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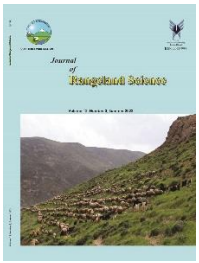

Review and Full Length Article:

Land Degradation Neutrality in the World's Rangelands: Contemporary Approaches to Old Problems Using New Solutions

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Received on: 09/05/2021
Accepted on: 08/09/2021
DOI: 10.30495/RS.2022.684639

Abstract. It is very easy to view land degradation and desertification as purely biophysical phenomena for which there are neat technological solutions. Yet millions of real people live in the affected lands, and they both cause land degradation and are impacted by it, so scientists and land managers need to find a good balance between reductionist rigor and societal applicability. The concept of Land Degradation Neutral World (LDN) offered great promise to meet the commitments made in the various National Action Plans as a road map for achieving goals for the affected country reports to the United Nations Convention to Combat Desertification (UNCCD). The operationalization of LDN is more challenging. We must recognize the consequences of past inaction on land degradation, climate change and biodiversity loss. Land degradation plays a key role in this 'vicious triangle' of threats to our sustainability. The LDN agenda provides a framework, and commitment to it by all nations affected by land degradation, is the key to successful outcomes by 2030. Adoption of the idea and implementation of measures could lead to reaching LDN, one of the UN's sustainable development goals that was agreed in 2015, but it won't be easy and there is an obligation for the richer nations to provide financial and technical support to affected party countries.

Key words: Climate change, Desertification, Biodiversity, Carrying capacity, Sustainability

Introduction

This paper is about rangelands and their management now and into the future. Specifically, it will focus on the philosophy underpinning the notion of Land Degradation Neutrality (LDN). More particularly it will consider the barriers to implementing the measures that will be necessary if LDN is to achieve its global goal by 2030 and analyze the outcomes of several UNCCD-led pilot studies.

The focus is on rangelands because they are on all continents, except Antarctica, and occur at high elevations (4500 m a.s.l. or at high latitudes). Above 60° N, some are below sea level (e.g. Danikal Depression in East Africa, Death Valley in USA, in the Lake Eye basin in central Australia and elsewhere. Collectively, rangelands as one of the most prevalent land systems on the planet, occupy about 40% of the world's land surface and are home to about 2 billion people (Squires, 2010).

There are divergent views on what the term "rangelands" might mean. At some stage there was a dominant view that rangeland referred to a 'type of land use'. Later, the emphasis shifted to regarding rangelands as 'a type of land that has a variety of potential uses', only one of which was livestock husbandry. Today, there is broad spectrum of systems for exploiting rangelands. People have many personal preferences that lower the efficiency of resource use and may even degrade natural resources. This makes it imperative that the definition of rangelands includes both physical attributes and land use aspects. Large areas of Africa, Asia, Australia and South America are home to indigenous peoples.

