Chapter 1

Benefits to people from avoiding land degradation and restoring degraded land

Coordinating Lead Author

Judith Fisher (Australia)

Lead Authors

Luca Montanarella (Italy/FAO), Robert Scholes (South Africa)

Contributing Authors

Janne S. Kotiaho (Finland), Ritesh Kumar (India), Dan Pennock (Canada), Stephen Prince (Unites States of America)

Review Editor

Oumarou Malam-Issa (Niger), Pascal Podwojewski (France)

This chapter should be cited as:

Fisher, J., Montanarella, L., and Scholes, R. Chapter 1: Benefits to people from avoiding land degradation and restoring degraded land. In IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem services, Bonn, Germany, pp. xx-xx.

Table of Contents

Executive Summary

This report presents the first comprehensive global assessment of land degradation incorporating restoration and rehabilitation responses to avoid, reduce and reverse land degradation (*well established*). The assessment is guided by the IPBES Conceptual Framework, draws on evidence from previous reviews on aspects of land degradation and aims to transform human understandings and behaviour to avoid, reduce and reverse land degradation. The assessment is a structured, evidence-based, multi-authored, expert-reviewed process by which knowledge from diverse scientific disciplines, stakeholder groups, evidence sources, including indigenous and local knowledge systems, differing values and worldviews is evaluated, summarized and presented to guide decisions {1.1}.

It is a challenge to bring together diverse understandings of land degradation as they respond to varied contexts, some of which are more closely related to decision-making (*well established*). The third session of the IPBES Plenary (IPBES, 2015) established definitions and geographic scope for this assessment whereby **degraded land** is defined as a state of land which results from the persistent decline or loss in biodiversity ecosystem functions or services that cannot fully recover unaided within decadal time scales. **Land degradation** refers to the many processes that drive the decline or loss in biodiversity, ecosystem functions or services, and includes the degradation of freshwater and coastal ecosystems that are closely interconnected with terrestrial ecosystems. **Restoration** is defined as any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state. **Rehabilitation** is defined as restoration activities that may fall short of fully restoring the biotic community to its pre-degradation state {1.1}. The geographic coverage encompasses all terrestrial regions and biomes of the world, excluding Antarctica, and encompasses the full range of human-altered systems, including but not limited to drylands, agricultural and agroforestry systems, savannahs and forests and associated aquatic systems. Here, land includes all the non-ocean and non-permanently ice-covered regions of the Earth, the freshwater bodies that drain them, and is defined as the terrestrial bio-productive system that comprises soil, vegetation, other biota and the ecological and hydrological processes that operate within the system {1.1}.

Actions that incorporate full and effective participation of indigenous peoples and local communities, including their knowledge in decision-making and in applying traditional systems of land use and resource management, have in many cases demonstrated solutions to avoid and reduce land degradation, recover degraded ecosystems while providing multiple benefits for the well-being of the society (*well established*). The inclusion of indigenous and local knowledge is a distinctive feature of the IPBES assessments. The Land Degradation and Restoration Assessment has incorporated a participatory mechanism and provided opportunities for indigenous knowledge holders, indigenous peoples, indigenous peoples' recognized groups and local communities to contribute to the assessment.

An operational framework, incorporating an integrated socio-ecological landscape approach, has been developed by this chapter. This framework can provide guidance on the interacting criteria most likely to deliver solutions to avoid, reduce and reverse land degradation, incorporating restoration and rehabilitation (*established but incomplete*). It supports policy, governance, economic, financial legal and regulatory decisions at the global to local scales {1.3, Figure 1.2}. This tool interlinks multidimensional processes, aimed at establishing effective socio-ecological governance, incorporating nature's contributions to people, diverse values and the demands of the biophysical environment, considering and incorporating approaches to deal with rapid change and guide co-ordinated solutions.

Rehabilitation of degraded lands has been successfully achieved in many places (*well established*). Successful cases of restoration or rehabilitation of formerly degraded land are presented in this chapter. These cases were selected from different systems, degradation types, parts of the world and with differing socio-ecological interactions {1.4} and the evaluation of their success to stated objective is laid out against the operation framework developed by this chapter {1.3.1}.

1.1 Introduction to the land degradation and restoration assessment

Land degradation is a global issue, costing the world an estimated 10-17% of the global Gross Domestic Product annually (ELD Initiative, 2015). Human well-being costs, associated with land degradation, are not only monetary in nature, but include negative outcomes for health, social cohesion and impacts on local management practices (see also Chapter 5). Food systems operating in the 21st century have developed as major innovations over a significant period; however, the impacts of many of these systems on the degradation of land provide significant threats to people's long term health and prosperity (IPES-Food, 2016)**.** One and a half billion people inhabit and depend on degraded land (UNCCD, 2015b). According to the ELD Initiative, the estimated global economic services loss due to land degradation is up to $10.6 trillion per year (ELD Initiative, 2015). On the basis of the estimates of annual soil erosion by Pimentel *et al.* (1995), a minimal estimate of the economic impact of land degradation is $40 billion annually (FAO, 2010), with large but unknown additional costs for human well-being.

The geographical scope of this assessment encompasses all the terrestrial regions and biomes of the world, excluding only the continent of Antarctica. This encompasses the full range of human-altered systems, including but not limited to drylands, agricultural and agroforestry systems, savannahs and forests and associated aquatic systems. This includes wetland and aquifer systems that are embedded in the land mass, to the landward side of coastal ecosystems and including saline systems. The state of wetlands is inextricably linked to actions in the drier parts of the landscape which drain into them. This scope includes the wetlands as defined within the Ramsar Convention on Wetlands, including areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, and including areas of marine water, the depth of which at low tides does not exceed six meters (Ramsar, 1994).

The definition for **land** for this assessment was that adopted by the UNCCD: **land** means the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system.

This definition of land matches the IPBES adopted definition of land degradation (see below), which is essentially ecosystem-based and includes the decline or loss of biodiversity, which is considered an integral part of land as a terrestrial ecosystem.

At its third session, the IPBES Plenary (IPBES-3) approved definitions for degraded land, land degradation, restoration and rehabilitation (IPBES, 2015). The expert team was not empowered to change these definitions or adopt other definitions. The process of the assessment revealed both strengths and limitations in the definitions, which are discussed below:

Degraded land is defined as land in a state that results from the persistent decline or loss of biodiversity, ecosystem functions and services that cannot fully recover unaided within decadal time scales.

Land degradation refers to the many processes that drive the decline or loss in biodiversity, ecosystem functions or services, and includes the degradation of all terrestrial ecosystems including associated aquatic ecosystems that are impacted by land degradation.

This is a broader definition than the one adopted by the UNCCD in Article 1 of the Convention text (UNCCD, 1994), whereby land degradation was defined as "reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns including soil erosion, deterioration in physical, chemical, biological or economic properties of soil and long term loss of vegetation."

The IPBES-adopted definition of land degradation fully includes the narrower definition adopted in 1994 by the UNCCD Convention and is the basis for this Land Degradation and Restoration Assessment. Hence, this assessment is fully compatible with the scope and mandate of the UNCCD and intends to contribute to the actions implemented within that multilateral environmental agreement in reversing land degradation in affected countries.

Note that degradation *sensu* IPBES is restricted to anthropogenic processes. A full discussion of the different perceptions and worldviews related to land degradation is available in Chapter 2. The assessment also recognizes that land degradation, including its drivers and processes, can vary in severity within regions and countries as much as between them.

Restoration is defined as any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state. This definition covers all forms and intensities of the degradation state and is in this sense inclusive of the definition adopted by the Society for Ecological Restoration (SER) (Mcdonald *et al.*, 2016).

Rehabilitation is used to refer to restoration activities that may fall short of fully restoring the biotic community to its pre-degradation state, including natural regeneration and emergent ecosystems.

The origin of the degraded land definition adopted by the IPBES plenary can be traced to the desertification synthesis of the Millennium Ecosystem Assessment (MA, 2005), which proposed that degradation could be unambiguously defined as a persistent reduction in ecosystem services. The word **persistent** is intended to exclude short-term fluctuations, such as between summer and winter or from a short run of dry years (MA, 2005). It also implies that the recovery processes are slow, even if the driver of the decline has been alleviated. This idea is consistent with the UNCCD definition of desertification, which is defined as land degradation in arid, semi-arid and sub-humid lands, where degradation is, among other things, a long-term loss of vegetation (UNCCD, 1994). It is important not to confuse areas of inherently low biodiversity, ecological function, or ecosystem service with degraded areas. They may be low in productivity or biodiversity for a range of entirely natural reasons, including among others, because they are climatically too dry or too cold to support much life, have thin soils, or are naturally saline.

Subsequent to the adoption of the land degradation definition by the third session of IPBES Plenary, the fifth session of IPBES Plenary (IPBES, 2017) replaced ecosystem services by nature's contributions to people (NCP). The new terminology includes all the contributions of nature, both positive and negative, to the quality of life of humans as individuals and societies. In this assessment we use both phrases – ecosystem services and nature's contribution to people – since much of the literature we assess uses the older terminology, as does our scoping document and definitions. Where appropriate and where it causes no ambiguity, we use the new terminology of nature's contribution to people.

The various parts of nature's contributions to people are conceptually similar to provisioning, cultural and regulating ecosystem services, but exclude supporting services (which are now considered ecosystem functions) and include natural harms such as floods. The nature's contribution to people terminology also avoids the perceived association of ecosystem services with economic valuation. The evolving IPBES approach to how nature's contributions to people are valued is more inclusive than previous studies (Pascual *et al.*, 2017). Ecosystem services (and nature's contribution to people) are linked to living organisms, but neither are synonymous with biodiversity in its widely-accepted sense of the variety of nature (CBD, 1992). For these reasons, loss of biodiversity and ecosystem functions were both made explicit in the IPBES definition of land degradation. However, doing so can result in ambiguities in quantifying and mapping land degradation or restoration. When ecosystem services, ecosystem functions and biodiversity all decline and fail to recover within ten or more years, it is clear that degradation has occurred. What can be concluded if one or more declines, but the others do not, or perhaps even increase? This situation occurs frequently. For instance, when land cover or land use is changed in order to promote the production of a particular ecosystem service (for example, food from agricultural systems, or timber from plantation forestry), biodiversity almost always declines, and other non-prioritized ecosystem services may also decline (MEA, 2005). However, much human well-being rests on such deliberate and socially-sanctioned conversions and land uses, and it would be perverse to automatically regard them as degradation. On the other hand, conversion to land uses focusing on a restricted set of ecosystem services – and the ongoing management actions used to maximize the yield of those services within the new land use – is a major cause of loss of biodiversity worldwide (MA, 2005; Sala *et al.*, 2000; Wood *et al.*, 2000) and the decline of ecosystem services such as climate regulation and the supply of clean water (Allan *et al.*, 2015; Oliver *et al.*, 2015).

In order to navigate the internal contradictions which, arise from the definition presented to it, this assessment makes a distinction between land transformation and land degradation. **Land transformation** – including the reverse transformation resulting from the abandonment or rewilding of formerly cultivated, settled or domestically grazed lands – has impacts on biodiversity, ecosystem functions and ecosystem services, some of which lead to either an increase or decrease in particular factors. The latter can therefore be considered a form of degradation. Since land transformations are by definition very apparent, they can usually be unambiguously identified and mapped. Therefore, transformation is often expressed in terms of the area affected: for instance, the number of square kilometres deforested, or the percentage of wetlands restored. Implicitly, targets such as the Aichi Target 15 of the Strategic Plan for Biodiversity 2011-2020 (CBD, 2010) and the UNCCD Land Degradation Neutrality Target (Orr *et al.*, 2017) rest on the assumption that such changes can be expressed in area terms.

Within a land use or cover, persistent changes in ecosystem services, function and biodiversity can also occur. These changes are often slower, continuous and thus difficult to detect, but nevertheless constitute land degradation as defined. They may apply over very large areas to varying degrees and cumulatively have large consequences. Defining the affected area also requires a determination of the degree of change (severity) considered to constitute degradation. Therefore, a more meaningful indicator of impact is the integral of severity over the area, and perhaps over time as well (duration), since long-lasting effects are more important than ephemeral effects. Past failures to effectively quantify severity and duration have hampered the ability of this assessment and previous studies to quantify this perhaps most important form of land degradation (i.e., the deterioration of the functioning of composition of an ecosystem without registering a change of area).

The final element in the land degradation definition is how to meaningfully combine a number of simultaneous changes of different magnitudes and even directions, into a single indicator. The ecosystem services literature uses the notion of bundles, which are groups of services that co-vary positively, to help reduce the dimensions which need to be considered (Raudsepp-Hearne *et al.*, 2010), but this approach does not solve the fundamental problem of incommensurability. Relationships exist between restoration and ecosystem services (Aronson *et al.*, 2016). Natural Capital Accounts (Robinson, *et al.*, 2014) show some promise in being able to combine ecosystem service changes of different types, extents, severities and durations into a single framework; in which case, it would be possible to say unambiguously whether the natural asset had on aggregate increased or decreased. To date it has not been possible to satisfactorily include all aspects and values of biodiversity in this framework. Furthermore, some perspectives reject any attempt to do so on the grounds that it may be unethical (Robinson *at al*., 2014).

As a result of the issues raised above, it is currently not possible to operationalize a land degradation definition alike the one provided to this assessment, which includes both ecosystem services and biodiversity. The compromise implemented in this assessment is to treat biodiversity and loss of ecosystem services separately where necessary, and to quantify land transformation separately from land degradation without transformation, within a land use.

Definitions of degradation and restoration also require a measurement of change over time if they are to be detected and quantified. Box 1.1 outlines this discussion briefly (for more detail, see Chapter 2, Section 2.3.1 and Chapter 4, Sections 4.1.3, 4.1.4, 4.4.2 and 4.4.3).

Box 1.1 Targets and baselines

Degradation and restoration are relative terms: “degraded relative to what?” and “restored towards what?” Thus, a reference state is required to detect and assess both the magnitude of degradation and the progress of restoration. Since degradation and restoration refer to change over time, information is needed at two or more times. There is no perfect reference state for all purposes, but allowing free selection of the reference is likely to reduce comparability and increase the risk of deliberate bias. In practice, the nature of a specific data set often dictates the choice of reference state.

The term **baseline** is defined as a reference state in the past up to the present, and is in principle verifiable by observation.

It should not be confused with a **target** which may exist now or, more commonly, is set in the future, and whereby its achievement can only be verified at that time in the future. A target is a political choice, weighing societal, economic and ecological factors, and it can vary case by case and be revised over time.

1. Targets

A target is a desired state. It is typically used for purposes of restoration, though it can be applied to measure degradation as well. The target is perhaps the most important of the reference states for policy purposes, since it represents the future, and thus a state whose achievement can be influenced by policy. It is based on a deliberate, societally-informed choice and is therefore context-dependent. The target may be updated over time, as societal preferences or circumstances change, or as knowledge accumulates, will generally vary from place to place. For example, the aim of restricting global mean temperature rise within 2°C of the pre-industrial mean is a target. An ecosystem target can be considered from the perspective of biodiversity (e.g., protect 17% of the original area of each ecosystem), or it can be considered from the perspective of ecosystem services (e.g., achieve a prescribed sustained flow of clean water). Targets can range from being pragmatic – based on modest investments and readily available technology (such as to slow the rate of species loss) – to aspirational, an ideal outcome with little practical chance of being reached. In the former case, outcome-based metrics are usually set, whereas in the latter case effort-based metrics are more relevant.

2. Baselines

There are two qualitatively different types of baselines which have been used for the measurement of human-caused ecosystem degradation and restoration. The first refers to the distant past, a “natural” state before human modification. The second is a “historical” state that refers to much more contemporary states, for which we have increasingly precise data.

2.1 Natural baselines

Establishing a natural reference state for an ecosystem is challenging, since most ecosystems have been influenced to some degree by humans for a very long time. Two approaches have been used:

2.1.1 Pre-modern natural baseline

This can be thought of as the ecosystem condition within the Holocene, but before the Anthropocene – in other words, sometime between 10 000 and 100 years ago. This seems to be an obvious baseline from which to assess degradation and recovery since it is before the onset of the profound modifications brought about by the rapid increases in the human population, consumption and waste production in the modern era, at which point a distinct discontinuity appears in the degree and type of disturbance. The pre-modern natural baseline has the advantage of not being easily manipulated. Several examples show it to be implementable in appropriately-selected cases, though not without challenges. Practically, it is rare to find data from so far in the past that includes all the variables needed to compare with current ecosystem condition. Proxies are commonly used, such as paleo-ecological data, which is sparse, expensive to collect and requires great expertise to interpret. Another strategy is “space-for-time” substitution, where a currently existing ecosystem in another place (for instance, a protected area) is taken to represent the pre-modern past of the human-altered ecosystem under consideration. But the climate and other biophysical environmental conditions may have changed in the intervening time, or may be subtly different at the reference location, and it is difficult to disentangle the effect of anthropogenic degradation from natural environmental change. In some cases, the ecosystem structure, composition and function which we desire to retain or achieve is inextricably a product of human actions, and in these cases, considering the ecosystem without human influence makes no sense.

***2.1.2 Counterfactual natural baseline*.**

Perhaps a more operational approach for establishing a natural state baseline is to use the current time, but apply counterfactual thinking, which can be characterized by the phrase “what might have been in the absence of human influences”. Counterfactual natural baselines avoid some of the challenges of pre-modern observation-based baselines, but they require a high level of expertise, sometimes using explicit process knowledge that constitutes a “model” of what would have happened in the absence of human effects. Some implementable examples exist: for instance, enough is known about the ecosystem dynamics of carbon to be able to state with good confidence what the soil carbon content at a site would have been under a natural cover.

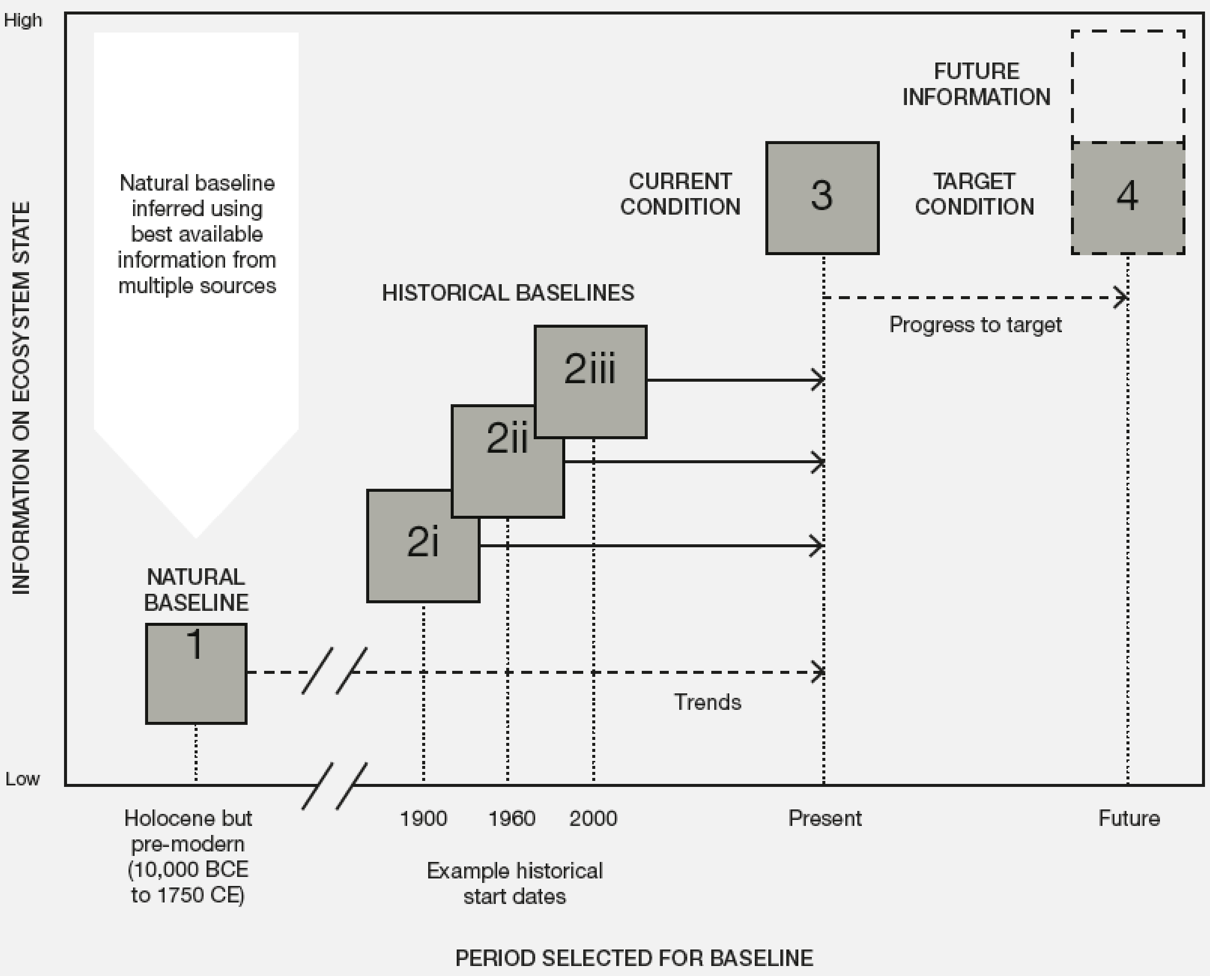
2.2 Historical baselines

Historical baselines use direct observations of the ecosystem state, and therefore seldom extend before about 1950; but they include our most reliable datasets, such as long-term datasets and ecological experiments, and are therefore an invaluable resource. Quantitative trend analysis sets no explicit baseline, but unavoidably uses the start of the record. Unlike natural baselines, it is accepted that historical baselines may have undergone some human-induced change prior to their establishment, and therefore provide underestimates of the totality of degradation or restoration. Particularly in the case of non-linear change (for instance, degradation which levels off at a limit), a recent historical baseline underestimates the total degradation, relative to those where it occurred before the baseline was established. The closer to the present baselines are established, the more data are available, but the less they represent the totality of degradation. The advantage of earlier references is that they allow better detection of slow changes, particularly against noisy short-term variation. Various historical baselines have been used in the land degradation and restoration domain. Their differing and sometimes arbitrary starting dates make comparisons difficult and are open to self-serving manipulation. When we are interested in the impacts of policy or management changes, a recent baseline can be used - for instance the date at which an agreement came into force.

For further discussion regarding baselines and targets, and citations of the underlying literature, see Chapter 2, Section 2.2.1.1, Figure 2.4 and Figure 2.5 and Chapter 4, Sections 4.1.3, 4.1.4, 4.4.2 and 4.4.3.

Fig. 1 1 **Schematic diagram of various types of baselines (reference conditions) which can be used to identify degradation and restoration, and as a starting condition from which to measure trends.**

1. Pre-modern Natural baseline - the information is inferred from the current state, historical data, paleo-ecological proxies and expert opinion. Since the actual date of this state is rarely known, the derived trend is indicated by a dashed line;
2. i, ii, iii. Historical baselines - data gathered in the recorded past (e.g. 1900, 1960, 2000);
3. Current state - used to measure past trends and to provide a reference for future monitoring;
4. Target – the state chosen as an objective for restoration.



1.2 When is the avoidance or reversal of land degradation successful?

1.2.1 An operational framework

The scope of this chapter is to provide examples of success cases which demonstrate the benefits to human well-being and quality of life achieved by avoiding, reducing and reversing land degradation through restoration and rehabilitation. The objective in highlighting cases is to show how land management and restoration measures can help improve livelihoods, reduce poverty and strengthen long-term sustainability of land use in different situations.

To determine the approach to the selection of cases, scientific and other literature was systematically assessed (see Section 1.2.1.1). More specifically, this literature search was done to identify, summarize and evaluate key recurring factors and criteria which are most likely to contribute to such success and to assist in determining the success cases to be highlighted in Chapter 1. The outcome of this systematic review lends itself to the development of an operational framework (Figures 1.2 and 1.3), which incorporates the landscape socio-ecological approach. This framework was subsequently used to guide the choice of cases and the quantitative assessment of their success (see Sections 1.3.1 and 1.4). The Operational Framework may also assist with project development, implementation and assessment.

1.2.1.1 Methodology to identify key criteria

A systematic seven-step methodology was developed to identify the key criteria most likely to deliver outcomes which will benefit human well-being and quality of life through the avoidance, reduction and reversal of land degradation, incorporating successful restoration and rehabilitation of degraded lands. This seven-step approach integrated the main elements of the IPBES Conceptual Framework (i.e., nature, anthropogenic assets, nature's contributions to people, drivers of change and good quality of life) (Figure 1 in Preface based on Díaz *et al.* (2015)), the IPBES approach to the valuation of nature's contributions to people (Pascual *et al.*, 2017), and the evolving IPBES approach to the inclusion of indigenous and local knowledge. The approach drew on information and insights from all other chapters. This seven-step methodology is described below:

Step 1: Search terms were established using the main elements of the IPBES Conceptual Framework and the valuation of nature's contributions to people, incorporating causes and consequences of land degradation. Search terms elements were also drawn from the Sustainable Development Goals, the Aichi Biodiversity Targets, and the UNCCD Convention. The authors incorporated differing knowledge systems and worldviews (including indigenous and local knowledge), the elements of quality of life and human well-being, the quality of life of individuals, communities, societies, nations and humanity, and successful solutions including restoration and rehabilitation (Chapter 1). Key elements from other chapters were reviewed and incorporated, including different perceptions (Chapter 2), direct and indirect drivers (Chapter 3), status and trends of biodiversity and ecosystem services (Chapter 4), scale and trade-offs (Chapters 4 and 5), changes in ecosystem functions, human well-being and good quality of life (Chapter 5), responses to land degradation and restoration (Chapter 6), trade-offs between social, economic and environmental objectives (chapters 4, 5, 6 and 7) and decision-support approaches (chapter 8).

