealth[12]. On an annual basis, as much as 27 per cent of the country is vulnerable to drought, alternating with floods and typhoons. The resulting degradation from these harsh environmental processes is further thought to contribute to worsening levels of poverty. Currently, the main policy document on land degradation for the Philippines is the National Action Plan (NAP) to Combat Desertification, Land Degradation and Drought[13]. The NAP, which is being implemented from 2010–2020, targets approximately 5.2 million hectares (or 17 per cent of the country's total land area), which is severely eroded. It comprises three long-term strategic thematic programmes:

1. Creation of livelihoods for affected populations;
2. Sustainable use and management of affected ecosystems, and;
3. Formulation of a national adaptation to climate change platform for food security and improved resilience to natural disasters.

This is aimed to be achieved through short- to medium-term operational thematic clusters, including:

- SLM technologies, including adaptation
- Capacity building and awareness
- Knowledge management and decision support
- DLDD and SLM monitoring and assessment
- Policy, legislative, and institutional framework
- Funding and resource mobilisation
- Participation, collaboration, and networking

The studies and activities of the ELD Initiative were identified to be able to support the Philippines NAP in the following ways:

1. The Philippines can learn from sound scientific case studies that demonstrate SLM practices around the world. This will contribute to attainment of the short to medium term operational thematic clusters mentioned above.
2. The ELD Initiative knowledge products will help the Philippines meet the plan's operational objective on advocacy, awareness raising, and education. This can potentially influence governance actors from the government, the private sector, and civil society in addressing drought and other land degradation problems.
3. Engagement with an international network of institutions, scientists and policy experts developed through the ELD Initiative will be useful in building the body of scientific and technical knowledge pertaining to DLDD and mitigation of the effects of drought. Engagement in multi-stakeholder and multi-sector dialogues will help in mainstreaming this knowledge into the policy agenda of government.
4. The ELD Initiative's outreach programs can foster partnerships between international institutions and organisations from other countries with counterparts from the Philippines, in order to increase knowledge sharing and lesson learning, and to mobilise resources to support the implementation of the UNCCD.

5. The ELD Initiative's e-learning MOOC, workshops, and related activities will help in attaining the objective of the NAP, to build the country's capacity to prevent and reverse desertification/land degradation and mitigate the effects of drought.

Land issues also feature in the 2011–2016 Medium Term National Development Plan. This document guides the country's economic and social development priorities. The Plan highlights the importance and use of market mechanisms such as payments for ecosystem services (PES) (see *Chapter 1* and *2*) in mitigating environmental degradation. PES is currently planned to be institutionalised at both national and local levels. It is planned to share the concept with communities to encourage local level natural resource protection and management, as well as to increase household income. In order to sustainably finance environment and natural resource management activities, the government has stated it will pursue the use of appropriate valuation methods in the computation of applicable fees and taxes for the use of the country's natural resources, as well as developing a system of natural capital accounting. The Philippines already has some experience in natural capital accounting, gained in the 1990s and 2000s, with the USAID-REECS Environment and Natural Resources Accounting Project (ENRAP), the UNDP Integrated Environmental Management for Sustainable Development (IEMSD) Project and the ADB RETA for Capacity Building in Environmental Economics. The country is also part of the World Bank's Wealth Accounting and the Valuation of Ecosystem Services (WAVES) initiative. WAVES supports the Philippine National Medium-Term Development Plan as well as the National Climate Change Action Plan (NCCAP). WAVES focuses particularly on developing indicators, tools and methodologies to help determine the sustainable use of the country's natural resources. Priority areas include: 1) mineral accounts; 2) mangrove accounts; 3) ecosystem accounts in Southern Palawan; and 4) ecosystem accounts in Laguna Lake Basin. Stakeholders across multiple levels have been engaged in the WAVES process, to identify priority areas and issues and highlight good practices in environmental conservation. Land also features in the National Physical Framework Plans and other action plans relating to agriculture, climate change and biodiversity, which support other multi-lateral environmental agreements and development goals.

In this context, ELD is usefully placed to support these policy initiatives in valuing land resources through the development of scalable methodologies. It can be used to inform the use of economic incentives and disincentives, helping to reorient the country towards a SLM trajectory. The 6+1 steps presented by the ELD Initiative (see *Chapter 2*) could be integrated into teaching materials, supporting university curricula and building capacity for valuation within policymaking departments of government. Further capacity building support provided through the ELD Asia hub and other networks (*Appendix 1*) could guide countries in applying the ELD approach and customise it to meet their own identified needs and priorities in managing their land sustainably.

The Mt. Mantalingahan study in the Philippines illustrates the usefulness of the economics of land degradation tools in policy decision making. In 2008, a study was conducted to value the ecosystem services of the Mt. Mantalingahan Range in Palawan, Philippines and to determine the management costs of protecting critical habitats within the proposed protected landscape[14]. The TEV framework was used to estimate the use values of the goods and services provided by a mountain range that spanned five municipalities. The use values include direct uses (timber, farming, livestock production, non-timber forest products gathering, water, and mining), and indirect uses (carbon stock, soil conservation, watershed and biodiversity functions, and protection of marine biodiversity). With a 2 per cent discount rate, the estimated TEV of Mt. Mantalingahan excluding mining was estimated to be 149.786 billion Philippine pesos (PHP). On the other hand, the total resource rent from mining was estimated to be PHP 15.022 billion, consisting of PHP 2.209 billion from sand and gravel, and PHP 12.814 billion from nickel. The estimated benefits from mining were only about 10 per cent of Mt. Mantalingahan's TEV. With a discount rate of 5 per cent, the resulting TEV is PHP 94.854 billion, which is still much higher than the resource rent from mining. Hence, the estimates showed that Mt. Mantalingahan provides goods and services whose values far exceed the benefits from mining. The results of the study led to the enactment of Presidential Proclamation 1815 on June 23, 2009. The Philippine President declared Mt. Mantalingahan as a protected landscape and Key Biodiversity Area and created a Protected Area Management Board to ensure its proper management. This demonstrates how using economic valuations can create a situation in which sustainable land management can be enacted.

Chile

Chile is one of the countries in the LAC region most affected by land degradation in terms of area, population, and production losses. Two-thirds of Chile's territory (48 million ha) are already affected or threatened by desertification and drought[15]. According to the Chile Desertification Map published by the Corporación Nacional Forestal[16], out of 290 municipalities in Chile's rural areas, 76 have experienced severe erosion due to drought, 108 have sustained moderate erosion, and 87 have experienced light erosion. Just 19 municipalities have been free of damage. Furthermore, around 1.3 million people inhabit the affected areas, with a significant proportion of them living in poverty.

The main causes of desertification and land degradation in Chile are overgrazing, farming on marginal lands without conservation practices, and over-exploitation or poor management of forests. Approximately half of Chile's 15.4 million ha of forests are already degraded. Forest degradation is advancing across the country at about 77,000 ha annually, occurring mainly in the southern forests where fuelwood extraction is a major contributor to the problem. This is despite a number of national programs to combat desertification and the effects of drought, which existed even prior to Chile's accession to the UNCCD. As part of these efforts, Chile implemented the following programs nationwide to recover degraded soils in the most affected areas: the National Reforestation Program (1984); the National Recovery Program of Degraded Lands (1990); and the National Program to Combat Desertification (1997).

Through these programs, it is estimated that Chile has recovered about 4 million hectares through

afforestation, recovery, and management of native forests and recovery of degraded soils and irrigation. These achievements have been highlighted in the report on the progress of implementation of the UNCCD (Fourth UNCCD reporting cycle, 2010–2011 leg; Report for Chile, 2014). However, there is still an urgent need for action in the light of recent, severe, and prolonged drought. The severe drought affecting the country over the last seven years has aggravated degradation. It was mainly in the north and central part of Chile, but has now reached southern parts of the country as well. To confront these challenges, it is necessary to significantly improve coordination between public policies and between the private and public sector, as well as enhance efficiency and effectiveness in the allocation of resources to combat DLDD.

As an initial intervention point to tackle this issue in Chile, urgent steps are needed to align country policies and programs to tackle the problem, provide technical guidance to field workers, and heighten awareness nationwide[17]. Economic methodologies can play a useful part in this, and build on work already undertaken. For example, with the support of UNDP Chile, a study was undertaken on costs of inaction on land degradation, covering most of the country[18]. Results were obtained at the *comuna* (county) level in terms of monetary losses, applying a methodology based on replacement costs and econometric functions for selected crops in affected and non-affected areas. Methodology and preliminary results were discussed, adjusted and validated in workshops in each region with the participation of farmers' organizations, scientists, non-governmental organisations (NGOs), and policy-/decision-makers from national to subnational levels. In the second stage, a capacity building programme was formulated that targeted regional and local stakeholders. Activities included the preparation of regional and local plans to mitigate and combat the effects of land degradation. These plans will be incorporated into the NAP and formulated on the basis of active stakeholder participation at *comuna* and regional levels.

To ensure the continued development of policy instruments to combat desertification, the Ministry of Agriculture has invested about USD 120 million annually, benefiting approximately 50,000 small and medium farmers and covering around 250,000 ha per year[19]. Use of the economic approaches could help inform future resource allocation and budgetary decisions.

The Chilean government is also currently implementing important reforms in the legal and institutional framework linked to water rights. Among these changes are the creation of a special unit dedicated to water resources, and a specialised division to deal with DLDD and climate change, plus the organization of special commissions in the Senate and Chamber of Deputies of the National Congress. All these measures must be harmonised considering SLM at national and regional levels in order to improve the policy decision and allocation resources process in terms of its efficacy and efficiency.

Conclusion

This chapter has set out the role of stakeholder engagement in the ELD Initiative, as well as possible entry points for action towards SLM. It has provided illustrative examples of the kinds of consultative and participatory mechanisms used to: a) raise stakeholder awareness of the utility of economic valuation approaches, and b) gain stakeholder feedback on both the ELD approach and the challenges and opportunities for its implementation. Through a focus on two national contexts as case studies (the Philippines and Chile), the chapter has shown how economic approaches can build on existing policy processes through the provision of new knowledge, to inform resource allocation and trigger a reorientation of decision-making along more sustainable natural resource management trajectories. It has also highlighted key stakeholder recommendations to help support and mainstream the use of economics approaches, building on existing country-level experiences and datasets. An important finding that emerged from the consultations at all levels is that stakeholders place considerable emphasis on capacity development and experience-sharing. They also highlight the importance of networking and the need to develop platforms for multi-stakeholder dialogue. The demand for such collaborative approaches underscores the importance of a coordinated and multi-scale approach in addressing the challenges of DLDD, as well as demonstrating the value of stakeholder engagement through and for the ELD Initiative.

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CHAPTER

06 Enabling action: Conditions for success

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Introduction

If more sustainable land use and land management practices are to be effectively adopted by land use practitioners, an appropriate enabling environment needs to be in place. Supportive and synergistic cultural, economic, environmental, legal, political, social, and technical conditions are needed to ensure an enabling environment that facilitates remedial or preventative actions over current land use or adoption of alternative land uses for long-term economic and environmental. This chapter focuses on points relating to adaptations of the wider environment outlined at the bottom of the ELD Initiative multi-level, multi-scale, simple decision-making framework (see *Figure 2.5* in *Chapter 2; Box 6.1*), consideration of which is required to enable adoption of one or more options for action.

Economically desirable land management options can be identified through assessment undertaken following the ELD approach (*Chapter 2*) at the global, regional, and national levels (*Chapter 3* and *4*). Such options should be implemented using socially relevant pathways for successful adoption, and which can be identified using stakeholder consultations and engagement processes (*Chapter 5*). Approaches involving stakeholders should ensure that the most economically desirable option is compatible with existing economic mechanisms, and is also technically and legally feasible, and environmentally and socially acceptable. Additionally, physical and monetary resources to achieve the practical implementation of sustainable land management should be accessible and available. Comprehensive (re)design of portfolios of options, including current, revised, and new measures, can help make sure that there is convergence and that action is taken based on assessment results.

This chapter details some of the possible ways that action can be enabled using economic instruments, some of the characteristics of the enabling

BOX 6.1

Examples of options for action available to land users
(from ELD Initiative, 2013, pg. 40–41[1])

Improved productivity with adoption of more sustainable land management

Improved productivity assumes the same type of land use is continued, and can refer to the adoption of more sustainable practices to improve agricultural yields and livestock production, afforestation/reforestation to control water flows, etc. Sustainable land management detailed in the literature is advocated as providing greater economic benefits than associated costs. These net benefits often materialise through increased revenues as a result of increased productivity and production, mitigation of impact over productivity of droughts or floods, etc. Increased benefits usually accrue directly to stakeholders and require access to the right information for the implementation of change. Improved productivity can lead to increased land prices for purchase or lease[2]. Certification schemes increasing value-added can be used to mitigate some of the production losses and keep revenues stable (e.g., FairTrade Foundation®, organic certification, Forest Stewardship Council certification etc.).

Establishment of alternative livelihoods: changing land use for more sustainable land management

Alternative land-dependent livelihoods assume changing land use, either a complete change of current land-based activities or, more usually, partial changes through diversification of activities. An example is the establishment of value-added medicinal and aromatic herbs (e.g., mint) in a region of Tunisia from 2003–2013. This brought an 200–800 per cent increase in profits to poor families, in addition to improving: the timing of acacia planting, groundwater recharge, and olive oil waste water reuse[3]. In other examples, ecotourism activities can contribute directly to conservation efforts and practices and complement existing income sources[4,5,6,7]. This is the case for mountain gorillas in Rwanda where some of the money made by tourist operators is redistributed to local communities. Production of arts and crafts (e.g., Kazuri handmade clay beads in Kenya) can be another source of additional income, particularly for women. Certification schemes such as those from the FairTrade Foundation® can be used to help promote alternative livelihood activities with added-value for land users (i.e., market premium) and make such activities more visible on the global market, though requires advertising campaigns to promote these alternative livelihood activities. In some cases, land use change is not always ecologically nor economically sustainable in the long term. For instance, oil palm plantations have been criticised for their unsustainability and some are now taking steps to change towards more sustainable practices (ProForest, *www.proforest.net/en/areas-of-work/palm-oil*).

environment (i.e., what stakeholders ideally want), possible transitions required to effectively promote action (i.e., how to remove identified barriers to action), and adaptive processes (i.e., how to reach the ideal environment for action from the current situation).

Possible pathways to enable action by land users: changing the incentive structure underlying land management and land use decisions

Some of the processes that can help facilitate the setting up of enabling environment suited to the specific context considered from local to national levels are stakeholder engagement and a multi-sector approach at national and sub-national levels (*Chapter 5*). This section focuses on possible instruments and mechanisms that influence land management options chosen by land users (*Box 6.2*). Identifying current instruments and mechanisms

BOX 6.2

Examples of instruments and mechanisms to enable the adoption of sustainable land management

(expanded from ELD Initiative, 2013, pg. 40–41[1]; CATIE & GM, 2012, pg. 9, Table 1[8])

The following instruments and mechanisms can be adopted individually or in combination with each other as feasible.

Public payment schemes

Implementation of bans or permanent conservation easements: Permanent conservation easements guarantee that a tract of land will not be used or farmed. This usually involves an annotation in the property title or at the land registry office – national parks would be in this category. The negative counterpart of easements – bans – can ensure that products harmful to health or environmental quality such as pesticides are not used. An example is the ban on plastic bags in Rwanda, in order to reduce environmental pollution. Bans and permanent conservation easements require strong action and monitoring and can be costly to enforce.

Contract farmland set-asides: Landowners give up the right to use part or all of their farmland, in exchange for payments. Set-asides are used in the European Union (EU).

Co-financed investments: Government pays part of the investment needed to achieve a certain land use or to promote specific production practices. This is the case in the Environmental Quality Incentives Program offered in the US.

Payments for proven investments in land conservation: Government provides a payment based on the investments made, per unit of area. This is used for example in the EU for some of the agri-environmental measures (e.g., dry stone wall restoration).

Subsidies: The government provides direct subsidies to those who implement sustainable land management practices or other environmental technologies. These involve government action and can target a range of stakeholders such as farmers or small holders. They can be provided on a one-off basis to lower establishment or switching costs (e.g., the United Nations Development Programme (UNDP)/Global Environment Facility (GEF) Small Grants Programme, Jayasinghe & Bandara, 2011[9]), or linked to land use or type of production in order to lower costs of operation (e.g., USA and EU agricultural policies). It requires both stakeholder access to information and the targeting of stakeholders by donors. The maintenance of a subsidy scheme in the long term usually requires strong lobbying from interest groups.

Taxes, tax breaks, environmental fees: These constitute environmental or green taxes levied on 'bads' used to correct existing land-use practices. Taxes and environmental fees aim to raise the cost of production or consumption of environmentally damaging goods, thereby reducing or limiting demand, and thus reducing or limiting environmental damage. It involves government action and monitoring and social acceptance of these taxes. An example of this is the eco-tax in Europe on plastic-based products, which are then meant to directly fund their recycling. Tax breaks can be granted for more sustainable practices. For example, Sweden, Denmark, and Norway have a tax on fertiliser use. In relation to land, unsustainable practices are often subsidised (production or fuel subsidy) rather than taxed. This situation implies that more sustainable practices often have a financial disadvantage.

Insurance schemes: This is the case in the US, Canada, and India, where the government provide insurance against crop losses. Modalities vary but the principle remains the same. A reference minimum amount (or market price) is decided before the cropping season starts and if actual production (or market prices) at the end of the season are lower than the pre-established reference, farmers receive a pre-established amount as compensation for losses. Such schemes are considered less trade distortive than subsidies, and so far are deemed acceptable under World Trade Organization rules.

Open trading under regulatory cap or floor

Conservation banks: Parcels used for conservation purposes are managed by a bank,

BOX 6.2

which sells credits to projects that want to have a positive impact on the environment.

Tradable development rights: These allow development of a certain area of land, on the condition that a similar type and quality of land are restored as a compensation measure.

Trading of emission reductions or removals (or other environmental benefits): A pollution goal/ allowance is set and pollution permits distributed which can thereafter be traded. The first attempt at using tradable permits was in the early 1990s with the establishment of emissions trading markets for sulphur dioxide (SO_2) and nitrogen oxides (NO_x) in the US and Canada. These were introduced to reduce the national and transboundary air pollution leading to acid rain. Attempts at trading carbon credits were made under the Kyoto Protocol, with little success to date. Trading of fertiliser permits has been considered in academic literature but has not been applied yet. Fixed quotas or standards still tend to be preferred by decision-makers.

Self organised private deals

Purchase of development rights: An interested party buys the development rights for a given piece of land to be dedicated to a particular use.

Conservation concessions: One party provides another with a concession to use a territory for conservation processes.

Direct payment for environmental services (e.g., payment for ecosystem service (PES) schemes): The users of environmental services pay the providers directly. Land managers are rewarded for conserving ecosystem services for those who use them[10,11,12,13,14,15]. Stakeholders usually reap the benefits directly, but this requires access to information, and national or international redistribution mechanisms to ensure payments. This can include payments to store carbon or to preserve biodiversity. The UN REDD programme is an effort to offer incentives to developing countries to reduce emissions from forested lands and invest in low-carbon pathways to sustainable development through the creation of a financial value for the carbon stored in forests. The REDD+ programme evolved from the original programme to go beyond deforestation and forest degradation to include the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks with a PES component. Additionally, private companies or NGOs have paid land users for provision of ecosystem services (e.g., Vittel, now part of Nestlé Water®, and hydroplants are paying for water quality or minimum flow, World Wildlife Fund in Kenya is paying for biodiversity and wildlife habitat conservation).

