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Land Degradation Neutrality (LDN) in drylands and beyond – where has it come from and where does it go

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Highlights

- LDN, a mechanism for offsetting new losses of land's productivity by restoring productivity of already degraded lands, would maintain the balance of productive lands.
- As target of Sustainable Development Goal LDN highlights the significance of land whose biological productivity is critical to human survival.
- Commissioning UNCCD to oversee the implementation of LDN empowers the UNCCD and its impact on sustainability.

Abstract

The paper first reviews the desertification/land degradation syndrome, the shortcomings of attempts to control it and the consequences of this failure, including to climate change and biodiversity. It then examines the experience gained by carbon and biodiversity offsets that helped adapting the offsetting principle to the context of land degradation, by emphasizing the restoration of the many already degraded lands on earth, as major component of the Land Degradation Neutrality (LDN) mechanism. 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 of their productivity. This by balancing the ongoing added degradation with 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. This review maintains that the failure of United Nations Convention to Combat Desertification (UNCCD) to reduce desertification triggered the emergence of LDN as a mechanism for addressing land degradation globally, rather than just desertification in the drylands. LDN accepted as target of a Sustainable Development Goal also legitimized UNCCD to lead and oversee the aspired process of achieving land degradation neutral world. This paper reviews the development of the LDN concept expressed in scientific deliberations and political advocacy, throughout the five years from inception in 2011 at the UNCCD Secretariat, to early 2016. It notes the fast and increasing acceptance of LDN, expressed in the initiation of implementation already in April 2015 by an increasing number of countries, and in the growing interest and engagement of scientists and policy-makers. But the paper also express concern regarding potential misuse of the concept.

Keywords climate change; desertification; ecosystem services; offsetting mechanism; Rio Conventions
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1 Introduction

The United Nations Convention to Combat Desertification (UNCCD) defined desertification as land degradation in drylands, which stands for "reduction or loss … of biological or economic productivity" (UNCCD 1994). The Millennium Ecosystem Assessment (MA) noted that fluctuation in productivity, measured "in terms of the things that ecosystems provide that matter to people… is normal, especially in drylands" (Adeel et al. 2005). It then presented land degradation and desertification as "persistent reduction in the levels of all ecosystem services over an extended period" and suggested that "persistent, substantial reduction in the provision of ecosystem services … is a much greater threat in drylands than in non-dryland systems" (Adeel et al. 2005).

While UNCCD has been at force since early 1997, land degradation and desertification at the global scale have not been arrested (e.g., Bai et al. 2008; Zika and Erb 2009). This paper briefly attends the land degradation/desertification syndrome and then reviews the emergence of Land Degradation Neutrality target (LDN) and its development throughout years 2005–2015.

2 The land degradation/desertification syndrome

2.1 Land, soil, degradation, desertification

When conceptualizing land as ecosystem or as land-based ecosystem, land degradation can be traced down to its impacts on specific ecosystem processes, those that underpin ecosystem services from which people derive benefits. These include interactions of the soil components with the diversity of its belowground, and aboveground biota. Furthermore, the soil functions as water storage and pool for organic matter and nutrients that contribute to soil fertility, which underpins land productivity, expressed in rates of biomass per time and land units.

Land users manage their land for augmenting its biological productivity expressed by its products of use/economic value, directly derived from wild plants (trees-derived timber), or indirectly from free-ranging livestock (feeding on wild plants), or from cultivated plant (crops). The management targets timber exploitation rates, livestock grazing pressure, and soil fertility (tillage, application of fertilizers, herbicides, irrigation water), respectively. In historical perspective, these interventions for promoting the food-provisioning service of the land ecosystem have kept pace with the increasing demands but also have often reduced soil fertility and the consequent land productivity.

Soil gains its fertility through its texture and structure – its mineral particles are bound together, mostly by the soil organic matter, to form aggregates with spaces between them, which retain water, dissolved minerals, and air. This specific structure, however, makes soil vulnerable to the mechanical force of wind, and especially water, leading to its loss through erosion processes. This loss detrimentally affects fertility, since most nutrient contents occur at the uppermost soil layers, which are directly exposed to eroding forces.

The soil plant cover provides protection by mitigating wind force and reducing the impact of raindrops that would otherwise breakdown the soil aggregates. This results in crusting that seals the soil surface, leading to a decrease in water absorbed by the soil. Rather than infiltrating and enriching the soil, this sealing generates surface runoff that erodes the soil either in bulk or just leaching away dissolved soil minerals functioning as nutrients and soil organic matter. The loss of soil organic matter directly reduces fertility and indirectly the soil's water holding capacity (Bot and Benites 2005).

Another major land degradation process is driven by irrigation, very rare in rangelands but a ubiquitous cultivation practice that has dramatically increased the land's economic productivity particularly in drylands. Yet, beside water logging, and loss of nutrients through leaching irrigation can gradually increase soil salinity which affects 20% of all irrigated cropland (Qadir et al. 2014), specifically in drylands (Adeel et al. 2005). Thus, soil erosion and salinization are major biophysical drivers of a persistent and often irreversible fertility decrease relative to the soil potential fertility (Safriel 2007; Prince et al. 2015). The consequent loss of land productivity is both an outcome but also a measure of land degradation/desertification (Adeel et al. 2005).