Step 2: Using the aforementioned terms, a systematic literature search was conducted, incorporating the cycle of events from causes through to solutions, drawing on relevant articles, books, regional and national assessments, reports by governments, United Nations bodies, national and international nongovernment organisations and indigenous peoples and local community knowledge sources. A total of 260 references were accessed during this search.

Step 3: The content of the 260 references were subjected to a systematic review process to identify key recurring and common terms associated with the causes of land degradation, its impacts on human well-being and quality of life, restoration, rehabilitation, successful outcomes and solutions. This review of literature revealed 106 key terms.

Step 4: The 106 key terms were grouped by similarity, reflecting on the initial search criteria. This resulted in 15 key headings, based on the frequency in which the term occurred. The information from the literature search was gathered into a table listing the pertinent references and divided by: (i) perspective; (ii) initial search criteria; (iii) the key term to which it is related; (iv) implementation outcomes; and (v) other factors.

Step 5: The information in the summary table (Step 4) was further analysed to reveal three overarching and overlapping criteria. The three overarching **criteria** emerging from this systematic iterative process were: (1) guiding instruments: (2) nature's contributions to people; and (3) biophysical conditions. In addition, three overarching **principles** emerged. These were: (1) communication; (2) coordination; and (3) participatory processes.

Step 6: All information in steps 1 through 5 was grouped within each of the relevant three key overarching criteria. This resulted in a number of sub-categories within each criterion, including those which overlapped with the three criteria, demonstrating the importance of interconnections between criteria for successful outcomes. An internal review of the initial outcomes occurred across all chapters in the assessment. Inputs from two external reviews enhanced the outcomes presented in Chapter 1 (Figures 1.2 and 1.3).

Step 7: Figure 1.2 represents the outcomes of the iterative systematic review process, summarising an operating approach which may guide actions. Section 1.3 expands on Figure 1.2 and provides information on the subcategory elements, their interlinkages and interconnections and their usefulness in potentially identifying and achieving future successful outcomes. A further literature search based on the developed Figure 1.2 was conducted. Additional 250 references supporting the outcomes of the systematic review process (total of 510 references) have been utilised to substantiate the information presented in Figure 1.2 and 1.3.

This systematic review process is summarised into an operational framework (Figure 1.2 and Section 1.3) which may guide coordinated approaches to achieve successful outcomes (Chapter 1) to avoid, reduce and reverse land degradation (Chapter 6) while benefiting human well-being and quality of life (Chapters 1, 2, 5), incorporating different perceptions and worldviews (Chapter 2) and understandings of the biophysical environment (Chapters 3, 4), including decision processes and tools (Chapters 7, 8). This review has demonstrated the importance of including information and insights from all chapters of the assessment, the IPBES Conceptual Framework and approach to values and nature's contributions to people, to identify an approach which may guide actions to achieve and measure the success of outcomes. The evaluation methodology (Figure 1.2 and Section 1.3.1), provides a quantitative approach to identify which criteria, and their sub-elements, have been achieved successfully and the elements for which improvements can be made.

1.2.1.2 Key aspects of the operational framework

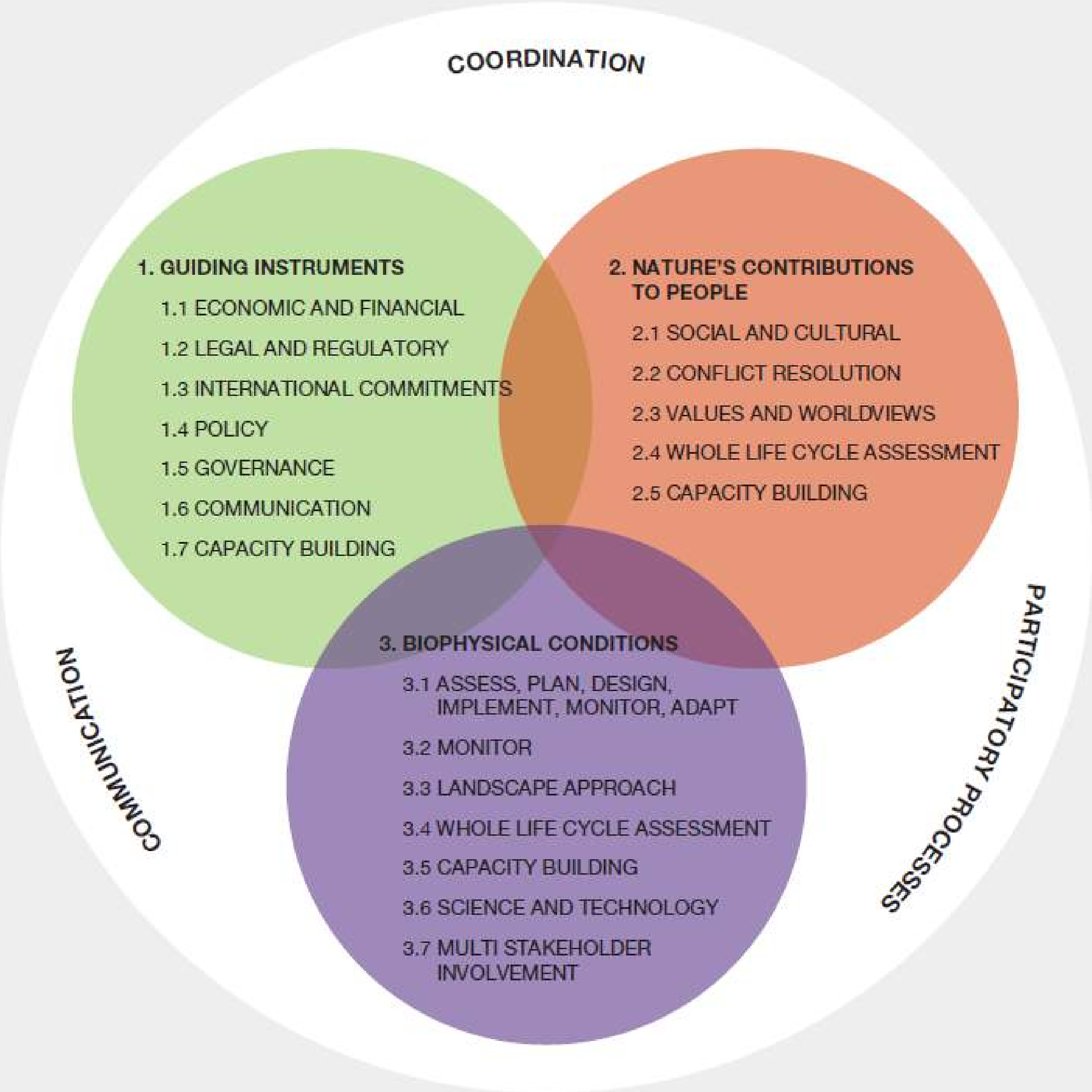
Key aspects of the operational framework are the socio-cultural relations between people and nature (Figure 1.2). This cultural context influences the perceptions and experiences of actions and what counts as success. Effective outcomes occur when actions are co-produced with people and nature and include the application of their knowledge and work. This guidance draws on insights from the seven subsequent chapters of the assessment, underpinned by a firm evidence base (Estrada-Carmona *et al.*, 2014). When all factors are implemented in a coordinated, interacting manner and communicated to all levels of society, outcomes are most likely to lead to positive solutions to avoid, reduce and reverse land degradation, benefitting human well-being, quality of life and nature (see Section 1.3).

Figure 1.2 provides direction for the selection of the eight success cases presented (see Section 1.4). To assess the outcomes of the success stories, our approach considers aspirations to benefit human well-being and quality of life while avoiding, reducing and reversing degradation processes utilising the restoration and/or rehabilitation of degraded land. The three key interacting criteria and associated elements have been used to frame, along with a quantitative evaluation (see Section 1.3.1), the outcomes of the success cases.

The three interacting criteria (i.e., guiding Instruments, nature's contributions to people and biophysical conditions) depend on active, multi-stakeholder involvement to ensure outcomes that: (i) incorporate human well-being, differing values and good quality of life; (ii) are technically and legally feasible, while being environmentally and socially acceptable; (iii) incorporate knowledge and capacity-building, establishing an enabling environment which is well understood, communicated and supported by all stakeholders; and (iv) incorporate economic and financial mechanisms compatible with all three interacting criteria (Figure 1.2). The operational framework utilizes the ecosystem approach at a landscape scale – that is, a socio-ecological ecosystem, delivering multiple functions, including multiple stakeholders with differing values. The **landscape-scale approach** incorporates the socio-ecological system, including natural and human-modified ecosystems, influenced by ecological, historical, economic, and socio-cultural processes. The landscape includes an array of stakeholders small enough to be manageable but large enough to deliver multiple functions for stakeholders with differing interests (Denier *et al.*, 2015; Scherr *et al.*, 2017).

Figure 1 2 Operational framework for guiding decisions and actions to establish and identify success in avoiding, reducing and reversing land degradation for the benefits of human well-being and good quality of life, while restoring and rehabilitating degraded land.

This approach is underpinned by coordination, communication and participatory processes; and the main IPBES elements (**Figure 1**) of nature, anthropogenic assets, nature's contributions to people, drivers of change, good quality of life and diverse values.



1.3 Understanding the operational framework

Coordination, communication and participatory processes are key influences of the three overarching criteria. They are underpinned by participatory planning and different knowledge systems (Brancalion, 2015; Guilfoyle, 2004; Hill *et al.*, 2013; Laestadius *et al.*, 2015). Together they may create evidence-based, enabling instruments and environments to avoid land degradation and deliver effective restoration and rehabilitation (ELD Initiative, 2015; Joly *et al.*, 2010).

Evaluating success

Several elements support each of the three overarching criteria (Table 1.1). None of these elements, across and within the three criteria are sufficient individually to establish or identify success. Positive solutions rarely, if ever, operate in isolation from all other factors. Our literature review (see Section 1.2.1.1) has demonstrated that interactions, alignments, implementation and measurements across the three criteria can be critical for success. A quantitative method is presented which can evaluate effectiveness of individual success stories (Table 1.1, Box 1.2), and may also provide an approach to measure effectiveness of new projects into the future. The scoring is conducted against and within each of the three criteria (Table 1.1, Figure 1.2), using scoring values as outlined in Box 1.2. All factors (Table 1.1) are given a scoring value between -1 to +5 (Box 1.2). These quantitative measurements can be used prior to restoration and rehabilitation actions, during implementation, at the end of implementation and can also assist project adaptation.

Table 1 1 Factors linked to the 3 overarching criteria of the operational framework (Figure 1.2) to score against to evaluate success, using scoring values -1 to 5* (Box 1.2).

* Scoring values

1. GUIDING INSTRUMENTS	2. NATURE'S CONTRIBUTIONS TO PEOPLE	3. BIOPHYSICAL CONDITIONS
1.1 Economic and finance	**2.1 Social and cultural instruments**	**3.1 Assess, Plan, Design, Implement, Monitor, Adapt** Land degradation state
1.2 Legal and regulatory 1.2.1 Formal recognition property rights, land tenure	**2.2 Conflict resolution** 2.2.1 Food and biodiversity 2.2.2 Livelihoods 2.2.3 International/national interests	**3.2 Monitor**
1.3 International Commitments	**2.3 Values and worldviews** 2.3.1 Non-monetary valuation 2.3.2 Human well-being, quality of life 2.3.3 Indigenous people & local communities	**3.3 Landscape approach** 3.3.1 Biodiversity, food, water, soils, carbon, climate
1.4 Policy Instruments 1.4.1 Formal recognition Property rights, land tenure	**2.4 Whole of life cycle assessment**	**3.4 Whole of life cycle assessment**
1.5 Governance 1.5.1 Active multiple stakeholder engagement	**2.5 Capacity-building**	**3.5 Capacity-building**
1.6 Communication		**3.6 Science and technology**
1.7 Capacity-building		**3.7 Stakeholder involvement**

Box 1 2 **Methodology to evaluate success of solution-based projects designed to improve human well-being and quality of life by avoiding and reducing land degradation and restoring and rehabilitating degraded lands.**

- -1 Negative
- 1 Limited
- 2 Slight
- 3 Slight to moderate
- 4 Moderate
- 5 Good

1. Guiding instruments	11 factors score each factor (-1 to + 5) max value 55 = **total 1**
2. Nature's contributions to people	11 factors score each factor (-1 to + 5) max value 55 = **total 2**
3. Biophysical Conditions	9 factors score each factor (-1 to + 5) max value 45 = **total 3**

Success value % = (total 1 + total 2+ total 3) / (55+55+45) * 100

* Scoring values

1.3.1 Guiding instruments

The guiding instruments (Figure 1.2, Points 1.1-1.7) are the core instruments which, if effectively developed, integrated and aligned, can provide opportunities for a positive impact for people and the land. Good governance structures (1.5) incorporating differing values, worldviews and indigenous and local knowledge can stimulate successful strategies which may reduce negative impacts of conflicting interests. Communication and capacity-building potentially can align all players.

1.3.1.1 Effective and implemented economic and financial instruments (Figure 1.2, point 1.1)

Successful restoration is underpinned by a strong business case, which incorporates ecological, social and economic benefits (FAO, 2015; IUCN & WRI, 2014). Successful restoration also needs to be supported by a decision-making framework aiming for net social and economic benefits, and implemented within strong legal, governance and institutional contexts (Laestadius *et al.*, 2015; Wortley *et al.*, 2013). The correct mix of policy incentives, excluding perverse incentives, can lead to the establishment of new incentives to lower or remove economic barriers (Global Landscapes Forum, 2015b), and encourage the adoption of more sustainable management practices (ELD Initiative, 2015). Subsidies which stimulate low profit agriculture, and negative landscape impacts, such as the European Union's Less Favoured Areas subsidies, predicates a support scheme (Salvati & Carlucci, 2014) with perverse incentives, hence this subsidy is being reviewed by the European Union. Policies and schemes for the payment of ecosystem services, which provide incentives for investment in land improvement and reward sustainable land use, have been employed as economic instruments in some parts of the world (Nkonya *et al.*, 2016). Successful application is relative to the country and its legislation. However, a singular focus on economic value, such as the payment of ecosystem services, provides limited opportunity to incorporate a pluralistic approach which embraces a diversity of non-monetary values, and limits opportunities for transformative integrated practices (Pascual *et al.*, 2017). Economic incentives for one ecosystem function or service can lead to unbalanced outcomes and negative impacts on communities, including indigenous peoples and local communities – particularly women, who disproportionally depend on non-monetary values. Private markets often fail to assign a price to many ecosystem services that adequately reflects their benefits to society as a whole (Kroeger & Casey, 2007). The Kisoro District in Uganda provides an example where fragmented landscapes and lack of collaboration, between upstream and downstream communities in the Chuho springs watershed, has resulted in upstream land degradation due to intensive agricultural practices and a lowered water supply to downstream users. The potential for a payment for ecosystem services scheme to benefit both communities was found to be very limited (Sengalama & Quillérou, 2016).

Effective examples incorporating financial instruments

Landscape partnerships, including businesses, have the potential to be effective for reducing land degradation, while benefitting and contributing to local communities, businesses, landscapes, food and nature. The Business for Sustainable Landscapes project, created by the Landscapes for People, Food and Nature Initiative, (partnered by EcoAgriculture, IUCN's SUSTAIN-Africa Programme, SAI Platform and the Sustainable Food Lab) catalysed input from 40 companies and organizations, to advance landscape partnerships - resulting in an Action Agenda to strengthen business participation and contributions. The Action Agenda aims to improve the quality of business engagement and scale up landscape partnerships for sustainable development including food, nature, business, local communities and landscapes (Scherr *et al.*, 2017).

Australia's Indigenous Land Corporation's National Indigenous Land Strategy is linked to Australia's Indigenous Economic Development Strategy and enables the Indigenous Land Corporation to meet their legislated function to assist indigenous people to acquire and manage land to achieve economic, environmental, social or cultural benefits (Indigenous Land Corporation & Australian Government, 2012; Indigenous Land Corporation, 2013).

A local Kenyan organization, Kijabe Environment Volunteers in the Kikuyu escarpment landscape has mobilized communities across their landscapes. These landscapes are rich in wild biodiversity, have strong cultural heritage and important areas of agricultural production. A landscape perspective was adopted to sustainably manage natural resources and balance the multiple functions of the landscape, enabling local communities to define and pursue their goals related to agricultural development and profitability while conserving the area's critical natural capital (Buck *et al.*, 2014).

Countries experiencing salt-induced land degradation have recognised the cost-effectiveness of investing in land remediation, incorporated into a broader strategy for food security. Including remediation in national action plans can identify and remove barriers to the adoption of sustainable land management, including perverse subsidies (Qadir *et al.*, 2014).

1.3.1.2 Effective and implemented legal and regulatory instruments (Figure 1.2, point 1.2)

Legal and regulatory instruments that guide countries' and states' policies for land restoration and rehabilitation, including extraction of natural resources, establish legal and regulatory frameworks to improve restoration outcomes and success. Such legal instruments are only as good as their implementation, particularly in controlling compliance and implementing potential prosecutions. Latin American countries have developed regulatory frameworks and supportive instruments aimed at guiding restoration. However, exclusion of stakeholder groups, limited institutional and organizational capacity to operationalize large-scale restoration and particularities of the high socio-ecological heterogeneity in legal and regulatory instruments have limited their effectiveness (Meli *et al.*, 2017). For example, the Secretariat for the Environment of the State of São Paulo, Brazil, drives planning and assesses achievement of legally-established goals and compulsory restoration targets. These are however only biophysical and exclude impacts on people, particularly indigenous peoples and local communities (Chaves *et al.*, 2015).

The Western Australian State legal and regulatory instruments (Western Australian Department of Mines Industry and Regulation, 1978), linked to Australian government legislation (Commonwealth of Australia, 2016), direct the formulation of policy and guidance statements around the extraction of natural resources, including rehabilitation and restoration completion criteria, definitions, measurement of success and timeframes, and are auditable (EPA, 2006). South Africa requires mining companies to rehabilitate land after open cast mining, which is costly. Estimating the farming revenue of land prior to and after open-cast mining can establish what the value of land use will be after mining, and can shift scenarios toward a win-win situation for all land users (McNeill & Quillerou, 2016).

Legal policies based on environmental compensation, without restoration recovery conditions, have failed in mangrove recovery projects in Mexico (Zaldivar-Jimenez *et al.*, 2010). To compensate for wetland losses through the implementation of the Clean Water Act in the United States, performance standards for wetland creation and restoration have been established (National Research Council 2001a, 2001b).

Formal recognition of property rights and land tenure (Figure 1.2, points 1.2 and 2.2)

Land tenure is the legal status and ownership of land, often with a mixture of formal and informal tenure systems and a mosaic of property rights, individual and collective. Effective rule of law – including property rights allocation and women's land tenure rights (Silverman, 2015; Plurality in Public Policy, 2014) – provides certainty, reduces conflict and land degradation. Case studies from 10 countries (Chile, Ethiopia, Iran, Panama, Paraguay, Russia, Samoa, Solomon Islands, South Africa and Uganda) established that legislation recognizing community land, conserved areas and traditional knowledge further enhanced project success (Global Forest Coalition, 2015).

Solid evidence exists that strong customary tenure and clear, uncontested land rights have a positive impact on good stewardship of landscapes and are critical to the success of large projects such as REDD+, community forest programs and integrated landscape management. Strong correlations exist between weak, poorly defined rights and insecure tenure, deforestation and landscape-level degradation (Global Landscapes Forum, 2015b). A lack of formal registration of customary property rights may not benefit the local and poorer populations, potentially causing unrest and marginalization of local communities (ELD Initiative, 2015). Difficulties occur where modernization has diluted such "law", and in colonial disputed lands where differing views exist on land tenure regimes (see Case Study 8).

Restoration and rehabilitation of degraded land can benefit by working with the knowledge of indigenous and local knowledge holders to aid restoration approaches, who have been on the land for generations, and have relevant intergenerational observational knowledge, as articulated in the Indigenous and Tribal Peoples Convention, 1989 (No 169) (ILO, 1991).

Indigenous law has key connections to sustainable land management. Adult traditional owners of the Girringun in northern Australia (and other indigenous traditional owners across the country) hold formal legal, cultural and spiritual obligations to care for ancestral lands and waters – based on a worldview and customary planning system with spiritual, social and physical connections between land and people, in addition to their responsibilities under customary law (Guilfoyle & Mitchell, 2015). Negative changes in ecosystem components, directly affect the mental health and spiritual well-being of these indigenous communities, including the quality of food and plant resources (Fisher, 2013; Robinson *et al.*, 2016).

1.3.1.3 Implementation of international commitments (Figure 1.2, point 1.3)

International commitments and targets can only be effectively implemented if there is local action and support. The following commitments all have provisions relevant to land degradation and restoration with obligations entered into by signatory countries: Sustainable Development Goals 2, 13 and 15; the land degradation neutrality (LDN) of the United Nations Convention to Combat Desertification (UNCCD); the United Nations Framework Convention on Climate Change (UNFCCC); The Ramsar Convention through the 4th Strategic Plan 2016-2024 (Ramsar, 2015) and the Convention on Biological Diversity (CBD) Aichi Target 15 of the Strategic Plan for Biodiversity 2011-2020 (Paustian *et al.*, 2016, Montanarella & Lobos, 2015). Land and soils are considered across the three Rio Conventions (UNFCCC, CBD and UNCCD), and while some advances have been made in the past two decades, land and soil degradation persist. This calls for a more integrated approach for the implementation across the Conventions. Opportunities exist to strengthen linkages between the Rio Conventions (UNFCCC, CBD and UNCCD) and the Sustainable Development Goals (SDGs), utilizing soil-based greenhouse gas mitigation policies (Paustian *et al.*, 2016), consolidating associations with the UNFCCC and the 171 countries who have become signatories to the

Box 1.3 Sendai Framework complementarities to the operational framework of this chapter

Elements of the Sendai Framework for Disaster Risk Reduction (2015-2030) which are complementary to the ecosystem and landscape approach proposed within the operational framework include:

28 (d) To promote transboundary cooperation to enable policy and planning for the implementation of ecosystem-based approaches with regard to shared resources, such as within river basins and along coastlines, to build resilience and reduce disaster risk, including epidemic and displacement risk;

30 (f) To promote the mainstreaming of disaster risk assessments into land-use policy development and implementation, including urban planning, land degradation assessments … the use of guidelines and follow-up tools informed by anticipated demographic and environmental changes;

30 (g) To promote the mainstreaming of disaster risk assessment, mapping and management into rural development planning and management of, *inter alia*, mountains, rivers, coastal flood plain areas, drylands, wetlands and all other areas prone to droughts and flooding,… and at the same time preserving ecosystem functions that help to reduce risks (UNISDR 2015);

30 (n) To strengthen the sustainable use and management of ecosystems and implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction.

Paris Agreement (April, 2016). Similarly, soils and land play a key role to achieve the post-2015 development agenda and can be found across the Sustainable Development Goals (Montanarella & Lobos, 2015).

SDG 15 (Targets 15.1-15.9) is relevant to this assessment and pertinent to the operational framework of success. Coordination and incorporation of all elements as outlined in the operational framework (Figure 1.2) may assist governments in choosing an appropriate suite of strategies to reach net positive impacts and the mitigation hierarchy (BBOP & UNEP 2010), the Bonn Challenge (Chazdon *et al.*, 2015) and the Latin American Initiative of 20x20 – a country-led initiative to restore 20 million hectares of degraded land in Latin America and the Caribbean by 2020, which is guided by the World Resources Institute and strongly influenced by the political agenda (Vergara *et al.*, 2016). The Sendai Framework for Disaster Risk

Reduction 2015-2030, adopted in 2015, is relevant to this assessment as it recognizes the benefits in reducing risk to the degradation of ecosystem services, and prioritizes a number of related actions (including at a landscape-scale) on ecosystem-based approaches to disaster risk reduction. A number of elements within the Disaster Risk Reduction Framework are well aligned with and complement the approaches of this chapter's operational framework (Figure 1.2) (Box 1.3).

1.3.1.4 Enabling policy instruments (Figure 1.2, point 1.4)

Enabling circumstances include coordination and communication across all **success factors** and provide strategic and coordinated efforts to strengthen them. Implementation of the following enabling instruments provide opportunities to achieve successful land degradation and restoration outcomes.

Successful policy instruments prioritize incentives and practices which increase restoration outcomes: removing disincentives; incorporating secure land and natural resource tenure; aligning with policies to avoid land degradation; and encouraging effective institutional coordination while incorporating good governance (ELD Initiative, 2015; Laestadius *et al.*, 2015). They also incorporate ecosystem services, economic, social and ecological benefits, enhance livelihoods and address political, cultural and economic concerns (Chazdon *et al.*, 2015). When integrated with national policy and international commitments, their effectiveness increases (Natural Resource Management Ministerial Council Government of Australia, 2010; COAG Standing Council on Environment and Water, 2012).

Formal recognition of property rights and land tenure through policy

Land tenure is the legal status and ownership of land, often with a mixture of formal and informal tenure systems and mosaic of property rights, individual and collective. A study of 21 indigenous and mestizo communities in four landscape mosaics in the Peruvian and Ecuadoran Amazon, demonstrates that social relationships, and not only legal formalities, play a powerful role in tenure security (Global Landscapes Forum, 2015a; Cronkleton & Larson, 2015). In many cases, the type of land tenure – such as private ownership, community-based, government protected areas – has created conflicts and been associated with degradation. Weak or poorly defined rights and insecure tenure are strongly associated with land degradation, while uncontested land rights and strong customary tenure have provided good landscape stewardship (Global Landscapes Forum, 2015a; ELD Initiative, 2015), strengthening dialogues which entrench free, prior and informed consent (Global Forest Coalition, 2015; Guilfoyle *et al.*, 2009)**.** FAO members, nearly all countries of the world, have adopted Voluntary Guidelines to improve governance of land tenure, fisheries and forests to achieve food security (FAO, 2012).

