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SCIENTIFIC CONCEPTUAL FRAMEWORK FOR LAND DEGRADATION NEUTRALITY

A Report of the Science-Policy Interface

United Nations
Convention to Combat
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SCIENTIFIC CONCEPTUAL FRAMEWORK FOR LAND DEGRADATION NEUTRALITY

A Report of the Science-Policy Interface

The scientific conceptual framework for Land Degradation Neutrality (LDN) explains the underlying scientific processes and principles that support achievement of LDN and its intended outcomes. The framework provides a scientifically-sound basis to understand LDN, to inform the development of practical guidance for pursuing LDN and to monitor progress towards the LDN target.

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The scientific conceptual framework for LDN was prepared in accordance with the rules and procedures established by the UNCCD Conference of the Parties (COP), by which any scientific output prepared under the supervision of the Science-Policy Interface (SPI) should undergo an international, independent review process (decision 19/COP.12).

The conceptual framework was prepared by an author team of 2 lead authors and 11 contributing authors. An author meeting was held on 22-23 February 2016 in Washington DC, USA; SPI members as well as external experts in neutrality applied to environmental challenges participated in the meeting.

The draft produced by the authors underwent a three-step review process, including an internal review (13 reviewers), an external scientific peer-review (8 reviewers) as well as a review by the Bureau of the COP. The lead authors have ensured that all government and expert review comments received appropriate consideration.

Foreword

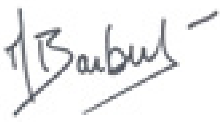
For a long time, global action to conserve productive land and recover degraded areas has not kept pace with the loss of productive land. Now, a team of highly dedicated experts from the biophysical sciences, the social sciences and environmental law has developed a scientific conceptual framework that can speed up the recovery of degraded land. Taken seriously, it will minimize the loss of productive land into the future.

The Scientific Conceptual Framework for Land Degradation Neutrality (LDN) laid out in this publication is a paradigm shift. This is an approach that counterbalances the expected loss of productive land with the recovery of degraded areas. It encourages the restoration of degraded land in the same physical location where new degradation is expected to occur. Stated differently, it places the measures to conserve, restore and rehabilitate land in the context of land use planning.

Crucially, the framework places the investment in the restoration of degraded land on par with the use of natural resources for development. It creates a pathway to seamlessly integrate in land-restoration, the actions to mitigate and adapt to climate change and to promote biodiversity. And it is highly pragmatic, in part because it was developed in conjunction with the national-level LDN target setting process.

Practical considerations from those working to implement LDN were incorporated in the design of the framework. Practitioners with experience on the ground, but also leadership in the agriculture, environment, planning and finance arms of government, are working with policy makers to ensure there is an enabling environment in their respective countries to assure its success. The achievement of land degradation neutrality by 2030 depends on this kind of collaboration at local, national and global scales. But it also depends on the participation of those with the highest stakes in its success or failure.

The SPI has laid out a structure and the principles necessary to create a robust scientific foundation for action. Together we can achieve the vision of Land Degradation Neutrality, a foundation for most countries to meet the Sustainable Development Goals.



Monique Barbut
Executive Secretary
United Nations Convention to Combat Desertification

Executive Summary

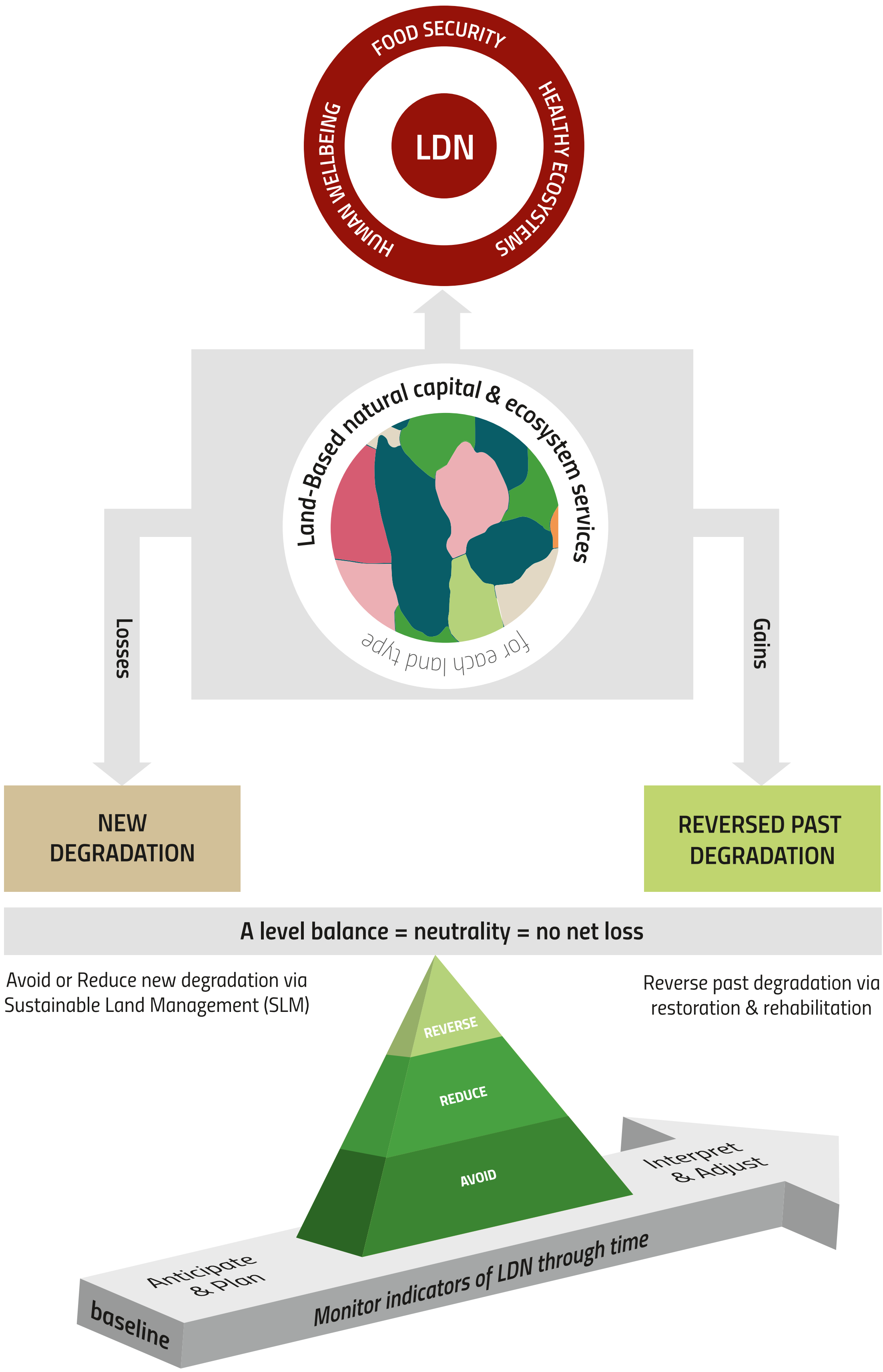
At the 12th Conference of the Parties to the UN Convention to Combat Desertification, Parties were invited to formulate voluntary targets to achieve land degradation neutrality (LDN). This "Conceptual Framework for Land Degradation Neutrality" is intended to provide a scientifically-sound basis for understanding and implementing LDN, and to inform the development of practical guidance for pursuing LDN and monitoring achievement of LDN for those UNCCD Parties that choose to pursue a LDN target. The LDN conceptual framework focuses on the goal of LDN and the supporting processes required to deliver this goal, including biophysical and socio-economic aspects, and their interactions.

The United Nations Convention to Combat Desertification (UNCCD) defines land degradation neutrality as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (decision 3/COP.12, UNCCD, 2015a).[1] The goal is maintaining or enhancing the land resource base – in other words, the stocks of natural capital associated with land resources and the ecosystem services that flow from them. The definition emphasises the importance of ecosystem services in achieving sustainability of food production. The objectives of LDN are:

- maintain or improve the sustainable delivery of ecosystem services;
- maintain or improve productivity, in order to enhance food security;
- increase resilience of the land and populations dependent on the land;
- seek synergies with other social, economic and environmental objectives; and
- reinforce responsible and inclusive governance of land.

Pursuit of LDN requires effort to avoid further net loss of the land-based natural capital relative to a reference state, or baseline. Planning for neutrality involves counterbalancing anticipated losses with measures to achieve equivalent gains, within individual land types, where land type is defined by land potential. Integration of planning for LDN interventions into existing land use planning is encouraged. Particular attention is paid to projecting and tracking the likely cumulative impacts of land use and land management decisions. Actions to achieve LDN include land management approaches that avoid or reduce degradation, coupled with efforts

1 Parties of the UNCCD recognize that for the purpose of this Convention, this definition is intended to apply to affected areas as defined in the text of the Convention.


FOOD SECURITY
HEALTHY ECOSYSTEMS
HUMAN WELLBEING
LDN
Land-Based natural capital & ecosystem services
for each land type
Losses
Gains
NEW DEGRADATION
REVERSED PAST DEGRADATION
A level balance = neutrality = no net loss
Avoid or Reduce new degradation via Sustainable Land Management (SLM)
Reverse past degradation via restoration & rehabilitation
REVERSE
REDUCE
AVOID
Anticipate & Plan
Interpret & Adjust
baseline
Monitor indicators of LDN through time

to reverse degradation through restoration or rehabilitation of land that has lost productivity. The response hierarchy of Avoid > Reduce > Reverse land degradation articulates the priorities in planning LDN interventions. The implementation of LDN is managed at the landscape scale, considering all land units of each land type and their interactions and ecological trajectories, so that LDN interventions can be optimized among those land units, in order to maintain or exceed no net loss, per land type. Monitoring achievement of neutrality will quantify the balance between the area of gains (significant positive changes in LDN indicators=improvements) and area of losses (significant negative changes in LDN indicators=degradation), within each land type across the landscape. The LDN indicators (and associated metrics) are land cover (land cover change), land productivity (net primary production) and carbon stocks (soil organic carbon).

The LDN conceptual framework is designed to be applicable to all land uses (i.e., land managed for production – e.g., agriculture, forestry; for conservation – e.g., protected areas; and also land occupied by human settlements and infrastructure); and all types of land degradation, across the wide variety of countries' circumstances, so that it can be implemented in a harmonized fashion by all countries that choose to pursue LDN. It helps build the bridge between the vision and the practical implementation of LDN through National Action Programmes, by defining LDN in operational terms. It is a process framework that captures the vision of what LDN is intended to achieve, and, based on this, provides guidance on how best to assess land degradation and identify appropriate management actions, and ultimately report on progress in achieving LDN.

Principles are provided to govern application of the framework and to help prevent unintended outcomes during implementation and monitoring of LDN. To achieve the broader development objectives of the UNCCD and the Sustainable Development Goals, LDN interventions should seek to deliver 'win-win' outcomes whereby gains in natural capital contribute to improved and more sustainable livelihoods. A key issue for governance is the need for safeguards to ensure that vulnerable communities are not displaced when lands are targeted for restoration. The implementation of LDN requires multi-stakeholder engagement and planning across scales and sectors, supported by national-scale coordination that should work with and incorporate existing local and regional governance structures. Learning is embedded throughout the framework, such that knowledge from monitoring is verified through stakeholder consultation, and applied to adapt LDN implementation and future management of land degradation.

This report is structured around five LDN conceptual framework 'modules': Vision of LDN, which captures the goal that LDN is intended to achieve; Frame of Reference, that explains the LDN baseline against which achievement is measured; Mechanism for Neutrality, that describes the counterbalancing mechanism; Achieving Neutrality, that presents the theory of change (logic model) articulating the pathway for implementing LDN, including preparatory analysis and enabling policies; and Monitoring Neutrality, which presents the LDN indicators. The report focuses on the neutrality aspect of LDN, highlighting the features of LDN that differ from historical approaches to land degradation assessment and management.

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LAND DEGRADATION NEUTRALITY: A STATE WHEREBY THE AMOUNT AND QUALITY OF LAND RESOURCES NECESSARY TO SUPPORT ECOSYSTEM FUNCTIONS AND SERVICES AND ENHANCE FOOD SECURITY REMAIN STABLE OR INCREASE.

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LIST OF ABBREVIATIONS

CBD	Convention on Biological Diversity
COP	Conference of the Parties
CSO	civil society organization
CST	Committee on Science and Technology
DLDD	desertification, land degradation and drought
DPSIheR	Driving force-Pressure-State- human/environment Impact-Response framework
DPSIR	Driving Force-Pressure-State-Impact-Response framework
ELD	Economics of Land Degradation
EVI	Enhanced Vegetation Index
FAO	Food and Agriculture Organization
GAEZ	Global Agro-ecological Zoning Tool (FAO)
GEF	Global Environment Facility
GEO	Group on Earth Observations
GEO BON	GEO Biodiversity Observation Network
GEOGLAM	GEO Global Agricultural Monitoring Initiative
GEOSS	Global Earth Observation System of Systems
GLRD	Gender and Land Rights Database (FAO)
GM	The Global Mechanism
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
LandPKS	Land-Potential Knowledge System
LCCS	Land Cover Classification System (FAO)
LDN	Land Degradation Neutrality
LDN Fund	Impact Investment Fund for Land Degradation Neutrality
LDRA	Land Degradation and Restoration Assessment (IPBES)
LULUCF	land-use, land-use change and forestry
LUTO	Land Use Trade-Offs model
MA	Millennium Ecosystem Assessment
NAP	National Action Programme (UNCCD)
NAP	National Adaptation Plan (UNFCCC)
NBSAP	National Biodiversity Strategies and Action Plan
NDC	Nationally Determined Contributions (UNFCCC)
NDVI	Normalized Difference Vegetation Index
NPP	net primary productivity
RAPTA	Resilience, Adaptation Pathways and Transformation Assessment framework
RIO+20	2012 UN Conference on Sustainable Development
SDGs	Sustainable Development Goals
SFM	sustainable forest management
SHARP	Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists

SLA	sustainable livelihood analysis
SLM	sustainable land management
SME	small and medium-sized enterprises
SOC	soil organic carbon
SPI	Science-Policy Interface of the UNCCD
TEEB	The Economics of Ecosystems and Biodiversity
UNCCD	United Nations Convention to Combat Desertification
UNDAF	United Nations Development Assistance Frameworks
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VGGT	Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries, Forests

GLOSSARY OF KEY TERMS

associative governance	A networked approach to governance that is based on mutual trust, collaboration, devolution of power and decentralization of decision-making to the lowest level practicable (Gunasekara, 2006).
baseline	The initial (t0) estimated value of each of the indicators used to monitor progress in the achievement of LDN for each land type. The baseline values of these indicators are measured at the time of implementation of the LDN conceptual framework.
biophysical or administrative domain	The spatial domain within which integrated land use planning and counterbalancing decisions for LDN are made. Can be biophysical (e.g., catchment) or administrative (e.g., province).
counterbalancing	The provision of an equal and opposite effect, over a specified timeframe. In the context of LDN, the neutrality mechanism at the integrated land use planning stage, anticipated losses with measures designed to deliver gains, in order to achieve the LDN target (country level). Counterbalancing is generally managed within the same land type, and within a biophysical (e.g., catchment) or administrative (e.g., province) spatial domain.
decision maker	A person who makes decisions (Collins, n.d). In the context of LDN, decision makers include anyone making decisions related to land use and management (e.g., policy makers, planners, managers, practitioners, land users).
ecological functions	Interacting biological, chemical and physical processes that underpin the provision of ecosystem services.
ecosystem services	The benefits that people obtain from ecosystems. These include: a) provisioning services such as supply of nutritious food and water; b) regulating services such as climate change mitigation, flood management and disease control; c) cultural services such as spiritual, recreational, and cultural benefits; and d) supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (adapted from Millennium Ecosystem Assessment, 2005).
gain (anticipated)	An increase in land-based natural capital, expected to increase the value of one or more of the indicators of LDN, projected during land use planning for a specific area of land (e.g., land unit) and a specified timeframe, where improvement is anticipated due to LDN interventions. See also loss (anticipated).

gain (monitored)

An increase in land-based natural capital for a specific area of land (e.g., land unit), over a specified timeframe, measured as significant increase in SOC or NPP, or a positive land cover change (as defined by a country, within agreed guidelines),[2] where there is no significant negative change in any of these three indicators/metrics.[3] See also loss (monitored).

harmonization

The process of making comparable or bringing into agreement different methods, procedures or systems used for the same purpose (adapted from UNCCD, 2011a). In the context of LDN, this refers to making comparable the different methods used to quantify the same indicator or metric. See also standardization.

indicators/metrics for monitoring LDN

Indicators are variables that reflect a process of interest. Metrics are measures that are used to quantify or assess the state or level of the indicators. The monitoring of LDN is based on evaluating the significant changes (positive and negative) in three global indicators (via associated metrics) which serve as proxies of most ecosystem services flowing from land-based natural capital: land cover/land cover change, land productivity/NPP, carbon stocks/SOC, and, for a few ecosystem services not covered by these, other SDG indicators, and/or national indicators (see Figure 3 and Figure 12).

integrated land use planning

Land use planning that seeks to balance the economic, social and cultural opportunities provided by land with the need to maintain and enhance ecosystem services provided by the land-based natural capital. It also aims to blend or coordinate management strategies and implementation requirements across multiple sectors and jurisdictions (adapted from United Nations General Assembly, 1992a).

land-based natural capital

The natural capital of land resources. This includes the properties of the soil (chemical, physical and biological factors), geomorphological, biotic and hydrological features, that interact with each other and with climate to determine the quantity and nature of ecosystem services provided by the land.

2 Guidelines on what constitutes a positive and negative change in land cover should be developed through a participatory process. See also chapters 7.2 and 7.4.

3 Or decline in any supplementary metric chosen by the country to be applied in the "one out-all out" approach for combining the indicators to evaluate LDN (chapter 7.3).

land cover	The physical material at the surface of the Earth, which may be vegetated or non-vegetated, natural or managed (adapted from Di Gregorio *et al.*, 2011). A specific land cover change, from one land cover class to another, may be designated by a country as land degradation (a negative land cover change; e.g., bush encroachment).
land cover class	A category of land cover differentiated by a combination of diagnostic attributes based on a nationally-refined application of an international standard such as the FAO Land Cover Classification System (LCCS; Di Gregorio *et al.*, 2011). The FAO system is a common reference structure for the comparison and integration of data for any generic land cover legend or nomenclature that allows correlation of land cover with a set of independent diagnostic criteria. Used to detect a significant change in land cover (one of the LDN indicators), and to identify land use.
land degradation neutrality (LDN)	A state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems (decision 3/COP.12, UNCCD, 2015a).
land management	The practices applied in managing land resources.
land potential	The inherent, long-term potential of the land to sustainably generate ecosystem services (UNEP, 2016), which reflects the capacity and resilience of the land-based natural capital, in the face of ongoing environmental change.
land type	Class of land with respect to land potential, which is distinguished by the combination of edaphic, geomorphological, topographic, hydrological, biological and climatic features that support the actual or historic vegetation structure and species composition on that land. Used in counterbalancing "like for like".
land use	Type of activity being carried out on a unit of land, in urban, rural and conservation settings (IPCC, 2006).
land unit	Finest resolution spatial unit used in LDN planning and monitoring.

LDN target (country level)	The objective to achieve LDN at national level, adopted voluntarily by a country.[4] The ambition of a country with respect to achieving LDN is no net loss of healthy and productive land for each land type, compared with the baseline, and thus the LDN target equals the baseline (see Figure 4). Countries may elect to set a more ambitious LDN target if they envision the possibility that gains will exceed losses. In rare circumstances a country may set its LDN target acknowledging and justifying that losses may exceed gains if they forecast that some portion of future land degradation associated with past decisions/realities is not currently possible to counterbalance.
LDN target (global)	The objective to achieve a land degradation-neutral world (United Nations General Assembly, 2015).
LDN vision	The aspirational goal of LDN, which is to maintain land-based natural capital, globally, and for countries adopting LDN, to achieve it at national level.
like for like	Refers to the principle of counterbalancing losses in one land type with equivalent (or greater) gains in the same land type elsewhere in order to maintain (or exceed) LDN.
loss (anticipated)	A decline in land-based natural capital expected to decrease the value of one or more of the indicators of LDN projected during land use planning for a specific area of land (e.g., land unit) and a specified timeframe, where new land degradation is deemed likely. See also gain.
loss (monitored)	A decline in land-based natural capital for a specific area of land (e.g., land unit) over a specified timeframe, measured as significant decline in SOC or NPP, or a negative land cover change (as defined by country, within agreed guidelines.[5] See also gain.
natural capital	The stock of natural resources that provides flows of valuable goods and services (World Bank, 2012).

4 The LDN conceptual framework will be used to inform countries in their pursuit of LDN. Countries formulate voluntary targets to achieve LDN, at national level. They may also adopt subnational targets. Throughout the report "the LDN target" refers to national or subnational LDN targets, as relevant to the context of the user.

5 See footnote 3.

no net loss The condition wherein losses are no greater than gains. In the context of LDN, this refers to the condition where land-based natural capital is maintained or enhanced between the time the LDN framework is put in place (t0) and a future date when progress is monitored (t1).

one-out, all-out A conservative approach to combining different indicators/metrics to assess status, which follows the precautionary principle (adapted from European Communities, 2013). The one-out, all-out approach is applied to LDN such that where any of the indicators shows significant negative change, it is considered a loss (and conversely, if at least one indicator shows a positive trend and none shows a negative trend it is considered a gain).

productivity Productivity in this document is used in biological terms. It refers to the rate of production of new biomass by an individual, population, or community (Oxford Dictionaries, n.d.).

reclamation Actions undertaken with the aim of returning degraded land to a useful state. While not all reclamation projects enhance natural capital, those that are more ecologically-based can qualify as rehabilitation or even restoration (adapted from Society for Ecological Restoration International Science and Policy Working Group, 2004).

rehabilitation Actions undertaken with the aim of reinstating ecosystem functionality, where the focus is on provision of goods and services rather than restoration see Figure 8 (adapted from McDonald *et al.*, 2016).

resilience The ability of a system to absorb disturbance and reorganise itself so as to retain essentially the same function, structure, and feedbacks. Resilience is a neutral property, neither good nor bad (adapted from Walker *et al.*, 2004).[6]

response hierarchy The set of prioritized actions/interventions that may be planned and then implemented in response to past or anticipated future land degradation.

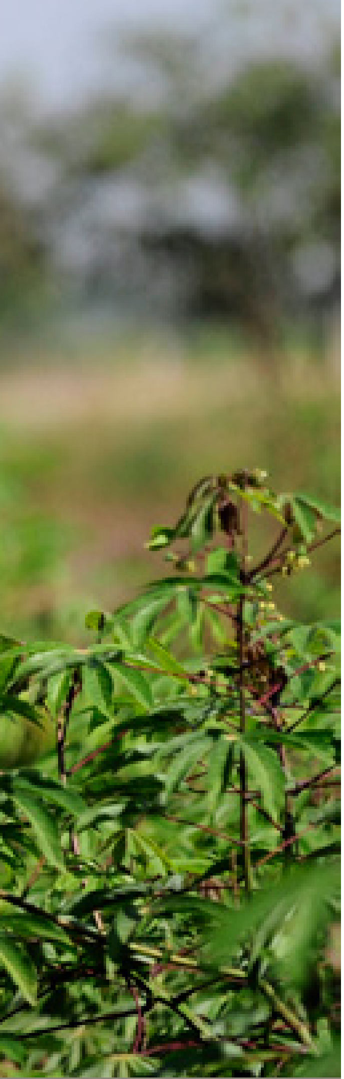
6 Whether or not resilience is beneficial in any situation depends on the specific circumstances – whether the system is in a desirable or undesirable state.

restoration	The process of assisting the recovery of an ecosystem that has been degraded (Society for Ecological Restoration International Science and Policy Working Group, 2004 & McDonald *et al.*, 2016). Restoration seeks to re-establish the pre-existing ecological structure and function, including biotic integrity (see Figure 8).
significant (with respect to indicators/metrics of LDN)	A change in an LDN metric that is (i) considered to be significant by experts, taking into consideration the precision of the method; or (ii) unlikely to have arisen by chance, according to statistical analysis.
stakeholder	An individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome (adapted from PMI, 2013).
standardization	The process of developing an agreed common method, procedure or system for a specific purpose.[7] In the context of LDN, this refers to developing a single agreed methodology for an indicator or metric. See also harmonization.
sustainable land management (SLM)	The use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions (WOCAT, n.d).
system model	A verbal, visual and/or mathematical representation of a system that describes the key elements and the linkages between them. A system model provides a basis for devising management strategies, planning monitoring, and interpreting the results of monitoring.

7 See footnote 3.

Background

HAVING AN AGREED SCIENTIFIC CONCEPTUAL FRAMEWORK FOR LDN WILL ASSIST IN DEVELOPING A DEEPER UNDERSTANDING OF THE LDN CONCEPT AND WILL CREATE A SCIENTIFIC FOUNDATION TO GUIDE LDN IMPLEMENTATION AND MONITORING.



Why a conceptual framework for LDN is needed

1.1 Why LDN?

The productive potential of land must be increased in order to deliver the goods and services required by a growing and increasingly affluent population, including increased per capita demand for high-quality nutritious food. In addition to food, feed and fibre, land resources also contribute to the often-overlooked regulating and supporting services, on which the provision of food, feed and fibre depend, as well as to cultural services delivered by healthy ecosystems. Maintenance of capacity to deliver these ecosystem services will depend on resilience in the face of global environmental change.

Because land is fixed in quantity, there is ever-increased competition to control land resources and harness the flows of goods and services from the land, which has the potential to cause social and political instability, exacerbating poverty, conflict and migration. Land is coming under growing pressure from competing uses. For example, urban expansion competes with production of food, animal feed and wood products. Climate change magnifies these tensions, as it increases the frequency of extreme weather events that stress land's capacity to supply vital services, particularly when water availability is reduced. Poor governance of land tenure, civil unrest and war contribute to environmental degradation as competing users fight for control of limited resources.

Estimates indicate that up to 25% of all land worldwide is currently highly degraded, 36% is slightly or moderately degraded but in stable condition, while only 10% is improving (FAO, 2011). Global vegetation productivity (an indicator of land degradation) is reported to have declined persistently during the 23 years between 1981 and 2003 (Bai *et al.*, 2008). Thus, the overall health and productivity of land is declining while at the same time the demand for land resources is increasing (Montanarella *et al.*, 2016).

Recognizing the multiple benefits of halting and reversing land degradation, the concept of "zero net land degradation" was proposed at the 2012 UN Conference on Sustainable Development (Rio+20). This was reformulated as "strive to achieve a land degradation neutral world" in the final outcome document, The Future We Want, and subsequently adopted by the United Nations General Assembly as part of the Sustainable Development Goals (SDGs), specifically SDG target 15.3. Acknowledging that the SDG targets are global and aspirational in nature, and subject to translation into national targets, this concept can be expressed as "a world where nations individually strive to achieve land degradation neutrality". The UNCCD defines LDN as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (decision 3/COP.12, UNCCD, 2015a), recognizing that within the scope of the Convention, this definition is intended to apply to affected areas as defined in the text of the Convention.

LDN was conceived to encourage a dual-pronged approach of measures to avoid or reduce degradation of land, combined with measures to reverse degradation of already degraded land, such that losses are balanced by gains, in order to achieve a position of no net loss of healthy and productive land.

1.2 Major political decisions encouraging LDN

During 2015, the global commitment to achieve LDN was expressed in various international resolutions and decisions. In September 2015, the SDGs were formally adopted by the United Nations General Assembly. SDG 15 aims at sustaining life on land and includes a target (15.3) that makes explicit reference to LDN: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation neutral world" (United Nations General Assembly, 2015).

In October 2015, LDN was officially recognised by the UNCCD by a decision of the twelfth session of the Conference of the Parties (COP 12), which stated that "striving to achieve SDG target 15.3 is a strong vehicle for driving implementation of the UNCCD, within the scope of the convention" and endorsed the definition of LDN (decision 3/COP.12, UNCCD, 2015a). In the same decision, the COP invited country Parties to "formulate voluntary targets to achieve LDN in accordance with their specific national circumstances and development priorities" and to integrate such targets in their National Action Programme (NAP), which is a key instrument for implementing the Convention within "affected" member countries. COP 12 also requested the Secretariat and Convention's bodies to "develop guidance for formulating national LDN targets and initiatives"; particularly, Parties directed the UNCCD Science-Policy Interface (SPI) to "Provide scientific guidance to the operationalization of the voluntary land degradation neutrality (LDN) target".[8] This report responds to this request by providing a scientific conceptual framework to support the operationalization of LDN.

In response to these decisions, a number of LDN initiatives and projects are underway or are expected to emerge. Most prominently, the Global Mechanism (GM) of the UNCCD, in close collaboration with the UNCCD Secretariat and through a global programme, is supporting interested countries in the national LDN target setting process, including the definition of national baselines, measures and targets to achieve LDN. As of December 2016, 103 countries have engaged in the LDN target setting programme (UNCCD-GM, 2016). Furthermore, the GM is in the process of spearheading the establishment of the Impact Investment Fund for Land Degradation Neutrality (LDN Fund) (UNCCD-GM, n.d) which aims to attract blended financial assistance to support large-scale efforts to restore or rehabilitate degraded land for sustainable and productive use with long-term private sector financing (UNCCD-GM & Mirova, 2015).

LDN ENCOURAGES A DUAL-PRONGED APPROACH OF MEASURES TO AVOID OR REDUCE DEGRADATION OF LAND, COMBINED WITH MEASURES TO REVERSE DEGRADATION OF ALREADY DEGRADED LAND ... IN ORDER TO ACHIEVE A POSITION OF NO NET LOSS ...

8 See footnote 4.

1.3 Need for a conceptual framework on LDN

A conceptual framework is a structured presentation (in graphical and/or narrative form) of a task or problem that can form the basis for a logical approach to addressing the problem/task. A conceptual framework demonstrates the logical connections between theory and actions; it provides the theoretical underpinning to help understand the links between key factors and variables. It presents principles, assumptions and rules in a structured format.

THE SPI HAS COORDINATED THE PREPARATION OF THIS REPORT TO ASSIST THOSE PARTIES THAT CHOOSE TO VOLUNTARILY PURSUE LDN TO DO SO IN A WELL-INFORMED MANNER.

A scientific conceptual framework explains the underlying scientific processes and principles surrounding the problem/task. Having an agreed scientific conceptual framework for LDN will assist in developing a common and deeper understanding of the LDN concept; it will create a scientific foundation to guide LDN implementation and monitoring.

A conceptual framework for LDN will also serve as a common point of reference for the emerging LDN discourse and various LDN initiatives. The LDN conceptual framework is intended to assist countries in implementing strategies to address land degradation and achieve LDN.

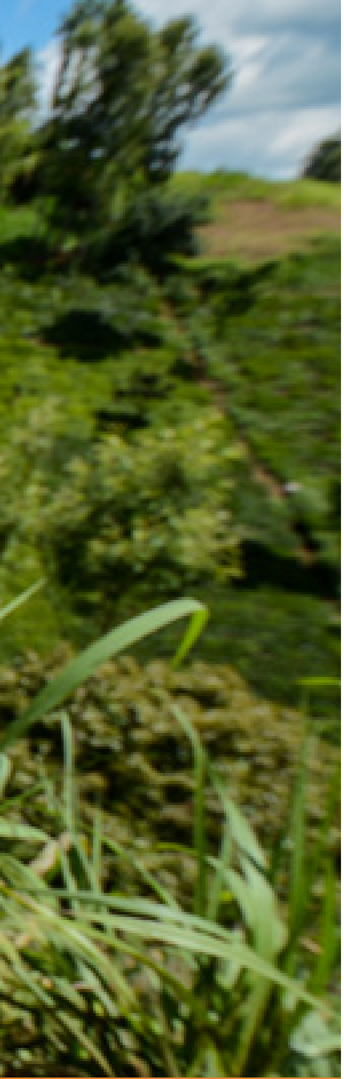
1.4 A note about the voluntary nature of LDN

In the Annex to UNCCD decision 21/COP.12 the Parties included in the SPI biennial work programme an objective to "Provide scientific guidance to the operationalization of the voluntary land degradation neutrality (LDN) target" (UNCCD, 2015a). The LDN target is a global goal and countries have been invited to voluntarily commit to LDN at the national level. The SPI has coordinated the preparation of this report to assist those Parties that choose to voluntarily pursue LDN to do so in a well-informed manner. This conceptual framework provides scientific guidance, informing the planning and implementation of measures, enhancing the capacity of those Parties to meet their LDN target.

While participation in LDN is voluntary, it is necessary that those countries that choose to pursue LDN apply consistent approaches. The framework therefore presents requirements to be followed by all countries that choose to pursue LDN. The requirements are presented as a set of principles within each module of the framework. Informative text is provided in each module to explain the principles and provide guidance in their application. There is flexibility in the application of many principles but the fundamental structure and approach of the framework are fixed. The objective of neutrality creates a particular challenge: due to inter-dependence between the elements, a change in one element can frequently mean one or more of the other elements must also change. For that reason, the language used in this report is rigorous in substance and exacting in detail where necessary to ensure the functional integrity of the overall framework.

Key Elements

FRAMING AND ADDRESSING THE ENVIRONMENTAL CHALLENGE OF LAND DEGRADATION IN TERMS OF 'NEUTRALITY' ADDS A DIMENSION NOT PREVIOUSLY TACKLED IN LAND DEGRADATION MANAGEMENT POLICY.



The key elements of a conceptual framework for LDN

2.1 Structure of the framework

Framing and addressing the environmental challenge of land degradation in terms of 'neutrality' adds a dimension not previously tackled in land degradation management policy. Achieving neutrality requires an approach that provides decision-makers with the means to *balance* potential gains and losses in terms of *intent* (capturing the expected outcomes of land use and management decisions in such a way that favours neutrality) and *results* (evaluating the impact of those decisions). The LDN framework therefore includes the *vision* (intended outcomes of LDN), the *frame of reference* (baseline) against which achievement is measured, the *mechanism for neutrality* (counterbalancing anticipated negative changes with actions planned to deliver gains, and tracking the cumulative effect of land use decisions), *achieving neutrality* (preparing for and pursuing LDN), and monitoring neutrality (evaluating progress and achievement of LDN). An adaptive approach, that elicits and responds to learning at each stage, is encouraged. Particularly because LDN is a novel approach to management of land degradation, and because the land-based social-ecological system will be affected by global environmental change, it is critical to embed adaptive management, based on learning, during planning, implementation, monitoring and interpretation of LDN. Figure 1 illustrates the key elements of the scientific conceptual framework for LDN and their interrelationships, detailed in this report.