2.2 Land degradation drivers and consequences

Millennia of accumulated traditional knowledge and centuries of scientific research supported practicing non-degrading land use, but the currently increasing demand for land's biological products intensifies the pressure on soil and biodiversity, what often turns exploitation to over-exploitation of soil fertility. This leads to land degradation and consequent poverty, especially in drylands (Adeel and Safriel 2005). Furthermore, local land degradation expressed in water-driven soil erosion may have off-site land degrading impact. This when the eroded soil is deposited in water reservoirs, what reduces their water-holding capacity. Or, the off-site deposits of eroded soil may contain fertilizers and pesticide residue, which could pollute off-site soil and reduce land's fertility (Roose 1996). In addition, wind-driven soil erosion often generates massive dust storms and long-distance dust transport (Kanayama et al. 2002; Prospero and Lamb 2003). These reduce visibility, what impedes land- and air-bound traffic, and the storm-transported contaminants risk human health (Griffin et al. 2001).

In extreme but not rare cases land degradation triggers poverty and famine and is the magnifying effect of within- and between-countries conflicts (Safriel 2006), which trigger migrations of refugees (e.g., Suhrke 1993; Myers 2002; Reuveny 2007). In addition, the spread of land productivity loss, associated with impaired soil function of carbon sequestration would undermine food security (Bowyer et al. 2009; Fischer et al. 2001; Tilman et al. 2001; Rosegrant and Cline 2003) and climate change mitigation, respectively, at local and mostly at global scale (Lal 2004).

The estimates of the spatial extent of land degradation provided by five global assessments carried out through 1977–2009 ranged between 15% to 63% of global land, and between 4% to 74% of global drylands (Safriel 2007; Zika and Erb 2009). The MA attributed medium certainty to the 10–20% range of global drylands degraded by year 2000 (Safriel and Adeel 2005) and an assessment based on 23-year remote sensing images revealed persistently declining productivity at 24% of global land (Bai et al. 2008), contested by Wessels (2009). Thus, quarter of global land may be degraded, and the impact of the socio-economic and policy drivers of land degradation have not weakened since the UNCCD entered into force.

One reason for this may be the neglect of addressing land degradation as a unified syndrome; many of the national policy responses to land degradation have addressed it in a fragmented mode, through attending each driver separately. Furthermore, with some exceptions, very few new national policies emerged since the UNCCD entered into force. This can be attributed to the commitment of the UNCCD to a bottom-up implementation, i.e., prioritizing the involvement of local populations as a prerequisite to launching activities (UNCCD 2012a), an approach that discourages higher scale legislation and its enforcement. To conclude, only in few cases land degradation-relevant policies address land degradation holistically, only a few new policies are known to have achieved their prescribed objectives, and others are too young for assessing their effectiveness (Akhtar-Schuster et al. 2010).

2.3 Land degradation interactions with climate change and biodiversity loss

Three out of forty actions for achieving global sustainability proposed by Agenda 21 adopted by the 1992 United Nations Conference on Environment & Development in Rio de Janeiro (UN 1992), protection of the atmosphere, conservation of biological diversity and combating desertification drove the emergence of the three, thematically interactive UN Framework Convention on Climate Change (UNFCCC), Convention on Biodiversity (CBD), and UNCCD, respectively. These were followed by eight Millennium Development Goals (MDGs), whose achievement by 2015 depended directly or indirectly on the state of land ecosystems (UN 2015a).

The first MDG to eradicate extreme poverty and hunger is linked to land productivity risked by land degradation, highlighted by UNCCD identifying poverty as both outcome and driver of land degradation (Safriel and Adeel 2005), and making combating desertification a contribution to achieving MDG1. Yet the 800 million people in extreme poverty and the 795 million people and 90 million under age five children undernourished in 2015 (UN 2015b) suggest that the UNCCD engagement in the poverty–desertification nexus has not been effective.

The land-degradation–biodiversity-loss nexus, is expressed where the land's vegetation cover of trees, shrubs and grasses providing habitats for animal biodiversity, loses its mechanical anchorage and source of nourishment. Regarding land-degradation − climate-change nexus, UNCCD's 3rd Scientific Conference attended climate change's potential as driver of land degradation, and highlighted land-based ecosystems' potential of mitigating climate change (UNCCD 2015a).

Overlooking the significance of desertification/land degradation as driver of poverty, climate change and biodiversity loss, possibly due to paucity of information and low awareness to the relevance of productive land to global sustainability, is accountable (with other processes), to the failure of the Rio Conventions and the MDGs in bringing the world much closer to global sustainability. Thus, throughout the generation following the Rio Summit, poverty has not been eradicated (in 2015), 14% of the population in the developing world live on less that $1.25 a day (UN 2015b), climate change intensified (annual global fossil-fuel carbon emissions increased from about 6200 to 8700 metric tons carbon in 1992 and 2010, respectively, (CDIAC 2015), biodiversity losses continued (Global Biodiversity Outlook 3 2010) and desertification/land degradation increased in many sites (Bai et al 2008). Regarding the latter, the only intergovernmental instrument dedicated to attend land degradation, the UNCCD, has been of a low profile and scant resources, what critically affected its implementation.