The SDG Indicators (United Nations Economic and Social Council, 2016) include specific indicators which address land tenure. Specific example includes SDG Indicator 1.4.2: proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure. Prohibiting formal registration of customary property rights and land tenure can lead to governments and international investors excluding local and poorer populations in restoration and rehabilitation projects, causing or exacerbating social unrest and marginalization (ELD Initiative, 2015; Plurality in Public Policy, 2014). Acknowledgment of distinct indigenous rights, including women's tenure rights (Silverman, 2015) and collaborative approaches combining different knowledge and "ways of knowing", offers the potential for successful co-generated outcomes (Araujo *et al.*, 2015; Feit *et al.*, 2013; Robinson *et al.*, 2016), including two-way knowledge techniques (Ens *et al.*, 2012; Kok & van Delden, 2009).

1.3.1.5 Good governance structures (Figure 1.2, point 1.5)

Governance, defined by the World Governance Indicators framework, is the traditions and institutions by which authority in a country is exercised (Kaufmann, 2011). This includes: (i) the process by which governments are selected, monitored and replaced; (ii) the capacity of the government to effectively formulate and implement sound policies; (iii) political commitment at the highest level; (iv) the role of coordination mechanisms that cross sectors, scales and administrative boundaries; (v) demonstrated value of mechanisms for science-policy dialogue with stakeholders; and (vi) the respect of citizens and the state for the institutions that govern economic and social interactions among them (Edelman *et al*., 2014).

Ecosystem governance integrates social and ecological components into ecosystem co-management, incorporating democracy and accountability (Vasseur *et al.*, 2017). In so doing goals, priorities, decision-making and management of the environment are determined by society, incorporating indigenous, local and practitioner knowledge to achieve successful outcomes (IUCN & State Forestry Ministry China, 2015).

Good governance affords sustainable management of environmental, economic and social resources. Multi-stakeholder involvement ensures transparency and accommodates multiple stakeholders' needs and concerns, establishing a cooperative mechanism for improving responses to avoid and reduce degradation and restore degraded lands (IUCN & State Forestry Ministry China, 2015).

Integral to good governance structures is the provision of access to information that: supports an informed dialogue; recognizes and includes multi-stakeholder engagement incorporating indigenous and local knowledge bases; and recognizes the value of diverse knowledge and opportunities for innovation, including intergenerational conservation and farming knowledge, incorporating western scientific knowledge (Fisher, 2012; FAO, 2012; Iniesta-Arandia *et al.*, 2015; Hill *et al.*, 2012; Murcia *et al.*, 2015; Robinson *et al.*, 2016)**.** Successful governance incorporates and respects indigenous and local knowledge (IUCN & State Forestry Ministry China, 2015).

An assessment of 21 case studies identified the importance of robust governance incorporating the integration of indigenous knowledge through four types of engagement: (i) indigenous-governed collaborations; (ii) indigenous-driven co-governance; (iii) agency-driven co-governance; and (iv) agency governance. The most successful outcomes have been shown to be derived from type (i) indigenous governance and type (ii) indigenous-driven co governance (Hill *et al.*, 2012; Robinson *et al.*, 2016)**.**

Active multiple stakeholder involvement and governance

A place-based approach may lead to effective economic, environmental and social outcomes. Success may result from involvement between communities, indigenous and local knowledge, business, national institutions, government officials and international institutions to achieve equal and full representation (ELD Initiative, 2015; Global Forest Coalition, 2015; Guilfoyle *et al.*, 2009; Latawiec *et al.*, 2015; Pinto *et al.*, 2014; Robinson *et al.*, 2016). Organizations in the finance sector are key partners for multi-stakeholder collaborations to avoid and reduce land degradation and restore landscapes (Van Leenders & Bor, 2016). Business and finance institutions are becoming increasingly aware of their dependency on a healthy natural environment, and understand that if their impacts are neutral, nature may sustain or regenerate itself. Degradation of the health of the ecosystems on which business depend is linked to vulnerability in business performance (Scherr *et al.*, 2017).

1.3.1.6 Communication and coordination (Figure 1.2, point 1.6)

Good communication begets good coordination. (Gottschalk-Druschke & Hychka 2015; Meli *et al.*, 2017; Robinson *et al.*, 2016; Thomas *et al.*, 2014; Schultz *et al.*, 2016). Therefore, unless all stakeholders – including legislators, policymakers, decision makers, scientists, managers, indigenous peoples and local communities, restoration innovators and others – are aware of the decisions and how they influence actions, approaches in different sectors may fail. Good communication includes horizontal frameworks as well as innovative and varying communication techniques.

1.3.1.7 Capacity-building (Figure 1.2, point 1.7)

A key factor in successful avoidance and reduction of land degradation and informed restoration is capacity-building. As we move forward with new ways of caring for the Earth and its people, it is important that everyone understands, is trained in and has capacity for implementing new and varied approaches. Capacity-building across the guiding principles is important for all elements and at all levels of understanding. Its effectiveness will be enhanced when innovative communication approaches are utilized (Calle *et al.*, 2013; Forest Peoples Programme, 2016; Ramsar, 2015; Rodrigues *et al.*, 2011; Scherr *et al.*, 2017; United Nations Economic and Social Council, 2016).

1.3.2 Solutions and nature's contributions to people

1.3.2.1 Incorporation of social and cultural instruments (Figure 1.2, point 2.1)

The IPBES Land Degradation and Restoration Assessment provides the first opportunity to catalyse the intangible assets of cultural ecosystem services by assessing and incorporating these indicators, which are strongly correlated with well-being and directly associated with land use (Hernández-Morcillo *et al.*, 2013), and pivotal to achieve effective solutions. The success and effectiveness of restoration actions may be significantly enhanced by the inclusion of traditional knowledge and local communities who live in and understand their local habitats, and are also motivated to restore them (Hallet *et al*., 2015). Perceptions and differing worldviews strongly influence understandings of success within and across the landscape and are incorporated into the assessment of success (Latawiec & Agol 2016; Nkonya *et al.*, 2016).

Cultures and the values established by people's relationships with their local environments, over time, result in the transfer of knowledge between generations – which end up playing an important role in maintaining resilient landscapes (Chazdon, 2008; Guilfoyle *et al.*, 2009; Guilfoyle, 2004; Kohler *et al.*, 2015; Kok *et al.*, 2017; Walsh *et al.*, 2015; Zheng *et al.*, 2015). Removing cultural, social, environment, legal and technical barriers improves the management of degraded land (ELD Initiative, 2015).

Across many landscapes and over time, traditional and local knowledge has decayed, whether due to immigration, emigration, marginalization or colonialism (see case study 8). For such communities to contribute positively, capacity-building mechanisms designed to restore social, cultural and local knowledge are required, such as two-way knowledge systems (Ens *et al.*, 2010; Ens, 2012).

The inclusion of social and cultural traditional practices into restoration and rehabilitation may enhance the success of projects and provide opportunities to include the key dynamics of the traditional approach into management policies (Ens *et al.*, 2015; Finlayson *et al.*, 2012; Ens *et al.*, 2010; Fisher, 2013; Fisher *et al.*, 2014; Hill *et al.*, 2013; Iniesta-Arandia *et al.*, 2015; Zheng *et al.*, 2015). Evidence from 15 countries and a wide range of traditional communities working on landscape-scale projects has identified bottom-up, place-based, participatory approaches incorporating cultural, social and differing worldviews to be highly successful in consensus decision-making (Brancalion *et al.*, 2015; Guilfoyle & Mitchell, 2015; Global Forest Coalition, 2015; Guilfoyle *et al.*, 2011; Hernández-Morcillo *et al.*, 2013; Pinto *et al.*, 2014; Robinson *et al.*, 2016).

1.3.2.2 Incorporation of approaches and strategies to resolve conflicting interests (Figure 1.2, point 2.2)

Successful mitigation and land restoration cases will be those that acknowledge that conflicts may exist, identify potential conflicts and develop a strategy to deal with known and potential conflicts (Sayer *et al.*, 2013; Scherr & Willemen, 2014).

Potential areas of conflict

Conflicting interests have the potential to impact all success factors. Conflict may occur in differing arenas and subsequently influence the degradation of land, with resultant negative impacts on people. Some examples are the extraction of natural resources (ICMM, 2013), offset proposals creating conflict between businesses, local communities and livelihood impacts (FAO, 2015), between food production, biodiversity conservation and poverty reduction (Ciccarese *et al.*, 2012), land claims and tenure (International Council on Mining and Metals, 2015; Hill *et al.*, 2013) and long term sustainability of land (IUCN & State Forestry Ministry China, 2015).

Corruption can directly impact the success or failure of excellent government policies and procedures developed for environmental and social-cultural protection. When high-level corruption occurs between, for example, government officials, large foreign enterprises, police and military, it can be difficult to stop land degradation and rehabilitate areas unless corruption can be addressed and eliminated.

Conflicts may arise among diverse values, thus integrated valuation may recognize values of multiple stakeholders, their worldviews regarding land and its values, and provide opportunities for more successful decision-making (Pascual *et al.*, 2017; Fontaine *et al.*, 2014). A coordinated landscape approach (as proposed by the operational framework) may provide opportunities to overcome such conflicts.

Food security competing with biodiversity conservation

Competition for land between, for example, agriculture and biodiversity, commercial operations and biodiversity, forest conversion, general land-use change and restoration, may result in poorly managed large-scale restoration projects. The potential outcomes being: inequality between landowners; displacement of marginalized community members; indirect land-use change; and associated social problems (Locatelli *et al.*, 2015; Latawiec *et al.*, 2015).

It is possible to maintain and increase agricultural productivity, while at the same time protecting natural resources at a national scale (Isbell *et al.*, 2015; Latawiec *et al.*, 2015; Seppelt *et al.*, 2016). To minimize agricultural impacts on biodiversity, Seppelt *et al.* (2016) proposed a framework to manage trade-offs between agriculture production and biodiversity conservation, namely land sharing and sparing. The most economically-desirable option needs to be compatible with existing economic mechanisms, while being technically, legally, environmentally and socially acceptable and feasible. This approach requires pre-conditions, an integrated suite of policies to ensure sustainable improvements in agriculture productivity, biodiversity outcomes and restoration resulting in long-term environmental and social benefits through an integrated landscape approach (Latawiec *et al.*, 2015; Seppelt *et al.*, 2016). Success would not include an “ecosystem service debt” by removing biodiverse areas for other outcomes, such as agriculture production (Isbell *et al.*, 2015).

A **whole of landscape ecosystem** approach provides possible solutions where food security and biodiversity concerns may be in conflict (Sengalama & Quillérou, 2016). Diversifying agricultural landscapes from large-scale industrial farming – such as intensive crop monocultures and industrial-scale feedlots, which can generate negative outcomes including widespread degradation of land, water and ecosystems, biodiversity losses, micro-nutrient deficiencies and livelihood stresses for farmers – has the potential to reduce land degradation, while incorporating the diversity of values of those engaged with food production. Diversified agroecological landscapes incorporate diverse farming practices which replace or greatly reduce chemical inputs, optimize biodiversity and stimulate interactions between different species. These approaches may provide a basis for secure farm livelihoods by including comprehensive strategies to build long-term soil fertility, keep carbon in the ground and sustain yields over time (IPES-Food, 2016).

Loss of livelihoods

Environmental policy designed to reduce land degradation, using livelihood change, should ensure that outcomes do not go against local interests. Successful solutions to avoid land degradation include biophysical processes and social issues, locally and broadly across the landscape and the spectrum of players. If not considered, outcomes that support more powerful actors who take control of resources while depriving villagers of their control over resources, may occur (Lestrelin & Giordano, 2007).

Substitution of natural capital with human-made capital

The replacement of resilient, self-repairing ecosystems with technological substitutes often does not provide all natural ecosystem services, and can require large engineering and maintenance costs (Moberg & Rönnbäck, 2003; UNEP-FI, 2012). Technological approaches, including environmental engineering, can often lose control and power over evolutionary functions and do not conserve natural capital (Sarrazin & Lecomte, 2016). Ecological constraints and the limiting growth factors of a site need to be considered – for example in China, learning from nature has proved to be more successful than utilizing artificial solutions alone (Grainger *et al.*, 2015; Wang, 2013). Nature-based solutions provide opportunities to sustainably manage and restore natural or modified ecosystems. Nature-based solutions, either on their own or in concert with technological and engineering solutions, aim to address societal challenges while incorporating human well-being and biodiversity benefits (Cohen-Shacham *et al.*, 2016).

Conflict between international and national interests

Clarity over acceptable trade-offs and effective strategies to deal with conflicting interests and competing objectives requires management in an all-encompassing manner to identify and prioritize impact avoidance and minimization actions, which determine whether to effectively use or avoid offsetting (Gibbons *et al.*, 2017). Drivers of degradation are not always found where local solutions are designed. Therefore, an understanding of trade policies and transboundary issues is important to establish and implement successful actions to reduce impacts of degradation activities associated with trade at the local scale (IUCN, 2016).

1.3.2.3 Values and worldviews (Figure 1.2, point 2.3)

Understanding the plurality of worldviews and diversity of values enhances coordination across the three overarching criteria and underlying factors of the operational framework. This applies particularly to situations of conflict wherein an understanding of the plurality of world views and diversity of values can provide opportunities to work towards developing effective solutions (Pascual *et al.*, 2017).

Values, human well-being and a good quality of life

The understanding of well-being and what constitutes a good quality of life is dependent on a complex mixture of values, cultures, traditions and interrelationships (Latawiec & Agol, 2016), including the point of view of those who analyse values. Some social upliftment programmes, poverty reduction schemes and agricultural policies designed to enhance human well-being may compromise the environment, human well-being and good quality of life, as was the case in Boteti, Botswana. In this case, formal land-use and management institutions have negatively influenced environmental change, through overstocking, land clearance and wildlife protection in conflict with traditional uses. These actions have led to the shrinking of Boteti's commons. Mulale's research recommends community-based natural resource strategies to secure livelihoods and conserve the commons (Mulale *et al.*, 2014). In order to achieve this outcome, it is also important for policymakers to avoid working in silos.

Effective incorporation of analyses to assess non-monetary, whole of life cycle valuation of a restoration project

Transdisciplinary approaches to valuation analyses of restoration projects incorporating nature's contributions to people may better inform decision-making and lead to greater success (Baker *et al.*, 2013; Pascual *et al.*, 2017).

The use of economics, alone, to assess projects aimed at rehabilitating and restoring degraded lands, may result in unanticipated project outcomes, potentially leading to conflict with local communities. Cultural factors can have a powerful and long-lasting effect on how individuals, communities and nations relate and respond to local implementations. Many local communities place a high value on non-monetary benefits, which are reflected in regionally-relevant social and cultural values (Easterlin *et al.*, 2010).

To avoid conflict, the development of projects would be better informed using a whole of life cycle assessment, incorporating public and private funds and including an impact measure of project outcomes (Van Leenders & Bor, 2016). A whole of life cycle assessment takes social and cultural values (i.e., non-monetary benefits) into account and includes fair participation of various stakeholder groups (Sutherland *et al.*, 2014). An impact measure could provide insights into potential negative outcomes on biodiversity and people, including values, health and well-being (Pascual *et al.*, 2017).

As countries, such as those in Latin America (Murcia *et al.*, 2015), move to reach ambitious large-scale restoration targets (Vergara *et al.*, 2016), a whole of life cycle assessment has the potential to provide an evidence base on which to operate and measure success (Murcia *et al.*, 2015). Such analyses provide opportunities to identify and remove potential barriers prior to the establishment of projects leading to greater opportunities for successful implementation (ELD Initiative, 2015).

1.3.2.4 Capacity-building (Figure 1.2, points 1.6, 2.4, and 3.5)

Successful integration of values, worldviews and nature's contributions to people within social and cultural instruments, conflict resolution, human well-being, quality of life and interactions with diverse communities may be achieved through capacity-building by fostering learning and leadership skills, and through integrated cross-sectoral approaches and communication (Cohen-Shacham *et al.*, 2016).

1.3.3 Biophysical conditions

In this section, we focus on the opportunities to enhance biophysical outcomes. Initial assessment of social and biophysical causes of land degradation provide evidence to set long-term restoration targets including comprehensive monitoring programmes to measure outcomes and adapt actions if required (Zaldivar-Jimenez *et al.*, 2010; Convertino *et al.*, 2013). Achieving successful changes to the biophysical condition is dependent on effective and well-designed biophysical and social measurements (Acuña *et al.*, 2013) . These include pre-condition and ongoing assessments in planning, design, monitoring, implementation, management and adaptation actions (see also Chapter 8, Section 8.2.3) to provide an evidence-based understanding of the outcomes of landscape change, while gaining an understanding of requirements to adapt management actions (Jackson *et al.*, 2010; Sayer *et al.*, 2013; Stanturf *et al.*, 2015; Weinstein *et al.*, 1996).

Restoration project design needs to consider potential impacts from biophysical conditions which may hinder its success – for example, through potential damage to a restoration site from hurricanes, winds, water currents, erosion and sediment. Lack of consideration may lead to projects doomed to failure (Zaldivar-Jimenez *et al.*, 2010).

1.3.3.1 Accurate assessment of ecological and biophysical conditions (Figure 1.3, point 3.1)

Successful restoration projects incorporate the establishment of firm goals (Matthews & Endress, 2008; Melo *et al.*, 2013; Ryder & Miller, 2005), include wide ranging measurements of processes and indicators (Wortley *et al.*, 2013) that are the result of inclusive and extensive consultations with scientists, policymakers, managers, stakeholders and local knowledge holders (Brancalion *et al.*, 2013; Latawiec & Agol, 2016). Successful outcomes may benefit from an assessment of ecological conditions prior to project implementation, assessing the state of land degradation (Weinstein *et al.*, 1996; Westwood *et al.*, 2014).

1.3.3.2 Monitoring (Figure 3.1, point 3.2)

Monitoring is a key procedure to measure and understand restoration success for the implementation of numerous international agreements (Murcia *et al.*, 2015) such as Aichi Target 15 of the Strategic Plan for Biodiversity 2011-2020 (CBD, 2010), CBD's Decision XI/16 (CBD 2012), the Bonn Challenge (IUCN & WRI, 2014), the New York Declaration (Murcia *et al.*, 2015) and the WRI Initiative 20x20 (IUCN & WRI, 2014). These country commitments require significant human and financial resources, for which accountability is key to understanding if actions reduce and reverse degradation and provide climate change adaptation benefits (Murcia *et al.*, 2015). Concerns exist in Latin America and other regions where, in response to countries commitments, large-scale restoration projects are being implemented with limited understanding of how to measure and guarantee success (Sansevero & Garbin, 2015; Aguilar *et al.*, 2015; Ehrenfeld 2000). An understanding of restoration responses can only be accurately determined with the incorporation of accurate evidenced-based monitoring prior to, throughout and post-restoration (Sondergaard *et al.*, 2007). Different restoration scales, ecosystem types require both their own approach and methodologies, and extensive knowledge of the dynamics, multifunctionality and interconnectedness across the landscape (Pinto *et al.*, 2014; Rodrigues *et al.*, 2011).

Similarly, understanding monitoring and design in successful agrobiodiversity projects requires an understanding of multiple socio-ecological options which improve the sustainability of the system, while improving livelihoods and providing benefits for future generations (Jackson *et al.*, 2010). The incorporation of effective landscape-scale systematic planning over time may benefit the implementation, management and success of restoration (Fisher, 2010; Grainger *et al.*, 2015; Wang, 2013; Palmer & Bernhardt, 2004; Turner II *et al.*, 2016; Pressey & Bottrill, 2008; Knight *et al.*, 2011; Knight *et al.*, 2006). There are examples where planning for conservation has been ineffective (Game *et al.*, 2013; Knight *et al.*, 2008).

To assess the ecological success of restoration projects, reliable measures of ecosystem health and function are beneficial (Jansson *et al.*, 2005; Martin *et al.*, 2005). The setting of long-term restoration targets can support and improve understanding of the cumulative impacts of climate change (FAO, 2015), which operate in concert with other degrading processes (see Chapters 3 and 4), including likely regional effects. Restoration provides opportunities to mitigate against cumulative impacts.

1.3.3.3 Landscape-scale ecological approach (Figure 1.2, point 3.3)

A landscape-scale approach considers degradation and restoration within the spatial context of the ecosystems and social systems which affect it or are affected by it – not only considering the immediate effects at the local site, but across the landscape including long-term timescales. An example of an active initiative using a landscape approach is the International Partnership for the Satoyama Initiative, which comprises 172 member organisations working to help maintain and rebuild more than 65 socio- ecological production landscapes and seascapes in at least 30 countries (Denier *et al.*, 2015; Forest Peoples Programme, 2016).

The Anthropocene is dominated by humans at all scales. Social and ecological actions in one location often influence responses some distance away (for further discussion on this see Chapter 2, Section 2.2.1.3). There is a need to mainstream a landscape and systems approach into land degradation and restoration policy and for effective monitoring over time. The landscape approach provides opportunities, for example, to incorporate existing protected areas into restoration beyond site-based activities (Bowman *et al.*, 2011; Díaz *et al.*, 2015; Grainger *et al.*, 2015; Haider *et al.*, 2016; Keenan *et al.*, 2015; Müller *et al.*, 2015; The Pew Charitable Trusts, 2014; Vellend *et al.*, 2013; Waters *et al.*, 2016).

Biodiversity, food, water, soils, carbon, climate

Accurate assessment of ecological and biophysical conditions, including reliable measures of ecosystem health and function, and landscape-scale ecological approaches (Doren *et al.*, 2009), are necessary to identify restoration success and changes in degradation in biodiversity, food, water, timber, soil, carbon, climate, wetland and urbanized landscapes (for detailed discussion of drivers and biophysical processes, see Chapters 3 and 4).

1.3.3.4 Whole of life cycle assessment (Figure 1.2, points 3.4 and 2.4)

To adequately assess the biophysical outcomes of restoration and rehabilitation programmes a whole of life cycle assessment, including biophysical, socio-ecological, financial, non-material values and fair inclusion of multiple stakeholders throughout the project, will accurately identify project results, particularly when assessed from project inception to completion (Robinson, *et al.*, 2014; Van Leenders & Bor, 2016).

1.3.3.5 Capacity-building (Figure 1.2, points 3.5, 4.5, and 1.7)

As governments work to achieve international commitments, capacity-building may assist delivery of successful outcomes in view of a potentially incremental increase of workforce in this field (Meli *et al.*, 2017; Rodrigues *et al.*, 2011; Vasseur *et al.*, 2017).

1.3.3.6 Incorporation of science and technology (Figure 1.3, point 3.6)

There are gaps and unevenness around the globe in the availability and understandings of scientific and technical knowledge to enhance restoration outcomes. In many regions, insufficient scientific and technical knowledge exists, while in other regions scientific and technical knowledge is very advanced (Grant & Koch, 2007). In situations where technological solutions are being considered to reduce degradation, the choice of technology can benefit by using interdisciplinary science to understand social, cultural and environmental effects. Any risks associated with the long-term outcomes of the introduction of new technologies will benefit from careful assessment (Similä *et al.*, 2014). Nature-based solutions provide opportunities to incorporate natural responses to reduce degradation alongside limited technological approaches (Cohen-Shacham *et al.*, 2016).

1.3.3.7 Multi-stakeholder involvement (Figure 1.2, points 1.5 and 3.7)

It is common agreement across all levels – including for implementing international commitments, effective restoration, indigenous and local communities, decision-making and policy formulation (to name a few) – that for successful outcomes to be achieved active multi-stakeholder inclusion and involvement is crucial (Van Leenders & Bor, 2016; United Nations Economic and Social Council, 2016; UN, 2012; United Nations Environment Finance Initiative, 2016; Murcia *et al.*, 2015).

1.4 A selection of success cases

These success stories represent a small number, selected from many others, with the objective to show how land management and restoration measures help improve livelihoods, reduce poverty and strengthen long-term sustainability of land use in different situations. Success cases are: results driven; have been established over a long period; provide evidence of positive ecological change, socio-economic improvements; lead, for instance, to greater food security, reduction in degradation, adaptation to change, improvement in human rights; and demonstrate long-lasting gains across the three interacting groups of the operating framework criteria (Figure 1.2). These cases show how land conservation and restoration measures have helped to deliver improvements in livelihoods, reduce poverty and strengthen long-term sustainability of land use and the extraction of natural resources.

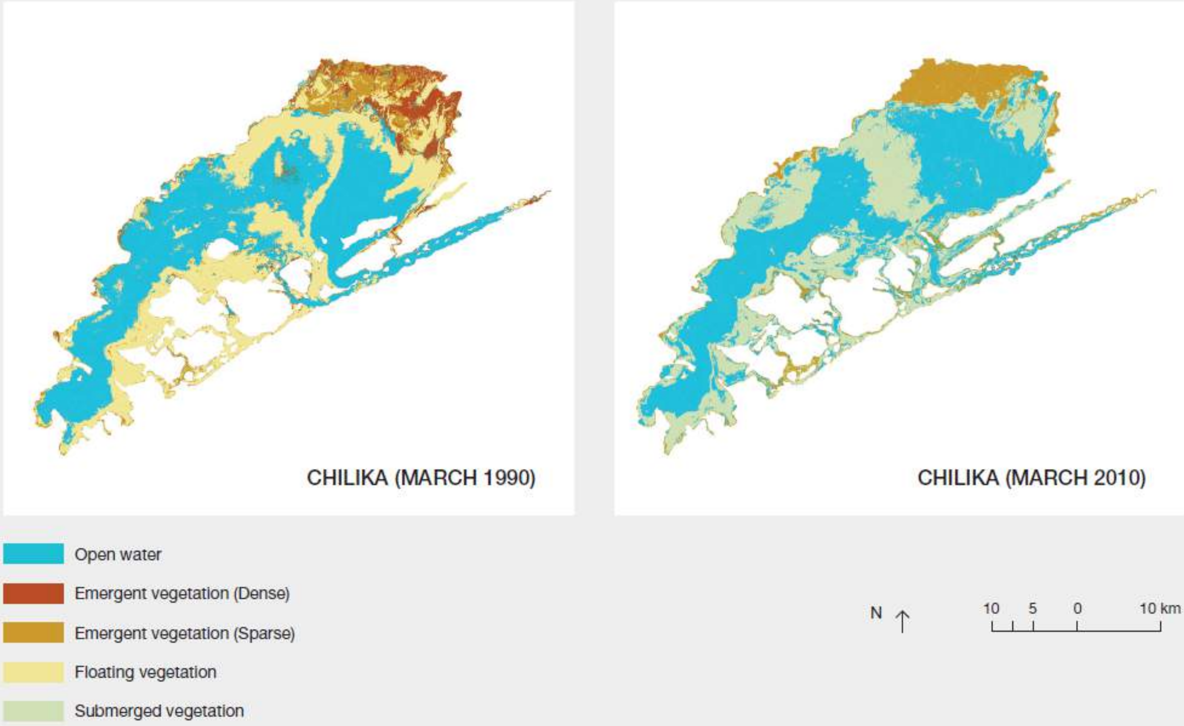
The eight success stories are deliberately selected from different regions of the world, in different landscapes and ecosystems impacted by different degradation processes. Comparisons of success evaluation scores across cases should be conducted with caution, due to these differences.