The target at the top of Figure 1 expresses the vision of LDN, emphasizing the link between human prosperity and the natural capital of land – the stock of natural resources that provides flows of valuable goods and services. The balance scale in the centre illustrates the mechanism for achieving neutrality: ensuring that future land degradation (losses) is counterbalanced through planned positive actions elsewhere (gains) within the same land type (same ecosystem and land potential). The fulcrum of the scale depicts the hierarchy of responses: avoiding degradation is the highest priority, followed by reducing degradation and finally reversing past degradation. The arrow at the bottom of the diagram illustrates that neutrality is assessed by monitoring the LDN indicators relative to a fixed baseline. The arrow also shows that neutrality needs to be maintained over time, through land use planning that anticipates losses and plans gains. Adaptive management applies learning from interim monitoring to inform mid-course adjustments to help ensure neutrality is achieved, and maintained in the future.

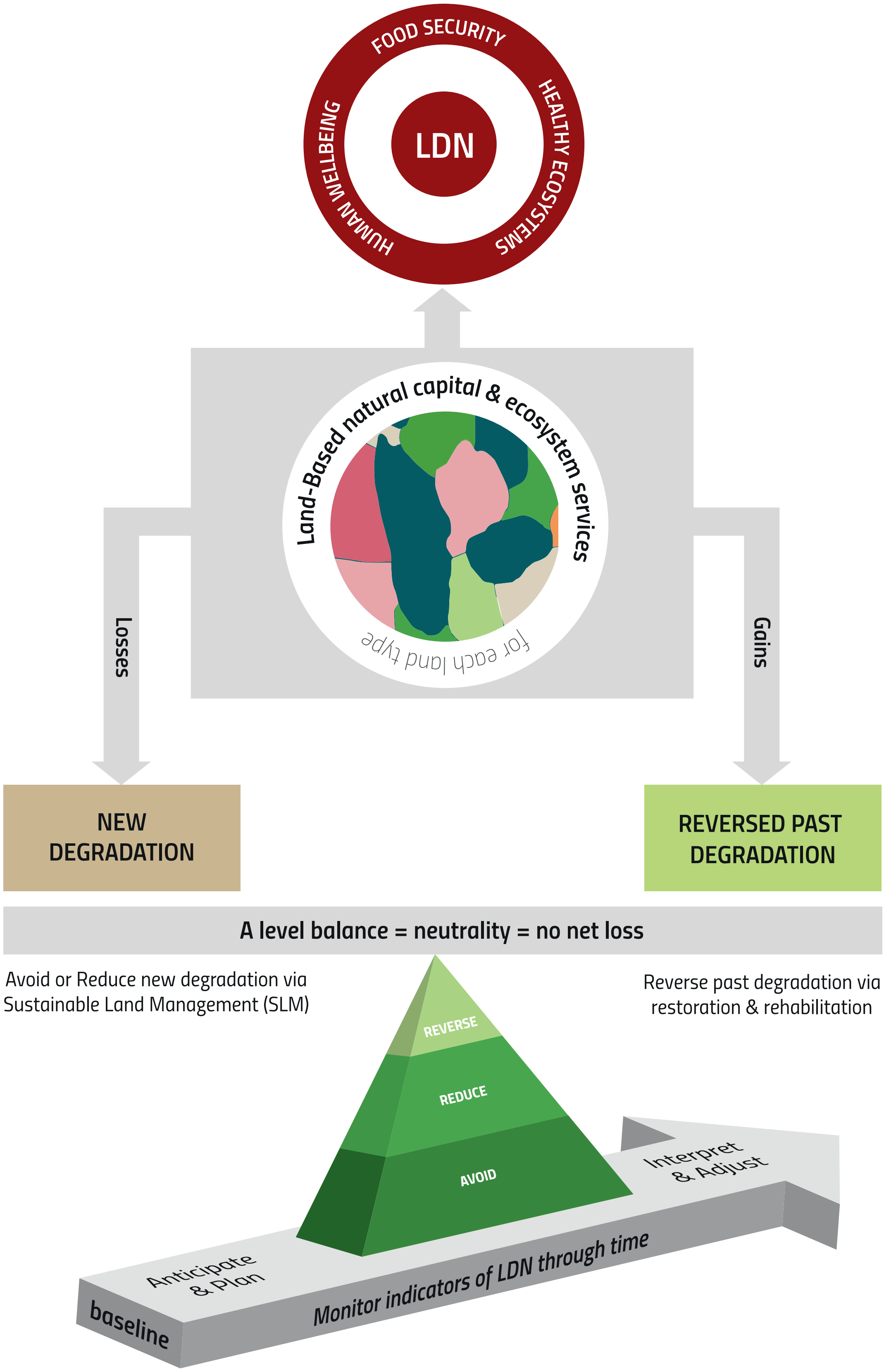


FIGURE 1

The key elements of the scientific conceptual framework for LDN and their interrelationships

2.2 The structure of this report

The LDN conceptual framework is presented as a series of five interconnected modules (A-E), which are detailed in chapters 3 through 7 of this report.

Chapters 3-5 (Modules A-C) establish the overall approach to LDN and address key concepts that underpin the LDN conceptual framework.

Within each module, the topic is introduced and principles pertinent to that chapter are presented, followed by discussion of critical issues that will influence how LDN is implemented. These modules are summarized in Table 1.

Chapter 3 **(Module A)** documents the vision and objectives of LDN

Chapter 4 **(Module B)** provides the LDN frame of reference (the baseline and why the baseline values represent the target when pursuing no net loss)

Chapter 5 **(Module C)** establishes the mechanism for neutrality (the counterbalancing of anticipated losses with planned gains elsewhere)

Chapter 6 **(Module D)** presents the elements necessary to **achieve LDN**, including

- Preparatory activities (enabling environment and preliminary assessments)
- Integrated land use planning for tracking LDN
- Interventions to achieve LDN
- Learning and adaptive management
- Governance

Chapter 7 **(Module E)** details methods for **monitoring LDN**, and covers

- Indicators, metrics and data integration to evaluate LDN status
- National and local inputs to support verification and interpretation of monitoring data
- Collaborative establishment of methodological standards
- Reporting for the UNCCD and SDG 15.3
- Synergies with other sustainable development initiatives

TABLE 1

The key modules of the scientific conceptual framework for LDN

	Vision	Frame of Reference	Mechanism for Neutrality	Achieving Neutrality	Monitoring Neutrality
Guiding Question	What is the goal of LDN?	Neutrality compared with what state?	How does counterbalancing work?	How can the goal of neutrality be achieved?	How is success at maintaining or exceeding neutrality determined?
Purpose	Determine what it is that must be maintained or improved.	Determine the state to which every future state will be compared.	Ensure that anticipated degradation is counterbalanced through planned positive actions elsewhere.	Provide guidance on a. Establishing an enabling environment b. Assessment in support of planning c. Pathways to avoid, reduce or reverse land degradation.	Provide guidance on assessing progress towards neutrality.
LDN Approach	Ecosystem services and ecological functions provided by land-based natural capital	Baseline state is the (minimum) target state.	Integrated land use planning approach to tracking and balancing anticipated new losses with gains, based on principles designed to limit unintended outcomes.	• Enabling environment • Land potential, degradation status, resilience, socio-economic assess-ments in support of integrated land-use planning • Interventions based on the LDN response hierarchy	Monitor relative to a fixed baseline value for each metric of the ecosystem services • Land cover • NPP • SOC • Others as needed (Integration of metrics based on a principle of "one-out, all-out")

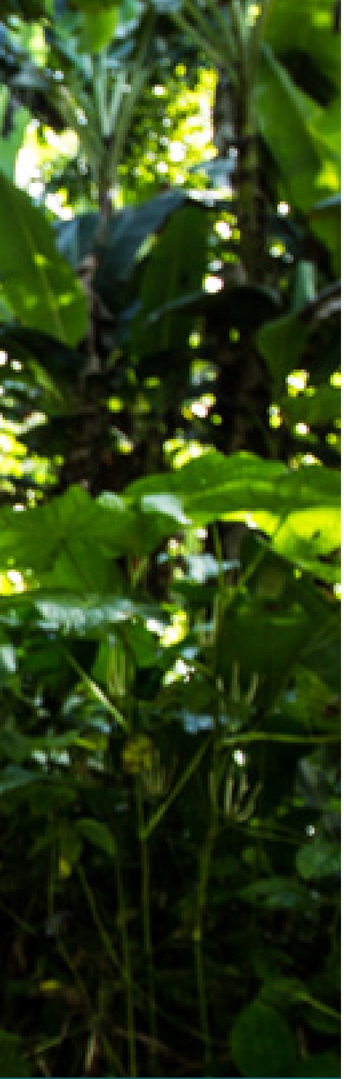
LD = land degradation | NPP = net primary productivity | SOC = soil organic carbon
NB = Learning is a cross-cutting theme relevant to all modules (chapter 6.3.8)

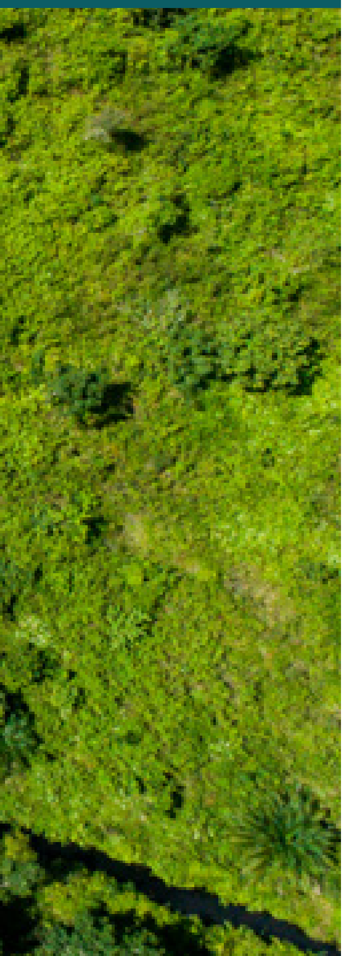
2.3 A note about terminology

Key terms and concepts that are fundamental to the LDN conceptual framework are defined in the Glossary of Key Terms at the beginning of this report and, where appropriate, within the text the first time they are used. These terms are sometimes used in other ways in other contexts, so it is important to take note of how they are used in this report. It will be helpful to revisit the glossary while reading the modules.

Module A

LDN IS ACHIEVED WHEN THE QUANTITY AND QUALITY OF LAND-BASED NATURAL CAPITAL IS STABLE OR INCREASING, DESPITE THE IMPACTS OF GLOBAL ENVIRONMENTAL CHANGE.





The Vision and Objectives of LDN

3.1 The goal and objectives of Land Degradation Neutrality (LDN)

LDN is defined as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (decision 3/COP.12, UNCCD, 2015a).[9] Achieving this state fundamentally requires that land-based natural capital[10] is maintained or enhanced. Thus, the aspirational goal of LDN could be stated as: to sustain and improve the stocks of land-based natural capital and the associated flows of ecosystem services, in order to support "the future prosperity and security of humankind".[11] Where the land-based natural capital has been enhanced by human intervention, to expand the ecosystem services provided,[12] sustaining this higher level becomes the goal of LDN. LDN will underpin the achievement of multiple SDGs related to food security, environmental protection and the sustainable use of natural resources, and enhance resilience to global environmental change.

The following objectives of LDN support this vision:

1. **Maintain or improve the sustainable delivery of ecosystem services**: Recognise ecological functions of different ecosystems; protect or restore vulnerable natural and managed[13] ecosystems and safeguard the services these provide for the long term, in the face of global environmental change. Land degradation and desertification cause a decline in the many essential services provided by ecosystems including provision of food and fibre, carbon sequestration, regulation of water supply, conservation of (agro) biodiversity and cultural heritage.

   i) **Maintain or improve productivity, in order to enhance food security**: Prevent further loss of productivity and improve the productive potential of land that is already degraded. Rural livelihoods and future food and water security are threatened by decline in soil quality, the loss of prime agricultural land to urbanization and other aspects of land degradation.

   ii) **Increase resilience of the land and populations dependent on the land:**

9 Parties of the UNCCD recognize that within the scope of the Convention, this definition is intended to apply to affected areas as defined in the text of the Convention.

10 Natural capital refers to the stock of natural resources that provides flows of valuable goods and services (See World Bank, 2012 – natural capital in the glossary). Land-based natural capital refers to the edaphic, geomorphological, hydrological and biotic features of a site.

11 Statement by the Executive Secretary of the United Nations Convention to Combat Desertification (UNCCD) Monique Barbut. Available online: http://sd.iisd.org/guest-articles/17-sdgs-but-is-there-a-priority-sdg-target/

12 Human intervention, such as through increasing availability of water, nutrients, organic matter, can enhance the resource base and increase ecosystem services (see Kust *et al.*, 2016 for conceptual discussion). However, there may be trade-offs, especially for biodiversity.

13 This framework covers all land degradation in all systems whether managed for production or conservation. However, it does not attempt to quantify ecosystem services associated with biodiversity in systems managed for conservation, as these are addressed elsewhere (e.g., CBD, IPBES, other SDGs).

In designing and implementing measures to achieve LDN, consider ways to increase resilience to climate variability and the impacts of climate change and other shocks and stressors. Build natural and social capital to increase the capacity of ecosystems and communities to cope with drought and other extreme weather events that are recognized as major factors contributing to land degradation, and adapt to the anticipated impacts of climate change.

2. **Seek synergies with other social, economic and environmental objectives:** Actions undertaken to address land degradation can simultaneously contribute to climate change, biodiversity and sustainable development objectives: sustainable land management (SLM) practices and land restoration can reduce land degradation, build soil carbon, improve soil fertility, water use efficiency, above and below ground biodiversity, and land productivity, thus provide a wide range of benefits to society, reduce pressure on natural systems and contribute to climate change mitigation and adaptation. There is thus potential for synergies by ensuring coherence between policies and measures that address these separate environmental and development objectives.

3. **Reinforce responsible and inclusive governance of land:** Govern land for the benefit of all, with emphasis on protection of land tenure rights of vulnerable and marginalized people.

Recognizing that the scope of the UNCCD is limited to affected areas as defined in the text of the Convention, the LDN conceptual framework is nonetheless intended to be applicable across all land types, land uses, and ecosystem services, so it can be used by countries according to their individual circumstances. It emphasises the multi-functional nature of land resources.

THE LDN CONCEPTUAL FRAMEWORK IS INTENDED TO BE APPLICABLE ACROSS ALL LAND TYPES, LAND USES, AND ECOSYSTEM SERVICES, SO IT CAN BE USED BY COUNTRIES ACCORDING TO THEIR INDIVIDUAL CIRCUMSTANCES.

It is designed to support pursuit of LDN in a manner that benefits all current land users in an equitable and responsible way, and provides for future generations. The framework recognises the interactions and interdependencies between natural and managed environments. Actions undertaken in pursuit of LDN should be planned and implemented with consideration of effects on current livelihood systems and measures applied to protect livelihoods of vulnerable communities now and in the future. The framework includes safeguards to limit negative impacts where there are trade-offs among other social, economic and environmental objectives while protecting land tenure rights, particularly among vulnerable and marginalized people. This framework is designed to work in concert with other agreements and measures

BOX 1
Principles underpinning the vision of LDN

The principles presented below, and in each of the other modules, are essential elements that must be adhered to in order to achieve LDN. These principles guide the implementation of LDN towards positive outcomes and avoid perverse outcomes. Governments may also establish nationally-specific principles to complement these generic principles.

1. Maintain or enhance land-based natural capital: LDN is achieved when the quantity and quality of land-based natural capital (World Bank, 2012) is stable or increasing, despite the impacts of global environmental change.
2. Protect human rights and enhance human well-being: Actions taken in pursuit of the LDN target should not compromise the rights of land users (especially small-scale farmers and indigenous populations) to derive economic benefit and support livelihoods from their activities on the land, and should not diminish the provisioning capacity and cultural value of the land.
3. Respect national sovereignty: Governments set national targets guided by the global level of ambition while taking into account national circumstances. Governments decide the level of aspiration and how LDN targets are incorporated in national planning processes, policies and strategies.

LDN IS ACHIEVED WHEN THE QUANTITY AND QUALITY OF LAND-BASED NATURAL CAPITAL IS STABLE OR INCREASING, DESPITE THE IMPACTS OF GLOBAL ENVIRONMENTAL CHANGE.

that focus specifically on natural ecosystems[14] and the *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security* (VGGTs; FAO, 2012b).[15]

3.2 The LDN causal framework

The vision described in chapter 3.1 provides the basis for devising a system model that describes the processes that sustain land-based ecosystem services, enhance the resilience of land-based natural capital and the populations that rely on it, and deliver human wellbeing (food security, sustainable livelihoods). Figure 2 presents a system model for LDN as a causal framework relating the state of the land-based natural capital to the drivers and pressures, the consequent impacts, and human responses. The figure identifies that the major factors leading to land degradation are land use changes (such as conversion from forest to agriculture, or agriculture to urban) and unsustainable land management practices. In turn, land use and management changes are often driven by system shocks (abrupt change), trends (long-term changes), or seasonality (short-term variability). Drivers include biophysical factors (e.g., drought) and

14 See footnote 13.

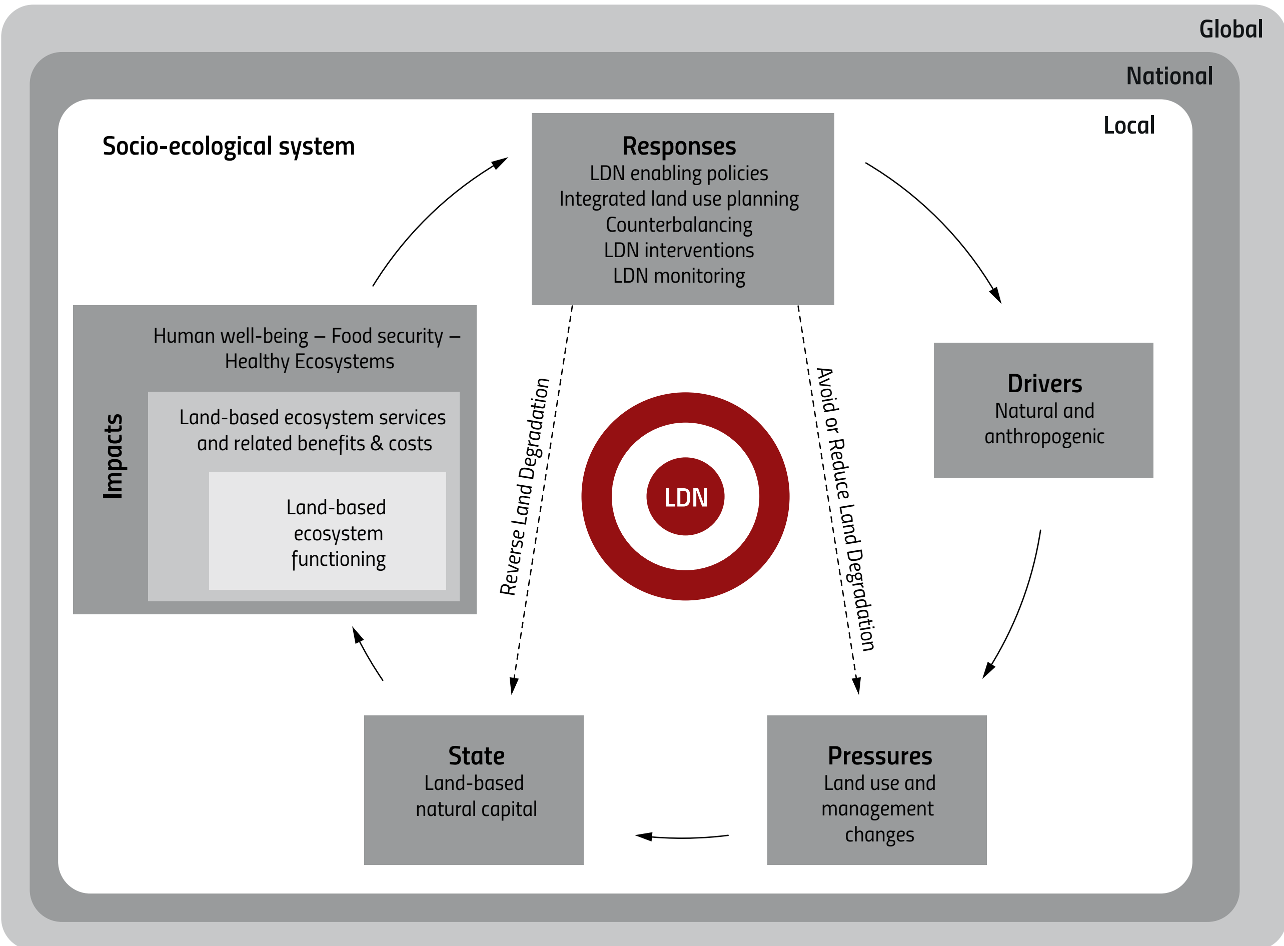
15 The VGGTs are central to how LDN can be pursued with less risk of unintended consequences associated with land tenure insecurity, land appropriation and land conflict.

socio-economic factors (e.g., market forces). These system changes can be perceived as risks, in the sense that they are events that may impede the achievement of LDN, and more broadly the desired livelihood outcomes. The causal framework provides a structure within which to consider the linkages between these pressures and the effects on land-based ecosystem functions and services, and points to the types of interventions – such as enabling policies – that are needed to address the drivers and pressures. Figure 2 also illustrates the links between the LDN vision, its governance, and implementation.

This system model for LDN is intended to describe causal relationships, particularly how natural and social capital interact, in a way that can help guide LDN policy-making. It is based on (i) the Driving Force-Pressure-State-Impact-Response (DPSIR) framework, which focuses on clarifying cause-effect relationships (Smeets & Weterings, 1999) (ii) the framework for sustainable livelihood analysis (SLA) (Scoonnes, 1998), which puts assets (e.g., land-based natural

FIGURE 2

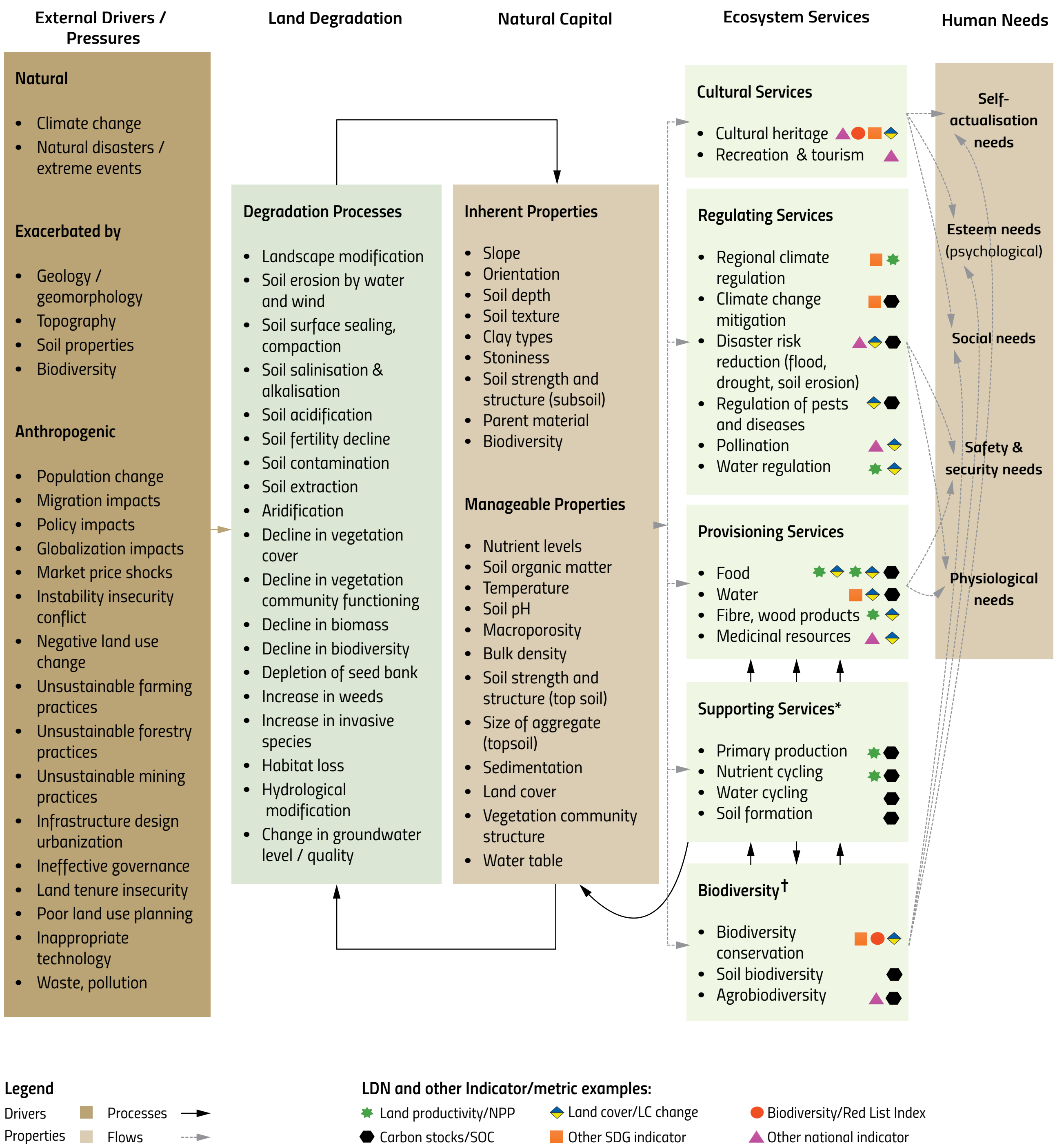
Conceptualizing LDN in a cause and effect model within the socio-ecological system



Solid arrows indicate cause-effect relationships; dotted arrows indicate response relationships.

FIGURE 3

System description relating the provision of ecosystem services to the land-based natural capital
(with indicator/metric examples mapped to specific ecosystem services)



* Services that support all other ecosystem services and also influence natural capital.
† Biodiversity underpins all ecosystem services.

Modified from Dominati *et al.,* 2010

NB: All elements in this diagram can change over time at different rates.

capital and associated ecosystem services) and the way they are used at the core of achieving livelihood outcomes, and (iii) the Driving force-Pressure-State- human/environment Impact-Response framework (DPSIheR) (adopted by the UNCCD for monitoring progress; UNCCD, 2013a). The latter borrows from the Millennium Ecosystem Assessment (MA, 2005) which, by separating the human from the environmental impacts, captures how human wellbeing can be impacted by environmental degradation. This system model, describing the linkages between key elements of the system, provides insights for devising implementation strategies, planning monitoring, and interpreting the results of efforts to quantify changes in the state of the resource base, which are applied in subsequent components of the framework. The components of the framework, as well as the interactions between them, are further elaborated in the remaining four modules of the LDN approach (presented in Chapters 4 to 7). A country seeking to implement LDN is encouraged to customize the generic system model illustrated in Figure 2 for its own system(s).

3.3 System description relating the provision of ecosystem services to land-based natural capital

The causal framework depicted in Figure 2 is underpinned by the natural and human-influenced biophysical processes that drive and impact the provision of ecosystem services flowing from land-based natural capital, and which ultimately contribute to human wellbeing. Figure 3 presents these complex interrelationships within a structure that seeks to simplify the complexity while emphasising the multiple linkages and pertinent processes (modified from Dominati *et al.*, 2010). At its core, Figure 3 highlights the ecosystem services delivered by the land-based natural capital. It demonstrates how human needs are met by these ecosystem services. The figure identifies the relevant features of land-based natural capital that are influenced by degradation processes,[16] which are listed along with their drivers and pressures (natural and anthropogenic). It also shows the relationship between the *stocks* of land-based natural capital that yield a *flow* of valuable ecosystem services for the fulfilment of human needs. To maintain natural capital as external pressures increase will require an expanding stock of human and social capital. Effective learning will be a critical enabler.

3.4 A note about indicators and metrics

In keeping with the terminology embraced by the UNCCD, this report distinguishes *what* to measure (indicators) from *how* it is assessed (metrics).[17] In the context of LDN, indicators are, necessarily, proxies for what LDN seeks to maintain, and a minimum set of indicators is identified, to reflect the key processes that underpin land-based natural capital. These indicators should be assessed using metrics that are universally applicable and interpretable, and, preferably, quantifiable with available data sets.

16 For a description of land degradation processes, see Henry and Murphy (2016).

17 See footnote 3.

It is important to ensure at the design stage that the desired outcome of implementing LDN can be measured and monitored. For this reason, Figure 3 maps a set of indicator/metric examples (coloured symbols) to specific land-based ecosystem services that are further elaborated in chapter 7 (Module E). This mapping suggests that it may be possible to use the selected group of indicators as a reasonable proxy of change in the capacity to deliver the ecosystem services flowing from land-based natural capital. These indicators and associated metrics were selected from amongst

a) the UNCCD progress reporting indicators and associated metrics (land cover/land cover change, land productivity/NPP and carbon stocks/SOC; decision 22/COP.11, UNCCD, 2013) that are also being considered for monitoring SDG 15.3 indicator 15.3.1 "Proportion of land that is degraded over total land area" (see also chapter 7.11.2; ECOSOC, 2016);

b) SDG indicators (ECOSOC, 2016); and

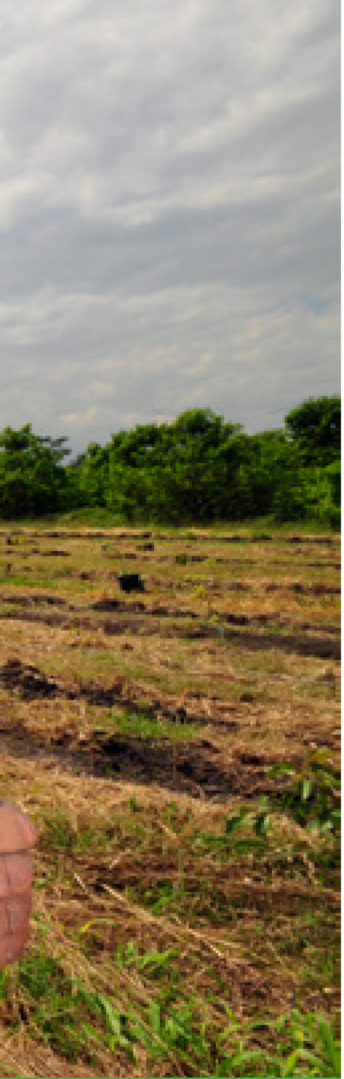
c) other national indicators.

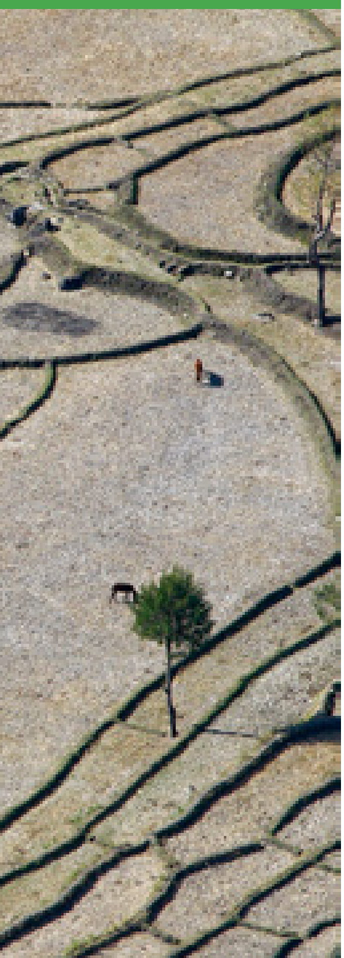
The Red List Index is also included, as a safeguard to ensure that impacts on threatened species are not overlooked (Bubb *et al.*, 2009).

Indicators/metrics for monitoring the identified ecosystem services and progress in implementation of LDN are discussed further in chapter 7 (Module E, Monitoring).

Module B

THE AMBITION OF A COUNTRY WITH RESPECT TO ACHIEVING LDN IS NO NET LOSS, AND THUS THE LDN TARGET IS EQUAL TO THE BASELINE.





Frame of Reference

4.1 The baseline in LDN

The novel aspect of the LDN target that sets it apart from earlier efforts to tackle land degradation is the specific adoption of *neutrality* as the goal. To assess whether this goal of neutrality has been met, a reference, or baseline, must be established, against which performance can be assessed.

COUNTRIES MAY ELECT TO SET THEIR LDN TARGET ABOVE NO NET LOSS AND RAISE THE LEVEL OF AMBITION.

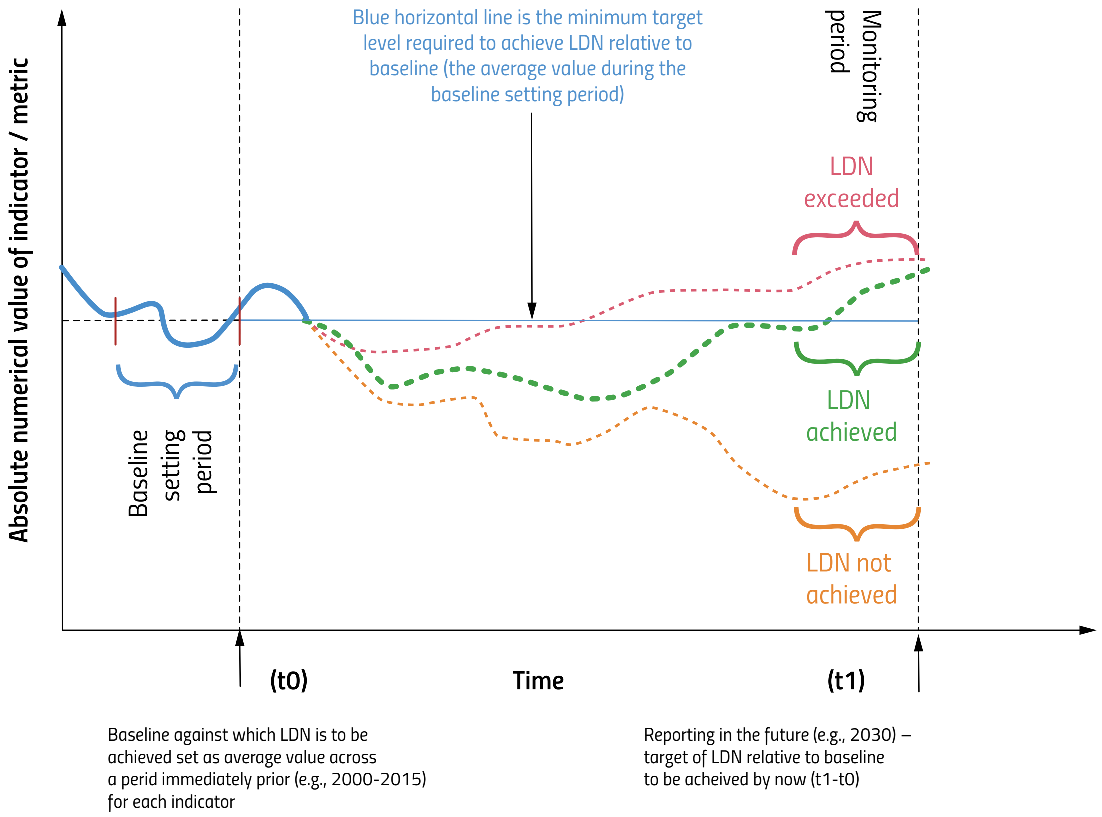
Neutrality implies that there is no net loss of what LDN is intended to maintain. Thus "no net loss" in this context means that land-based natural capital is maintained or enhanced between the time of implementation of the LDN conceptual framework (t0, typically the year 2015, when the decision to pursue LDN was adopted by the UNCCD) and a future date (such as the year 2030) when progress is monitored (t1). This frame of reference is important for two reasons. First, it places the focus on the aspirational goal of LDN, that is, *ensuring that there is no net loss of land-based natural capital*. Second, neutrality is monitored through *change* in values of a specific set of consistently measured indicators, which is more readily detected than land degradation status per se, as degradation does not occur in linear or easily discernible patterns. The precision (repeatability) in such measurements of change can be quite high, whereas the precision and accuracy (how close the measured value is to the actual value) of many efforts to assess land degradation *status* has been relatively low. This is reflected in the wide range, from 1 – 6 billion ha, in global estimates of degraded land.[18] The accuracy of these estimates is widely disputed, and all have a large error associated with them (low precision), making them less than ideal for a baseline, which should be as precise as possible, to facilitate detection of change.