3 Land Degradation Neutrality – from Zero Net Land Degradation to Land Degradation Neutrality

3.1 The offsetting principle and Zero Net Land Degradation emergence

Around 2008 the incoming UNCCD Executive Secretary Luc Gnacadja, initiated horizon scanning for tools to invigorate the UNCCD and to improve visibility of its subject matter, soil and land. Inspired by the revelation of cases in which local and regional Common Pool Resources have been used sustainably rather than become tragedy of the commons (Ostrom et al. 1999), it was anticipated that soil too could become widely recognized as a Global Common. Then, this would enable to politically legitimize UNCCD to address land degradation and not just desertification, globally and not just in the drylands.

This horizon scanning drew an attention to the offsetting principle already preached and practiced by the sister environmental conventions. These are the biodiversity offsets and emissions offsets targeting reduction of biodiversity losses and mitigation of climate change by the biodiversity and the climate conventions, respectively. Regarding the CBD, its Conferences of the Parties in 2008 and 2010 considered biodiversity offset mechanisms and decided to encourage implementing them. This through offsetting biodiversity habitat losses in a site undergoing development such as urban sprawl, by conserving/restoring biodiversity habitat in another site that had lost its biodiversity, thus achieving no net loss and preferably a net gain of biodiversity on the ground at the global scale (BBOP 2012).

This concept was also applied to offsetting deforestation at one site by afforestation elsewhere for achieving MDG 7.A target. In this context, it was reported that an annual net loss of forest from deforestation of 8.3 million hectares in the 1990s was reduced by afforestation (and also by natural forest expansion) to an annual 5.2 million hectares between years 2000 and 2010 (UN 2015a). In addition, the 2005 Clean Development Mechanism of Kyoto Protocol created an option for afforest and reforest areas deforested years earlier, and then trade the reduced carbon emissions. This mechanism was later developed to the Reducing Emission from Deforestation and forest Degradation (REDD+) mechanism, for offsetting emissions at the country level (UN 2015c).

Given the CBD and UNFCCC experiences with the offsetting mechanism the UNCCD Executive Secretary envisioned an adaptation of the offsetting principle for addressing land degradation globally − Zero Net rate of Land Degradation (ZNLD) (a title reminiscent to net zero anthropogenic greenhouse gases emissions later used in the discourse around the 2015 Paris Agreement (Levin et al. 2015). But being aware of the concern that offsetting could be maliciously interpreted by some as license to trash nature and license to pollute (CBD 2013), and recognizing the need for ZNLD to be rigorously science-based, the UNCCD Executive Secretary commissioned, informally, an initial scientific assessment of ZNLD.

The resulting document titled, So much depends on so little – soil, A global common under threat, provided the first science-based rationale for ZNLD advocacy. It has been instrumental in presenting ZNLD in several arenas: the Caux Forum for Human Security, Switzerland in July 2011 (Gnacadja 2011); the High-Level Meeting of the 66th UN General Assembly Addressing Desertification of September 2011; and the interactive dialogue sessions of UNCCD COP10 on November 2011. The document also provided the template to a UNCCD Secretariat's officially commissioned document, Zero Net Land Degradation: A New Sustainable Development Goal (SDG) for Rio+20 (Lal et al. 2012), used for ZNLD advocacy documents at Rio+20 Conference in June 2012.

Selecting these arenas for ZNLD advocacy has been significant, since the ZNLD had neither been commissioned by, nor presented to the UNCCD COP. It was therefore anticipated that since ZNLD scope is far beyond the UNCCD restrictive mandate, it requires wider support than UNCCD and its stakeholders could provide. Furthermore, it was envisioned that ZNLD positioned as an SDG target would facilitate its adoption by the international community. The ambition has therefore been to make ZNLD a globally agreed sustainable development target for sustainable land management. Thus, the mid-June 2012 Rio+20 scheduled to launch the Post 2015 process of replacing the MDGs with SDGs, in view of expediting the advance toward global sustainability, provided an excellent opportunity to make the international and the intergovernmental communities acquainted with the ZNLD.

3.2 Zero Net vs neutrality

Already in the first ZNLD exposure at the UN General Assembly it became evident that applying the offsetting principle for land degradation would be acceptable if zero-net is replaced with neutrality such that Land-Degradation Neutral World (LDNW) would represent the target (Gnacadja 2015). Yet, it was assumed that ZNLD will not become redundant but would function locally for achieving LDNW globally (UN 2011), namely, using land degradation neutral world as the global scale derivative of zero net land degradation.

Thus, the advocacy document used by the Executive Secretary and his team in Rio+20 was titled, Zero Net Land Degradation, a Sustainable Development Goal to Rio+20… (UNCCD 2012, b, c), with cover portraying zero% sign which stands for the zero net of ZNLD and the ambition to stabilize, rather than to eradicate land degradation. UNCCD Secretariat campaign in Rio+20 achieved introducing to the outcome document The Future We Want paragraph 206, *"*… the need for urgent action to reverse land degradation" and to "achieve a land-degradation neutral world" (UN 2012), where reversing highlights the pivotal role of restoration as the offsetting mechanism of ZNLD.

The replacement of ZNLD whose zero net made it a restrictive commitment, with LDNW whose neutrality sounded less alarming, contributed to building the consensus expressed in paragraph 206. But the diverging understandings and interpretations of LDNW required interactions between scientists and policy-makers in order to substantiate it (LDNW) with science-based definition (Gnacadja 2015).