There are many other examples of successful avoidance of degradation and/or restoration of degraded land. Please see chapters 2 through 8 for further examples of successful cases.

1.4.1 Success Story 1: Lake Chilika, Odisha, India

Figure 1 3 Change in vegetation structure of Lake Chilika.

The image on the left shows the structure of Lake Chilika before hydrological restoration (March 1990) and the right panel shows the structure after restoration (March 2010). The dominant floating vegetation is *Eichornia* crassipes and the dominant emergent vegetation is Phragmites karka. Source: Pattnaik & Kumar (2016).



1.4.1.1 Context and degradation

Chilika, a brackishwater coastal lagoon on the east coast of India, in the state of Odisha, forms the base of livelihood security of more than 200,000 fishers and 400,000 farmers. The inundated area is 1,165 km^2, flanked by ephemeral floodplains of 400 km^2. Chilika is an assemblage of shallow to very shallow marine, brackish and freshwater ecosystems. Designated as a Wetland of International Importance in 1981, Chilika is famed as one of the largest congregation sites of migrating water birds in the Central Asian Flyaway, the habitat of globally vulnerable Irrawaddy Dolphin (*Orcaella brevirostris*) population and has contiguous seagrass bed in the adjacent ocean exceeding 10,000 ha.

Nature and nature's contributions to the people of Chilika are closely related to the maintenance of coastal and freshwater hydrological processes. The wetland went through a phase of reduced connectivity to the sea (1950-2000) owing to increasing sediment loads from upstream degrading catchments. As the lagoon evolved towards a freshwater environment, its fisheries rapidly declined (from an annual landing of 8600 metric tonnes in 1985/86 to 1702 metric tonnes in 1998/99), invasive freshwater aquatic plants choked the waterspread and the lagoon shrank in size. The introduction of shrimp culture in a predominantly capture fisheries setting led to the gradual breakdown of community management systems, loss of traditional fishing grounds and conflicts. Chilika was ultimately placed in the Ramsar Convention's Montreux Record in 1993 (sites having undergone adverse ecological character change).

1.4.1.2 Restoration

Responding to the immense social pressure to address wetland degradation, the Government of Odisha created the Chilika Development Authority (CDA) in 1991 as the nodal agency to undertake ecological restoration. The Authority was constituted as a multi-stakeholder institution, under the chairmanship of Chief Minister of the state. In 2000, a major hydrological intervention in the form of opening of a new mouth to the sea was undertaken based on modelling and stakeholder consultations. The intervention was complemented by basin-wide measures for treating degraded catchments, improving the well-being of fishers, communication and outreach on needs of integrated management and systematic ecosystem monitoring.

1.4.1.3 Outcomes for nature and nature's contributions to people

The response of the hydrological intervention and lake basin management has been rapid and sustained. After initial trophic bursts, the annual fish landing stabilised at nearly 13,000 metric tonnes per year. Annual censuses of Irrawaddy dolphins within Chilika reported an increase from 89 to 158 individuals between 2003 and 2015, an increase in habitat use, as well as improved breeding, dispersal and decline in mortality rates. The sea grass meadows expanded from 20 km^2 in 2000 to 80 km^2, and a significant decline in freshwater invasive species. In 2001, the site was de-listed from Montreaux Record and the intervention recognzed with the Ramsar Wetland Conservation Award and Evian Special Prize for "wetland conservation and management initiatives". Management continues under the framework of a basin-scale stakeholder-endorsed integrated management plan. Changing patterns of extreme events (as floods and cyclones) in the region, intensification of water use in the upstream reaches and rising sea-levels are major challenges which are currently being addressed through specific research (Pattnaik & Kumar, 2016).

1.4.1.4 Evaluation of success

Table 1 2 Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	4	4	1	4	4	3	4	4	4	4
Nature's contributions to people	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	4	4	4	5	3	3	4	4	4	4
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	5	4	4	4	4	3	3	4	4		

LEGEND

1. Guiding Instruments	40/55
2. Nature's Contributions to People	43/55
3. Biophysical Conditions	35/45
1, 2, 3 combined	% Total 76%

-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

* *Coord. = coordination*
** *LD = land degradation*

1.4.2 Success Story 2: Dune forest ecosystem rehabilitation after titanium mining

Figure 1 4 Dune restoration in Richards Bay, South Africa.

The left panel shows dune restoration weeks after mining and the right panel shows restoration after 25 years. Location: Richards Bay, South Africa (28.758 S 32.114 E to 28.705 S 32.404 E). Photo courtesy: R van Aarde.

1.4.2.1 Degradation process

The dune cordon on the north-east coast of South Africa is enriched with about 5% with the minerals ilmenite, rutile and zircon, which have been mined since about 1980 (van Aarde *et al.*, 1996). The undisturbed dunes are covered by species-rich forests and grasslands of the Maputaland centre of endemism (a "centre of endemism" is an area with an unusually high diversity of species not found elsewhere) (Wassenaar & Van Aarde, 2005) and known as a dune forest for being established on an old dune substrate. This is a fossil dune (along the coast from Richards Bay with titanium mines until

Mozambique). Further north of the mine, these littoral dunes are protected in a National Park. They provide inland protection against Indian Ocean storms, and are a source of many benefits to the local communities. Extracting the heavy metal particles involves complete removal of the plant cover and topsoil, forming a freshwater pond which is dredged to the entire depth of the deposit, up to 100 m. What is left behind is low-nutrient sand, devoid of vegetation and organic matter. Unrehabilitated, it would remain in this state for many decades while slow succession by primary dune colonizing plants occurred. During the non-vegetated time, it is a source of dust pollution, is severely compromised as a bulwark against beach erosion and produces little in the way of grazing, fuelwood, medicinal plants, edible organisms and/or tourist attractions.

1.4.2.2 Rehabilitation process

The topsoil is removed in 100m wide strips ahead of the mine and replaced within 2 months to cover the tailings behind the mine, after they have been reshaped into correctly oriented bi-parabolic dunes. Fast growing annual exotic grass (*Sorghum spp*), sunflowers, the nitrogen-fixing forb *Crotolaria* spp and the indigenous grass *Digitaria eriantha* are seeded into the 150mm thick topsoil layer, which already contains propagules of many indigenous species. The germinating cover is protected from sand-blasting with low plastic mesh windbreaks and the endemic dune pioneer tree *Vacheria* (*Acacia*) *kosiensis* is planted among the nursery cover, which is weeded to remove alien species. Once a stable cover has formed after a few years, a selection of other indigenous dune forest trees is planted as saplings (Richards, 2017).

1.4.2.3 Outcomes

Herbaceous cover is established within a year. A monodominant *Vacheria kosiensis* tree cover is complete within roughly 10 years and forest gaps begin to open after about 15 years. A three-layered forest structure (herbs, sub-canopy shrubs and canopy trees) is present by 25 years, but even by 32 years, only two-fifths of the original forest tree species are present (van Aarde *et al.*, 2012). During this period, the soil organisms, arthropods, birds and small mammals are all on a recovery trajectory which mimics that of natural dune succession (van Aarde *et al.*, 1996; Davis *et al.*, 2003; Ferreira & van Aarde, 2000; Kritzinger & van Aarde, 1998; van Aarde *et al.*, 1998; Wassenaar & van Aarde, 2001). Functions that are restored very early in the process include erosion control, storm protection, hydrological and visual rehabilitation. Grazing, fuelwood and other useful resources become available from around year 10. Biodiversity-friendly habitat structure consolidate after a couple of decades, but a full complement of pre-degradation species has not returned over a 40-year observation period (van Aarde *et al.*, 2012).

1.4.2.4 Evaluation of success

The mining company, the mine regulation authorities, the ecological research community and some local communities and environmental NGOs regard the process as a success (van Aarde *et al.*, 2012). On the other hand, other local communities and environmental NGOs have argued that the local communities have reaped few benefits and are intimidated by the propaganda power of the industry, which is a major local source of employment. (Richards Bay Minerals Dune Mining, 2017).

Table 1 3 **Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).**

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	-1	4	1	-1	-1	1	-1	-1	-1	-1	-1
	Post	4	4	4	-1	3	4	-1	3	3	3	1
Nature's contributions to people	Pre	-1	-1	-1	-1	1	-1	-1	-1	-1	-1	-1
	Post	3	3	4	4	3	3	3	3	2	3	3
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	4	4	4	4	4	3	2	4	2		

LEGEND

1. Guiding Instruments	27/55
2. Nature's Contributions to People	34/55
3. Biophysical Conditions	31/45
1, 2, 3 combined	% Total 61.50%

-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

* *Coord. = coordination*
** *LD = land degradation*

1.4.3 Success Story 3: indigenous land, culture and fire management in the tropical Kimberley Region, Australia

Figure 1 5 Location of the Kimberley fire management area and Indigenous Ranger Network who implement indigenous fire management to reduce land degradation from large uncontrolled wildfires. Source of the map: Kimberley Land Council.

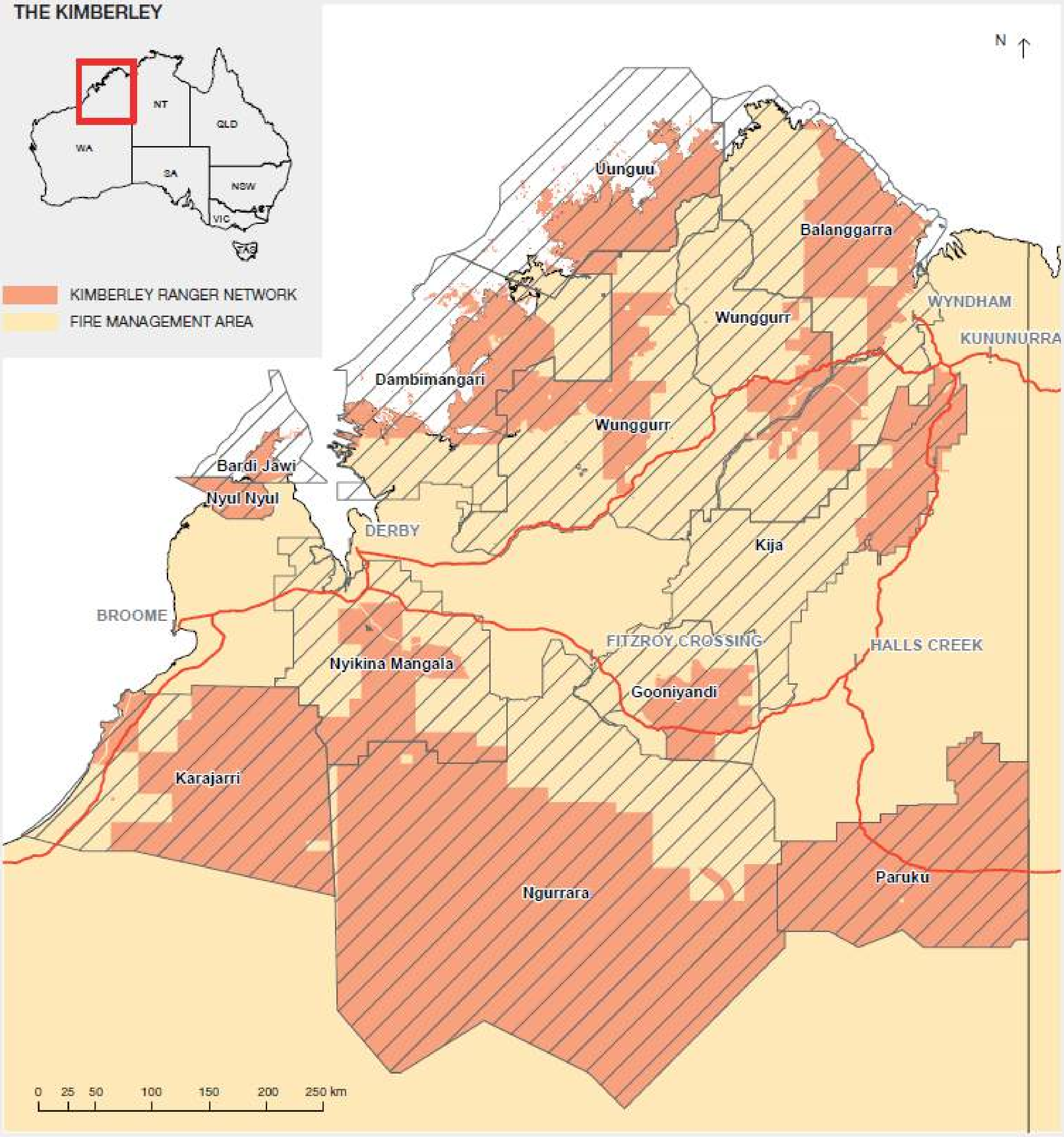


Figure 1 6 **Fire management in the tropical Kimberley Region, Australia.**

Left panel shows wildfire in the Kimberley region. Right panel shows the indigenous, early dry season mosaic burning, which reduces fire-induced land degradation. Photo credit: CSIRO Tropical Ecosystems Research Centre.

1.4.3.1 Context and degradation activity

Aboriginal people in the Kimberley Region of North Western Australia, covering 423,000 km ^{2} (Figure 1.6), have been managing their country for more than 40,000 years. They have a cultural, spiritual and social connection to country that adapts with time and space. Indigenous law, culture, language, knowledge, traditions, stories and people are embedded in the landscape, being interconnected and dependent on each other (Kimberley Land Council, 2016 b). With the onset of colonization and the removal of aboriginal people from traditional lands, during the 20th century, traditional burning practices were largely stopped (Vigilante, 2001). This led to the emergence of large, uncontrolled tropical wildfires, usually occurring late in the dry season, burning for long periods (Russell-Smith *et al.*, 2003) and damaging important ecosystems, habitats, culturally-significant sites, degrading the landscape and promoting the invasion of invasive species (Figure 1.7) (Fisher *et al.*, 2014; Russell-Smith *et al.*, 2003; Vigilante *et al.*, 2004). At the end of the dry season, the savannah grasslands across the region are extremely dry and burn out of control across large areas. Late dry season wildfires impact and degrade grazing pasture, cultural sites, biodiversity infrastructure and other assets (Russell-Smith *et al.*, 2003). Years of neglect and mismanagement, particularly of fire, and dispossession of traditional owners have created major environmental degradation problems for the savannah, pindan woodland and monsoon vine thicket plant communities and heavily impacted livestock grazing. The lower socio-economic circumstances of the aboriginal people also make it more difficult for them to adapt to and respond to the cumulative impacts of climate change (Kimberley Land Council 2016b, 2016a).

1.4.3.2 Rehabilitation actions

The Kimberley Land Council was formed in 1978 and works with aboriginal people to look after their country and gain control of their future. The Kimberley Land Council Land and Sea Management Unit began in 1998. This has enabled aboriginal people to create strong regional organisations, founded on aboriginal cultural values and governance structures. A network of 13 ranger groups, who look after land and sea across 378,704 km^2 of the Kimberley, now exists. They work to avoid and reduce degradation and restore degraded lands, achieving the cultural and environmental management outcomes that their elders and cultural advisors want to see happen on the ground (Kimberley Land Council, 2016b). Fire management, wildlife and biodiversity monitoring, and the passing on of traditional knowledge and cultural practices from old people to young people, are key priorities of the ranger groups (Kimberley Land Council 2016a). In the last 25 years, with the introduction of native title and the recognition that western fire prevention methods have not been working effectively, there has been a reinvigoration of traditional fire management in the Kimberley and across northern Australia (Legge *et al.*, 2011). In addition to improving degraded landscapes with traditional mosaic early dry season fires, aboriginal people achieved some economic independence using traditional fire management practices to develop carbon businesses (Walton *et al.*, 2014; Walsh, Russell-Smith, & Cowley, 2014) through the Indigenous Savanna Burning Carbon Projects (Figure 1.7) (Sigma Global, 2015). The North Kimberley Fire Abatement Project (Kimberley Land Council, 2016b) – working with indigenous traditional knowledge and modern scientific practices – reduces land degradation, builds cultural intergenerational knowledge transfer and is reducing the amount of greenhouse gas emissions released into the atmosphere from unmanaged and potentially dangerous wildfires (Dore *et al.*, 2014).

1.4.3.3 Outcomes

Indigenous people using traditional knowledge for fire management have reduced the greenhouse gases released into the atmosphere. For example, single wildfire events once burned up to half the 800,000 ha the Wunambal Gaamberaa project area. In the managed period, fires have been contained to within 10,000 ha in size (Moorcroft *et al.*, 2012) – avoiding emissions of 350,000 tonnes of carbon dioxide equivalent. In northern Australia, traditional fire management has proven to deliver as much as a 50% reduction in wildfires reduced emissions by 8 million tonnes, enriched biodiversity and generated more than $85 million for indigenous communities. North Kimberley native title groups generated 230,000 Kyoto Carbon Credit Units in two years. The sale of these credits provides an economic boost, delivering social and environmental outcomes through improved biodiversity and landscape health, reinvigorating social and cultural traditions, strengthening climate change adaptability, reversing socio-economic disadvantage and increasing employment opportunities (Heckbert *et al.*, 2012; Sigma Global, 2015; Dore *et al.*, 2014; Walton *et al.*, 2014). Uunguu Rangers have found major reductions in the negative impacts of uncontrolled wildfires since ramping up traditional burning methods four years ago. Through this project, traditional owners spend more time on country looking after important cultural sites and facilitating the sharing of traditional knowledge across generations, while caring for country and reducing degradation (Fitzsimons *et al.*, 2012). The Kimberley Land Council is working with the corporate sector to secure long–term benefits to increase the demand and value paid for the biodiversity, social and cultural benefits generated (Kimberley Land Council, 2016a)***.***

1.4.3.4 Evaluation of success

The change in fire management approaches has been considered a major success by land managers, indigenous communities and state and federal government departments. Positive outcomes have occurred for biodiversity, providing concurrently indigenous economic development and cultural traditional benefits, re-engaging aboriginal people with their traditional practices across generations.

Table 1.4 Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	4	4	4	4	4	4	4	4	4	4
Nature's contributions to people	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	3	4	4	4	4	3	3	4	3	4
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	4	4	4	4	4	3	4	3	4		

LEGEND

1. Guiding Instruments	44/55
2. Nature's Contributions to People	40/55
3. Biophysical Conditions	34/45
1, 2, 3 combined	% Total 76%

-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

** Coord. = coordination*
*** LD = land degradation*

1.4.4 Success Story 4: adoption of conservation tillage in Prairie Canada

Figure 1.7 Adoption of conservation tillage in Prairie Canada.

Left panel shows bare soil after being fallowed using tillage. Right panel shows soil protected by residue cover. Photo: courtesy of Department of Soil Science, University of Saskatchewan.

1.4.4.1 Context and degradation

The former grasslands of western Canada were almost entirely converted to agricultural production during the 20th century, with an estimated 29 Mha of cropland in the region. For the first 75 years of the 20th century, the dominant soil management practice was a two-year crop-fallow system, with multiple tillage events in the fallow year leaving the soil completely bare (termed "tillage summer fallow"). Tillage summer fallow was used primarily as a water conservation measure, with soil moisture recharge during the fallow year contributing to higher yields in the crop year. The bare soil fallow and high tillage intensity led to losses of soil organic carbon estimated at approximately 25% compared to native soils and to high and continuing rates of erosion, especially wind erosion. Significant areas of the region were abandoned during the 1930s due to catastrophic wind erosion events. The high tillage intensity also led to significant tillage erosion on knolls and upper slope positions in agricultural fields, creating a patchwork of soil distribution in fields and hence high levels of within-field crop yield variability.

1.4.4.2 Description of rehabilitation actions

In the 1970s, progressive producers in the region began to adopt tillage and cropping practices that provided significantly more protection for the soil. First and most importantly, producers began to adopt conservation tillage (defined in the Canadian context as where at least 30% of the crop residue is left on the surface after seeding) and zero tillage, rather than the conventional tillage practices that left the soil bare. Second, producers reduced the frequency of fallow in the crop system. The reduction in fallow was coupled with the introduction of new crops to the region, principally canola (rape) and pulse crops such as lentils. Weed control, which had previously been accomplished with multiple tillage events each year, was instead accomplished with a broad spectrum of herbicides, especially glyphosate. Adoption of the new practices spread slowly until the 1990s, when improvements in seeding equipment, rising fuel costs and rising public concern about soil degradation combined to spur high rates of adoption. The area under conservation tillage in the region was less than 5% in 1981; by 2011, of the 29.6 Mha seeded, 16.7 Mha (56%) were in no-till and a further 7.2 M ha (24%) in conservation tillage. Only 1.4 M ha (5%) was in tillage summer fallow, down from 5.3 M ha in 1991. Throughout this period the main impetus for adoption came from the producers themselves, assisted by public sector research and extension from conservation organizations.

1.4.4.3 Outcomes

The widespread adoption of conservation tillage or no-till in Prairie Canada has led to major reductions in the risk of erosion from water, wind and tillage, and an increase in soil organic carbon levels. The erosion risk indicator calculated by Agriculture and Agri-Food Canada has steadily decreased: in 2011, 61% of cropland was in the very low risk category, whereas in 1981 only 29% was in this category. The shift to improved tillage has also led to small increases in soil organic carbon storage. A recent meta-analysis found increases in soil organic carbon in the Prairie region of approximately 3 Mg soil organic carbon ha^{-1} over the past 20 years. Although the per hectare amount is small (perhaps equal to 10 to 15% of the soil organic carbon lost due to initial cultivation), the overall contribution to Canada’s greenhouse gas budget is substantial - soils went from being a 1 Mt CO_2e source in 1981 to an 11.7 Mt CO_2e sink in 2006, driven largely by the shift in management practices in the Canadian Prairies. Concerns continue to be raised, however, about the continuing use of glyphosate to suppress weeds and its possible effects on soil biota and aquatic ecosystems (AAFC, 2013; Awada *et al.*, 2014; Clearwater *et al.,* 2016; Statistics Canada, 2015; Vandenbygaart *et al.*, 2003). A detailed account on the impact of glyphosate is available in Chapter 4 (see Section 4.2.4.2).

1.4.4.4 Evaluation of success

Table 1 5 Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	5	4	3	1	3	3	1	4	4	5	5
Nature's contributions to people	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	4	5	4	2	4	3	4	1	3	4
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	5	4	4	4	5	4	4	4	4		

LEGEND

1. Guiding Instruments	38/55
2. Nature's Contributions to People	38/55
3. Biophysical Conditions	38/45
1, 2, 3 combined	% Total 73%

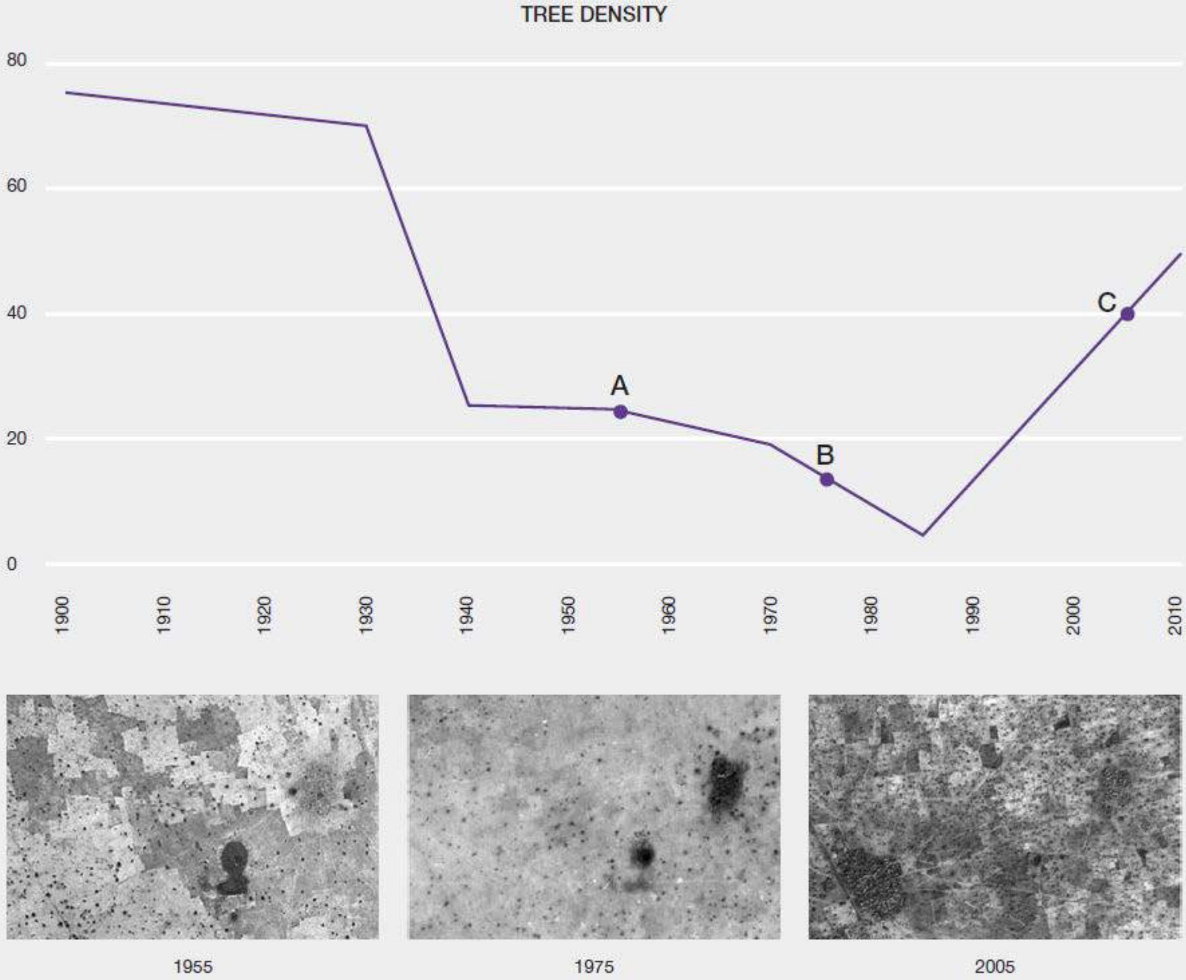
-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

* *Coord. = coordination*
** *LD = land degradation*

1.4.5 Success Story 5: regreening the Sahel through tree regeneration

Figure 1 8 Regreening the Sahel through tree regeneration.