Provision of opportunities to make voluntary payments for environmental conservation or offset: An example of this is voluntary payments to offset carbon consumption, or the provision of monetary support to environmental conservation charities and NGOs, which are currently being promoted by some airline and train organisations. Such voluntary payments can be invested in restoring, replacing or even expanding forested land.

Establishment of new markets for ecosystem services: example of carbon storage and sequestration: Within most markets, not all ecosystem services have an economic value assigned to them. A specialised PES scheme works within the market system to assign monetary values for services previously not or under-valued[16]. Establishment of new markets goes beyond PES, as the price for carbon is determined through an actual market. This can directly benefit some stakeholders, but depends on fluctuations in market price, and could lead to a switch in land management strategies. It also requires monitoring of the market operation and of financial speculation. Examples of new market establishment include the carbon market in Europe and China.

Provision of credit schemes and microfinance: Credit helps reduce peak demands in monetary resources for investment and smooths cash flows requirements over time with known amounts of loan repayments. Microfinance is a specific form of credit scheme that focuses on promoting local and small scale business establishments. Credit facilities are provided at a lower interest rate than those offered by traditional banks, who consider these initiatives as too small or risky. Microfinancing is seen by economists as a good alternative to subsidies which tend to have adverse consequences on society and

BOX 6.2

behaviours[17]. For example, access to microfinance has successfully contributed to poverty reduction in Bangladesh at the individual level (especially for women), as well as at the village level[18]. Recent evidence suggests that access to microfinance is insufficient on its own to lead to improvements in health, education, and women's empowerment[19,20] but is an integral part of the 'action option mix' to promote sustainable land management.

Eco-labeling of products and services

Marketing labels: Payment for ecosystem services is embedded in a product/service, or a market develops for products produced sustainably. This is the case in the EU for protected designation of origin, protected geographical indication and traditional specialities guaranteed labels. Allocation of such labels is associated with specific and sustainable production standards.

Certification schemes: A third party provides written assurance that a product, process or service complies with certain standards (e.g., ISO 1996). This is the case for organic products (e.g., Soil Association), fair trade products (e.g., FairTrade Foundation®), Forest Stewardship Council, etc.

The majority of these instruments can provide direct benefits to private stakeholders but often rely on policy-making processes and government facilitation. The provision of funding from external donors or private investors depends on their incentives to do so (which may change over time). Private investors will act if they can be convinced that they will get a return on their investment. Short term funding will be effective in promoting change if it lowers financial barriers to change.

can then help identify the existing incentive structure and thus decisions taken by land users. Instruments and mechanisms can be altered to foster change through new or revised incentive structures. Such mechanisms and instruments can be identified, chosen, designed, adapted, or revised during stakeholder engagement or with a multi-sector approach at national and sub-national levels. Choosing which instrument or mechanism or combination thereof to implement depends on a range of factors: economic efficiency, effectiveness, transaction costs associated with implementation, perceived simplicity or difficulty for implementation, monitoring constraints, equality and fairness, influence from 'winners' and 'losers', etc.

When sustainable land management options are economically desirable to land users and managers, it may not be necessary to revise current instruments and mechanisms. However, sustainable land management practices are often not perceived as economically viable by private land users and smallholders. This is the case when provision of instruments and mechanisms to change the underlying incentive structure around land management may be needed and justified from an economic perspective, or also for non-economic reasons. For example, investment into the research and development of more sustainable land management practices may be needed for them to be seen as economically viable. Alternatively, there could be a political decision to invest in more sustainable land management practices because this is perceived as 'right' for ethical, moral, social, sociological, or cultural reasons. Such a normative orientation often requires an explicit political choice regarding the desired future.

Selecting an appropriate mix of instruments and mechanisms is fundamental in promoting long-lasting sustainable land management. A given instrument will not work the same everywhere and thus depends on specific national and local conditions. Plastic bags are a source of visual pollution in developing countries, which could reduce the international tourism appeal. Making people pay a small price for plastic bags drastically reduced their usage in France when introduced, whilst an equivalent price in Malawi was not high enough to curb usage. Thus, instruments and mechanisms need to be chosen in specific contexts and in answer to particular problems, to successfully help to achieve more sustainable land management.

BOX 6.3

Assessment methodology developed by CATIE and the Global Mechanism of the UNCCD
(from CATIE & GM, 2012, pg.10–11, 47–48[8])

The assessment methodology comprises four elements to identify which instruments and mechanisms could be suitable in relation to specific national, local and economic contexts:

1. A quantitative **scorecard** tool ranking the applicability of instruments (called incentives in this case) and mechanisms in a given context according to a set of pre-defined success factors which affect their impact such as institutional capacity, governance, environmental awareness and local specificities (see first column of *Table 6.1* for more examples). This scorecard tool has been developed to: (1) help identify instruments and mechanisms that are most appropriate in a country or site-specific context; (2) establish using a simple quantitative approach, the minimum conditions under which each of the instrument or mechanism could achieve its goals; and (3) identify deficiencies that government and cooperation agencies could address in future development efforts. The scorecard can be used together with a checklist of questions to help identify and rank the strength or presence of the success factors and enabling conditions for each instrument and mechanism. The scorecard compares the requirements of each instrument or mechanism with the actual situation. For example, some instruments and mechanisms require better legal systems, others greater institutional capacity. Results identify which mechanisms are better suited to a particular situation as well as weaker areas or capacity to be strengthened;
2. A **qualitative assessment** of which instruments or mechanisms could achieve the set goal, based on variables that cannot be measured in practice and lessons learned from using other mechanisms;
3. A **cost-benefit analysis** of the instruments or mechanisms, considering, for example, transaction costs and who is receiving and paying what price for what ecosystem service (the cost-benefit analysis described in *Chapter 2* of this report could be augmented to assess the impact of instruments or mechanisms, transaction costs etc.), and;

4. **Additional analyses**, including legal and institutional analysis of the instruments or mechanisms on the short list.

The scorecard provides initial screening to assess the feasibility of implementing different instruments and mechanisms. It helps in asking relevant questions and discussing the issues necessary for the feasibility and design phases, and provides a ranking of different options facilitated by the use of numerical scores. However, numerical scores are not enough to provide the final word on feasibility: the last three steps are just as important in choosing appropriate instruments and mechanisms. The overall assessment should consider the outcomes of the screening exercise, transaction costs, price of the ecosystem services in the site, and legal, regulatory, and governance issues. It should also consult closely with complementary processes, studies, or activities (e.g., economic valuation, mapping of sustainable land management, political mainstreaming, stakeholder engagement processes, etc.).

TABLE 6.1

Table 6.1: Example of scorecard for Zambia
(from CATIE & GM, 2012, pg. 49, Table 48[8])

		Permanent conservation easements	Contract farmland set asides	Co-financed investments	Payments for proven investment in land conservation	Subsidies	Taxes, tax breaks, environmental fees	Conservation banks	Tradable development rights	Trading of emission reductions or removals	Purchase of development rights	Direct payments for environmental services	Conservation concessions	Marketing labels	Certification schemes
NATIONAL/LOCAL CONTEXT															
Institutions (institutional capacity)		-1	-1	1	1	-1	-1	2	-1	-1	1	0	1	0	0
Governance		-1	-1	2	2	0	0	2	-1	-1	0	0	0	1	0
Macroeconomics (economic freedom)		0	0	0	0	1	1	-2	-2	-2	-1	0	-1	-1	-1
Regulatory framework		1	1	1	0	0	-1	0	-1	-1	0	1	1	1	1
Environmental Awareness		1	1	1	-1	-1	1	-1	-2	-2	1	-1	0	-1	-1
SITE SPECIFIC CONTEXT															
Ecosystem type		-1	0	1	1	2	1	-1	1	1	2	0	1	0	0
Environmental know-how		-1	-1	-1	-1	1	1	0	-1	-1	-1	0	0	1	1
Production Units / land economics		2	2	0	0	2	2	1	0	0	1	1	2	0	0
Land Tenure		0	1	2	2	2	3	0	0	0	1	2	0	3	3
ECONOMICS OF SUSTAINABLE LAND USE PRACTICES															
Demand for environmental services	On site benefits	1	1	0	0	-1	-1	0	2	2	1	1	0	2	2
	Off site benefits	-1	-1	0	-1	0	0	-2	-2	-2	-2	-1	-1	-2	-2
	Awareness/payment culture	-1	-1	0	0	1	1	-1	-2	-2	0	-2	0	-2	-2
Supply of environmental services	Low Opportunity cost	-1	-1	2	2	2	2	0	1	1	-1	0	0	2	2
RESULTS		-2	0	9	4	8	9	-2	-8	-8	2	1	3	4	3

CASE STUDY 6.1

Conflict arising from undervaluing land: Sierra Leone
(from ELD Initiative 2013, pg.25[1]*, original source: Provost & McClanahan, 11 April 2012, The Guardian*[19]*)*

In Sierra Leone, farmers receive USD 5/ha/yr for leasing land to a foreign plantation investor under a 50 year contract. However, this payment has been perceived as unacceptable to many, as it does not fully compensate farmers for the loss of valuable trees and plants destroyed in the clearing of the land, or more specifically, for the loss of ecosystem services and goods previously provided by these trees and plants. This perceived unfairness led to social unrest and widespread demonstrations in 2012, turning what could have been a win-win situation into a lose-lose one. Such contestation from the local populace can deter foreign investors and limit further opportunities for development.

In this case, the winner from the deal is the foreign investor, and the losers are the Sierra Leone farmers. The problem is that the redistribution mechanism in place is so small that farmers feel they have lost out. Consequently, both farmers and the foreign investor lose out from the deal: farmers because of the reduction in their livelihoods and livelihood options, and the investor because of the costs and negative image associated with social unrest. One action could be to revise the level of compensation provided by the investor to the farmers. A total economic valuation of their land and services derived from it could help assess a 'fair' level of compensation for the farmers (higher than their current USD 5/ha/yr), and thereby reduce social unrest.

The Global Mechanism (GM) of the UNCCD has developed a methodology to identify which instruments and mechanisms could be suitable in relation to specific national, local, and economic contexts (*Box 6.3*). Provision of these instruments and mechanisms can help address the gap between prices faced by smallholders and the economic value to society as whole (e.g., compensation or payments). They can be set through active participation from communities, private sector players, and governments, and contribute to increased income and livelihood improvements for land users. This raises awareness over the aggregate value of land, and tames conflicts arising out of perceived unfair land deals (*Case study 6.1*).

Enabling environment for successful action

There are several conditions for action to be successful in terms of fostering adoption of more sustainable land management: the cultural, economic, financial, legal, political, social, and technical environment all need to be aligned to ensure that one or several complementary options can be implemented successfully. Access to physical, technical, and monetary resources has been identified as a limitation to address land degradation problem effectively[21], and should be made available at the local level as well as higher scales, to ensure action is effectively taken. A lack of access to these resources and information about sustainable land management is particularly acute in Sub-Saharan African countries, preventing adoption at a large-enough scale to make a difference over land degradation processes and livelihoods.

Financial conditions for success: mobilising necessary funding

Any action that requires investment or relies on instruments or mechanisms such as subsidies, grants, and action enablers will be successful only if the necessary funding is mobilised and made accessible. This requires identifying funding sources and a fundraising strategy that mobilises funds effectively. Funding assessments undertaken parallel to cost-benefit analyses can identify whether the current funding environment could promote adoption of more sustainable land management practices or uses, or if it needs to be altered.

Depending on the amount to be raised, necessary funding could be mobilised from several possible sources: rotating saving schemes within a community, savings in a bank, migrant remittances coming into the country, investments by the private sector into community development (e.g., under corporate social responsibility schemes), local up to national government resources, foreign direct investment, grants from charities, foundations, philanthropists, international donors and supra-national organisations such as the World Bank or the GEF, access to credit, equity, loans or microfinance (with the latter associated with relatively small projects with high risk of repayment failure).

There are additional ways of raising funding through writing grant requests, project proposals, crowdsourcing initiatives, auctions, charity donation raising, selling objects or products with a fraction of the profits reinvested or redistributed (e.g., ecotourism in Rwanda), etc. Some banks and supra-national bodies such as the World Bank are also offering 'green bonds'. These bonds are fixed income products offered to investors as a means to raise funds for environmentally-related projects, in particular those that aim to facilitate climate change mitigation or adaptation[22,23].

In addition to those providing funding, there are several institutions involved in mobilising it. Charities typically raise funds to be able to implement their projects. Banking institutions are also part of the picture as they can mobilise funding available from savings accounts and provide necessary resources. Local communities can organise themselves to generate the needed cash for collective or rotating investment. Certification agencies such as the FairTrade Foundation® and organic certification bodies can also help generate the needed cash through consumer payments of market premium prices. Specific to land management, the GM of the UNCCD is mandated to improve the effectiveness of financing for UNCDD implementation and the sustainable management of dry and degrading land, and to promote the mobilisation of additional resources (see CATIE & GM, 2012, pg. 14[8]). It does not provide funding as such, but rather acts as a broker (see Hill Clarvis, 2014, pg. 7[24]).

Integrated funding strategies can be designed to identify and harness a mixture of financial sources, instruments, and mechanisms to fund efforts to promote more sustainable land management. The GM has also identified a set of principles and steps to guide the design of an integrated funding strategy that focuses on land management and channels greater investment into sustainable land management (*Box 6.4*). The identification of relevant and feasible funding sources can then inform an analysis of financial flows into land

BOX 6.4

Design and establishment process of an integrated funding strategy
(from GM, 2007[26], 2008[27], cited in Akhtar-Schuster et al., 2011[25])

Principles and steps used to design an integrated funding strategy:

(1) Identify entry points, stakeholders, and partners;
(2) Collate and disseminate analyses;
(3) Establish a communication and coordination strategy;
(4) Design a better policy, legal, and institutional environment, and;
(5) Enhance coordination and partnerships.

These principles guide the steps to be followed to establish an integrated financing strategy process:

Step 1: Set up an Integrated Financing Strategy process;
Step 2: National context analysis and identify sources of financing;
Step 3: Elaborate an Integrated Financing Strategy action plan through identifying priorities and key activities, and;
Step 4: The integrated investment framework.

(More information can be found at: www.global-mechanism.org)

management and the conditions that can influence mobilisation of financial resources[25].

Economic conditions for success: removing perverse incentives and establishing the right mix of economic incentives

Economic conditions for success include removing perverse incentives which deter the adoption of sustainable land management; setting up new economic incentives to lower economic barriers to adoption of more sustainable land management practices; and ensuring a stable or predictable macroeconomic environment, so that actions can be planned accordingly and economic returns estimated in a credible way. Specific assessments parallel to the cost-benefit analysis can be undertaken to identify whether the current economic environment could promote the adoption of more sustainable land management practices or uses.

Perverse incentives can take several forms. A commonly cited example is the EU providing agricultural production subsidies to its farmers[28]. The subsidies were introduced in 1957 under a Common Agricultural Policy framework in an attempt to boost agricultural production to feed the European population. This subsidy system was successful in that it led to 'butter mountains' and 'wine lakes' (surplus production) by the 1980s. The response was the introduction of payments for storage and transformation of surplus products rather than a decrease in agricultural production subsidies to farmers. Production subsidies led to an intensification of production with pollution side effects (negative externalities, e.g., nitrates), which became very visible by the early 1980s. What was originally a positive incentive to production had become a perverse incentive leading to overproduction and pollution. Instead of decreasing subsidies to agricultural production, the EU chose to pay for environmental quality in addition to paying for the intensive agricultural production that was creating the pollution. Production-related subsidies are currently provided under what constitutes *Pillar I* of the Common Agricultural Policy and are 'decoupled' from current production levels. *Pillar II* was created as part of the Agenda 2000 reform of the Common Agricultural Policy with payments provided to farmers in recognition of the environmental and rural development services they provide to society – the notion of 'multifunctionality' of agriculture. For a long time, the Common Agricultural Policy received 50 per cent of the EU budget. Pillar I remains the main beneficiary and Pillar II is dwarfed in comparison[29]. Several economists have argued that removing production related subsidies would easily address the problems of overproduction and environmental pollution. A slow but progressive removal of perverse production subsidies seems to be the path taken now by the EU, following budgetary pressure as well as pressures from the WTO negotiations.

A second alternative to promoting the adoption of more sustainable land management or more sustainable land use is **setting up new economic incentives to lower or remove economic barriers to adoption**. Providing subsidies as positive incentives to more sustainable land use or land management practices is one example. Taxing environmental pollution – after the 'polluter-pays' principle – is another possibility. One of the deterrents often put forward by land users to switching to more sustainable land use and management is the high cost of switching to such practices. Switching practices constitutes a very big financial risk for poorer farmers in developing countries: they know what they are getting with current practices, however, there is no guarantee new ones will pay off in their specific situation. In 2007, the UNDP/GEF Small Grants Programme provided small grants to farmers who were part of a Community Development Centre, Aranayake located in the district of Kegalle in Sri Lanka, to adopt soil conservation methods in their home gardens so as to minimise soil erosion[9]. The grant for switching practices provided a financial safety net so that farmers could try out new practices without compromising their ability to feed their families. Contrary to other forms of subsidies, grants for switching practices do not need to be maintained over time. A survey of 104 beneficiaries of a population of 150 farmers showed that respondents used the following soil conservation methods: sloping agriculture land technology methods (60 per cent), lock and spill drains (56 per cent), and stone hedges (30 per cent). Eighty seven per cent of the respondents reported that their income had increased and 93 per cent improved their soil quality improved under the conservation practices. Over 80 per cent of the respondents reported an increase in harvest of 50 per cent or more, and 82 per cent an increase in land available for cultivation after the introduction of soil conservation practices. The improved soil quality and yields with the conservation practices convinced 93 per cent of respondents to continue using the soil conservation practices even without subsidy. A majority of neighbouring farmers that did not benefit from the switching grant were convinced enough by the results achieved with the new practices to adopt them even without the subsidy. Small grants were perceived as very good by beneficiaries in that they are easily accessible to the grass root level (74 per cent), personal (63 per cent), with visible results (63 per cent), and directly benefiting the community (62 per cent).

Additionally, **a stable macroeconomic environment** is fundamental for any action to be successful in the long term. It can help plan actions and estimate future economic returns in a credible way. In particular, some relative visibility is needed over new policies that impact inflation, unemployment, or the exchange rate and balance of payment. High inflation contexts are not very conducive to investment or change. Exchange rate fluctuations can impact imports of inputs or exports of outputs, which can reduce domestic producers' visibility of future costs and revenues, thereby also deterring investments. Changes in the balance of payments can impact government funding available for investment into sustainable land management. Unstable macroeconomic environments also typically deter foreign investors from investing into the country. Local action can still be taken in context of relative macroeconomic instability but may not be scaled up easily. Local impacts on livelihoods of macroeconomic instability can be mitigated through diversification of economic activities relying on land. For example, falls in cotton, chocolate, or coffee prices on the international market have had significant impacts on some country's macroeconomic situation as well as local livelihoods (e.g., Ivory Coast), which could have been mitigated through diversification of activities.