Therefore, the baseline for LDN is the initial value of the indicators, and deviations at a point in the future are the basis for monitoring achievement of neutrality. The LDN baseline is therefore the initial value of each of the indicators used to monitor progress in achieving LDN. The baseline values of these indicators are averaged over the period leading up to implementation of the LDN conceptual framework (t0 e.g., 2015) and re-measured at t1 (e.g., 2030) to determine the change in land-based natural capital. The ambition of a country with respect to achieving LDN is no net loss, and thus the LDN target is equal to the baseline (Figure 4). A goal of no net loss may not seem ambitious but many countries are experiencing trends of increasing degradation (e.g., due to unsustainable land management practices, land conversion for agriculture, and urban expansion), and so the vision of LDN requires this trend to be halted and reversed. In recognition of specific national circumstances, flexibility in implementing LDN is required. Countries may elect to set their LDN target above no net loss and raise the level of ambition. Under rare circumstances, a country may elect an LDN target that includes some net loss, if they anticipate future land degradation that

18 A recent comparative study of the data sets of four major global assessments of the area of degraded land revealed large differences in magnitude of the results (from less than 1 billion ha to over 6 billion ha), with an equally wide disagreement in their spatial distribution, see Gibbs & Salmon, (2015).

FIGURE 4

In LDN the minimum target equals the baseline because the goal of LDN is to achieve no net loss. The figure illustrates alternative trajectories for a hypothetical indicator/metric, showing paths that achieve, exceed or do not achieve LDN



is not possible to counterbalance with gains elsewhere. In such circumstances, a country would need to justify this target.

It is important to note that LDN considers all land degradation whether due to human or natural causes. In particular, climate change is likely to increase the risk of land degradation in many countries, and could lead to losses despite efforts to reduce or reverse land degradation, making LDN more difficult to achieve.

Monitoring progress toward the LDN target involves both quantifying the baseline (the initial values of the indicators) and gains and losses relative to the baseline in the future. The condition of the land, particularly in the drylands, is highly variable temporally, largely due to climate variability. Therefore, the baseline should be quantified by averaging the indicator values over an extended period (e.g., 10-15 years) prior to t0, rather than using the values of a single year. Similarly, monitoring achievement is undertaken by averaging over an extended period of at least 5 years (chapter 7.2). Uncertainty in the estimates of indicators must also be considered in monitoring, to determine whether a change is significant, as discussed in chapter 7.3 Interim monitoring, that occurs prior to t1, such as the regular reporting to the

BOX 2

Principles related to the frame of reference

1. The LDN target equals (is the same as) the baseline: The baseline (the land-based natural capital as measured by a set of globally agreed LDN indicators at the time of implementation of the LDN conceptual framework) becomes the target to be achieved, in order to maintain neutrality.

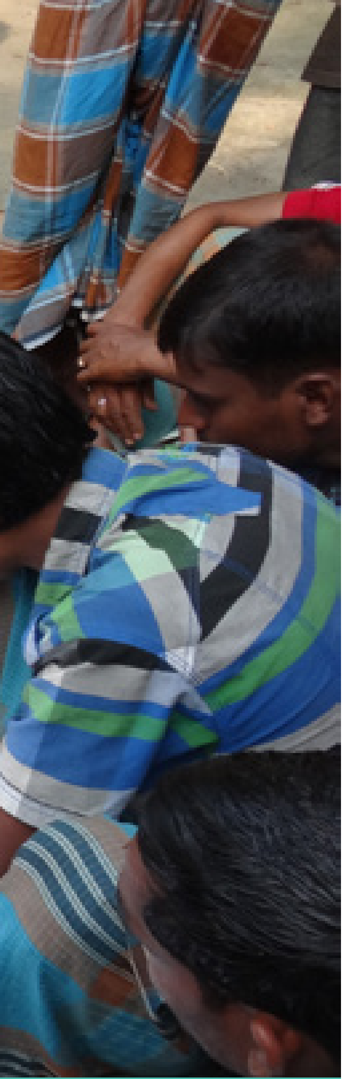
2. Neutrality is usually the minimum objective: countries may elect to set a more ambitious target, that is, to improve the land-based natural capital above the baseline, to increase the amount of healthy and productive land. In rare circumstances a country may set (and justify) its LDN target acknowledging that losses may exceed gains, if they forecast that some portion of future land degradation associated with past decisions/ realities is not currently possible to counterbalance.

UNCCD, should be undertaken to evaluate progress towards the target and provide the opportunity to modify plans as needed, and contributes to the iterative learning that is necessary to effectively implement this framework.

Ideally all countries would agree to use the same baseline period for tracking progress. The use of a dynamic forward baseline (such as a "business as usual" projection over the period t0 to t1) or a shifting window (recalculated every five years, for example) could mask absolute changes in land degradation, and thus would not reflect the LDN vision. The LDN monitoring approach is detailed in chapter 7 (Module E).

Module C

THE LDN MECHANISM FOR NEUTRALITY COMPRISES THE COUNTERBALANCING OF ANTICIPATED LOSSES IN LAND-BASED NATURAL CAPITAL WITH PLANNED GAINS, WITHIN UNIQUE LAND TYPES.



Mechanism for Neutrality

5.1 The neutrality mechanism

A mechanism for neutrality could involve voluntary measures, regulatory instruments and/or market-based incentive schemes. While any combination of these might be applied domestically by a country, the LDN neutrality mechanism must be applicable to all types of land degradation and across the wide variety of countries' circumstances so that it can be implemented consistently by all countries that choose to pursue LDN. This mechanism should be implemented at the spatial resolution of the biophysical or administrative domains at which land use decisions are made, and be scalable so that the results can be reported nationally.

The neutrality mechanism is designed to assist land use decision-makers to maintain or do better than "no net loss" (as a minimum standard), so that losses due to land degradation can be counterbalanced by (at least) equivalent gains. To be effective, the neutrality mechanism should be integrated into existing land use planning processes, to facilitate consideration of the likely cumulative impacts of these decisions on land-based natural capital and the implications for achieving neutrality.

This framework applies a counterbalancing mechanism for maintaining (or exceeding) neutrality that is voluntary, focussed pro-actively on planning (rather than regulating) to achieve no net loss. It is guided by principles designed to avoid negative outcomes (Box 3), and to facilitate implementation by existing institutions through integration with existing processes. It seeks to protect the rights of local land users by embracing the internationally accepted standards for the responsible governance of tenure (VGGTs; FAO, 2012b).[19]

19 See footnote 15 .

Planning for neutrality by projecting potential losses and planning for comparable or greater gains should be linked to long-term land use planning, whereby decisions are based not only on threats of serious or irreversible damage within a particular site, but also the contribution of each of those decisions, positive or negative, to the goal of neutrality at the landscape or national level. This builds on well-established precedents for the integration of land use planning and management in order to balance the promotion of human well-being and the protection of the environment. The 1992 Rio Declaration on Environment and Development (United Nations General Assembly, 1992b) encouraged countries to develop policies and strategies to progress sustainable development (Rio Principles 1, 4, 8), to adopt a precautionary approach in order to protect the environment (Rio Principle 15),[20] to undertake environmental impact assessments as a national instrument of environmental policy and planning (Rio Principle 17) and to encourage participation of citizens at the relevant level, including granting citizens access to information concerning the environment (Rio Principle 10). The precautionary principle provides a sound foundation for LDN, considering that is one of the most widely adopted environmental principles in history and is already considered by land use planners.

The LDN mechanism for neutrality comprises the counterbalancing of *anticipated losses* in land-based natural capital with *planned gains*,

20 The precautionary principle: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (Principle 15, United Nations General Assembly, 1992).

within unique land types. In practice, projected negative changes in land-based natural capital (anticipated losses) are counterbalanced with actions to achieve gains through reversing degradation (anticipated gains). Note that, as introduced in Module A (chapter 3.3) and detailed in Module E (chapter 7), *monitoring* progress towards LDN is based on evaluating the area,[21] per land type, of significant changes (positive and negative) in three global indicators/metrics serving as proxies for ecosystem services: land cover/land cover change, land productivity/NPP, and carbon stocks/SOC.[22] Therefore, the mechanism for neutrality aims to counterbalance anticipated negative changes in the LDN indicators with actions anticipated to lead to positive changes over an equal area of the same land type over the timeframe to be monitored.[23] The estimate of anticipated losses should include not only the effects of active decisions on land use (e.g., granting permits for open-cut mining, land clearing, urban expansion) but also effects of passive decisions (e.g., continuation of agricultural practices known to deplete soil carbon) and natural drivers (e.g., impacts of drought, wildfire). Changes associated with natural drivers, while not resulting directly from land use decisions, and difficult to predict, nevertheless will impact land-based natural capital and thus the indicators for LDN, so in order to achieve LDN their anticipated effects need to be counterbalanced. Furthermore, efforts to estimate these factors can inform planning to mitigate their severity.

Counterbalancing is generally managed within the same land type in order to ensure conservation of unique ecosystems, and to increase the likelihood that there is no net loss in ecosystem services. In the LDN context, land type is determined by land potential, which depends on inherent features aligned with key ecosystem functions, such as geomorphology, topography, vegetation structure and species assemblages, and relatively static soil properties, such as texture. Land potential influences vegetation community composition and determines suitability for uses such as cropping, grazing, forestry, infrastructure or urban development. Counterbalancing will generally not occur between different land types, to ensure "like for like", when assessing and managing the counterbalancing between losses and gains. In other words, a gain in one land type cannot counterbalance a loss in a different land type. Also, the counterbalanced land should have as high or greater natural capital value than that which is anticipated to be lost. Note also that land with the same biophysical characteristics may have different value with respect to human

COUNTERBALANCING IS GENERALLY MANAGED WITHIN THE SAME LAND TYPE IN ORDER TO ENSURE CONSERVATION OF UNIQUE ECOSYSTEMS, AND TO INCREASE THE LIKELIHOOD THAT THERE IS NO NET LOSS IN ECOSYSTEM SERVICES.

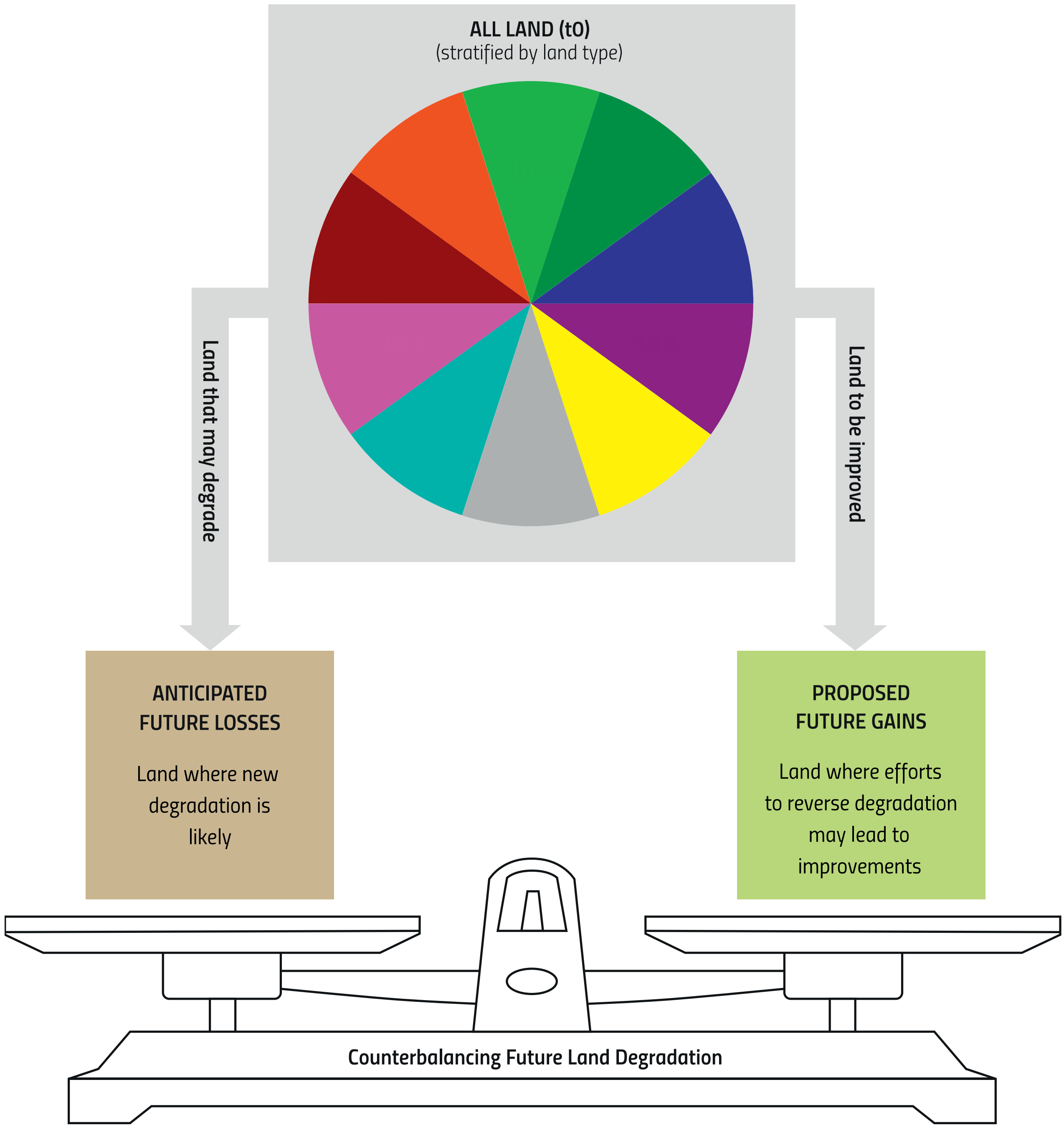
21 The pros and cons of the area-based approach to planning for neutrality and monitoring neutrality are discussed in chapters 5.2 and 7.5, respectively.

22 In addition, for a few ecosystem services not covered by NPP, SOC or land cover, other SDG indicators and/or national indicators may be applicable (see Figure 3.). See (ECOSOC, 2016; UNCCD, 2013)

23 See footnote 21.

FIGURE 5

The LDN mechanism for neutrality is the counterbalancing of anticipated gains and losses in land-based natural capital within unique land types via land use and management decisions



wellbeing and livelihoods depending on where it is located. Counterbalancing losses in land types managed for conservation with gains in land types managed for production should be avoided, as this would violate the vision of LDN and conflict with the goals of the Convention on Biological Diversity (CBD), REDD+[24] and the SDGs. By following the guidance on transparent and participatory land use planning provided in the VGGTs, LDN can be implemented in a way that safeguards land tenure rights of smallholders (Part 5, Administration of tenure, Section 20, regulated spatial planning, FAO, 2012b).

In planning counterbalancing it is important to consider the resilience of the counterbalancing intervention over the long term, such as to the potential impacts of climate change, and the likely trade-offs between ecosystem services. For example, a land unit close to a spatial boundary of a land type may be at risk of changing state (and thus becoming a different land type) as a result of climate change, and thus would be less suitable for counterbalancing activities than another area of that land type that has greater resilience. Likewise, reclamation with a monoculture of a fast-growing exotic tree species may result in significant positive change in land productivity and carbon stocks and deliver benefits in the form of wood products, but lead to high risk and low co-benefits in terms of biodiversity. Similarly, conversion to intensive agricultural production, with inputs of fertiliser and irrigation water, may enhance land productivity and stimulate crop yields but reduce the resilience of the agro-ecosystem to drought, and increase risk of soil salinity and acidification, and eutrophication of water bodies.

It is important to note that under this counterbalancing mechanism, areas where gains are anticipated are used to counterbalance areas where losses are anticipated; avoiding a loss cannot be used to counterbalance a loss elsewhere. That is, maintaining the same condition, whether degraded or not, does not lead to either a loss or a gain.

Figure 5 illustrates the counterbalancing concept and Table 2. provides a hypothetical example of a balance sheet of anticipated gains and losses generated at the planning stage. Counterbalancing can be embedded in land use planning at any level but it will likely be managed within a biophysical (e.g., catchment) or administrative (e.g., province) spatial domain. Linking counterbalancing decisions with integrated land use planning is designed to assist a country to keep track of likely impacts of land use change and land management, and thereby to plan for neutrality based on a "no net loss" approach.

Although counterbalancing decisions occur at the planning stage, the actual impact of those decisions and the actions taken is determined when neutrality is monitored. Figure 6 illustrates planning for counterbalancing on the basis of expected changes in the indicators over the timeframe that will be monitored, for one land type.

24 REDD+, a mechanism under the UNFCCC, refers to "reducing emissions from deforestation and forest degradation in developing countries, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries". The UN-REDD Programme supports nationally led REDD+ processes. See (FAO, UNDP,UNEP, n.d).

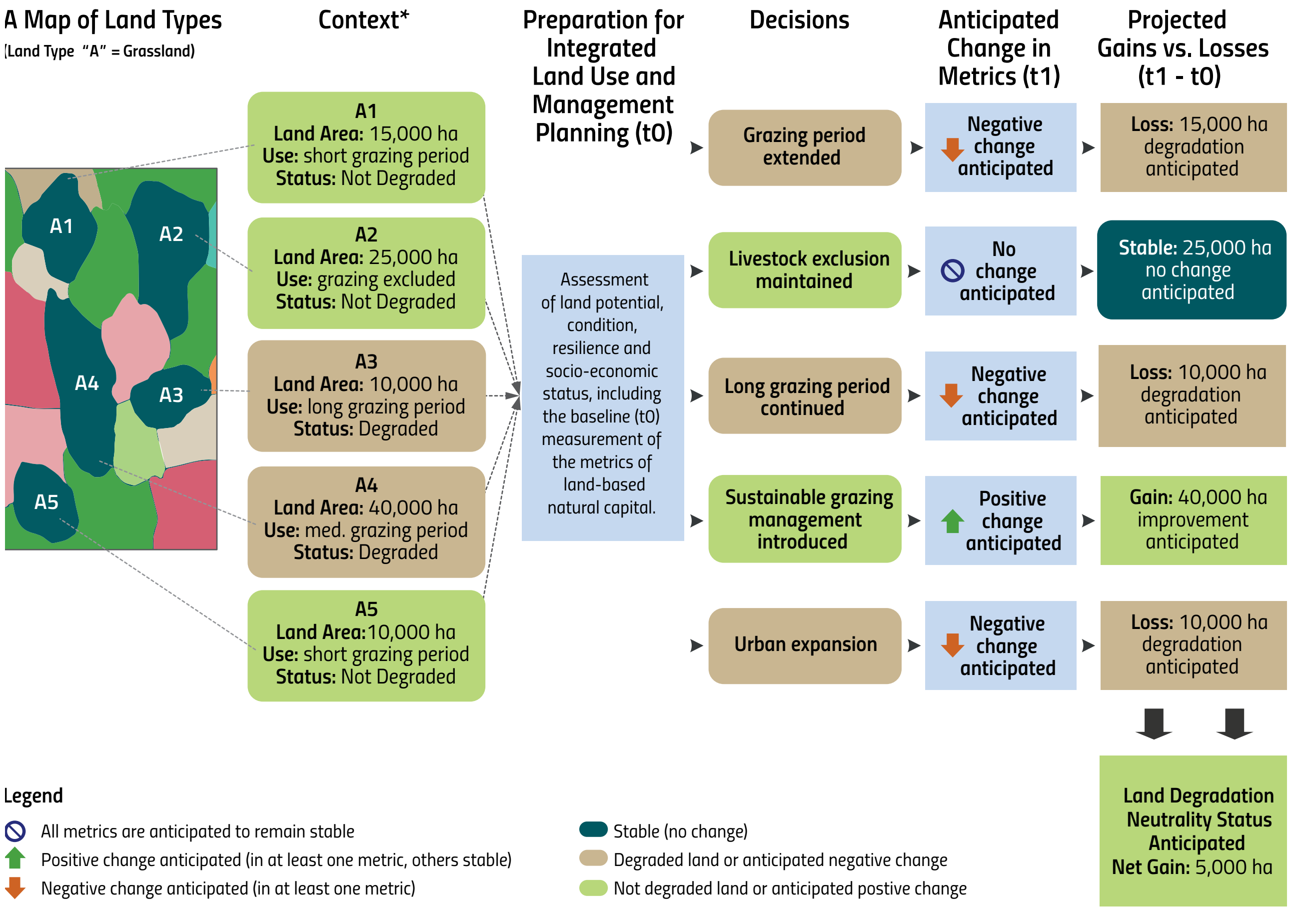
TABLE 2

An example of a neutrality mechanism balance sheet to track and help counterbalance anticipated losses with planned gains elsewhere

Neutrality Mechanism Balance Sheet	
(a hypothetical example for an administrative unit with multiple land types)	**Land Area (ha)****
A. Proposed Future Gains (where increases in natural capital are anticipated)	
Degradation avoided	
Managed land to be protected and improved	50,000
Sub-total of proposed new actions to avoid land degradation and increase natural capital	50,000
Degradation reduced	
Unsustainable agriculture to be put under sustainable land management (SLM)	400,000
Unsustainable forestry to be put under sustainable forest management (SFM)	100,000
Other mitigation initiatives	100,000
Sub-total of proposed new actions to reduce land degradation	600,000
Degradation reversed	
Proposed restoration projects	125,000
Proposed rehabilitation projects	225,000
Sub-total of proposed new actions to reverse land degradation	350,000
A. Total Proposed Gains	1,000,000
B. Anticipated Future Losses (where natural capital is anticipated to decline)*	
Land management that may lead to a decline in natural capital	
Estimated new losses from unsustainable land management	400,000
Sub-total of anticipated new losses due to land management	400,000
Land use changes that may lead to a decline in natural capital	
Estimated conversion from natural vegetation to agriculture	200,000
Estimated conversion of natural and production lands to urbanization	200,000
Estimated conversion of natural and production lands to mining	50,000
Other land use change that could lead to degradation	50,000
Sub-total of anticipated new losses due to land use changes	500,000
Non-anthropogenic and indirect anthropogenic losses	
Estimated losses from non-anthropogenic and indirect anthropogenic factors (e.g., wildfire, flood, drought)	100,000
Sub-total of non-anthropogenic and indirect anthropogenic losses	100,000
B. Total Anticipated Losses	**1,000,000**
C. Net loss or gain (A - B)	**0**

FIGURE 6

A hypothetical example showing how land use decisions influence the metrics used to monitor neutrality for a specific land unit, designed to illustrate, for one land type, how anticipated losses may be estimated and counterbalanced by planned gains



*This hypothetical example is designed to show how land use and management decisions affect metrics of land-based natural capital and how these changes should be anticipated in planning for Land Degradation Neutrality (LDN). This example illustrates a grassland grazed by livestock.

* These types of land degradation are referential and should be defined/estimated by countries according their regulations, policies and national/international commitments.

** This example LDN neutrality balance sheet is intended to be employed during land use planning, and because most land planning decisions are focused on specific areas of land, the "currency" is land area. The pros and cons of the area-based approach are discussed in chapter 5.2.

BOX 3

Principles related to the mechanism for neutrality

1. Apply an integrated land use planning principle that embeds the neutrality mechanism in land use planning: The mechanism for neutrality should be based on a guiding framework for categorizing and accounting for land use decisions and the impacts of land use and management with respect to a "no net loss" target.
2. Counterbalance anticipated losses in land-based natural capital with gains over the same timeframe, to achieve neutrality: Achieving LDN may involve counterbalancing losses in land-based natural capital with planned gains elsewhere within the same land type.
3. Manage counterbalancing at the same scale as land use planning: Counterbalancing should be managed within national or subnational boundaries at the scale of the biophysical or administrative domains at which land use decisions are made, to facilitate effective implementation.
4. Counterbalance "like for like": Counterbalancing gains and losses should follow, as far as possible, "like for like" criteria and thus will generally not occur between different types of ecosystem-based land types, except where there is a net gain in land-based natural capital from this exchange. Clear rules should be established ex ante for determining what types of "net gains" permit crossing land type boundaries, to ensure that there is no unintended shifting in the overall ecosystem composition of a country and no risk to endangered ecosystems.
5. Within a land type, counterbalancing cannot occur between protected areas and land managed for productive uses.
6. Ensure that all stakeholders, public and private, pursue LDN responsibly by working in partnership with relevant levels of government and local land holders, doing no harm, ensuring that planning processes are transparent and participatory, providing spatial systems to record individual and collective tenure rights, and safeguarding against dispossession of legitimate tenure right holders, environmental damage, and other threats and infringements.

5.2 A note concerning the binary, area-based approach of the neutrality mechanism

The LDN conceptual framework is intended to encourage progress towards maintaining "no net loss" through facilitating LDN, rather than through regulating LDN. Land degradation processes are often rapid, but recovery is usually slow – too slow for monitoring to deliver information useful in planning and managing the pursuit of LDN. Therefore, the neutrality mechanism is introduced as a measure by which to keep track of active decisions (i.e., decisions on actions e.g., restoration and rehabilitation projects, SLM initiatives, mining permits, rezoning for urban development) and passive decisions (e.g., ongoing degrading land management practices).

Land use decisions tend to be made on a spatial basis – that is, they apply to a specific site. Thus, the neutrality mechanism considers, for each land unit, the direction of potential change anticipated at that site, at the time land use and management decisions are made – it tracks those decisions that are likely to lead to losses in land-based natural capital and those likely to lead to gains. This binary approach (distinguishing land use decisions as having either anticipated positive or negative effects on land-based natural capital) has an important negative feature: an area where relatively small gains are likely may be assumed to counterbalance an equal area where much larger losses are likely.

Ideally the neutrality mechanism would consider not just the *direction* of change but also the *magnitude* of change. It would theoretically be possible to apply a neutrality planning system that is based on anticipated gains and losses in the measures of land-based natural capital (e.g., absolute quantity of SOC), rather than on the area of land where gains or losses are anticipated. Such an approach may seem to be more closely aligned with the objectives of LDN. However, there are several barriers to implementing a counterbalancing approach that accommodates magnitude of change in measures of land-based natural capital:

1. Responses to poor land management are commonly non-linear: gradual changes in a given pressure or control factor (aridity, grazing pressure, unsustainable management) might have little effect on the land use system until a threshold is crossed, after which a large shift occurs that might be difficult or impossible to reverse (Westoby *et al.*, 1989; Scheffer & Carpenter, 2003; Bestelmeyer *et al.*, 2015). Although models driven by empirical data can predict the end result of a system in transition ex post, threshold dynamics have rarely been documented through direct observations or experiments (Dai *et al.*, 2012). While small changes are likely to be reversible (Bestelmeyer *et al.*, 2013), regime shifts have the greatest impact on ecosystem services. In many pastoral systems, such transitions are sufficiently well-understood, allowing the identification of tipping points and distinguishing of practices that are likely to lead to regime shift. Thus, it is possible to identify those land use planning decisions that are anticipated to cause significant losses or significant gains in land-based natural capital. However, our current knowledge of most land systems is not yet sufficient to be able to relate management practices to the rate of change in ecosystem functions.

2. Land use planning, including governance of land tenure and permits for development, is generally applied on a spatial basis. Decisions to counterbalance anticipated losses in carbon stocks/SOC or land productivity/NPP with equivalent gains in these indicators/metrics are not easily integrated with current land management approaches.

3. Reversing degradation is often a slow process; the time frame in which ecosystem services will be restored is uncertain. Thus, it is more certain that gains will occur through the application of restorative actions over a given area, than that a gain of a specific magnitude will occur over a specified period.

4. An approach based on magnitude of anticipated gain or loss is more complex and costly to implement, and some countries do not currently have the capacity to do so.

In future, countries may choose to implement a more refined neutrality mechanism that categorizes land use decisions according to the anticipated magnitude of change in the indicator results and plans interventions to deliver similar magnitude of gains. This will require:

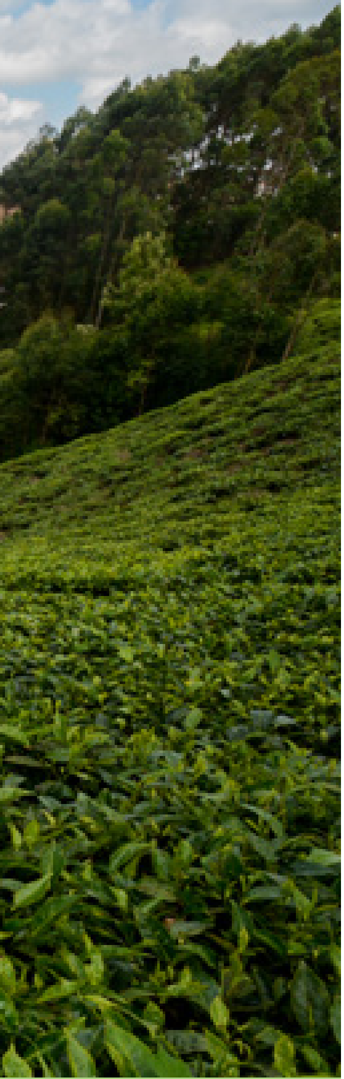
- Rules, standardized within land types, for projecting the estimated magnitude of change;
- agreement on the boundaries between categories, which will vary between environments and land use systems, and should be informed by knowledge of the thresholds for key variables for each system;
- measurement of these key variables at the locations subject to land use planning decisions;
- quantitative understanding of the relationships between management practices and response of the metrics; and
- rules to integrate and manage trade-offs between the measures, over specified time frames.

The efficacy of the area-based approach should be evaluated by applying learning from monitoring, with consideration of the assumptions underpinning the assessment and integrated land use planning processes. The costs, benefits, advantages and disadvantages of the magnitude-based approach should be evaluated to inform future decisions on adopting this approach.

Note that under this conceptual framework the *actual* change in land-based natural capital is captured in future monitoring, as documented in chapter 7 (Module E), using the indicators of land-based natural capital, which are also applied in a binary manner on a land area basis. The pros and cons of a land area-based approach to monitoring LDN are discussed in chapter 7.4.

Module D

LDN PLANNING AND IMPLEMENTATION SHOULD BE ALIGNED WITH AND INCORPORATED INTO EXISTING PLANNING PROCESSES, AND MAINSTREAMED INTO NATIONAL DEVELOPMENT PLANS AND OTHER POLICY PROCESSES.



Achieving Neutrality

Modules A-C framed LDN with respect to the pursuit of neutrality, emphasising the theoretical basis. Module D presents the fundamental elements in a logical framework that supports the practical pursuit of LDN. Module D includes guidance on preparation for LDN (data, tools, enabling policies, land stratification, capability assessment, resilience assessment); planning for LDN (assessing options, planning interventions and tracking anticipated impacts); and governance of LDN. The approach draws on, *inter alia*, literature on Theory of Change, social-ecological resilience, and integrated land use planning that embraces the VGGTs.

As explained in chapters 1 and 5, the core feature of LDN that distinguishes it from other policy approaches to managing land degradation lies in the aim of *ensuring that there is no net loss of land-based natural capital*. This means that efforts to pursue actions that 1) reduce the level and risk of land degradation, 2) prevent the degradation of healthy land, and 3) restore or rehabilitate degraded land, where (1) and (2) reduce losses, and (3) delivers gains, are considered simultaneously with efforts to *anticipate* losses. The implementation of LDN interventions therefore requires the identification of land where these measures will be applied, and selection of the appropriate measures to apply. Thus, it will involve in some cases changes in land management practices by land users, and in other cases, transformations to different land uses. Implementation will require decision-makers to actively engage with stakeholders to foster an enabling environment to encourage and facilitate these land management and land use decisions, recognizing that effective governance regimes can maximize the potential for success while protecting the rights of vulnerable individuals and communities. Optimal use should be made of existing and new multi-stakeholder platforms that leverage existing initiatives and innovations associated with local organizations ranging from civil society organizations (CSOs) to small and medium-sized enterprises (SMEs). While the focus of land use planning is local, decision-makers should be cognisant of national and international policies and initiatives that influence land use and distribution of benefits, such as trade agreements and sustainability schemes.

THE RESPONSE HIERARCHY OF AVOID > REDUCE > REVERSE LAND DEGRADATION IS BASED ON THE RECOGNITION THAT PREVENTION IS (MUCH) BETTER THAN CURE.

6.1 The LDN response hierarchy

The *LDN response hierarchy* is an overarching principle that guides decision-makers in planning measures to achieve LDN. The response hierarchy of Avoid > Reduce > Reverse land degradation (Figure 7) is based on the recognition that “prevention is (much) better than cure” i.e., avoiding or reducing further land degradation will maximize long-term benefits and is generally more cost-effective than efforts to reverse past degradation.

Informed by the assessment of land potential, priority for intervention is placed first on lands where prevention or avoidance of land degradation is possible, followed by land where mitigation through improved land management practices

BOX 4

Principles related to achieving neutrality

1. Balance economic, social and environmental sustainability: LDN seeks to maintain or enhance the quality of all ecosystem services, optimizing the trade-offs between environmental, economic and social outcomes. Implementing LDN contributes to sustainable development by integrating economic and social development and environmental sustainability within the biophysical limits of natural capital, and seeking to manage the land for ecosystem services while avoiding burden shifting to other regions or future generations.[25]

2. Base land use decisions on multi-variable assessments: Land use decisions should be informed by appropriate assessments (land potential, land condition, resilience, social, cultural and economic factors, including consideration of gender), validated at the local level before initiating interventions to ensure evidence-based decisions and reduce the potential risk of land appropriation.

3. Ensure that land management aligns with the capability of the land to minimise the risk of land degradation and help identify and prioritize appropriate land use practices.

4. Leverage existing planning processes: LDN planning and implementation should be aligned with and incorporated into existing planning processes, including UNCCD NAPs, United Nations Framework Convention on Climate Change (UNFCCC) National Adaptation Plans (NAPs) and Nationally Determined Contributions (NDCs), and mainstreamed into national development plans and other policy processes. This will promote action to achieve LDN, reduce burdens and minimise the duplication of effort. Promote review of existing planning processes, to facilitate revision and adoption of innovated approaches, where appropriate.