The tree and field cover trends estimated as changes in tree density (unit = percent of precolonial tree cover): landscape dynamics in southwest Zinder. Scale is 1:5000. The 1975 aerial photos (1:50 000) were zoomed in to the specific terroir shown. Note: the emergence of a large village and severe shrinking of a wet area east of it may suggest that the 2005 image is of a different area, but all three images cover the identical geographical location. Remote sensing imagery courtesy of Dr. G. Tappan (Tappan & Cushing 2004, 2008).



1.4.5.1 Degradation process

The Sahel is a semi-arid region (200-700 mm annual rainfall) immediately south of the Sahara Desert, an approximately 500 km wide band stretching almost across Africa, with a total area of around 160 million ha and a population of 100 million people, mostly very poor. The annual rainfall, highly variable throughout the period of record, decreased abruptly and persistently by about a fifth between 1968 and 2005 and then apparently recovered (Mitchell, 1997; Ouedraogo *et al.*, 2014). Severe food insecurity, increased morbidity, loss of livestock and livelihoods was a region-wide phenomenon during the three-decade dry period (Franke & Chasin, 1980). The prolonged dry phase is now attributed to a temporary change in ocean circulation (Giannini *et al.*, 2003). At the time, it was thought that land degradation was either directly caused by overgrazing and tree cutting (Mainguet & Chemin, 1991; Le Houérou, 2002), or those activities had led to regional-scale desiccation (Xue & Shukla, 1988) – although some viewed the changes as mostly reflecting decadal rainfall variability (Nicholson, 2001).

The traditional farming system includes crops grown interspersed with selected and nurtured trees, in a rangeland matrix supporting cattle and goats. Clearing of the trees was advised by colonial and post-colonial extension services, since the trees were viewed as “weeds” competing with the crops and grass. Without the trees, however, soil exposed to sun and wind lost its capacity to absorb and retain water. Fertility declined and wind-blown sand covered the exposed crops. Crop plagues and pests increased over time, while the population of insects and birds that control them, deprived of their habitats, declined. Crop and livestock yields fell, increasing chronic hunger. Without fuelwood, people burned manure and crop residues for domestic cooking fuel, eliminating the main source of soil improvement (Reij et al., 2005; Herrmann & Tappan, 2013) .

1.4.5.2 Rehabilitation actions

The dry “mode” of regional climate apparently returned to “normal” mode, without human intervention. Yet, it remains an open question as to whether future reverse flips will occur and if they are and will be related to global climate changes (Giannini *et al.,* 2003). As a response to the degraded conditions, a project was set up in Niger to encourage farmers to regenerate natural trees from stumps. The new trees provided firewood, fruits, edible leaves and nuts, timber, medicines, fodder, dyes, soil protection and ameliorated the microclimate. Using the wood, provided for fire once again, freed-up crop residues and manure as soil amendments, improving their fertility, structure and reducing soil erosion, and leading to greater rainwater infiltration. Fewer pests and diseases were observed. The return of favourable conditions of both rainfall and soils led to higher crop yields and diversification of food sources and income - which in turn increased production resilience to extreme weather events. However, it remains disputed what fraction of this recovery was due to active rehabilitation efforts and how much was due to the return of the previous climate (Brandt *et al.*, 2015; Mbow *et al.*, 2015; Brandt *et al.*, 2017; Olsen *et al.*, 2015; Fensholt & Rasmussen, 2011), but all agree that active tree regeneration played a significant role (Behnke & Mortimore, 2015). Regulation also played an important role; previous attempts to plant windbreaks and woodlots of exotic trees in the region failed because trees were state property, thus farmers could not cut the trees planted on their land. Changes in the laws gave farmers ownership of the trees. Advantages derived from trees on the land stimulated more farmers to adopt this practice. The initial project spread to Burkina Faso, Mali and Senegal (Reij *et al*., 2005; Herrmann & Tappan, 2013).

1.4.5.3 Outcomes

The vegetation cover of the Sahel, as observed by satellites and measured by the Normalised Difference Vegetation Index (NDVI), has generally increased over the period 1987 to 2015 (Anyamba & Tucker, 2005; Anyamba *et al.*, 2014; Dardel *et al.*, 2014; Fensholt *et al.*, 2009; Horion *et al.*, 2014), but not everywhere (Rasmussen *et al.*, 2014). Much of this increase has been attributed to the return of higher rainfall and some is due to tree planting (Brandt *et al.*, 2015; Mbow *et al.*, 2015; Brandt *et al.*, 2017; Olsen *et al.*, 2015; Fensholt & Rasmussen, 2011). There is field- and satellite-based evidence for increases in tree and shrub cover (Brandt *et al.*, 2017; Horion *et al.*, 2014; Hänke *et al.*, 2016). More than 200 million trees of various species, generally indigenous and local, were established or planted since 1985 – restoring more than 5 million ha of land. Grain production increased by half a million tonnes per year and there was fodder for many more livestock. As a result, food security improved for more than 2.5 million people (Reij *et al.*, 2009). The capacity of the Sahelian landscape to deliver natural contributions to people is agreed by all to have increased over the past two decades, relative to the previous three decades.

1.4.5.4 Evaluation of success

Table 1 6 Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	5	4	5	4	5	4	4	4	5	4	4
Nature's contributions to people	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	4	5	5	4	4	4	5	3	4	4
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	5	3	4	5	5	3	4	3	4		

LEGEND

1. Guiding Instruments	48/55
2. Nature's Contributions to People	46/55
3. Biophysical Conditions	36/45
1, 2, 3 combined	% Total 82%

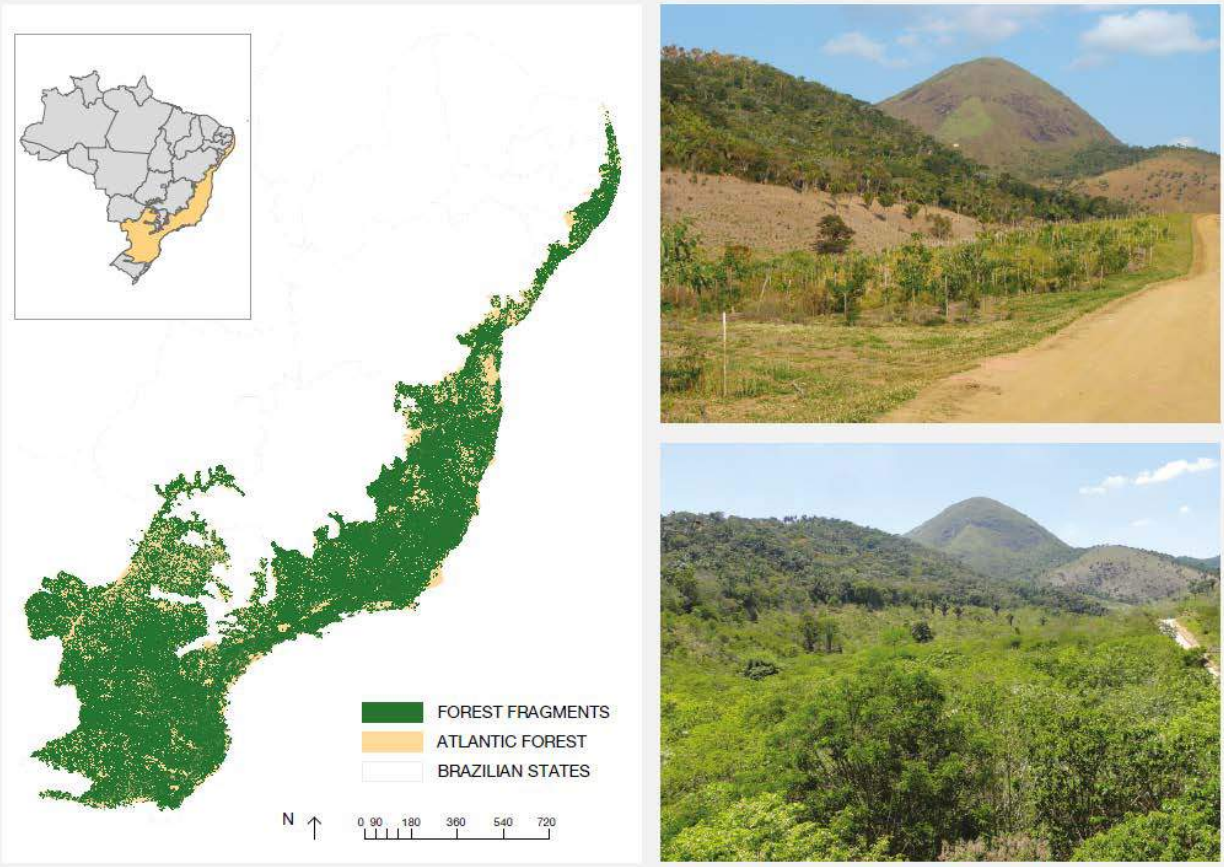
-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

** Coord. = coordination*
*** LD = land degradation*

1.4.6 Success Story 6: the Brazilian Atlantic Forest

Figure 1 9 The Brazilian Atlantic Forest.

The map on the left shows the location of the Atlantic Forests and Atlantic Forests fragments.
The right panels show an example of a restoration site before restoration (top right) and after restoration (bottom right).
Map source: Instituto Internacional de Sustentabilidade. Photos: courtesy of Ricardo R. Rodrigues.



1.4.6.1 Context and degradation activity

The Atlantic Forests, with high species diversity and endemism, extend along the Atlantic coast of Brazil from Rio Grande do Norte, in the north, to Rio Grande do Sul, in the South, and inland as far as Paraguay and the Misiones province of Argentina. The Tupi people dominated the Brazilian Atlantic coast before the arrival of European settlers. After 500 years of land-use change, less than 12% of the original forest cover (1.2 million km^2) remains, mostly in isolated fragments and of which 90% is privately held. Forest clearing for coffee plantations and cattle ranching, and logging for hardwoods are the principles threats (Pinto *et al.*, 2014). Throughout the twentieth century, the Brazilian Government enacted a series of legal instruments to support sustainable forest use, including laws regulating the use of native forests (1965). Weak environmental governance, poor compliance and - from the 1980s onward social concern for the Atlantic Forest pressured governments to enforce laws more rigorously and support grew for the restoration of the Atlantic Forest (Rodrigues *et al.*, 2009). In 1988, the Brazilian Federal Constitution established that authorities should promote restoration of ecological processes with the aim to guarantee a healthy environment for Brazilian society (Pinto *et al.*, 2014). Public prosecution, from 2000 onwards, resulted in large-scale restoration projects – with more recent innovative legal instruments regulating forest restoration and incorporating socio-ecological benefits. Despite such instruments and social understanding of the need for restoration, the restoration process was disorganized, with poor dialogue between the multiple stakeholders and limited incentives for implementation. A disaggregated approach to forest landscape restoration led to inefficiencies which, in the end, did not lead to effective restoration at the landscape scale. The solution was to bring everyone together with the creation of the Atlantic Forest Restoration Pact.

1.4.6.2 Description of rehabilitation actions

In 2006, a group of NGOs and researchers developed a plan, including a diverse coalition of interests and agendas from all forest restoration actors, which resulted the 2009 Atlantic Forest Restoration Pact. The Pact is a multi-stakeholder coalition aiming to restore 1 million ha of the Atlantic Forest by 2020 and 15 million ha by 2050, doubling native cover to at least 30% of the original biome area (Aguilar *et al.*, 2015). The Pact aims to: promote biodiversity conservation; create jobs and provide income generating opportunities through the restoration supply chain; restore key ecosystem services for millions of people; and establish incentives for landowners to comply with the Forest Act. The joint effort of more than 270 members from the private sector, governments, NGOs and research organisations has changed how large-scale forest landscape restoration is practiced in the region. The development of a new web-based database allows continuous monitoring of progress towards the ambitious goal and allows project implementers to optimise the benefits from restoration. The Atlantic Forest Restoration Pact has produced thematic maps to guide restoration, economic models to lead forest rehabilitation projects, guides for restoration and monitoring and capacity-building programs (Brancalion *et al.*, 2013; Calmon *et al.*, 2011; Melo *et al.*, 2013; Pinto *et al.*, 2014; Rodrigues *et al.*, 2011).

1.4.6.3 Outcomes

The Atlantic Forest Restoration Pact aims to restore tens of thousands of hectares (as of late 2017). It is estimated that the potential for job creation is as high as 6 million new jobs (Melo *et al.*, 2013), mostly in rural communities, for full implementation. Maintaining the Pact's governance mechanisms is fundamental to its success. Several challenges need to be overcome, such as representation from all four major sectors. Moreover, the uneven geographical distribution of its members will need to be addressed in the future. Achieving success is dependent on the engagement and commitment of all its members towards a common vision, goals and objectives. The Atlantic Forest Restoration Pact is incorporating people and human well-being into restoration planning and action, and working to reverse the Atlantic Forests' reputation as a dwindling biodiversity hot spot, into a region of hope for the future. To reduce the negative impacts of climate change on society and their livelihoods, the Pact is involving society in the protection and restoration of nature to improve peoples' standards of living (McKenna & Hemphill, 2010; Rodrigues *et al.*, 2011; Scarano & Ceotto, 2015).

1.4.6.4 Evaluation of success

Despite innovative legal instruments, problems occurred in implementing effective restoration of the Atlantic Forest due to weak environmental governance, poor compliance and limited connections between multiple stakeholders. The establishment of the Atlantic Forest Pact (2009) has played a key role in working to overcome these conflicts by fostering collaborations. A consistent monitoring approach has been developed, capacity-building and guidelines established, with the AFRP having more than 40,000 ha of restoration projects registered. At this stage, it is too early to understand the long-term ecological and social effectiveness of these projects and, to date, there does not appear to be much engagement with or involvement from indigenous peoples. For these reasons, a low value was given for biophysical conditions and a medium value for nature's contributions to people.

Table 1 7 Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	-1	1	3	-1	1	1	-1	-1	-1	-1	-1
	Post	5	4	5	1	4	4	1	5	5	4	4
Nature's contributions to people	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	4	3	3	4	4	3	3	1	2	4
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	1	4	4	4	3	3	4	5	4		

LEGEND

1. Guiding Instruments	42/55
2. Nature's Contributions to People	35/55
3. Biophysical Conditions	36/45
1, 2, 3 combined	% Total 69%

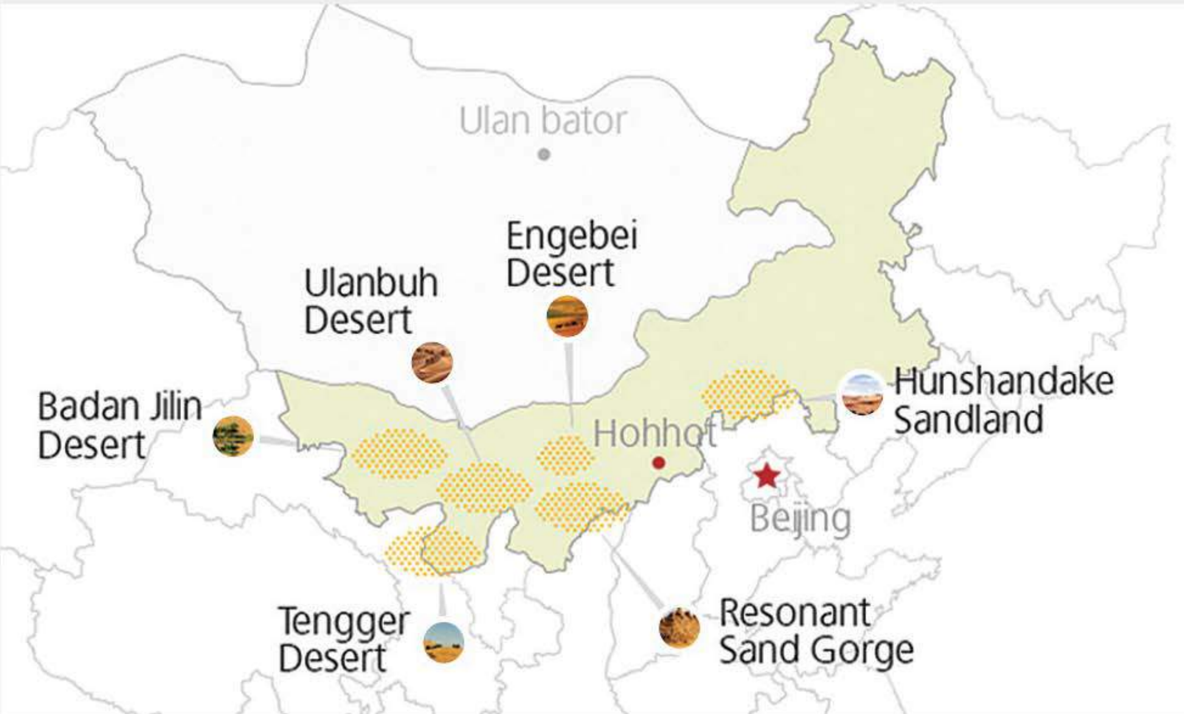
-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

** Coord. = coordination*
*** LD = land degradation*

1.4.7 Success Story 7: Hunshandake Sandland Inner Mongolia - sustainable management of marginal drylands (SUMAMAD)

Figure 1 10 Sustainable management of marginal drylands (SUMAMAD) in Hunshandake Sandland Inner Mongolia.

The map below shows the location of Hunshandake Sandland Inner Mongolia: 41°56'-44°22' N, 112°22'-117°57' E, 1100-1300 m a.s.l.



1.4.7.1 Context and degradation

China's rangelands are the second largest in the world. Hunshandake Sandland (41°56′-44°22′ N, 112°22′-117°57′ E, 1100-1300 m a.s.l.) is located within the Xilin Gol Plateau close to the Xilin Gol Biosphere Reserve, in a semi-arid grassland ecosystem - with habitats of sparse elm forests, lowlands, hills and wetlands. It is 450 km long, 50~300 km wide and has an area of 53,000 km^2. Monthly temperatures range from -18.3 °C in January to +18.5 °C in July and most of the annual precipitation (250 to 400 mm) falls during summer. Hunshandake has a population of 128,000 people, 40% of whom are Mongolian (Thomas *et al.*, 2014). Virtually all (92%) of the local population's income is derived from stockbreeding, including cattle, goats, sheep, horses and camels. Towards the end of the twentieth century, these animal numbers increased rapidly, reaching 108,0000 animals. The large number of medium to-large mammals is the main reason for the serious degradation of the Hunshandake Sandland. Serious land degradation has limited the ability of the land to carry enough animals to sustain the livelihoods of local families (Liu *et al.*, 2013; Jiang, 2009).

1.4.7.2 Restoration

The sustainable management of Marginal Drylands established a comprehensive, multi-partner/stakeholder project, which included government, local farmers, scientists/experts and businesses, (Thomas *et al.*, 2014).

This project adopted an alternate strategy to that usually employed in grassland restoration, artificially increasing primary production. This alternative replaced the major grassland consumers with less destructive animals (i.e., chickens). The natural grasslands were used for chicken farming, reducing overgrazing ruminant pressure, establishing a different source of income for the local community. However, it is important that these practices are designed in such a way that they have minimal impact on traditional nomadic cultures (Su *et al.*, 2017).

The community's work intensity has been reduced. Chicken farming requires 4 months of activity, while the traditional practices of intensive rearing of lambs and calves requires 12 months of continuous activity. Grasslands have a variety of trees, shrubs, forbs and grasses with fruits, leaves and insects - forming the natural diet for free-range chickens. The above-ground plant biomass was similar between the chicken faming and the control situations. Pecking and scratching caused less soil disturbance and compaction than in the case of large and middle-sized mammals. More water was found in soils manured by chickens, sustaining non-degrading grassland soils. As a restoration pathway, chicken farming also enhances local people's income. The economic benefit of chicken farming, raised organically, was approximately six times higher (per hectare) than grazing sheep. This restoration approach has been applied across 10 800 km^2 of the of the Hunshandake sandland and sequesters more carbon than the degraded ecosystem (Su *et al.*, 2017; Liu *et al.*, 2007, 2013). Satellite images were used to calculate land-use patterns for different land coverages (e.g., meadow, steppe, spare elm tree, desert and crop farm) throughout the restoration process (Schaaf, 2011).

Further research is being conducted to establish the impacts on grassland ecosystems of selective feeding of chickens. Future use of this restoration approach would limit the number of medium and large livestock and ensure traditional nomadic practices, however not prohibit livestock grazing, to ensure traditional nomadic practices are enduring (Liu *et al.*, 2013). The deep-rooted attachments of the local herdsmen to livestock grazing, suggest that the most effective approach is an integrative land-use approach, where herders systematically use their rangelands incorporating both practices (Li, 2011; Papanastasis *et al.*, 2015; Li & Huntsinger, 2011; Papanastasis *et al.*, 2015).

1.4.7.3 Outcomes

Thanks in part to the uptake of policy recommendations and good restoration outcomes on degraded grasslands, there has been a three-fold increase in above- ground plant biomass in chicken farmed land compared to land with medium to large animals. The sustainable management of Marginal Drylands project has received large financial investments from the Chinese government and other partners. Potential has also been identified for carbon payments. Together with the traditional deep-rooted livestock grazing of the local herdsmen, organic chicken farming is a viable integrated and comprehensive landscape-farming method. Farmers have received a six-fold increase in economic return, for less intensive time commitments. Raising free-range chickens increased the communities' income by 54%, compared with sheep grazing. The reduction in livestock grazing has resulted in an increase in biomass of groundcover, reducing soil erosion, and land degradation.

1.4.7.4 Evaluation of success

Table 1 8 **Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).**

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	2	1	1	-1	1	-1	1	-1	-1	-1	-1
	Post	4	5	1	-1	2	4	3	4	5	4	4
Nature's contributions to people	Pre	2	-1	2	2	1	-1	-1	-1	2	-1	-1
	Post	4	4	5	5	1	3	4	4	4	4	4
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	4	4	3	4	4	3	4	4	4		

LEGEND

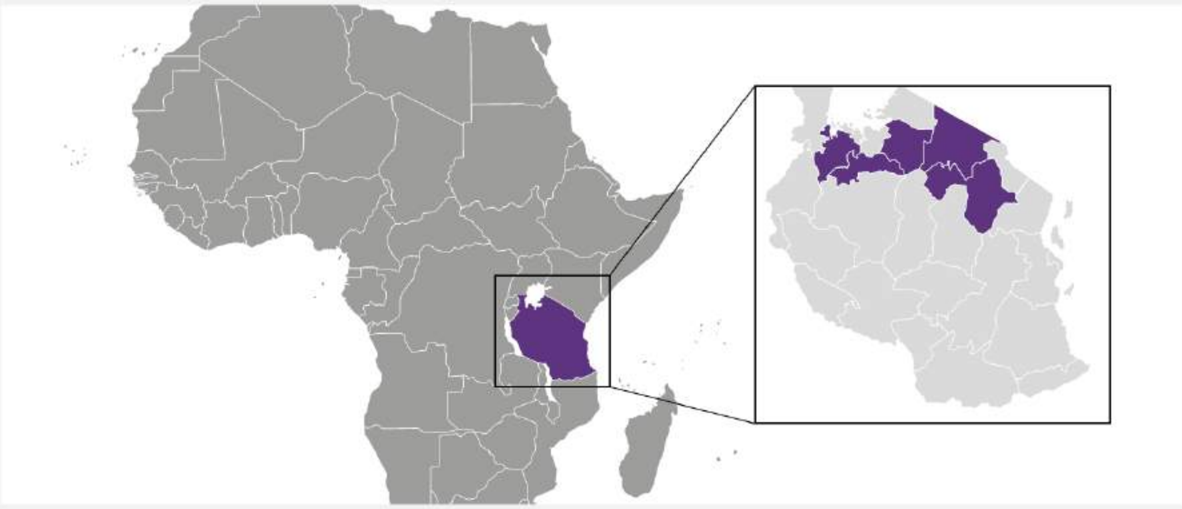
1. Guiding Instruments	34/55
2. Nature's Contributions to People	42/55
3. Biophysical Conditions	34/45
1, 2, 3 combined	% Total 71%

-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

** Coord. = coordination*
*** LD = land degradation*

1.4.8 Success Story 8: Ujamma community resource team - northern Tanzania pastoralist and agro-pastoralist communities

Figure 1 11 Ujamaa Community Resource Team location. Source: Tanzania/UNDP Equator Initiative.



1.4.8.1 Context and degradation

Northern Tanzania has rich savannas, grasslands and montane landscapes, a diverse array of farmers, traditional pastoralists and hunter-gatherer communities. Longstanding competition over land and its resources exists amongst local communities. Over the last century, the loss of extensive areas of land to large-scale commercial farms or state protected areas has had negative impacts on indigenous communities. Legal and policy instruments often commandeered local resources, degrading landscapes and traditional livelihoods, and failing to recognise traditional systems of land use. The livelihoods of pastoralist, agro-pastoralist and hunter-gatherer communities, such as the Maasai, Barabaig, Akie, Sonjo and Hadzabe communities, are under threat from: the overexploitation of natural resources; political marginalization; limited resources; and access to knowledge. Marginalization has been further exacerbated by the geographical remoteness of many ethnic minority communities.