High fluctuations in international market prices can limit investment into more sustainable land use or management practices, as well as clearly impact livelihoods of poorer populations. The recent food crises and subsequent political instabilities in Mexico and Northern Africa illustrate this need for a stable economic environment. Investment in food storage facilities is one way to limit market price variations. Investment into research and development of innovative funding mechanisms, and marketing of more sustainably produced products (organic certification, FairTrade®, etc.) can also help remove some of the economic barriers to adoption. These investments started off in answer to niche demand and are now expanding with the private sector picking them up and helping to up-scale.

Technical conditions for success: identifying appropriate and 'future-proofed' technology and securing access to physical resources

'Standard' techniques can be compiled for reference and use, but their application needs to be customised to local biophysical and socio-economic circumstances so that they actually work for stakeholders. In a sense, agronomic research can establish standard management techniques, which can then be promoted through a form of extension service. However, research and extension services still need to be complemented by sharing experiences between land users so that their application suits local circumstances and delivers expected benefits. Specific assessments undertaken parallel to cost-benefit analyses could identify whether the current technical environment could promote the adoption of more sustainable land management practices or land uses.

Not all technologies to mitigate or adapt to land degradation are appropriate in all biophysical or geographical contexts, but also depend on the nature of the problem being faced. For example, mitigation or remediation measures are different for agricultural land subject to water and wind erosion on slopes, than that of salt-induced land degradation. Going even further, not all types of salt-induced land degradation are the same, with very different measures to mitigate the impact of such degradation on agricultural yields or to rehabilitate land to some of its former productivity levels[30]. This means that there is not one blueprint approach to technical measures, but rather techniques need to be thought through and customised to ensure they are appropriate to current and future conditions, and will deliver benefits to land users over both the short and long term. Evidence-based results of specific techniques should be considered carefully before promoting their scaling up and out, especially in places that are outside of the conditions for which the technology was designed.

Knowledge availability and sharing, and capacity of land users is also key to informing the choice of appropriate technology out of several possible options (see *Chapter 5*). Knowledge sharing can ensure cross-fertilisation of good ideas (see UNDP/GEF small grant example, where farmers adopted the technologies after seeing how much better off their neighbours were[9]). This requires building connections, networks, and platforms. WOCAT has a database that references possible sustainable land management technologies with agronomic, vegetative, structural and management measures that can be adopted. The database also details some conditions surrounding the adoption of such measures for specific case studies and locations (*www.wocat.net*). In addition, they have a second database on sustainable land management approaches and a third database on sustainable land management mapping. General, instructional, and dialogue-based videos with land users sharing their experiences with specific sustainable land management technologies or approaches are also available.

Not all techniques require a high level of capital investment into machinery, and in fact techniques can be very low cost with successful results. Promotion of specific techniques require that land users have the know-how and skills, but also access to necessary physical resources such as machinery, equipment (including replacement parts), and the labour needed to implement such techniques. Gender often plays a determining role in the uptake of such options and is an important consideration. Adequate market access can also ensure such techniques are implemented. For example, the lack of market for legumes has been identified in the governorate of Béja in Tunisia as limiting farmers' interest to include legumes into their cropping patterns, in spite of the environmental benefits they provide[31].

Finally, it is important to consider that not only do sustainable land management techniques need to deliver under current conditions but they also need to deliver in the future. Some technologies work in some places at present but may not continue to be appropriate under future climate change. The Climate Change, Agriculture and Food Security of the Consultative Group for International Agricultural Research (CGIAR) supported and funded an initiative to help identify climate analogues to specific sites (*www.ccafs-analogues.org*). The principle of the tool is simple: it uses future climate projections and scenarios for a given location, and identifies locations on the planet where such future conditions are already happening. By pairing 'future climate' sites with their current analogues in other places, this tool helps identify and test technologies that are currently appropriate in terms of whether they are 'future proof'.

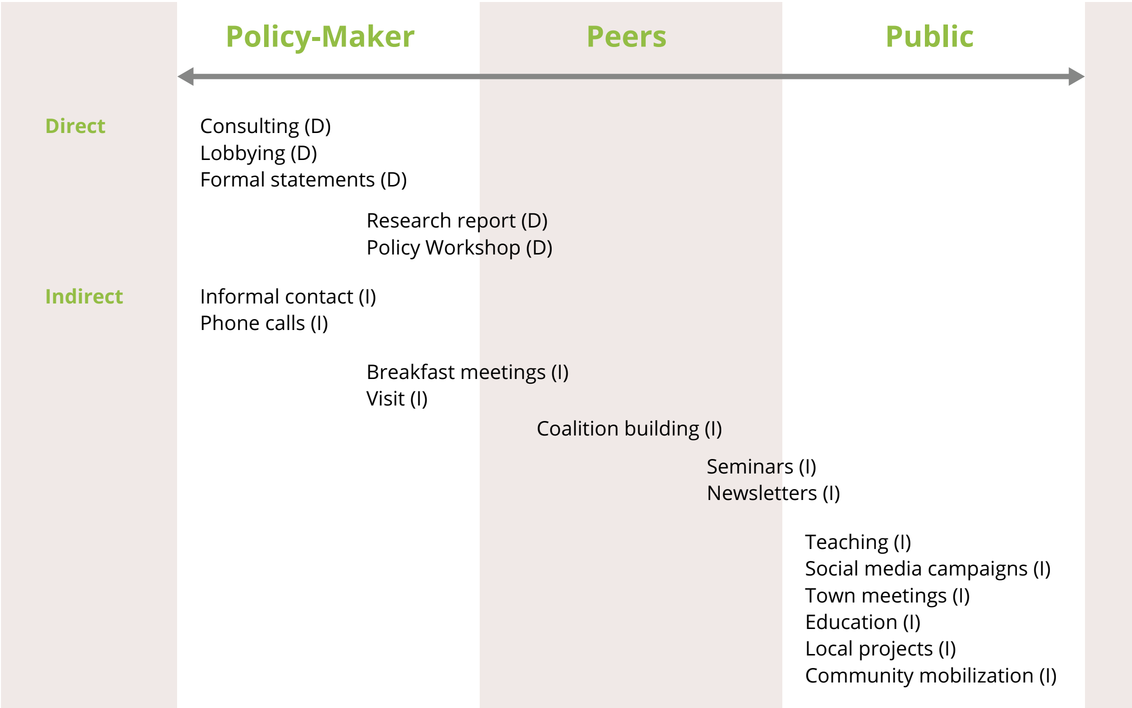
Political conditions for success: establishing good governance and enabling policies

Political conditions for success are often seen as overarching any other types of conditions. Without political will for change, setting up comprehensive incentives to promote the adoption of sustainable land management is difficult, if not impossible. Such incentives need to be resilient to political dynamics, in particular those associated with changes in government leadership or international political pressures. Political science and political economy of public policy are some disciplines that can help shed light on the necessary political conditions for success. Assessments undertaken parallel to the economic assessment could identify whether the current political environment could promote adoption of more sustainable land management practices or uses.

Political conditions for success are associated with the realms of **policy-making** and governance. Policy-making can introduce policy instruments such as taxes, subsidies, tradable permits, or norms and standards for a range of economic activities that have a close or more distant relationship with land and the services it provides. Political consultation processes can facilitate provision of targeted and concise scientific information to high-level decision-makers, of more technical information with examples of application to mid-level decision-makers, and of digested and directly applicable information to local authorities and traditional leaders[25]. Policies can be designed so as to select the 'right' kind of beneficiaries, which is the case for agri-environmental policies implemented in the United Kingdom (UK) which 'auspiciously' select farmers in landscape

FIGURE 6.1

Examples of NGO participation activities targeting a spectrum of policy stakeholders.
(from McCormick, 2014, Figure 1, pg. 13[34])



D: Direct mode of participation
I: Indirect mode of participation

regions of higher societal value for provision of environmental services[32].

Governance refers to the degree of transparency of a country's institutions such as its ministries, parliament, and other government bodies and agencies and processes such as elections and legal procedures[33]. Good governance is associated with high accountability and low corruption of government, but also with equity, participation, pluralism, and the rule of law. Governance is sometimes associated with the concept of stewardship, which implies some control over reasoned decisions whilst governance tends to be a more passive assessment of a system. For example, the UNCCD specifies that NGOs should be included in policy-making processes around land management and used as a way to increase accountability of government and thereby the quality of governance[34].

Each type of stakeholder tends to have their own more or less explicit political agenda, sometimes defended by particular interest groups. Stakeholders use a range of different strategies to interact with government as part of policy-making processes as well as less formal interaction processes. For example, NGOs in Uganda use a wide spectrum of strategies for participating in policy-making processes (*Figure 6.1*). These agendas and how they interact to deliver specific policy outcomes can be studied using political economy methods.

Legal conditions for success: rule of law and property rights allocation

Following up on governance issues, economic sustainability of land use and land-based economic activities depends on the rule of law associated with a working legal system.

Legal systems need to **recognise ecosystem services and total economic valuation** as principles for decision-making and action[1] (see CATIE & GM, 2012, pg. 38–39[8]). Unless the total economic value of all ecosystem services

BOX 6.5

Legal and economic incentives for land restoration in South Africa after open cast mining
(from McNeill, 2014[37])

In South Africa, the granting of mining licenses explicitly require land rehabilitation (and/or restoration) to a pre-determined state to remedy open cast mining damage when the extraction is finished. Mining property rights include rights to prospect, explore, and mine natural resources found in ore bodies and seams. These natural resources are deemed a public good, with mining rights allocated by the state as custodian of the nation's natural assets (South Africa, Mineral & Petroleum Resource Development Act 2002). Mining rights applications are required by this law to include:

- A public participation process with all stakeholder interests and concerns documented, addressed and where possible resolved, and;
- Environmental Impact Assessments and Environmental Management Plans providing technically and financially for land rehabilitation (and/or restoration) to a pre-determined state to remedy open cast mining damage when mining is finished.

The rights to use the surface of the land ('surface rights'), including the right to drill or mine through the surface when subsurface rights are involved, are deemed a private good. Surface rights can be transferred through commercial transactions. The mining companies therefore have strong incentives generated by statutory and regulatory requirements to:

- Purchase land ahead of the mining application to reduce transaction costs associated with the legally required stakeholder consultation process. There are possible trade-offs between higher purchase prices paid to farmers and more expensive leases paid by farmers;
- Restore land at minimum costs because of the lack of legal definition over what constitutes a 'natural' or 'pre-determined state' and the associated level of interpretation around these concepts, and;
- Restore land to a level so that it can be leased out to farmers for natural grasslands and cultivated pastures for cattle production after mining is finished. There are possible trade-offs between lower costs and revenues derived from land use after rehabilitation compared to before (with the same overall profits with change or adaptation of land use).

In the case of South Africa, legal incentives seem to be lined up with economic ones to promote a level of land restoration that is satisfactory to society as a whole.

is recognised by legal systems as the basis for compensation to those who depend on the land, it will be difficult to avoid social unrest and marginalisation[35]. This is even more so when international investors, perceived as 'rich' by the local populations, are involved. Specific assessment parallel to the cost-benefit analysis could be undertaken to identify whether the current legal environment could promote adoption of more sustainable land management practices or uses.

Economic sustainability of land use and land-based economic activities also depends on how the property rights for land tenure and land uses are allocated and formally recognised, with both the type of property right owner (open access, individual property, common property) and type of land use and management formally recognised (user rights, access rights, control rights, transfer rights, tenure security[25,36,37]) (see *Box 6.5*). When customary property rights are not formally registered, they can be ignored or overlooked by governments or international investors to the detriment of local and poorer populations, leading to social unrest and marginalisation. Customary rights are referred to as *de facto* property rights while formally registered claims are referred to as *de jure* property rights. Establishing formally recognised land registers and enforcing individual and collective property rights can help to identify the appropriate stakeholder(s) who should be taking action against land degradation or receiving compensation when property rights are transferred to another land manager (e.g., foreign investors). The UNDP/GEF Small Grants Programme benefited mainly people with less than an acre of home garden to cultivate, with 82 per cent of them having legal ownership of the land in their own name or that of a family member[9].

In many developing countries, there is a lack of harmonisation of customary and statutory laws, resulting in considerable contradiction[25]. Well-developed land registers recognising all types of land uses can facilitate identification of such contradictions. It can also facilitate the implementation, monitoring and evaluation of various instrument and mechanisms based on land-use restrictions and operating on a per-unit-of-area basis (see CATIE & GM, 2012, pg. 38–39[8]). Who compensates whom differs depending on whether the 'beneficiary-pays' (/duty of care) or 'polluter-pays' principle applies. The FAO has established a set of voluntary guidelines regarding responsible governance and land tenure, which could act as a policy template for governments, policy-/decision-makers, and practitioners in determining what constitutes acceptable or fair practices for all.

Cultural conditions for success

Sustainable land management options may not all be feasible depending on cultural values, practices, ideas, beliefs, and behaviours, which can be very strong at the local level. The main constraint is often the objective(s) to be attained, such as poverty reduction, equality of opportunities provided to stakeholders, etc. For example, the establishment of latrines with anaerobic digestion of organic waste can improve sanitation practices and provide energy for cooking and lighting (biogas or fuel briquettes from bioslurry), thereby improving quality of life. It can also provide slurry that can be used as agricultural fertiliser and improve the sustainability of agricultural practices[38,39]. However, not all communities or societies are comfortable with the handling of human waste, with social stigma placed on those 'poo managers'[39]. The success and sustainability of establishing anaerobic digestion systems thus depends more often on cultural acceptability than technical or economic feasibility. Specific assessment undertaken parallel to cost-benefit analyses could identify whether the current cultural environment could promote the adoption of more sustainable land management practices or uses.

The sustainability of the options that are adopted also depends on cultural norms and values relating to gender relations. For example, in Hunshandake China, overgrazed grasslands by cattle, goat, and sheep caused severe dust storms impacting distant locations as well as local populations[3]. Replacement of some of hoofed animals with free-range chicken farming has helped to reduce soil erosion and raised family incomes six-fold through sales of chickens, eggs, and hay from 'spared' biomass. However, genders may have different responses to incentives offered, and changing the incentive structure (i.e., males may manage hooved animals, whereas women may care for poultry) may change the gender balance, intentionally or not. The UNDP/GEF Small Grants Programme's main beneficiaries were women (91 per cent), over 40 years old (69 per cent) and the majority (53 per cent) with formal education up to General Certificate of Education Ordinary Levels[9].

Sustainability of options that are adopted further depends on cultural norms and values relating to power relations. If power relations are unbalanced or if key stakeholder groups are ignored in establishing land use agreements, as was the case in *Case study 6.1*, consensus reached over land use may not hold in the long run. The TEV framework can be used to help rebalance some of the bargaining power asymmetries through provision of a common basis for assessment of the comprehensive value of land.

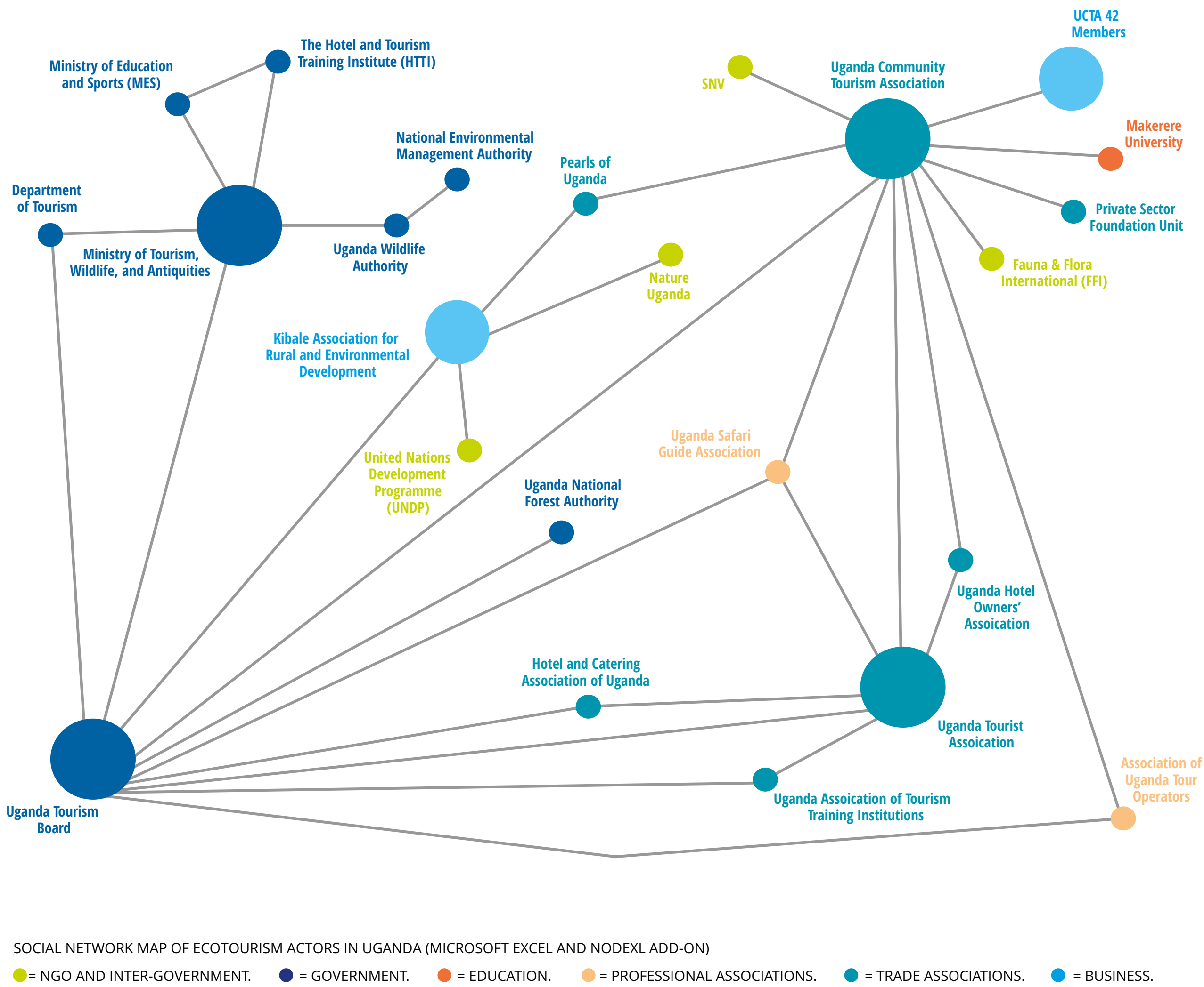
Provision of outreach activities and land-related education may help change some of the cultural values associated with different land management options through provision of and access to information at the levels they are needed.

