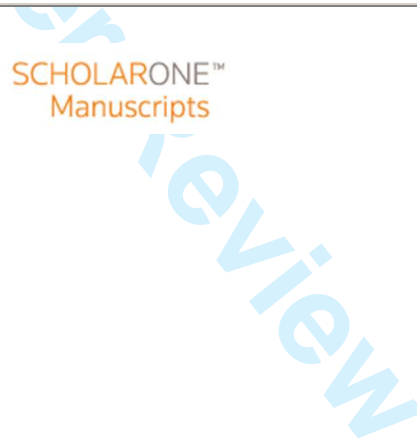




Degraded or just different? Perceptions and value judgements in restoration decisions

Journal:	<i>Restoration Ecology</i>
Manuscript ID	REC-15-292.R2
Manuscript Type:	Opinion Article
Date Submitted by the Author:	n/a
Complete List of Authors:	Hobbs, Richard; University of Western Australia, Plant Biology
Keywords:	ecosystem change, degradation, novel ecosystem, non-native species



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Running head: Degraded or just different?

Author contributions: R Hobbs conceived and wrote the manuscript (100% contribution)

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Abstract

An underlying premise of ecological restoration is that it focuses on the recovery of degraded systems. While this is an apparently straightforward aim, there is in fact considerable variation in how the term “degraded” is defined, used and assessed. In addition, there is a notable subjective component to decisions regarding what is degraded and what isn’t, and this often relates to the values and goals being considered. There is likely to be little argument over highly degraded systems where damage and loss of valued characteristics are evident. But where system change is less stark and the changes have mixed benefits and disbenefits, the decision on whether the system is degraded and hence in need of restoration becomes more difficult. As systems continue to change in the face of ongoing climate, land-use and other environmental changes, decisions become more difficult regarding which systems are degraded and which are merely different from what was there before. Difference does not necessarily equate to degradation. Effective use of scarce management resources relies on an improved ability to openly debate and resolve such issues.

Keywords: ecosystem change, degradation, novel ecosystem, non-native species

Implications

- As ecosystems change in response to altered biophysical settings, increasing consideration of “difference” as well as “degradation” is needed to inform restoration and management decisions

- Different motivations, levels of resourcing and scales will determine what type and intensity of intervention is considered appropriate
- Open discussion of the perceived values of systems in different states will facilitate effective decisions in restoration and management

Introduction

There has been increasing discussion in the scientific literature, popular press and internet blogs on the topic of whether any ecosystem can or should be a valid candidate for restoration, or whether some systems may have changed to such an extent that restoration is no longer a practical, or desirable, goal. In particular, the term “novel ecosystem” has been used to describe systems that comprise new mixtures of species (resulting from species invasions and local extinctions) and/or new abiotic settings (resulting from climate and land use change) (Hobbs et al. 2006; Hobbs et al. 2009; Hobbs et al. 2013). However, this has led some commentators to question the validity of the term and particularly the argument that some systems may not be amenable to standard restoration practices or that restoration may not even be appropriate. For instance, Clewell & Aronson (2013) suggest that “...many so-called novel ecosystems are really impaired ecosystems that can be recovered by ecological restoration in the holistic sense of the term” (p245). In response to the suggestion that a framework that includes novel ecosystems provides the opportunity to prioritize actions and decide when it is impossible or impractical to restore a system, Murcia et al. (2014) state that: “All ecosystems should be considered candidates for restoration, regardless of the requisite resources”. Other commentators suggest that the introduction of terms such as ‘novel ecosystem’ has important implications for how society and policy makers view systems and the capacity for restoration: for instance Woodworth states: “to write about a ‘novel ecosystem in a new ecological world order’ creates a very different impression, and a very different call to action, than to write about a ‘chronically degraded ecosystem in a new ecological world disorder” (Paddy Woodworth Newsletter: August 2015 <http://us5.campaign-archive2.com/?u=db8ea84381fc9156638b9dbcf&id=7a1e070537&e=81c3d92967>).

