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The need for a global rangeland health monitoring framework

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Abstract

Globally, rangelands contribute to biodiversity (above- and below-ground), climate change adaptation and mitigation, ecosystem restoration, wildlife habitat and human well-being. However, these critically important ecosystems are degrading at unprecedented rates, due to lack of investment and awareness. Further limiting these investments are the vast knowledge gaps on the status of rangeland health, including the ability to reliably measure the impact of rangeland restoration interventions on key indicators of ecosystem health. We propose that building and implementing a global rangeland monitoring framework, aimed to build consistent datasets, will enable the comparison of management practices across diverse systems, track the efficacy of interventions over time, and provide the evidence-base to inform policy and practice. In addition, we see an additional benefit of such a system is the contribution to the various standards around value chains from rangeland systems, ultimately providing additional income to pastoralists and value chain actors. Within the STELLAR (Sustainable Investments for Large-scale Rangeland Restoration) project, we have conducted a review of standards and their associated monitoring frameworks across the rangeland value chains in the Americas, Central Asia, and Africa. We collated the variables and indicators within each framework and found wide disparities in indicators monitored, monitoring techniques, and assumptions made. Variations in how data are collected and which variables are included demonstrated a lack of consistency across frameworks. For example, the Land Degradation Surveillance Framework (LDSF) is a comprehensive field based method that collects multiple indicators of soil health, land degradation and vegetation diversity, but does not include local knowledge or socio-economic variables. We call for a framework that combines systematic field-based assessments, with citizen science and remote sensing to deliver accurate assessments of rangeland health indicators at scales relevant to stakeholders (pastoralists, value chain actors, land managers, standards experts, and policy makers) and to track interventions over time.

Introduction

Rangelands are incredibly vast ecosystems and provide multiple critical ecosystem services and livelihoods for millions of people. Yet, rangelands are highly degraded, with soil erosion being dominant in dryland systems (Vågen and Winowiecki, 2019). Therefore, there is an urgent need for rangeland restoration efforts. A significant

obstacle to attracting private investment in rangeland restoration, as Burrows (2024) points out, is the absence of reliable and straightforward performance indicators. Livestock value chain development (LVCD) offers a promising pathway for driving investment and improving rangeland management. By involving actors across the livestock value chain - including the commercial sector - LVCD can help establish sustainable and climate-resilient systems. This involves directing investments toward the resource base (rangelands) to enhance productivity and enable targeted restoration efforts. Furthermore, LVCD can build international momentum for rangeland restoration through collaboration among key stakeholders, alliances, and evidence-based approaches. However, the lack of globally validated standards, tools, and frameworks for assessing restoration progress has hindered effective scaling of robust value chain models, particularly in developing nations.

Ecological monitoring involves tracking changes in ecosystems by measuring specific variables and indicators across space and time. Indicators are measurable attributes of an ecosystem that provide critical insights into its health and functionality (Suter 2001). These indicators can either directly quantify significant ecosystem attributes or services - such as vegetation biomass as an indicator of productivity - or indirectly measure elements correlated with processes or features that are more challenging to assess directly. An ecological monitoring framework offers a systematic approach to observing, evaluating, and interpreting ecosystem conditions and their dynamics over time. Its primary purpose is to enhance the understanding of ecological processes, identify changes or trends, and support informed management decisions (Schlesinger and Bernhardt 2013).

To address these gaps, we aim to co-develop a comprehensive framework for monitoring rangeland health that can be applied across various value chains and landscapes.

Methods

A first step in this development process was to conduct an extensive review of existing monitoring frameworks. An initial review assessed 30 monitoring frameworks, including 15 connected to sustainability standards, 11 based on field methodologies, and five relying on remote-sensing techniques. Additionally, a review of 65 publications - across topics of rangelands, grasslands, savannas, restoration, degradation, drylands, monitoring, and surveillance - was conducted to identify current practices and best approaches in rangeland monitoring. This review assessed 59 biophysical and 18 socioeconomic indicators across the frameworks. To assess the frameworks, we rated them based on the number of indicators assessed under the following categories: 1) Soil health; 2) Vegetation; 3) Hydrology; 4) Landscape Level; 5) Faunal Diversity; 6) Community Indicators; 7) Ease of Implementation; and 8) Data Collection and Integration. If a framework had five or more variables measured under each category, it was scored high. We also conducted interviews with key informants, including standard developers and commercial sector representatives, to better understand practical challenges and priorities for LVCD investment. Further, a consultation workshop on the proposed global rangelands monitoring framework and indicators was held with representation of 22 organizations to provide feedback and suggestions.

Results

The results of this review illustrated that no one monitoring framework adequately covered all aspects of socio-economic, biodiversity, and animal health and diversity. While some frameworks were excellent in biophysical indicators and ease of implementation (the Land Degradation Surveillance Framework (LDSF), others were strong in the socio-economic and community indicators (Sustainable Fibre Alliance) (Table 1). Furthermore, there was little overlap in indicators, making it difficult to use data from different frameworks to compare and assess rangeland health. However, from the 59 biophysical indicators and the 18 socio-economic indicators assessed we narrowed down to a list of 10 biophysical indicators and 12 socio-economic indicators, see below. These indicators were narrowed down through a multi-step process including: 1) Assessing whether the indicators adhered to the SMART indicator framework (Specific, Measurable, Attainable, Relevant, and Timebound); 2) Multi-stakeholder consultation workshops; and 3)Key informant interviews. This process will continue through the next six months to finalize the list.

Biophysical Indicators
Soil: Soil organic carbon content, soil compaction, soil erosion prevalence, bare ground cover
Vegetation : Annual primary productivity, herbaceous cover, woody cover
Biodiversity: diversity and density of grasses, forbs, woody vegetation
Hydrology: soil-water infiltration capacity

Socioeconomic indicators
Rangeland Enterprise: Rate of return on investment, palatable forage cover, livestock density/health, presence of a feasible management plan, governance structure, secure land tenure
Community Livelihoods: Income inequality, local ecological knowledge utilized, education, employment diversity

Table 1: An evaluation of 11 rangeland health frameworks according to the number and type of soil, vegetation, hydrological, biodiversity, landscape, and community indicators, and the framework's ease of implementation and infrastructural integration. Dark green represents the highest rating, followed by light green, yellow, and pale red representing the lowest rating.

Monitoring Framework	Soil Indicators	Vegetation Indicators	Hydrological Indicators	Landscape Indicators	Faunal Biodiversity	Community Indicators	Ease of Implementation	Data Collection and Integration
AusPlots								
ILRI Participatory Rangeland Management								
IUCN Land Health Monitoring								
Landscape Functional Analysis								
LDSF – Rangeland Health Module								
MARAS								
Rangeland Baseline Master Protocol								
Sustainable Fibre Alliance								
USDA-ARS								
Veld Management								
Western Australia RMS								

Discussion

There is a clear need for a comprehensive monitoring framework that combines globally relevant, validated indicators while also capturing the unique nuances of local contexts. This framework should generate reliable evidence of the impacts of restoration activities and support investments in sustainable rangeland value chains. We recommend integrating robust field-based methods with citizen science and remote sensing technologies. This combination will allow for the establishment of accurate baselines and facilitate long-term monitoring of key biophysical indicators, all while providing geo-referenced data on the location and types of actual

interventions taking place on the ground. Such an approach would provide the necessary evidence to support adaptive management, guide policy decisions, and attract further investment in sustainable rangeland management.

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