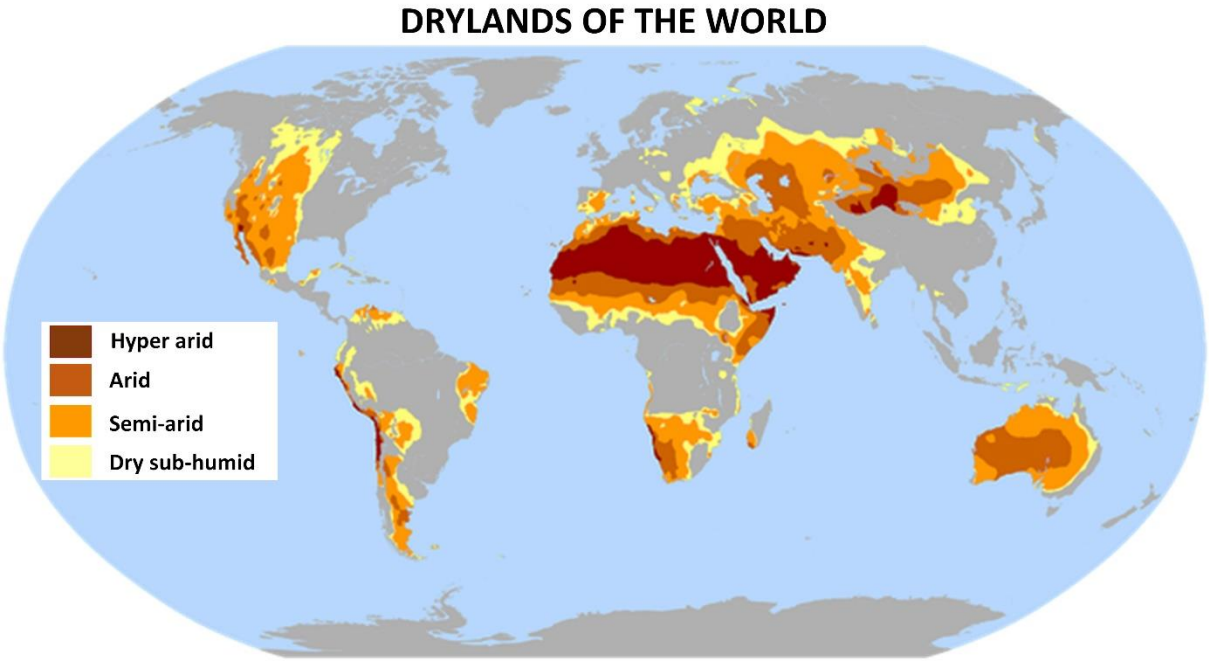

Fig. 1. Map showing the extent and location of the world's drylands. Although not all rangelands are drylands, the map indicates the areas where most land systems are classified as rangelands (Source: http://www.fao.org/dryland-forestry/background/what-are-drylands/en/)

There is an exceptional array of ecosystem services from the drylands. However, human interference in many places has led to acceleration in the loss of habitat and biodiversity, thus eventually reducing the scope and flow of ecosystem services (Gaur *et al.*, 2020a).

Efforts to combat land degradation from whatever cause, especially in dry areas, have moved away from a strictly technological fix approach to a more integrated approach that ensures that the perspectives of the local people are taken into account and more emphasis is placed on developing viable options with the full

participation of the people in the affected area. This inevitably involves the complex interactions of people with the environment and requires holistic and diverse interventions that are customized to needs of different localities (Winslow *et al*. 2004).

The notion of '*multiple use*' prevailed in many circles and non-conventional uses (at the time but well-accepted today) such as eco-tourism, biodiversity conservation, mining and utilization by the military for weapons testing, sites for large-scale solar energy collection etc came to be accepted. More recently, alternative energy facilities such as wind turbines and photovoltaic cells now covering many hectares can be seen in western China, North America, Australia and other regions. For example, areas in dryland regions of western Rajasthan (India) where a high proportion of the electricity generated comes from wind and solar parks (Gaur *et al*., 2020b). China has similar, large-scale wind and solar generators.

Rangelands are critical habitats for a myriad of plant and animal species and form many of the world's major watersheds e.g. the major rivers that arise in the Tibet plateau such as the Mekong, Yellow River and Yangtze and several important rivers that nurture India (Ganges, Brahmaputra), the Orange River that arises in Lesotho and runs across South Africa and Namibia, the Amu-Daria and the Syr-Daria that flow across southern Kazakhstan and the Kyzyl Kum and Karakum deserts in Central Asia, as well as the Euphrates and Tigris rivers that flow through rangelands in Turkey and Syria and Iraq.

Land degradation in rangelands is not a new thing (Oswald & Harris, 2018; Thomas, 2008, D'odorico *et al*., 2013). Recognition of its serious consequences on a global scale emerged in the 1970s. It is more than 40 years since the United Nations Conference on Desertification (UNCOD) was held. UNCOD created a great deal of optimism that something positive could be done. The intervening years have not been all the comforting (Behnke and Mortimer, 2016). New hope arose in 1990, when the Intergovernmental Panel on Climate Change (IPCC, 1990) published its First Assessment Report, which showed, among other things, the potential for revegetating degraded lands to sequester large amounts of carbon to tackle global climate change, while helping to combat land degradation too. A UN Framework Convention on Climate Change (FCCC) and a UN Convention to Combat Desertification (UNCCD) followed in 1992 and 1994, respectively, but progress on implementing these two conventions has been painfully slow (Squires and Ariapour, 2018). The same is true for the exploitation of synergies between the two conventions despite a pioneering workshop under the auspices of the United Nations Environment Program (UNEP) in Nairobi in 1995 which identified these synergies and provided estimates of the potential amount of carbon that could be sequestered in drylands (Squires *et al.,* 1995). Exploiting synergies for action that benefit all three UN conventions, including the Convention on Biodiversity (CBD), is not a luxury but is absolutely vital. These three Conventions came to be known as 'the Rio Conventions' following the major international conference (UNCED) held there in 1992. Now, as we get ever closer to the ultimate carrying capacity of human beings on Planet Earth, the interactions between the issues dealt with in these three global environmental conventions will increasingly become constraints on our freedom of action. We cannot run away from the necessity of dealing with these three threats. We should greatly increase our activities to control the effects and impacts while it is still possible to do so. We must recognize the consequences of past inaction on land degradation, climate change (Burke *et al*., 2008) and biodiversity loss (Glenn, *et al*. 1995; Safriel, 2017).

Rangeland Ecology and Management:Implications for Biodiversity Conservation, Land Protection and Livelihoods

In 2015, UNCCD defined "Land Degradation Neutrality" (in areas affected by desertification) 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". This could be achieved by a) Sustainable Management of Land (SML) to reduce the rate of degradation; or b) increasing the rate of restoration of degraded land, so that these two trends converge to a zero net rate of land degradation. So, LDN is a new voluntary and aspirational target of a Sustainable Development Goal (SDG) under the UN 2030 Agenda for Sustainable Development, aimed at neutralizing the rate of lands coming under degrading use that diminish their productivity. This is by balancing the ongoing added degradation with a similar rate of restoring equivalent lands whose productivity had been already degraded.