Responding to this challenge several gatherings of the scientific community took place during the period following Rio+20 in June 2012 and until SDGs adoption in September 2015.

The first one was the 3rd international Conference on Drylands Deserts and Desertification (Sede Boqer, Israel, 12–15 November 2012) session on Operationalizing the Zero Net Land Degradation target, summarized by The ZNLD target – a tool for achieving LDNW (UNCCD 2013a) and resulting in several peer-reviewed papers (Gnacadja 2015; Chasek et al. 2015; Grainger 2015; Tal 2015; Stavi and Lal 2015; Nkonya and Anderson 2015). This conference was followed by the first Global Soil Week in Berlin, Germany, in November 2012 and the second in October 2013, both addressing the incorporation of ZNLD as target in one of the SDGs.

At the same period UNCCD COP11 (September 2013) set an Intergovernmental Working Group (IWG) "to establish a science-based definition of land degradation neutrality…" (UNCCD 2013c). LDN (rather than LDNW) was then addressed in the 3rd UNCCD Scientific Conference (Cancun, Mexico, March 2015 (UNCCD 2014) and in the 3rd Global Soil Week (April–May 2015). Thus, ZNLD has been fully replaced by LDN, to be achieved at local, national and regional sites that when aggregated, their contribution to LDNW can be assessed.

Following these and other preparatory meetings, a committee representing the global scientific and policy-making communities translated the 283 paragraphs of The Future We Want into 17 SDGs, adopted by the United Nations Sustainable Development Summit in September 2015. SDG15 addressing Life on Land calls for actions to halt and reverse land degradation, which actually are the traditional mechanisms of reducing the rate of land degradation. But Target 3 of SDG15 is innovative: "By 2030, … combat desertification, restore degraded land and soil, including land affected by desertification … and strive to achieve a land degradation-neutral world" (UN 2016). Aligned with LDN concept, the language of this target replaces reversing with restoring and includes desertification just as a subset of all degraded land and soil on earth.

4 What Land Degradation Neutrality is?

4.1 Land Degradation Neutrality rationale and attributes

At the basis of the LDN concept is the distinction between two alternative phases of land degradation. Used land can either be at a process of being degraded through a degrading use that reduces productivity with time, or be at a state of an already degraded land, abandoned or still used but generates a persistently low productivity relative to the land's potential (Fig. 1). Therefore, the degradation of land area under degrading use is to be offset by productivity restoration of another land that is already degraded. The LDN aspiration is that its achievement will be eventually expressed in both areas attaining a persistent state of non-degrading, sustainable use. Unfortunately, land

Fig. 1. Two phases of used land ecosystems in an arid dryland of Israel:
A: land at a degraded state: a rangeland ecosystem with a natural vegetation cover that protected the soil, has been converted to a cultivated ecosystem by removing the vegetation cover, ploughing and growing cereals. Subsequent droughts common in this climate region left the land coverless for several years. When rain returned, the unprotected soil has been gulley-eroded by surface run off channeled through the old furrows. More soil is eroded in every rainy year, and the land has not been ploughed again. Restoration would include letting the natural vegetation to recover, protecting it from livestock grazing for several years, and creating bunds on these sloping lands for reducing runoff flow and further gully erosion.
B: land at a degrading process, ploughed and sawed after first rain of the year, but much of the land is coverless, and signs of erosion in furrows are evident in the bottom right of the photo. Reducing this rate of degradation could be through introducing irrigation in low rainfall years or abandoning cultivation, letting the natural vegetation cover coming back, and then using the land for livestock grazing.
In the two sites, used by the same local agro-pastoral community, the preferred livelihood for this arid dryland is pastoral rather than farming. It will take several years to restore the productivity of the originally rangeland site presented in Fig. 1A, which would neutralize the ongoing degradation of the site presented in Fig. 1B as long as the degrading process of that site continues.

degradation statistics are habitually presented with no distinction between the two land degradation phases, a distinction critical for implementing LDN.

In addition, three observations provide the rationale for the LDN target: (a) even though the precise spatial dimensions of land degradation process and state is not consensual (Wessels 2009), lands at a process of being degraded prevail in many areas (Safriel and Adeel 2005); (b) additional land in degraded state continuously accumulates (Lepers et al. 2005), a process projected to continue (Adeel et al. 2005); and (c) lands in the degraded state can be rehabilitated such that their fertility and productivity can be restored, as demonstrated by a number of well-studied cases, in non-drylands (Macedo et al. 2008) and in drylands (Fatondji et al. 2006).

These observations support the notion that a target of completely halting land degradation processes by 2030 is not realistic. But offsetting on-going degradation process by restoring productivity of lands in degraded state, may not be a far-off shot. LDN concept, therefore, identifies agricultural and pastoral land uses as risky. But when the risk is substantiated, the newly added degraded land can be neutralized by setting to restore an already degrade land, where it occurs. LDN concept is also premised on the resolve not to give up the already degraded lands, whose restoration could neutralize the added degradation, thus stabilizing the global amount of productive, non-degraded land.

Practically, achieving LDN includes detecting a process and implementing an activity, within a set period of time. Within that time period, entering into a degradation process is detected in a land plot that had previously been under sustainable use; Within the same time period, the productivity of another plot of equivalent area and ecological attributes but in a degraded state, is restored.