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5 It is certainly valuable to examine and use terms and language carefully, and
6 hence I wish to explore the above commentary in more detail. In particular, I
7 wish to question the assumption that novel ecosystems can always be viewed as
8 “degraded”. Instead, I posit that some altered systems are simply different from
9 what was there before, and hence are not necessarily degraded and in need of
10 restoration.
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16 **Restoring degraded ecosystems**

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18 The commonly accepted definition of restoration comes from the SER Primer:
19 “Ecological restoration is the process of assisting the recovery of an ecosystem
20 that has been degraded, damaged, or destroyed” (Society for Ecological
21 Restoration International Science & Policy Working Group 2004). As Stanturf et
22 al. (2014) state: “The starting point for restoration is determined by the
23 definition of degraded, because restoration is the reversal of degradation.” The
24 SER Primer carries on to state: “The terms degradation, damage, destruction and
25 transformation all represent deviations from the normal or desired state of an
26 intact ecosystem. The meanings of these terms overlap, and their application is
27 not always clear.” The Primer indicates that “*Degradation* pertains to subtle or
28 gradual changes that reduce ecological integrity and health”. To clarify what is
29 meant by this, the Primer states: “The terms ecosystem integrity and ecosystem
30 health are commonly used to describe the desired state of a restored ecosystem.
31 Although some authors use the terms interchangeably, they are distinct in
32 meaning. *Ecosystem integrity* is the state or condition of an ecosystem that
33 displays the biodiversity characteristic of the reference, such as species
34 composition and community structure, and is fully capable of sustaining normal
35 ecosystem functioning. *Ecosystem health* is the state or condition of an ecosystem
36 in which its dynamic attributes are expressed within ‘normal’ ranges of activity
37 relative to its ecological stage of development.”
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54 Clewell & Aronson (2013) further state: “We refer to ecosystems as being *intact*
55 or whole if they exhibit integrity and health. Conversely, degradation, damage,
56 destruction and transformation all represent deviations from the normal or
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3 desired state of an intact ecosystem” (p10). They define *degradation* as: “The
4 incremental and progressive impairment of an ecosystem on account of
5 continuing stress events or punctuated minor disturbances that occur with such
6 frequency that natural recovery does not have time to occur” (p258). However,
7 they also define *impairment* somewhat circularly as “The state or condition of an
8 ecosystem or landscape that has been degraded, damaged, or destroyed as a
9 result of extraordinary impact or disturbance from which spontaneous recovery
10 to its former state is unlikely, at least in the short term” (p260).
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18 Several questions arise from these statements and definitions. Particularly, how
19 are the “normal or desired state” and “normal ecosystem functioning” to be
20 ascertained, and who decides on this? And how are ecosystem integrity and
21 health to be measured, and against what? In other words, how do we, in reality,
22 decide what’s degraded (or impaired) and what isn’t?
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28 **How is ‘degraded’ defined?**