If extensively implemented, LDN would stabilize the global amount of productive land by 2030. This would increase global food security and reduce poverty of land users, thus contributing to global sustainability. The world's commitment towards land degradation neutrality (LDN) became enshrined in various international agreements and decisions throughout 2015.

The three Rio Conventions (the UN Con vention to Combat Desertification (UNCC D), the UN Framework Convention on Cli mate Change (UNFCCC) and the Conventi on on Biological Diversity (CBD) play key roles in shaping the international LDN governance and implementation cont ext. Their different but related foci create a number of challenges and opportunities fo r advancing LDN. The LDN agenda provides a framework and commitment to it by all nations affected by land degradation is the key to successful outcomes by 2030. However, it must be realized that it will not be an easy task (Grainger, 2015) and working on ways to make it operational is still a major hurdle to overcome (Chasek *et al*., 2014). Chasek *et al*. (2014) and Grainger (2015) have examined the bottlenecks and assessed the feasibility of the operationalization of LDN. However, measuring dryland degradation is particularly difficult because there is a strong interaction between the erratic and natural rainfall and anthropogenic changes that affect vegetation cover.

Box 1. Operationalization of Land Degradation Neutrality (LDN)

Degraded land is costly to reclaim and, if severely affected, may no longer provide a range of ecosystem functions and services, with a loss of goods and many other potential environmental, social, economic and non-material benefits that are critical for society and development.

Strategies to implement the LDN scheme are organized in five main steps (Chasek *et al*. 2015):

- **Step 1:** ***Scoping scale and domain:*** although the ambition of LDN is to address global issues, since local land degradation directly affects land inhabitants, any plan for LDN actions needs to determine the spatial scale and the thematic domain targeted,
- **Step 2:** ***Mapping degradation:*** Monitoring the implementation of LDN (Step 5) necessitates the definition of baselines. This means classifying and mapping the lands in the areas where LDN is to be achieved, i.e. the identification of lands already degraded and lands under degradation, but also lands not degrading – the difficulty being to differentiate these states along a continuum.

• **Step 3:** ***Prescribing relevant practices:*** Good practices in Sustainable Land Management (SLM), when implemented in a given context, lead to improved land management performance. Several criteria determine whether a practice is a good or relevant one. Several regional or international initiatives focus on guidelines and best practices, but more should be done particularly in terms of focus on:

• **Step 4:** ***Stakeholder knowledge brokering systems*** to share best practices and economic valuations of the best practices. Practices which do not degrade the land, or which reduce or fight against degradation are relevant if they are targeted and appropriate to the context and to the state of the land degradation, accepted and fair according to the points of view of all stakeholders. That means:

–They should take into account the specificities of the place and its connexion with its immediate (local) and global environment.

–They should be appropriate to the type and severity of the damage, taking into account the intrinsic characteristics of the place, the climate and human activities, the temporal dynamics and the spatial diversity of the degradation, the multifunctionality of landscapes and the diversity of stakeholders.

–They should be built with several stakeholders and be based on experienced practices

–They should promote a judicious combination of practices (e. agroforestry, agroecology, integration of agriculture and livestock practices), and their integration in existing exploitation and territorial systems.

– They should be applied without taking the risk of affecting other areas or systems near or far, and within a legal framework.

• **Step 5:** ***Monitoring:*** Earth Observation, Official Statistics, with supported by survey sampling/grounds measurements and citizen sourcing will be used to monitor, detect and validate the changes in the sub indicators. Several international and regional organisations (FAO, OSS, JRC, NASA, ESA) have developed a methodology (land cover classification system) and databases that could be used. One of the key ways to ensure effective LDN monitoring is to set up baselines on land cover information, land productivity and for carbon stocks to determine the initial status of the sub-indicators. The challenge is therefore to use appropriate indicators.

In line with SDG target 15.3 and to monitor progress, the indicator: "the percentage of land that is degraded over total land area", is being considered by international organizations (UNCCD, FAO, CBD) and would be based on the use of three metrics:

• Land cover and land cover change
• Land productivity
• Carbon above (plant biomass) and below (soils) stocks.