The innovative element in the LDN practice therefore, is the attention to lands at the already degraded state, a charge more onerous and expensive than slowing the degrading process (Nkonya et al. 2016). The rationale for this is rooted in the awareness of the increasing demands for non-degraded lands driven by increasing population and per capita consumption, and the trend of diminishing areas of the non-degraded, productive land. However, since restoration is costly than avoiding degradation, investing in reducing the degrading use would decrease the area of already degraded land required for offsetting degradation, what would also cut the overall cost of attaining LDN.

4.2 United Nations Convention to Combat Desertification official definition of Land Degradation Neutrality

While the scientific process was engaged in modes of LDN operationalization (e.g., Chasek et al. 2015), the political process of defining LDN by the IWG concluded its work, approved by COP12 (July 2015) (UNCCD 2015b). Now the science-based definition is preceded by LDN occurs as the result of a combination of avoiding or reducing the rate of land degradation and increasing the rate of recovery, which is compatible with the initial ZNLD perception. What follows – LDN may contribute to maintaining or improving ecosystem services for the social, economic, and environmental benefit of current and future generations – is a language foreign to most land users but fully aligned with the language of the SDGs and sustainable development processes operated by UN organizations, e.g. United Nations Environmental Program (UNEP) and others.

The language of the definition itself, Land degradation neutrality [in affected areas] [in arid, semi-arid and dry sub-humid areas] is 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 is technically correct but non-friendly, especially to land users. Furthermore, bracketing the drylands is symptomatic to the UNCCD chronic grappling with its dryland-confined mandate, even though the UNCCD's 1997 precursor, the Plan of Action to Combat Desertification attended the productivity of arid, semi-arid, sub-humid and other areas vulnerable to desertification (Corell 1999).

4.3 Selecting a domain and identifying lands for Land Degradation Neutrality project implementation

Unlike the case of offsetting carbon emissions in one site by planting forests in another site on earth, land ecosystems are not identical in their use category (i.e., cropland, rangeland, intercropping, etc.) and in their potential productivity levels. One approach for striving for LDNW is to determine the annual rate of all lands entering into a degraded process and then scan the global stock of already degraded lands for restoring their lost productivity. The less ambitious approach is to strive achieving LDNW by aggregating a gradually increasing number of LDN sites, until a global LDN, i.e. LDNW is achieved (Chasek et al. 2010).

Addressing the latter approach, first stage for setting an LDN project is delineating the spatial domain targeted to become land degradation neutral, considering availability and inclusion of all land phases relevant for LDN application, and the human and financial resources for carrying out the project. This will require classifying lands to those under degradation process, those already at degraded state, and those under current non-degrading sustainable use, to be included in the domain in which the LDN project is to take place. Since the degrading land process is a continuum (Zucca et al. 2002) often leading to the degraded state, the distinction between the land classes may be challenging. It is therefore necessary to select and agree on indicators for executing this classification and setting the LDN project spatial boundaries.

Once each land plot within the project's domain is classified and its location mapped (Fig. 2), the indicators should be used also in assessing the degree of degradation and/or productivity of each plot, and in setting the aspired level of productivity to be restored in already degraded lands, what would enable making an estimate of the efforts required for achieving LDN. The indicators will also be used in monitoring the land productivity throughout the life-time of the project for determining the distance of the domain from its aspired LDN state.

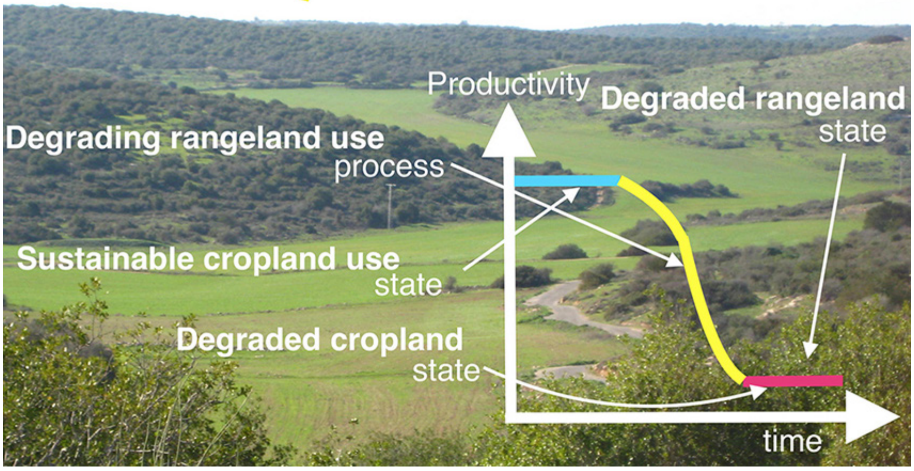

Fig. 2. Schematic presentation of identifying types of land use and their phases of land degradation as an initial step for a local LDN project.

4.4 Identifying drivers and prescribing land use measures and monitoring

The drivers of degradation of the lands selected for the LDN project need to be identified and removed prior to any other activity. This is a major challenge regarding the underlying social, economic and policy drivers that trigger the direct biophysical drivers. Once the drivers have been identified and removed, measures for reducing or restoring productivity need to be prescribed. Much of the grey literature advocates applying Sustainable Land Management (SLM) to all lands under productivity exploitation uses. But much of the literature (Liniger and Critchley 2007) often prescribes the same practices without distinguishing between the two land phases, being degraded and already degraded, to which either reducing or restoring productivity practices will be applied. Then, land use and soil/vegetation management practices that conserve or enhance the provision of ecosystem services that support and regulate the land's provisioning of forage, food, fiber or timber would qualify as relevant. And most important, caution should be taken at this stage, to avoid practices that maximize production in the short term only; these would surely not qualify as SLM, but as direct driver of land degradation.