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30 To seek assistance in clarifying these issues, I examined how degradation is
31 defined in recent textbooks, policy documents and papers in the literature. The
32 definitions focused variably on ecosystems, forests, land or soil. These are listed
33 in Table 1. Others are discussed in more detail by Stanturf et al. (2014) in
34 relation to forest restoration, and these authors also provide a perspective on the
35 large range of forest attributes, degradation agents and potential degradation
36 indicators considered in the sphere of forest degradation.
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44 The SER Primer definition proved to be the vaguest of the definitions provided,
45 while most of the definitions focused more on functional and ecosystem service
46 aspects rather than compositional change per se. Amongst the various textbooks
47 available currently, Greipsson (2010) and Galatowitsch (2012) did not provide a
48 definition of degradation, and the array of other books and sources provide a
49 rich array of different definitions with differing emphases. This appears to
50 corroborate a comment by Plesník et al. (2011), who concluded that: “Although
51 environmental/ecosystem degradation has been one of the most often used
52 subjects in environmental protection and nature conservation and management,
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3 a precise definition has been lacking both in science and policy. 'Degraded
4 ecosystem' has been understood and consequently recognized more intuitively
5 than based on the well-developed criteria applied during ecosystem
6 assessment."
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11 Lamb & Glilmour (2003) discussed the inherent subjectiveness in the way
12 degradation is perceived, and pointed to the problems associated with whether
13 a particular system or site should be viewed as degraded: "Badly degraded sites
14 are easy to recognize...Degraded forests have lost much of their productivity and
15 biodiversity as well as many of the ecological goods and services they once
16 provided. But are less disturbed sites degraded? In fact, just when does a forest
17 become 'degraded'? What is the threshold condition beyond which degradation
18 occurs?" They went on to consider how different people with different
19 perspectives or management goals will have different views on this: "The Food
20 and Agriculture Organization of the United Nations (FAO) has defined forest
21 degradation as changes within a forest that affect the structure and function of
22 the stand or site and thereby lower its capacity to supply products or services. In
23 practice, however, degradation is much more subjective; people can have quite
24 different perceptions about the same landscape. For example, a wildlife
25 enthusiast may see an impoverished forest, while a forester sees a productive
26 forest regenerating after logging. Similarly, a forester may see a degraded forest
27 while a shifting cultivator sees a piece of prime agricultural land. Almost
28 inevitably, 'degradation' is in the eye of the beholder. Not all landholders or
29 managers will necessarily agree that degradation has occurred; even if they do,
30 they may disagree about the most appropriate response. These contrasting
31 perceptions make it hard to define and measure degradation, and to obtain
32 definitive statistics on its regional, national or global scale." (Lamb & Glilmour
33 2003). Adding different cultural contexts into this mix adds further complexity
34 (e.g., Burger et al. 2008).
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53 **Degraded or not?**

54 Hence, in summary, the definitions of degradation vary considerably and relate
55 to different features of ecosystems depending on the policy and management
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3 context. This context also determines how different people perceive and
4 interpret presence/absence and levels of degradation. ~~Discussions over~~
5 ~~definitions can be endless and perhaps represent a distraction from the more~~
6 ~~relevant question of~~An important question is how the definitions translate into
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10 what happens in practice.