5. Apply the response hierarchy: In devising interventions and planning for LDN, the response hierarchy of Avoid > Reduce > Reverse land degradation (Figure 6) should be applied, in which avoid and reduce have priority over reversing past degradation, so that the optimal combination of actions can be identified and pursued with the aim of achieving no net loss across the landscape.

6. Quantify projected land degradation: Projected land degradation due to anticipated land use changes (e.g., projected urban expansion), or due to anticipated ongoing unsustainable management needs to be estimated so that ways to reduce or counterbalance these anticipated losses with positive interventions elsewhere can be identified.

7. Apply a participatory process: Planning and implementation of LDN involves well-designed participatory processes that include stakeholders, especially land users, in designing, implementing and monitoring interventions to achieve LDN. Processes should consider local, traditional and scientific knowledge, applying a mechanism such as multi-stakeholder platforms to ensure these inputs are included in the decision-making process. The process should be sensitive to gender, and imbalances in power and information access.

25 Adapted from ISO DIS 14055-1 Environmental management — Guidelines for establishing good practices for combating land degradation and desertification — Part 1: Good practices framework.

BOX 4 (cont'd)

8. Apply good governance: Good governance underpins LDN and thus planning and implementation should involve: [26]
    a. removing and reversing policy drivers that lead to poor land management
    b. applying the principles and standards of the VGGTs to ensure tenure rights and security in the pursuit of LDN (FAO, 2012b)[27]
    c. taking account of availability of resources (human and economic) for implementing good practices to combat land degradation and desertification;
    d. making provision for monitoring and reporting on LDN implementation;
    e. developing a mechanism for the coordination of integrated land use and management planning across scales and sectors to ensure stakeholder input to national and international decision-making and reporting;
    f. developing a mechanism for the timely review of implementation outcomes and recommendations for improvement; and
    g. ensuring upward and downward accountability and transparency.

26 Adapted from ISO 14055 Environmental management – Guidelines for establishing good practices for combating land degradation and desertification (Under development).

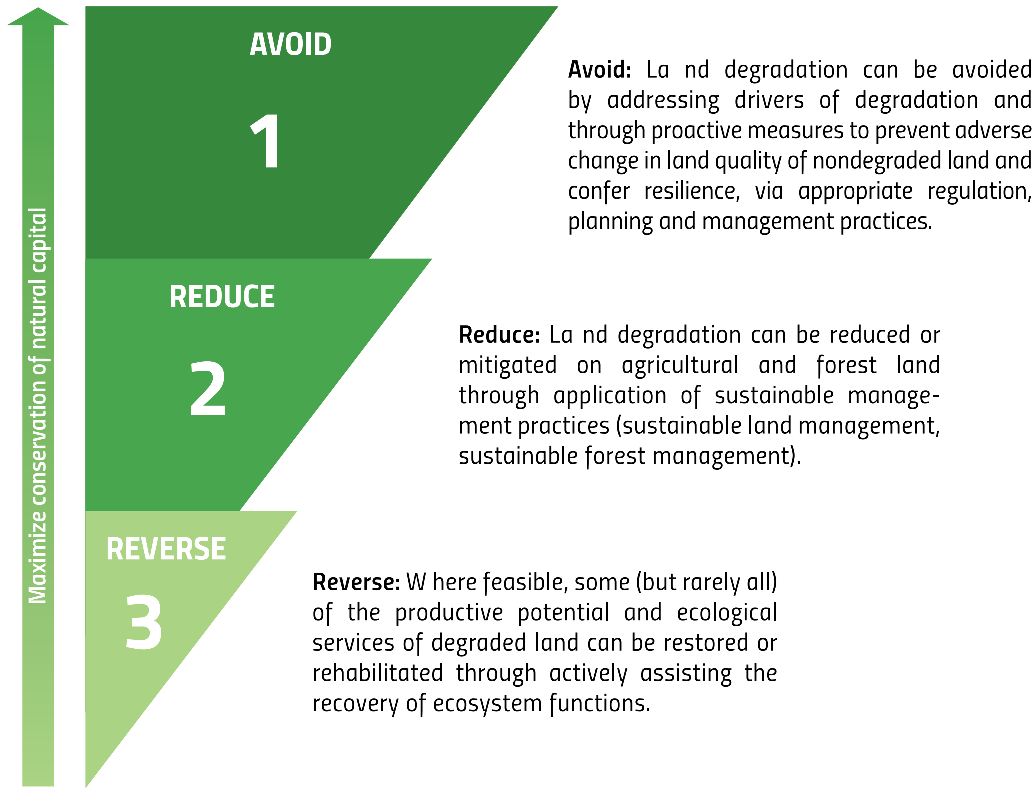
27 Article 7 in the VGGTs speaks about safeguards to avoid infringing on or extinguishing tenure rights of others, including legitimate tenure rights that are not currently protected by law. In particular, safeguards should protect women and the vulnerable who hold subsidiary tenure rights, such as gathering rights. Where States intend to recognize or allocate tenure rights, they should first identify all existing tenure rights and right holders, whether recorded or not. Indigenous peoples and other communities with customary tenure systems, small-scale farmers, pastoralists and anyone else who could be affected should be included in the consultation process.

is suited, and lastly on land suitable for restoration or rehabilitation. Where there is no alternative but to accept degradation or the risk of it, the anticipated losses should be counterbalanced with planned gains elsewhere, in order to achieve no net loss (see example in Figure 6). Thus, LDN will be achieved at landscape or ecosystem scale, through the combined effect of interventions designed to avoid, reduce or reverse land degradation, to achieve a neutral outcome at that scale. The focus of the response hierarchy is therefore *not* on prioritizing investment for a given site, but rather on guiding integrated land use planning across the mosaic of social, economic and environmental contexts within the landscape, and pursuing the most appropriate combination of mitigation options before accepting (potentially) degrading land use change or land management that will require actions to reverse degradation losses, in order to achieve LDN.

Reversing land degradation calls for actions that are designed to improve land-based natural capital. One option is restoration, the process of assisting the recovery of an ecosystem that has been degraded. Restoration seeks to re-establish the pre-existing ecological structure and function, including biotic integrity (Figure 8). The second option is rehabilitation, which aims to reinstate ecosystem functionality, where the focus is on provision of goods and services rather than restoration (McDonald *et al.*, 2016). A range of factors influence which of these approaches to reversing land degradation is most applicable in a given circumstance: the long-term potential of the land, its land use history, its baseline condition, its potential uses and associated values, and likely impacts of climate change and other shocks and stressors (chapter 6.3). An ecosystem that undergoes restoration or rehabilitation can follow different trajectories leading to acceptable outcomes as long as they fall within the target reference range (Figure 8). In situations where complete restoration or rehabilitation of a disturbed land is not feasible or desirable, reclamation could be undertaken (Society for Ecological Restoration International Science and Policy Working Group, 2004). However, the focus of reclamation is returning degraded land to a useful

FIGURE 7

The LDN response hierarchy encourages broad adoption of measures to avoid and reduce land degradation, combined with localised action to reverse degradation, to achieve LDN across each land type

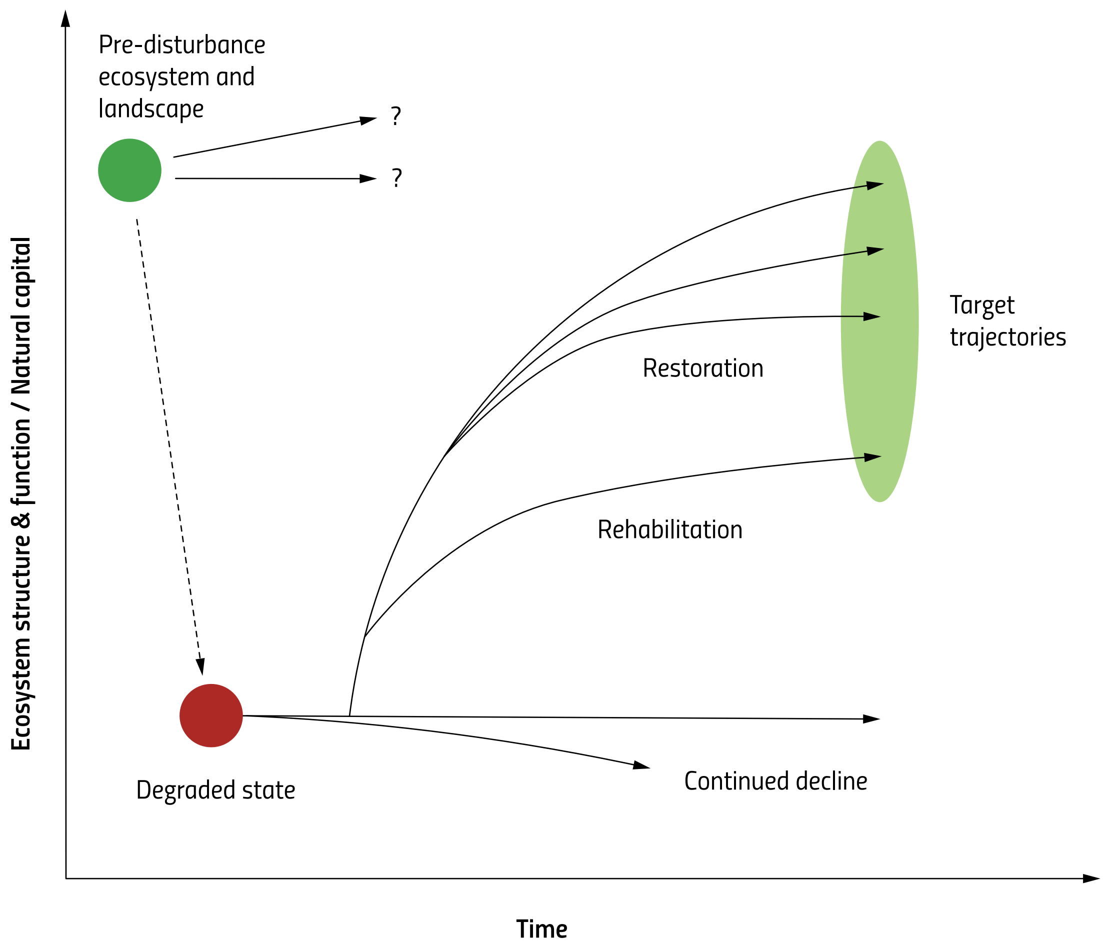


state, as defined in the local context. While not all reclamation projects enhance natural capital, those that are more ecologically-based can qualify as rehabilitation or even restoration and so may make limited contribution to reversing land degradation.

Restoration or rehabilitation activities are not likely to reinstate 100% of lost productivity and ecosystem services, at least in the short-medium term (Benayas *et al.*, 2009; Maron *et al.*, 2012; Dominati *et al.*, 2014). Therefore, the most effective strategy is to take immediate action to prevent land degradation where non-degraded land is at risk, followed by efforts to reduce or mitigate land degradation by implementing practices with low risk, and finally actions that reverse land degradation. Across the landscape, application of the response hierarchy will involve a combination of protection measures and wide-scale implementation of sustainable land management, with

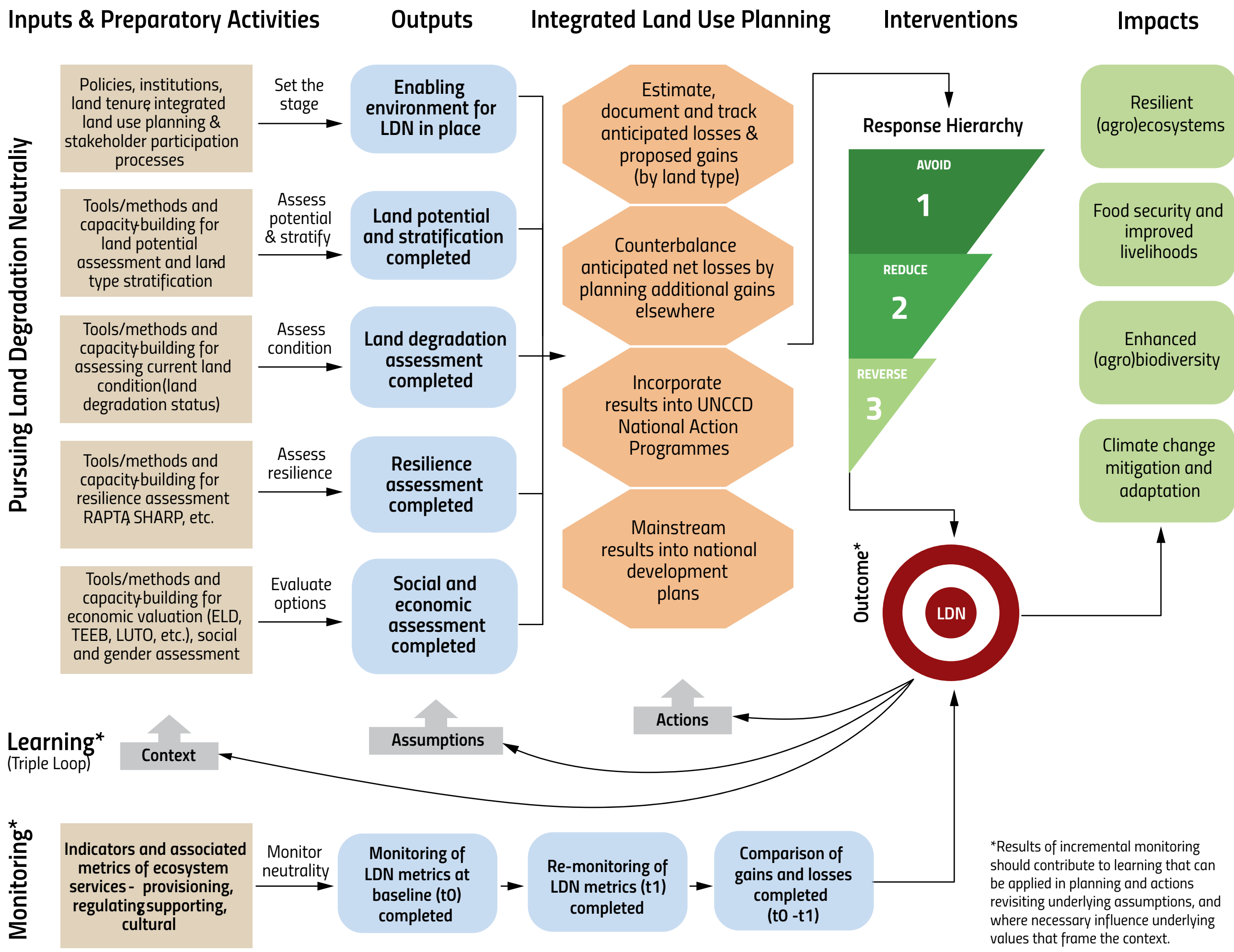
FIGURE 8

Options for reversing land degradation



Adapted from: McDonald *et al.*, (2016); Society for Ecological Restoration International Science and Policy Working Group, (2004); Hobbs & Norton, (1996); Aronson *et al.*, (2007).

FIGURE 9
Logic model for the effective implementation of LDN



localized restoration and/or rehabilitation actions, to deliver neutrality.

6.2 The logic and fundamental elements behind achieving LDN

Figure 9 presents a logical framework for achieving LDN, connecting inputs, activities, outputs, and interventions to the desired outcome (LDN), that is, the impact pathway. Users are encouraged to adapt this figure to suit their own context and priorities in order to identify the actions that are most critical, such as policy reforms that could assist in the effective implementation of LDN. In devising intervention options and the required enabling mechanisms, it is often helpful to work backwards from the desired outcome (the right-hand side of Figure 9) as this will assist in

TABLE 3

Elements of preparation and implementation of LDN showing requirements and outputs of each element

Element	Land potential assessment	Land type stratification	Land degradation assessment	Resilience assessment (including need for adaptation or transformation)	Integrated land-use planning decisions	Monitoring indicators of gains / losses in land-based natural capital	Interpretation of indicator/ metric values	Neutrality assessment
Product	Map of potential of land to sustainably generate ecosystem services	Map of land types based on land potential, subdivided by vegetative cover	Map of land condition	Assessment of whether the system is heading in desired trajectory	Balance sheet of land use planning decisions	Map of land areas that have experienced significant change over monitoring period compared with the baseline	Verification of estimates of change and identification of negative land cover change	Neutrality assessment
Requires*	Maps of soil type, landform, climate, erosion hazard	Maps of land potential, vegetative cover, land use and management.	National land degradation assessment including trend analysis of the LDN indicators/ metrics; local verification of results	Land potential assessment; Tipping points; climate change projections; resilience tool; scenarios. Comprehensive and representative participation of stakeholders; Gender assessment	All previous plus economic and social assessment results; Local stakeholder input	Absolute numerical values of LDN indicator/ metric data at t0 and t1 to identify significant pos./ neg. change	Estimate of uncertainty of metric values. Refinement indicator/ metric values for false positives; Resilience assessment; Local stakeholder input	Data comparison (t1 - t0); Aggregation of data on all areas of gains and losses, per land type
Spatial resolution	Land type	Land unit	Land unit	Land unit	Watershed or admin. domain	Land unit	Land unit	National
Feeds into	Stratification, identifying land use/ management options, restoration / rehabilitation options, resilience assessment	Land cover change detection for neutrality monitoring and counterbalancing like for like	Identifying land use and management options based on land condition	Interpretation of land cover change (deciding negative trends); Options and pathways for interventions; Identification of supplementary indicators	Setting national targets for interventions; Estimating losses; Counterbalancing anticipated losses and gains	Quantifying actual gains and losses to assess neutrality	Adjustment to neutrality monitoring	Assessment of achievement of target

* All elements require full consideration of the perceptions and realities of local land users, ideally through their direct participation.

identifying the critical barriers to be overcome and the most effective actions to undertake. Thus, a critical first step is defining the goals with respect to country-specific circumstances. The LDN Target Setting Programme assists countries to apply a participatory, transparent process to devise their goals and set the stage for implementing LDN (UNCCD-GM, 2016).

It is not possible to show all linkages in Figure 8, but users should be aware of interactions between the input elements. Feedback arrows are included to indicate the importance of "triple loop learning" (chapter 6.3.8), through which information from monitoring is used to test hypotheses and modify the action plans, and conceptual model of the system.

The key elements of the LDN logic model correspond to the columns in Figure 9. Table 3 tabulates the elements of preparation and implementation of LDN showing requirements and outputs of each element.

6.3 Preliminary assessments

The preliminary assessments are preparatory activities that will assist in achieving LDN. They are designed to help ensure that public and private decisions that might lead to positive or negative change are guided by

(i) assessments that inform decision-makers about the potential of the land, its current condition, use, resilience and socio-economic context, and the relative consequences of alternative options both locally and with respect to the objective of no net loss across the nation (counterbalancing);
(ii) a response hierarchy (Figure 7), where avoid and reduce have priority over reversing past degradation;
(iii) attention to estimation and tracking of losses due to land use change or ongoing land management.

The following subchapters provide more detail on the preliminary activities listed on the left-hand side of Figure 9 which, taken together, support appropriate and effective decisions and physical actions on the land.

6.3.1 Ensure an enabling environment

In order to set the stage for effective LDN implementation, an enabling environment must be in place. A first step is to identify drivers of land degradation, so that policy can be designed to address these. It may be that some existing policies exacerbate land degradation, so they need to be modified or replaced. To ensure that the pursuit of LDN does not compromise the tenure rights of land holders or lead to land conflict, the principles and standards of the VGGTs (FAO, 2012b)[28] should be applied. The enabling environment should also include policies that encourage LDN by incentivizing and helping coordinate sustainable land management practices and activities designed to reverse land degradation across concerned sectors (e.g., environment, agriculture, water resources, urban planning), and that remove disincentives to adoption of these practices. LDN efforts should be linked to land administration (chapter 6.4) at whichever level is appropriate in a given country (Table 4). It is critical that governance facilitates achieving the vision of LDN while ensuring land tenure security, and encourages stakeholder participation in integrated land use

28 See footnote 15 and 27.

planning decisions (chapter 6.6). Interactions between local, national and international governance levels should be understood and harnessed (chapter 6.6).

It is advised to establish multi-stakeholder platforms and frameworks at local, national and regional levels to collaborate in planning, implementing, monitoring and evaluating LDN interventions undertaken in pursuit of LDN

LAND USE DECISIONS SHOULD BE INFORMED BY APPROPRIATE ASSESSMENTS, VALIDATED AT THE LOCAL LEVEL.

(chapter 6.6.5). This process should be inclusive, participatory, gender sensitive, implementable, cost effective and sustainable, and should link evaluation with future planning. It should allow CSOs and SMEs to take a leading role in the design and implementation of LDN activities. In carrying out these tasks, countries may seek technical support from regional and international bodies. Many countries will have existing institutions that can be readily realigned or evolved to meet this role.

Information from other elements of the preliminary assessment will be valuable in assessing and devising policies to create an enabling environment. Thus, this component should be considered an iterative element, revisited when new information is received, and regularly reviewed.

6.3.2 Land potential assessment and land stratification

Long-term land potential is defined as the inherent, long-term potential of the land to sustainably generate ecosystem services (UNEP, 2016). Land potential plays multiple roles in the LDN conceptual framework. Land potential is the basis for classifying land types. The emphasis on ecosystem services provides a link between the fundamental characteristics of different land types, and subsequent land use decisions. Land potential is also an important input to assessing resilience, and it contributes to stratification of land that helps to ensure that the pursuit of LDN will not result in inequality, in counterbalancing.

Land types are used in LDN integrated land use planning to ensure "like for like" when assessing and managing counterbalancing between anticipated losses and gains so that policies, regulations, and management practices relate in a coordinated way to each class in the administrative or biophysical domain within which decisions are being made. Different land types have potential to deliver different ecosystem services, and in different proportions, but all land types must be managed for neutrality to achieve LDN at national level.

Land stratification divides the land into units for accounting, and planning land use including interventions to reverse degradation through restoration or rehabilitation. Stratification should take into account (a) land type i.e., long-term potential (which depends on climate, topography, and relatively static soil properties), as primary stratum, and (b) current vegetative cover (which reflects the more responsive soil properties, such as organic matter level, that influence land condition), as secondary division. Where this is impossible due to a lack of soil information, initial stratification may be based on land cover, with units in areas targeted for intervention subsequently subdivided (Di Gregorio *et al.*, 2011, 2016)[29] In mapping land types it is essential to estimate error in delimitating areas. The map of land types should remain spatially consistent throughout the monitoring period (baseline, interim monitoring and final monitoring).

Stratification should be undertaken at a scale that takes into account the primary sources of variability in both long-term land potential and land cover or use, and then used in conjunction with the other preliminary assessments to support integrated land use planning decisions. An estimate of long-term land potential generalized at the national and subnational scales can be obtained using Global Agro-ecological Zoning Tool (GAEZ) of the Food and Agriculture Organization (FAO)[30] which takes advantage of geographic information systems databases and models based on the guidelines for land evaluation first introduced by FAO in 1976 and most recently updated in 2007 (FAO, 1976, 2007). Though the precision of GAEZ outputs is insufficient for land potential evaluation at management and intervention planning scales, the approaches have been adapted in a number of countries in support of land use and management decision-making at scales more appropriate for the pursuit of LDN (UNEP, 2016). A key limitation of GAEZ is that it is limited to potential productivity and does not consider resilience. This can be partially addressed by applying the U.S. Department of Agriculture's 8-class Land Capability Classification system, which identifies limitations to sustainable production, with an emphasis on soil erosion (Klingebiel & Montgomery, 1961; NRCS, 1973). First introduced in 1961, this system has formed the basis of the land capability classification approaches now in use in number of countries. Detailed land cover and agro-ecological zone mapping has already been completed for many areas. Many if not most of these remain filed in paper form. They are often of higher quality than is possible today due to the loss of trained soil surveyors. Prior to beginning a new survey, these resources should be sought and updated where anthropogenic factors or natural disturbance have altered the fundamental land characteristics, and reinterpreted relative to LDN.

Moreover, there are now rapidly expanding efforts to facilitate land potential evaluation at the point-scale, such as the Land-Potential Knowledge System (LandPKS), to combine crowd-source local knowledge with cloud-based scientific knowledge on the most fundamental factors upon which land potential depends (climate, topography, and relatively static soil properties, such as soil texture, depth, and mineralogy) in order to provide end-users site-specific and sustainable land management options (Herrick *et al.*, 2016). LandPKS is being designed to complement GAEZ by using similar models and upscaling the data collected by land users so it can be linked to the global information provided by the GAEZ tool and similar tools currently in use at the subnational level (UNEP, 2016).

29 Where stratification is based on current land cover rather than potential, due to lack of soil information, land cover classes could be based on nationally refined FAO Land Cover Classification System (LCCS) land cover classes. The LCCS provides a common reference structure for the comparison and integration of data for any generic land cover legend or nomenclature that allows correlation of land cover with a set of independent diagnostic criteria. This integrated system for land cover observation provides worldwide consistency and links local and global levels of observation, and as such, has been adopted at the international level by ISO TC211 on the basis of the Land Cover Meta Language (LCML) developed by FAO.

30 http://www.fao.org/nr/gaez/

6.3.3 Land degradation assessment

To inform planning decisions, and decisions on interventions to support LDN, land managers need information about the condition of the land, with respect to its state of degradation (as recent as possible). Ideally, degradation assessment would be undertaken based on a functional typology related to change processes (Geist, 2004; Sietz *et al.*, 2011). This assessment can be based on national and/or global data sources relevant to land degradation (ITPS, 2015). Ideally determining land degradation status would involve the same data sets that will be used to monitor LDN, analysed to assess land condition, including, for example, a trend analysis of the UNCCD land-based progress indicators and their associated metrics (e.g., land cover/land cover change; land productivity/NPP; carbon stocks/SOC).[31] Analysis of trends in each of the indicators can help identify degradation "hotspots" (where land condition is good but deteriorating) in support of efforts to select and prioritize interventions to arrest degradation on the highest priority locations. Information about land condition can inform decisions on actions to avoid or reduce land degradation. Finally, the initial land degradation status is also necessary for calculating SDG indicator 15.3.1 "Proportion of land that is degraded over total land area", making use of the same set of metrics (chapter 7.11.2; ECOSOC, 2016).

31 A trends analysis approach was applied in the land degradation assessment conducted during the LDN pilot. See chapter 7.11 for more details on the important difference between using trends to assess land degradation and using absolute numerical values for monitoring LDN. See UNCCD 2013, ECOSOC, 2016, Walker *et al.* (2004)

6.3.4 Resilience assessment

Exploring the resilience of current and proposed land uses and management will assist in devising effective interventions in pursuit of LDN. Resilience refers to the ability of a system to absorb disturbance and reorganise so as to retain essentially the same function, structure, and feedbacks, that is, the capacity of the system to continue to deliver the same ecosystem services in face of disturbance (Walker *et al.*, 2004). Resilience assessment considers the current condition of the land, the adaptive capacity of the land use system, and its likely trajectory under anticipated stressors and shocks. It considers the capacity of the system to meet human needs both now and in the future and identifies the factors that limit the potential for LDN to be achieved. It involves considering the system's vulnerability to known shocks and trends, general resilience to cope with unknown shocks, and assessing proximity to known thresholds. Particular attention should be paid to the likely impacts of climate change. The assessment will therefore consider risk exposure and system stability (sensitivity) to avoid tipping points, particularly those that lead to shift to a less productive state. Assumptions applied and timeframe of resilience assessment should be clearly stated.

Assessment of the social-ecological system, within which the land is a component, will help guide land use decisions, identify whether current management approaches are likely to lead to degradation, select which interventions are most appropriate (and if degraded already, whether the land is a likely candidate for restoration or rehabilitation, and whether or not the proposed interventions would help achieve LDN. Resilience assessment may identify opportunities to improve the resilience of current land use systems, or the need to introduce adaptation measures in order to manage risks. Furthermore, it may highlight the need to plan for transformation in some parts of the system particularly in the longer term, in order to cope, for example, with the anticipated interactions between climate change and land degradation risks. Tools including the Resilience, Adaptation Pathways and Transformation Assessment (RAPTA)[32] framework and the Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists (SHARP)[33] are available to guide resilience assessment.

6.3.5 Socio-economic assessment

Next it is necessary to evaluate social and economic impacts of alternative land use options and proposed interventions, not only locally, but ideally in aggregate at the landscape or national scale. "Winners" and "losers" across social groups should be identified. Because the economic benefits of achieving LDN are both public and private, and accrue over the long term, and there are often trade-offs, the full suite of benefits and costs must be considered to determine whether the benefits outweigh the costs. There is growing evidence that SLM investments show a positive return on investment (ELD Initiative, 2015). As the economic benefits associated with gains towards LDN will include a mix of direct private and indirect public values, it is informative to estimate the economic value of the improvements to natural capital and ecosystem services arising from LDN activities[34] so that the impact on local and national economies due to LDN investments may be quantified relative to business as usual. Scenario analyses could be used to evaluate options for achieving LDN by 2030[35] and investigate impacts beyond 2030, recognising that SLM and restoration activities are long-term investments. Under scenarios compatible with the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), it would be possible to assess future spatial land use arrangements that would achieve LDN, and calculate the economic and social costs and benefits of these arrangements, so that various policy drivers and incentives (market and non-market) could be assessed and the most cost-effective pathways to achieving LDN could be identified.[36] Assumptions applied in such scenarios must be clearly stated. Incentive mechanisms could be devised that reward land managers for the public benefit delivered by their actions, bridging the gap between initial economic outlay and private benefits that accrue in the long term.

Social assessments should include measures addressed and monitored by the other SDGs such as improvement to food security and poverty alleviation, access to water and

32 The Resilience, Adaptation Pathways and Transformation Assessment RAPTA framework was acknowledged in decision 21/COP.12. (Report of the 12th session of the COP, ICCD/COP(12)/20/Add.1UNCCD COP12). For the RAPTA guideline, see O'Connell, *et al.*, 2016).

33 http://www.fao.org/in-action/sharp/en/

34 This can be done, for example through the United Nations Statistics Division (UNSD) System of Environmental-Economic Accounting (SEEA) Experimental Ecosystem Accounts or The Economics of Ecosystems and Biodiversity (TEEB).

35 Recent assessment of scenario modelling tools for the SDGs can be found in: (Allen *et al.*, 2016).

36 There are tools that can be used at the national scale to assess land use efficiency and evaluate trade-offs, such as the Land Use Trade-Offs (LUTO) model. See Bryan, *et al.*, 2015).

other natural resources, gender inclusiveness, cultural aspects and macro-economic indicators like gross domestic product and employment (ECOSOC, 2016). Consideration should be given to cross-scale concerns such as impacts of international trade that may affect land use decisions, lead to imperfect markets or increase land speculation and large-scale land acquisitions.

6.3.6 Gender considerations for the design of preliminary assessments

Poverty is a root cause, and at the same time a consequence, of land degradation, and gender inequality plays a significant role in land-degradation related poverty (UNDP, 2005; UNCCD, 2011b):

- Globally, women are the majority of world's poor – they account for 70% of those who live on less than one dollar a day.
- Women own less than 10% of the land worldwide.
- In most developing countries, land degradation impacts men and women differently, mainly due to unequal access to land, water, credit, extension services and technology.
- Land degradation impacts may cause younger men to migrate to look for work, leaving women behind to manage the land, collect firewood, fetch water, and take care of children and the elderly.
- At the country level, development achievements are inhibited by these gender differences, particularly in developing countries where land degradation is severe.

There are a number of excellent sources for best practices in gender assessment and analysis (e.g., Doss & Kieran, 2015). Recommended practices include:

- Collect information about both men and women. Ask questions about specific individuals or groups and identify them by sex.
- Collect information from men and women.
- Those collecting and analysing the data need to understand gender roles, social dynamics, with questions adapted for context.
- Budget and plan for the collecting of sex-disaggregated data.
- Work with a gender expert early in the process to define the research question and methodology.
- Make use of FAO's Gender and Land Rights Database (GLRD) which highlights the major political, legal and cultural factors that influence the realisation of women's land rights throughout the world.[37]

Women are also central to successful efforts to manage land sustainably, build resilience, and ensure food security and they play critical roles in the agricultural value chain including the availability, access and utilization of food (Richardson Temm, 2016). In this sense, women are not only essential for assessing resilience and the socio-economic factors that influence potential responses to land degradation; they also capitalize on the potential of the land and are impacted by its condition, and can consequently play a key role in building resilience through the implementation of interventions.

Gender consideration should be integrated into the planning and implementation of LDN (chapter 6.3.6). Stakeholder engagement (chapter 6.6.5) should be undertaken with recognition of the different needs of men and women, ensuring that women are able to contribute. The preliminary assessments for LDN

37 http://www.fao.org/gender-landrights-database/background/en/

(chapter 6.3) should include consideration of gender inequality and its impacts on land management, such as through land tenure arrangements. In assessments and implementation of LDN, if women are not actively invited to participate, and regularly engaged, the impact of interventions designed to avoid, reduce or reverse land degradation will be much less than their potential because the strong influence of women in most land-based livelihood systems (e.g., Agrawal, 2010). If preliminary assessment data are collected without the capacity to be evaluated within livelihood system context, even if women participate, the results will be less useful (and certainly misleading). Moreover, if gender is excluded from the analysis of preliminary assessment data (e.g., poorly selected indicators, lack of advanced planning for the disaggregation of data by sex), then the findings will be incomplete or misleading. While environmental indicators may seem independent of gender, it is important to underscore that indicators are not neutral tools (Beck *et al.*, 1997; Doss & Kieran, 2015). Like all methodologies, indicators are influenced by political values and contexts and thus must be selected, measured, collected and analysed with the intention and capacity to be integrated with other data that can be disaggregated by gender. When they are, it is possible to measure gender-related changes in society and the environment over time. Therefore, preliminary assessments should be conducted strategically so that the data collected can be disaggregated by sex, socio-economic and ethnic grouping and age, against which progress and results can be measured. All trend monitoring of indicators thereafter will then have the capacity to be sex-disaggregated.

6.3.7 Initiate LDN monitoring

Complementary to the preliminary assessment process is the necessity to initiate monitoring of the LDN indicators/metrics to establish the baseline at t0, which also establishes the LDN target against which significant changes will be compared in the future (t1) (e.g., 2030) (as explained in chapter 4, Module B and illustrated in Figure 4). This provides the basis for monitoring and assessing the impact of interventions. The specifics of the monitoring approach are provided in chapter 7.

6.3.8 Establish mechanisms for learning and adaptive management

Achieving LDN targets will require a strategic and iterative approach to learning. Results of monitoring for UNCCD reporting can provide valuable information on progress towards the LDN target and outcomes of interventions undertaken in pursuit of LDN. Effective implementation of a structured learning approach that is embedded within management practices can build socio-ecological resilience, fundamental to sustainable land management and building adaptive capacity (Berkes & Folke, 1998). Ideally both individual and social learning (Armitage *et al.*, 2007; Reed *et al.*, 2010) are integrated into an overall approach to implementing LDN that encourages "triple-loop learning", where the first learning loop can lead to incremental changes in routine actions, the second leads to revisiting underlying assumptions, and the third may influence underlying values and core beliefs.[38] While the usefulness of such a

38 The concept of triple loop learning was described by (Hargrove, 2002), adapted to resource governance by Pahl-Wostl (2009) and applied to resilience in drylands by Stafford Smith *et al.* (2009).

structured approach has been demonstrated and guidelines for stakeholder engagement that emphasize cyclic learning have been developed (e.g., UNDP, 2010; Bautista *et al.*, 2016), putting a structured approach into practice is challenging because of limited stakeholder capacity relative to complexity of the overall process (Butler *et al.*, 2015). Chapter 6.6.5, on stakeholder engagement, recommends an experience-sharing component to LDN multi-stakeholder platforms, which could facilitate sharing of lessons learned and thereby support capacity building.