Social and sociological conditions for success

Options for sustainable development may not all be feasible depending on social and sociological factors. Success requires consideration of all groups of stakeholders – including marginalised and poorer people that do not always have a strong voice – as well as social capital, social networks, and local, indigenous traditions and knowledge. Social analysis could be used to ensure that an option is

FIGURE 6.2

Figure 6.2: Social network map of ecotourism actors in Uganda
(from UNU-INWEH, 2015, Figure 2, pg.16[39])



socially acceptable. Social networking maps may help visualise whether different stakeholders involved in governance or policy-making interact together to identify possible communication channels for adoption of sustainable land management, possible conflicts between specific stakeholders over pathways to be set up because of a lack of communication[38,39,41] (see *Figure 6.2*). Stakeholder selection and knowledge exchange processes set up by public decision-makers can help discuss and identify win-win options that are socially and sociologically acceptable[42,43,44,45,46] (*Chapter 5*). Options that establish sustainable land management often fit with local, indigenous traditions and knowledge. These forms of knowledge are now seen as highly relevant and valuable, to the extent that organisations and initiatives are becoming interested in putting traditional knowledge forward. This includes WOCAT, the UNU-IAS Traditional Knowledge Initiative (*www.unutki.org*), as well as the UNCCD scientific conferences. Specific assessments undertaken parallel to cost-benefit analyses could identify whether the current social environment could promote the adoption of more sustainable land management practices or uses.

Environmental conditions for success

Options for sustainable development may not all be feasible depending on environmental factors, and particularly externalities (costs or benefits imposed to a third party, e.g., pollution). Activities to raise awareness on the links in physical terms between environmental quality and economic activities may be needed to ensure options are environmentally acceptable (see CATIE & GM, 2012, pg. 39[8]). Environmental Impact Assessments and Environmental Management Plans – mandatory or voluntary – could be used to ensure sustainable land management options put forward are environmentally acceptable[37] (see *Box 6.5*). This would be important for alternative livelihood options or options that require land use change.

Enabling action through identifying and removing barriers to action

Identification of barriers to action can help inform the choice of relevant sustainable land management options or the design of pathways so as to ensure successful adoption of selection option, using a mix of economic instruments and mechanisms, legislation and regulation, participatory processes etc. The methodology developed by CATIE and the GM[8] (see *Box 6.3*), particularly the scorecard element, can be used to identify the main barriers to action. The scorecard structure can be expanded and structured along cultural, economic, legal, political, social, sociological, and technical factors, to assess which aspects constitute barriers to action. Combined with participatory approaches, scorecards, and cost-benefit analyses, legal, political, institutional, and environmental analyses can help uncover barriers to action through listening to or establishing dialogue with stakeholders. Participatory discussion can help reveal social, sociological, and cultural barriers to adoption of specific more sustainable land management options[46] (*Chapter 5*). Participatory processes can be used as a means to raise awareness over issues that need to be addressed urgently, such as land degradation, but also a possible means of addressing them. They further provide a channel to build individual, local, social, and institutional capacity. They can help design appropriate measures, building on local traditions and customs and giving an active role to traditional authorities whose support is often needed to spur action[47]. Transdisciplinary approaches – holistic approaches that draw from multiple disciplines and various types of knowledge and expertise – may prove useful and appropriate here. Such approaches may help uncover market failures (i.e., situations where economic markets do not work perfectly), and institutional and policy failures (e.g., when government action cannot compensate for market failures).

Lack of stakeholder participation in policy-making processes has been identified as a possible barrier to action. Providing opportunities for stakeholders

CASE STUDY 6.2

Pioneering a system of payments for ecosystem services: Carbon storage and watershed services in Costa Rica

(from ELD Initiative, 2013, pg. 26–27[1]; Chomitz et al., 1999[50]; Kosoy et al., 2007[51]; Engel et al., 2008[10])

The problem

In the late 1900s in Costa Rica, forest on privately owned land was rapidly being converted to agricultural land and pastures. This conversion was done without consideration of the value of ecosystem services derived from these forests by others, both in Costa Rica and abroad. In response, Costa Rica adopted a law in 1996 that formally recognised the value of services provided by these forests in terms of carbon fixation, hydrological services, biodiversity protection, and provision of scenic beauty. The country has aimed to provide payments to forest owners for each of these values, but has so far only been successful for carbon fixation, hydrological services, and some biodiversity protection.

What is the level of payment?

Levels of payments have generally been set based on previous payment levels provided to forest owners in a different form, and/or after consultation of stakeholders and negotiation. Even when available, no environmental valuation study was used to set up payments levels (e.g., the estimated willingness to pay for water quality in

CASE STUDY 6.2

Honduras was not used to inform the setting up of payment levels for the PES scheme). Payment levels typically tend to be fixed and at a lower level than the costs of provision. Forest owners around Heredia (Central Valley of Costa Rica) are paid USD 51/ha/yr for forest conservation, USD 124/ha for reforestation their first year, USD 100/ha for their second year of restoration, and USD 67/ha for the third to fifth years.

Who pays?

In the case of carbon and other greenhouse gas fixation, polluters (mostly fossil fuel users) foot the bill – the 'polluter-pays' principle. This is in accordance with the Kyoto Protocol on emission reductions which has now become mandatory to its signatories. On the contrary, beneficiaries can choose to pay for hydrological services on a voluntary basis – the 'beneficiary-pays' principle. GEF granted a budget to fund agro-forestry contracts for biodiversity conservation and carbon sequestration benefits, but the local tourism industry has not yet committed any funds to conserve the benefits of natural ecosystems – land users may or may not be aware of the available PES schemes in place.

How is the budget levied?

Most of the budget is levied through a mandatory, dedicated tax on fuel sales, with one third of the tax (5 per cent of fuel sales in 1999) earmarked for forestry. A much smaller part of the budget comes from negotiated voluntary payments by water users such as bottlers, municipal water supply systems, irrigation water users, and hotels. This voluntary contribution changed in 2005 to a mandatory conservation fee earmarked for watershed protection as part of a water tariff.

Who benefits?

Costa Rican forest owners benefit directly from the scheme because they receive financial compensation for forest maintenance. Evidence however suggests that the level of compensation is too low compared to the opportunity costs of conservation. Polluters benefit because they can keep operating on the global market while looking for less polluting technologies or inputs. Users benefit because of the improved environmental quality. They also have a way of expressing their views by providing for these payments, which was not previously an option.

Ultimately, Costa Rica directly benefits as a country: new institutions have been set up to administer these payments with either with the government or NGOs acting as intermediaries, with the associated creation of employment opportunities and increased economic activities. Costa Rica has also received payments from other countries for this system of payments for ecosystem services (e.g., from the Norwegian government, private companies, GEF).

Who administers the programme?

The Costa Rican government and its administrations facilitate the budget collection and implementation of payments. Local level intermediaries have been created in order to reduce the transaction costs associated with payment implementation, and take advantage of economies of scale. These local level intermediaries have helped forest owners fill in the paperwork and liaised between forest owners and the government (e.g., FUNDECOR, a Costa Rican NGO).

What are the conditions for success?

The ecosystem service values to society are recognised by the Costa Rican legal system. The government has been proactive in establishing such payments on a decentralised basis, letting intermediaries establish themselves, obtaining commitments from both stakeholders and providers, and ensuring environmental objectives are met. These commitments are crucial to ensure long-term sustainability of the payments for ecosystem services system.

Being pioneers in payments for ecosystem services meant that Costa Rican stakeholders and institutions have had to be flexible enough over time to evolve and take into account lessons learnt and changing circumstances.

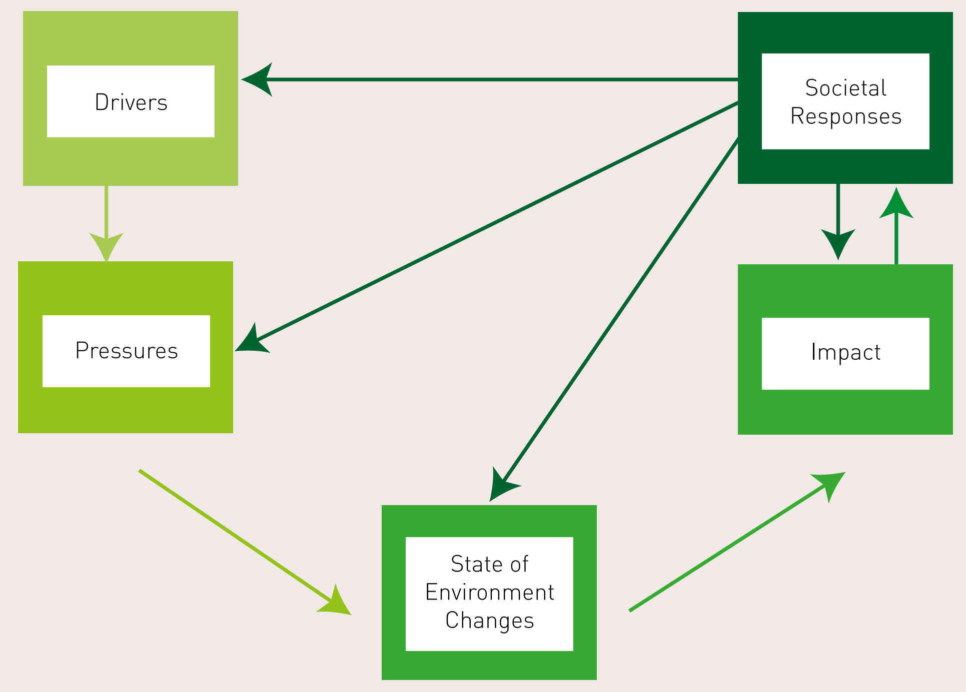
to participate in policy-making has thus been put forward as a way to help make policy more relevant to on-the-ground action. However, providing opportunities to participate does not guarantee that stakeholders will, or that they will do so equally, as this depends on their available human and financial resources for such activities[34]. In some cases, it is more empowering for stakeholders to make a conscious choice not to participate. Stakeholders may also devise various strategies in relation to the means they have to try and influence the setting up of an enabling environment. This encompasses the idea of indirect participation strategies[34] as well as created/claimed spaces for participation[48].

Another way to remove barriers to action can be the co-development of economic sectors, building on their complementarities and synergies. Joint development of complementary economic sectors may lead to faster development than that which would be achieved if developed independently. For example, an ecotourism sector and sustainable sanitation sector in Uganda could be jointly developed so as to take advantage of synergies between the two (see scoping study by UNU-INWEH[39]). Adequate sanitation facilities are key for a pleasurable (eco)tourism experiences, both in terms of personal use and cleanliness of the environment in which they are staying. In turn, (eco)tourists increase the volume of waste generated and collected and therefore increase the volume of positive waste management by-products generated (energy and fertiliser). These by-products can be used to support local tourism for cooking and lighting (energy) and for increased food production (fertiliser). Common physical flows of waste and waste management by-products can be associated with monetary flows. The level of flows will vary depending on specific negotiations and level of mutual benefits.

Another barrier to action is the lack of recognition of the stewardship role land users can have. Land users managing their land sustainably are often stewards of important ecosystem services benefiting society. Managing the land in a sustainable way may contribute to local, and potentially national, regional, and global benefits (e.g., food security, carbon sequestration, water regulations). If society acknowledges these benefits, and that land users may incur costs in providing or protecting them, compensation schemes may be economically justified. This can be done via private deals, with intermediaries such as NGOs, or by public regulations or funding. For example, Costa Rica has chosen to pioneer a PES scheme paying forest owners for ecosystem services, with the government or NGOs acting as intermediaries (*Case study 6.2*). In Vietnam, a decree has been put in place regulating payments from water companies to farmers[49].

FIGURE 6.3

The Driver-Pressure-State-Impact-Response (DPSIR) framework



Design by Carly Popenko, UNU-INWEH

Implementing adaptive processes: building in flexibility to take lessons learnt into account and adapt to changing circumstances

This section focuses on specific operational thematic clusters listed in *Chapter 5*, and expands them by taking a flexibility angle:

1. Sustainable land management technologies, including adaptation;
2. Capacity building and awareness;
3. Knowledge management and decision support;
4. DLDD and SLM monitoring and assessment;
5. Policy, legislative, and institutional framework;
6. Funding and resource mobilization, and;
7. Participation, collaboration and networking.

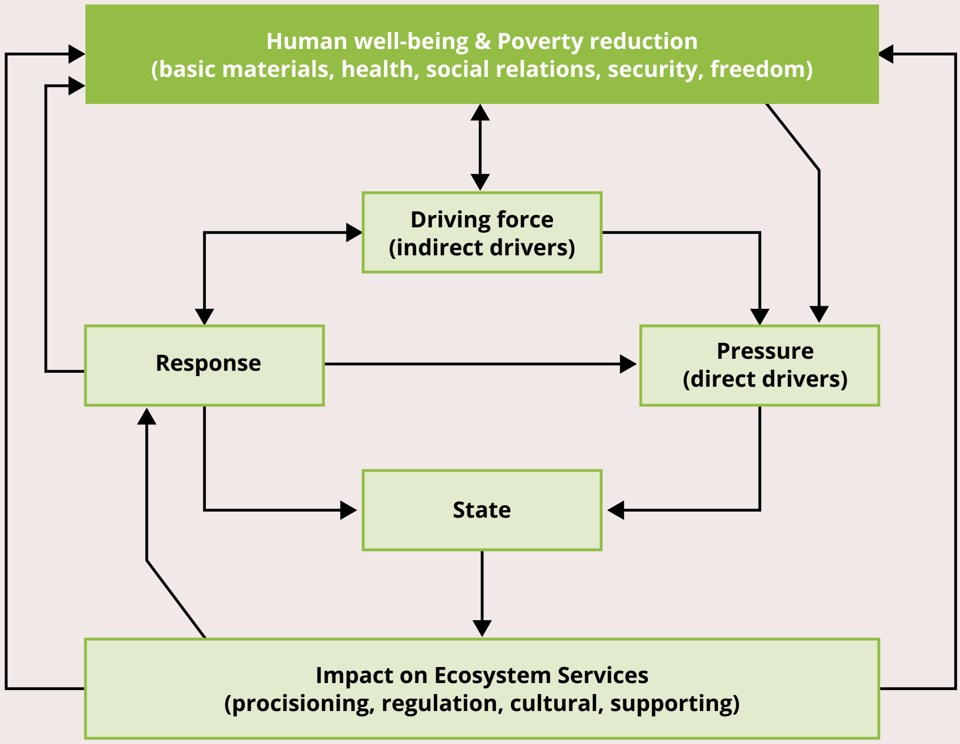
Assessment and policy cycles

The experience of pioneering payments for ecosystem services in Costa Rica (*Case study 6.2*) has shown the importance of **keeping processes flexible** to be able to take lessons learnt into account over time and adapt to changing circumstances. Being able to adapt to changing circumstances implies that assessments will eventually need to be repeated. The future cannot be predicted, but it is possible to consider and prepare for a range of possible futures[52]. Assessments should thus not be a one-off exercise, but rather be applied at regular intervals to gain an idea of how the benefits derived from ecosystems evolve over time. This requires iterative processes that are in line with a changing environment, drivers, and pressures from natural or human forces.

One framework that could help decision-makers take appropriate action is the Driver-Pressure-

FIGURE 6.4

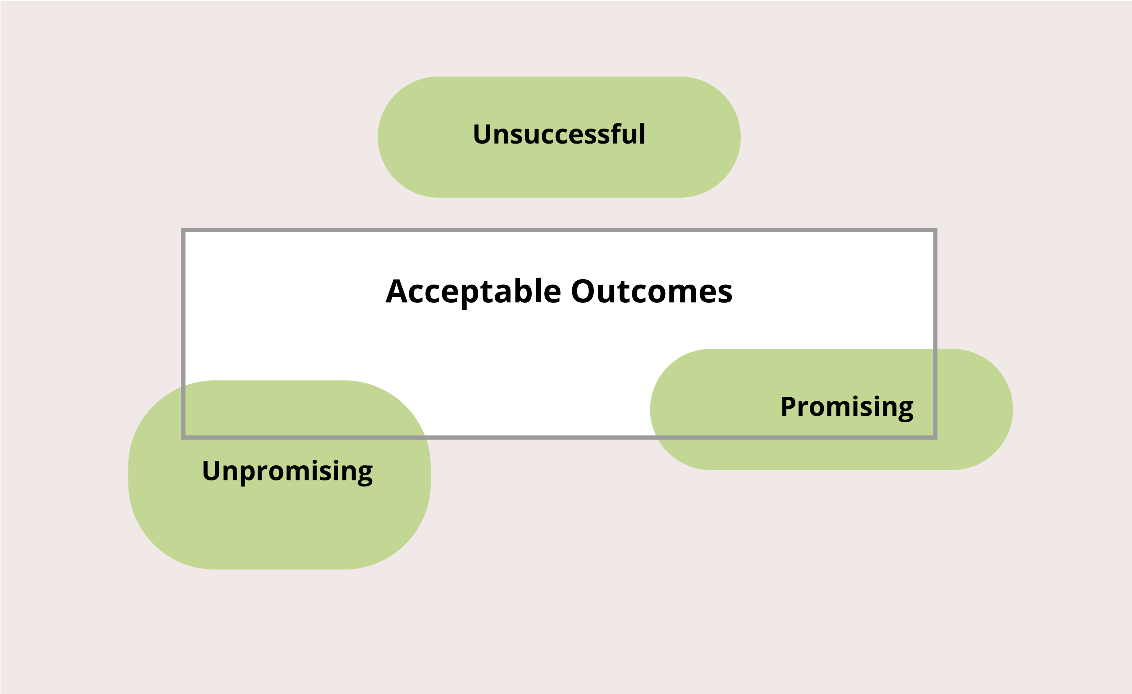
Hybrid SLM framework for monitoring and assessing impacts from SLM interventions
(Schuster et al., 2010 [58])



State-Impact-Response (DPSIR) framework (*Figure 6.3*). The DPSIR framework was originally designed in the 1990s to bridge the science policy gap. It integrates different types of knowledge and dimensions to show cause-effect relationships between environmental and human systems. The DPSIR framework can be used as a basis to communicate solid facts and evidence, which are often rigid, unidirectional, and difficult to understand, by structuring information in a way that is meaningful to policy-makers in formulating their decisions, monitoring the outcomes of such, and reacting to unexpected events[53]. Drivers (e.g., future socio-economic trends, including technological development and policy drivers), which may be social, economic or environmental developments, exert Pressures on a certain environment. As a result of these Pressures, the State of the environment changes (including ecosystem service provision). This then leads to an Impact (social, economic, or environmental), which may lead to a societal Response. The response may feed back to *Drivers*, *Pressures*, *States* or *Impacts*[53,54]. As such, the framework adopts an explicit dynamic perspective. The DPSIR framework nicely complements the ecosystem service framework which also outlines the links between ecosystems and the services they provide society but in a way that put across a more static perspective (relating to states rather than pressures). The DPSIR framework links up instruments and mechanisms (drivers) as possible ways to mitigate and regulate pressures. Inclusion of a wide diversity of stakeholders has been shown to reduce potential biases in the results generated by applying the DPSIR framework. Combined with the frameworks and assessment approach detailed in *Chapter 2*, previous sections of this chapter (*Box*

FIGURE 6.5

The acceptable outcomes zone to inform the design of adaptive policies resilient to a range of possible future changes
(from Walker et al., 2001, Figure 2, pg. 287[52])



6.3), and participatory and stakeholder engagement approaches, the DPSIR framework shows potential to provide insights into the selection of relevant and appropriate sustainable land management options and establishment of action enablers. Ultimately this can help facilitate the delivery of healthy ecosystems and associated human well-being (*Figure 6.4*).[58]

Similarly to assessments necessitating repetition over time, policy also needs to be revised regularly to avoid becoming obsolete. Policy formulation and supporting legislation need to be flexible and forward looking to encourage the institutionalisation of action planning and implementation[25, 52]. Such formulation needs to be supported by evidence with monitoring and evaluation informing revisions and adaptations of policies, but also instruments and mechanisms in a comprehensive way. Policy can be designed to be more resilient over time by taking a range of plausible possible future evolutions of the natural and human environment into account[52] (*Figure 6.4*). The notion of the policy cycle is often put forward in relationship to this need to design policies that can be adapted and revised in time. The policy cycle includes the 'feedback loops' or 'backward engineering' necessary in order to iteratively re-adjust information, instruments and mechanisms to the often very versatile needs of users[25]. An example of policy evolution over time is the development of agri-environmental measures in the EU. Their format was piloted in the 1980s by the UK and the Netherlands. They were then adopted in all EU Member States from 1985, originally on a voluntary basis then with compulsory implementation at national level from 1992. Over a 30-year time period, agri-environmental measures have been given progressively more importance in terms of allocated budget as well as requirements over outputs to be achieved. Such policy evolution was driven in part by the EU itself, and partly in answer to pressure exerted by other countries under the WTO negotiations. As for the PES system established in Costa Rica (*Case study 6.2*), this shows that it is sometimes just as important to start a process and let it evolve over time in a flexible way, in order to best suit the objectives to be achieved, the transaction costs, and other considerations.