This has resulted in less productive agriculture, exacerbated by drought, loss of fertility and climate change. Moreover, the kinds of knowledge that hunter-gatherers possess about harvesting wild foods (plants, honey and so on) become more important to food security and nutritional well-being. While the policy environment enables local groups to formalise rights over lands and resources, the political economic environment can skew power relations in favour of non-local actors, such as commercial investors or national government bodies.

1.4.8.2 Restoration and rehabilitation processes

The Ujamma Community Resource Team was founded in 1998 and operates across the Yaeda valley, as well as in the Kiteto, Ngorongoro, Simanjiro, Longido and Hanang districts of northern Tanzania. The Ujamma Community Resource Teams' mandate is to work with indigenous groups in Northern Tanzania who depend on communal natural resources to support their livelihoods, towards rehabilitating and restoring northern Tanzania's degraded landscapes by including their customary rights and practices. Ujamma Community Resource Team works with Tanzania's village land legislation (Tanzanian Land Act of

1999) and assists communities to develop by-laws from this legislation and develop land-use plans for their customary lands, while focusing on improving their ecosystem management capacity.

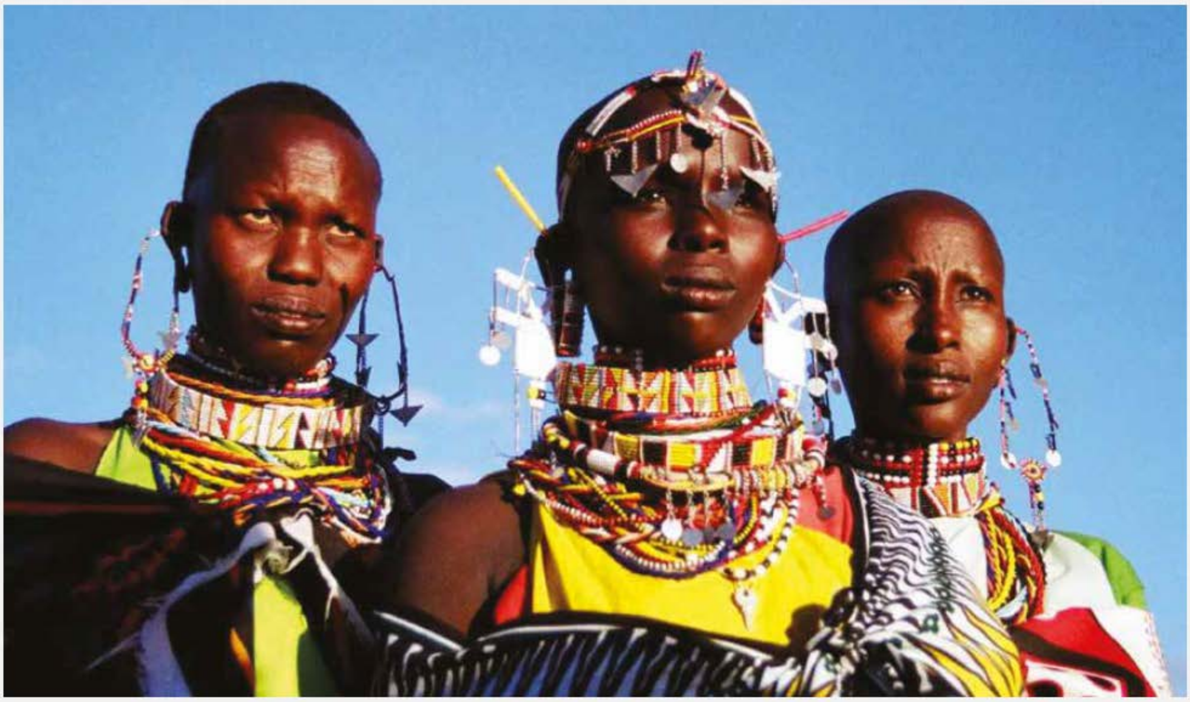
Figure 1 12 Ujamaa Community Resource Team. Photo credit: Tanzania/UNDP Equator Initiative.

They operate across four key foci: land use, natural resource management, community empowerment and advocacy. The goal is the restoration and rehabilitation of marginalized lands and communities to: secure land and resource rights; improve natural resource management capacities; develop management skills and tools; establish and manage community reserved areas using indigenous land management practices, while enhancing economic benefits. Capacity-building, conflict resolution and sustainable livelihood programmes underpin the work, enhancing the effectiveness of the rural communities as land and resource managers. Ujamma Community Resource Team has secured several landmark agreements, including the legal demarcation of the first village for hunter-gatherers in Tanzania - which has increased land access and security, improved gender rights and raised community confidence across marginalized indigenous communities, while reducing land degradation.

The Ujamma Community Resource Team assists with the development of land-use plans that ensure communities have secure property rights and resource access, and has assisted with surveying, mapping and demarcating community lands to ease inter-community conflicts and the process of formalizing tenure. To ensure good governance they assist committees within village councils to oversee resource plans and monitor resource use. This resource mapping has resulted in innovative partnerships between communities.

Ujamma has worked with four other Tanzanian groups to found the Mama Ardhi Alliance, which has played an instrumental role in successful efforts to ensure provisions enshrining women's rights to land ownership, were included in the new proposed Constitution 2014, or Katiba inayopendekezwa, passed by the Constituent Assembly in October 2014. Women's empowerment programmes are operated in conjunction with the Pastoral Women's Council of Tanzania: an NGO working with pastoralist groups in northern Tanzania to advance women's rights and the education of Maasai girls.

Figure 1 13 Ujamaa Community Resource Team. Photo credit: Tanzania/UNDP Equator Initiative.



1.4.8.3 Outcomes

These sustainable management practices have reduced conflict, achieved secure land tenure and provided improvements in the health and well-being of the land, wildlife and communities between 1998 and 2016. In 2008 the Ujamaa Community Resource Team was awarded the UNDP Equator Prize and, in 2016, Edward Loure, the Director for a decade, was the 2016 Goldman Environment Prize Winner for Africa (United Nations Development Programme, 2012; Siandei, 2016; Ujamaa Community Resource Team, 2015). The continued success of these partnerships has brought awareness, understanding and acceptance at all levels of society. One of the main socio-economic impacts has been the fostering of private sector partnerships that have enabled villages to earn income.

The ecological condition of this area has improved considerably over the past decade and can support hunter-gatherer livelihoods. It has also allowed the recovery of local wildlife populations, which faced pressures from competing livestock grazing, as well as hunting by farmers that had immigrated to the area. The recovery of natural resources (e.g., water sources, forested areas) has improved the food security of the local people and established clear rules for governing access to land and resources - in conjunction with local government authorities to demarcate, plan and legally formalize ownership of their land. Large numbers of people and communities have gained responsibility for the management of their land and livelihoods (Ujamaa Community Resource Team, 2010, 2011, 2015; Siandei, 2016; Nelson & Makko, 2005; UNDP, 2012; Katiba Initiative, 2012; Ardhi, 2013).

1.4.8.4 Evaluation of success

Table 1 9 Scoring for all factors (Table 1.1) across the 3 overarching criteria (Figure 1.2) of the operational framework, both pre- and post-restoration, to evaluate the success of the project, scored against the coloured scoring values (-1 to 5) (Box 1.2).

1. Guiding instruments		Coord.*	1.1	1.2	1.2.1	1.3	1.4	1.4.1	1.5	1.5.1	1.6	1.7
2. Nature's contributions to people		2.1	2.2	2.2.1	2.2.2	2.2.3	2.3	2.3.1	2.3.2	2.3.3	2.4	2.5
3. Biophysical conditions		LD**	3.1	3.2	3.3	3.3.1	3.4	3.5	3.6	3.7		
Guiding instruments	Pre	-1	-1	1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	5	5	4	4	4	5	4	4	4	5
Nature's contributions to people	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Post	4	5	4	4	4	4	4	4	5	4	4
Biophysical conditions	Pre	-1	-1	-1	-1	-1	-1	-1	-1	-1		
	Post	4	4	4	4	4	4	4	2	5		

LEGEND

1. Guiding Instruments	48/55
2. Nature's Contributions to People	46/55
3. Biophysical Conditions	35/45
1, 2, 3 combined	% Total 82%

-1	Negative
1	Limited
2	Slight
3	Slight to moderate
4	Moderate
5	Good

** Coord. = coordination*
*** LD = land degradation*

1.5 Conclusion

This chapter has developed an operational framework, incorporating the socio-ecological landscape approach, which may provide guidance and direction on the planning and implementation of new projects with the aim to improve human well-being and quality of life, while avoiding and reducing the impacts of land degradation and restoring and rehabilitating degraded lands. This operational framework incorporates a whole of life cycle implementation and evaluation process with the active participation of multiple stakeholders, including indigenous peoples and local communities, and businesses in order to embrace both monetary and non-monetary valuations of natural resources. Eight existing long-term cases have been evaluated against the three overarching criteria and the underlying elements of the operational framework. This approach has proven to be useful in gaining a holistic understanding of the outcomes of the eight case projects and in identifying future directions.

1.6 References

AAFC. (2013). *Environmental Sustainability of Canadian Agriculture* (Agri-Environmental Indicator Report Series No. 3). Retrieved from http://publications.gc.ca/collections/collection_2011/agr/A22-201-2010-eng.pdf

Aarde, R. Van, Coe, M., & Niering, W. (1996). On the rehabilitation of the coastal dunes of KwaZulu-Natal. *African Journal of Science*, *92*, 122–124.

Acuña, V., Díez, J. R., Flores, L., Meleason, M., & Elosegi, A. (2013). Does it make economic sense to restore rivers for their ecosystem services? *Journal of Applied Ecology*, *50*(4), 988–997. https://doi.org/10.1111/1365-2664.12107

Aguilar, M., Sierra, J., Ramirez, W., Vargas, O., Calle, Z., Vargas, W., Murcia, C., Aronson, J., & Barrera Cataño, J. I. (2015). Toward a post-conflict Colombia: restoring to the future. *Restoration Ecology*, *23*(1), 4–6. https://doi.org/10.1111/rec.12172

Alexander, S., Aronson, J., Whaley, O., & Lamb, D. (2016). The relationship between ecological restoration and the ecosystem services concept. *Ecology and Society*, 21(1). http://dx.doi.org/10.5751/ES-08288-210134

Allan, E., Manning, P., Alt, F., Binkenstein, J., Blaser, S., Blüthgen, N., Böhm, S., Grassein, F., Hölzel, N., Klaus, V.H. and Kleinebecker, T. (2015). Land use intensification alters ecosystem multifunctionality via loss of biodiversity and changes to functional composition. *Ecology Letters*, *18*(8), 834–843.

Anyamba, A., Small, J., Tucker, C., & Pak, E. (2014). Thirty-two Years of Sahelian Zone Growing Season Non-Stationary NDVI3g Patterns and Trends. *Remote Sensing*, *6*(4), 3101–3122. https://doi.org/10.3390/rs6043101

Anyamba, A., & Tucker, C. J. (2005). Analysis of Sahelian vegetation dynamics using NOAA-AVHRR NDVI data from 1981–2003. *Journal of Arid Environments*, *63*(3), 596–614. https://doi.org/10.1016/j.jaridenv.2005.03.007

Araujo, K., Griut, M., Miggiano, L., & Springer, J. (2015). *Land Rights Indicators in the Post-2015 SDGs*. Recommendations for Inter-Agency Expert Group & Other Policymakers. International Land Coalition. Retrieved from http://www.landcoalition.org/sites/default/files/documents/resources/post2015_landrightsindicators_10marchb.pdf

Awada, L., Lindwall, C. W., & Sontag, B. (2014). The development and adoption of conservation tillage on the Canadian Prairies. *International Soil and Water Conservation Research*, *2*, 47–65.

Baker, S., Eckerberg, K., & Zachrisson, A. (2013). Political science and ecological restoration. *Environmental Politics*, *23*(3), 509–524. https://doi.org/10.1080/09644016.2013.835201

BBOP & UNEP. (2010). Mitigation Hierarchy. Retrieved from http://bbop.forest-trends.org/pages/mitigation_hierarchy

Behnke, R., & Mortimore, M. (2015). *The End of Desertification? Disputing Environmental Change in the Drylands.* Springer-Praxis Earth System Science Series.

Boelsums Barreto Sansevero, J., & Garbin, M. L. (2015). Restoration Success Of Tropical Forests: The Search For Indicators. In A. Latawiec & D. Agol (Eds.) *Sustainability Indicators in Practice* (pp. 146-159). Boston: De Gruyter Open.

Bowman, D. M. J. S., Balch, J., Artaxo, P., Bond, W. J., Cochrane, M. A., D'Antonio, C. M., DeFries, R., Johnston, F. H., Keeley, J. E., Krawchuk, M. A., Kull, C. A., Mack, M., Moritz, M. A., Pyne, S., Roos, C. I., Scott, A. C., Sodhi, N. S., & Swetnam, T. W. (2011). The human dimension of fire regimes on Earth.

Journal of Biogeography, *38*(12), 2223–2236. https://doi.org/10.1111/j.1365-2699.2011.02595.x

Brancalion, Pedro HS *et al.* (2015). Forest and Landscape Restoration (Special Issue). *Unasylva (FAO)*, *66*(3), 1–165.

Brancalion, P. H. S., Melo, F. P. L., Tabarelli, M., & Rodrigues, R. R. (2013). Restoration reserves as biodiversity safeguards in human-modified landscapes. *Natureza a Conservacao*, *11*(2), 186–190. https://doi.org/10.4322/natcon.2013.029

Brancalion, P. H. S., Viani, R. a. G., Calmon, M., Carrascosa, H., & Rodrigues, R. R. (2013). How to Organize a Large-Scale Ecological Restoration Program? The Framework Developed by the Atlantic Forest Restoration Pact in Brazil. *Journal of Sustainable Forestry*, *32*(September), 728–744. https://doi.org/10.1080/10549811.2013.817339

Brandt, M., Mbow, C., Diouf, A. A., Verger, A., Samimi, C., & Fensholt, R. (2015). Ground- and satellite-based evidence of the biophysical mechanisms behind the greening Sahel. *Global Change Biology*, *21*(4), 1610–1620. https://doi.org/10.1111/gcb.12807

Brandt, M., Tappan, G., Diouf, A., Beye, G., Mbow, C., & Fensholt, R. (2017). Woody Vegetation Die off and Regeneration in Response to Rainfall Variability in the West African Sahel. *Remote Sensing*, *9*(1), 39. https://doi.org/10.3390/rs9010039

Buck, L. E., Wallace-stokes, C., Milder, J. C., & Kuria, D. (2014). *Advancing and Balancing Ecological Conservation, Agricultural Production and Local Livelihood Goals in Kenya's Kikuyu Escarpment Landscape*. Washington D.C: EcoAgriculture Partners on behalf of the Landscapes for People, Food and Nature Initiative. Retrieved from https://peoplefoodandnature.org/wp-content/uploads/2014/12/AdvancingandBalancinginKikuyuEscarpment_December_2014.pdf

Calle, Z., Murgueitio, E., Chará, J., Molina, C. H., Zuluaga, A. F., & Calle, A. (2013). A Strategy for Scaling-Up Intensive Silvopastoral Systems in Colombia. *Journal of Sustainable Forestry*, *32*(7), 677–693. https://doi.org/10.1080/10549811.2013.817338

Calmon, M., Brancalion, P. H. S., Paese, A., Aronson, J., Castro, P., da Silva, S. C., & Rodrigues, R. R. (2011). Emerging Threats and Opportunities for Large-Scale Ecological Restoration in the Atlantic Forest of Brazil. *Restoration Ecology*, *19*(2), 154–158. https://doi.org/10.1111/j.1526-100X.2011.00772.x

Chaves, R. B., Durigan, G., Brancalion, P. H. S., & Aronson, J. (2015). On the need of legal frameworks for assessing restoration projects success: new perspectives from São Paulo state (Brazil). *Restoration Ecology*, *23*(6), 754–759. https://doi.org/10.1111/rec.12267

Chazdon, R. L. (2008). Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands. *Science*, *320*(5882), 1458–1460. https://doi.org/10.1126/science.1155365

Chazdon, R. L., Brancalion, P. H. S., Lamb, D., Laestadius, L., & Calmon, M. (2015). A policy-driven knowledge agenda for global forest and landscape restoration. *Conservation Letters*, 10(1), 125-132. https://doi.org/10.1111/conl.12220

Ciccarese, L., Mattsson, A., & Pettenella, D. (2012). Ecosystem services from forest restoration: thinking ahead. *New Forests*, *43*(5–6), 543–560. https://doi.org/10.1007/s11056-012-9350-8

Clearwater, R. L., Martin, T., & Hoppe, T. (2016). *Environmental Sustainability of Canadian Agriculture*. Agri-Environmental Indicators Report Series, Report #4. Ottawa: Agriculture and Agri-Food Canada.

COAG Standing Council on Environment and Water. (2012). *Australia's Native Vegetation Framework - A National Framework to Guide the Ecologically Sustainable Management of Australia's Native Vegetation*. Canberra: Australian Government, Department of Sustainability, Environment, Water, Population and Communities.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). *Nature-Based Solutions to address* *societal challenges*. Gland: International Union for the Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en

Commonwealth of Australia. (2016). *Environment Protection and Biodiversity Conservation Regulations 2000*. Statutory Rules No. 181, 2000 made under the Environment Protection and Biodiversity Conservation Act 1999. Compilation No. 21. Australian Government. Retrieved from https://www.legislation.gov.au/Details/F2016C00914

ILO (1991) *Convention concerning Indigenous and Tribal Peoples in Independent Countries*. C169 - Indigenous and Tribal Peoples Convention, 1989 (No. 169). Geneva: 76th ILC session. Geneva: International Labour Organization.

CBD. (1992). United Nations Convention on Biological Diversity United Nations. *Convention on Biological Diversity: Text of the Convention*. Retrieved from https://www.cbd.int/convention/text/

CBD. (2010). *Aichi Biodiversity Target 15*. Retrieved from https://www.cbd.int/sp/targets/

CBD. (2012). *Decision XI/16: Ecosystem Restoration UNEP/CBD/COP/DEC/XI/16*. Retrieved from https://www.cbd.int/doc/decisions/cop-11/cop-11-dec-16-en.pdf

Convertino, M., Baker, K. M., Vogel, J. T., Lu, C., Suedel, B., & Linkov, I. (2013). Multi-criteria decision analysis to select metrics for design and monitoring of sustainable ecosystem restorations. *Ecological Indicators*, *26*, 76–86. https://doi.org/10.1016/j.ecolind.2012.10.005

Cronkleton, P., & Larson, A. (2015). Formalization and Collective Appropriation of Space on Forest Frontiers: Comparing Communal and Individual Property Systems in the Peruvian and Ecuadoran Amazon. *Society and Natural Resources*, *28*(5), 496–512. https://doi.org/10.1080/08941920.2015.1014609

Dardel, C., Kergoat, L., Hiernaux, P., Mougin, E., Grippa, M., & Tucker, C. J. (2014). Re-greening Sahel: 30years of remote sensing data and field observations (Mali, Niger). *Remote Sensing of Environment*, *140*, 350–364. https://doi.org/10.1016/j.rse.2013.09.011

Davis, A. L. V., van Aarde, R. J., Scholtz, C. H., & Delport, J. H. (2003). Convergence Between Dung Beetle Assemblages of a Post-Mining Vegetational Chronosequence and Unmined Dune Forest. *Restoration Ecology*, *11*(1), 29–42. https://doi.org/10.1046/j.1526-100X.2003.00133.x

Denier, L., Scherr, S. J., Shames, S., Chatterton, P., Hovani, L., & Stam, N. (2015). *The Little Sustainable landscapes Book*. Oxford: Global Canopy Programme 1st ed. Oxford.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., Báldi, A., Bartuska, A., Baste, I. A., Bilgin, A., Brondizio, E., Chan, K. M., Figueroa, V. E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G. M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E. S., Reyers, B., Roth, E., Saito, O., Scholes, R., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z. A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, T. S., Asfaw, Z., Bartus, G., Brooks, A. L., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A. M. M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W. A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J. P., Mikissa, J. B., Moller, H., Mooney, H. A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A. A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., & Zlatanova, D. (2015). The IPBES Conceptual Framework — connecting nature and people. *Current Opinion in Environmental Sustainability, 14*, 1-16. https://doi.org/10.1016/j.cosust.2014.11.002

Dore, J., Michael, C., Russell-Smith, J., Tehan, M., & Caripis, L. (2014). Carbon projects and Indigenous land in northern Australia. *Rangeland Journal*, *36*(4), 389–402. https://doi.org/10.1071/RJ13128

Doren, R. F., Trexler, J. C., Gottlieb, A. D., & Harwell, M. C. (2009). Ecological indicators for system-wide assessment of the greater everglades ecosystem restoration program. *Ecological Indicators*, *9*(6 SUPPL.), 2–16. https://doi.org/10.1016/j.ecolind.2008.08.009

Dudgeon, P., & Wright, M. (2010). The social, cultural and historical context of Aboriginal and Torres Strait Islander Australians. *Working Together: Aboriginal and Torres Strait Islander Mental Health and Wellbeing Principles and Practice*, 25–42. Retrieved from http://works.bepress.com/cgi/viewcontent.cgi?article=1072&context=nola_purdie#page=59

Easterlin, R. A., McVey, L. A., Switek, M., Sawangfa, O., & Zweig, J. S. (2010). The happiness-income paradox revisited. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(52), 22463–22468. https://doi.org/10.1073/pnas.1015962107

Edelman, A., Gelding, A., Konovalov, E., McComiskie, R., Penny, A., Roberts, N., Templeman, S., Trewin, D., Ziembicki, M., Trewin, B., Cortlet, R., Hemingway, J., Isaac, J., and Turton, S. (2014) S*tate of the Tropics 2014 report*. Cairns: James Cook University.

Ehrenfeld, J. G. (2000). Defining the limits of restoration: the need for realistic goals. *Restoration Ecology*, *8*, 2–9.

ELD Initiative. (2015). The value of land: Prosperous lands and positive rewards through sustainable land management. Retrieved from http://www.eld-initiative.org/fileadmin/pdf/ELD-main-report_05_web_72dpi.pdf

Ens, E., Fisher, J., & Costello, O. (2015). *Indigenous people and invasive species: Perceptions, challenges, management and uses*. IUCN Commission on Ecosystem Management Community Booklet. Retrieved from https://www.iucn.org/backup_iucn/cmsdata.iucn.org/downloads/ipis_booklet_v6_low_rez_final.pdf

Ens, E. J. (2012). Conducting two-way ecological research. In J. C. Altman & S. Kerins (Eds.), *People on Country, Vital Landscapes, Indigenous Futures* (pp. 45-64). The Federation Press.

Ens, E. J., Daniels, C., Thompson, W., Ponto, S., Rogers, K., Roy, J., Dixon, P., & Nelson, E. (2010). Combining Aboriginal knowledge and Western science to investigate possible explanations for the decline in fruit production of a bush tucker shrub, Djutpi, near Ngukurr, Northern Territory. *Ecological Management and Restoration*, *11*(2), 146–148. https://doi.org/10.1111/j.1442-8903.2010.00535.x

Ens, E. J., Daniels, C., Thompson, W., Ponto, S., Rogers, K., Roy, J., Dixon, P., Nelson, E., Cooke, P., Nadjamerrek, R., Namundja, S., Garlngarr, V., & Yibarbuk, D. (2010). Combining aboriginal and non-aboriginal knowledge to assess and manage feral water buffalo impacts on perennial freshwater springs of the aboriginal-owned arnhem plateau, Australia. *Environmental Management*, *11*(2), 146–148. https://doi.org/10.1007/s00267-010-9452-z

Ens, E. J., Finlayson, M., Preuss, K., Jackson, S., & Holcombe, S. (2012). Australian approaches for managing "country" using Indigenous and non-Indigenous knowledge. *Ecological Management and Restoration*, *13*(1), 100–107. https://doi.org/10.1111/j.1442-8903.2011.00634.x

Ens, E. J., Towler, G. M., & Daniels, C. (2012). Looking back to move forward: Collaborative ecological monitoring in remote Arnhem Land. *Ecological Management and Restoration*, *13*(1), 26–35. https://doi.org/10.1111/j.1442-8903.2011.00627.x

Environmental Protection Authority. (2006). *Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) Rehabilitation of Terrestrial Ecosystems (No. 6)*. Western Australia: Environmental Protection Authority. Retrieved from http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/GS6-Rehab-Terrestrial-Ecosystems-260606.pdf

Estrada-Carmona, N., Hart, A. K., DeClerck, F. A. J., Harvey, C. A., & Milder, J. C. (2014). Integrated landscape management for agriculture, rural livelihoods, and ecosystem conservation: An assessment of experience from Latin America and the Caribbean. *Landscape and Urban Planning*, *129*, 1–11. https://doi.org/10.1016/j.landurbplan.2014.05.001

Feit, U., Korn, H., & Paulsch, A. (2013). *Report of the International Expert Workshop connecting diverse Knowledge Systems in the context of IPBES*. April 22-25, 2013 at the International Academy for Nature Conservation, Isle of Vilm, Germany. Retrieved from https://www.bfn.de/fileadmin/MDB/documents/service/Skript_341.pdf

Fensholt, R., & Rasmussen, K. (2011). Analysis of trends in the Sahelian "rain-use efficiency" using GIMMS NDVI, RFE and GPCP rainfall data. *Remote Sensing of Environment*, *115*(2), 438–451. https://doi.org/10.1016/j.rse.2010.09.014

Fensholt, R., Rasmussen, K., Nielsen, T. T., & Mbow, C. (2009). Evaluation of earth observation based long term vegetation trends — Intercomparing NDVI time series trend analysis consistency of Sahel from AVHRR GIMMS, Terra MODIS and SPOT VGT data. *Remote Sensing of Environment*, *113*(9), 1886–1898. https://doi.org/10.1016/j.rse.2009.04.004

Ferreira, S. M., & van Aarde, R. J. (2000). Maintaining diversity through intermediate disturbances: evidence from rodents colonizing rehabilitating coastal dunes. *African Journal of Ecology*, *38*(4), 286–294. https://doi.org/10.1046/j.1365-2028.2000.00254.x

Fisher, J., Beames, L., Rangers, B. J., Rangers, N. N., Majer, J., & Heterick, B. (2014). Using ants to monitor changes within and surrounding the endangered Monsoon Vine Thickets of the tropical Dampier Peninsula, north Western Australia. *Forest Ecology and Management*, *318*, 78–90. https://doi.org/10.1016/j.foreco.2014.01.010

Fisher, J. L. (2010). *The incorporation of Traditional Ecological Knowledge and Western Ecological Science into mine operations from pre-exploration to mine closure, in order to maintain cultural and ecological integrity in the post mine restored environment.*

Fisher, J. L. (2012). *A Cross Analysis of Outcomes and Actions for the Urban Waterways Renewal Project, SERCUL assessment of Knowledge Gaps and Baseline Monitoring needs to determine future directions for baseline monitoring to assess the effectiveness of the implementation*.