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13 Decisions to “restore” areas to alternative ecosystem types are often taken on the
14 basis of perceptions of what was there, or what “should have been” there, rather
15 than a consideration of the relative value of the existing system and the costs
16 versus benefits of the restoration. As Lamb & Gilmour (2003) point out above,
17 the decision may be relatively straightforward for highly degraded systems, but
18 becomes less clear in less extreme cases. The question of what is perceived as
19 degradation becomes particularly complex in the context of cultural landscapes.
20 Cultural landscapes require the continuation of particular forms of management,
21 without which they change into other ecosystem types – this applies equally in
22 both the old and new worlds, where thousands of years of human use have
23 shaped landscapes through cultivation, pastoralism, fire, selective planting of
24 favoured species and so on. While this influence is obvious in some places,
25 particularly in many parts of Europe, the importance of human management in
26 shaping ecosystems in the Americas, Australia and elsewhere is only recently
27 being fully recognised and is the subject of ongoing debate and controversy (e.g.,
28 popular accounts in Mann (2005) and Gammage (2011). A failure of European
29 colonial science and governance to correctly interpret the human influence on
30 landscape has led to interesting misdiagnoses regarding the condition of
31 ecosystems. For instance, Fairhead & Leach (1996) discuss the case of small
32 islands of dense forest in a savannah landscape in Guinea that were interpreted
33 by colonial scientists and policy makers as the last relicts of a once more
34 extensive forest that was degraded by human use. In fact, detailed historical,
35 social and ecological analysis indicated that the exact opposite was true: the
36 forest patches were created by human management around villages in an
37 otherwise more sparsely vegetated landscape.
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3 Misinterpretation of the condition of ecosystems continues, even today. Recent
4 studies point to the danger of unintended consequences arising from
5 inappropriate labelling of lands as “degraded”, both at a regional and global
6 scale. Analysis by Veldman et al. (2015) showed that, at the global scale, the Atlas
7 of Forest and Landscape Restoration Opportunities (World Resources Institute
8 2014) misclassified 9 million km² of grassy biomes as “deforested” or “degraded”
9 and therefore providing “opportunities” for forest restoration. Clearly, care is
10 required in interpreting calls for restoration that might involve significant
11 modification of existing ecosystems and the loss of their biodiversity and
12 services.
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21 In cases where ecosystems change due to the alteration or cessation of
22 traditional management practices, should the resulting systems be viewed as
23 degraded? Or are they simply different from what was there before? The key
24 consideration at the centre of this question is how much relative value people
25 place on the past and current systems: degradation is in the eye of the beholder,
26 and may relate to loss of, or change in, particular ecosystem characteristics – for
27 instance, functional aspects such as water and nutrient flows or compositional
28 aspects such as species compositions and vegetation structure. So, when a patch
29 of land is currently a forest but is known historically to have been a grassland, is
30 the forest a degraded state in need of restoration? Conversely, if a current
31 heathland may once have been a forest (e.g. Hobbs 2008), is it a degraded state
32 or something worth conserving in its own right? And if the heathland starts
33 spontaneously changing to a forest when fire and grazing management change,
34 should that be viewed as degradation in progress?
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47 In an increasingly anthropogenic world in which rapid and ongoing
48 environmental change is evident, these questions become more frequent and
49 prevalent. Complexity is added when the changes involve the development of
50 new species combinations and configurations and landscapes become complex
51 mixes of patches in differing degrees of alteration (Hobbs et al. 2014). Several
52 commentators have recently reiterated the fact that ecosystems and biotic
53 assemblages have always been, and continue to be, dynamic entities both
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3 temporally and spatially (e.g., Jackson 2013; Handel 2015). The current situation
4 differs mainly in terms of rate of change, with many regions experiencing rapid
5 change in both environmental conditions and biotic composition, mainly due
6 directly or indirectly to human activities (e.g., Ellis 2015).
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11 Although change is a perennial and natural phenomenon, changes in ecosystems
12 are perceived through value-based filters, even if the values involved are
13 recognised implicitly rather than explicitly. Some changes undoubtedly have
14 negative impacts on ecosystem characteristics. Where these altered
15 characteristics have clear effects on human society as a whole (for instance flood
16 mitigation or fire risk), then it is clear that the system can be relatively
17 unambiguously labelled as degraded. Similarly, few people would argue with the
18 observation that a highly salinized lake (formerly freshwater) is degraded
19 (Standish et al. 2014). In other cases, however, the effects may be mixed or
20 neutral, impacting characteristics that are valued by some members of human
21 society but not by others, or altering the suite of characteristics in ways that
22 subtract from some values but add to others. Here, assigning the label
23 “degraded” becomes more problematic. For some members of society, changes
24 such as increased abundances of non-native species may be perceived as entirely
25 negative. However, the same change may be perceived differently or even go
26 unnoticed by other members of society. A high profile recent example of this is
27 Mt Sutro in California, where local residents are opposed to proposed
28 “restoration” of cloud forest dominated by non-native eucalypts (Venton 2013).
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44 Reconciling these differences is currently a topic of major concern in restoration
45 and conservation biology. Taking invasive species as an example, there has been
46 a polarized debate between those that see all non-native species as actual or
47 potential threats that require management action and those that see pragmatic
48 reasons to view some non-native species as either benign or beneficial (Davis et
49 al. 2011; Simberloff 2011; Shackelford et al. 2013; Simberloff 2014; Thompson
50 2014). The label “non-native” has many of the same issues attached to it as the
51 label “degraded”, and there is more ambiguity surrounding the term than has
52 previously been apparent (e.g., examples in Thompson 2014; Pauli et al. 2015).
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3 Many restoration efforts are focused wholly or partially on removal of invasive
4 species, often rightly so because of the well-evidenced impacts of these species
5 on the native ecosystem. In some cases, however, impacts are assumed rather
6 than confirmed, and the species concerned are now an established part of the
7 local ecological community. Hence their removal may either be unjustified or
8 unwise, particularly where the methods of removal have potential flow-on
9 ecosystem effects, and may waste scarce management resources. There is also
10 the possibility that removal of the species will have unintended adverse effects
11 on other species or system properties (e.g. Sheehan & Ellison 2015). Advising on
12 this dilemma, (Clewell & Aronson 2013) suggest, on the one hand, that
13 restorationists should “take courage from the numerous successful campaigns
14 undertaken to control or eradicate harmful invasives, and carry on in the same
15 spirit, with all the means at our disposal.”, but on the other hand that they “may
16 have to practice triage to decide which invasives can be effectively extirpated
17 and which are too well established to even bother.” (Pp45-46). In the face of
18 such conflicting advice, open discussion is required on whether the presence of a
19 non-native species automatically renders a system degraded and hence in need
20 of restoration. More generally, there is a pressing need for an ongoing
21 examination of what types of intervention are justified under an array of
22 different circumstances (Hobbs et al. 2011).
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39 **Conclusion**