BOX 6.6

Examples of innovation platforms

The Consortium for Sustainable Development of the Andean Ecoregion (*www.condesan.org*) uses innovation platforms to address issues in natural resource management. They engage local actors to discuss how to share benefits and resolve conflicts.

In the Fodder Adoption Project, the International Livestock Research Institue used innovation platforms in Ethiopia to improve livestock feeding (*www.feeding-innovation.ilri.org*). Through platform discussions, the project's initial narrow focus on feed broadened to include the procurement of improved crossbred cows, new milk transportation arrangements, and the establishment of a dairy cooperative.

Innovation platforms are also used in several other projects notably the Nile Basin Development Challenge (*www.nilebdc.org*), and the imGoats (*www.imgoats.org*) and PROGEBE (*www.cgspace.cgiar.org/handle/10568/27871*) projects.

In southern Africa, the International Crops Research Institute for the Semi-Arid Tropics (*www.icrisat.org*) used innovation platforms to improve the production and marketing of goats. Innovation platforms helped lower transaction costs in the value chain, meant that farmers could make a bigger profit, and ensured that the market could guide investment in goat production.

The Convergence of Science–Strengthening Innovation Systems program (*www.cos-sis.org*) used innovation platforms in West Africa to improve smallholder agriculture. The platforms studied bottlenecks in production systems and induced institutional changes in value chains and policymaking.

The International Center for Tropical Agriculture and its partners (*www.alianzasdeaprendizaje.org*) developed a regional 'learning alliance' in Central America to improve market access for farmers through collaborative innovation.

The Forum for Agricultural Research in Africa (*www.fara-africa.org*) promotes the use of innovation platforms in integrated agricultural research for development programs that target productivity, markets, natural resource management and policy issues.

(More information can be found at: www.ilri.org/taxonomy/term/58)

BOX 6.7

Examples of knowledge and capacity building

Building institutional capacity with establishment of research, policy, and stakeholder networks and platforms for exchange. The development of networks and platforms leads to greater information exchange between local stakeholders and decision-makers, as well as increasing the scientific basis for informed decision-making[40]. The ELD Initiative is promoting the establishment of regional hubs for exchange around knowledge but also to promote joint projects and activities (see *Appendix 1*).

Improving data availability. The current spatial variations in data availability impair scientific research activities and active international communications[57]. Data availability depends on the wealth level (per capita GDP), language (English), security level, and geographical location in relation to the country. Through scientific education, communication, research, and collaboration, data availability can be improved by building capacity in low-GDP countries with fewer English speakers that are located far from the Western countries that host global databases, and in countries that have experienced conflict.

Building stakeholder capacity. Training workshops for case studies (Tunisia, Central Asia) and two e-learning courses (*www.mooc.eld-initiative.org*) have been set up as part of ELD Initiative activities to build stakeholder and research capacities in specific countries. Such activities require participants to actively engage and apply theoretical content to a real situation of their choice.

Innovation pathways

Innovation platforms defined as spaces for learning and change are being tested as ways to bring together different stakeholders including farmers, agricultural input suppliers, traders, food processors, governments, etc., to identify solutions for common problems or to achieve common goals[55,56] (see *Box 6.6*). They can help spread the risks and start-up costs of interventions to achieve sustainable land management and can work at village, community, district, or other scales. Organisations that use innovation platforms include agricultural research, development agencies, NGOs, local and national governments, the private sector, and donors. They can be initiated by any one organisation or stakeholder group, and by including stakeholders can identify the focus and bottleneck around a particular issue, identify and test options, and develop any lacking capacities. Once a successful option has been established, the platform can facilitate its implementation and scale-up via training and use of communication media. Being highly participatory, innovation platforms create ownership and facilitate communication, both in terms of space (replication to other areas) and institutions leading up to policy-/decision-makers, and hence able to achieve greater impact.

Knowledge and capacity building: supporting flexible designs and evolutions

Knowledge and capacity, alongside building the necessary connections, networks and platforms, provide important support to flexible designs and discussions around how to make the enabling environment evolve in time *(Box 6.7*). In most cases, building individual, social and institutional capacity needs to be done “one brick at a time”, in a way that is adapted to stakeholders’ needs and values. Solutions and an enabling environment need to be carefully considered by people knowing the context inside out to select sustainable land management options and pathways that are adapted to the specific environment. Guiding and coaching are often more important than providing a finished product, and knowledge and capacity building need to remain flexible, with lessons learnt supporting flexible evaluation and revision processes. The ease of implementation will vary, as some cultures may traditionally value and be more comfortable with blueprint approaches than flexible processes.

Conclusion

Mainstreaming and multi-stakeholder communication and action on land issues are more than ever the crux for sustainable land management, together with shared ownership and polycentric approaches to action. People seem to be ready to accept additional efforts and costs if they can identify with the issues being tackled and trust the actors that are promoting them.

Making options and pathways for action successful in terms of promoting adoption of sustainable land management is feasible but presents some challenges. Such challenges summed up by the GM of the UNCCD represent the need for people working to promote sustainable land management to:

- Secure reliant donor or government support ;
- Establish willingness by governments to put in place policies, strategies, and plans with appropriate instruments and mechanisms working in synergy;
- Consider transaction costs which can be in some cases very high;
- Consider situations where demand for specific ecosystem services is limited, and;
- Consider a mix of different actions for different scales for land use management change, partial or full land use change.

Economics are part of the solution, but are not necessarily sufficient to promote lasting change on their own. Transdisciplinary approaches drawing from multiple disciplines and including knowledge and experiences from practitioners and traditional sources can be key in the success of specific options and pathways. Psychological and behavioural barriers are possibly the most difficult to overcome. There is a need to debunk incorrect perceptions of future benefits, switching and novel operating costs, level of efforts required, and difficulty in going around 'red tape'. There is a rationale for choosing pathways and ways to promote relevant land management options by drawing insights from the psychology of individuals as well as group psychology. Psychology insights could help promote adoption of more sustainable land management and alternative livelihood options, but also aid with scaling up and out current practices where suitable. The main barrier to action is to encourage people to overcome their natural tendencies to keep doing 'business-as-usual' even when not in their best interest. It is possible to build evidence to take down one barrier to action after another, but the state of land degradation globally currently exists in a context where action is often needed now and fast rather than later and slow.

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CHAPTER

07 Outcomes and conclusions

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Introduction

This report has explored the ELD Initiative's approach to establishing economic valuation and cost-benefit analyses that can help identify economically desirable options, with examples and applications at the global, regional, national, and local scales. This includes outlining how to apply and understand these methods, which are further supported by the ELD User Guide (2015)[1], and ELD Practitioner Guides (2014, 2015)[2,3]. Contributing experts have researched and analysed a variety of case studies and examples across scales, and it has been consistently shown that investing in sustainable land management can be economically rewarding with benefits outweighing costs several-fold in most cases. Approaches to sustainable land management must take into consideration the biophysical, cultural, economic, financial, legal, political, social, and technical conditions of each targeted area and scale, and analyses should consist of different, practical scenarios. This is so that land users can select and ensure the success of chosen sustainable management options. It additionally must include – though it often does by proxy – consideration of marginal populations and the rural poor, local and indigenous traditions, knowledge, land rights, gender, diverse livelihoods, and income equality, amongst other factors.

With desertification, land degradation, and urbanisation encroaching on fertile lands globally, now is the time to mobilise our collective resources – intellectual, physical, human, and financial. We must efficiently and effectively harness what ecosystems can provide in an economically and environmentally sustainable way. Beyond protecting existing fertile lands from degradation and adapting or changing land use where necessary to be more sustainable, over two billion hectares of land across the Earth are currently suitable for rehabilitation[4]. A multitude of international initiatives are being established with the objective of betterfood, energy, and water security, including Germany's 'One World, No Hunger' initiative or the Building Resilience through Innovation, Communication, and Knowledge Services project hosted by Comité permanent Inter-Etats de Lutte (CILSS), other initiatives related to sustainable development under climate change, etc. The ELD Initiative has compiled findings and recommendations from available literature, recent case studies and key ELD partners to guide the way to achieving the goals of improvedfood, energy, and water security. As we are in the middle of the United Nations Decade for Deserts and the *Fight Against Desertification*, guided by the target of land degradation neutrality, the time is ripe for action. To further cement this goal, the ELD Initiative presents the following findings and recommendations:

Summary of Findings

- Reduced productivity and increased demand for land threatens the security of the global food-water-energy nexus, human and environmental wellbeing, and particularly endangers the rural poor;

- Globally, annual ecosystem service value losses of USD 6.3 to 10.6 trillion occur, representing 10–17 per cent of the world's GDP and highlighting the importance of combating land degradation;

- Sustainable land management approaches and techniques can slow down or pause land degradation processes, and can restore foregone productivity and provide economic benefits and higher return on investments;

- Scenarios based on different development pathway options indicate that the adoption of SLM-enabling environments can provide an additional USD 75.6 trillion annually;

- Understanding the benefits from SLM helps decision-makers to make informed decisions on resource management and contribute to the maintenance of human-wellbeing;

- Sustainably managed land can help to maintain biodiversity, alleviate poverty, and foster economic prosperity, contributing to the SDGs in a number of ways;

- By adapting to SLM techniques for current and novel conditions under climate change, the 'carbon sink' function of land can be increased and help mitigate climate change;

- The ELD Initiative addresses the knowledge gap on the benefits of SLM by providing adequate tools, which guide the assessment of potential action pathways and activities:

  - The *impact pathway framework* provides understanding of different investment opportunities and options, which could be pursued by policy-/decision-makers
  - The *capital asset framework* focuses on human-wellbeing and highlights how humans and the environment are interconnected
  - The *ecosystem service framework* provides classification of the benefits, which are obtained from a specific landscape and helps to assess the full value of such landscape in the *total economic value (TEV) framework*
  - A *decision-making framework* with net economic benefits based on the TEV structures assessment of the most beneficial pathway;

- The ELD 6+1 step approach functions as a frame for these tools and integrates them into a structured and applicable methodology. It provides a harmonised and internationally recognised method to identify the benefits from SLM;

- The integration of scaled perspectives is crucial for success of envisioned projects. Available data, appreciation, and prioritisation of natural resources and contextual factors can vary across national boundaries and thus must be addressed according to scale and context;

- Alliances between policy-/decision-makers and researchers provide essential feedback mechanisms and should be sought to ensure relevance and applicability of the economic assessment;

- Capacity building is key in creating the necessary understanding amongst stakeholders to disseminate key findings, stimulate discussions and feedback on assessment results, ensure monitoring and evaluation of land use changes, and identify gaps in policies and the SLM framing environment;

- Multi-stakeholder consultations on regional, national, and sub-national scales also facilitate the identification of entry points for transition towards towards SLM, and integration of results into into ongoing and relevant policy processes, such as contributing to development plans or action plans contributing to international conventions, such as the UNCCD;

- An enabling environment created through supporting biophysical, cultural, economic, environmental, legal, financial, political, social, and technical conditions must be in place to successfully motivate the uptake of SLM;

- In order to enable action by land users, a wide range of incentive mechanisms has been identified by the ELD Initiative and are available for policy makers depending on contextual factors. These can be divided into:

  - Public payment schemes involving financial incentives paid to or by the government to promote the uptake of SLM technologies
  - Open trading under regulatory caps or floors to create markets by reducing and subsequently marketing degradation of ecosystems or rehabilitation credits
  - Self-organised private deals can be established between individuals or companies and help to balance costs and benefits from land degradation and SLM
  - Eco-labeling of products and services providing a strong incentive to the private sector to re-design its land management or investment endeavours;

- The design of appropriate incentive systems depends on the context, and is of high importance where SLM is not perceived as a viable approach without external support. The appropriate selection of incentive mechanisms to support SLM uptake can be informed, e.g., by a tool developed by the GM & CATIE (2012), which includes:

  - Quantitative scorecards, highlighting the impact of incentives on pre-defined success factors
  - Qualitative assessments indicating which mechanisms help to achieve previously set goals
  - Cost-benefit analyses;

- Several success factors have been identified, which need to be considered and taken into account when reshaping the enabling environment:

  - Mobilisation of necessary funding for investments. This can be raised in cooperation with multi- or bilateral donors, but also by accessing collective funds. Integrated funding strategies help to mainstream the different resources
  - Securing a stable macro-economic environment that allows long-term planning and investment by private financiers
  - Future-proof SLM technologies by taking into account future developments such as climate change. This can also include a mix of SLM technologies, which are socially and biophysically applicable
  - Integration of ecosystem services into decision-making, and reflection of the value of land in legal systems and design of property rights
  - Secure policies that address the uptake of SLM by benefiting providers of ecosystem services while respecting good governance principles
  - Ensure that selected SLM technologies, which are incentivised comply with the cultural and social setting;

- Barriers which hinder the adoption of SLM technology need to be identified, discussed, and addressed. Participation of different stakeholder groups ensures that all perspectives are integrated accordingly and avoids future obstacles to more sustainable pathways.

Recommendations

- **Economic considerations:**

  - Sustainable land management can be facilitated through a range of instruments, from state land ownership and regulatory mechanisms to more

incentive-based approaches, including financial instruments (e.g., subsidy reform, or tax breaks) and the development and enhancement of new markets for different ecosystem services (e.g. payments for ecosystem services, carbon credit commercialisation, etc.). Identification and elimination of perverse incentives (e.g., encouraging overharvesting) is a necessary step, especially when commercial markets are created;
- Economic instruments should maximise social value, human well-being as well as economic value, i.e., create shared values[5] that do not compromise an equitable distribution of benefits, and;
- Economic measures should create incentives for land users to invest in land resources (e.g., by preventing the provision of certain services at the expense of others).

- **Policy and institutional considerations:**

  - Greater efforts are required to capture the benefits and costs associated with ecosystem services. Policies that fail to take a holistic approach to valuing ecosystem services will require amendments to ensure that land degradation is comprehensively addressed and thereby avoid seen and unforeseen social and economic costs;
  - Combined socio-economic, cultural, and environmental assessments are key in policy development that aims for sustainable livelihoods with limited environmental impacts;
  - Political leaders need to demonstrate increased willingness to act on the evidence-base for sustainable intensification of land use, in particular to fairer policies with respect to land ownership and access;
  - Land degradation issues need to be mainstreamed into development frameworks, plans, and strategies need to take into account cultural implications that impact livelihoods;
  - By enhancing harmonised national capacity and inter-sectoral institutional building, increased coordination and implementation of existing policies can be achieved, as well as the mainstreaming of land issues across sectors, policies, and disciplines towards sustainable and inclusive economic growth. This should be particularly encouraged in developing countries to support land policy and planning, as sustainable land management is key in poverty alleviation and job creation;
  - Policy recommendations should target all sectors involved in land use and management, drawing on the strengths of each in advancing sustainable land management, and;
  - Subnational and local level institutions should be reinforced, so that payments for ecosystem services and other economic instruments can be enacted.

- **Private sector:**

  - The private sector needs to become actively involved in sustainable land management, especially those who desire to invest in land and its people, as well as land managers;
  - For private sector involvement to be achieved, evidence of the returns on investments of sustainable land management practices must be generated, and;
  - The private sector has a key role to play in the scaling up of successful interventions but requires appropriate incentives to share the costs of remedial or preventative practices that are often beyond the reach of small holder land users.

- **Communication:**

  - Communications on land degradation must be tailored to meet different stakeholder needs, involve two-way dialogues at country and local levels, and be made available, accessible, and visible to all in a timely way, and;
  - ELD networks can feed into existing networks such as National Coordinating Bodies in support of the implementation of National Action Plans (NAPs), and should be extended to the local (village) level, allowing the provision of additional input and feedback to national platforms.

- **Scaling up (and out), and best practices:**

  - There is a need to go beyond fragmented, one-off projects. A systematic approach

should be established to scale up (and out) successful innovations for transdisciplinary approaches that enable an understanding of how land and land use can be better planned and managed from different scale and stakeholder perspectives;
- Partnerships should be fostered between government, civil society, private sector, international, and regional actors, in order to build multi-stakeholder teams that allow resource, learning, governance, and knowledge gaps to be addressed, enabling SLM;
- The up-scaling process has to be linked to national priorities and budgets in order to be effective;
- ELD champions at different scales should be identified and encouraged to raise public awareness of the issues;
- Key barriers to up-scaling (e.g., lack of financial resources, knowledge, institutional capacity, and adequate national policy, economic, legislative, and regulatory frameworks) must be removed, and;
- Projects that have been successful in addressing SLM using participatory methodologies, even if small in scale, should be used as models for up-scaling where appropriate.

Taking action:

- Assessments can be performed with limited data availability (methods like multi-criteria decision analysis can be used effectively when data is limited), and taking action now is more critical than ever. Time should not be lost debating semantics or refining assessment methods, as uncertainty is inevitable but not an excuse for not taking action;
- The ELD User Guide[1] and approach (step-by-step economic valuation and decision support tools) should be adapted for implementation by national and sub-national stakeholders, and existing studies should be put in place;
- Local participation must be ensured through review and integration of the different approaches and decisions by local actors;
- There is a need for more detailed information on how action can be implemented (pathways and toolkits for decision-makers);
- Landscape-scale computer simulation models can help create and evaluate scenarios for ecosystem restoration compared to business as usual, and should be used to engage the larger public in thinking about the kind of future they really want, and;
- With the adoption of the SDGs countries will have the incentives to build capacity for holistic assessments of land use change options based on a thorough economic analyses of the costs and benefits using the methodology and approaches that the ELD has provided.

