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Land in balance: The scientific conceptual framework for Land Degradation Neutrality

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ABSTRACT

The health and productivity of global land resources are declining, while demand for those resources is increasing. The aim of land degradation neutrality (LDN) is to maintain or enhance land-based natural capital and its associated ecosystem services. The Scientific Conceptual Framework for Land Degradation Neutrality has been developed to provide a scientific approach to planning, implementing and monitoring LDN. The Science-Policy Interface of the United Nations Convention to Combat Desertification (UNCCD) led the development of the conceptual framework, drawing in expertise from a diverse range of disciplines.

The LDN conceptual framework focuses on the supporting processes required to deliver LDN, including biophysical and socio-economic aspects, and their interactions. Neutrality implies no net loss of the land-based natural capital relative to a reference state, or baseline. Planning for neutrality involves projecting the likely cumulative impacts of land use and land management decisions, then counterbalancing anticipated losses with measures to achieve equivalent gains. Counterbalancing should occur only within individual land types, distinguished by *land potential*, to ensure "like for like" exchanges. Actions to achieve LDN include sustainable land management (SLM) practices that avoid or reduce degradation, coupled with efforts to reverse degradation through restoration or rehabilitation of degraded land. 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 level through integrated land use planning, while achievement is assessed at national level.

Monitoring LDN status involves quantifying the balance between the area of gains (significant positive changes in LDN indicators) and area of losses (significant negative changes in LDN indicators), within each land type across the landscape. The LDN indicators (and associated metrics) are land cover (physical land cover class), land productivity (net primary productivity, NPP) and carbon stocks (soil organic carbon (SOC) stocks).

The LDN conceptual framework comprises five modules: A: Vision of LDN describes the intended outcome of LDN; B: Frame of Reference clarifies the LDN baseline; C: Mechanism for Neutrality explains the counterbalancing mechanism; D: Achieving Neutrality presents the theory of change (logic model) articulating the

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impact pathway; and E: Monitoring Neutrality presents the LDN indicators. Principles that govern application of the framework provide flexibility while reducing risk of unintended outcomes.

1. Introduction

Land resources provide food and materials, and the often-overlooked regulating and supporting ecosystem services on which the provisioning services depend (MA, 2005). Demands on global land resources are increasing as the world's population increases in number and affluence, yet the health and productivity of land is deteriorating (Montanarella et al., 2016) and prime agricultural land is being lost to urbanization. Increased competition for land resources will increase social and political instability, exacerbating food insecurity, poverty, conflict and migration (UN-Habitat-GLTN, 2016). It is critical that land degradation is effectively addressed. Management of land degradation will have co-benefits for climate change mitigation and adaptation, and biodiversity conservation, in addition to enhancing food security and sustainable livelihoods (Cowie et al., 2007).

The concept of land degradation neutrality (LDN) was introduced into the global dialogue to stimulate a more effective policy response to land degradation. LDN was adopted as target for Sustainable Development Goal 15, and building capacity to achieve LDN is a primary goal of the UNCCD (UNCCD, 2016).

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" (UNCCD, 2016). The concept was raised to galvanise effort around a concrete target of "no net loss" and it aims to maintain the world's resource of healthy and productive land through a dual-pronged approach of measures to avoid or reduce land degradation, combined with measures to reverse existing degradation, such that losses are balanced by gains. The LDN target is a global goal and countries have been invited to commit voluntarily to LDN at the national level.

The UNCCD Science-Policy Interface (SPI) (See Supplementary information (SI) Table S1 for abbreviations) was requested by the UNCCD's Conference of the Parties (COP) to develop a scientific "Conceptual Framework for Land Degradation Neutrality" to provide a scientifically-sound basis for understanding and implementing LDN, and to inform the development of practical guidance for pursuing LDN and monitoring progress towards the LDN target. While the scope of the UNCCD is limited to drylands, the LDN conceptual framework is applicable across all land types, land uses, and ecosystem services. LDN will underpin the achievement of multiple SDGs related to food security, environmental protection and the sustainable use of natural resources.

This paper presents the scientific conceptual framework for LDN. It conveys the principles, assumptions and rules surrounding LDN in a structured format, and explains the links between its key components, to inform an evidence-based holistic solution to combating land degradation. Section 2 describes the participatory process adopted to develop the framework, while Sections 3 and 4 present the key elements of the conceptual framework followed by a detailed description of its five modules.

2. Development of the framework

While the concept of LDN may seem simple – requiring actions to reverse degradation in order to balance any future degradation – the means of achieving LDN have not been agreed, and concerns have been raised about its feasibility (e.g. Safriel, 2017). The UNCCD Parties therefore recognised the need for a scientific foundation for LDN. An agreed scientific conceptual framework for LDN should facilitate development of a common understanding of the concept, and serve as a common point of reference for the emerging LDN discourse and various LDN initiatives. Therefore, the LDN conceptual framework is intended to assist countries in implementing strategies to address land degradation and achieve LDN.

The framework was devised through a participatory process of knowledge co-creation that began with a survey targeting a diverse mix of domain experts[2] responding to "thought starter" statements designed to generate initial ideas from a range of disciplinary perspectives (SI, Table S4). On the basis of the survey, the following details were agreed:

(1) The scope of the scientific conceptual framework for LDN should include socio-economic as well as biophysical aspects. It should include a conceptual system model, and also describe the application of the model to implement and monitor LDN, and governance of LDN.
(2) Development of the framework should be guided by an agreed Theory of Change (Weiss, 1995) for LDN.
(3) Resilience concepts (Connell et al., 2016, 2015; Connell et al., 2016, 2015) should inform the framework, recognising that LDN interventions must be resilient to deliver LDN and effectively manage land degradation over the long term.

The development of the framework continued with a "writeshop" of the interdisciplinary expert group of authors, to agree on the elements of the framework, and subsequent drafting of the report. The draft was reviewed by eight international experts with expertise in land degradation science, the science-policy interface, and the needs of UNCCD parties.

3. Key elements of the scientific conceptual framework for LDN

LDN is a novel approach to address land degradation. It acknowledges that the land system will be affected by global environmental change and, hence, the framework encourages adaptive management during planning, implementation, monitoring and interpretation of LDN. The framework is structured around the counterbalancing mechanism to achieve neutrality, which projects and seeks to balance anticipated positive and negative changes (Fig. 1). The framework comprises five interconnected modules:

- **Module A** documents the **vision and objectives** of LDN;
- **Module B** explains the LDN **frame of reference,** that is, the baseline against which neutrality is assessed;
- **Module C** establishes the **mechanism for neutrality** (the counterbalancing mechanism);
- **Module D** presents the elements necessary to **achieve LDN**, including the theory of change (logic model), which articulates the pathway for implementing LDN, preparatory assessments and enabling policies, learning and governance;
- **Module E** details the process for **monitoring LDN**, including quantifying, verifying and interpreting the LDN indicators.

Key terms and concepts are defined in the Glossary (SI, Table S2). Principles are provided to guide the implementation of LDN, enabling context-specific adjustments while avoiding perverse outcomes

[2] The initial survey targeted an interdisciplinary team of international experts, SPI members and the UNCCD's Science, Technology and Implementation unit, including the authors of this article.