40 It is becoming increasingly important to examine the premises behind
41 restoration efforts and ask the difficult question of whether observed changes
42 are resulting in a system that is degraded or merely different. Despite ongoing
43 debate about appropriate goals for restoration in the 21st century, little thought
44 has been given to the underlying assumption that altered systems are
45 automatically to be perceived as degraded. Difference per se is not necessarily a
46 symptom of degradation, particularly if the change from the previous system has
47 neutral, mixed or positive impacts on ecosystem characteristics that are valued.
48 Graham & Hicks (2015) go further to suggest that, for coral reefs, different
49 ecosystem configurations may actually prove to be useful management goals in
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3 the face of ongoing rapid change and that these may prevent actual degradation
4 from irreversibly damaging the systems in question.
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8 Rather than arguing over the validity of different approaches to ecosystem
9 restoration and management, restoration scientists and practitioners could
10 benefit from a step back that allows a broader perspective on how systems are
11 changing and where efforts are best placed to allow effective management into
12 the future. This will likely include a recognition of the plurality of situations and
13 motivations involved in restoration (Higgs et al. 2014). There will continue to be
14 a place for efforts to restore one or two hectares of land ~~and~~, and, where there is
15 access to the required financial and other resources or large volunteer groups,
16 the aspiration may be to ~~recreate what is assumed to be the original~~
17 ecosystem as far as possible towards fully restoring system properties. On the
18 other hand, efforts to overcome degradation on a much greater scale and having
19 fewer resources to do so are less likely to be concerned with the some ~~of the~~
20 niceties aspects of ecological restoration. Although the term 'restoration' has
21 been used in the context of broad-scale restoration efforts, ecological restoration,
22 in the sense used by SER, will likely be uncommon over most of this area, at least
23 in the immediate future.
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37 This does not mean we should "lower the bar" and entirely forgo the original SER
38 goals but that ~~restorationists~~ might give more attention to developing a wider
39 range of interventions that recognize the trade-offs needed to match the degree
40 of degradation, the aspiration of landholders and the actual capacity (or
41 willingness) of these landholders to do anything (bearing in mind that may
42 people living in degraded landscapes ~~are poor~~ live in poverty). Restoration can
43 legitimately focus on restoring functionality or ecosystem services rather than
44 just the original biodiversity.
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52 On top of these broad differences in motivations for undertaking restoration are
53 the more contentious concerns around what to do about changed or changing
54 systems that can be valued in their own right. An array of recent contributions
55 aim to address this concern in some way: for instance, value considerations in
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3 novel ecosystems (e.g., Thompson & Jackson 2013), managing whole landscapes
4 consisting of patches in an array of different degrees of modification (Hobbs et
5 al. 2014) and comprehensive ecological restoration (Suding et al. 2015). Indeed,
6 any ecosystem decision framework needs to embed a process of deliberation in
7 restoration decision making (e.g., Higgs & Hobbs 2010), i.e., decision
8 In other
9 words, decision processes that increasingly need to recognize there are varying
10 perceptions of degradation that must somehow be resolved if effective
11 conservation, restoration and intervention are to be undertaken in the future,
12 and that the same decision will not necessarily be taken everywhere. This short
13 article has enunciated some of the issues surrounding this: the challenge now
14 will be to forge a way forward that tackles these issues in a constructive and
15 effective manner.
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27 Acknowledgements