Recalling that land degradation is a persistent decline in productivity, it would take several years of sustained management and monitoring for recognizing persistent change in productivity, attributed to the prescribed measures for reduced degradation and increased restoration. It is therefore necessary to set a sufficiently long time frame and milestones for any LDN project, such that striving to achieve, if not achieving LDNW by 2030, could be attainable.

5 Land Degradation Neutrality in dryland only or also beyond – source and state of the conflict

COP12 of UNCCD removed the bracketed in affected areas and in arid, semi-arid and dry sub-humid areas terms from UNCCD official LDN definition originally proposed by the IWG. But it also added "that for the purpose of the scope of this Convention, this definition is intended to apply to affected areas as defined in the text of the Convention" (UNCCD 2016a). This means that though LDN aims at land degradation neutral world, the UNCCD mandate is restricted to drylands. However, the COP also decided that striving to achieve SDG target 15.3 is a strong vehicle for driving implementation of the UNCCD, within the scope of the Convention, thus sending the message that addressing LDN in both drylands and non-drylands would strengthen the Convention.

Indeed, LDN target that has been conceived by and emerged from the UNCCD echelons, has been motivated by the need to invigorate this convention, and it was the Rio+20 process that implicitly expanded LDN scope from drylands to global lands. This is expressed in paragraph 207 of Rio+20 outcome – "We reaffirm our resolve in accordance with the UNCCD to take coordinated action nationally, regionally and internationally, to monitor, globally, land degradation and restore degraded lands in arid, semi-arid and dry sub-humid areas" (UN 2012). This statements commits UNCCD to monitor land degradation in both drylands and non-drylands, but confines its restoration activities to drylands.

This historical confinement to drylands could be traced down to the negotiations for drafting the convention's text. Apparently, the negotiators visualized the upcoming convention as a mechanism for channeling support to developing countries whose drylands have been considered as most affected by desertification. Hence, when financial resources have become pivotal in the negotiations (Corell 1999), neither the negotiators of dryland developing countries nor those of the donor countries wished expanding the mandate of the convention to include in it more needy countries, i.e., the non-dryland ones.

However, the distinction between drylands and non-drylands have been based on climatic factors, annual precipitation and potential evapotranspiration, spelled out by Agenda 21 that initiated the mantra arid, semi-arid and dry sub-humid areas, adopted by UNCCD (Corell 1999). It was the MA, probably among the first to tag these areas as drylands (Safriel and Adeel 2005).

The rationale for classifying all lands exposed to precipitation that is at least ~1.5 times lower than potential evapotranspiration (aridity index < 0.65), is possibly that where this index is higher water cease to function as the first limiting factor of biological productivity (Delgado-Baquerizo et al. 2013). This makes drylands more susceptible to human-induced productivity loss compared to non-drylands whose higher water availability makes them more resilient than drylands to drivers of land degradation (Adeel et al. 2005). Yet, land degradation may depend more on land use than on whether it is dryland or not (Bai et al. 2008), and that human-induced land degradation in non-drylands may be severe (Arnalds 2009).

Furthermore, support provided under UNCCD commitments targets dryland countries, not dryland areas, which means that much of the support channeled under the convention for combating desertification is invested in addressing land degradation off the delineated dryland areas. Based on dryland maps of MA database, 90 countries are affected countries or dryland countries. But only 43% of them have drylands covering more than 95% of their territory, and in third of dryland countries drylands cover less than 50% of their territories (Safriel and Adeel 2005).

In addition, since the delineation of drylands is based on climatic index, the anthropogenic-induced climate change is expected to change the index values. Indeed, some areas mapped as non-drylands in early 1990s have already become drylands. This is since the aridity index used for mapping the global drylands had been based on rainfall and temperatures of 1951–1980 (Middleton and Thomas 1992). A comparison between 1931–1960 and 1961–1990 (Hulme et al. 1992) demonstrated that African non-drylands of 1931–60, lost 25 million ha to become dry sub-humid drylands in 1961–90, what signals a trend that is projected to intensify (IPCC 2008).

In practice UNCCD attends non-dryland countries too: In year 2000 the UNCCD adopted Annex 5 added to the convention's text, of 17 Central and Eastern European Countries, 11 of which with no drylands within their territories, and hence formally not at desertification risk. Nevertheless, "the particular conditions of the country Parties of the region, include: …variety of forms of land degradation … including risks of desertification in regions prone to soil erosion …" (Article 2(b) of Annex V). Thus, incorporating Annex 5, UNCCD *de facto* legitimized its acting off the drylands too. Finally, responding to Annex 5 members' concern regarding LDN implementation, in recognition that significant proportion of land degradation occurs beyond the drylands COP12 (September 2015), decided that Parties may use the UNCCD … when striving to achieve LDN. All these combined contributed to making the UNCCD's dryland/non-dryland issue redundant, thus enabling UNCCD parties to unfold sleeves for implementing LDN on the ground.