The resulting indicators will allow countries to focus on the relevance and effectiveness of current land and planning policies and agricultural practices. This monitoring approach should be accompanied by local and participatory initiatives including a broad range of stakeholders. Countries will also need adequate capacity building in data interpretation and validation and their use to inform national authorities and international reporting

Towards achieving Land Degradation Neutrality: Turning the concept into practice

The challenge now becomes one of addressing its operation (Akhtar-Schuster *et al*., 2016; Safriel, 2017; Cowie *et al.*, 2018; Grainger, 2015) in order to achieve these new policy goals and targets by the year 2030. Achieving LDN demands attention to what the LDN concept seeks to achieve, as well as unravelling the perspectives of the key multilateral environmental agreements through which progress can be made. As Grainger says:

'A goal of Land Degradation Neutrality by the year 2030 was agreed by the Rio+20

conference in 2012, and subsequently included in the Sustainable Development Goals. It dilutes earlier goals of unrestricted control of desertification, for example, by proposing that the rate of land degradation should be reduced and the rate of restoration of degraded land increased so they offset each other by 2030. As with many environmental concepts that have emerged in recent decades, Land Degradation Neutrality was proposed in the political arena, and scientific study is only now starting to evolve'.

Grainger further states "national and international implementation would involve political, organizational and technological challenges. Monitoring restoration of desertified land by revegetation would be feasible immediately, but monitoring cuts in national rates of desertification would not, because *no baseline rates are currently available*; national and international scientific capacities to measure desertification are limited; and further scientific knowledge is required to supplement existing knowledge of desertification processes and of land use and land cover change processes generally".

Akhtar-Schuster *et al*. 2016) critically analyze the literature to elucidate potential challenges and opportunities in moving LDN towards implementation, considering the mandates and objectives of all three Rio conventions. Examination of the LDN pilot projects spearheaded by the UNCCD to identify key lessons for LDN implementation led to synthesis of these lessons. They then present a portfolio of blended interventions that seek to address the aspirations of the UNCCD, UNFCC and the CBD in the LDN space. They also identified synergistic linkages between the three Rio conventions and the respective National Action Plans (NAPs) of participating countries. Proper implementation of development plans may be difficult if the country does not have an appropriate national land use policy and/or an up-to-date NAP to combat desertification and land degradation. A functional drought mitigation policy, at least for the more vulnerable districts is also required as part of the agenda to achieve LDN by 2030. At the same time, many countries are focusing on implementation of land reform and gender empowerment policies that are supported by relevant laws.

It is also necessary to develop and implement policies on management of grazing lands and any common property resources, including surface and ground water. Apart from executing sustainable development programs, it is necessary to establish a robust monitoring mechanism on land degradation and an early warning system so that the impact of different programs and schemes can be regularly monitored and evaluated, and corrective steps could then be taken (Campbell *et al*., 2013). Sustainability is such a broad and diffuse concept that anyone can read into it whatever they wish (World Bank, 2006; Squires, 2012). The meaning of sustainability presents problems, its meaning 'in theory' can be intuited but 'in practice' it is seldom really explained or understood. Likewise, there are on-going responses to periodic changes in population density, weather patterns (even climate change) competing land uses, alternative economic uses and natural condition of the resource base for each rangeland site (Grainger *et al.,* 2000). Perhaps a more appropriate goal is to strive for "more adaptable and less exploitative ways of living for rangeland societies. Maintaining the productive qualities of rangeland (Fig. 2) and its flow of ecological goods and services for continued future use is one of the most important challenges directly confronting the rural population in rangelands across the entire globe but the problems impact on the wider society. Both rural and urban of all countries where rangelands are an important feature of the landscape.

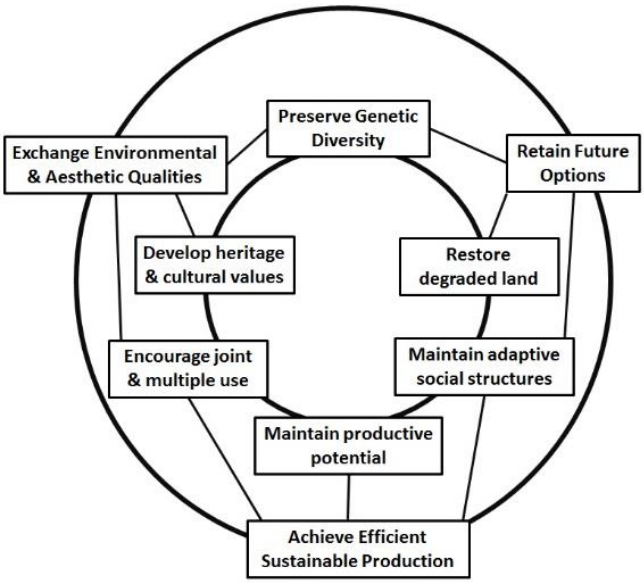

Fig. 2. Aims and objectives of rangeland management include a focus on three key aspects i) achieve efficient and sustainable production of tradeable product (meat, milk, fiber, hides) ii) Enhance environmental and aesthetic qualities of landscapes and iii) Retain future options, with an eye to intergenerational equity (Source: Squires, 2016)

Many rangeland users manage their land in ways that capture its biological productivity through its products of use/economic value, directly derived from wild plants (e.g. tree-derived timber), or indirectly from free-ranging livestock (feeding on wild plants). Others now utilize the scenic value, the 'spiritual' or cultural aspects of the land as a way to derive value and sustain livelihoods. Others still are involved in mining, the setting up of alternative energy facilities -- even inland aquaculture!