28 I thank Lauren Hallett, Gillian Henderson, Eric Higgs and two anonymous
29 referees for helpful comments on the draft, and the Australian Research Council
30 Centre of Excellence for Environmental Decisions for funding support.
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For Peer Review

Table 1. Definitions of the term 'degradation' taken from a range of current textbooks, policy documents and selected literature. The selection is designed to be illustrative rather than comprehensive.

Definition	Source
Degradation pertains to subtle or gradual changes that reduce ecological integrity and health. (See text for further discussion)	(Society for Ecological Restoration International Science & Policy Working Group 2004).
The simplification and loss of biodiversity caused by disturbances that are too frequent or severe to allow natural ecosystem recovery. Degradation generally reduces the flow of ecosystem goods and services.	(Howell et al. 2012)
The simplification and loss of biodiversity in an ecosystem caused by disturbance factors. Different 'degrees of ecosystem degradation' can be distinguished depending on whether or not one or more thresholds of irreversibility have been crossed. In cases of severe and prolonged ecosystem disturbance, natural ecosystem recovery is sometimes no longer possible in a relevant or 'reasonable' period of time. Degradation, resulting from various factors, including climate change and extreme events, as well as human activities, generally reduces flows of ecosystem goods and services.	(van Andel & Aronson 2012)
The incremental and progressive impairment of an ecosystem on account of continuing stress events or punctuated minor disturbances that occur with such frequency that natural recovery does not have time to occur.	(Clewel & Aronson 2013)
Land degradation refers to any reduction or loss in the biological or economic productive capacity of the land resource base. It is generally caused by human activities, exacerbated by natural processes, and often magnified by and closely	(UN Convention to Combat Desertification (UNCCD) 2014) http://www.unccd.int/Lists/SiteDocumentLib

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<p>intertwined with climate change and biodiversity loss.</p>	<p>rary/Publications/Land Degrad Neutrality E Web.pdf</p>
<p>Soil degradation is defined as a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries. Degraded soils have a health status such, that they do not provide the normal goods and services of the particular soil in its ecosystem. Land degradation has a wider scope than both soil erosion and soil degradation in that it covers all negative changes in the capacity of the ecosystem to provide goods and services (including biological and water related goods and services – and ... also land-related social and economic goods and services.</p>	<p>FAO, http://www.fao.org/soils-portal/soil-degradation-restoration/en/</p>
<p><i>Ecosystem degradation:</i> A persistent reduction in the capacity to provide ecosystem service. The degradation of an ecosystem service is:</p> <p><i>For provisioning services,</i> a decreased production of the service through changes in area over which the service is provided, or decreased production per unit area.</p> <p><i>For regulating and supporting services,</i> a reduction in the benefits obtained from the service, either through a change in the service or through human pressures on the service exceeding its limits.</p> <p><i>For cultural services,</i> a change in the ecosystem features that decreases the cultural benefits provided by the ecosystem.</p>	<p>(Millennium Ecosystem Assessment 2005)</p>
<p>Land degradation implies reduction of resource potential by one or a combination of processes acting on the land. These processes include water erosion, wind erosion and sedimentation by those agents, long-term reduction in the amount or diversity of</p>	<p>(United Nations Environmental Program (UNEP) 1992)</p>

natural vegetation, where relevant, and salinization and sodication.	
Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems and the extinction of wildlife. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable.	(Johnson et al. 1997)
Forest degradation is broadly defined as a reduction in the capacity of a forest to produce ecosystem services such as carbon storage and wood products as a result of anthropogenic and environmental changes	(Thompson et al. 2013)
Land degradation can be considered in terms of the loss of actual or potential productivity or utility as a result of natural or anthropic factors; it is the decline in land quality or reduction in its productivity	(Eswaran et al. 2001) http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/?cid=nrcs142p2_054028

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