6 United Nations Convention to Combat Desertification Secretariat's Land Degradation Neutrality pilot project – first phase

6.1 United Nations Convention to Combat Desertification guidelines for operationalizing Land Degradation Neutrality by its Party Countries

Since all SDGs' targets are defined as aspirational and global, with each Government setting its own national targets, the UNCCD COP12 in 2015 adopted the IWG commissioned report options that Parties might consider should they strive to achieve land degradation neutrality (UNCCD 2016a). It provides guidelines for operationalizing LDN at the national level, on the ground and policy-wise (UNCCD 2015b). It follows a sequence of actions proposed by Chasek et al. (2015) adding indicators for assessing LDN benefits.

COP12 also called to mainstream LDN operationalization in UNCCD implementation, using mechanisms available in the UNCCD arsenal, and to establish an independent LDN fund, to be made available for the full realization of LDN initiatives. Looking forward, COP12 commissioned its new mechanism, the Science-Policy Interface (SPI), to include in its work programme for 2016–2017 producing user guide for implementing LDN at the country level, based on a review of proposed conceptual and methodological frameworks that would scientifically underpin the implementation of LDN (UNCCD 2015c). This review, or The Scientific Conceptual Framework for Land Degradation Neutrality was completed by the end of 2016 by the SPI (UNCCD 2016b).

6.2 Pilot project participants and the plan of work

In late 2014, in her first year in office, UNCCD's Executive Secretary Monique Barbut initiated moves for implementing an LDN pilot project titled Towards achieving Land Degradation Neutrality: turning the concept into practice. This project was presented first to UNCCD delegates in March and September 2015 in the margins of UNCCD official meetings. The project's strategic goal is "to contribute to reaching an agreement among Parties by 2017 (COP 13), by which every country adopts its own national voluntary target to achieve land degradation neutrality, and reports to the COP every two years on … the progress made towards achieving such target" (UNCCD 2015d). Once an agreement is achieved, the effort of all countries combined would result in offsetting the rate of global degradation estimated as 12 million ha year^{-1}, by annually restoring 12 million ha of already degraded land, of a currently available 2 billion ha stock of degraded land (UNCCD 2015e).

The tactical objective is to recruit and support a representative sample of affected country Parties for two linked assignments: first, to translate the LDN goal into national voluntary targets and second, making use of the implementation framework and the monitoring and assessment mechanisms established within the UNCCD process (UNCCD 2015f).

In January 2015, the voluntary representative sample of affected country Parties comprising 14 countries covering all five regions/annexes of the UNCCD, assembled at the project's inception meeting addressing the project's first phase of translating LDN to a national target. This included for each country: determining the project's baseline productivity dynamics (declining, early stages of decline, stable but stressed, stable not stressed, increasing) in years 2000 and 2010–2013 of forest, shrub/grassland, cropland, wetland, artificial and bare land use/land cover categories of productivity. This by using long-term satellite-generated Normalized Difference Vegetation Index (NDVI) time series data of the European Space Agency. These enabled identifying drivers of the negative trends; prescribing corrective measures; selecting LDN pilot sites; identifying the legal regulatory framework and assessing costs; identifying national voluntary LDN level; and evaluating the project's expected co-benefits.

6.3 United Nations Convention to Combat Desertification pilot project first report

The countries' reports submitted at the end of 2015 (UNCCD 2015g) were subjected to independent evaluation (UNCCD 2015f), which was positively responded by the project's management team (UNCCD 2005h) in early 2016. The evaluator commented that using and also testing the UNCCD mechanisms for LDN implementation, such as the progress indicators (UNCCD 2016c) designed for serving the UNCCD 10-year Strategy's objective, was problematic. This is since these indicators have not been set having possible LDN targets in mind and their relevance to LDN goals and targets is still to be proven.

The reports also lacked distinction neither between already degraded and being degraded lands, nor between needs and practices to reduce degradation of the latter and restoration of the former. Furthermore, the project has not set to offset degradation at the country level, but to increase productivity in selected lands that their productivity has been lower than the potential, and then qualify the productivity increase as restoration, irrespective of which or where it offsets on-going degradation. Thus, provided that this project would serve as a template to an International network of sites/projects under voluntary and harmonized LDN monitoring and evaluation, the aggregated restorations implemented by this international (global?) network would strive to jointly offset the 12 million hectares expected to become annually degraded during the years 2016 to 2030.

This version of conceptualizing LDN at the global scale through national restoration rather than through aggregating land degradation neutral countries is compatible with the UNCCD website implicitly distancing itself from the offsetting principle in its FAQ (Frequently Asked Questions) section (UNCCD 2015h) where the question, "Is LDN an offset or compensation scheme that could result in a license to degrade?" is answered by "No, the focus and aim of LDN is to maintain and improve the productivity of land resources by sustainably managing and restoring soil, water and biodiversity assets", what reflects the conventional and generic combating desertification more than the refreshing and focused striving to achieve land degradation neutrality (UNCCD 2015i).

6.4 Enabling mechanism for the United Nations Convention to Combat Desertification's Land Degradation Neutrality pilot

Following COP decision "full implementation of SDG target 15.3 will require contributions from other bodies … the Convention should seek to work with other bodies" (UNCCD 2015j, k), the Secretariat set to create an independent LDN fund through making LDN profitable, by generating revenue stream from the sustainable production/use of the restored lands.