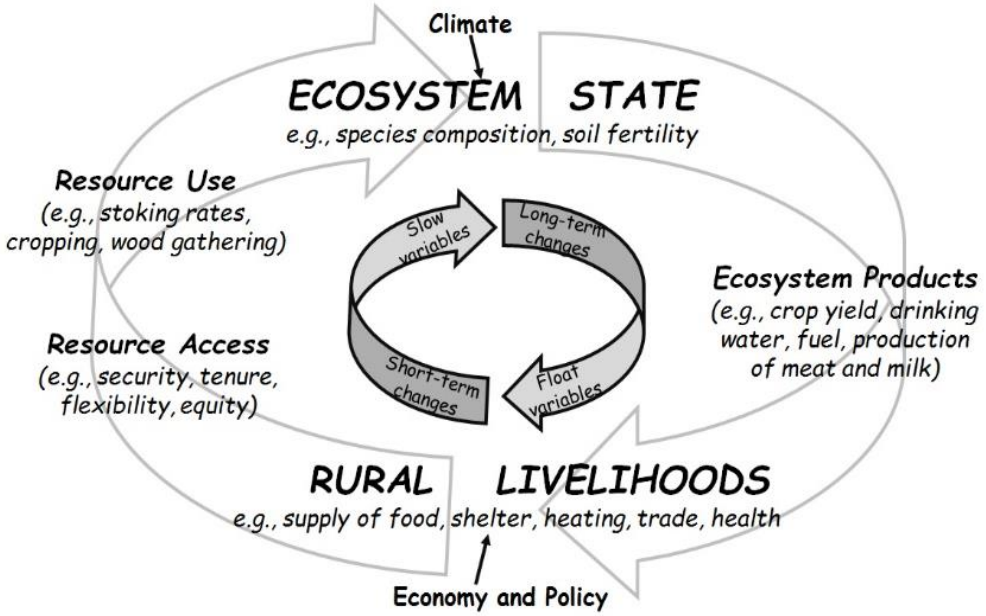

Fig. 3. Social and biophysical factors in rangelands are closely linked, difficult to predict and involve a mixture of 'fast' and 'slow' variables. The core of the biophysical system is the 'state of the ecosystem', whereas the core of the socioeconomic system is 'rural livelihood' (Source: Mark Stafford Smith, pers.com)

Putting aspirations for an LDN world into practice

There are three major challenges to assessing LDN that we need to be clear about.

(i) What is the geographical unit to be taken into account?

Should the land degradation (LD) of *one bioregion* or of the *whole nation state* be zero? For any given "geographical unit" (ecosystem, bioregion or nation state) that is already degraded, there may be big differences in the severity and extent of LD. Should we take that level as "time zero" or is the starting point set at some earlier point in time when ecosystems were more intact? Can one area be 'traded off' against another area? Or is the zero net calculation an overall calculation, so that the land restoration that takes place in one bioregion can "neutralize" the land degradation in another? If so, who is going to decide what the trade-offs are? And at what cost? There is a risk that targets set at an inappropriate scale, for example, nationally rather than at the individual ecosystem level, could encourage trade-offs between similar and dissimilar ecosystems, or could lead to unsustainable outcomes

(ii) What is the benchmark or starting point for implementing LND?

What are the operational definitions of *land degradation* and *restoration*? It is related to question (i) To work from the present status might be measurable although the option of using some pre-degradation status would be much harder to achieve.

(iii) Who is going to measure and monitor the rate of land degradation and restoration?

What is the unit of measure for land degradation? It is per hectare or per square km? Will new indices apply to all countries? Who is actually responsible for measuring and monitoring? Is the data verifiable? How do local communities, land users, citizens/and or other stakeholders participate in the decision making over LDN initiatives/strategies, about the whereabouts of these areas and the monitoring of those same areas? Finally, what are the characteristics of restored/degraded land that are allowed under the LDN concepts?

The countries, organizations or sectors that wish to contribute to an 'LND world' need to determine the spatial scale and the specific thematic domain within which they aspire to achieve LDN.