In the context of the pursuit of LDN, what is learned at each incremental monitoring effort should lead to refinements in integrated land use planning decisions and associated LDN interventions (first learning loop), revisiting underlying assumptions drawn from the preliminary assessments (second loop), and where necessary influence underlying values that frame the context and enable an environment conducive to achieving LDN (third loop) as shown in Figure 9. Between t0 and t1 the UNCCD envisions LDN status will be monitored three times,[39] providing multiple opportunities for mid-course corrections in planning and intervention decisions as well as adequate time for adjustments in original guiding assumptions and modification of the underlying enabling environment (policy, governance, participation, etc.) based on learning, to help ensure that LDN is maintained or exceeded at t1. The learning process should, using the knowledge generated through monitoring, evaluate the hypotheses that underpin this framework: consider whether the metrics are suitable measures of land-based natural capital; examine the outcomes of counterbalancing, particularly with respect to achieving "like for like"; and consider the effectiveness of the safeguards, especially with respect to protecting rights of local people.

6.4 Integrated land use planning for LDN

LDN planning and implementation should be embedded into existing planning processes rather than being an additional process. LDN intervention planning and efforts to document planned gains, anticipated losses and associated measures to reach LDN should be incorporated into UNCCD NAPs (middle column, Figure 9). UNCCD NAPs are considered to be dynamic and adaptable frameworks, and for those countries that choose to engage in "LDN target setting" at the national level, the process should be fully incorporated into their NAPs in order to facilitate implementation on the ground. In addition, LDN implementation should be mainstreamed into national development plans (e.g., through United Nations Development Assistance Frameworks (UNDAF))[40] and other national policy processes (e.g., UNFCCC NAPs),[41] to leverage investments in these related measures, while utilizing information from relevant assessments (e.g., Land Degradation and Restoration

39 As the same indicators are used, the regular reporting to the UNCCD will provide data that could be used for interim monitoring prior to the final monitoring at t1 to evaluate LDN status.

40 UNDAFs are the planning framework for the development operations of the UN system at the country level, providing support for land use planning and environmental impact assessment.

41 http://unfccc.int/adaptation/workstreams/national_adaptation_plans/items/6057.php

Assessment (LDRA) of the IPBES;[42] Global Land Outlook (GLO) of the UNCCD;[43] the Economics of Land Degradation (ELD) Initiative;[44] the IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems;[45] Global Environment Outlook assessments of the United Nations Environment Programme (UNEP);[46] Millennium Ecosystem Assessment (MA, 2005). This will promote action to achieve LDN and minimise duplication of efforts.

Furthermore, through Decision 2/COP.12, the UNCCD endorsed the formulation, revision and implementation of action programmes in view of the 2030 Agenda for Sustainable Development, (United Nations General Assembly, 2015) encouraging the linkage between planning and the implementation of LDN.

The LDN preliminary assessments (chapter 6.3) are designed to provide decision makers with the necessary information and tools to identify and prioritise appropriate options for specific sites, and explore trade-offs within a biophysical or administrative domain. However, determining whether the combined set of planned interventions designed to lead to improvement in the land-based natural capital will be sufficient to counterbalance land use and management that is anticipated to lead to a decline in the natural capital elsewhere, requires an inventory or accounting process. This holistic analysis can be made operational if an appropriate means for tracking potential gains and anticipated losses is available. Ideally this would occur at the point where land use decisions are made. Although the concept of counterbalancing anticipated losses with gains is relatively straightforward (Figure 5), keeping track of land use decisions with respect to neutrality requires an effective mechanism. This chapter documents how this can be operationally feasible through *integrated land use planning*. Integrated land use planning seeks to balance the economic, social and cultural opportunities provided by land, with the need to maintain and enhance ecosystem services provided by the land-based natural capital. It also aims to blend or coordinate management strategies and implementation requirements across sectors. These characteristics are also necessary to enable holistic land use decision-making that accounts for the cumulative potential changes

WHAT IS LEARNED AT EACH INCREMENTAL MONITORING EFFORT SHOULD LEAD TO REFINEMENTS IN INTEGRATED LAND USE PLANNING AND ASSOCIATED LDN INTERVENTIONS.

42 http://www.ipbes.net/work-programme/landdegradation-and-restoration

43 http://global-land-outlook.squarespace.com/

44 http://eld-initiative.org/

45 The scoping process for the "IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems" is slated to begin in early 2017. More information is available online: https://www.ipcc.ch/report/sr2/

46 http://www.unep.org/geo/geo5.asp

INTEGRATION OF PLANNING FOR LDN INTERVENTIONS INTO EXISTING LAND USE PLANNING IS ENCOURAGED. PARTICULAR ATTENTION IS PAID TO PROJECTING AND TRACKING THE LIKELY CUMULATIVE IMPACTS OF LAND USE AND LAND MANAGEMENT DECISIONS.

(positive and negative) on all land units of each land type with the ultimate aim of achieving or exceeding LDN.

The decision to leverage existing planning processes for tracking LDN rather than relying on an LDN monitoring programme is based on the temporal realities of degradation and recovery processes. A monitoring programme, while indispensable over the longer term for the assessment of the *impacts* of both land degradation and responses to it, unfortunately cannot help decision makers keep track of their efforts to maintain (or exceed) LDN. This is because effects of land degradation become apparent much more rapidly on the landscape than the impacts of interventions to mitigate it or restore/rehabilitate degraded land. Decision makers therefore will need to keep track of their efforts to achieve LDN at the point that land use planning decisions are made – those actions designed to deliver significant positive change (gains) as well as those potentially leading to negative change (losses). This will allow land use planners, managers and policy makers to, on a regular basis, gauge the cumulative impact of land use decisions with respect to pursuit of neutrality. Without such a planning inventory, the pursuit of LDN will be fragmented, with risk of decisions being made in one location or sector without knowledge of the larger reality for the overall biophysical (e.g., watershed) or administrative (e.g., province) domain.

It is important to recognise that projecting changes in natural capital due to land use and management decisions is challenging. The accuracy of these estimates will be variable; for example, the impacts of some land use decisions may be more readily estimated than others, which could result in an uneven error in the estimate of anticipated losses and gains. Another challenge arises because land use decisions often require trade-offs in ecosystem services. Specific ecosystem services will have different values in different places to different stakeholders, and human values may change over time.[47] It should also be recognised that counterbalancing can lead to the transfer of resources or funding from places being degraded to those where gains are sought, either as a direct commercial exchange or indirectly through public measures such as taxes. Land use decisions need to consider issues of equity, and also need to address timing of impacts, power relations and compensation of potential 'losers' in the arrangements.

To make integrated land use planning operational, it is necessary for a country to link LDN planning as closely as possible with existing land administration processes and land information infrastructure, without restricting innovation. This linkage is not without precedent. It is central to how efforts to pursue the environmental goals of the Rio conventions and efforts to achieve sustainable development

47 The spatial aspect of these trade-offs is addressed through the response hierarchy (chapter 6.1), and the social aspect should be addressed during stakeholder engagement (chapter 6.6.5).

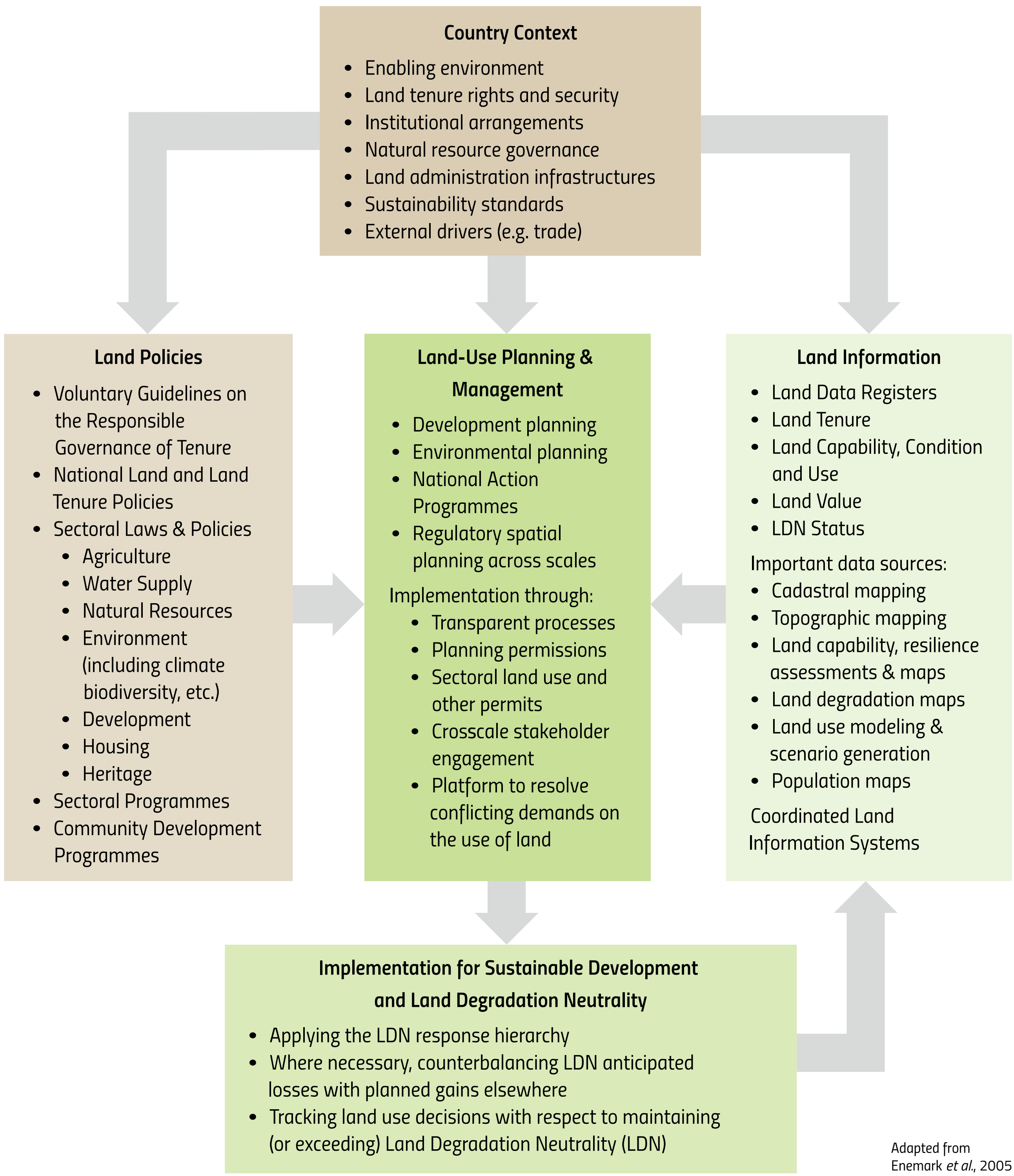
have been integrated in the past, e.g., Chapter 10 of Agenda 21 which provides the foundational guidance for an integrated approach to the planning and management of land resources, (adapted from United Nations General Assembly, 1992a).[48] A recent review of Agenda 21 suggests that the pursuit of integrated land use planning has had mixed results due to a range of political and technical challenges; however, there have been significant enhancements in land evaluation and land administration technologies in recent years that have made effective integrated land use planning much more feasible (Stakeholder Forum for a Sustainable Future, 2012; Dodds *et al.*, 2012). These include the technological means to provide a basic data infrastructure for implementing land-related policies and land management strategies to ensure social equity, economic growth and environmental protection (Williamson *et al.*, 2010). When pursued to its full potential, the operational component of a coordinated land administration system integrates the range of functions that ensure the proper management of rights, restrictions, responsibilities and risks in relation to property, land and natural resources. These functions include the processes related to land tenure (securing and transferring rights in land and natural resources), land value and land use (planning and control of the use of land and natural resources). Figure 10 documents the key elements of a fully integrated land use planning and management system with respect to sustainable development and LDN (adapted from Enemark, Williamson, & Wallace, 2005). While the contribution of specific elements may vary among countries, all are important for effective integration and can contribute to maximizing the potential for a country to track land use decisions with respect to achieving LDN. Embedding iterative learning (chapter 6.3.8) will be important, to enable adjustment to planning processes when outcomes do not match expectations.

There are a variety of approaches to land administration and associated systems, and the nature and capacity of these systems varies widely from country to country. The LDN framework provides tiered options for leveraging integrated land use planning in order to track gains and losses (Table 4). These options range from tracking gains and losses in parallel to a country's land administration system (Level 1), to the addition of direct links to data from preparatory assessments (Level 2), to full integration into a country's land administration system (Level 3). In addition, all three levels have the potential to be linked to LDN monitoring efforts, which are discussed in chapter 7 (Module E).

48 In Agenda 21, the case for integrated land use planning is summarized in Chapter 10, section 10.3: "Land resources are used for a variety of purposes which interact and may compete with one another; therefore, it is desirable to plan and manage all uses in an integrated manner. Integration should take place at two levels, considering, on the one hand, all environmental, social and economic factors (including, for example, impacts of the various economic and social sectors on the environment and natural resources) and, on the other, all environmental and resource components together (i.e., air, water, biota, land, geological and natural resources). Integrated consideration facilitates appropriate choices and trade-offs, thus maximizing sustainable productivity and use. Opportunities to allocate land to different uses arise in the course of major settlement or development projects or in a sequential fashion as lands become available on the market. This in turn provides opportunities to support traditional patterns of sustainable land management or to assign protected status for conservation of biological diversity or critical ecological services."

FIGURE 10

Integrated land use planning for sustainable development and LDN



Adapted from Enemark *et al.*, 2005

6.5 Interventions to achieve LDN

The final implementation step is putting LDN plans into action and carrying out the interventions. In the broader context, acting involves establishing enabling governance (institutions, laws, regulations), engaging stakeholders and pursuing land management practices that prevent degradation, reduce degradation, or restore ecosystem functions in accordance with the response hierarchy (Figure 7). Various tools, including those recommended for assessment of land potential and resilience provide guidance in devising effective implementation pathways. There is substantial literature and guidance available on the wide range of land management interventions and associated good practices.[49] Table 5 provides some examples of these with respect to the LDN response hierarchy (Figure 7) and the "Interventions" column in Figure 9. It is important to recognize that some land use change is inevitable, leading to transformed ecosystems (Figure 11) which may (depending on the change and future management) have a structure and function that decreases, maintains, or even enhances, (Kust *et al.*, 2016) natural capital, with associated effects on provision of ecosystem services (Bestelmeyer *et al.*, 2015).

The preliminary assessments provide information that is used to identify and evaluate options for interventions. Decisions should consider the projected change in natural capital and the flow of ecosystem services delivered by the proposed action, estimated from the land potential and resilience assessments. This information, combined with the economic assessment, will help decision makers compare the return on investment of different options under consideration. Evaluating the potential impact of various options can also be facilitated through scenario planning and analysis, and through back-casting. Scenario planning involves formulating a goal and then identifying options and analysing the pathways (policies, strategies) that would enable the goal to be attained. Intervention options should be critically assessed for their impacts on all ecosystem services, considering trade-offs for example between biomass production (which could be maximised, for example, by a monoculture of exotic trees) and biodiversity (which will be favoured by a mix of native species), and risk of future loss (which, in this example, would be lower with the mixed species stand). Where decisions involve trade-offs between ecosystem services, or between environmental and social goals, transparent participatory processes should be applied to prioritise between different ecosystem services, based on needs and goals of the stakeholders. The same resilience-focused methods used for assessment (chapter 6.3.4) can be applied at this stage, where consideration of the needs for resilience, adaptation or transformation (in some or all parts of the system) will assist in evaluating intervention options and identifying those sites and interventions that are most likely to deliver required gains in the medium to long term, in order to achieve LDN. Interventions should be devised with consideration of the context,

LDN PLANNING AND IMPLEMENTATION SHOULD BE EMBEDDED INTO EXISTING PLANNING PROCESSES RATHER THAN BEING AN ADDITIONAL PROCESS.

49 For example, there is a major ongoing effort to harmonise guidelines on implementing SLM: See GSP (2016).

TABLE 4

Options for linking LDN tracking to a country's existing land administration systems

Level 1. LDN tracking outside of land administration systems

In countries where existing land administration systems do not currently integrate land use planning and the management of land resources, LDN land use decision tracking can be conducted when LDN interventions are planned (gains) and anticipated degradation is estimated (losses), ideally in conjunction with UNCCD NAP processes, national development processes, and, where applicable, other directly related activities. Leveraging these efforts will ensure more comprehensive tracking and minimise duplication of efforts. The information recorded to help track LDN would be similar to that provided in the balance sheet example (Table 2) and in the example for a specific land type illustrated in Figure 6.

Level 2. Level 1 tracking coupled with systematic preliminary assessments

A fundamental input to integrated land use and management planning efforts is the systematic assessment of land and land use options (e.g., land potential, condition, resilience, socio-economic status, trade-offs). Coupling these preliminary assessment data with LDN intervention planning would provide a more streamlined first order analysis of degradation risk associated with specific land use options, which could help both guide those decisions and increase the accuracy of impact estimates. The additional information tracked would include data associated with land potential, condition, resilience, socio-economic factors and trade-offs coming from the preliminary assessments.

Level 3. Levels 1 & 2 tracking embedded into a country's land administration system

Land administration systems vary from country to country, but it should be relatively easy and inexpensive to augment these systems to keep track of gains and losses with respect to LDN. Adding LDN information (Level 1 – anticipated losses and proposed gains) and land assessment results (Level 2) into the country's land administration systems would enable ongoing tracking of land use decisions, so that the balance of gains and losses estimated for those decisions, by land type, could be calculated at any time, scenarios could be generated to help decision makers consider options when making future land use decisions, and transparent information on land tenure decisions related to LDN would be openly available.

Option of a link to LDN monitoring for more effective implementation.

Integration of LDN land use decision tracking with LDN monitoring (chapter 7, Module E) can occur at any of the three levels of tracking, since all three levels track the location and area of intended interventions on the land. Linking the LDN monitoring system would allow site/project specific analysis of the actual impacts resulting from those decisions.

including motivation and capacity of stakeholders, and ecological, market and policy conditions. Tools are available to assess the context of and guide planning for interventions to reverse land degradation, (e.g., Hanson *et al.*, 2015; IUCN, 2014; Liniger *et al.*, 2011; Tongway & Hindley, 2004; Whisenant, 1999)

Within a land type, different land units will have different potential for success in restoration/rehabilitation. In planning LDN interventions (within a land type), countries should prioritise actions at sites that are anticipated to deliver the greatest gains in those services that are valued most in that country/locality, informed by land use and land condition.

6.6 Governance and LDN

This chapter addresses several aspects of governance and LDN, including the role ofnational governments, local governance, stakeholders, partnerships and finance.

Governance with respect to LDN in the context of sustainable development is intrinsically linked to land governance, thus includes the policies, processes and institutions by which land, property, natural resources and tenure are managed, including decisions on land use and management, land development, access to land, land value and land rights (Enemark, 2012). Aspects of governance relevant to LDN include legislation governing land use and land management practices, schemes to promote sustainable land management (standards, possibly including certification), industry development plans, infrastructure policies, agricultural subsidies, trade agreements and trade regulations.

6.6.1 Governance of land tenure

The governance of tenure is a crucial element in determining if and how people, communities and others are able to acquire rights, and exercise the responsibilities that come with those rights, to use and control land. Many tenure problems arise because of weak governance, and attempts to address tenure problems are affected by the quality of governance. Weak governance adversely affects social stability, sustainable use of the environment, investment and economic growth. People can be condemned to a life of hunger and poverty if they lose their tenure rights to their homes, land, fisheries and forests and their livelihoods because of corrupt tenure practices or if implementing agencies fail to protect their tenure rights. People may even lose their lives when weak tenure governance leads to violent conflict. Conversely, responsible governance of tenure promotes sustainable social and economic development that can help eradicate poverty and food insecurity, and encourages responsible investment. In response to growing and widespread interest, FAO and its partners embarked on the development of guidelines

WHERE DECISIONS INVOLVE TRADE-OFFS BETWEEN ECOSYSTEM SERVICES, OR BETWEEN ENVIRONMENTAL AND SOCIAL GOALS, TRANSPARENT PARTICIPATORY PROCESSES SHOULD BE APPLIED.

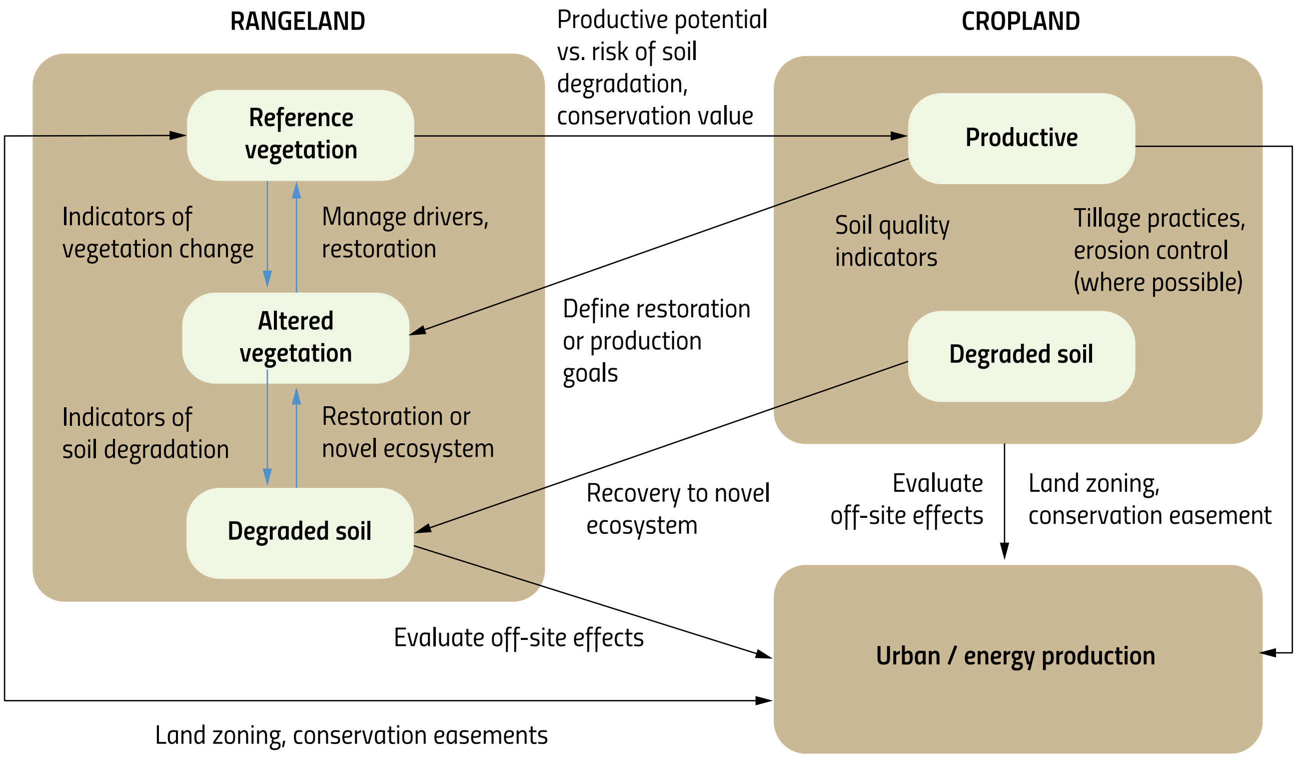
TABLE 5

Examples of land use and land management activities applicable at each level of the response hierarchy, with focus on agricultural land

Action	Starting condition	Activities (examples)
Prevent: Avoid land degradation	Not degraded productive (agricultural land) Not degraded, intact natural system (conservation land)	Low impact agriculture and forestry: SLM and SFM practices (as suited to the context), that conserve soil fertility (nutrients, organic matter), minimise disturbance and erosion, avoid contamination. Practices Include: judicious chemical inputs; reduced/zero tillage, crop rotations, retaining residues, controlled traffic; green manure cropping; organic amendments; biochar; pasture phase; agroforestry; intercropping; permaculture. Management of protected areas to prevent soil erosion, vegetation loss and weed incursion through appropriate design of roads and walking tracks.
Reduce rate of degradation	Partly degraded, reduced productivity	Reduce rate of land degradation: As above, but more intensive, targeted management – organic matter addition, pasture phase, water conservation; active measures to reduce erosion (e.g., contour banks), correct degrading processes (such as acidification and salinization though liming and strategic reforestation respectively)
Reverse: i.e., restoration or rehabilitation of severely degraded land	Degraded land, unproductive	Substantial (possibly transformational) Interventions to enhance productivity: high rates of organic amendment (compost, manure) to build nutrient levels and biological activity; amendments to address soil limitations e.g., lime, gypsum, clay (to sandy soils), biochar, water harvesting.
Situations that require counterbalancing*		
Anticipated ongoing land degradation	Partly degraded managed land	Degrading management practices: intensive biomass removal, high chemical inputs, frequent tillage, burning crop residues
Anticipated degrading land use change	Forest or other natural area Productive agricultural or forestry land	Deforestation Drain wetland Convert farmland to settlement Convert forest to open-cut mine

* With respect to LDN status, severely degraded land at t0 does not require counterbalancing because it will not show further losses in the metrics assessed. It may be a candidate for gains through restoration

FIGURE 11
Conceptual model of state change in the drylands



Major land uses (large boxes), generalized alternative vegetation/soil states within each major land use (small boxes), showing state change and regime shifts within a land use resulting from management interventions (blue arrows), and considerations in managing land-use change (black arrows). Source: (Bestelmeyer *et al.*, 2015).

on responsible tenure governance.[50] The VGGTs were adopted by the UN Committee on World Food Security (CFS) in 2012, and endorsed by the G20, Rio+20, the UN General Assembly and the Francophone Assembly of Parliamentarians. They form the basis of how responsible governance underpins the pursuit of what the vision of LDN can achieve (Chapter 3, Module A).

50 See footnote 15 and see footnote 27.

6.6.2 Actions policy makers can take for governance in support of LDN

For governance to be effective in supporting efforts to achieve the vision of LDN, policy makers need to take specific actions, which have been explained in the context of each of the LDN conceptual framework modules. Annex 1 summarizes in a checklist format those activities that require awareness and/or action by policy makers seeking to ensure appropriate governance in support of LDN.

6.6.3 The role of national governments

At the national level, governments and policy makers play a critical role in determining the success of LDN, as they not only represent their country at the international level and define international action on LDN, they also must establish the national policies, measures and rules and funding mechanisms that determine how LDN activities will be implemented and supported on the ground. For countries developing LDN policies, a thorough understanding of the policy, legislative, institutional, socio-economic and cultural context, the knowledge base on land and ecosystems, and national conservation and development objectives and plans is essential and must underpin all aspects of policy design.

Accurate assessment data concerning land potential, resilience and socio-economic conditions need to be integrated into land use planning. There are likely to be trade-offs and compromises but where they are based on defensible evidence there is scope for greater transparency in decision making. Clear guidance is needed to support appropriate and consistent use and interpretation of landscape-level land use and conservation plans. The limits to development must also be defined and applied,

BOX 5

Principles related to good governance

1. **Effectiveness:** define clear LDN goals and targets at all levels of government in order to focus policy development and implementation efforts towards achieving those goals and meeting the agreed targets;

2. **Efficiency:** maximise the benefits of avoiding, reducing and reversing land degradation at the least cost to society;

3. **Trust and engagement:** build public confidence and ensure inclusiveness through collaborative legitimacy, ensuring the security of livelihoods and fairness for society at large;

4. **Sustainability and local responsiveness:** balance the economic, social, and environmental needs of present and future generations and ensure the interchange between institutions/multi-stakeholder platforms at different scales;

5. **Legitimacy and equity:** achieve societal endorsement through collaborative processes and deal fairly and impartially with individuals and groups, providing non-discriminatory access to services;

6. **Transparency, accountability and predictability:** strive for open governance that demonstrates stewardship, responds to feedback and communicates decisions in accordance with rules and regulations;

7. **Integrity:** ensure a clear separation between private interests and governance decisions.

particularly if estimates of potential losses are likely to exceed planned gains.

It is important that national legislation is stable and consistent, and provides support to local and subnational LDN interventions through institutional links that ensure awareness and effective decision making across scales. Establishing a national guiding framework on LDN is also important while retaining flexibility to allow the details of the planning and implementation to be tailored to local contexts.

Policy makers should also integrate LDN policies with broader development strategies to avoid conflicting land-use policies that can undermine efforts to achieve LDN. Economic development plans, infrastructure policies, agricultural subsidies and land-use planning policies should be reviewed to ensure coherence with LDN policies. In particular, governments should pay special attention to reforming policies specific to land ownership and use, such as land tenure, use rights and agricultural subsidies, to ensure they do not create perverse incentives.

The capacities of all relevant institutions (at national, sub-national and local levels) must be strengthened to understand the implications that a national LDN policy can have on their activities, and, conversely, how their policies could affect the success of LDN. It is critical that all government agencies that affect or are affected by land use—whether directly or indirectly—understand how LDN works, and what activities, policies and measures will be needed to ensure its success. Particular emphasis should be placed on building capacity within the relevant ministries and sectors, including those responsible for agriculture, forestry, infrastructure development, urban planning, mining, water, energy and the environment, to ensure coherence between ongoing development plans and LDN initiatives. Multi-sectoral coordination will be essential in this regard, as will vertical coordination from the national level to sub-national and local governments and authorities (Bizikova *et al.*, 2015).

Governments should establish mechanisms, such as legal covenants, to ensure long-term protection of gains on land restored through counterbalancing. In some countries, this may require investment in processes to clarify and secure tenure rights. Policies should underpin appropriate and enabling land tenure that ensures long-term protection under a variety of mechanisms such as community use and stewardship, resource rights schemes, private and state-owned land.

National, sub-national and local governments may also need to develop and incentivize alternative, sustainable livelihood activities for local communities, such as SLM, SFM, sustainable agriculture, and community land management, to ensure that they have sufficient employment and income-generating opportunities. Introduction of such policies and programmes can have flow-on effects, generating livelihoods, such as through opportunities for small businesses, in the local community.

In addition, there are a number of challenges that governments will have in defining their national approaches to achieving LDN. Currently, according to the UNCCD, country Parties are responsible for submitting their NAPs and ensuring that they are aligned with the Convention's Ten Year Strategic Plan. The next step should be for Parties to align their NAPs with the LDN vision. Many countries have already aligned or are in the process of aligning their NAPs with their commitments under other multilateral environmental agreements, including the CBD's National Biodiversity Strategies and Action Plans (NBSAPs), the UNFCCC's national greenhouse gas inventories related to land-use, land-use change and forestry (LULUCF) and REDD+, along UNFCCC NAPs and NDCs, in a way that minimises the duplication and potential contradiction among policies that are being implemented under the various conventions (UNCCD, 2012; Jenner & Howard, 2015; Harvey *et al.*, 2010).

It is also important for governments to take into consideration lessons learned and best practices from other similar policies, including carbon and biodiversity offsets, to guide their implementation of LDN interventions and to monitor progress towards achievement of LDN (Welton *et al.*, 2015; Maron *et al.*, 2015).

6.6.4 The role of local governance

One central element of promoting good governance at the local level is known as social capital strengthening (Gruet, 2008; Cheema & Maguire, 2003). Putting land use governance in practice on the ground implies supporting and strengthening existing organizations and networks that often operate in a way that is not linked to formal or official governance systems. This involves actively connecting local systems among those organizations in order to make them stronger, efficient and more representative of the interests of local communities and then working with them to link to broader governance systems at the national level. Associative governance (Gunasekara, 2006) is essential for improving the implementation of key interventions which require local commitment, like SLM. Good governance also requires establishing mechanisms to empower local systems for the monitoring of land resources, which can then be linked to the national level.

6.6.5 The role of stakeholder engagement

Good governance includes efforts to promote knowledge sharing so that land users can learn what options are available and have the capacity to inform other stakeholders and decision makers on practical, sociocultural limitations and opportunities. The cross-fertilization of good ideas is essential and genuine stakeholder engagement leads to social learning, increased social capital and better acceptance of well-informed decisions on the ground. For any LDN project to be effective, governments must develop inclusive, participatory consultation and outreach programmes to engage stakeholders in the co-production of knowledge and mutual learning at both the national and local levels, which could be accomplished through the establishment or leveraging of multi-stakeholder platforms at each relevant scale, with established links across scales (De Vente *et al.*, 2016; Puppim de Oliveira & Paleo, 2016; Reed *et al.*, 2014). This would enable regular consultative and feedback processes on the design of the national LDN strategy to ensure that concerns of relevant stakeholders are properly addressed. At the national level, such a programme should ensure that relevant information is disseminated to the general public, all government agencies, and the private sector on national and local approaches to LDN. At the local level, there should be engagement and participation of all local stakeholder groups (including local communities, indigenous peoples, farmers, individual landowners, etc.) that may impact or be impacted by LDN policies and measures. Outreach programmes should include capacity-building activities so that local stakeholders are enabled to participate in LDN initiatives. The multi-stakeholder platforms should also have transparent mechanisms for providing regular updates to stakeholders as well as receiving and responding to stakeholder feedback.

To accomplish this, it may be necessary to develop and disseminate clear, simple, basic information on the concepts, goals and indicators of LDN through workshops, meetings, internet, social media and radio programmes, to build stakeholder capacity and encourage their participation. Where possible, national and local governments and others should take advantage of relevant existing training and outreach materials such as those developed by NGOs, consultants and universities with prior experience in sustainable land management or land restoration or rehabilitation.

Local and/or national governments should work with existing local organizations and civil society groups to undertake stakeholder outreach and engagement on LDN. Local groups such as environmental CSOs, farmers' groups, indigenous peoples' organizations, regional government networks and SMEs can be useful allies for organizing outreach activities, disseminating ideas and information, organizing training activities and channelling stakeholder feedback.