For building capacity to attain LDNW under UNCCD leadership the Secretariat launched a Soil Leadership Academy (SLA), supported by the World Business Council for Sustainable Development (WBCSD), lead by Syngenta Company. SLA charge is distilling and sharing the latest science, knowledge and expertise in soil conservation and sustainable practice by creating network of research institutes, universities and key decision makers that would offer information and training opportunities to eligible policy makers and land users (UNCCD 2013b). This innovative public-private partnership and its proposed mode of operation were presented in COP12 (UNCCD 2015l).

Thus, LDN concept emerging in 2013 can be credited for triggering a surge of attention and actions directed to land degradation, already evident in 2015. Yet, caution is required such that the enthusiasm expressed in the mobilization of LDN projects would not blur LDN's initial identity. This concern is reflected by the LDN project report reviewer – "space should be reserved for reflection … to review whether LDN appears to be fulfilling its potential as the key that unlocks the door to serious commitment to implement the Convention" (UNCCD 2015f).

7 Conclusions

Entering into force of UNCCD in late1996 completed the process of disaggregating three of the impediments for achieving sustainable development globally, the interlinked climate change, biodiversity loss and desertification. This by secluding each in its silo to be independently addressed by the UNFCCC, CBD and UNCCD, respectively, rather than implementing them jointly and interactively, as was first proposed by an Expert Meeting on Synergies … among the Rio Conventions convened by the United Nations Development Program (UNDP) in Sede Boqer, Israel, in March 1997 (UNDP 1997).

Though the mandates of both the UNCCD and the CBD are global, and desertification intensifies climate change and biodiversity losses, the mandate of the UNCCD is not global. It has been limited to only 35% of global land (drylands, excluding much of the deserts), to desertification, and to be active particularly in Africa. Given this, and that desertification being captive in its silo for nearly fifteen years, the UNCCD could not do much more than struggle to achieve the best possible results. This with the tools allowed into its tool kit, what apparently have not made a significant effect on desertification. Therefore, getting out of the box had, by then, become imperative.

Adopting the offsetting tool, already used by the other two sister conventions even though as yet without great success, has been a daring move, but rooted in solid observations, translated to sober recognition, that the degradation of lands coming under use for exploiting their productivity cannot be fully arrested and that the amount of already degraded land on earth is significant and continuously increasing. Yet, there is hope – the productivity of degraded lands has been, and can be restored.

These insights support the notion that a target of completely halting land degradation processes by 2030 is not realistic, but offsetting on-going degradation by restoring productivity of lands in degraded state, may not be a far-off shot. Hence, the LDN conceived by UNCCD actors, has evolved not into one more UNCCD COP decision, but emerged as a globally recognized SDG, and as a concept of high potential effectiveness.

Thus, LDN encapsulated in SDG 15.3, addresses all lands on earth rather than just those in the drylands. And, besides contributing to poverty reduction among land users who extract the critically essential biological products from the global land ecosystems on which all humanity depends, and beside contributing also to global food security, it would also significantly contribute to mitigating climate change and to promoting the functionality of terrestrial biodiversity.

The road of LDN from inception in 2011 to recognition by the highest possible global fora, has been arduous but since its insertion into the UN official vocabulary in 2015, it has quickly precipitated into and aligned with many UN functions, and inserted into the global development-environment discourse. A risk of this initial success is that since the literal meaning of its name is not self-explanatory it requires official definition elaborated by negotiations in committees, what often impede implementation on the ground, and take it lands away off its original conceptual framework and intention.

However, this review attempts to point a way forward that is close to the original intention of those who conceived the LDN target. The proposed approach is, therefore, to present LDN as a potentially effective tool for grappling with the risk to global food security, emanating from degradation of productive lands and from the risks to the livelihood of the land users in drylands and beyond. The LDN tool, therefore, exclusively focus on lands exploited for their biological productivity, and especially on those that had been productive but are currently degraded. These should not be given up; through channeling currently existing and emerging knowledge as well as resources, their productivity could be restored, such that the amount of productive land on earth can be stabilized.

LDN also needs to be attentive to the natural land ecosystems through regulating the rate of their conversion, so that the remaining ones would be able to supply the regulating services on which the productivity of the used land ecosystems depend. Efforts to achieve LDN also require a global network of monitoring the actions on the ground for achieving LDN and their outcome in terms of uniform currencies for land productivity. This, in turn, would require agreement on common sets of indicators to be monitored, and acknowledging the diversity of countries' lands and cultures, but not permitting these differences to serve as an excuse for not implementing the monitoring schemes.

This review has set to describe where LDN has come from, what could facilitate projections on where does it go. Encouraging signs of the effectiveness of the concept are rapidly accumulating. These include: the first LDN project taking off by the UNCCD Secretariat and implemented by 14 countries, that occurred simultaneously with its COP12 LDN-relevant decisions-taking; the publication of LDN Conceptual Framework commissioned by that COP and presented as a policy-brief by the SPI, just a year following COP12 decision; the 102 countries that embarked on voluntary LDN target-setting processes, already by the end of year 2016 (IISD 2016). Finally, right at the start of 2017, googling "land degradation neutrality" (a term that emerged at the end of 2015) generated more than half the number of results generated by googling "combating desertification" (a term that is with us since 1996).

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