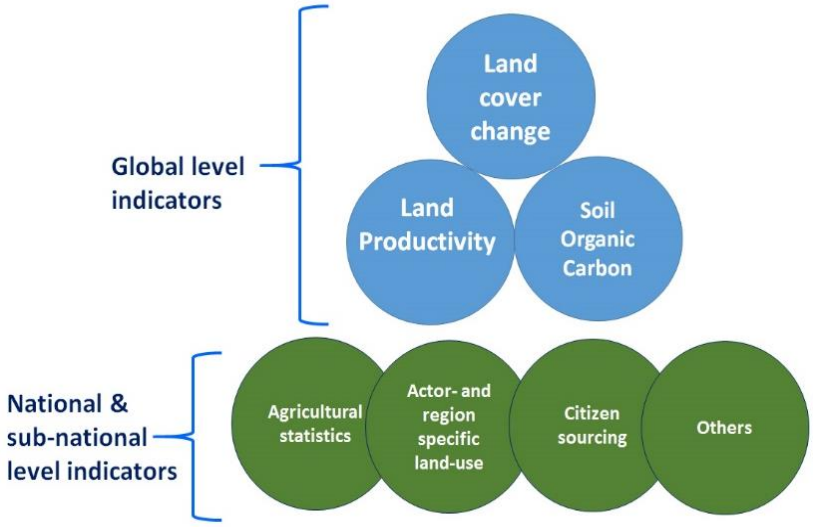

Fig. 4. Proposed land and soil indicators to monitor the achievement of the Sustainable Development Goals (IASS, 2015)

The selected geographic domain can be an individual farm, watershed, an administrative region or a geopolitical region. Once the domain is agreed, mapping degradation within the boundaries can proceed. There is a requirement to classify and map land. Rangelands, being complex biosocial systems, offer a near infinite array of possibilities for choice of variables and how to collect and interpret the data. Geomatics (remote sensing, GIS, and GPS) opens the possibility of frequent, synoptic (everywhere, instantaneously) landscape coverage via satellite imagery (Bai *et al*., 2008).

Indisputable evidence of cause(s) requires concurrent data on these influences along with similar trends from similar circumstances (replications) and controls [reference areas lacking the putative cause(s) of LD]. In the LDN context, the conventional reliance on monitoring plant succession and its trajectory could be replaced with three alternatives. These are: risk assessment, sustainability, and land degradation. Risk assessment is well proven where biophysical indicators can be employed, although politically neutral incorporation of socioeconomic considerations has yet to be demonstrated, however. Sustainability is such a broad and diffuse concept (see above) that anyone can read into it whatever they wish. Land degradation is the preferred macro-concept to guide us into the future, because its use can more objectively encompass both biophysical and socioeconomic features, at any scale in time and space. Although LDN implies global scale neutrality, this globality is similar but not identical with the globality of greenhouse gas emissions. Whereas emissions from a local site directly affect global warming, local land degradation directly affects the local land user, but only indirectly affects global food security.

Therefore, striving for LDN is a cumulative result of striving to increase the number of sites that reach LDN. Targets can potentially be reached by applying a combination of measures that collectively add up to the desired level (Fig. 5).

Fig. 5. Mitigation Hierarchy and LDN shows how different factors can contribute to meeting LDN targets. The strategy is to go by stages from 'Degraded' to at least partly 'Restored' whilst ensuring that every effort is made to 'Minimize' those factors cause degradation. Source: https://www.iucn.org/sites/dev/files/content/documents/tech_brief_land_degradation_neutrality_revised_2017_2.pdf

Measuring Progress towards LDN

At COP12 the UNCCD adopted a set of three land-based progress indicators which will become central to reporting on progress towards LDN.

• Tier 1: trends in land cover;
• Tier 2a: Trends in land productivity or functioning of the land;
• Tier 2b: Trends in carbon stock above and below ground.

While these indicators provide a simple set of comparable indicators that can be

informative when used in combination, they also have considerable limitations. Existing data sets may offer a low-cost way of improving monitoring progress towards LDN. The IUCN Red List of Ecosystems (RLE), for example, provides a repeatable and consistent method for assessing the risk of ecosystem collapse worldwide. UNCCD publish updates as to targets, pilot projects and progress to date (UNCCD, 2018; 2019).

Discussion

Experience elsewhere (Keestra *et al*. 2018) has shown that to effectively address LDN, greater governmental cooperation and coordination is required across the responsibilities of different government agencies in order to: (i) bring together the fragmented knowledge base on, for example, agriculture, forestry, soil and water conservation, rangeland management, hydrology, local and indigenous knowledge; (ii) incorporate the input of all relevant stakeholders; (iii) bridge the science-policy divide; and (iv) implement coordinated activities at the national level that will also interact with the community of local land users.

To be effective, there needs to be streamlining of the governance structures to enable effective interactions among the numerous actors across national, regional and local jurisdictions and across policy domains (Fig. 6).