A learning plan should be devised and implemented, that could include an experience-sharing platform developed at the local, national or even international levels. This could be made part of the aforementioned multi-stakeholder platforms. It would enable project and field managers to access the knowledge and experience gained in other LDN initiatives, and government agencies to learn from collective field experiences to inform the design of national LDN policies (Chasek *et al.*, 2011). Ideally this approach would be integrated into the UNCCD Knowledge Hub which provides one-stop access to a number of relevant knowledge sharing systems as well as the UNCCD Capacity Building Marketplace.[51]

In view of lessons learned with REDD+ projects and other offset programmes (May *et al.*, 2011; Naughton-Treves & Day, 2012; Slezak, 2016), it is important to acknowledge first and foremost that counterbalancing interventions might restrict pre-existing land use and cause conflict among land users, and between land users and other stakeholders. It is therefore essential to establish strong, experienced, comprehensive and representative multi-stakeholder platforms to guide LDN interventions. Ideally these platforms would leverage existing partnerships. These platforms should include representatives of local land users, experts in sustainable land and forest management, agriculture, ecosystem services, those with practical experience in local stakeholder engagement and project implementation, familiarity with the local context, project management skills, good relationships with government officials and detailed knowledge of relevant national and international laws and policies. Partners with experience in local stakeholder engagement, including communities and indigenous peoples in the area where interventions may occur, are important

AT THE LOCAL LEVEL, THERE SHOULD BE ENGAGEMENT AND PARTICIPATION OF ALL LOCAL STAKEHOLDER GROUPS THAT MAY IMPACT OR BE IMPACTED BY LDN POLICIES AND MEASURES.

51 http://knowledge.unccd.int/

as their familiarity and track record will provide credibility and facilitate work on the ground. Involvement of local communities, critical to long-term success, must be facilitated with consideration of power relations, and acknowledgement that there are likely to be “winners” and “losers” amongst the stakeholders.

Building on successful existing partnerships and relationships can help ensure confidence among partners and local stakeholders and create a culture of trust and collaboration. As LDN initiatives are new and are expected to continue for years to come, partners need to be comfortable in working with each other over the long term. The roles and responsibilities of each partner should be specified and the structure should be formalized through appropriate agreements. A detailed strategy for communication and coordination among partners and between the government and other stakeholders is important.

6.6.6 Finance

The achievement of LDN is linked to sufficient financing. Successful implementation of LDN initiatives depends on the effective mobilization of resources from all sources, including national budgets, external donors and innovative sources of finance, ideally concurrent with local and national programming. The UNCCD is facilitating the integration urgently needed to package the results of various negotiations and emerging finance in a meaningful, action oriented way that will assist country Parties in implementing LDN more effectively. Most UNCCD NAPs provide guidance for addressing desertification, land degradation and drought (DLDD), having been developed both as a policy and as a strategy document in many developing countries (Squires, 2013). These policies must now begin to incorporate LDN policies and programmes in a way that facilitates not only *obtaining* the necessary financing, but also efficient and effective *investment* in LDN interventions.

Effective use of financial and human resources can be enhanced by seeking synergies among policies, commitments and investments at both the global and national levels. Fostering policy coherence and integrating commitments (e.g., leveraging climate finance) would involve creating links between, for example, climate change adaptation and LDN, taking into consideration that adaptation initiatives in many cases are land-based, and that LDN interventions deliver adaptation benefits. Synergies should also be identified between a country’s commitments – from restoration commitments. For example there could be links between the African Forest Landscape Restoration - AFR100[52] or Initiative 20x20[53] in Latin America and the Caribbean to the how land-based climate action is considered in the UNFCCC NDCs. Effective use of resources could also involve scaling up and bundling smaller/pilot projects that have demonstrated positive impact into larger programmes, supported by multi-partner arrangements and by tapping into innovative financing such as blended finance packages that creatively combine public and private, national and international, climate and development resources.

52 AFR100 is an African initiative which aims to restore 100 million hectares of deforested and degraded land by 2030. http://www.wri.org/our-work/project/AFR100/about-afr100

53 Initiative 20x20 is an initiative in Latin American and the Caribbean which aims to restore 20 million hectares of degraded land by 2020. http://www.wri.org/our-work/project/initiative-20x20

The flow of funds from a variety of donors to the implementation of LDN activities in the field must be facilitated by creating the conditions needed to access financing. These conditions include legal frameworks that enable the institutionalization of financing vehicles for LDN as a conservation mechanism and facilitate the transfer of funds allocated to conservation. These frameworks need to include clear pathways for beneficiaries and local community involvement. It is important that all stakeholders, including private sector and other donors, embrace the aspiration of LDN to maintain all the ecosystem services flowing from land-based natural capital (supporting, provisioning, regulating, and cultural) (Figure 3.) while simultaneously embracing the principles of good governance, including safeguarding land tenure rights, when devising plans for counterbalancing anticipated losses and gains to achieve LDN. Governance aspects that could impact on capacity to achieve LDN targets, such as trade regulations, should be reviewed and effort made to harmonise objectives, to facilitate leverage of funds and resources applied to related activities.

The Global Mechanism, in cooperation with Global Environment Facility (GEF) and other bilateral and multilateral public and private organizations and initiatives, is currently developing supporting mechanisms to provide up-front financing for LDN initiatives during their initial phases, as access to sufficient funding for early project and programme development is crucial. Central to this is the establishment of the LDN Fund (UNCCD-GM, 2016), which the GM is undertaking in collaboration with Mirova[54] – the responsible investment division of Natixis.[55] With a minimum capitalization of USD300 million, the LDN Fund is the most significant global response yet by public and private sector investors to land degradation. The LDN Fund is designed as a public-private platform for blended finance to provide long-term financing to projects that meet strict environmental and social standards. Its main focus will be on direct investments into large-scale land rehabilitation and land degradation avoidance projects, but will also integrate smallholders and local communities, and offer a dedicated window for small-scale projects and SMEs, through indirect investment with micro-finance specialists and local banks. Through a separate technical assistance facility, the LDN Fund will also facilitate project preparation and knowledge sharing aimed at attracting blended financial assistance to support large-scale efforts to restore or rehabilitate degraded land for sustainable and productive use with long-term private sector financing.

6.7 Summary of process for achieving LDN

The details of the process for achieving LDN will vary depending on the circumstances in each country. Table 6 summarizes the key features of the process. It may also be useful to consider Figure 9, which illustrates their interrelationship relative to the vision of what LDN can achieve, and Table 3, which summarizes the requirements and outputs of each preparation and implementation element.

54 Mirova – Responsible Investing. http://www.mirova.com/

55 Natixis, the international corporate, investment, insurance and financial services arm of Groupe BPCE. https://www.natixis.com/

TABLE 6

Summary of the key features of the process for achieving LDN*

Prepare for implementation of LDN through • Establishing required governance mechanisms, policy alignment (across scales and sectors), safeguards for land tenure rights and multi-stakeholder platforms; • Stratifying land area according to land types, based on ecosystem features; • Undertaking preliminary assessments of land potential, land degradation, resilience and relevant social and economic factors; • Developing capacity for resilience assessment and socio-economic assessment.
Integrate neutrality-focused land use planning mechanisms into existing land administration system, at the scale relevant to land use planning. Create national-level inventory of land use planning decisions to keep track of cumulative impact on achieving LDN.
Track land use and management decisions; apply resilience and other assessments to identify land area likely to be affected by significant losses or gains in land-based natural capital.
Plan a strategy to maintain the land-based natural capital through a dual-pronged approach of applying conservation measures to avoid or reduce the risk of degradation of land used for production, and restoration or rehabilitation measures on land that is already degraded. This strategy will involve the establishment of national targets for reversing land degradation (gains) as well as limiting any anticipated future degradation (losses).
Apply the response hierarchy: the preferred option is to take action to prevent land degradation, where non-degraded land is at risk of loss, followed by efforts to reduce land degradation by implementing practices with low land degradation risk, on managed lands, and finally actions that reverse land degradation.
Where counterbalancing is required, identify and evaluate alternative actions to reverse degradation and select actions that satisfy the principles of LDN, including the response hierarchy; counterbalance "like for like", within the appropriate spatial domain.
Establish monitoring of LDN indicators (t0) that determine the baseline values of the indicators.
Apply triple-loop learning and adaptive management (chapter 6.4.8)
Apply local knowledge to verify and interpret monitoring results, through a multi-stakeholder engagement process (chapter 6.7.5).
Monitor achievement of LDN by assessing indicators in the future (t1) (chapter 7).

*All these features require full consideration of the perceptions and realities of local land users, ideally through their direct participation.

Module E

MONITORING LDN FOCUSES ON ASSESSING CHANGE IN THE VALUES OF METRICS IDENTIFIED FOR INDICATORS OF LAND-BASED NATURAL CAPITAL FROM THEIR BASELINE VALUES.

Monitoring LDN

This chapter provides guidance on monitoring and reporting LDN achievement, including applying indicators and associated metrics for monitoring progress, and using changes in the values measured for the metrics of each indicator to evaluate LDN status.

Monitoring LDN focuses on assessing change in the values of metrics identified for indicators of land-based natural capital from their baseline (t0) values. The LDN conceptual framework approach to monitoring neutrality is separate but parallel to *planning* for neutrality ("the neutrality mechanism", chapter 5 (Module C)) and implementing the steps required to achieve LDN ("achieving neutrality" chapter 6 (Module D)).

MONITORING LDN FOCUSES ON ASSESSING CHANGE IN THE VALUES OF METRICS IDENTIFIED FOR INDICATORS OF LAND-BASED NATURAL CAPITAL FROM THEIR BASELINE VALUES.

7.1 Indicators of LDN

Indicators of LDN are proxies to monitor the key factors and driving variables that reflect the capacity to deliver land-based ecosystem services. Indicators should be assessed using metrics that are universally applicable, interpretable, and, preferably, quantifiable with available data sets. Indicators of LDN should be identified from the conceptual models presented in Figure 2 and Figure 3, which describe the factors and linkages that govern the maintenance of land-based natural capital. Additional indicators are required to monitor progress in implementation of LDN and socio-economic outcomes of LDN. Tools like RAPTA[56] can provide guidance on selection of appropriate indicators to complement the three global indicators.

7.1.1 The three global indicators

Globally relevant indicators for land degradation have inherent challenges due to the wide variability in land degradation as well as very practical considerations concerning capacity in collecting, analysing, interpreting and reporting of governments and stakeholders.

A goal-driven conceptual framework provides the basis for identification and selection of the most appropriate indicators and associated data and information necessary for their formulation. Over recent years there has been significant progress towards the development of a conceptual framework for monitoring the progress of the UNCCD in addressing DLDD. In decision 22/COP.11, the UNCCD COP established a monitoring and evaluation approach consisting of: (i) progress indicators; (ii) a conceptual framework that allows the integration of indicators; and (iii) mechanisms for data sourcing and management at the national/local level (UNCCD, 2013b).

The UNCCD progress indicators include three biophysical indicators: land cover, land productivity and carbon stocks (UNCCD, 2013b). In 2015 the SPI conducted an assessment of the current scientific understanding of the integrative potential of the land-based progress indicators for monitoring DLDD (UNCCD, 2015b),

56 See footnote 32.

BOX 6

Principles related to monitoring

1. Make use of three land-based indicators and associated metrics: land cover (assessed as land cover change), land productivity (assessed as NPP) and carbon stocks (assessed as SOC), as minimum set of globally agreed indicators/metrics, which were adopted by the UNCCD for reporting and as a means to understanding the status of degradation (UNCCD, 2013b).

2. Monitoring and reporting should be primarily based on national data sources, including aggregated sub-national data;

3. Make use of additional national and sub-national indicators, both quantitative and qualitative data and information, to aid interpretation and to fill gaps for the ecosystem services not fully covered by the minimum global set.

4. Methods for monitoring need to be available to all countries. Monitoring does not require sophisticated technology or high investment and can be carried out at different levels of intensity and involve different stakeholders. Many different monitoring techniques are available and each country should select the technique(s) most appropriate to its priorities and available resources, and apply these consistently over time.

5. The pursuit of harmonization in monitoring methods across countries is important, with the potential for standardization where appropriate and feasible, while also accommodating variability in the causes and consequences in land degradation among countries, and in their capacity to measure and monitor change.[57]

6. The integration of results of the three global indicators should be based on a "one-out, all-out" approach where if any of the three indicators/metrics shows significant negative change, it is considered a loss (and conversely, if at least one indicator/metric shows a significant positive change and none shows a significant negative change it is considered a gain).

7. Apply in-situ validation and local knowledge obtained through local multi-stakeholder platforms to interpret monitoring data according to local context and objectives, within agreed guidelines.

8. Recognizing that a minimum set of globally accepted indicators will lead, under certain circumstances, to "false positives" (e.g., shrub encroachment may lead to higher NPP and SOC), the monitoring system needs to provide the opportunity to report false positives, supported by national data and contextual information.
    - National level monitoring should include process indicators to complement outcome indicators.

9. Monitoring should be viewed as a vehicle for learning. Monitoring provides: opportunities for capacity building; the basis for testing hypotheses that underpin the counterbalancing decisions and the interventions implemented, the LDN concept, and this conceptual framework; and knowledge to inform adaptive management.

57 The definitions of harmonization and standardization are adapted from those endorsed by the UNCCD. See footnote 3.

leading to UNCCD decision 3/COP.12 to explore these indicators further with respect to LDN and the associated SDG 15.3 and with consideration for maximizing synergies across the Rio conventions as endorsed by UNCCD decision 9/COP.12 (UNCCD, 2015a).

COUNTRIES ARE ENCOURAGED TO IDENTIFY COMPLEMENTARY INDICATORS THAT ADDRESS THEIR NATIONAL AND SUB-NATIONAL SPECIFICITIES.

Thus, this conceptual framework for LDN builds on the previous conceptual framework and indicator selection processes undertaken by the UNCCD. For the purposes of LDN, it is important to determine how well the three land-based UNCCD indicators reflect the land-based ecosystem services that underpin LDN. Figure 3 demonstrates that these three indicators provide good coverage and together can assess quantity and quality of land-based natural capital and most of the associated ecosystem services. In addition, the metrics for these indicators address changes in the system in different yet highly relevant ways. NPP, the metric for land productivity, captures relatively fast changes, while SOC, the metric for carbon stocks, reflects slower changes that suggest trajectory and proximity to thresholds. Land cover provides a first indication of changing vegetation cover, to some extent as proxy of the underlying use, and of land conversion and resulting habitat fragmentation.

7.1.2 Complementary indicators of ecosystem services

While the three global indicators address key aspects of land-based natural capital, additional indicators may be required to fully assess trends in land-based ecosystem services. Therefore, the global indicators should be supplemented by national (or sub-national) level indicators to provide coverage of the ecosystem services associated with the land (Figure 3) that are important in each context. Countries are encouraged to identify complementary indicators that address their national and sub-national specificities and will strengthen the interpretation of the global LDN indicators with respect to achievement of the goals of LDN. These may include indicators/metrics for other SDGs (ECOSOC, 2016) or other national indicators/metrics, e.g., biodiversity assessed through the Red List Index (Bubb *et al.*, 2009) and national Red Lists, and indicators that address locally-relevant issues such as heavy metal contamination.

7.1.3 Process indicators

Progress in implementing actions to achieve LDN should also be monitored. At the national level, process indicators should be used to monitor actions taken and thus measure progress along the LDN implementation pathway. Process indicators could include:

- indicators to measure progress with developing/strengthening enabling policies, adoption of the neutrality mechanism, establishing monitoring systems, and
- indicators of actions that reduce risk of land degradation such as hectares of land under integrated land use plans, under an LDN scheme.

This information will provide early indication of whether LDN is likely to be achieved by the target date, and allow corrective action to be taken if necessary. Countries that are pursuing a DPSIR approach to environmental monitoring could use the supplementary indicators collected to assess the drivers, pressures, impacts and responses, to aid interpretation of changes in state, and to evaluate implementation of policies to achieve LDN.

7.1.4 Social and economic outcome indicators

The final category of indicators that should be identified includes those that assess the mid- and long-term social and economic impact of LDN policies and activities. These could include indicators of human wellbeing including maintenance of land rights and impacts on local communities. The optional narrative indicators for reporting under the UNCCD (UNCCD, 2013b), and indicators for SDGs,[58] could provide data for monitoring impacts of LDN interventions.

7.2 Metrics for LDN

Once the appropriate indicators are selected, the next step is to identify metrics that can be used to quantify each indicator. Figure 12 provides examples relating the ecosystem services to be assessed to the indicators identified as a proxy for the ecosystem service, the metrics for their quantification and the data sets required to estimate the value of that metric. Each ecosystem service derived from the land-based natural capital was considered in this way, which led to the mapping of indicators and their metrics to the land-based ecosystem services provided in Figure 3. In association with the LDN Target Setting Programme (UNCCD-GM, 2016), efforts are under way to develop guidance for measurement of the three global indicators. Examples of potentially suitable approaches include:

- Land Cover mapped in a harmonized fashion using nationally-refined FAO LCCS classes (Di Gregorio *et al.*, 2011; FAO, n.d.), where change in class may be characterized as positive or negative. Global scale land cover, according to the FAO LCCS, can be obtained from the FAO Global Land Cover SHARE database (FAO, 2012a).
- Land productivity assessed through estimates of NPP (tDM/ha/yr), where a change in the absolute numerical value may be positive or negative. NPP can be quantified using indices derived from Earth observation data such as the Normalized Difference Vegetation Index (NDVI) or Enhanced Vegetation Index (EVI).
- Carbon stocks assessed through estimates of SOC (tC/ha, to 30 cm), where a change in the absolute numerical value may be positive or negative.[59]

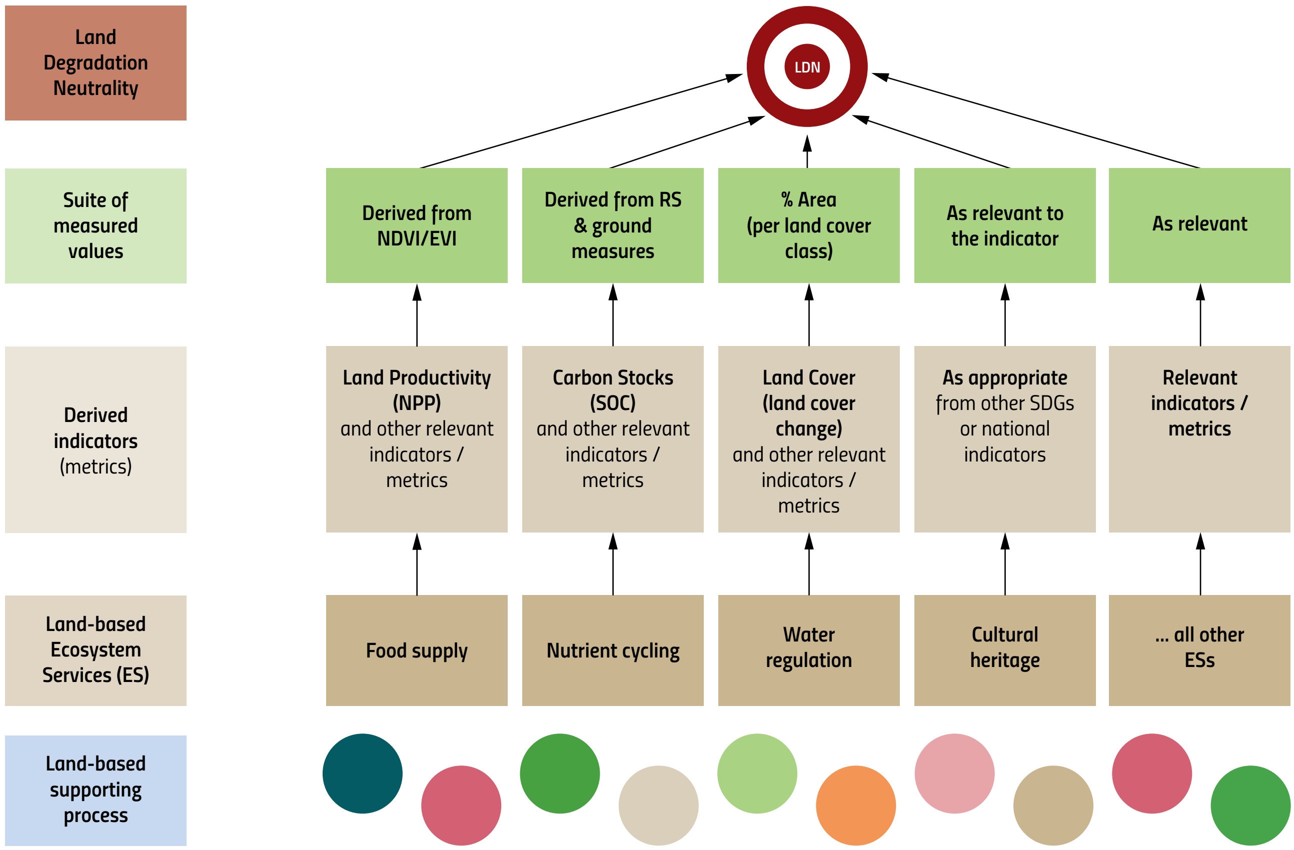
Datasets for these metrics should be calibrated and verified using field validation data. As noted in Figure 3 and on the right of Figure 12 monitoring some ecosystem services will require indicators/metrics from the other SDGs (ECOSOC, 2016) and/or national indicators. For

58 The most directly relevant being: SDG 1 - No Poverty; SDG 2 - Zero Hunger; SDG 6 - Clean Water and Sanitation; SDG 11 - Sustainable Cities and Communities; SDG 13 - Climate Actions; SDG 15 - Life on Land. See: Sustainable Development Goals https://sustainabledevelopment.un.org/sdgs . See ECOSOC (2016).

59 The current initiatives to improve capacity to measure UNCCD indicators include special efforts to address the acknowledged challenges in measuring soil carbon stocks.

FIGURE 12

Selection of indicators based on ecosystem services to be monitored



example, the Red List Index (Bubb *et al.*, 2009; complemented by national Red Lists) can provide a high-level indicator of biodiversity impacts.

The absolute numerical values for each land type for each of the metrics should be quantified for the baseline, at t0. To minimise the effects of seasonal and inter-annual climate variability the baseline value should be an average across an extended period prior to t0.[60] Values for NPP and SOC should be averaged over 10-15 years. For land cover, available data sets cover epochs of 5 years. (The basis for using absolute numerical values rather than trends for monitoring neutrality is explained in Annex 2.)

To monitor achievement of LDN the metrics must be quantified again (using the same methods employed at baseline) at the final monitoring date (t1) (e.g., 2030), with at least two intermediate monitoring points. The future monitoring points may comprise shorter periods than used to create the baseline (e.g., 5 years) to limit overlap with the baseline measurement period.[61]

60 An alternative to averaging out the temporal variability, in calculating the baseline, could be to use it to distinguish natural from human influences on environmental change. See Bastin *et al.*, 2012).

61 It is important to note that shorter monitoring periods may give misleading results in environments subject to multi-year rainfall fluctuations.

To determine significant positive changes (gains), significant negative changes (losses) and those areas without significant change (stable), t0 and t1 values are compared.

7.3 Combining the indicators to evaluate LDN status

Together the indicators and associated metrics depicted in Figure 3 and detailed in chapters 7.1 and 7.2 are suitable proxies for the ecosystem services flowing from land-based natural capital. However, there is no scientific basis for combining these into a composite indicator to give a single aggregated value. Aggregation would mask the changes detected in the individual measures, and would prevent the interpretation of individual measures at the national level based on local knowledge. Gains in one of these measures therefore cannot compensate for losses in another because all are complementary, not additive, components of land-based natural capital. Therefore, if one of the indicators/metrics shows a negative change, LDN is not achieved, even if the others are substantially positive. Therefore, the one-out, all-out principle is applied.

To apply the one-out, all-out rule, each of the indicators/metrics needs to be enumerated and evaluated separately. One-out, all out is the most comprehensive and most conservative way to integrate the separate indicator values, consistent with the precautionary principle, however it is prone to false positive error (See Borja *et al.* (2014)

According to the one-out, all-out principle, degradation occurs when (compared with baseline):

a. SOC decreases significantly; or
b. NPP decreases significantly; or
c. negative land cover change occurs.

For (a) and (b) this requires determining how much change in these values is considered significant. Significance can be determined in several ways: it can be estimated by experts; determined from the detection limit and precision of the method; or based on uncertainty quantified by statistical analysis, if multiple observations are collected for each polygon.

For (c) it is recommended that guidelines be developed to assist countries in determining what transitions are classed as negative land cover change. Some transitions may be universally agreed as negative, such as conversion of high conservation value forest to farmland or settlements; conversion of natural areas and productive farmland to settlements. Countries may declare other specific transitions to be negative (e.g., bush encroachment), even though the metrics SOC and NPP may show positive change. Such "false positive" results are discussed further in chapter 7.4.

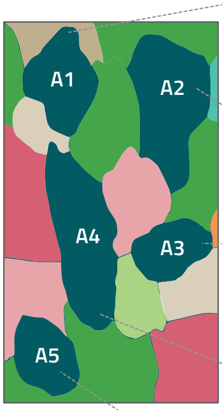
ACCORDING TO THE ONE-OUT, ALL-OUT PRINCIPLE, DEGRADATION OCCURS WHEN (COMPARED WITH BASELINE): SOC DECREASES SIGNIFICANTLY; OR NPP DECREASES SIGNIFICANTLY; OR NEGATIVE LAND COVER CHANGE OCCURS.

With respect to complementary national and subnational indicators, a country will select appropriate indicators/metrics for locally-relevant ecosystem services that are not covered by SOC, NPP or land cover change (chapters 7.1 and 7.2. The country may choose to apply one or more of these using the one-out, all-out approach, in addition to (a)-(c) above. Alternatively, these complementary indicators may be used only to provide supplementary information to enhance understanding of land degradation trends, and to interpret the results of the three global indicators, to inform responses. It should be noted that the one-out, all-out approach will become increasingly conservative as the number of indicators applied in this manner increases.

FIGURE 13

A hypothetical example showing how LDN status is monitored on the basis of changes in value of the metrics, using the one-out, all-out approach applied to each land unit

A Map of Land Types
(Land Type "A" = Grassland)



Context*	Metric values at Baseline (t0)	Decisions	Metric values in Future (t1)	Gains vs. Losses (t1 - t0)
A1 **Land Area:** 15,000 ha **Use:** short grazing period **Status:** Not Degraded	**Land Cover:** Grassland NPP=11.7 tDM/ha/yr SOC=54.5 tC/ha	Grazing period extended	⦸ **Land Cover:** Grassland ↓ NPP=7.1 tDM/ha/yr ⦸ SOC=53.9 tC/ha	**Loss:** 15,000 ha significant degradation
A2 **Land Area:** 25,000 ha **Use:** grazing excluded **Status:** Not Degraded	**Land Cover:** Grassland NPP=12.8 tDM/ha/yr SOC=63.6 tC/ha	Livestock exclusion maintained	⦸ **Land Cover:** Grassland ⦸ NPP=13.1 tDM/ha/yr ⦸ SOC=63.8 tC/ha	No Change in LDN Status 25,000 ha stable
A3 **Land Area:** 10,000 ha **Use:** long grazing period **Status:** Degraded	**Land Cover:** Grassland NPP=6.5 tDM/ha/yr SOC=51.1 tC/ha	Long grazing period continued	⦸ **Land Cover:** Grassland ↓ NPP=3.9 tDM/ha/yr ↓ SOC=40.7 tC/ha	**Loss:** 10,000 ha significant degradation
A4 **Land Area:** 40,000 ha **Use:** med. grazing period **Status:** Degraded	**Land Cover:** Grassland NPP=10.3 tDM/ha/yr SOC=47.6 tC/ha	Sustainable grazing management introduced	⦸ **Land Cover:** Grassland ⦸ NPP=10.8 tDM/ha/yr ↑ SOC=51.2 tC/ha	**Gain:** 40,000 ha significant improvement
A5 **Land Area:** 10,000 ha **Use:** short grazing period **Status:** Not Degraded	**Land Cover:** Grassland NPP=11.9 tDM/ha/yr SOC=54.6 tC/ha	Urban expansion	↓ **Land Cover:** Urban ↓ NPP=7.1 tDM/ha/yr ⦸ SOC=54.3 tC/ha	**Loss:** 10,000 ha significant degradation

Land Degradation Neutrality Status (t1-t0):
Net Gain: 5,000 ha

Metrics
Land Cover: nationally refined land potential class where change in class may be characterized as positive or negative

NPP level (tDM/ha/yr, where a change in the absolute value may be positive or negative

SOC stock (tC/ha, to 30 cm) where a change in the absolute value may be positive or negative

NPP: Net Primary Productivity
SOC: Soil Organic Carbon
DM: dry matter

Legend
- ⦸ No significant change in the metric
- ↑ Significant positive change in the metric
- ↓ Significant negative change in the metric
- Stable (no change)
- Degraded land or negative change
- Not degraded land or postive change

* This hypothetical example is designed to explain how LDN can be monitored. The initial status is not necessary for monitoring LDN, but provides context for each of the five examples. This example illustrates a grassland grazed by livestock.

Figure 13 utilises the same hypothetical example shown in Figure 6 to illustrate how LDN status is determined by assessing the values for the metrics, for each land unit. The areas of gains and losses are tabulated for each land type in each biophysical or administrative domain. These are then summed to determine the LDN status for each land type in a country, and combined across land types to determine the LDN status for the entire country.

IT IS ESSENTIAL THAT THE RESULTS OF LDN MONITORING ARE REVIEWED WITH COORDINATED INPUT FROM LOCAL STAKEHOLDERS FOR BOTH VERIFICATION AND INTERPRETATION OF THE RESULTS.

7.4 Verification and interpretation

Land degradation is a global problem that is manifested locally, meaning that a practical, minimum set of global indicators may be more or less applicable in different countries and at subnational level. It is therefore essential that the results of LDN monitoring are reviewed with coordinated input from local stakeholders for both verification and interpretation of the results. Verification is required to:

- ensure that the monitoring data accurately reflect changes on the ground,
- ensure that the classification as gain or loss is consistent with the local definition of degradation,
- determine whether other ecosystem services that influence land-based natural capital, not detected by the indicators used, have been affected, and
- confirm that the changes and trajectory are consistent with LDN target and sustainable development goals.

Interpretation considers likely explanations for the observed changes – whether anthropogenic or natural – to inform adaptive management and future policy initiatives, and is discussed further in chapter 7.6.

The results of the monitoring of LDN indicators should be verified against national and local data sets and expert opinion, to confirm the accuracy of monitoring data and the consequent assessment of LDN status. Guidance is needed on how monitoring and verification can be conducted at national level, using a participatory approach through a multi-stakeholder platform that links to comparable platforms at the local level (chapter 6.6.5). The verification of monitoring results should form a component of the learning process (chapter 6.3.8), which will inform the adaptation of actions to achieve the LDN target. Local communities could participate in verification, applying methods such as the Land Degradation Surveillance Framework (Vågen *et al.*, 2015) or a crowd-sourced method such as envisaged for LandPKS (Herrick *et al.*, 2016).

Verification by stakeholders is also required to identify any "false positives", where significant positive change in one or more indicators may be the result of an undesirable trend, such as shrub encroachment on grassland which results in a higher NPP and SOC, but in reality, a loss of ecosystem services with less forage available for grazing animals and wildlife. It is also possible that a "false negative" result could be obtained, for example where salinity risk leads to management decision to convert from irrigated agriculture to dryland pastoralism, with significantly lower NPP but higher resilience and lower risk of severe degradation. In cases where a false positive or a false negative have been identified countries could report such anomalies, backed by evidence, to provide a more accurate assessment of LDN status.

7.5 The area-based approach to monitoring neutrality: pros and cons

The approach to monitoring neutrality presented in the LDN framework assesses losses as the area affected, per land type, in which at least one of the three indicators shows a significant negative change. Similarly, it assesses gains as the area, per land type, over which there is a significant positive change in at least one of the indicators (and none shows a negative change). Neutrality is achieved when the area of losses equals the area of gains, within each land type, and across land types, at national scale.

Under this approach each land unit (a polygon, based on an aggregation of measurements inside that unit, whether they be pixels or points) is "scored" as loss/stable/gain, as illustrated in Figure 13, utilising the metrics for indicators that have been identified as proxies for ecosystem services (i.e., SOC, NPP, land cover; UNCCD, 2013b) to detect gains or losses. Thus, the indicators are applied in a binary sense (considering only direction of change), similar to the neutrality mechanism (chapter 5.2). As a result, neutrality is assessed using the *area of land* that experiences significant change (either positive or negative) in the indicators rather than the *magnitude of change* in the indicators.

Not considering the magnitude of the change in the indicators of land-based natural capital creates a risk that a loss that entails severe degradation will be considered to be counteracted by a small gain in land-based natural capital on an equal area. There is a legitimate concern that the binary nature of classifying land as gain/loss could lead to land that has barely improved (that just meets the threshold for a significant gain) being used to counterbalance severe degradation at the time of monitoring and reporting. If this occurred consistently, it could lead to substantial under-reporting of land degradation. This risk has been encountered in other neutrality-based agreements in the implementation of offsets, such as wetlands mitigation banking in the United States where use of area ("acreage") as the transaction unit has led to low conservation value wetland areas being substituted for high quality wetland areas (Salzman & Ruhl, 2006, 2000; Robertson, 2004). Biodiversity offsetting frameworks have experienced similar perverse outcomes, particularly where offsetting can be cheaper than to avoid, reduce or reverse degradation, leading to a potential legitimisation of degrading practices that might not otherwise occur (McKenney & Kiesecker, 2010; Maron *et al.*, 2016, 2015; Gordon *et al.*, 2015; Miller *et al.*, 2015). In order to prevent these unintended outcomes, offsetting agreements have implemented measures to ensure equality in trades, something that the magnitude of change in the indicators themselves could provide.

Table 7, based on Figure 13, demonstrates the risk of unequal substitution using the area-based approach. The values for the metrics are shown for each land unit for the baseline (t0) and for t1 (the time of final monitoring), and each land unit is classified as loss/stable/gain. Areas of significant gains are summed, as are areas of losses. The balance between the areas of gains and losses shows a net gain of 5000 ha using the area-based approach (right hand side of Table 7. In contrast, using the *magnitude-based* *approach,* based on the absolute changes in the metrics (lower left in Table 7) the total change in soil carbon, summed across the land type, shows a net gain of 42,000 t SOC, while the total change in NPP shows a net loss of 115,500t DM. Also, there is a net conversion of 10,000 ha agricultural land to urban land. Thus, while the area-based approach shows that this land type achieved neutrality (in fact, exceeded neutrality), the approach based on magnitude of change in the metrics shows a substantial increase in SOC but a decrease in NPP, and a negative change in land cover. If the one-out, all-out rule is applied using the magnitude of change in the value of indicators at the level of the entire land type, this land type would fail to achieve neutrality. Furthermore, as counterbalancing between land types is not permitted, the country as a whole cannot achieve LDN, however much land is restored or rehabilitated in other land types. This example highlights the potential deficiency of the land-area based approach, that is, that it may not adequately reflect changes in land-based natural capital resulting from land degradation and measures to reverse it. To address this, countries should apply a magnitude-based approach to supplement the monitoring using the land-area based approach (chapter 7.6).