Next Steps for the ELD Initiative:

The work of the ELD Initiative is intending to continue beyond the initial time frame of 2015 to a next phase which will see the fostering and reaping of further benefits from the network of experts, practitioners, and decision-makers that has been established. It will retain its mission statement and vision as noted in the beginning of this report.

The ELD Initiative will take a stronger role in facilitating improved decision-making, as the scientific results of the Initiative's research activities will be transformed into decision-support tools.

The ELD Initiative has become institutionalised and has established a positive global reputation, with a presence in many different countries and institutions (e.g., the new portfolio of collaborative research programs of the CGIAR). As the Initiative has evolved, there has been an increase in requests for training and further studies. Based on these requests but also the need for action on the ground, the ELD Initiative will reduce their focus on pure research and fill the gap of action-oriented research, with a clear focus on national and regional issues, linked to national and regional decision-making processes. This will include co-funding of case studies, the establishment of additional funding partnerships with organisations capable of research support, the extension and integration and exchange with relevant partner networks, and the development of

TABLE 7.1

Areas of action for the ELD Initiative, post-2015

Capacity building (development of training materials)	▮ Virtual e-learning ▮ Further facilitation to develop user-based assessments ▮ University courses ▮ Training for economic assessments targeting national level decision-makers (e.g., Soil Leadership Academy (see *Appendix 1*) and training for land degradation neutrality)
Regional work	▮ Extension of the ELD regional hubs and networks (see *Appendix 1*) ▮ Expert databases and using ELD as a knowledge hub (methods and data case studies, background information, experts) ▮ ELD in Africa (presentation at regional meetings, collaboration, etc.)
Science-policy dialogues	▮ Scientific support to assessments and case study implementation (Tunisia) ▮ Stakeholder consultations and engagement for the establishment of policy-relevant tools
Private sector	▮ Extension of collaboration groups in knowledge portals ▮ Increased focus on smallholder and gatekeeper organisations (World Business Council for Sustainable Development (WBCSD), World Resources Institute (WRI)) ▮ Link to existing organisations (i.e., Commonland, Natural Capital Foundation) ▮ Contribute to implementation of the tools (e.g., ELD Land Materiality Risk Assessment tool, to be released late 2015) ▮ Link to the insurance sector (e.g., micro-insurance as a tool for smallholders in linking to the private sector), with research (e.g., AXA foundation, coop partners, etc.)
Other	▮ Link to special initiatives (e.g., SEWOH of BMZ), and research in the soil/land context ▮ Link to climate change (e.g., Climate Smart Agriculture, REDD+, etc.) ▮ Link to the Collaborative Research Programs of the CGIAR

an automatised tool kit. This list of non-exhaustive efforts will follow the 6+1 step approach supported by the ELD Initiative and focused on:

- Awareness-raising and introductions to the ELD Initiative
- Brief scientific study on the gaps and options, linked with training of local experts so these research methods can be duplicated (capacity-building)
- Presentation of results and options for sustainable land management scenarios to policy-/decision-makers

Table 7.1 outlines specific areas for action post-2015 for the ELD Initiative.

Final Conclusion

As we shift into uncertainty over future climates and other major global stresses on water and land, it is critical that we take informed action to protect and preserve our natural resources in a sustainable manner for ourselves, for others, and for generations to come. As part of global efforts to address these issues, a wide range of experts and practitioners, through this report, have established:

- A review and database of the economics of land degradation and desertification, and the need for, and benefits of economic approaches to sustainable land management as one of the solutions;

- A guideline for the ELD approach to holistic cost benefit analyses through total economic valuations (with the provision of other methods and approaches where there are temporal, spatial, logistical, or financial constraints), that can function at any scale;

- A global approach to the ecosystem services that land and land based ecosystems provide, the types of trends functioning at this scale, and the possible models which can make projections based on different scenarios;

- A regional perspective on the benefits of sustainable land management, emphasising the need for larger databases to understand the net present value of action versus the costs of inaction at this scale;
- National and local stakeholders engagement processes to provide scientific inputs to the development of appropriate national action plans, determination of appropriate pathways to action, and integration of local knowledge while building up local capacity for resilience in sustainable land management, as well as capacity for policy-/decision-makers to make informed and beneficial decisions;
- A review of conditions for success, and;
- An understanding of the broader networks, collaborations, and partnerships that are both available and possible to work in harmonised efforts for a land degradation neutral world that uplifts the people to achieve security, livelihoods, self-sustenance, and equality.

The Constitution of the Iroquois First Nations people of what is now North America contains a powerful belief that it is our responsibility to look ahead and consider the impacts of our actions on those seven generations ahead of us, *"In every deliberation, we must consider the impact on the seventh generation... even if it requires having skin as thick as the bark of a pine."* Even beyond that, the ethics of stewardship create a responsibility for us to care for the welfare of all environments on earth and the interconnected web that keeps everything balanced.

It is our expectation that the economic tools, methods, and guides presented here and in all other endeavours of the ELD Initiative act as both a catalyst for and driver of sustainable land management through an understanding of the economic rewards of investing in such, for a land degradation neutral world for ourselves, and for generations to come. May the holistic understanding and experiential knowledge of land management like that of the Iroquois drive efforts to restore balance to a world that includes careful, relevant consideration for the well-being, livelihoods, security, and health of all global citizens, man, woman, child, and nations alike.

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Appendix 1: ELD networks and collaborations

The ELD Initiative maintains a set of networks and collaborations in different regions globally, to ensure that issues at this scale are understood and targeted, for effective movement towards sustainable land management through economic understanding.

ELD Regional Hubs

As the intent of the ELD Initiative is to provide scalability, part of these efforts also includes setting up regional hubs. The devolution of the meta-structure of ELD into regional hubs has the aims of: i) collating current case studies, ii) facilitating the preparation of case study proposals, and iii) training and linking with different initiatives. Bringing the global assessments of the ELD Initiative down to the ground level allows for the nuances of local and indigenous knowledge, practices, languages, and goals to be centralised and thus support sustainable land management practices in a practical, relevant way. It can also capitalise on the existing datasets and knowledge within each region and help to identify gaps, as well as serving as a platform for experience-sharing and knowledge exchange. The establishment of such hubs is currently being explored by the ELD Initiative and its partners in several regions of the world, as follows:

Sub-Saharan/Eastern Africa

a. Overview of the issue

Sub-Saharan Africa accounts for 18 per cent of the worlds degraded lands, an issue which is most severe in their drylands, at a rate of almost 50 per cent degradation[1]. The main drivers of degradation in the region are: soil erosion (wind and water induced), nutrient depletion (caused by overgrazing, de-vegetation, and limited application of fertiliser), degrading crop production practices, and declining use of fallow[2]. Decreased agricultural performance also induces poverty and insecurity in addition to severely hampering ecosystem services. Given that the rural poor depend primarily on agriculture for their livelihoods, and that the primary use of land in in this region is agricultural and pastoral[3], it is crucial to address this issue and restore the lands sustainably.

b. ELD Regional Hub

The ELD Initiative is actively looking to establish a regional hub for Eastern Africa, with hopes to expand it to all of Sub-Saharan Africa. Given its excellent connectivity to global institutions as well as on-the-ground practitioners, Nairobi, Kenya was selected as the logical location for an inaugural ELD Regional Hub. As of 2015, discussions have involved the International Center for Tropical Agriculture (CIAT-Kenya) as the potential coordinator, with partners at the International Union for the Conservation of Nature (IUCN), Stockholm Environment Institute (SEI Africa), United Nations Environment Programme (UNEP), and United Nations Development Programme (UNDP), along with the ELD Secretariat and Scientific Coordination, to participate in and coordinate a network relevant in the Eastern African, and eventually all of the Sub-Saharan context.

The ELD-Africa Hub would include the goals of: collating and exchanging case studies, facilitating the set-up of collaborative proposal between institutions working on the economics of land degradation/sustainable land management, and organising and coordinating between different training initiatives on economic methods related to the ELD Initiative. An initial meeting was hosted by CIAT in June 2014 in Nairobi, in parallel with the ELD Initiative's 3rd Scientific Meeting. Participants discussed the additional goals of ensuring that there is a unified message for and from the region, and using the hub to push ELD research to the next level, including raising its profile through the promotion of discourse and action around ELD. Research on the economics of land degradation is now being included in the new portfolio of several CGIAR Research Programs that will run from 2017 (*www.cgiar.org*).

Asia

a. Overview of the issue

Asia faces unique challenges when it comes to land issues, due to its widely varying geography and populations, and traditionally has the highest proportion of degraded forests in the world[4]. Land degradation in the region has been caused by a combination of poor resource management policies, overexploitation, over cultivation (especially in marginal lands), overgrazing, declining soil and water resources, and last but not least, rapidly increasing population pressures[5]. Over half of the world (4.4. billion people) lives in Asia, with 90 per cent of the population living in arid, semi-arid, and dry sub-humid regions, unfortunately those most affected by degradation[5]. This increases demand for agricultural production; further placing pressure on Asia's many fragile drylands. Although rates of degradation vary widely depending on the sub-region, it is a problem that all of Asia faces. It is particularly severe in Central Asia, an area that the ELD Initiative is actively working in and discussed later in the section on *ELD Regional Networks*.

b. ELD Regional Hub

The ELD Initiative is actively establishing a regional hub for south-eastern Asia, with hopes to connect it with the wider continent. As of 2015, discussions have involved the Economy and Environment Program for Southeast Asia (EEPSEA) as the coordinator, with Stockholm Environment Institute (SEI Asia), the local branch of the UNCCD, Sukhothai Thammatirat Open University, Resources, Environment and Economics Center for Studies in the Philippines, (REECS), the CGIAR centre World Fish, along with the ELD Secretariat and Scientific Coordination, to participate in and coordinate a network relevant in an Asian context.

The ELD-Asia Hub includes similar goals to the ELD-Africa Hub of: collating and exchanging case studies, facilitating the set-up of collaborative proposals between institutions working on the economics of land degradation/sustainable land management, and organising and coordinating between different training initiatives on economic methods related to the ELD Initiative. There will be an emphasis on creating enabling legal frameworks, contributing to national economies, and supporting the efforts of the various governments to meet their commitments to the SDGs, especially the envisioned land degradation neutrality goal. The target countries are Myanmar, Vietnam, Thailand, and the Philippines, based on the severe extent of land degradation found in these nations. An initial meeting was hosted by KFS in January 2015 in Bangkok in parallel with the ELD Initiative Writeshop, where participants identified additional goals of linking on-going efforts in the region (e.g., with EEPSEA) with the ELD Initiative to strengthen synergies, creating opportunities for new case studies and funded research, and harmonising the needs different regions of Asia (e.g., eastern, south-east, south, central, etc.) succinctly.

Latin America and the Caribbean

a. Overview of the issue

Similar to Asia, Latin America and the Caribbean (LAC) encompasses a wide variety of geographic regions and populations that face unique issues when it comes to land degradation. The primary driver of land degradation is poor agricultural practices, coupled with over extraction of resources, and further exacerbated by increasing effects of climate change[6]. Other geographically specific issues include erosion, water shortages, severe droughts, deforestation, and vulnerability to natural disasters and climate change[7]. Over 20 per cent of all land in the LAC region is degraded, with over 50 per cent of forest cover lost, nearly 45 per cent of croplands degraded in South America, and much higher numbers in Meso-America with 74 per cent of cropland degraded[6]. For the Caribbean, the island nature of the countries is an issue, particularly when it comes to the nexus between land and water, as both are finite.

b. **ELD Regional Hub**
As the latest region to be explored for its potential as an ELD Regional Hub, developing a LAC hub is still in an early stage as of the writing of this report. Potential partners could include practitioners at local universities and governments that have expressed interest, as well as the Economic Commission for Latin America and the Caribbean (ECLAC/CEPAL) in Santiago de Chile, which currently supports a Regional Coordination Unit for the UNCCD, and AridasLAC, along with the ELD Secretariat and Scientific Coordination, to participate in and coordinate a network relevant to the LAC context. During ELD stakeholder consultations held in Chile in 2014, discussions were held with AridasLAC to consider this hub and integrate their objectives of: i) producing a dryland outlook for the LAC countries focusing on economic and social processes and impacts of land degradation and drought, ii) linking scientific approaches with knowledge and actions on the ground to addressing land degradation and drought, and iii) provide high-level (Ph.D.) training to field officers. This was explored in more depth in *Chapter 5*.

ELD Regional Studies

Central Asia

a. **Overview of the Issue**
Central Asia has a variety of geographical regions, including mountains, steppe, and shrublands. It is naturally a very dry and cold region, with rapidly decreasing water availability that is increasing the vulnerability of the land. As a result, Central Asia currently has high degrees of land degradation and desertification, and particular difficulties with poor irrigation practices that have resulted in the salinisation of over 50 per cent of the land[8]. Other land degradation issues common across Central Asia include waterlogging, overgrazing, wind and water erosion, soil compaction, nutrient depletion, and desertification, which are caused by overgrazing, poor management practices, pollution, and over extraction[8,9]. Agriculture is crucial for the development of the region, and as many of the rural poor depend on agriculture for their livelihoods, implementing sustainable land management is also crucial for the security of these marginal populations in Central Asia.

b. **ELD Research and Network**
In response to the need for sustainable land management in Central Asia, UNCCD has initiated a process where the ELD Initiative is working collaboratively with Korea Forest Services (KFS), the Advisory Service on Agricultural Research for Development (GIZ-BEAF), and CGIAR (previously known as the Consultative Group on International Agricultural Research) Program Facilitation Unit for Central Asia and Caucasus, hosted by the International Center for Agricultural Research in the Dry Areas (ICARDA). The project goal is to create national case studies in five countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, with further analysis on issues they are facing collectively.

Using the approach outlined by the ELD Initiative in its Scientific Interim Report[10], the project will assess land management with a cost benefit-analysis for both current and alternative sector-specific land management plans, inclusive of gender-informed livelihood options and income generation. Through a specific focus on the economic impact and viability of different options, it will provide decision-makers with a basis from which to choose the most appropriate economic options for sustainable land management. It is expected that the outcomes of these studies will inform the development of the respective National Environmental Action Plans and National Strategies for Sustainable Development. Results will be presented in a report from each nation, along with a summary report for the entire sub-region, with an expected delivery of late 2015.

Other land initiatives

In addition to the wider ELD network discussed in the beginning of this report, there are a mosaic of partner institutions, universities, think thanks, NGOs, businesses, and intergovernmental organisations, there are a broad variety of other land and land-degradation initiatives that ELD Initiative collaborates with, learns from, and/or seeks to connect with, for greater momentum and synergy for sustainable land management globally. Some of these networks, non-exhaustively, include:

Global Mechanism of the UNCCD

Inaugurated in 1998, the GM is a UNCCD body aiming to assist nations in securing financial resources and increase their investments in sustainable land management. They were mandated by the UNCCD to "increase the effectiveness and efficiency of existing financial mechanisms and to promote actions leading to the mobilisation and channelling of substantial financial resources, the GM supports developing countries to position SLM as an investment priority. In addition, it provides countries with specialised advice on accessing finance for SLM from a range of public and private sources, both domestic and international"[11].

Throughout the course of the ELD Initiative, the GM has counseled and supported their work in matters particularly related to efforts to reach out and engage with the private sector. Understanding the mechanisms and drivers for businesses investing in sustainable land management is critical in securing a land degradation neutral world. More details on private sector engagement with the economics of land degradation are available in the ELD Business Brief: 'Opportunity lost: Mitigating risk and making the most of your land assets'[12], and private sector summary report that parallels this one, to be to be published in late 2015.

World Business Council for Sustainable Development

The World Business Council for Sustainable Development (WBCSD) was created in 1992 to "galvanize the global business community to create a sustainable future for business, society, and the environment", and " ... plays the leading advocacy role for business. Leveraging strong relationships with stakeholders, it helps drive debate and policy change in favor of sustainable development goals"[13]. It is composed of 200 CEO-led organisations that represent all sectors from across the world. The WBCSD is divided into focus areas, sector projects, system solutions, and capacity building. Their sector projects are a special feature, and are practical initiatives to work out how critical industries can meet sustainability challenges. They promotes capacity building activities to support the integration of sustainable development into business practices, as well as toolkits, valuation/account/reporting, natural infrastructure action, impact measurements, data, communication and events, and public policy.

The WBCSD is an active partner of both the UNCCD and the ELD Initiative. With the ELD Initiative, it aims to support and promote the use of cost-benefit analyses, as well as determining the most optimal investments towards sustainable land management. The WBCSD both counsels and advises the ELD Initiative on matters relevant to the private sector, to ensure uptake and implementation of sustainable land management practices by businesses through robust economics and science.

Soil Leadership Academy

The Soil Leadership Academy (SLA) is a joint public-private partnership currently between the WBCSD, UNCCD, and Syngenta, with an open call for all business and institutions to partner with them. Through knowledge sharing and training opportunities, the SLA aims to increase the ability of policy-/decision-makers to strengthen their frameworks and processes towards the conservation of soil resources, while promoting sustainable land and water management practices to combat land degradation and desertification.

Provided with a concise, tailored curriculum, SLA participants will engage in interactive simulation exercises through a variety of modules that focus on the 'Land Degradation Neutral Policy Cycle'. This includes: (i) assessment, (ii) prioritisation and target setting, (iii) policy options/selection, (iv) implementation/management, and (v) monitoring and evaluation. The ELD Initiative is responsible for the section 'The Economics of Land' in the module on assessments, and will demonstrate the economic methodologies, mechanisms, models, and incentives involved in addressing this issue.

In addition to supporting and actively working towards the accomplishment of a land degradation neutral world, the SLA also supports the SDGs.