Fisher, J. L. (2013). Decline in the Availability of Traditional Food Sources in Indigenous Australia. In G. D. Das (Ed.), *Food and Environmental Security - Imperatives of Indigenous Knowledge Systems* (pp. 383–389). Agrobios Publications.

Fitzsimons, J., Russell-Smith, J., James, G., Vigilante, T., Lipsett-Moore, G., Morrison, J., & Looker, M. (2012). Insights into the biodiversity and social benchmarking components of the Northern Australian fire management and carbon abatement programmes. *Ecological Management and Restoration*, *13*(1), 51–57. https://doi.org/10.1111/j.1442-8903.2011.00624.x

Fontaine, C. M., Dendoncker, N., De Vreese, R., Jacquemin, I., Marek, A., Van Herzele, A., Devillet, G., Mortelmans, D., & François, L. (2014). Towards participatory integrated valuation and modelling of ecosystem services under land-use change. *Journal of Land Use Science*, *9*(3), 278–303. https://doi.org/10.1080/1747423X.2013.786150

FAO. (2015). Global guidelines for the restoration of degraded forests and landscapes in drylands Building resilience and benefiting livelihoods. *Forestry Paper, 175*, 171.

FAO. (2012). *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security*. Rome: Food and Agriculture Organization of the United Nations.

Forest Peoples Programme. (2016). *Local Biodiversity Outlooks: Indigenous Peoples' and Local Communities' Contributions to the Implementation of the Strategic Plan for Biodiversity 2011-2020*. A complement to the fourth edition of the Global Biodiversity Outlook. Moreton-in-Marsh: Forest Peoples Programme, the International Indigenous Forum on Biodiversity and the Secretariat of the Convention on Biological Diversity. Retrieved from http://localbiodiversityoutlooks.net/wp-content/uploads/2016/12/local-biodiversity-outlooks-2016-english-web.pdf

Franke, R. W., & Chasin, B. H. (1980). *Seeds of famine: ecological destruction and the development dilemma in the West African Sahel.* Montclair, New Jersey: Allanheld, Osmun and Co. Publishers. Retrieved from https://www.cabdirect.org/cabdirect/abstract/19806736140

Game, E. T., Kareiva, P., & Possingham, H. P. (2013). Six Common Mistakes in Conservation Priority Setting. *Conservation Biology*, *27*(3), 480–485. https://doi.org/10.1111/cobi.12051

Giannini, A., Saravanan, R., & Chang, P. (2003). Oceanic Forcing of Sahel Rainfall on Interannual to Interdecadal Time Scales. *Science*, *302*(5647).

Gibbons, P., Macintosh, A., Constable, A. L., & Hayashi, K. (2017). Outcomes from 10 years of biodiversity offsetting. *Global Change Biology, 24*(2), e643-e654.

Global Forest Coalition. (2015). Report of the Community Conservation Resilience Initiative. Asunción: Global Forest Coalition. Retrieved from http://globalforestcoalition.org/wp-content/uploads/2015/11/full-CCRI-report-final.pdf

Global Landscapes Forum. (2015a). *Background Brief: Tenure and rights*. Paris: Global Landscapes Forum. Retrieved from https://archive.globallandscapesforum.org/wp-content/uploads/docs/Briefs/GLF-Brief_Tenure-and-rights.pdf

Global Landscapes Forum. (2015b). *Outcome Statement*. Paris: 5–6 December 2015, held on the sidelines of the UNFCCC 21st Conference of the Parties (COP21). Retrieved from https://archive.globallandscapesforum.org/wp-content/uploads/docs/GLF-Paris-Outcomes-Statement.pdf

Gottschalk-Druschke, C., & Hychka, K. (2015). Manager perspectives on communication and public engagement in ecological restoration project success. *Ecology and Society*, *20*(1), 58. https://doi.org/10.5751/ES-07451-200158

Grainger, A., Andersson, E., Brogaard, S., Olsson, L., Arthington, A. H., Chukwuma Sr, C., Geeson, N., Quaranta, G., Salvia, R., Brandt, J., John, M., Pannell, D., Kingwell, R., Ramos, M. A., Lucena, R. F. P. de, Albuquerque, U. P., Reed, M. S., Stringer, L. C. L. C., Dougill, A. J. A. J., Perkins, J. S., Atlhopheng, J. R., Mulale, K., Favretto, N., Tun, K. K. K., Shrestha, R. P., Datta, A., Vu, Q. M., Le, Q. B., Vlek, P. L. G., Wang, X., Wang, Y. Y., Wang, Y. Y., Zheng, H., Lu, C., Shang, D., & Cao, S. (2015). Use of exotic species during ecological restoration can produce effects that resemble vegetation invasions and other unintended consequences. *Journal of Environmental Management*, *22*(6), 247–251. https://doi.org/10.1080/13504509.2011.543837

Grant, C., & Koch, J. (2007). Decommissioning Western Australia's First Bauxite Mine: Co-evolving vegetation restoration techniques and targets. *Ecological Management and Restoration*, *8*(2), 92–105. https://doi.org/10.1111/j.1442-8903.2007.00346.x

Guilfoyle, D. R., Mitchell, M. B. (2015). Compliance-based archaeological heritage management and place-based participatory mapping for negotiated outcomes. *Australian Archaeology*, *80*, 80-90.

Guilfoyle, D. R., Webb, W., Webb, T., & Mitchell, M. (2011). A structure and process for 'working beyond the site' in a commercial context: A case study from Dunsborough, southwest Western Australia. *Australian Archeology, 73*, 25-32.

Guilfoyle, D. R., Bennell, B., Webb, W., Gillies, V., & Strickland, J. (2009). Integrating Natural Resource Management and Indigenous Cultural Heritage. *Heritage Management*, *2*(2), 149–176.

Guilfoyle, D. R. (2004). A Model for the Pueblo I Settlement of the Elk Ridge Region, Southeast Utah. *Kiva*, *70*(2), 121–141.

Haider, L. J., Strassburg, B., Iribarrem, A., Gardner, T., Latawiec, A., & Alves-Pinto, H. (2015). Understanding indicators and monitoring for sustainability in the context of complex social-ecological systems. In A. E. Latawiec & D. Agol (Eds.), *Sustainability Indicators in Practice* (pp. 23–36). Boston: De Gruyter.

Hänke, H., Börjeson, L., Hylander, K., & Enfors-Kautsky, E. (2016). Drought tolerant species dominate as rainfall and tree cover returns in the West African Sahel. *Land Use Policy*, *59*, 111–120. https://doi.org/10.1016/j.landusepol.2016.08.023

Heckbert, S., Russell-Smith, J., Reeson, A., Davies, J., James, G., & Meyer, C. (2012). Spatially explicit benefit-cost analysis of fire management for greenhouse gas abatement. *Austral Ecology*, *37*(6), 724–732. https://doi.org/10.1111/j.1442-9993.2012.02408.x

Hernández-Morcillo, M., Plieninger, T., & Bieling, C. (2013). An empirical review of cultural ecosystem service indicators. *Ecological Indicators*, *29*, 434–444. https://doi.org/10.1016/j.ecolind.2013.01.013

Herrmann, S. M., & Tappan, G. G. (2013). Vegetation impoverishment despite greening: A case study from central Senegal. *Journal of Arid Environments*, *90*, 55–56. Retrieved from http://doi.org/10.1016/j.jaridenv.2012.10.020

Hill, R., Grant, C., George, M., Robinson, C. J., Jackson, S., & Abel, N. (2012). A typology of indigenous engagement in Australian environmental management: Implications for knowledge integration and social-ecological system sustainability. *Ecology and Society*, *17*(1), 23. https://doi.org/10.5751/ES-04587-170123

Hill, R., Pert, P., Davies, J., Robinson, C. J., Walsh, F., & Falco-Mammone, F. (2013). *Indigenous Land Management in Australia: Extent, Scope, Diversity, Barriers and Success Factors*. Cairns: CSIRO Ecosystem Sciences. Retrieved from http://www.researchgate.net/publication/257653257_Indigenous_Land_Management_in_Australia._Diversity_scope_extent_success_factors_and_barriers/file/5046352842f1f6d058.pdf

Horion, S., Fensholt, R., Tagesson, T., & Ehammer, A. (2014). Using earth observation-based dry season NDVI trends for assessment of changes in tree cover in the Sahel. *International Journal of Remote Sensing*, *35*(7), 2493–2515. https://doi.org/10.1080/01431161.2014.883104

Indigenous Land Corporation. (2013). National Indigenous Pastoral Enterprises Agribusiness Strategy 2014-2017. Retrieved from https://www.ilc.gov.au/IndigenousLandCorporation/media/Items/Content/ILC%20Businesses/National-Indigenous-Pastoral-Enterprises-Agribusiness-Strategy-2014-17.pdf

Indigenous Land Corporation, & Australian Government. (2012). *People Land Opportunity: National Indigenous Land Strategy 2013–2017.* Retrieved from http://www.ilc.gov.au/IndigenousLandCorporation/media/Items/Content/Publications/Corporate%20Documents/National_Indigenous_Land_Strategy_2013-17_for_download.pdf

Iniesta-Arandia, I., del Amo, D. G., García-Nieto, A. P., Piñeiro, C., Montes, C., & Martín-López, B. (2015). Factors influencing local ecological knowledge maintenance in Mediterranean watersheds: Insights for environmental policies. *Ambio*, *44*(4), 285–296. https://doi.org/10.1007/s13280-014-0556-1

ICMM. (2015). *Good Practice Guide: Indigenous Peoples and Mining*. 2nd Edition. London: International Council on Mining and Metals. Retrieved from http://www.icmm.com/website/publications/pdfs/social-and-economic-development/9520.pdf

IUCN. (2016). *Net Positive Impact on biodiversity: The business case*. Gland: International Union for the Conservation of Nature. Retrieved from https://portals.iucn.org/library/sites/library/files/documents/Rep-2015-008.pdf

IPBES. (2015). *IPBES/3/18: Report of the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Serviceson the work of its third session.* Retrieved from https://www.ipbes.net/event/ipbes-3-plenary

IPBES. (2017). *IPBES/5/INF/6: Progress report on the guide on the production of assessments (deliverable 2 (a)).* Retrieved from https://www.ipbes.net/event/ipbes-5-plenary

IPES-Food. (2016). *From uniformity to diversity: a paradigm shift from industrial agriculture to diversified agroecological systems.* International Panel of Experts on Sustainable Food systems. Retrieved from http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf

Isbell, F., Tilman, D., Polasky, S., & Loreau, M. (2015). The biodiversity-dependent ecosystem service debt. *Ecology Letters*, *18*, 1–26. https://doi.org/10.1111/ele.12393

IUCN, & WRI. (2014). *A guide to the Restoration Opportunities Assessment Methodology (ROAM): assessing forest landscape restoration opportunities at the national or sub-national level: working paper (road-test edition).* Gland: International Union for the Conservation of Nature. Retrieved from https://portals.iucn.org/library/node/44852

IUCN, & State Forestry Ministry China. (2015). *First World Forum on Ecosytem Governance, Beijing Declaration: Governing Ecosystems for Human Wellbeing*. Beijing: First World Forum on Ecosystem Governance. Retrieved from http://cmsdata.iucn.org/downloads/beijing_declaration___final__b_18__nov__2015.pdf

Jackson, L., van Noordwijk, M., Bengtsson, J., Foster, W., Lipper, L., Pulleman, M., Said, M., Snaddon, J., & Vodouhe, R. (2010). Biodiversity and agricultural sustainagility: From assessment to adaptive management. *Current Opinion in Environmental Sustainability*, *2*(1–2), 80–87. https://doi.org/10.1016/j.cosust.2010.02.007

Jansson, R., Backx, H., Boulton, A. J., Dixon, M., Dudgeon, D., Hughes, F. M. R., Nakamura, K., Stanley, E. H., & Tockner, K. (2005). Stating mechanisms and refining criteria for ecologically successful river restoration: A comment on Palmer *et al.* (2005). *Journal of Applied Ecology*, *42*(2), 218–222. https://doi.org/10.1111/j.1365-2664.2005.01022.x

Jiang, G. (2009). *Hunshandake Sandland Sustainable management of the restored Hunshandake Sandland: Basic Scientific Research and Income Generation*.

Joly, C.A, Ricardo R. Rodrigues, Jean Paul Metzger, Célio F. B. Haddad, Luciano M. Verdade, Mariana C. Oliveira, V. S. B. (2010). Biodiversity Conservation Research, Training, and Policy in São Paulo. *Science*, *328*(5984), 1358–1359.

Katiba Initiative. (2012). *Policy Briefing: Improving pastoralists and hunter-gatherer interests in Tanzania's constitution*. Retrieved from http://www.ujamaa-crt.org/uploads/1/2/5/7/12575135/kai_policy_brief.pdf

Kaufmann, D., Kraay, A., & Massimo, M. (2011). The Worldwide Governance Indicators: Methodology and Analytical Issues. *Hague Journal on the Rule of Law, 3*, 220–246.

Keenan, R. J., Reams, G. A., Achard, F., De Freitas, J. V, Grainger, A., & Lindquist, E. (2015). Dynamics of global forest area: Results from the FAO Global Forest Resources Assessment 2015. *Forest Ecology and Management*, *352*, 9–20. https://doi.org/10.1016/j.foreco.2015.06.014

Kimberley Land Council. (2016a). *Cultural Enterprises Hub: Concept Report Kimberley Land Council*.

Kimberley Land Council. (2016b). *Fighting Fire with Fire Indigenous Management in the Kimberley*.

Kimberley Land Council. (2017). *Cultural Enterprises Kimberley*. Retrieved from https://www.klc.org.au/cultural-enterprises/

Knight, A. T., Cowling, R. M., Boshoff, A. F., Wilson, S. L., & Pierce, S. M. (2011). Walking in STEP: Lessons for linking spatial prioritisations to implementation strategies. *Biological Conservation*, *144*(1), 202–211. https://doi.org/10.1016/j.biocon.2010.08.017

Knight, A. T., Cowling, R. M., & Campbell, B. M. (2006). An operational model for implementing conservation action. *Conservation Biology*, *20*(2), 408–419. https://doi.org/10.1111/j.1523-1739.2006.00305.x

Knight, A. T., Cowling, R. M., Rouget, M., Balmford, A., Lombard, A. T., & Campbell, B. M. (2008). Knowing but not doing: Selecting priority conservation areas and the research-implementation gap. *Conservation Biology*, *22*(3), 610–617. https://doi.org/10.1111/j.1523-1739.2008.00914.x

Kohler, F., Marchand, G., & Negrão, M. (2015). Local history and landscape dynamics: A comparative study in rural Brazil and rural France. *Land Use Policy, 43*, 149-160. https://doi.org/10.1016/j.landusepol.2014.11.010

Kok, K., & van Delden, H. (2009). Combining two approaches of integrated scenario development to combat desertification in the Guadalent watershed, Spain. *Environment and Planning B: Planning and Design*, *36*(1), 49–66. https://doi.org/10.1068/b32137

Kok, M. T. J., Kok, K., Peterson, G. D., Hill, R., Agard, J., & Carpenter, S. R. (2017). Biodiversity and ecosystem services require IPBES to take novel approach to scenarios. *Sustainability Science, 12*(1), 177-181. https://doi.org/10.1007/s11625-016-0354-8

Kritzinger, J., & Aarde, R. Van. (1998). The bird communities of rehabilitating coastal dunes at Richards Bay, KwaZulu-Natal. *South African Journal of Science*, *94*(2), 71–78.

Kroeger, T., & Casey, F. (2007). An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecological Economics*, *64*(2), 321–332. https://doi.org/10.1016/j.ecolecon.2007.07.021

Laestadius, L., Buckingham, K., Maginnis, S., & Saint-Laurent, C. (2015). Before Bonn and beyond: the history and future of forest landscape restoration. *Unasylva Forest Landscape Restoration (Special Issue)*, *245*(66), 11–18.

Latawiec, A. E., & Agol, D. (2016). Sustainability Indicators In Practice: Lessons Learned From The Past , Directions For The Future. In A. E. Latawiec & D. Agol (Eds.), *Sustainability Indicators in Practice* (pp. 16–18). Boston: De Gruyter.

Latawiec, A. E., Strassburg, B. B. N., Brancalion, P. H. S., Rodrigues, R. R., & Gardner, T. (2015). Creating space for large-scale restoration in tropical agricultural landscapes. *Frontiers in Ecology and the Environment*, *13*(4), 211–218. https://doi.org/10.1890/140052

Le Houérou, H. N. (2002). Man-Made Deserts: Desertization Processes and Threats. *Arid Land Research and Management*, *16*(1), 1–36. https://doi.org/10.1080/153249802753365296

Legge, S., Murphy, S., Kingswood, R., Maher, B., & Swan, D. (2011). EcoFire: Restoring the biodiversity values of the Kimberley region by managing fire. *Ecological Management and Restoration*, *12*(2), 84–92. https://doi.org/10.1111/j.1442-8903.2011.00595.x

Lestrelin, G., & Giordano, M. (2007). Upland development policy, livelihood change and land degradation: interactions from a Laotian village. *Land Degradation & Development*, *18*(1), 55–76. https://doi.org/10.1002/ldr.756

Li, W., Huntsinger, L. (2011). China's grassland contract policy and its impacts on herder ability to benefit in Inner Mongolia: tragic feedbacks. *Ecology & Society*, *16*(1). https://doi.org/https://doi.org/10.5751/ES-03969-160201.

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., Pell, A. N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C. L., Schneider, S. H., & Taylor, W. W. (2007). Complexity of Coupled Human and Natural Systems. *Science*, *317*(5844), 1513–1516. https://doi.org/10.1126/science.1144004

Liu, M., Wang, B., Osborne, C. P., & Jiang, G. (2013). Chicken Farming in Grassland Increases Environmental Sustainability and Economic Efficiency. *PLoS ONE*, *8*(1), 1–7. https://doi.org/10.1371/journal.pone.0053977

Locatelli, B., Catterall, C. P., Imbach, P., Kumar, C., Lasco, R., Marín-Spiotta, E., Mercer, B., Powers, J. S., Schwartz, N., & Uriarte, M. (2015). Tropical reforestation and climate change: beyond carbon. *Restoration Ecology*, *23*(4), 337–343. https://doi.org/10.1111/rec.12209

Mainguet, M., & Chemin, M. C. (1991). Wind degradation on the sandy soils of the Sahel of Mali and Niger and its part in desertification. In O. E. Barndorff-Nielsen & B. B. Willetts (Eds.) *Aeolian Grain Transport* (pp. 113–130). Vienna: Acta Mechanica Supplementum, vol 2. Springer. https://doi.org/10.1007/978-3-7091-6703-8_9

Mama Ardhi. (2013). *Who Is Mama Ardhi ?* Retrieved from http://www.ujamaa-crt.org/uploads/1/2/5/7/12575135/mama_ardhi_brochure_-_womens_land_rights.pdf

Martin, L. M., Moloney, K. A., & Wilsey, B. J. (2005). An assessment of grassland restoration success using species diversity components. *Journal of Applied Ecology*, *42*(2), 327–336. https://doi.org/10.1111/j.1365-2664.2005.01019.x

Matthews, J. W., & Endress, A. G. (2008). Performance criteria, compliance success, and vegetation development in compensatory mitigation wetlands. *Environmental Management*, *41*(1), 130–141. https://doi.org/10.1007/s00267-007-9002-5

Mbow, C., Brandt, M., Ouedraogo, I., de Leeuw, J., & Marshall, M. (2015). What Four Decades of Earth Observation Tell Us about Land Degradation in the Sahel? *Remote Sensing*, *7*(4), 4048–4067. https://doi.org/10.3390/rs70404048

Mcdonald, T., Gann, G. D., Jonson, J., & Dixon, K. W. (2016). *International Standards for the Practice of Ecological Restoration – including Principals and Key Concepts.* 1st Edition (December 2016). Washington D.C.: Society for Ecological Restoration. Retrieved from http://c.ymcdn.com/sites/www.ser.org/resource/resmgr/docs/SER_International_Standards.pdf

McKenna, S., & Hemphill, A. (2010). *Nomination for Sargasso Sea MPA Status*. Retrieved from www.gobi.org/Our Work/rare-2/at_download/pdf

McNeill, T., & Quillerou, E. (2016). Making money after mining. *Sustainable Land Solutions*, *7*(5).

Meli, P., Herrera, F. F., Melo, F., Pinto, S., Aguirre, N., Musálem, K., Minaverry, C., Ramírez, W., & Brancalion, P. H. S. (2017). Four approaches to guide ecological restoration in Latin America. *Restoration Ecology*, *25*(2), 156–163. https://doi.org/10.1111/rec.12473

Melo, F. P. L., Pinto, S. R. R., Brancalion, P. H. S., Castro, P. S., Rodrigues, R. R., Aronson, J., & Tabarelli, M. (2013). Priority setting for scaling-up tropical forest restoration projects: Early lessons from the Atlantic forest restoration pact. *Environmental Science & Policy*, *33*, 395–404. https://doi.org/10.1016/j.envsci.2013.07.013

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Synthesis*. Washington, DC: Island Press.

Mitchell, T. (1997). Sahel Precipitation Index. https://doi.org/10.6069/H5MW2F2Q

Moberg, F., & Rönnbäck, P. (2003). Ecosystem services of the tropical seascape : interactions , substitutions and restoration. *Ocean & Coastal Management*, *46*, 27–46.

https://doi.org/10.1016/S0964-5691(02)00119-9

Montanarella, L, Lobos, I. A. (2015). Putting soils on the agenda: the three Rio Conventions and the post-2015 development agenda Review Article. *Current Opinion in Environmental Sustainability*, 41–48.

Moorcroft, H., Ignjic, E., Cowell, S., Goonack, J., Mangolomara, S., Oobagooma, J., Karadada, R., Williams, D., & Waina, N. (2012). Conservation planning in a cross-cultural context: The Wunambal Gaambera Healthy Country Project in the Kimberley, Western Australia. *Ecological Management and Restoration*, *13*(1), 16–25. https://doi.org/10.1111/j.1442-8903.2011.00629.x

Mulale, K., Chanda, R., Perkins, J. S., Magole, L., Sebego, R. J., Atlhopheng, J. R., Mphinyane, W., & Reed, M. S. (2014). Formal Institutions and Their Role in Promoting Sustainable Land Management in Boteti, Botswana. *Land Degradation & Development*, *25*(1), 80–91. https://doi.org/10.1002/ldr.2274

Müller, F., Bergmann, M., Dannowski, R., Dippner, J. W., Gnauck, A., Haase, P., Jochimsen, M. C., Kasprzak, P., Kröncke, I., Kümmerlin, R., Küster, M., Lischeid, G., Meesenburg, H., Merz, C., Millat, G., Müller, J., Padisák, J., Schimming, C. G., Schubert, H., Schult, M., Selmeczy, G., Shatwell, T., Stoll, S., Schwabe, M., Soltwedel, T., Straile, D., & Theuerkauf, M. (2015). Assessing resilience in long-term ecological data sets. *Ecological Indicators, 65*, 10-43. https://doi.org/10.1016/j.ecolind.2015.10.066

Murcia, C., Guariguata, M. R., Andrade, Á., Ignacio, G., Aronson, J., Escobar, E. M., Etter, A., Flavio, H., Ramirez, W., & Montes, E. (2015). Challenges and prospects for scaling-up ecological restoration to meet international commitments : Colombia as a case study. *Conservation Letters, 9*(3), 213-220. https://doi.org/10.1111/conl.12199

National Research Council. (2001a). 2 Outcomes fo Wetland Restoration and Creation. In *Compensating for Wetland lLsses under the Clean Water Act* (p. 322). National Academies Press. https://doi.org/2001004921

National Research Council. (2001b). Appendix E Examples of Performance Standards for Wetland Creation and Restoration in Section Permits and an Approach to Developing Performance Standards. In *Wetland Losses Under the Clean Water Act onal Academies Press* (p. 322). National Academies Press. https://doi.org/2001004921

Nations, U., Council, E., Economic, E., For, C., Fifth, A., Committee, A., Development, S., Meeting, R. I., & Ababa, A. (2007). *Economic Commission for Africa*.