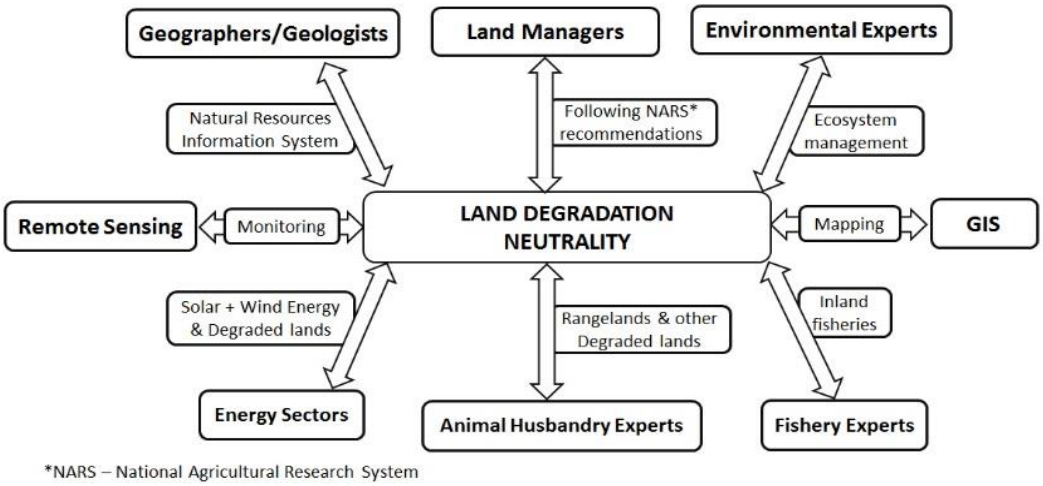

Fig. 6. Schematic diagram showing a tentative policy to achieve land degradation neutrality (LDN). In India, the NARS system maintains the national repository of related data. Source: Bhattacharyya, 2020

The local-scale and biophysical and socio-economic contexts within which land degradation occurs, implies that the level of administration that engages more closely with land users will be the most effective in implementing interventions that are based on principles of SML. To improve on better design and implementation, a better understanding of the interplay between land users' decision-making processes, land use change (brought on by climate change and exacerbated by population pressure) and the policy framework.

The analysis and contextualization of LDN at the watershed scale to provide decision support for the formulation of policies and programs towards transformative LDN interventions. Land use planning based on river basins and large water bodies, offer an entry point for implementation of landscape-scale approaches that integrate agriculture, forestry, water and infrastructure agendas (Fig. 7).

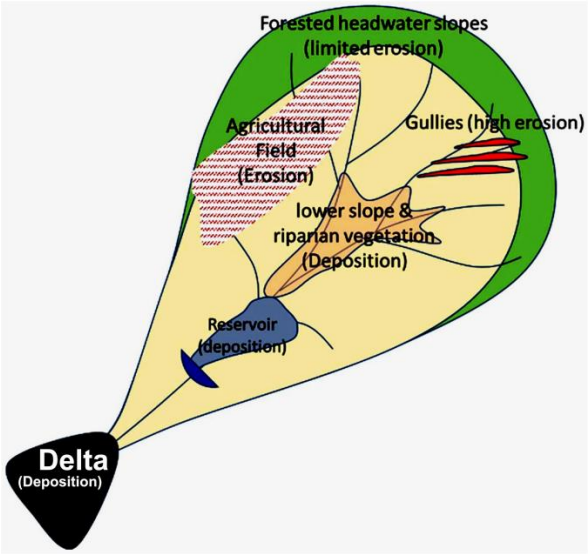

Fig. 7. Experience in a number of countries has shown the benefit of using a river basin as a useful unit and an entry-point for implementing measures that are required to achieve LDN. Source: Keestra *et al*. 2018

Conclusions

Reversing land degradation is essential if we are to achieve the goals of the UNCCD, CBD or the UNFCCC as well as to continue meeting related sustainable development targets. The translation of global targets into national ones, such as LDN, will help position the interconnected challenges of Desertification, Land Degradation and Drought at the centre of the conservation sector, and will provide impetus towards more integrated responses to climate change (Burke *et al*., 2006, Thomas, 2008) and the other major environmental crises of our time.

It is clear from the UNCCD and a perusal of the various NAPs of affected party countries and from country profiles compiled by FAO, UNDP, the World Bank and others that work is proceeding to combat desertification and other forms of land degradation, revegetate land and implement other measures, including policy, reform of land tenure arrangements and so on. These measures might be lumped under the general heading of Sustainable Land Management (SLM). The most widely agreed definition of SLM states that it is 'a dynamic and evolving concept that aims to maintain and enhance the economic, social and environmental value of all types of lands, for the benefit of present and future generations'. SLM has been a central pillar of the UNCCD and the CBD since their inception and most of the above approaches contain or incorporate SLM elements.

Land Degradation Neutrality is essentially an equation between three processes: degradation, restoration and sustainable land management. Different approaches have been formulated and implemented to restore and sustain land resources (i.e. soil, water and biodiversity), such as Sustainable Land Management, Landscape Restoration and/or rehabilitation, and Ecosystem-based Approaches and Area-based Conservation. And while SLM is an essential component of any effort to halt land degradation there is an increasing recognition that conservation and sustainable use measures are no longer sufficient to stem the loss of ecosystem services and achieve LDN on a global or even a nationwide scale. Commitment to LDN will require a re-think of NAPs and technical and financial support from the international community. Land Degradation should not be solely regarded as the domain of the UNCCD, given its close links with other environmental and sustainable development challenges, including

poverty, climate change and biodiversity loss (IUCN, 2015).