Others

There are a number of other land initiatives that exist as complementary to the efforts of the ELD Initiative, including but not limited to:

- *DesertNet International:* a network and think tank working on addressing and improving desertification globally. [*www.desertnet-international.org*]
- *Global Land Tool Network (GLTN):* An alliance contributing to gender-sensitive poverty alleviation through land reform, improved land management and security of tenure. [*www.gltn.net*]
- *Landesa:* efforts focus on securing land rights for the poor. [*www.landesa.org*]
- *World Overview of Conservation Techniques (WOCAT):* A network of soil and water conservation specialists dedicated to SLM through scalable knowledge management/decision support. [*www.wocat.net*]
- *Commonland:* An initiative focused on creating a cooperative, investable large-scale landscape restoration industry – aligned with international guidelines and policies. [*www.commonland.com*]
- Offering Sustainable Land-use Options (OSLO): a global partnership that promotes responsible land-use through total economic value and sustainable land use options. [*www.theoslo.net*]
- *Land Policy Initiative (UNECA):* An initiative with the aim to enable the use of land to lend impetus to the process of African development. [*www.uneca.org/lpi*]
- *IUCN's Hima rangeland conservation project:* Work encouraging the revival of traditional Hima systems across the Arab region [*www.iucn.org/about/union/secretariat/offices/rowa/?14762/Al-Hima-Possibilities-are-Endless*]
- *International Centre for Integrated Mountain Development (ICIMOD):* A regional inter-governmental learning/knowledge centre, assisting populations to understand and adapt to climate and ecosystem changes in their fragile mountain ecosystems. [*www.icimod.org*]

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Appendix 2: Institutional and socio-economic land databases

(compiled by Stephanie E. Trapnell (Results For Development), for the Global Land Outlook meetings held in Bonn, Germany July 2015)

Institutions that mediate land management outcomes

Indicator category	Source	Year	Countries	Type of Data	Website	Notes
Land tenure and enforcement	Land Acquisition Laws	2015	32	Yes/No	WRI, word document	Addressing compulsory land acquisition laws. Lack of coverage is problem
	Community Land Security	Ongoing	15	Scores 1–4	WRI, word document	Well-designed indicators, but lack of coverage is problem.
	National legal framework for land	2014	84	Narrative	www.fao.org/gender-landrights-database/country-profiles/en/	
	Oversight institutions	2014	84	Narrative	www.fao.org/gender-landrights-database/country-profiles/en/	National institutions enforcing land regulations
	Legal System & Property Rights, Economic Freedom of the World, Fraser Institute	2012	153	Scores 1–10	www.freetheworld.com/release.html	Legal System & Property Rights: Judicial independence, Impartial courts, Protection of property rights, Military interference in rule of law and politics, Integrity of the legal system, Legal enforcement of contracts, Regulatory restrictions on the sale of real property, Reliability of police, Business costs of crime
	Rule of Law, World Justice Project	2014	100	Scores 0–1	www.worldjusticeproject.org/	Constraints on Government Powers, Absence of Corruption, Open Government, Fundamental Rights, Order and Security, Regulatory Enforcement, Civil Justice, Criminal Justice, Informal Justice

Gender inclusion	Legislation Assessment Tool for gender-equitable land tenure (LAT)	2014	18	Scores 0–4	www.fao.org/gender-landrights-database/legislation-assessment-tool/en	The LAT is built around 30 legal indicators, divided under 8 clusters of key elements for targeted policy intervention:1. Ratification of human rights instruments 2. Elimination of gender-based discrimination in the Constitution3. Recognition of women's legal capacity4. Gender-equality of rights with respect to nationality5. Gender equality in property rights6. Gender equality in inheritance7. Gender-equitable implementation, dispute mechanisms and access to justice8. Women's participation in national and local institutions enforcing land legislation
	Agricultural Land Ownership/Value by sex	2014	104 for landholders, other indicators less than 25	Percentage	www.fao.org/gender-landrights-database/data-map/statistics/en/	Landholders, Users, Owners, Value, disaggregated by sex
	Local decision-making organizations and women's representation in them	2014	84	Narrative	www.fao.org/gender-landrights-database/country-profiles/en/	
	Environment and Gender Index, International Union for Conservation of Nature (IUCN) Global Gender Office	2013	72	Scores 0–100	www.genderandenvironment.org/egi/	Underlying data not published, need to ask if available. Gender based rights and participation, Ecosystem, Gender based education and assets, Governance, Country reported activities, Livelihood
Market access	Trade Freedom and Investment Freedom, Index of Economic Freedom, Heritage Foundation	2014	186	Scores 0–100	www.heritage.org/index/download	No underlying data

Indicator category	Source	Year	Countries	Type of Data	Website	Notes
Market access	Freedom to Trade Internationally, Economic Freedom of the World, Fraser Institute	2012	153	Scores 1–10	www.freetheworld.com/release.html	Freedom to trade internationally: Tariffs, Non-tariff trade barriers, Compliance costs of importing and exporting, Regulatory trade barriers, Black market exchange rates, Foreign ownership/investment restrictions, Capital controls, Freedom of foreigners to visit, Controls of the movement of capital and people
	Agriculture and Rural Development Indicators, World Development Indicators, World Bank	2014	Depends on indicator, but many	Percentages	www.databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators	Loads of indicators, but none specifically on domestic market access. Proxies are available, e.g., infrastructure, access to credit, investment, etc.
	Microfinance data, MIX market	2014	?	Percentages	www.mixmarket.org/	Fee-based access
International policies	Ratification of International conventions	2014	84	Narrative	www.fao.org/gender-landrights-database/country-profiles/en/	Input from UNCCD would be helpful to narrow down which policies and/or conventions are the most relevant from their standpoint.
	Ratification of International conventions	2010	200+	Date of ratification	www.unstats.un.org/unsd/environment/governance.htm	Basel Conv, Conv. On Biological Diversity, CITES, Conv. On Migratory Species World Heritage Conv, Montreal Protocol, Ramsar Conv., Rotterdam Conv., Stockholm Conv., UN Conv. Combat Desertification, UN Conv. On the Law of the Sea,
National policies	World Resources Institute, Indicators of Sustainable Agriculture	2014	None	None	www.wri.org/publication/indicators-sustainable-agriculture-scoping-analysis	Comprehensive and well-designed, but little data is available for relevant indicators.
	Agricultural policies, Environmental Performance Index, Yale	2014	236	Varies	www.epi.yale.edu/	Agricultural subsidies, Pesticide regulation, Critical habitat protection, Water withdrawals (includes but not specific to agriculture)
	Agriculture data, OECD	2014	30	Percentages/ Amounts	www.stats.oecd.org/	Many questions on management and incentives in land, water, and soil.
	FAOSTAT, FAO Statistics Database	2014	175	Varies	www.faostat3.fao.org/home/E	Production, Investment, Agri-environmental indicators

Decentralization and local capacity	CSOs/NGOs working in agriculture	2014	84	Narrative	www.fao.org/gender-landrights-database/country-profiles/en/	Civil Society Organisations supporting gender-equitable land tenure
	Local decision-making organizations	2014	84	Narrative	www.fao.org/gender-landrights-database/country-profiles/en/	
	Worldwide Agricultural Extension Survey, IFPRI and GRAS	80	2014	Varies	www.g-fras.org/en/world-wide-extension-study#africa	Survey data of Ag ministries and government organizations that must be aggregated and analyzed.
Information access (including data availability)	Environmental Democracy Index	2014	70	Scores 0–3	www.environmentaldemocracyindex.org/	The degree to which countries have enacted legally binding rules that provide for environmental information collection and disclosure, public participation across a range of environmental decisions, and fair, affordable, and independent avenues for seeking justice and challenging decisions that impact the environment. In addition to the legal index, EDI contains a separate and supplemental set of indicators that provide key insights on whether environmental democracy is being manifested in practice.
	Open government Index, World Justice Project	2014	102	Scores 0–1	www.worldjusticeproject.org/open-government-index	Not exemplary, but the only available global dataset on open government: publicized laws and government data, right to information, civic participation, and complaint mechanisms
	Open Data Barometer	2013	87	Yes/No	www.opendatabarometer.org/	10 questions on accessibility for each type of data: Land ownership data, National environmental statistics data
	Web Index	2013	87	Scores 1–10	www.thewebindex.org/	Impact of open data on environmental sustainability, Use of ICTs to increase environmental awareness and behavioural change, Impact on environmental campaigns/action, Web-based information for farmers, Government implementation of gender equity of web access for women and girls

Appendix 3:
Database of ecosystem service value losses

(from Chapter 3, relating to the Imhoff and Haberl models)

ESV – Ecosystem Service Value in USD
sq km – areal etent of land surface of country (km^2)
sq m – area extent of land surface of country (m^2)
ESV-Terrest – is the value in dollars of the land without any degradation effects
%Deg_hab – is the percent change in the value of the land resulting from the Haberl representation of land degradation
%Deg_imho – is the percent change in the value of the land resulting from the Imhoff representation of land degradation

Country name	2015 Population	2005 Population	sq km	sq m	ESV_terrest	ESV for Haberl model	%Deg_ hab	ESV for Imhoff model	%Deg_imho
Russia	146.531.140	143.420.309	16.897.294	6.524.044	14.148.651.821.100	13.101.177.838.500	7,4	13.546.698.067.900	4,3
Canada	35.749.600	33.098.932	9.832.884	3.796.477	3.310.731.625.550	3.164.148.189.380	4,4	3.073.072.446.310	7,2
United States	321.504.000	295.734.134	9.426.295	3.639.493	5.212.482.947.600	4.794.246.500.410	8,0	4.378.262.054.000	16,0
China	1.371.210.000	1.306.313.812	9.402.887	3.630.455	3.149.889.472.520	2.941.508.831.470	6,6	1.726.595.765.690	45,2
Brazil	204.671.000	186.112.794	8.493.132	3.279.198	6.806.175.667.670	6.352.281.515.570	6,7	6.411.140.056.580	5,8
Australia	23.846.700	20.090.437	7.694.273	2.970.759	3.290.360.649.480	3.066.790.443.510	6,8	3.211.115.267.230	2,4
India	1.274.830.000	1.080.264.388	3.153.010	1.217.377	1.777.194.322.420	1.416.469.457.420	20,3	484.125.370.253	72,8
Kazakhstan	17.519.000	15.185.844	2.832.826	1.093.754	1.007.663.857.170	896.146.652.513	11,1	895.063.737.227	11,2
Argentina	43.131.966	39.537.943	2.776.913	1.072.166	2.134.944.725.840	1.945.834.216.540	8,9	2.018.051.967.460	5,5
Sudan	38.435.252	40.187.486	2.496.340	963.837	1.357.783.593.060	1.205.412.282.940	11,2	1.261.280.697.330	7,1
Congo, DRC	71.246.000	60.085.804	2.336.471	902.111	1.732.249.366.120	1.648.055.850.240	4,9	1.642.185.692.580	5,2
Algeria	39.500.000	32.531.853	2.323.510	897.107	101.734.036.585	71.113.126.156	30,1	70.480.695.548	30,7
Greenland	55.984	56.375	2.118.140	817.814	16.108.997.747	15.957.570.000	0,9	13.425.581.351	16,7
Mexico	121.470.000	106.202.903	1.953.851	754.382	831.883.939.928	745.221.250.753	10,4	723.800.204.264	13,0
Saudi Arabia	31.521.418	26.417.599	1.936.713	747.765	28.789.030.111	27.880.811.565	3,2	7.767.954.532	73,0
Indonesia	255.770.000	241.973.879	1.847.033	713.139	1.654.724.361.960	1.426.984.106.250	13,8	1.341.866.023.510	18,9
Iran	78.521.000	68.017.860	1.680.136	648.701	245.139.136.130	219.928.651.744	10,3	153.752.531.965	37,3
Libya	6.317.000	5.765.563	1.626.966	628.172	7.470.804.809	4.209.316.004	43,7	4.397.993.391	41,1
Mongolia	3.028.222	2.791.272	1.557.318	601.281	315.058.346.109	298.505.444.086	5,3	306.914.249.732	2,6
Peru	31.151.643	27.925.628	1.296.605	500.619	895.343.136.380	839.787.366.767	6,2	851.511.676.644	4,9
Chad	13.606.000	9.826.419	1.270.759	490.640	300.166.987.967	273.138.458.551	9,0	265.165.535.978	11,7
Mali	16.259.000	12.291.529	1.258.013	485.719	368.982.387.012	306.929.750.476	16,8	259.888.836.498	29,6
Angola	24.383.301	11.190.786	1.252.935	483.758	554.607.181.753	517.469.927.495	6,7	541.890.628.699	2,3

South Africa	54.002.000	44.344.136	1.219.930	471.015	460.032.415.732	349.655.148.375	24,0	412.811.280.059	10,3
Niger	19.268.000	11.665.937	1.184.364	457.283	145.522.881.758	115.110.183.689	20,9	83.915.885.161	42,3
Colombia	48.236.100	42.954.279	1.143.017	441.319	716.054.937.685	658.550.160.246	8,0	657.047.339.243	8,2
Ethiopia	90.077.000	73.053.286	1.134.156	437.898	483.385.465.431	397.966.416.478	17,7	365.929.910.888	24,3
Bolivia	11.410.651	8.857.870	1.090.564	421.067	1.266.014.104.920	1.212.982.904.360	4,2	1.243.888.219.690	1,7
Mauritania	3.631.775	3.086.859	1.038.293	400.885	84.313.981.062	66.139.471.048	21,6	72.207.530.962	14,4
Egypt	89.211.400	77.505.756	1.000.942	386.464	37.946.871.205	36.881.567.130	2,8	10.710.214.762	71,8
Tanzania	48.829.000	36.766.356	942.536	363.913	470.259.561.299	435.374.964.270	7,4	363.226.038.778	22,8
Venezuela	30.620.404	25.375.281	913.485	352.697	687.905.093.658	647.445.345.281	5,9	664.826.563.400	3,4
Nigeria	183.523.000	128.771.988	913.388	352.659	483.684.347.551	371.659.506.206	23,2	250.742.911.792	48,2
Pakistan	190.476.000	162.419.946	880.203	339.846	215.598.474.382	209.384.732.993	2,9	42.322.613.372	80,4
Namibia	2.280.700	2.030.692	827.897	319.651	308.542.783.163	299.166.531.928	3,0	297.669.190.218	3,5
Mozambique	25.727.911	19.406.703	793.980	306.556	294.631.960.656	273.601.927.801	7,1	257.820.339.026	12,5
Turkey	77.695.904	69.660.559	778.602	300.618	352.510.270.023	276.212.101.216	21,6	225.018.718.936	36,2
Zambia	15.473.905	11.261.795	753.941	291.097	488.217.658.883	458.222.575.968	6,1	466.573.452.199	4,4
Chile	18.006.407	15.980.912	722.511	278.961	256.151.917.823	242.298.715.358	5,4	208.662.062.594	18,5
Myanmar	54.164.000	42.909.464	659.592	254.669	369.854.638.360	314.097.712.461	15,1	290.181.088.186	21,5
Afghanistan	27.101.365	29.928.987	641.358	247.628	125.604.005.570	107.437.394.250	14,5	70.798.814.656	43,6
Somalia	11.123.000	8.591.629	637.888	246.289	237.589.530.224	222.276.331.149	6,4	183.607.524.180	22,7
Central African Republic	4.803.000	3.799.897	619.933	239.356	238.962.420.945	232.040.357.207	2,9	233.940.792.996	2,1
Ukraine	42.836.922	47.425.336	593.788	229.261	339.916.939.287	210.981.130.860	37,9	273.873.444.850	19,4
Madagascar	24.235.000	18.040.341	591.713	228.460	285.539.677.789	231.744.229.750	18,8	256.848.489.779	10,0
Kenya	46.749.000	33.829.590	584.683	225.746	232.580.510.608	205.618.967.358	11,6	183.349.911.895	21,2
Botswana	2.056.769	1.640.115	579.783	223.854	375.350.854.610	362.256.724.388	3,5	362.909.432.191	3,3
Turkmenistan	4.751.120	4.952.081	552.479	213.312	70.421.423.516	68.189.735.380	3,2	40.858.108.947	42,0
France	66.162.000	60.656.178	546.970	211.185	255.861.977.097	242.660.569.391	5,2	171.794.789.557	32,9
Thailand	65.104.000	65.444.371	515.357	198.979	278.217.006.344	189.920.967.664	31,7	180.334.601.452	35,2
Spain	46.439.864	40.341.462	503.250	194.305	225.871.319.918	174.941.008.537	22,5	160.307.775.966	29,0
Cameroon	21.143.237	16.380.005	466.387	180.072	267.957.070.122	230.944.783.979	13,8	230.089.517.729	14,1

Country name	2015 Population	2005 Population	sq km	sq m	ESV_terrest	ESV for Haberl model	%Deg_hab	ESV for Imhoff model	%Deg_imho
Papua New Guinea	7.398.500	5.545.268	458.666	177.091	382.426.184.286	365.964.707.656	4,3	349.484.421.091	8,6
Yemen	25.956.000	20.727.063	455.126	175.724	24.962.733.913	24.297.086.955	2,7	5.919.046.211	76,3
Uzbekistan	31.022.500	26.851.195	446.633	172.445	89.865.211.619	85.847.120.933	4,5	20.423.260.575	77,3
Sweden	9.784.445	9.001.774	442.246	170.751	696.318.638.583	656.301.572.980	5,7	547.664.964.400	21,3
Iraq	36.004.552	26.074.906	434.754	167.858	46.556.282.387	27.604.710.136	40,7	35.041.294.549	24,7
Morocco	33.337.529	32.725.847	406.452	156.931	103.057.948.860	71.172.474.630	30,9	75.727.347.655	26,5
Paraguay	7.003.406	6.347.884	401.191	154.900	497.135.043.355	479.604.107.999	3,5	472.456.702.066	5,0
Zimbabwe	13.061.239	12.746.990	391.456	151.141	155.663.001.987	143.702.164.405	7,7	138.288.947.533	11,2
Japan	126.865.000	127.417.244	370.727	143.138	149.230.560.387	134.483.597.123	9,9	51.326.643.406	65,6
Germany	81.083.600	82.431.390	355.246	137.160	179.034.858.361	174.173.822.223	2,7	64.659.989.478	63,9
Congo	4.671.000	3.039.126	345.447	133.377	287.961.442.785	278.494.971.928	3,3	278.811.389.282	3,2
Finland	5.483.533	5.223.442	330.958	127.783	560.257.063.515	523.579.183.340	6,5	380.980.222.364	32,0
Malaysia	30.657.700	23.953.136	328.536	126.848	233.773.982.290	201.539.949.449	13,8	169.574.001.225	27,5
Vietnam	91.812.000	83.535.576	322.743	124.611	162.603.792.051	132.965.385.577	18,2	96.052.939.554	40,9
Cote d'Ivoire	22.671.331	17.298.040	321.085	123.971	131.173.975.227	101.384.546.451	22,7	117.839.052.575	10,2
Poland	38.484.000	38.635.144	312.136	120.516	150.781.294.242	110.867.520.190	26,5	67.860.925.405	55,0
Oman	4.163.869	3.001.583	310.328	119.818	4.799.186.314	4.537.996.391	5,4	2.640.095.860	45,0
Norway	5.176.998	4.593.041	305.866	118.095	516.752.911.018	475.694.325.365	7,9	451.582.893.101	12,6
Italy	60.788.245	58.103.033	301.101	116.255	141.511.690.207	119.861.277.752	15,3	61.714.004.622	56,4
Philippines	101.816.000	87.857.473	280.958	108.478	187.631.541.215	133.036.117.065	29,1	95.507.307.365	49,1
Burkina Faso	18.450.494	13.925.313	274.056	105.813	131.690.280.755	101.942.349.319	22,6	70.376.519.601	46,6
Western Sahara	510.713	273.008	268.179	103.544	418.429.456	407.974.300	2,5	409.178.391	2,2
New Zealand	4.603.530	4.035.461	267.214	103.171	116.184.352.404	109.672.447.619	5,6	101.203.419.239	12,9
Gabon	1.751.000	1.389.201	262.971	101.533	167.492.911.054	162.391.225.102	3,0	160.664.409.992	4,1
Ecuador	15.538.000	13.363.593	254.767	98.365	159.133.422.199	144.593.225.833	9,1	129.926.508.015	18,4
Uganda	34.856.813	27.269.482	245.631	94.838	139.726.325.318	108.996.141.195	22,0	89.514.926.417	35,9
Guinea	10.628.972	9.467.866	245.517	94.794	154.882.657.107	136.827.275.800	11,7	134.342.528.191	13,3