Natural Resource Management Ministerial Council Government of Australia. (2010). *Australia's Biodiversity Conservation Strategy 2010-2030*. Retrieved from http://www.environment.gov.au/biodiversity/strategy/index.html

Nelson, F., & Ole Makko, S. (2005). *Communities, conservation, and conflicts in the Tanzanian Serengeti - Preserving Rights to Gain Benefits*. Retrieved from http://www.ujamaa-crt.org/uploads/1/2/5/7/12575135/assets_chapter_5.pdf

Nicholson, S. (2001). Climatic and environmental change in Africa during the last two centuries. *Climate Research*, *17*(2), 123–144. https://doi.org/10.3354/cr017123

Nkonya, E., Mirzabaev, A., & von Braun, J. (2016). Economics of land Degradation and Improvement: An Introduction and Overview. In *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development* (pp. 1-14). Cham: Springer Open. https://doi.org/10.1007/978-3-319-19168-3

Oliver, T.H., Isaac, N.J., August, T.A., Woodcock, B.A., Roy, D.B. and Bullock, J. M. (2015). Declining resilience of ecosystem functions under biodiversity loss. *Nature Communications*, *6*, 10122.

Olsen, J. L., Miehe, S., Ceccato, P., & Fensholt, R. (2015). Does EO NDVI seasonal metrics capture variations in species composition and biomass due to grazing in semi-arid grassland savannas?

Biogeosciences, *12*, 4407–4419. https://doi.org/doi:10.5194/bg-12-4407-2015

Orr, B.J., A.L. Cowie, V.M. Castillo Sanchez, P. Chasek, N.D. Crossman, A. Erlewein, G. Louwagie, M. Maron, G.I. Metternicht, S. Minelli, A.E. Tengberg, S. Walter, and S. Welton. 2017. Scientific Conceptual Framework for Land Degradation Neutrality. A Report of the Science-Policy Interface. United Nations Convention to Combat Desertification (UNCCD), Bonn, Germany.

Ouedraogo, I., Runge, J., Eisenberg, J., Barron, J., & Sawadogo-Kaboré, S. (2014). The Re-Greening of the Sahel: Natural Cyclicity or Human-Induced Change? *Land*, *3*(3), 1075–1090. https://doi.org/10.3390/land3031075

Palmer, M. A., Bernhardt, E., & J.D., A. (2004). Standards for ecologically successful river restoration. *Journal of Applied Ecology*, *42*(May), 208–217.

Papanastasis, V., Bautista, S., Chouvardas, D., Mantzanas, K Papadimitriou, M., Mayor, A., Koukioumi, P Papaioannou, A., & Vallejo, R. (2015). Comparative assessment of goods and services provided by grazing regulation and reforestation in degraded Mediterranean rangelands. *Land Degradation & Development, 28*(4), 1178-1187*.*

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R. T., Başak Dessane, E., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S. M., Wittmer, H., Adlan, A., Ahn, S., Al-Hafedh, Y. S., Amankwah, E., Asah, S. T., Berry, P., Bilgin, A., Breslow, S. J., Bullock, C., Cáceres, D., Daly-Hassen, H., Figueroa, E., Golden, C. D., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P. H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B. B., van den Belt, M., Verma, M., Wickson, F., & Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*, *26*, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006

Pattnaik, A.K and Kumar, R. (2016). Lake Chilika (India): Ecological Restoration and Adaptive Management for Conservation and Wise Use. In C. M. Finlayson (Eds.) *The Wetland Book: Distribution, Description and Conservation (Volume II)*. Dordrecht: Springer.

Paustian, K., Lehmann, J., Ogle, S., Reay, D., Robertson, G. P., & Smith, P. (2016). Perspective Climate-smart soils. *Nature*, *532*(7597), 49–57. https://doi.org/10.1038/nature17174

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Shpritz, L., Fitton, L., Saffouris, R., & Blair, R. (1995). Environmental and Economic Costs of Soil Erosion and Conservation Benefits. *Science*, *267*(5201), 1117–1123.

Pinto, S., Melo, F., Tabarelli, M., Padovesi, A., Mesquita, C., de Mattos Scaramuzz, C., Castro, Carrascosa, H., Calmon, M., Rodrigues, R., César, R., & Brancalion, P. (2014). Governing and delivering a biome-wide restoration initiative: The case of Atlantic Forest Restoration Pact in Brazil. *Forests*, *5*(9), 2212–2229. https://doi.org/10.3390/f5092212

Plurality in Public Policy. (2014). Recommendations for the governments of Latin America and international organisations. *Fourth International Workshop Plurality in Public Policy: Incorporating the Perspective of Indigenous, Afro-Descendent and Peasant Women*, (1), 1–5.

Pressey, R. L., & Bottrill, M. C. (2008). Opportunism, threats, and the evolution of systematic conservation planning. *Conservation Biology*, *22*(5), 1340–1345. https://doi.org/10.1111/j.1523-1739.2008.01032.x

Qadir, M., Quillérou, E., Nangia, V., Murtaza, G., Singh, M., Thomas, R. J., Drechsel, P., Noble, A. D. (2014). Economics of salt–induced land degradation and restoration. *Natural Resources Forum, 38*, 282-295.

Ramsar Convention. (2015). The 4th Strategic Plan 2016 – 2024 The Convention on Wetlands of International Importance especially as Waterfowl Habitat – the " Ramsar Convention ." *12th*

Meeting of the Conference of the Parties at Punta Del Este, (June 2015), 1–9.

Rasmussen, K., Fensholt, R., Fog, B., Vang Rasmussen, L., & Yanogo, I. (2014). Explaining NDVI trends in northern Burkina Faso. *Geografisk Tidsskrift-Danish Journal of Geography*, *114*(1), 17–24. https://doi.org/10.1080/00167223.2014.890522

Raudsepp-Hearne, C., Peterson, G. D., Tengö, M., Bennett, E. M., Holland, T., Benessaiah, K., MacDonald, G. K., & Pfeifer, L. (2010). Untangling the Environmentalist's Paradox: Why Is Human Well-being Increasing as Ecosystem Services Degrade? *BioScience*, *60*(8), 576–589. https://doi.org/10.1525/bio.2010.60.8.4

Reij, C., Tappan, G., & Belemvire, A. (2005). Changing land management practices and vegetation on the Central Plateau of Burkina Faso (1968–2002). *Journal of Arid Environments*, *63*(3), 642–659.

Richards Bay Minerals. Richards Bay Minerals Standard Operating Procedure Dune Rehabilitation - Indigenous, Pub. L. No. ECO-01R10, Standard Operating Procedure 5 (2017). Retrieved from http://www.srk.co.za/sites/default/files/File/South-Africa/publicDocuments1/ZultiSouth/Response/App_F_ECO-01_-_Dune_Rehabilitation_-_Indigenous_updated_2017.pdf

Richards Bay Minerals dune mining, South Africa. (2017.). Retrieved April 7, 2017, from https://ejatlas.org/conflict/richards-bay-minerals-dune-mining-south-africa

Robinson, D.A.; Fraser, I.; Dominati, E.J.; Davidsdottir, B.; Jonsson, J.O.G.; Jones, L.; Jones, S.B.; Tuller, M.; Lebron, I.; Bristow, K.L.; Souza, D.M.; Banwart, S.; Clothier, B. E. (2014). On the value of soil resources in the context of natural capital and ecosystem service delivery. *Soil Science Society of America Journal*, *78*(3), 685–700.

Robinson, C. J., Maclean, K., Hill, R., Bock, E., & Rist, P. (2016). Participatory mapping to negotiate indigenous knowledge used to assess environmental risk. *Sustainability Science*, *11*, 115–126. https://doi.org/10.1007/s11625-015-0292-x

Rodrigues, R. R., Gandolfi, S., Nave, A. G., Aronson, J., Barreto, T. E., Vidal, C. Y., & Brancalion, P. H. S. (2011). Large-scale ecological restoration of high-diversity tropical forests in SE Brazil. *Forest Ecology and Management*, *261*(10), 1605–1613. https://doi.org/10.1016/j.foreco.2010.07.005

Rodrigues, R. R., Lima, R. a F., Gandolfi, S., & Nave, A. G. (2009). On the restoration of high diversity forests: 30 years of experience in the Brazilian Atlantic Forest. *Biological Conservation*, *142*(6), 1242–1251. https://doi.org/10.1016/j.biocon.2008.12.008

Russell-Smith, J., Yates, C., Edwards, A., Allan, G. E., Cook, G. D., Cooke, P., Craig, R., Heath, B., & Smith, R. (2003). Contemporary fire regimes of northern Australia, 1997–2001: change since Aboriginal occupancy, challenges for sustainable management. *International Journal of Wildland Fire*, *12*(4), 283. https://doi.org/10.1071/WF03015

Ryder, D. S., & Miller, W. (2005). Setting goals and measuring success: Linking patterns and processes in stream restoration. *Hydrobiologia*, *552*(1), 147–158. https://doi.org/10.1007/s10750-005-1512-7

Sala, O.E., Chapin, F.S., Armesto, J.J., Berlow, E., Bloomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, L.F., Jackson, R.B., Kinzig, A. Leemans, R. (2000). Global biodiversity scenarios for the year 2100. *Science*, *287*(5459), 1770–1774.

Salvati, L., & Carlucci, M. (2014). Zero Net Land Degradation in Italy: The role of socioeconomic and agro-forest factors. *Journal of Environmental Management*, *145*, 299–306. https://doi.org/10.1016/j.jenvman.2014.07.006

Sarrazin, F., & Lecomte, J. (2016). Evolution in the Anthropocene. *Science*, *351*(6276), 922–923. https://doi.org/10.1126/science.aad6756

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.-L., Sheil, D., Meijaard, E., Venter, M., Boedhihartono, A. K., Day, M., Garcia, C., van Oosten, C., & Buck, L. E. (2013). Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proceedings of the National Academy of Sciences*, *110*(21), 8349–8356. https://doi.org/10.1073/pnas.1210595110

Scarano, F. R., & Ceotto, P. (2015). Brazilian Atlantic forest: impact, vulnerability, and adaptation to climate change. *Biodiversity and Conservation*, *24*(9), 2319–2331. https://doi.org/10.1007/s10531-015-0972-y

Schaaf, T. (2011). Sustainable Management of the Restored Hunshandake Sandland : Basic Scientific Research and Income Generation Progress Report of SUMAMAD Activities.

Scherr, S. J., Shames, S., Gross, L., Borges, M. A., Bos, G., & Brasser, A. (2017). *Business for Sustainable Landscapes: An action agenda for sustainable development*. Washington, D.C.: EcoAgriculture Partners and IUCN, on behalf of the Landscapes for People, Food and Nature Initiative.Retrieved from http://peoplefoodandnature.org/wp-content/uploads/2017/05/Business-for-Sustainable-Landscapes-An-Action-Agenda-for-Sustainable-Development-May-2017.pdf

Scherr, S.J., Buck, L., & Willemen, L. (2014). Ecoagriculture: Integrated Landscape Management for People, Food, and Nature. In *Alfen NKV, editor. Encyclopedia of Agriculture and Food Systems. Oxford: Academic Press* (pp. 1–17).

Schultz, M., Hahn, T., Hällström, N., & Ituarte-Lima, C. (2016). *The biggest single opportunity we have is dialogue - Dialogue seminars as a methodology for transformative social learning and conflict resolution in international environment negotiations*. SwedBio at Stockholm Resilience Centre. Retrieved from http://swed.bio/wp-content/uploads/2017/03/SwedBio-Report-on-Dialogues-Seminars_2016_2.pdf

Sengalama, T., & Quillérou, E. (2016). Paying for Water in Uganda: Is Paying Upstream Land Users a Possible Solution? *Solutions*, *7*(5), 64–73.

Seppelt, R., Beckmann, M., Ceau, S., Cord, A. F., Gerstner, K., Gurevitch, J., Kambach, S., Klotz, S., Mendenhall, C., Phillips, H. R. P., Powell, K., Verburg, P. H., Verhagen, W., Winter, M., & Newbold, T. (2016). Harmonizing Biodiversity Conservation and Productivity in the Context of Increasing Demands on Landscapes. *BioScience*, *66*(10), 890-896. https://doi.org/10.1093/biosci/biw004

Siandei, M. (2016). *Ujamaa Community Resource Team Annual Report 2016*.

Sigma Global. (2015). *Preliminary Feasibility Report on Savanna Fire Management Projects for Native Title Groups in the North Kimberley 600-1,000mm low rainfall zone*.

Silverman, A. (2015). *Using International Law to Advance Women's Tenure Rights in REDD+*. Edited by N. Amerasinghe. Washington, DC: Rights and Resources Initiative and Center for International Environmental Law. Retrieved from http://www.ciel.org/wp-content/uploads/2015/06/WomensTenureRights_REDD_June2015.pdf

Similä, M., Aapala, K., & Penttinen, J. (2014). *Ecological restoration in drained peatlands - best practice from Finland*. Vantaa: Metsähallitus, Natural Heritage Services. Retrieved from https://julkaisut.metsa.fi/assets/pdf/lp/Muut/ecolres-peatlands-1.pdf

Sondergaard, M., Jeppesen, E., Lauridsen, T. L., Skov, C., Van Nes, E. H., Roijackers, R., Lammens, E., & Portielje, R. (2007). Lake restoration: Successes, failures and long-term effects. *Journal of Applied Ecology*, *44*(6), 1095–1105. https://doi.org/10.1111/j.1365-2664.2007.01363.x

Stanturf, J. A., Kant, P., Lillesø, J-P. B., Mansourian, S., Kleine, M., Graudal, L., & Madsen, P. (2015). *Forest Landscape Restoration as a Key Component of Climate Change Mitigation and Adaptation*. Vienna, Austria: International Union of Forest Research Organizations (IUFRO). IUFRO World Series, Vol. 34.

Statistics Canada. (2015). CANSIM - 004-0205 - Census of Agriculture, tillage practices used to prepare land for seeding. Retrieved April 12, 2017, from http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0040205&pattern=0040200..0040242&tabMode=dataTable&srchLan=-1&p1=1&p2=50

Su, H., Liu, W., Xu, H., Yang, J., Su, B., Zhang, X., Wang, R., & Li, Y. (2017). Introducing Chicken Farming into Traditional Ruminant-Grazing Dominated Production Systems for Promoting Ecological Restoration of Degraded Rangeland in Northern China. *Land Degradation and Development, 29*(2), 240-249. https://doi.org/10.1002/ldr.2719

Sutherland, W. J., Gardner, T., Haider, L., & Dicks, L. (2014). How can local and traditional knowledge be effectively incorporated into international assessments? *Oryx*, *48*(1), 1–2. https://doi.org/10.1017/S0030605313001543

Tappan, G., Cushing, M. (2004). *Use of SLC-Off Landsat image data for monitoring land use / land cover trends in West Africa.* Sioux Falls, South Dakota, USA.

Tappan, G., Cushing, M. (2008). Experiences of mapping land use and land cover and deriving trends over the vast West African region. Reston, USA: U.S. Geological Survey (USGS).

The Pew Charitable Trusts. (2014). *The Modern Outback*. Retrieved from http://www.pewtrusts.org/en/research-and-analysis/reports/2014/10/the-modern-outback

The Ramsar Convention on Wetlands. (1994). *Convention on Wetlands of International Importance especially as Waterfowl Habitat*. Retrieve from https://www.ramsar.org/about/history-of-the-ramsar-convention

Thomas, R., Stewart, N., & Schaaf, T. (2014). *Drylands: Sustaining Livelihoods and Conserving Ecosystem Services*. Canada: UNU-INWEH. Retrieved from https://collections.unu.edu/view/UNU:2664

Turner II, B., Esler, K. J., Bridgewater, P., Tewksbury, J., Sitas, J. N., Abrahams, B., Chapin, F. S., Chowdhury, R. R., Christie, P., Diaz, S., Firth, P., Knapp, C. N., Kramer, J., Leemans, R., Palmer, M., Pietri, D., Pittman, J., Sarukhán, J., Shackleton, R., Seidler, R., van Wilgen, B., & Mooney, H. (2016). Socio-Environmental Systems (SES) Research: what have we learned and how can we use this information in future research programs. *Current Opinion in Environmental Sustainability*, *19*, 160–168. https://doi.org/10.1016/j.cosust.2016.04.001

Ujamaa Community Resource Team. (2010). *Participatory Land Use Planning as a Tool for Community Empowerment in Northern Tanzania*. Retrieved from http://pubs.iied.org/pdfs/14608IIED.pdf

Ujamaa Community Resource Team. (2011). *Annual Narrative Report*.

Ujamaa Community Resource Team. (2015). *Annual Report*. Retrieved from http://cdn.static.bundesliga.de/media/native/autosync/gb_dfl_bl_report_2015_150dpi.pdf

UN. (2012). *Realizing the Future We Want for All - Report to the Secretary-General*. New York: UN System Task Team on the Post-2015 UN Development Agenda. Retrieved from http://www.un.org/millenniumgoals/pdf/Post_2015_UNTTreport.pdf

UN-FAO. (2010). *Land Degradation Assessment in Drylands (LADA). Assessing the status, causes and impacts of land degradation*.

UNCCD. (1994). *United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa – Final Text*.

UNEP-FI, GCP, & GVces. (2012). The Natural Capital Declaration, 3.

UNISDR. (2015). S*endai Framework for Disaster Risk Reduction 2015-2030*. New York: United Nations Office for Disaster Risk Reduction. Retrieved from https://www.unisdr.org/we/inform/publications/43291

UNCCD. (2015a). *Evaluation of the project " Towards achieving Land Degradation Neutrality : turning the concept into practice "* (Vol. 49).

UNCCD. (2015b). *Sustainable financing for forest and landscape restoration. Discussion paper. Rome*, Italy.

UNDP. (2012). *Ujamaa Community Resource Team, Tanzania. Equator Initiative Case Study Series*. New York. Retrieved from https://www.equatorinitiative.org/wp-content/uploads/2017/05/case_1348261312.pdf

United Nations Economic and Social Council. (2016). *Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators*.

van Aarde, R. J., Ferreira, S. M., & Kritzinger, J. J. (1996). Millipede communities in rehabilitating coastal dune forests in northern KwaZulu/Natal, South Africa. *Journal of Zoology*, *238*(4), 703–712. https://doi.org/10.1111/j.1469-7998.1996.tb05424.x

van Aarde, R. J., Wassenaar, T. D., & Guldemond, R. A. (2012). *Dune forest restoration*. Pretoria: Conservation Ecology Research Unit. Retrieved from http://www.ceru.up.ac.za/downloads/dune_forest_restoration_2009.pdf

van Aarde A-M. Smit A. S. Claassens, R. J. (1998). Soil Characteristics of Rehabilitating and Unmined Coastal Dunes at Richards Bay, KwaZulu-Natal, South Africa. *Restoration Ecology*, *6*(1), 102–110. https://doi.org/10.1046/j.1526-100x.1998.06113.x

van Leenders, C., & Bor, A. (2016). *Finance for One Planet* 2016 - CoP Financial Institutions and Natural Capital. Netherlands: Netherlands Enterprise Agency. Retrieved from www.rvo.nl/CoP_FINC

Vandenbygaart, A., Gregorich, E. G., & Angers, D. (2003). Influence of agricultural management on soil organic carbon: A compendium and assessment of Canadian studies. *Canadian Journal of Soil Science*, *83*(4), 363–380.

Vasseur, L., Horning, D., Thornbush, M., Cohen-Shacham, E., Andrade, A., Barrow, E., Edwards, S. R., Wit, P., & Jones, M. (2017). Complex problems and unchallenged solutions: Bringing ecosystem governance to the forefront of the UN sustainable development goals. *Ambio, 46*(7), 731-742. https://doi.org/10.1007/s13280-017-0918-6

Vellend, M., Baeten, L., Myers-Smith, I. H., Elmendorf, S. C., Beauséjour, R., Brown, C. D., De Frenne, P., Verheyen, K., & Wipf, S. (2013). Global meta-analysis reveals no net change in local-scale plant biodiversity over time. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(48), 19456–19459. https://doi.org/10.1073/pnas.1312779110

Vergara, W., Lomeli, L. G., Rios, A. R., Isbell, P., Prager, S., & De Camino, R. (2016). *The Economic Case for Landscape Restoration in Latin America*. World Resources Institute. Retrieved from http://www.wri.org/sites/default/files/The_Economic_Case_for_Landscape_Restoration_in_Latin_America.pdf

Vigilante, T. (2001). Analysis of Explorers' Records of Aboriginal Landscape Burning in the Kimberley Region of Western Australia. *Australian Geographical Studies*, *39*(July), 135–155. https://doi.org/10.1111/1467-8470.00136

Vigilante, T., Bowman, D. M. J. S., Fisher, R., Russell-Smith, J., & Yates, C. (2004). Contemporary landscape burning patterns in the far North Kimberley region of north-west Australia: Human influences and environmental determinants. *Journal of Biogeography*, *31*(8), 1317–1333. https://doi.org/10.1111/j.1365-2699.2004.01104.x

Walsh, D., Russell-Smith, J., & Cowley, R. (2014). Fire and carbon management in a diversified north Australian rangelands economy: research, policy and implementation challenges for northern

Australia. *Rangeland Journal*, *36*(4), 313–322.

Walsh, F., Christophersen, P., & Mcgregor, S. (2013). Indigenous perspectives on biodiversity (pp. 81–100).

Walton, N., Smith, H., Bowen, L., Mitchell, P., Pethybridge, E., Hayes, T., & O'ryan, M. (2014). Opportunities for fire and carbon on pastoral properties in the savanna rangelands: Perspectives from the Indigenous Land Corporation and the Northern Territory Cattlemen's Association. *Rangeland Journal*, *36*(4), 403–409. https://doi.org/10.1071/RJ14025

Wang, X., Wang, Y., & Wang, Y. (2013). Use of exotic species during ecological restoration can produce effects that resemble vegetation invasions and other unintended consequences. *Ecological Engineering*, *52*, 247–251. https://doi.org/10.1016/j.ecoleng.2012.11.007

Wassenaar, T. D., & Van Aarde, R. J. (2001). Short-term responses of rehabilitating coastal dune forest ground vegetation to livestock grazing. *African Journal of Ecology*, *39*(4), 329–339. https://doi.org/10.1046/J.1365-2028.2001.00318.X

Wassenaar, T., & Van Aarde, R. (2005). *The ecology of coastal dune forest restoration*. Pretoria: Conservation Ecology Research Unit. Retrieved from http://www.ceru.up.ac.za/downloads/coastal_dune_forest_restoration.pdf

Waters, C. N., Zalasiewicz, J., Summerhayes, C., Barnosky, A. D., Poirier, C., Ga, A., Cearreta, A., Edgeworth, M., Ellis, E. C., Ellis, M., Jeandel, C., Leinfelder, R., Mcneill, J. R., Richter, D., Steffen, W., Syvitski, J., Vidas, D., Wagreich, M., Williams, M., Zhisheng, A., Grinevald, J., Odada, E., Oreskes, N., & Wolfe, A. P. (2016). The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science*, *351*(6269), aad2622-1-aad2622-10. https://doi.org/10.1126/science.aad2622

Weinstein, M. P., Balleto, J. H., Teal, J. M. and Ludwig, D. F. (1996). Success criteria and adaptive management for a large-scale wetland restoration project. *Wetlands Ecology and Management, 4*(2), 111-127.

Western Australian Department of Mines Industry and Regulation. (1978). *Western Australian Mining Act*.

Westwood, A., Reuchlin-Hugenholtz, E., & Keith, D. M. (2014). Re-defining recovery: A generalized framework for assessing species recovery. *Biological Conservation*, *172*, 155–162. https://doi.org/10.1016/j.biocon.2014.02.031

Wood, A., Stedman-Edwards, P., & Mang, J. (2000). The root causes of biodiversity loss. In *Earthscan*.

Wortley, L., Hero, J. M., & Howes, M. (2013). Evaluating ecological restoration success: A review of the literature. *Restoration Ecology*, *21*(5), 537–543. https://doi.org/10.1111/rec.12028

Xue Y, & Shukla J. (1988). The influence of land surface properties on Sahel climate: Part I. Desertification. *Journal of Climate*, *6*, 2232–2345. Retrieved from http://escholarship.org/uc/item/1j78v965

Zaldivar-Jimenez, M. a., Herrera-Silveira, J. a., Teutli-Hernandez, C., Comin, F. a., Andrade, J. L., Molina, C. C., & Ceballos, R. P. (2010). Conceptual Framework for Mangrove Restoration in the Yucatan Peninsula. *Ecological Restoration*, *28*(3), 333–342. https://doi.org/10.3368/er.28.3.333

Zheng, H., Lu, C., Shang, D., & Cao, S. (2015). Cultural invasions and land degradation. *Regional Environmental Change*, *15*(5), 939–944. https://doi.org/10.1007/s10113-015-0785-2

UNITED NATIONS

Food and Agriculture Organization of the United Nations

BES

IPBES/6/INF/1/Rev.1

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Distr.: General
22 June 2018

English only

Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
Sixth session
Medellin, Colombia, 18–24 March 2018
Agenda item 7

Thematic assessment of land degradation and restoration

Chapters of the thematic assessment of land degradation and restoration

Note by the secretariat

1. In paragraph 2 of section IV of decision IPBES-3/1, the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services approved the undertaking of a thematic assessment of land degradation and restoration in accordance with the procedures for the preparation of the Platform's deliverables set out in annex I to decision IPBES-3/3, based on the scoping report for the assessment set out in annex VIII to decision IPBES-3/1.

2. In response to the decision, a set of eight chapters (IPBES/6/INF/1) and a summary for policymakers (IPBES/6/3) were produced by an expert group in accordance with the procedures for the preparation of the Platform's deliverables for consideration by the Plenary at its sixth session.

3. In paragraph 1 of section V of decision IPBES-6/1, the Plenary approved the summary for policymakers of the thematic assessment of land degradation and restoration (IPBES/6/15/Add.5) and accepted the individual chapters of the assessment, on the understanding that the chapters would be revised following the sixth session as document IPBES/6/INF/1/Rev.1 to correct factual errors and to ensure consistency with the summary for policymakers as approved. The annex to the present note, which is presented without formal editing, sets out the final set of chapters of the thematic assessment of land degradation and restoration including their executive summaries.

4. A laid-out version of the final thematic assessment report on land degradation and restoration (including a foreword, statements from key partners, acknowledgements, a preface, the summary for policymakers, the revised chapters and annexes setting out a glossary and lists of acronyms, authors, review editors and expert reviewers) will be made available on the website of the Platform prior to the seventh session of the Plenary.