As demonstrated in Table 7, it is possible to apply a magnitude-based approach to assess change in land-based natural capital based on the same metrics as applied for the area-based approach, using the numerical values of each of the metrics. The magnitude-based approach has the advantage that it reflects the change in "amount" of land-based natural capital (as measured by the indicators). It gives one value per land type per indicator, so is a less complex result than the area-based approach which comprises a value for each indicator for each land unit. However, it has the practical disadvantage that the assessment does not apply to specific areas of land, but rather to a whole land type, so it is not related to land management at the land unit level, either in terms of planning or interpretation. Within the entire land type, the magnitude-based approach does not inform how much land has become degraded, nor where and therefore does not help to plan management solutions, such as where to target interventions. In addition, the magnitude-based approach is difficult to interpret in terms of the net impacts on ecosystem function. The relationship between land degradation status and values of the metrics SOC, NPP and land cover change is likely to be non-linear (e.g., Patrick *et al.*, 2013) so it should not be assumed that counterbalancing a loss in a particular metric with a gain of the same quantity will deliver exactly the same ecosystem services. Without knowing the land area affected by losses it is difficult to assess the likely effect on food security, for example. Integrating multiple metrics also presents a challenge for this approach: in the Table 7 example, it is difficult to interpret a gain in SOC and a simultaneous decline in NPP across the land type; without knowing whether these have occurred in the same or different sites, and what land uses they are associated with, it is difficult to link them to drivers and estimate the impacts on ecosystem functions. Furthermore, the indicators are proxies for ecosystem services; they are not, of themselves, the service that LDN is intended to deliver and are not a comprehensive measure of ecosystem services in total. Thus, a narrow focus on delivering a specific quantity of SOC increase, for example, may be contrary to the objectives of LDN. Therefore, this framework applies the land-area based approach for monitoring achievement of LDN, but also requires application of the magnitude-based approach to supplement the area-based result, to assist in interpretation and planning ongoing land management (chapter 7.4).

This framework applies the land area-based approach for the following reasons:

- It is relatively easy to apply, requiring no interpretation other than the assessment of significance.
- It aligns with land use planning, which occurs on a spatially explicit basis.
- It specifies which land is considered a loss and a gain, and records achievement towards LDN on the basis of area, so aligns with reporting on SDG 15.3 (chapter 7.11.1).

The following features of this framework minimise the risk of perverse outcomes from the land area-based approach:

- Requirement for precise land type stratification (chapter 6.3.2)
- Requirement that counterbalancing can only occur within the same land type (chapter 5, Module C)
- Measures to enhance the success of restoration or rehabilitation (see Land potential, chapter 6.3.2; Resilience assessment, chapter 6.3.4)
- Measures to protect restored or rehabilitated land from future degradation (chapter 6.6.3)
- Embedded triple loop learning structure (chapter 6.3.8), that applies results of interim monitoring to test hypotheses that underpin the approach to LDN devised in this conceptual framework, and adapt the implementation where necessary.

Additional measures could be applied:

- Requirement to restore or rehabilitate a larger area than that affected by anticipated loss.[62]
- Neutrality planning based on scale of anticipated change (chapter 5.2).

An alternative that lies between the magnitude-based approach and the land area-based approach is an option that classifies change in metrics into scale categories of loss/gain (e.g., minor, moderate, major loss). This overcomes, to a certain degree,[63] the deficiencies of the area-based and magnitude-based approaches identified above. It is similar to the category-based approach discussed for the neutrality mechanism in chapter 5.2. The barriers to implementing a category-based approach to monitoring are also similar to those for a category-based approach to the neutrality mechanism. That is, the need for:

- agreement on the boundaries between categories, which will vary between environments and land use systems, and should be informed by knowledge of the thresholds for key variables for each system, and
- rules to integrate the metrics and manage trade-offs between them.

In future, parties may agree to apply a scale-based category approach to monitoring LDN. For now, countries can minimise the risk of perverse outcomes by considering scale of anticipated change in planning counterbalancing, and/or applying ratios based on the projected extent of recovery to increase the likelihood that the amount of land being

62 For example, this could be based on a ratio linked to the expected extent of recovery of land-based natural capital and associated ecosystem services by the target date, under the planned restoration or rehabilitation activity.

63 It can be argued that even with scale categories, the differences in degree could be manipulated during counterbalancing. While this risk could be reduced by introducing more categories, more categories would make counterbalancing more complex and less manageable.

restored or rehabilitated compensates for the land-based natural capital lost in land degradation elsewhere.

7.6 Supplementary assessment to guide future management of land degradation

7.6.1 Application of the magnitude-based approach

Chapter 7.5 presents the pros and cons of the area-based and magnitude of change approaches to assessing achievement of LDN. As discussed, there are several undesirable features of the magnitude-based approach so it is not applied for monitoring achievement of LDN in this framework. Nevertheless, its merits address an important concern, that is, the area-based approach may not adequately reflect changes in land-based natural capital resulting from land degradation and measures to reverse it. Furthermore, the magnitude-based approach can be applied using the same metrics as used for the land-area based approach, as demonstrated in Table 7. Therefore, the magnitude of change in each of the metrics should be calculated as supplementary information, using the approach shown in Table 7. If there is a discrepancy between the results of the area-based approach and the magnitude-based approach this should trigger an investigation to identify the cause and appropriate response.

7.6.2 Comparing observed with expected change

LDN indicators assess absolute productivity and carbon stocks, which can be influenced by both natural and anthropogenic factors. Comparison between observed and expected change in the value of LDN metrics allows the impact of land use and management to be distinguished from natural factors. Rainfall is a key driver of change in NPP in the drylands. Variability in rainfall tends to be high, and is a cause of wide variation in NPP. Changes observed in the LDN indicators/metrics, especially in NPP, are likely to reflect variation or trends in rainfall. Change in NPP that is inconsistent with rainfall pattern, reflecting a change in water use efficiency, is a strong indication that degradation, or reversal of degradation, has occurred: decline in NPP observed when rainfall is above average suggests that degradation has occurred at that site, restricting growth of vegetation. An increase in NPP suggests reversal of degradation through restoration or rehabilitation. It may reflect recovery towards the natural ecosystem, or alternatively, the response to intensive agriculture, in which NPP is enhanced by fertiliser and irrigation. An increase in NPP that occurs despite lower than average rainfall would suggest the latter. Thus, comparison with rainfall received can assist in distinguishing the likely cause of observed changes in the indicators, and thereby guide interpretation with respect to land degradation status and risk, and required management responses.

7.6.3 When a threshold is crossed

External shocks and trends, such as climate change, can result in a shift from one land type to another, characterised by different species composition and/or level of productivity. For example, a land unit affected by overgrazing in combination with drought may lose ground cover and cross a threshold to a low productivity state. Some land use changes will affect land potential, while others will not. For example, urban development may not alter potential, so the land unit retains the same land type. In contrast, invasive species may completely change the land potential, diminishing the capacity to continue grazing or to restore original native vegetation – for example, cheat grass invasion in sagebrush grasslands. A change in state in one land unit, if detected through interim monitoring, could suggest a need for a refocusing of LDN intervention effort to another land unit with greater likelihood of improvement through restoration. Changes in state observed through final monitoring of LDN indicators at t1 should be used to make adjustments to land type maps and develop future policy for management of land.

TABLE 7

Area-based (two columns on the far right) vs. magnitude (bottom four rows) approaches to monitoring achievement of LDN. All data correspond to Fig. 12

		Baseline (t0)		Future (t1)	
Land Unit	Metrics	Mean Metric Values	Metric Totals	Mean Metric Values	Metric Totals
A1 Grassland 15,000 ha	LC	1 ha	15,000 ha	1 ha	15,000 ha
	NPP	11.7 tDM/ha/yr	175,500 tDM	7.1 tDM/ha/yr	106,500 tDM
	SOC	54.4 tC/ha	816,000 tC	53.9 tC/ha	808,500 tC
A2 Grassland 25,000 ha	LC	1 ha	25,000 ha	1 ha	25,000 ha
	NPP	12.8 tDM/ha/yr	320,000 tDM	13.1 tDM/ha/yr	327,500 tDM
	SOC	63.3 tC/ha	1,582,500 tC	63.8 tC/ha	1,595,000 tC
A3 Grassland 10,000 ha	LC	1 ha	10,000 ha	1 ha	10,000 ha
	NPP	6.5 tDM/ha/yr	65,000 tDM	3.9 tDM/ha/yr	39,000 tDM
	SOC	51.1 tC/ha	511,000 tC	40.7 tC/ha	407,000 tC
A4 Grassland 40,000 ha	LC	1 ha	40,000 ha	1 ha	40,000 ha
	NPP	10.3 tDM/ha/yr	412,000 tDM	10.8 tDM/ha/yr	432,000 tDM
	SOC	47.6 tC/ha	1,904,000 tC	51.2 tC/ha	2,048,000 tC
A5 Grassland 10,000 ha	LC	1 ha	10,000 ha	1 ha (Urban)	10,000 ha
	NPP	11.9 tDM/ha/yr	119,000 tDM	7.1 tDM/ha/yr	71,000 tDM
	SOC	54.6 tC/ha	546,000 tC	54.3 tC/ha	543,000 tC
			↓		↓
Totals for Land Type (Grassland)	**LC**		**100,000** ha		**90,000** ha
	NPP		**1,091,500** tDM		**976,000** tDM
	SOC		**5,359,500** tC		**5,401,500** tC
		LDN status at t1: Magnitude Approach			

LC = land cover | NPP = net primary productivity | SOC = soil organic carbon | DM = dry matter

7.7 Beyond monitoring: adaptive management

The objective of monitoring is to quantify achievement of LDN. However, the goal of the LDN policy initiative is to inform and enhance management of land, to minimise degradation and encourage actions to reverse degradation, in order to sustain and enhance flows of land-based environmental services. Thus, the learning based on monitoring the three global land indicators and supplementary indicators and subsequent verification processes should be used to inform evaluation of the effectiveness of past interventions in maintaining ecosystem services, and to plan future land management. Interim monitoring provides the opportunity to adjust LDN interventions to enhance the prospects of meeting the LDN target. Final monitoring provides data to inform future land degradation policy. Data for the land measures (area undergoing significant change), the measures of natural capital (magnitude of change in the indicators) and measures of ecosystem services, provide the opportunity to quantify and manage trade-offs between ecosystem services. If there are inconsistencies between the results of the area-based assessment of LDN status and the calculations using the magnitude-based approach, the cause should be investigated, and the implementation processes (policies, assessment methods) reviewed and modified to address identified deficiencies.

t1 - t0		LDN status at t1: Area-based Approach	
Change in Metrics		Status of Metrics	LDN Status by Land Unit
0	ha	stable	LOSS -15,000 ha degradation
-69,000	tDM	sig neg change	
-7,500	tC	stable	
0	ha	stable	STABLE 25,000 ha no change
7,500	tDM	stable	
12,500	tC	stable	
0	ha	stable	LOSS -10,000 ha degradation
-26,000	tDM	sig neg change	
-104,000	tC	sig neg change	
0	ha	stable	GAIN 40,000 ha improvement
20,000	tDM	stable	
144,000	tC	sig pos change	
-10,000	ha	sig neg change	LOSS -10,000 ha degradation
-48,000	tDM	sig neg change	
-3,000	tC	stable	
↓			NET GAIN 5,000 ha
-10,000	ha		
-115,500	tDM		
42,000	tC		

7.8 Summary of process for monitoring neutrality

The specific details of the process for monitoring LDN will vary depending on the circumstances in each country. Table 8 summarizes the key features of the process.

TABLE 8

Summary of the process of monitoring neutrality and interpreting the result

Assessing progress towards LDN involves:

- using the three land-based indicators identified as proxies for the ecosystem services that flow from land-based natural capital, that LDN is designed to maintain;
- applying the identified metrics for these three land-based indicators: land cover (assessed as land cover change), land productivity (assessed as NPP) and carbon stocks (assessed as SOC; UNCCD, 2013b); and
- using additional globally relevant indicators (e.g., indicators for other SDGs; ECOSOC, 2016) as well as national and sub-national indicators that provide both quantitative and qualitative data and information to aid interpretation and to fill gaps for ecosystem services not adequately covered by the minimum global set.

Monitoring neutrality involves the following procedure:

- Stratify and map the land area according to land types, based on ecosystem features.
- Measure/estimate the baseline absolute numerical values for each land unit within each land type for each of the three global metrics. For NPP and SOC, this should be based on an average for an extended period, to address variability, e.g., 10-15 years prior to the reference year (t0). For land cover, available data sets cover epochs of 5 years.
- Measure/estimate again (using the same methods employed at baseline) at a time in the future (t1) (e.g., 2030, with at least two intermediate monitoring points). The future monitoring points may involve shorter periods than used to create the baseline (e.g., 5 years) to limit overlap with the baseline measurement period.
- Subtract t0 and t1 values to identify significant positive changes (gains), significant negative changes (losses) and those areas without significant change (stable).
- Countries may declare other specific transitions to be negative (e.g., bush encroachment) even where the indicators show positive change, e.g., bush encroachment.

According to the one-out, all-out principle, degradation occurs when (compared with baseline):

- SOC decreases significantly; or
- NPP decreases significantly; or
- negative land cover change* occurs; or
- a negative change occurs in another indicator/metric that has been chosen by the country to include in the one-out, all-out approach.**

To determine LDN status:

- tabulate the areas of gains and losses for each land type in each biophysical or administrative domain;
- sum across the land type to give the LDN status for each land type in the country; and
- sum across land types to determine the LDN status for the entire country.

Interpretation of the monitoring result should consider:

- quantitative and qualitative data from national and subnational indicators;
- additional globally relevant indicators (e.g., indicators for other SDGs; ECOSOC, 2016)
- results of the supplementary assessment using the magnitude-based approach; and
- change in indicators with respect to expectations.

This information should be used to enhance understanding of the health of the land resource base and trade-offs between ecosystem services, to test the assumptions and hypotheses of this conceptual framework including the specific outcomes sought by the individual country, and to plan future action.

* A land use transition that has been agreed to be negative - e.g., clearing of natural forest for agriculture.

** There is no necessity to include additional indicators in the one-out, all-out list. These may be used only for interpretation. Expanding the list of one-out, all-out measures can lead to an overly conservative outcome. See (Oxford Dictionaries, n.d. & Borja *et al.*, 2014).

7.9 Pursuing standards in metrics collaboratively

While all of the UNCCD land-based progress indicators show great promise, none has been monitored specifically for helping individual countries implement and monitor progress towards LDN. Rather than choosing among several different approaches that exist for each indicator, a process of harmonization leading to standardization,[64] where possible, is recommended.

The Group on Earth Observations (GEO) has a strong track record serving as a platform to support multiple countries and organizations working collaboratively to implement tracking systems similar to LDN monitoring, which will require consistency and collaboration.[65] GEO does not develop metrics or collect primary data, but rather provides a platform to share data collected by others. The GEO community[66] is creating a Global Earth Observation System of Systems (GEOSS) that will link Earth observation resources world-wide across multiple societal benefit areas that are relevant to LDN. GEO has successfully coordinated participatory processes towards harmonization (e.g., the forest carbon tracking system, the GEO Biodiversity Observation Network (GEO BON), the GEO Global Agricultural Monitoring (GEOGLAM) initiative). A similar process for LDN could involve international organizations, national bodies, space agencies and research institutions all working together within the intergovernmental GEO to facilitate access to satellite, airborne and *in situ* data, including citizen science data (e.g., like the data contributed to LandPKS; Herrick *et al.*, 2016), to establish technical standards and to create the appropriate framework for the implementation of an LDN monitoring system, based on a network of national and/or regional systems.

7.10 Monitoring trends of land degradation

An advantage of the UNCCD land-based progress indicators and associated metrics is that the same data set collected for the indicators can also be used for monitoring trends in land degradation in addition to monitoring achievement of LDN. As described above, neutrality status is determined from the change in the absolute numerical value of indicator/metrics compared with the baseline. (See Annex 2. for explanation of why absolute values rather than trends are used to monitor neutrality).

Past monitoring of land degradation has appropriately focussed on trends analysis. Trends in each of the indicators over a 10-15 year assessment period can reveal anomalies and thus contribute to the assessments necessary for making good decisions about potential interventions, and can be an effective tool for management (e.g., in prioritization of local efforts to understand more about these locations and deciding where interventions should be focussed). The same data sets used for trends analysis in the past can be used (expressed as the average absolute numerical value across the time period) to create the baseline against which progress towards neutrality ("no net loss") can be monitored. Also, the same data that are used in future to monitor LDN status can be used to assess the trend in each indicator.

64 See footnote 3.

65 https://www.earthobservations.org/

66 The GEO community is currently comprised of 101 nations and the European Commission, and 95 Participating Organizations comprised of international bodies with a mandate in Earth observations.

7.11 How this conceptual framework meet the needs of relevant reporting processes

The LDN conceptual framework can support monitoring and reporting for the UNCCD, the other Rio conventions, and work synergistically with other global initiatives such as the Sustainable Development Goals. Important opportunities for synergies include linking monitoring and reporting processes related to LDN indicators, collaborating to leverage existing systems to monitor socio-economic indicators, and the monitoring of key enabling environment factors such as governance, land rights and security.

7.11.1 LDN can leverage UNCCD processes and reporting

The LDN Framework has been designed to be integrated within UNCCD NAP processes and sustainable development frameworks. The information currently collected for land use planning efforts can be augmented to ensure that LDN tracking is possible by recording whether land use changes proposed, or ongoing land management, are predicted to lead to significant positive changes (gains) or significant negative changes (losses) in each land type, as illustrated in Table 2. Recognizing that every country approaches land administration in a different way, three levels of integration of LDN information have been proposed for consideration (Table 4).

The monitoring of neutrality also builds on current processes and data sets. The LDN Framework has been designed to build on past decisions of the UNCCD (e.g., participatory processes, monitoring and reporting, indicators, resilience frameworks). This means the essential monitoring data being collected will not change, although those data will be analysed in additional ways. Currently the three UNCCD land-based indicators and associated metrics are analysed to track progress towards the strategic objectives of the Convention; now they will also be analysed to establish the LDN baseline (t0) and be reanalysed in a similar way in the future (t1) to determine LDN status, as described in chapters 7.1 and 7.2.

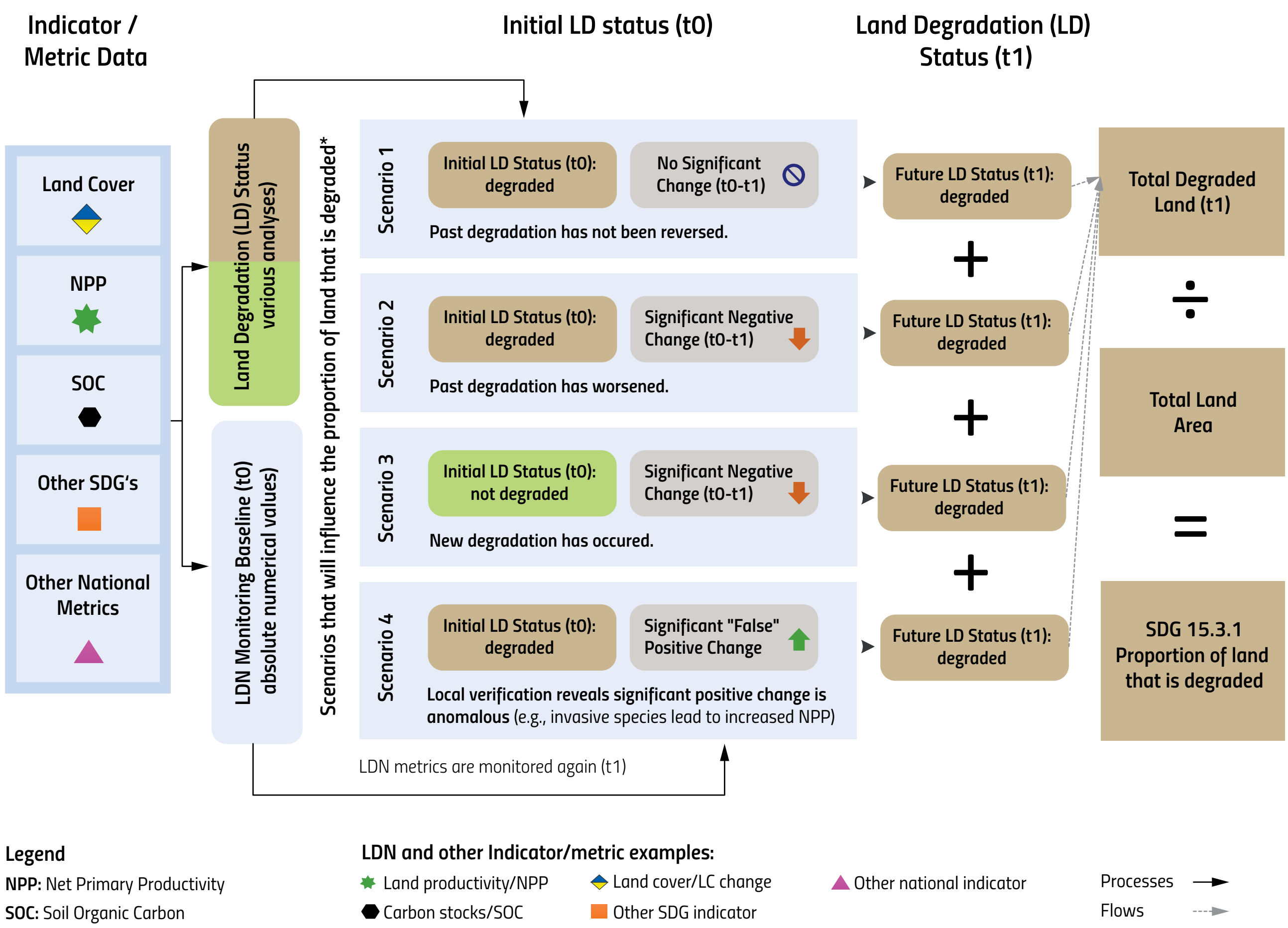
7.11.2 LDN monitoring can contribute to reporting on SDG Indicator 15.3.1

SDG Target 15.3 reads "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world." The global indicator (15.3.1) is "Proportion of land that is degraded over total land area" (ECOSOC, 2016).

This differs from LDN monitoring, which is focused on the monitoring of neutrality, that is, ensuring that net area of significant *new* negative changes (losses) are counterbalanced with *new* significant positive changes (gains) in the same land type. A neutrality mechanism balance sheet, like the one depicted in Table 2, only reports *projections* of significant change. Monitoring LDN, which records *actual* changes observed, leads to a report of *LDN status*. However, the same data sets used to make this determination can be used to support current and future land degradation assessments, which could be used to report on SDG indicator 15.3.1. Figure 14 illustrates how the initial land degradation assessment and monitoring of the LDN indicators can support reporting on the SDG 15.3.1. Figure 14 shows only scenarios

FIGURE 14

Conceptual diagram of how the initial land degradation assessment and monitoring of LDN can support reporting on the SDG 15.3.1 indicator "proportion of land that is degraded over total land area"



* Includes only scenarios where land is classed as degraded at time t1. Any land that in not degraded at time t0, and remains stable, or land that is degraded at t0 but shows a gain in the indicators at t1, is excluded from the calculation of proportion of degraded land.

where land is classed as degraded at time t1. Any land that in not degraded at time t0, and remains stable, or land that is degraded at t0 but shows a gain in the indicators at t1, is excluded from the calculation of proportion of degraded land.

7.11.3 Synergies with the other Rio conventions and other global initiatives

The relationship between land-based natural capital and ecosystem services including climate change mitigation and biodiversity conservation is illustrated in Figure 3. Thus, the land-based indicators identified for LDN monitoring are also relevant to the UNFCCC and the CBD. The potential for synergies through coordinated monitoring and reporting to the three conventions has been identified (Cowie *et al.*, 2007), and efforts to achieve this are in progress. Moreover, GEO, through a proposed voluntary partnership of governments and organizations, has offered to serve as a platform to support multiple countries and organizations in implementing tracking systems required for monitoring these indicators (chapter 7.9).

In the last five years, a number of global and regional commitments have been made to halt and reverse land degradation and restore degraded ecosystems. Starting in 2010, these include the CBD Aichi Biodiversity Targets, one of which includes restoring at least 15% of degraded ecosystems,[67] the Bonn Challenge on Forest Landscape Restoration,[68] the New York Declaration on Forests (United Nations, 2014), the 4 per 1000 Initiative,[69] and related regional initiatives such as the Initiative 20x20 in Latin America,[70] the Africa Forest Landscape Restoration Initiative (AFR100),[71] the Great Green Wall Initiative of Africa[72] and the Great Green Wall Initiative of China.[73] Efforts are also being undertaken to assess the status of land degradation and its impacts. These include the on-going LDRA of the IPBES[74] and the ELD Initiative.[75] There are also platforms to help facilitate the sharing of environmental information that could be leveraged, such as UNEP-Live.[76] This list is by no means comprehensive, but rather provided to suggest the great potential for synergistic activities (data sharing, integrated processes, etc.), that should be strongly encouraged.

67 https://www.cbd.int/sp/targets/

68 http://www.bonnchallenge.org/content/challenge

69 http://4p1000.org/understand

70 http://www.wri.org/our-work/project/initiative-20x20

71 http://www.wri.org/our-work/project/AFR100/about-afr100

72 https://www.thegef.org/gef/great-green-wall

73 For more on the Great Green Wall of China initiative, see: http://english.forestry.gov.cn/ and http://tghl.forestry.gov.cn/

74 http://www.ipbes.net/work-programme/land-degradation-and-restoration

75 http://eld-initiative.org/fileadmin/pdf/ELD-main-report_05_web_72dpi.pdf

76 http://uneplive.unep.org/

REFERENCES

Agrawal, B. (2010). Gender and green governance: the political economy of women's presence within and beyond community forestry. *Ecological Economics, 68*(11), 2785-2799.

Allen, C., Metternicht, G., & Wiedmann, T. (2016). National pathways to the global Sustainable Development Goals (SDGs): a comparative review of scenario modelling tools. *Environmental Science and Policy*(66), 199-2017. doi:10.1016/j.envsci.2016.09.008

Armitage, D., Berkes, F., & Doubleday, N. (Eds.). (2007). *Adaptive Co-Management: Collaboration, Learning, and Multi-Level Governance.* Vancouver: University of British Columbia Press.

Aronson, J., Milton, S.J., & Blignaut, J. (Eds.). (2007). *Restoring Natural Capital: Science, Bussiness and Practice.* Washington, D.C: Island Press.

Bai, Z.G., Dent, D.L., Olsson, L., & Schaempan, M.E. (2008). *Global Assessment of Land Degradation and Improvement - 1. Identification by Remote Sensing. Report 5 2008/01, GLADA - ISRIC World Soil Information.* Wageningen, Netherlands: ISRIC. Available online: http://www.isric.org/isric/webdocs/docs/Report%202008_01_GLADA%20international_REV_Nov%202008.pdf

Bastin, G., Scarth, P., Chewings, V., Sparrow, A., Denham, R., Schmidt, M., O'Reagain, P., Sheperd, R., and Abbott, B. (2012). Separating grazing and rainfall effects at regional scale using remote sensing imagery: A dynamic reference-cover method. *Remote Sensing of Environment*(121), 443-457.

Bautista, S., Llovet, J., Ocampo-Melgar, A., Vilagrosa, A., Mayor, A.G., Murias, C., Vallejo, V.R, and Orr, B.J. (2016). Integrating knowledge exchange and the assessment of dryland management alternatives - A learning- centered participatory approach. *Journal of Environmental Management*, (195), 35-45.

Beck, T., Stelcner, M., & Alexander, R. (1997). *A Project Level Handbook: The Why and How of Gender-Sensitive Indicators.* Hull, Quebec, Canada: Canadian International Development Agency (CIDA). Available online: http://www.acdi-cida.gc.ca/INET/IMAGES.NSF/vLUImages/Policy/$file/WID-HAND-E.pdf

Benayas, J.R.M., Newton, A.C., Diaz, A., & Bullock, J.M. (2009). Enhancement of biodiversity and ecosystem services by ecological restoration: a meta analysis. *Science*(325), 1121-1124.

Berkes, F., & Folke, C. (Eds.). (1998). *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience.* Cambridge: Cambridge University Press.

Bestelmeyer, B.T., Duniway, M.C., James, D.K., Burkett, L.M., & Havstad, K.M. (2013). A test of critical thresholds and their indicators in a desertification-prone ecosystem: more resilience than we thought. *Ecology Letters*(16), 339-345. doi:10.1111/ele.12045

Bestelmeyer, B.T., Okin, G.S., Duniway, M.C., Archer, S.R., Sayre, N.F., Williamson, J.C., & Herrick, J.E. (2015). Desertification, land use, and the transformation of global drylands. *Frontiers of Ecology and the Environment, 13*(1), 28-36. doi:10.1890/140162

Bizikova, L., Metternicht, G., & Yarde, T. (2015). Advancing environmental mainstreaming in the Caribbean region: the role of regional institutions for overcoming barriers and capacity gaps. *Sustainability, 7*(10), 13836-13855. doi:10.3390/su71013836

Borja, A., Prins, T., Simboura, N., Andersen, J.H., Berg, T., Neto, J.M., Reker, J., Teixeira, H., and Uusitalo, L. (2014). Tales from a thousand and one ways to integrate marine ecosystem components when assessing the environmental status. *Frontiers in Marine Science, 1*(Article 72), 1-20. doi:10.3389/fmars.2014.00022

Bryan, B.A., Crossman, N.D., Nolan, M., Li, J., Navarro, J., & Connor, J.D. (2015). Land use efficiency: anticipating future demand for land-sector greenhouse gas emissions abatement and managing trade-offs with agriculture, water, and biodiversity. *Global Change Biology, 21*(11), 4098-4114. doi:10.1111/gcb.13020

Bubb, P.J, Butchart, S., Collen, B., Dublin, H., Kapos, V., Pollock, C., Stuart, S.N., and Vie, J.-C. (2009). IUCN Red *List Index-Guidance for National and Regional Use.* Gland, Switzerland: IUCN.

Butler, J.R.A., Wise, R.M., Skewes, T.D., Bohensky, E.L., Peterson, N., Suadnya, W.,Yanuartati, Y., Handayani, T., Habibi, P., Puspadi, K., Bou, N., Vaghelo, D., and Rochester, W. (2015). Integrating top-down and bottom-up adaptation planning to build adapative capacity: a structured learning approach. *Coastal Management*(43), 346-364.

Chasek, P., Essahli, W., Akthar-Schuster, M., Stringer, L.C., & Thomas, R. (2011). Integrated land degradation monitoring and assessment: Horizontal knowledge management at the national and international levels. *Land Degradation and Development*(22), 272-284. doi:10.1002/ldr.1096

Cheema, G.S., & Maguire, L. (2003). *Democracy, governance and development: A conceptual framework.* New York: United Nations Public Administration Network (UNPAN). Available online: http://unpan1.un.org/intradoc/groups/public/documents/un/unpan005781.pdf

Collins. (n.d). decision-maker. Collins English Dictionary. Available online: http://www.collinsdictionary.com/dictionary/english/decision-maker

Cowie, A., Schneider, U.A., & Montanarella, L. (2007). Potential synergies between existing multilateral environmental agreements in the implementation of land use, land-use change and forestry activities. *Environmental Science & Policy, 10*(4), 335-352. doi:10.1016/j.envsci.2007.03.002

Dai, L., Vorselen, D., Korolev, K.S., & Gore, J. (2012). Generic indicators for loss of resilience before a tipping point leading to population collapse. *Science, 336*(6085), 1175-1177. doi:10.1126/science/1219805

De Vente, J., Reed, M.S., Stringer, L.C., Valente, S., & Newig, J. (2016). How does the context and design of participatory decision making processes affect their outcomes? Evidence from sustaianble land management in global drylands. *Ecology and Society, 21*(2), 24.

Di Gregorio, A. (2016). *Classification Concepts: Land Cover Classification System Classfication Software version (3).* Rome: Food and Agriculture Organization of the United Nations.

Di Gregorio, A., Jaffrain, G., & Weber, J.-L. (2011). *Land cover classification for ecosystem accounting. Expert Meeting on Ecosystem Accounts, 5-7 December 2011, London, UK.* Available online: http://unstats.un.org/unsd/envaccounting/seeaLES/egm/Issue3_EEA_FAO.pdf

Dodds, F., Schneeb, K., & Ullah, F. (2012). *Review of implementation of Agenda 21 and the Rio Principles: Synthesis.* New York: Stakeholder Forum for a Sustainable Future and the United Nations Department of Economic and Social Affairs (UN DESA). Available online: http://www.uncsd2012.org/content/documents/194Synthesis%20Agenda%2021%20and%20Rio%20principles.pdf

Dominati, E.J., Mackay, A., Lynch, B., Heath, N., & Millner, I. (2014). An ecosystem services approach to the quantification of shallow mass movement erosion and the value of soil conservation practices. *Ecosystem Services*(9), 204-215.

Dominati, E., Patterson, M., & Mackay, A. (2010). A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological Economics*(69), 1858-1868.

Doss, C., & Kieran, C. (2015). *Standards for collecting sex-disaggregated data for gender analysis: A guide for CGIAR researchers.* CGIAR Gender and Agriculture Research Network. Available online http://gender/cgiar.org/

ECOSOC. (2016). *Report of the inter-agency and expert group on sustainable development goal indicators. Note by the Secretary-General. E/CN.3/2016/2/Rev.1, Statistical Commission 47th Session, 8-11 March 2016.* New York: United Nations Economic and Social Council (ECOSOC).

ELD Initiative. (2015). *The value of land: Prosperous lands and positive rewards through sustainable land management.* The Economics of Land Degradation (ELD) Initiative. Available online: http://eld-initiative.org/fileadmin/pdf/ELD-main-report_05_web_72dpi.pdf

Enemark, S. (2012). *Sustainable land governance: Three key demands. TS 03A - Land Governance, paper no. 5998. FIG Working Week - Knowing to Manage the Territory, Protect the Environment, Evaluate the Cultural Heritage.* Rome, Italy. Available online: http://www.fig.net/resources/proceedings/fig_proceedings/fig2012/papers/ts03a/TS03A_enemark_5998.pdf

Enemark, S., Williamson, I.P, & Wallace, J. (2005). Building modern land administration systems in developed economies. *Journal of Spatial Science, 50*(2), 51-68.

European Communities. (2013). *Overall Approach to the Classification of Ecological Status and Ecological Potential, Guidance Document No 13.* Luxembourg: European Union.

FAO. (1976). A framework for land evaluation. *FAO Soils Bulletin 32. Soil resources development and conservation service land and water development division*. Rome: Food and Agriculture Organization of the United Nations (FAO). ISBN 92-5-100111-1. Available online: http://www.fao.org/docrep/x5310e/x5310e00.htm

FAO. (2007). Land evaluation: Towards a revised framework. *Land and Water Discussion Paper 6. TC/D/A1080E/1/04.07*. Rome: Food and Agriculture Organization of the United Nations (FAO). ISSN 1729-0554. Available online: http://www.fao.org/nr/lman/docs/lman_070601_en.pdf

FAO. (2011). *The state of the world's land and water resources for food and agriculture (SOLAW) - Managing systems at risk.* Rome and Earthscan, London: Food and Agriculture Organization of the United Nations.

FAO. (2012a). *Global Land Cover database (GLC-SHARE 2012 Beta-release 1).* Rome: FAO Geonetwork, Food and Agriculture Organization (FAO). ISBN 978-92-5-107277-6. Available online: http://www.fao.org/geonetwork

FAO. (2012b). *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (VGGT).* Rome: Food and Agriculture Organization. Available online: http://www.fao.org/docrep/016/i2801e/i2801e.pdf.