Ghana	27.043.093	21.029.853	240.310	92.784	105.370.419.169	83.921.874.285	20,4	71.350.234.815	32,3
United Kingdom	64.800.000	60.441.457	238.074	91.920	106.563.514.916	102.014.440.151	4,3	55.650.603.532	47,8
Romania	19.942.642	22.329.977	237.076	91.535	162.276.500.633	123.778.519.131	23,7	104.855.666.805	35,4
Laos	6.802.000	6.217.141	231.035	89.203	110.805.683.156	99.941.930.696	9,8	101.715.165.803	8,2
Guyana	746.900	765.283	210.336	81.211	185.657.415.526	179.451.230.494	3,3	177.603.345.188	4,3
Belarus	9.481.000	10.300.483	205.964	79.523	131.703.050.541	102.380.018.155	22,3	102.626.261.512	22,1
Kyrgyzstan	5.944.400	5.146.281	200.634	77.465	67.131.373.376	64.022.028.135	4,6	46.641.964.212	30,5
Senegal	13.508.715	11.126.832	197.396	76.215	165.340.510.453	135.169.597.754	18,2	104.097.086.271	37,0
Syria	23.307.618	18.448.752	190.030	73.371	31.811.426.773	21.570.707.029	32,2	17.810.309.011	44,0
Cambodia	15.405.157	13.607.069	181.911	70.236	103.682.202.311	83.682.684.965	19,3	80.759.114.813	22,1
Uruguay	3.415.866	3.415.920	178.438	68.895	126.020.633.160	120.116.484.754	4,7	115.970.907.829	8,0
Azerbaijan	9.636.600	7.911.974	164.056	63.342	46.312.333.886	40.902.056.654	11,7	17.550.323.320	62,1
Tunisia	10.982.754	10.074.951	156.669	60.490	28.377.378.458	13.106.917.361	53,8	9.785.880.364	65,5
Nepal	28.037.904	27.676.547	148.253	57.240	61.433.193.925	57.162.076.130	7,0	22.847.032.925	62,8
Tajikistan	8.354.000	7.163.506	143.924	55.569	37.547.875.382	33.598.374.813	10,5	17.281.529.678	54,0
Suriname	534.189	438.144	143.155	55.272	142.145.073.413	139.723.218.870	1,7	139.321.314.057	2,0
Bangladesh	158.757.000	144.319.628	135.693	52.391	145.511.923.428	128.540.088.330	11,7	41.761.808.596	71,3
Nicaragua	6.134.270	5.465.100	129.796	50.114	87.319.317.035	74.705.072.802	14,4	72.172.902.942	17,3
Greece	10.903.704	10.668.354	125.515	48.461	58.193.849.117	52.275.916.398	10,2	39.779.609.835	31,6
North Korea	25.155.000	22.912.177	122.847	47.431	39.562.403.102	34.683.099.813	12,3	24.491.498.027	38,1
Eritrea	6.738.000	4.561.599	119.905	46.295	28.031.333.658	23.589.421.724	15,8	11.931.335.589	57,4
Benin	10.315.244	7.460.025	118.509	45.756	51.166.122.089	42.113.953.538	17,7	41.590.544.061	18,7
Malawi	16.310.431	12.158.924	117.440	45.344	67.943.987.307	62.888.020.250	7,4	35.655.720.880	47,5
Honduras	8.725.111	6.975.204	113.029	43.641	68.706.871.037	56.225.360.370	18,2	56.652.356.466	17,5
Bulgaria	7.202.198	7.450.349	110.523	42.673	49.875.530.520	37.284.470.551	25,2	36.730.497.022	26,4
Guatemala	16.176.133	14.655.189	109.829	42.405	57.092.842.827	48.041.768.447	15,9	41.154.721.894	27,9
Cuba	11.238.317	11.346.670	107.891	41.657	67.191.556.452	52.505.469.053	21,9	53.553.802.591	20,3
Serbia & Montenegro	10.830.000	10.829.175	102.667	39.640	45.891.606.736	33.370.985.034	27,3	32.755.206.002	28,6

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Iceland	330.610	296.737	99.900	38.571	116.306.950.961	93.015.419.729	20,0	105.774.536.881	9,1
Liberia	4.503.000	3.482.211	95.659	36.934	50.294.224.586	46.103.677.437	8,3	45.926.674.604	8,7
South Korea	51.431.100	48.422.644	94.773	36.592	34.290.170.182	33.925.123.042	1,1	14.095.102.043	58,9
Hungary	9.849.000	10.006.835	92.174	35.588	48.413.573.141	40.637.594.875	16,1	30.656.638.128	36,7
Portugal	10.477.800	10.566.212	90.411	34.908	39.854.111.835	30.351.239.117	23,8	24.260.177.937	39,1
Jordan	6.759.300	5.759.732	87.399	33.745	4.317.802.912	3.626.423.738	16,0	779.101.991	82,0
French Guiana	239.648	195.506	83.726	32.327	78.425.332.139	77.569.156.555	1,1	76.918.399.692	1,9
Austria	8.602.112	8.184.691	82.869	31.996	34.955.562.713	31.785.458.841	9,1	16.331.474.732	53,3
Czech Republic	10.537.818	10.241.138	78.282	30.225	34.927.962.985	28.341.802.384	18,9	12.459.964.296	64,3
Panama	3.764.166	3.039.150	73.680	28.448	50.932.961.350	40.143.737.324	21,2	44.680.177.483	12,3
Sierra Leone	6.319.000	6.017.643	73.113	28.229	49.346.128.568	43.092.200.752	12,7	39.251.347.269	20,5
Georgia	3.729.500	4.677.401	69.677	26.902	28.981.353.589	24.813.791.410	14,4	23.165.453.039	20,1
United Arab Emirates	9.577.000	2.563.212	68.172	26.321	710.124.052	696.125.158	2,0	67.702.736	90,5
Ireland	4.609.600	4.015.676	67.565	26.087	33.415.694.386	31.682.274.562	5,2	24.569.720.772	26,5
Latvia	1.980.700	2.290.237	64.745	24.998	53.549.724.621	40.782.027.286	23,8	27.601.826.530	48,5
Sri Lanka	20.675.000	20.064.776	64.665	24.967	33.704.825.005	24.281.749.087	28,0	16.087.778.510	52,3
Lithuania	2.904.391	3.596.617	64.439	24.880	32.184.929.072	22.601.838.129	29,8	20.152.311.362	37,4
Svalbard	2.562	2.701	60.119	23.212	46.264.110	41.262.500	10,8	32.959.200	28,8
Togo	7.171.000	5.681.519	56.187	21.694	23.658.437.294	15.729.364.925	33,5	17.536.376.573	25,9
Croatia	4.267.558	4.495.904	53.541	20.672	24.838.916.955	19.195.106.082	22,7	19.107.126.087	23,1
Costa Rica	4.773.130	4.016.173	52.894	20.423	42.277.286.901	35.485.475.508	16,1	30.626.198.464	27,6
Bosnia & Herzegovina	3.791.622	4.025.476	51.366	19.833	20.963.567.418	16.259.075.274	22,4	18.429.442.188	12,1
Slovakia	5.421.349	5.431.363	48.560	18.749	21.132.915.391	16.804.736.591	20,5	10.159.012.474	51,9
Dominican Republic	10.652.000	8.950.034	47.266	18.249	25.297.893.069	18.786.808.261	25,7	18.807.804.292	25,7
Estonia	1.313.271	1.332.893	45.515	17.573	60.700.981.423	50.545.493.215	16,7	36.266.329.143	40,3
Switzerland	8.256.000	7.489.370	41.854	16.160	17.531.017.091	16.331.837.966	6,8	8.562.325.484	51,2

Denmark	5.668.743	5.432.335	41.103	15.870	27.586.694.805	27.010.572.172	2,1	10.930.907.296	60,4
Bhutan	763.160	2.232.291	39.408	15.216	14.638.105.710	14.035.832.013	4,1	11.056.055.307	24,5
Netherlands	16.913.100	16.407.491	34.691	13.394	16.808.004.168	16.558.247.881	1,5	3.057.601.140	81,8
Moldova	3.555.200	4.455.421	33.548	12.953	18.002.628.428	11.239.488.385	37,6	13.141.314.264	27,0
Guinea-Bissau	1.788.000	1.416.027	31.398	12.123	107.728.807.704	89.287.644.228	17,1	84.466.301.172	21,6
Lesotho	2.120.000	1.867.035	30.800	11.892	11.770.323.259	8.750.726.434	25,7	7.921.694.838	32,7
Belgium	11.248.330	10.364.388	30.711	11.858	14.808.681.191	14.413.500.562	2,7	3.354.077.515	77,4
Armenia	3.006.800	2.982.904	30.178	11.652	14.515.333.345	12.627.210.140	13,0	8.325.895.330	42,6
Albania	2.893.005	3.563.112	28.798	11.119	13.342.184.554	9.301.152.510	30,3	10.343.353.746	22,5
Haiti	10.911.819	8.121.622	27.949	10.791	15.365.266.431	7.865.903.042	48,8	4.763.352.490	69,0
Burundi	9.823.827	6.370.609	27.098	10.463	13.276.114.120	7.523.876.386	43,3	4.906.703.216	63,0
Equatorial Guinea	1.430.000	535.881	26.693	10.306	17.501.870.922	16.040.246.762	8,4	15.668.157.188	10,5
Macedonia	2.065.769	2.045.262	25.272	9.758	11.184.225.370	8.659.776.258	22,6	8.781.835.497	21,5
Rwanda	10.996.891	8.440.820	25.036	9.666	11.513.699.608	6.582.060.155	42,8	4.182.131.297	63,7
Israel	8.358.100	6.276.883	22.671	8.753	6.434.257.968	6.149.800.873	4,4	715.530.875	88,9
Belize	358.899	279.457	22.668	8.752	11.749.302.912	11.028.903.027	6,1	10.468.817.452	10,9
Solomon Is.	581.344	538.032	21.573	8.329	20.149.908.224	18.128.421.600	10,0	13.531.321.378	32,8
Slovenia	2.067.452	2.011.070	20.625	7.963	7.664.569.273	6.720.506.703	12,3	4.240.017.014	44,7
Djibouti	900.000	476.703	20.503	7.916	3.145.713.144	2.900.751.059	7,8	2.056.580.434	34,6
El Salvador	6.401.240	6.704.932	19.917	7.690	14.759.091.667	10.629.312.599	28,0	6.166.808.212	58,2
New Caledonia	268.767	216.494	17.946	6.929	14.994.039.242	13.966.543.900	6,9	13.365.901.340	10,9
Fiji	859.178	893.354	17.816	6.879	13.655.125.803	12.929.517.800	5,3	10.669.212.907	21,9
Swaziland	1.119.375	1.173.900	16.823	6.495	6.552.971.715	6.438.764.831	1,7	4.549.439.152	30,6
Timor Leste	1.212.107	1.040.880	15.496	5.983	8.739.535.440	7.237.456.206	17,2	5.547.700.824	36,5
Jamaica	2.717.991	2.731.832	10.992	4.244	5.633.821.483	4.676.462.478	17,0	3.549.209.814	37,0
Lebanon	4.104.000	3.826.018	10.808	4.173	4.724.136.687	4.056.179.385	14,1	1.390.559.895	70,6
The Bahamas	368.390	301.790	10.714	4.137	26.834.976.107	23.697.360.900	11,7	21.749.728.947	19,0
Qatar	2.344.005	863.051	10.621	4.101	263.008.968	247.938.500	5,7	10.559.499	96,0
Falkland Is.	3.000	2.967	10.217	3.945	8.021.687.736	7.508.688.700	6,4	7.675.112.808	4,3

Country name	2015 Population	2005 Population	sq km	sq m	ESV_terrest	ESV for Haberl model	%Deg_hab	ESV for Imhoff model	%Deg_imho
The Gambia	1.882.450	1.593.256	9.970	3.849	34.830.546.465	29.593.996.254	15,0	19.502.444.375	44,0
Cyprus	858.000	780.133	9.894	3.820	4.186.790.682	3.428.043.223	18,1	1.822.442.753	56,5
Puerto Rico	3.548.397	3.916.632	9.084	3.507	4.765.444.725	3.918.165.168	17,8	24.437.185	99,5
Vanuatu	264.652	205.754	8.457	3.265	9.595.348.990	8.915.714.000	7,1	8.341.357.986	13,1
Brunei	393.372	372.361	6.078	2.347	7.247.561.360	6.752.775.715	6,8	6.370.204.383	12,1
West Bank	1.715.000	2.385.615	4.861	1.877	6.434.257.968	6.149.800.873	4,4	715.530.875	88,9
Trinidad & Tobago	1.328.019	1.088.644	4.421	1.707	5.896.615.368	4.124.821.629	30,0	3.136.189.835	46,8
Luxembourg	562.958	468.571	2.578	995	1.027.792.692	1.014.842.369	1,3	490.276.377	52,3
Reunion	844.944	776.948	2.230	861	1.532.869.636	1.328.358.500	13,3	243.458.495	84,1
Cape Verde	518.467	418.224	2.168	837	1.248.942.465	1.181.882.200	5,4	266.406.091	78,7
Mauritius	1.261.208	1.230.602	1.413	546	4.408.485.986	3.871.917.300	12,2	1.485.101.458	66,3
Guadeloupe	405.739	448.713	1.120	432	1.485.997.432	1.044.958.900	29,7	176.789.451	88,1
Comoros	784.745	671.247	1.119	432	1.487.886.624	1.213.456.600	18,4	226.777.778	84,8
Martinique	381.326	432.900	780	301	741.585.744	660.934.600	10,9	160.761.687	78,3
Faroe Is.	48.846	46.962	710	274	472.114.397	465.394.100	1,4	66.039.984	86,0
Sao Tome & Principe	187.356	187.410	708	273	1.382.025.848	1.323.907.500	4,2	297.369.742	78,5
Jan Mayen	20	0	470	181	46.264.110	41.262.500	10,8	32.959.200	28,8
Netherlands Antilles	227.049	219.958	440	170	828.402.876	692.714.400	16,4	207.557.516	74,9
Andorra	76.949	70.549	336	130	223.529.166	221.310.650	1,0	165.497.566	26,0
St. Lucia	185.000	166.312	321	124	431.649.302	366.389.100	15,1	2.292.808	99,5
Isle of Man	84.497	75.049	290	112	235.599.950	230.193.200	2,3	199.723.100	15,2
St. Pierre & Miquelon	6.069	7.012	286	110	166.747.493	160.280.000	3,9	135.815.751	18,6
Mayotte	212.645	193.633	268	103	886.407.732	758.904.300	14,4	851.471.800	3,9
Antigua & Barbuda	86.295	68.722	255	99	861.399.012	626.925.000	27,2	199.523.464	76,8

St. Vincent & the Grenadines	109.000	117.534	237	91	653.252.979	580.307.800	11,2	10.819.869	98,3
Bahrain	1.316.500	688.345	236	91	292.018.573	289.582.900	0,8	1.560.858	99,5
Palau	20.901	20.303	231	89	360.091.025	290.916.600	19,2	212.005.825	41,1
Gaza Strip	1.816.000	1.376.289	228	88	6.434.257.968	6.149.800.873	4,4	715.530.875	88,9
Seychelles	89.949	81.188	222	86	839.646.528	592.080.100	29,5	407.891.600	51,4
Grenada	103.328	89.502	179	69	371.044.884	339.403.700	8,5	29.426.560	92,1
Virgin Is.	106.405	108.708	178	69	169.419.874	157.442.200	7,1	47.544.441	71,9
St. Kitts & Nevis	55.000	38.958	165	64	453.596.858	415.176.200	8,5	354.308.700	21,9
Turks & Caicos Is.	31.458	20.556	163	63	531.984.720	480.144.400	9,7	430.047.375	19,2
Cayman Is.	55.691	44.270	158	61	330.895.287	301.996.200	8,7	203.770.584	38,4
Micronesia	101.351	108.105	156	60	2.046.907.355	1.745.195.000	14,7	137.736.765	93,3
Aruba	107.394	71.566	140	54	588.301.896	376.692.900	36,0	136.321.257	76,8
Liechtenstein	37.370	33.717	112	43	66.211.756	64.920.538	2,0	2.356.814	96,4
Jersey	99.000	90.812	110	42	56.099.736	55.837.600	0,5	655.826	98,8
Christmas I.	2.072	361	99	38	32.100.096	30.621.600	4,6	28.784.304	10,3
Anguilla	13.452	13.254	74	29	88.400.970	87.877.400	0,6	60.539.699	31,5
Northern Mariana Is.	53.883	80.362	73	28	482.246.849	460.964.800	4,4	78.598.693	83,7
Guernsey	65.150	65.228	46	18	31.308.536	31.052.600	0,8	171.672	99,5
British Virgin Is.	28.054	22.643	40	15	324.964.224	323.012.200	0,6	63.581.518	80,4
Cocos Is.	550	628	10	4	385.810.908	326.093.100	15,5	374.074.777	3,0
Monaco	37.800	32.409	5	2	5.158.276	5.022.836	2,6	475.194	90,8
Juan De Nova I.	0	0	5	2	1.532.869.636	1.328.358.500	13,3	243.458.495	84,1
Glorioso Is.	0	0	5	2	1.532.869.636	1.328.358.500	13,3	243.458.495	84,1
			Global	**Total**	**68.782.784.666.249**	**62.462.358.238.329**	**9,2**	**58.322.604.672.952**	**15,2**
			Lost annual	**ESV**	**Haberl**	**6.320.426.427.920**	**Imhoff**	**10.460.179.993.297**	

Appendix 4:
Regional population and land cover values

(based on the database from Appendix 3)

	Population	Land cover (km²)
Africa	**1.128.671.435**	**29.987.249**
Eastern Africa	358.095.508	6.391.228
Middle Africa	143.220.894	6.582.303
Northern Africa	218.294.648	8.279.058
Southern Africa	61.578.844	2.675.233
Western Africa	347.481.541	6.059.427

	Population	Land cover (km²)
Americas	**982.488.456**	**41.793.901**
Caribbean	42.660.124	222.567
Central America	167.803.499	2.475.674
South America	414.709.180	17.718.056
Northern America	357.315.653	21.377.604
Latin America and the Caribbean**	625.172.803	20.416.297

	Population	Land cover (km²)
Asia	**4.299.450.345**	**31.440.963**
Central Asia	67.591.020	4.176.495
Eastern Asia	1.577.689.322	11.548.553
South-eastern Asia	623.138.408	4.388.837
Southern Asia	1.779.161.429	6.742.725
Western Asia	251.870.166	4.584.352

	Population	Land cover (km²)
Europe	**743.698.873**	**22.769.419**
Eastern Europe	293.841.269	18.609.345
Northern Europe	102.352.366	1.762.154
Southern Europe	154.601.968	1.302.884
Western Europe	192.903.270	1.095.036
Western Asia	251.870.166	4.584.352

	Population	Land cover (km²)
Oceania	**37.998.806**	**8.486.405**
Australia and New Zealand	28.450.230	7.961.487
Melanesia	9.372.441	524.457
Micronesia	176.135	461

	Population	Land cover (km²)
World	**7.192.307.915**	**134.477.937**

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