We leave readers with a question to ponder. If a target is set at ecosystem or national level, then will it bring additional obligations to that affected country? What will be the obligations of other signatory states under the UNCCD given that developed countries have an obligation to help affected-country parties (UNCCD, 2017). Innovative funding should be developed to support implementation of action towards LDN. Important efforts are needed to explore how synergies between conservation and sustainable development contribute to LDN.

Actions can be financed through national and international financial flows, justified by ecosystem benefits that accrue to society at the national and global levels, in the form of Payment for Ecosystem Services (Stavi and Lal, 2015).

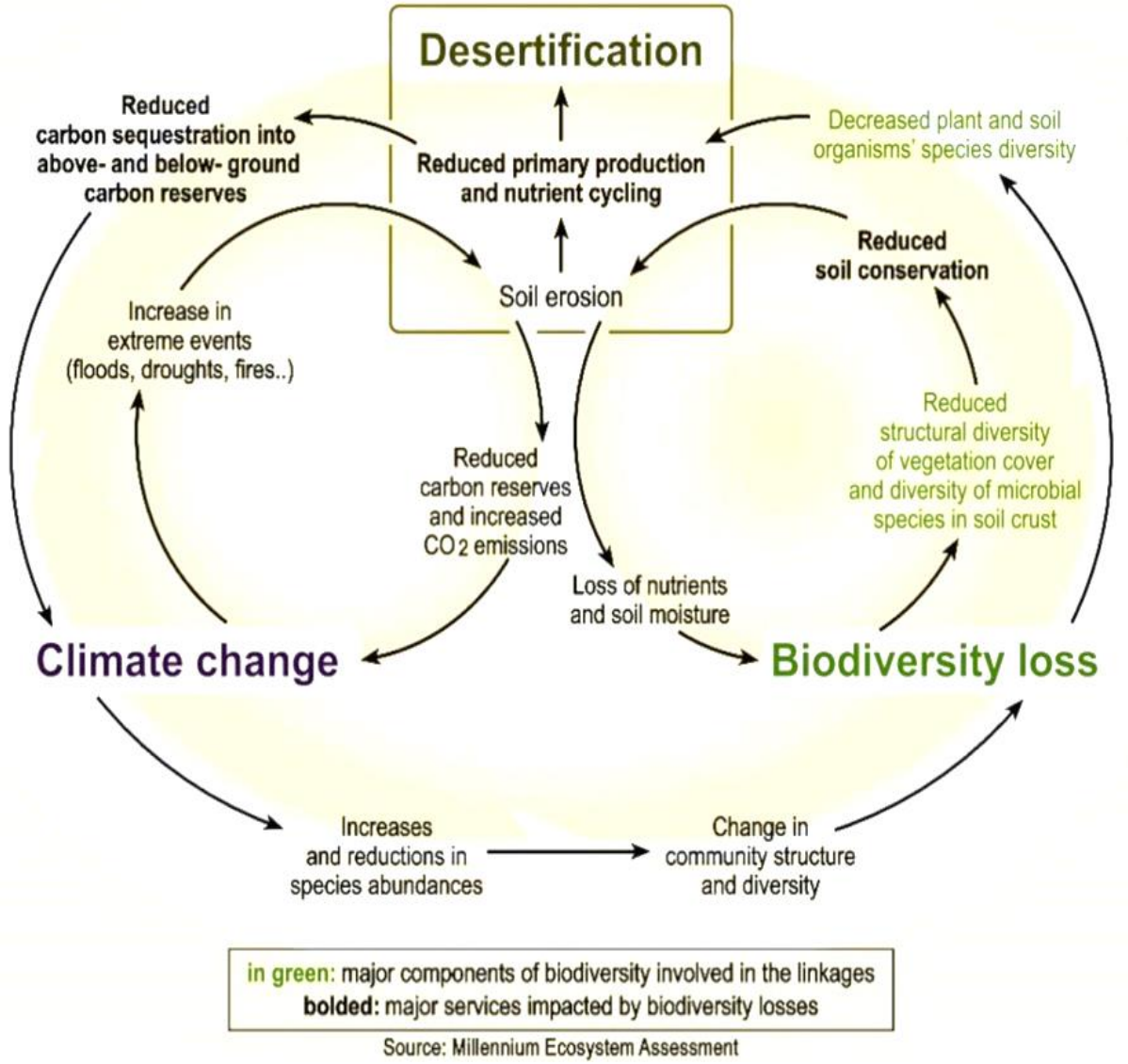

Fig. 8. Feedback loop between land degradation, biodiversity and climate change Source: https://www.iucn.org/sites/dev/files/content/documents/tech_brief_land_degradation_neutrality_revised_2017_2.pdf

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