FAO. (n.d.). *Global Agro-Ecological Zones (GAEZ).* Rome: Food and Agriculture Organization. Available online: http://www.fao.org/nr/gaez/

FAO, UNDP, UNEP. (n.d). *UN-REDD Programme*. Available online: http://www.un-redd.org/

Geist, H. (2004). The Causes and Progression of Desertification. Burlington, VT, USA: Ashgate.

Gibbs, H.K, & Salmon, J.M. (2015). Mapping the world's degraded lands. *Applied Geography*(57), 12-21.

Gordon, A., Bull, J.W., Wilcox, C., & Maron, M. (2015). Perverse incentives risk undermining biodiversity offset policies. *Journal of Applied Ecology, 52*(2), 532-537. doi:10.1111/1365-2664.12398

Gruet, E. (2008). *An annotated bibliography of the new governance concepts.* Montreal, Quebec, Canada: ReCo. Karl Polanyi Institute, Concordia University. Retrieved from http://reco.concordia.ca/pdf/Gruet08.pdf

GSP. (2016). Voluntary Guidelines on Sustainable Soil Management (VGSSM). Developed through the Global Soil Partnership (GSP). Rome: Food And Agriculture Organization of the United Nations (FAO). Available online: http://www.fao.org/3/a-bl813e.pdf

Gunasekara, C. (2006). Universities and associative regional governance: Australian evidence in non-core metropolitan regions. *Regional Studies, 40*(7), 727-741.

Hanson, C., Buckingham, K., De Witt, S., & Laestadius, L. (2015). *The Restoration Diagnostic.* Washington, DC: WRI. Retrieved from http://www.wri.org/publication/restoration-diagnostic

Hargrove, R. (2002). *Masterful Coaching* (Revised Edition ed.). Wiley, USA: Jossey-Bass / Pfeiffer.

Harvey, C.A., Zerbock, O., Papageorgiou, S., & Parra, A. (2010). *What is needed to make REDD+ work on the ground? Lessons learned from pilot forest carbon initiatives.* Arlington, Virginia: Conservation International. Available online: http://www.conservation.org/publications/Documents/redd/CI_REDD_lessons_executive_summary_english.pdf

Henry, B., & Murphy, B. (2016). *Sustainable Land Management and its Relationship to Global Environmental Benefits and Food Security. A shynthesis report for the GEF.* Washington, D.C: Global Environmental Facility. Available online: http://www.stapgef.org/publications/

Herrick, J.E., Beh, A., Barrios, E., Bouvier, I., Coetzee, M., Dent, D., Elias, E., Hengl, T., Karl, J.W., Liniger, H., Matuszak, J.,Neff, J.C., Ndungu, L.W., Obersteiner, M., Shepard, K.D., Urama, K.C., van den Bosch, R., and Webb, N.P. (2016). The Land-Potential Knowledge System (LandPKS): mobile apps and collaboration for optimizing climate change investments. *Ecosystems Health and Sustainability, 2*(3). Available online: http://onlinelibrary.wiley.com/doi/10.1002/ehs2.1209/epdf.

Hobbs, R.J., & Norton, D. A. (1996). Towards a conceptual framework for restoration ecology. *Restoration Ecology, 4*(2), 93-110.

IFAD. (2012). *National Programme for Rangeland Rehabilitation and Development, The Hashemite Kingdom of Jordan: Project Perfomance Assessment. Report No.2525-JO.* Rome: International Fund for Agricultural Development (IFAD). Available online: https://www.ifad.org/documents/10180/8b581baa-a32b-499b-9bcc-f2f70f421cf3

IPCC. (2006). *IPCC Guidelines for National Greenhouse Gas Inventories: Glossary. Prepared by the National Greenhouse Gas Inventories Programme.* (H. S. Eggleston, L. Buendia, K. Miwa, T. Ngara, & K. Tanabe, Eds.) Hayama, Japan: Institute for Global Environmental Strategies (IGES). Available online: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/0_Overview/V0_2_Glossary.pdf

ITPS. (2015). *Status of the World's Soil Resources.* Rome: Prepared by Intergovernmental Technical Panel on Soils (ITPS) for the Food and Agriculture Organization of the United Nations (FAO). Available online: http://www.fao.org/documents/card/en/c/c6814873-efc3-41db-b7d3-2081a10ede50/

IUCN. (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).* Available online: http://www.iucn.org/theme/forests/our-work/forest-landscape-restoration/restoration-opportunities-assessment-methodology

Jenner, N., & Howard, P. (2015). *Biodiversity Offsets: Lessons learnt From Policy and Practice Synthesis Report.* Cambridge, UK: Flora and Fauna International.

Klingebiel, A.A., & Montgomery, P.H. (1961). *Land-Capability Classification, 210-221.* Washington, D.C: U.S.C. Service. U.S. Government Print Office.

Kust, G., Andreeva, O., & Cowie, A. (2016). Land Degradation Neutrality: Concept development, practical applications and assessment. *Journal of Environmental Management,* (195), 16-24.

Liniger, H., & Critchley, W. (2007). *Where the Land is Greener. Case Studies and Analysis of Soil and Water Conservation Initiatives Worldwide.* Bern, Switzerland: CTA, FAO, UNEP, CDE on behalf of the World Overview of Conservation Approaches and Technologies (WOCAT). Available online: https://www.wocat.net/fileadmin/user_upload/documents/Books/WOOK_PART1.pdf

Liniger, H.P., Mekdaschi Studer, R., Hauert, C., & Gurtner, M. (2011). *Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa.* Rome: TerrAfrica, World Overview of Conservation Approaches and Technologies (WOCAT) and Food and Agriculture Organization of the United Nations (FAO). Available online: https://www.wocat.net/fileadmin/user_upload/documents/Books/SLM_in_Practice_E_Final_low.pdf

Maron, M., Bull, J.W., Evans, M.C., & Gordon, A. (2015). Locking in loss: Baselines of decline in Australian biodiversity offset policies. *Biological Conservation*(192), 504-512. doi:10.1016/j.biocon.2015.05.01

Maron, M., Gordon, A., Mackey, B.C., Possingham, H.P., & Watson, J.E.M (2015). Conservation: Stop misuse of biodiversity offsets. *Nature, 523*(7561), 401-403. Available online: http://www.nature.com/polopoly_fs/1.18010!/menu/main/topColumns/topLeftColumn/pdf/523401a.pdf

Maron, M., Hobbs, R.J., Moilanen, A., Matthews, J.W., Christie, K., Gardner, T.A., Keith, D., Lindenmayer, D.B., and McAlpine, C.A. (2012). Faustian bargains? Restoration realities in the context of biodiversity offset policies. *Biological Conservation*(155), 141-148.

Maron, M., Ives, C.D., Kujala, H., Bull, J.W., Maseyk, F.J.F, Bekessy, S., Gordon, A., Watson, J.E.M, Lentini, P.E, Gibbons, P. Possingham, H.P., Hobbs, R.J, Keith, D.A, Wintle, B.A and Evans, M.C. (2016). Taming a wicked problem: Resolving controversies in biodiversity offsetting. *BioScience*, Advance Access puiblication. doi:10.1093/biosci/biw038

May, P.H., Millikan, B., & Gebara, M.F. (2011). The context of REDD+ in Brazil: Drivers, agents and institutions. *Occasional paper 55. 2nd edition.* Bogor, Indonesia: CIFOR Available online: http://www.cifor.org/publications/pdf_files/OccPapers/OP-55.pdf

McDonald, T., Gann, G.D, Jonson, J., & Dixon, K.W. (2016). *International Standards for the Practice of Ecological Restoration - Including Principles and Key Concepts.*First Edition. Washington D.C: Society for Ecological Restoration (SER). Available online: http://c.ymcdn.com/sites/www.ser.org/resource/resmgr/docs/SER_International_Standards.pdf

McKenney, B.A., & Kiesecker, J.M. (2010). Policy development for biodiversity offsets: A review of offset frameworks. *Environmental Management*(45), 165-176. doi:10.1007/s00267-009-9396-3

Millennium Ecosystem Assessment (MA). (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC. Available online: http://www.millenniumassessment.org/documents/document.356.aspx.pdf

Miller, K.L., Trezise, J.A., Kraus, S., Dripps, K., Evans, M.C., Gibbons, P., Possingham, H.P., and Maron, M. (2015). The development of the Australian environmental offsets policy: from theory to practice. *Environmental Conservation, 42*(4), 306-314. doi:10.1017/S037689291400040X

Montanarella, L., Pennock, D.J., McKenzie, N., Badraoui, M., Chude, V., Baptista, I., Mamo, M., Yemefack, M., Singh Aulakh, M., Yagi, K., and Young Hong, S. (2016). World's soils are under threat. *Soil, 2*(1), 79-82.

Naughton-Treves, L., & Day, C.(Eds). (2012). *Lessons about Land Tenure, Forest Governace and REDD+. Case Studies from Africa, Asia and Latin America.* Madison, Wisconsin: University of Wisconsin Land Tenure Centre. Available online: https://www.nelson.wisc.edu/ltc/docs/Lessons-about-Land-Tenure-Forest-Governance-and-REDD.pdf

NRCS. (1973). *Land-Capability Classification (LCC).* Washington, D.C: U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

O'Connell, D., Abel, N., Grigg, N., Maru, Y., Butler, J., Cowie, A., Stone-Jovicich, S., Walker, B., Wise, R., Ruhweza, A., Pearson, L., Ryan, P., and Stafford Smith, M. (2016). *Designing Projects in a Rapidly Changing World: Guidelines for Embedding Resilience, Adaptation and Transformation (RAPTA) into Sustainable Development Projects (Version 1.0).* Washington, D.C: Global Environment Facility (GEF). Available online: http://www.stapgef.org/sites/default/files/publications/RAPTA%20Guidelines%20-%20Low%20Resolution.pdf

Oxford Dictionaries. (n.d.). *productivity.* Oxford Dictionaries. Available online: http://www.oxforddictionaries.com/definition/english/productivity

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multilevel learning processes in resource governance regimes. *Global Environmental Change*(19), 354-365.

Patrick, M., Tenywa, J.S., Ebanyat, P., Tenywa, M.M., Mubiru, D.N., Basamba, T.A, & Leip, A. (2013). Soil organic carbon thresholds and nitrogen management in tropical agroecosystems: concepts and prospects. *Journal of Sustainable Development, 6*(12), 31.

PMI. (2013). *Managing Change in Organizations: A Practice Guide.* Newtown Square, Pennsylvania, USA: Project Management Institute (PMI). Available online: http://www.pmi.org/~/media/Files/Home/ManagingChangeInOrganizations_A_Practice_Guide.ashx

Puppim de Oliveira, J., & Paleo, U. (2016). Lost in participation: How local knowledge was overlooked in landuse planning and risk governance in Tohoku, Japan. *Land Use Policy*(52), 543-551. doi:10.1016/j.landusepol.2014.09.023

Reed, M.S., Evely,A.C., Cundil, G., Fazey, I., Glass, J., Laing, A., Newig, J., Parrish, B., Prell, C., Raymond, C., and L.C. Stringer. 2010. What is social learning? *Ecology and Society (*15)4.

Reed, M.S., Stringer, L.C., Fazey, I., Evely, A.C., & Kruijsen, J.H.J (2014). Five principles for the practice of knowledge exchange in environmental management. *Journal of Environmental management*(146), 337-345. Retrieved from 10.1016/j.jenvman.2014.07.021

Richardson Temm, G. (2016). Climate change impacts are not gender-neutral - Box E. In D. O'Connell, N. Abel, N. Grigg, Y. Maru, J. Butler, A. Cowie, S. Stone-Jovicich, B. Walker, R. Wise, A. Ruhweza, L. Pearson, P. Ryan, and M. Stafford Smith, *Designing Projects in a Rapidly Changing World: Guidelines for Embedding Resilience, Adaptation and Transformation (RAPTA) into Sustainable Development Projects (Version 1.0). A STAP Advisory Document.* Washington, D.C: Global Environment Facility (GEF). Available online: http://www.stapgef.org/sites/default/files/publications/RAPTA%20Guidelines%20-%20Low%20Resolution.pdf

Robertson, M.M (2004). The neoliberalization of ecosystem services: wetland mitigation banking and problems in environmental governace. *Geoforum*(35), 361-373. doi:10.1016/j.geoforum.2003.06.002

Salzman, J., & Ruhl, J. B.(2000). Currencies and the commodification of environmental law. *Stanford Law Review*(53), 607-694.

Salzman, J., & Ruhl, J.B. (2006). "No Net Loss": Instrument choice in wetlands protection. In J. Freedman, & C. D. Kolstad (Eds.), *Moving to Markets in Environmental Regulation: Lessons fromTwenty Years of Experience.* Oxford, UK: Oxford University Press.

Scheffer, M., & Carpenter, S.R. (2003). Catastrophic regime shifts in ecosystems: linking theory to observation. *Trends in Ecology & Evolution, 18*(12), 648-656. doi:10.1016/j.tree.2003.09.002

Scoonnes, I. (1998). *Sustainable rural livelihoods: A framework for analysis. Working Paper 72.* Brighton, UK: Institute for Development Studies. Available online: https://www.staff.ncl.ac.uk/david.harvey/AEF806/Scoonnes1998.pdf

Sietz,D., Luedeke,M.K.B., & Walther, C. (2011).Categorisation of typical vulnerability patterns in global drylands. *Global Environmental Change-Human and Policy Dimensions* (21), 431-440.

Slezak, M. (2016, February 2). NSW Farmers member quits executive in dispute over land clearing. *The Guardian*. Available online: http://www.theguardian.com/environment/2016/feb/02/nsw-farmers-member-quits-executive-in-dispute-over-land-clearing

Smeets, E., & Weterings, R. (1999). *Environmental Indicators: Typology and Overview. European Environment Agency Report No. 25.* Copenhagen: European Environment Agency. 19 p. Available online: http://www.eea.europa.eu/publications/TEC25

Society for Ecological Restoration International Science and Policy Working Group. (2004). *The SER International Primer on Ecological Restoration.* Tucson, Arizona: Society for Ecological Restoration International. Available online: http://c.ymcdn.com/sites/www.ser.org/resource/resmgr/custompages/publications/SER_Primer/ser_primer.pdf

Squires, V.R. (2013). *Alignment of National Action Programmes with UNCCD 10 Year Strategy through use of integrated financing strategy tools.* Bonn: UNCCD. Available online: http://www.unccd.int/Lists/SiteDocumentLibrary/actionProgrammes/Draft%20Pedagogic%20tool.pdf

Stafford Smith, D.M., Abel, N.O., Walker, B.H, & Chapin III, F.S. (2009). Drylands: coping with uncertainty, thresholds, and changes in state. In F.S. Chapin III, G.P. Kofinas, & C. Folke (Eds.), *Principles of Ecosystem Stewarship: Resilience-Based Natural Resource Management in a Changing World* (pp. 171-195). New York: Springer-Verlag.

Stakeholder Forum for a Sustainable Future. (2012). *Review of implementation of Agenda 21. Sustainable Development in the 21st century (SD21).* New York: Division for Sustainable Developmente of the United Nations Department of Economics and Social Affairs (UN DESA). Available online: https://sustainabledevelopment.un.org/content/documents/1126SD21%20Agenda21_new.pdf

Tongway, D., & Hindley, N. (2004). Landscape function analysis: a system for monitoring rangeland function. *African Journal of Range & Forage Science, 21*(2), 109-113. doi:10.2989/10220110409485841

UNCCD. (2011a). *Report on the refinement of the set of impact indicators on strategic objectives 1, 2 and 3. Note by the secretariat. ICCD/COP (10)/CST/2, 9-21 October 2011.* Bonn: United Nations Convention to Combat Desertification (UNCCD). Available online: http://www.unccd.int/Lists/OfficialDocuments/cop10/cst2eng.pdf

UNCCD. (2011b). *Report on the scientific peer review for the refinement of the set of impact indicators on strategic objectives 1, 2 and 3. Note by the secretariat. ICCD/COP(10)/CST/INF.1.* Avaialble online: http://www.unccd.int/Lists/OfficialDocuments/cop10/cstinf1eng.pdf

UNCCD. (2012). *Ten Steps in the practical organisation of the NAP alignment Process.* Bonn: United Nations Convention to Combat Desertification (UNCCD). Available online: http://www.unccd.int/en/programmes/Capacity-building/CBW/Resources/Pages/NAP/NAPtensteps.aspx

UNCCD. (2013a). *Refinement of the set of impact indicators on strategic objectives 1, 2 and 3. Reccomendations of the ad hoc advisory group of technical experts. ICCD/COP(11)/CST/2 and Corr.1..* Bonn: United Nations Convention to Combat Desertification (UNCCD).

UNCCD. (2013b). *Report of the Conference of the Parties on its eleventh session, held in Windhoek from 16 to 27 September 2013.*

Part two: Action taken by the Conference of the Parties at its eleventh session. ICCD/COP(11)/23/Add.1. Bonn: United Nations Convention to Combat Desertification (UNCCD).

UNCCD. (2015a). *Report of the Conference of the Parties on its twelfth session, held in Ankara from 12 to 23 October 2015. Part two: Actions taken by the Conference of the Parties at its twelfth session. ICCD/COP(12)/20/Add.* Bonn: United Nations Convention to Combat Desertification.

UNCCD. (2015b). *Refinement of the UNCCD monitoring and evaluation framework in view of the post-2015 development agenda: strategic objectives 1, 2 and 3. ICCD/COP(12)/CST/3-ICCD/CRIC(14)/7 (Chapter 3).* Available online: http://www.unccd.int/Lists/OfficialDocuments/cric14/7eng.pdf

UNCCD-GM & Mirova. (2015). *Land Degradation Neutrality Fund: An Innovative Investment Fund Project.* Bonn, Germany: Global Mechanism (GM) of the United Nations Convention to Combat Desertification (UNCCD). Retrieved from http://www.global-mechanism.org/content/land-degradation-neutrality-fund-brochure

UNCCD-GM. (2016). *Achieving Land Degradation Neutrality at the country level - Building blocks for LDN Target Setting.* Bonn, Germany: Global Mechanism (GM) of the United Nations Conventions to Combat Desertification (UNCCD). Available online: http://www2.unccd.int/sites/default/files/documents/160915_ldn_rgb_small%20%281%29.pdf

UNCCD-GM. (n.d). *An Impact Investment Fund for Land Degradation Neutrality.* Bonn, Germany: Global Mechanism (GM) of the United Nations Convention to Combat Desertification (UNCCD). Available online http://www.unccd.int/LDN-fund

UNDP. (2005). *Human Development Report 2005. International cooperation and cross-roads: Aid, trade and security in an unequal world. HDR2005.* New York: United Nations Development Programme (UNDP). Available online: http://hdr.undp.org/sites/default/files/reports/266/hdr05_complete.pdf\

UNDP. (2010). *Designing Climate Change Adaptation Initiatives: A UNDP Toolkit for Practitioners.* New York: United Nations Development Programme (UNDP), New York. Available online: http://adaptation-undp.org/sites/default/files/downloads/toolkit_for_designing_climate_change_adaptation_initiatives___november_2010.pdf

UNEP. (2016). *Unlocking the Sustainable Potential of Land Resources: Evaluation Systems, Strategies and Tools. A Report of the Working Group on Land and Soils of the International Resources Panel.* (J. E. Herrick, O. Arnalds, B. Bestelmeyer, S. Bringezu, G. Han, M. V. Johnson, D. Kimiti, Yihe Lu, L. Montanarella, W. Pengue, G. Toth, J. Tukahirwa, M. Velayutham and G. Zhang, Eds.) Nairobi. Available online: http://www.unep.org/resourcepanel/AreasofResearchPublications/AssessmentAreasReports/LandSoils/tabid/133334/Default.aspx

United Nations. (2014). The New York Declaration on Forests (Section 1). In *Forests: Action Statements and Action Plans.* New York: Climate Summit 2014. United Nations (UN). Forests: Action Statements and Actions Plans. Climate Summit 2014. Available online: http://www.un.org/climatechange/summit/wp-content/uploads/sites/2/2014/07/New-York-Declaration-on-Forest-%E2%80%93-Action-Statement-and-Action-Plan.pdf

United Nations General Assembly. (1992a). *Report of the United Nations Conference on Environment and Development. Annex II. Agenda 21.* Rio de Janeiro, 3-14 June 1992. Avaialble online: http://www.un.org/documents/ga/conf151/aconf15126-1.htm

United Nations General Assembly. (1992b). *Report of the United Nations Conference on Environment and Development. Annex I. Rio Declaration on Enviroment and Development.* Rio de Janeiro, 3-14 June 1992. Avaialble online: http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm

United Nations General Assembly. (2015). *Transforming Our World: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015.* Available online: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

Vågen, T.-G., Winowiecki, L., Tamene Desta, L., & Tondoh, J.E. (2015). *The Land Degradation Surveillance Framework (LDSF) - Field Guide v4.1.* Nairobi, Kenya: World Agroforestry Centre.

Walker, B., Holling, C.S., Carpenter, S.R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society, 9*(2): Article 5. Available online: http://www.ecologyand-society.org/vol9/iss2/art5/

Welton, S., Biasutti, M., & Gerrard, M.B. (2015). Legal & Scientific Integrity in Advancing A "Land Degradation Neutral World". *Columbia Journal of Environmental Law, 40*(1), 40-97. Available online: http://www.columbiaen-vironmentallaw.org/assets/welton-WEB-final-1-16-2015.pdf

Westoby, M., Walker B, B., & Noymeirl, I. (1989). Opportunistic management for range-lands not at equilibrium. *Journal of Range Management, 42*(4). doi:10.2307/3899492

Annex 1

Checklist of actions to support appropriate governance of LDN

This checklist provides a summary of activities that require awareness and/or action by policy makers seeking to ensure appropriate governance in support of LDN.

- ☑ Align LDN planning and implementation with the VGGTs and existing planning processes including UNCCD National Action Programmes, national development plans and other national policy processes to maximize efficiency and effectiveness.

- ☑ Implement or strengthen, as needed, laws to secure land tenure and support communal tenure.

- ☑ Incorporate aspirational and global LDN targets in national planning processes, policies and strategies in a way that seeks to maintain or enhance the quality of all ecosystem services while minimising trade-offs between environmental, economic and social outcomes.

- ☑ Determine the national LDN target. Some countries may decide to aim higher than neutrality, that is, to improve the land-based natural capital above the baseline.

- ☑ Ensure that actions taken in pursuit of the LDN target do not compromise the rights of land users (especially small-scale farmers, pastoralists, indigenous peoples, women and the vulnerable who hold subsidiary tenure rights, such as gathering and grazing rights) to derive economic benefit and food security from their land.

- ☑ Pursue an integrated approach to land use planning that a) considers all (in)formal tenure rights, including overlapping and periodic rights, b) includes wide public participation in the development of planning proposals and the review of draft LDN plans to ensure that priorities and interests of communities are reflected, c) ensures information on the LDN interventions that publicized in an accessible location, in an appropriate form which is understandable and in applicable languages, d) enhances land administration systems with information essential to tracking LDN decisions, assessing land potential, condition and resilience, and monitoring LDN.

- ☑ Provide access through impartial and competent judicial and administrative bodies to timely, affordable and effective means of resolving disputes over LDN interventions in general with a special focus on tenure rights, including alternative means of resolving such disputes, and should provide effective remedies and a right to appeal. Such remedies should be promptly enforced.

- ☑ Make available, to all, mechanisms to avoid or resolve potential disputes at the preliminary stage, either within the implementing agency or externally. Dispute resolution services should be accessible to all, women and men, in terms of location, language and procedures.

- ☑ Ensure that different land types remain isolated from one another during planning so that gains or losses in one land type will not be counterbalanced with attendant gains or losses in another type. Rules must be as explicit as possible to prevent unintended negative impacts on any land type. Counterbalancing gains and losses should follow, as far as possible, "like for like" criteria and thus will generally not occur between different ecosystem-based land types, except where there is a net gain in land-based natural capital from this exchange. Clear rules should be established ex ante for determining what type boundaries, to ensure that there is no risk to endangered ecosystems.

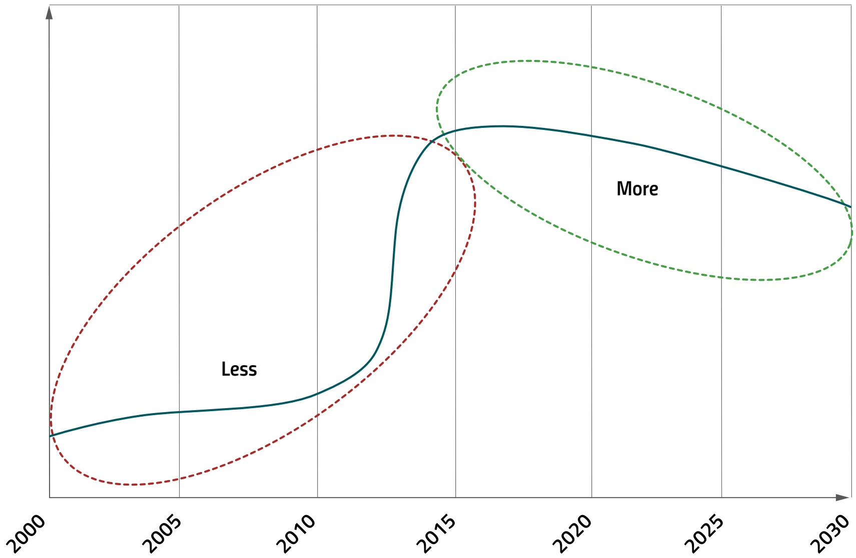
- ☑ Ensure that counterbalancing does not occur between protected areas and land managed for productive uses.
- ☑ Ensure that counterbalancing occurs at the resolution of the biophysical or administrative domains at which land use decisions are made.
- ☑ Ensure that, after assessing the land for its potential, priority is placed first on lands where land degradation can be avoided, followed by land where land degradation can be reduced, and finally on land suited to activities designed to reverse land degradation.
- ☑ Recognize that the counterbalancing activity within LDN is based on the intent of land use and management decisions; whether or not what was intended when those decisions were made is actually manifest in impacts on the landscape is determined by a separate but parallel effort to monitor actual changes in land-based natural capital in order to assess LDN achievement at a future date. This means that the key to success of LDN is in how effective integrated land use planning is at appropriately planning interventions designed to achieve gains and accurately estimating potential new degradation that may lead to losses.
- ☑ Ensure local input in the assessments that set the stage for better land use planning and counterbalancing decisions, and also in verifying and interpreting monitoring data.
- ☑ Ensure that learning is effectively embedded at all levels, through all the components of LDN, that is, in planning, implementation and monitoring, and that learning informs adaptive management.

Annex 2

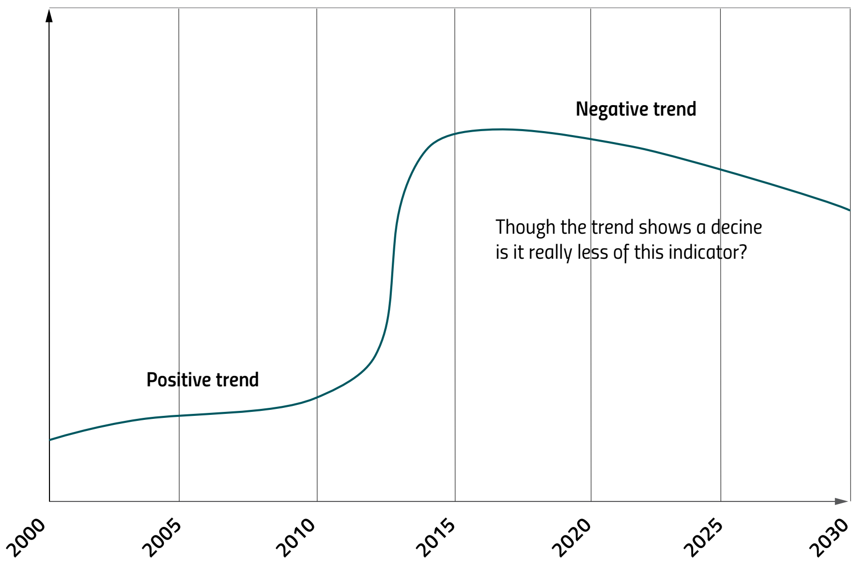
Why comparing trends is not appropriate for assessing neutrality

Comparing trends is not useful or appropriate for assessing neutrality. If a trend metric were used to create a baseline this would mean that when neutrality is determined in 2030, the process would involve comparing trends with trends (rather than an absolute numerical value vs. an absolute numerical value). This could lead to an unintended outcome where, for example, the measure could have been increasing from a low start point 2000-2010, jumped up a lot 2010-2015, but then declined a little 2015-2030. The unintended outcome is that this would be labelled as declining when the magnitude of the change suggests otherwise, as illustrated in Figure 15. Comparing absolute numerical values versus trends of a hypothetical indicator of LDN status.. Extending the period in the second moment would not solve this (in the example, even if not switching from positive to negative, it will still show a decline of the trend).

An additional concern is that the sign of change (up or down) in absolute numerical values is scale invariant (for any monotone function, as a log-scale), which is not necessarily the case for changes in trends. What would be invariant is the sign of each trend (positive or negative), so the type of trend at the final monitoring point (t1) could be useful as added information that could be obtained from the same data.



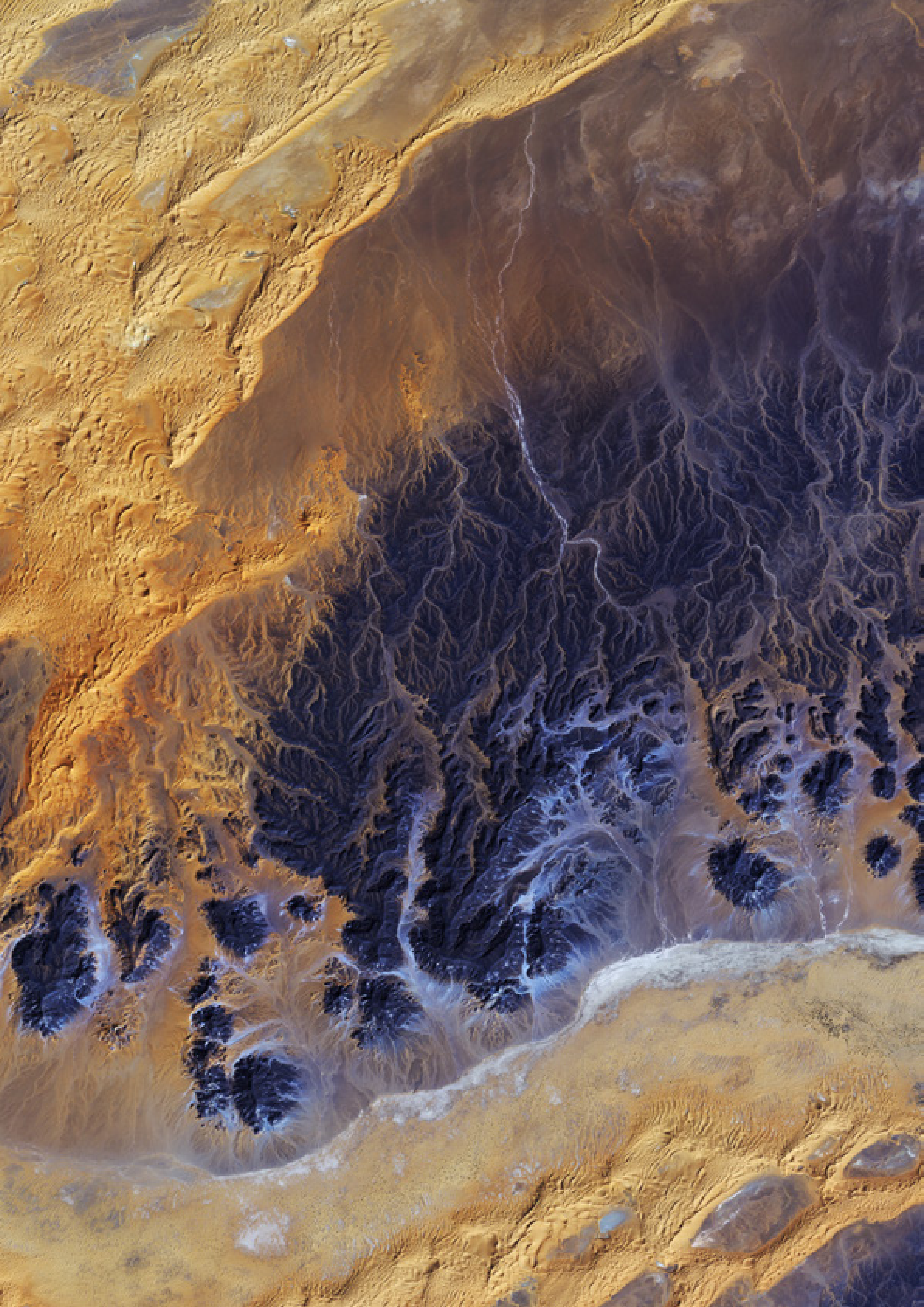
Assessing the absolute value of this indicator (e.g., mean of 2000-2015 vs. a mean of 2015-2030 would show a positive result (more of this indicator)



Assessing trends (e.g., trends in this indicator from 2000-2015 vs. trends from 2015-2030 would show a negative result (less of this indicator).

FIGURE 15

Comparing absolute numerical values versus trends of a hypothetical indicator of LDN status



HAVING AN AGREED SCIENTIFIC CONCEPTUAL FRAMEWORK FOR LDN WILL ASSIST IN DEVELOPING A DEEPER UNDERSTANDING OF THE LDN CONCEPT AND WILL CREATE A SCIENTIFIC FOUNDATION TO GUIDE LDN IMPLEMENTATION AND MONITORING.

The scientific conceptual framework for Land Degradation Neutrality (LDN) explains the underlying scientific processes and principles that support achievement of LDN and its intended outcomes. The framework provides a scientifically-sound basis to understand LDN, to inform the development of practical guidance for pursuing LDN and to monitor progress towards the LDN target.

The scientific conceptual framework for LDN was prepared in accordance with the rules and procedures established by the UNCCD Conference of the Parties (COP), by which any scientific output prepared under the supervision of the Science-Policy Interface (SPI) should undergo an international, independent review process (decision 19/COP.12).

The conceptual framework was prepared by an author team of 2 lead authors and 11 contributing authors. An author meeting was held on 22-23 February 2016 in Washington DC, USA; SPI members as well as external experts in neutrality applied to environmental challenges participated in the meeting.

The draft produced by the authors underwent a three-step review process, including an internal review (13 reviewers), an external scientific peer-review (8 reviewers) as well as a review by the Bureau of the COP. The lead authors have ensured that all government and expert review comments received appropriate consideration.

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The mission of the UNCCD Science-Policy Interface (SPI) is to facilitate a two-way dialogue between scientists and policy makers in order to ensure the delivery of science-based, policy-relevant information, knowledge and advice.

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