Degradation and Restoration of Land and Ecosystems

Overview of the Global Study Commissioned by the CBD

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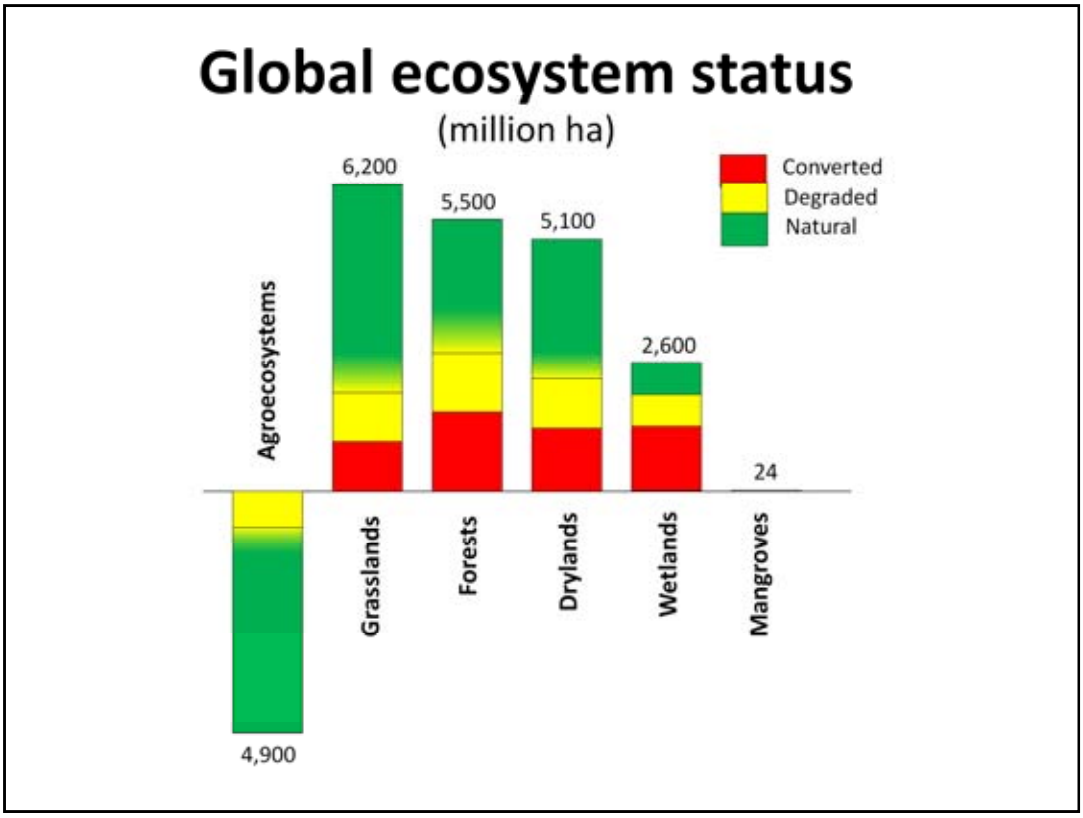
Convention on Biological Diversity

United Nations Decade on Biodiversity

Aichi Biodiversity Targets

Part of the Strategic Plan for Biodiversity 2011-2020

20 headline targets to reverse the loss of biodiversity



Overview: Globally, it has been estimated that half of the global wetlands has been converted with a quarter of the remainder being degraded. The world's forests are close to these figures, whereas the planetary damage done to grasslands appears somewhat lower.

These figures are based on published assessments. They are very uncertain because of
- Lack of agreement on definitions
- Poor data

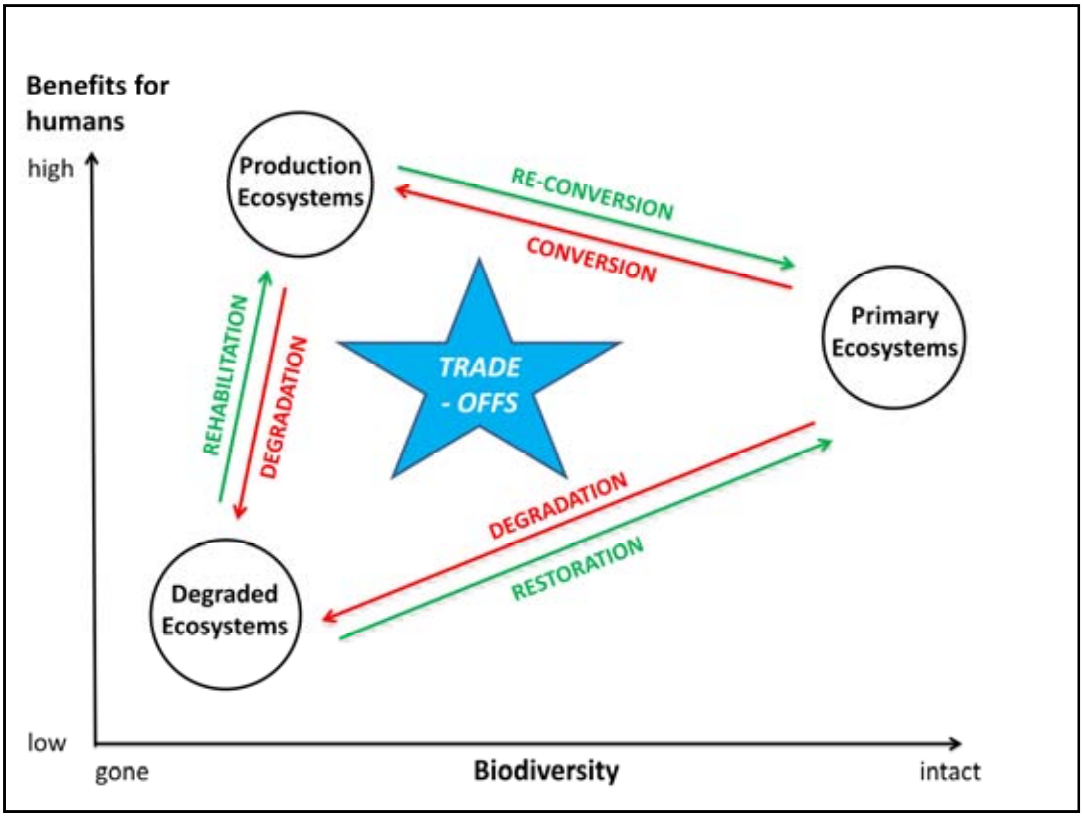
Given the limited time and resources available for the production of this technical report, the authors would clearly like to state that these findings represent the first step in a long-term, iterative process of assessing the scope of land and ecosystem degradation and the potential for restoration and rehabilitation.

Objectives

For ecosystems and landscapes …

- Provide a clear conceptual framework
- Review global and selected sub-global estimates
- Assess global area of degradation and restoration potential ("reasonable estimates")
- Identify and quantify expected benefits of restoration

The aim of this technical report is fourfold:
First, to provide a clear and simple conceptual framework, including terms and definitions for degradation and restoration of ecosystems and landscapes;
Second, to review existing global and selected sub-global estimates of the extent of degraded ecosystems and landscapes, and to compare and summarize the methodologies used;
Third, to assess the area of degraded ecosystems and landscapes and the area with potential for restoration, rehabilitation, and conversion to productive land; and
Fourth, to identify, and where possible quantify in physical and/or economic terms, the expected benefits of restoration including climate change mitigation and adaptation, biodiversity conservation, combatting desertification and land degradation, and other benefits.



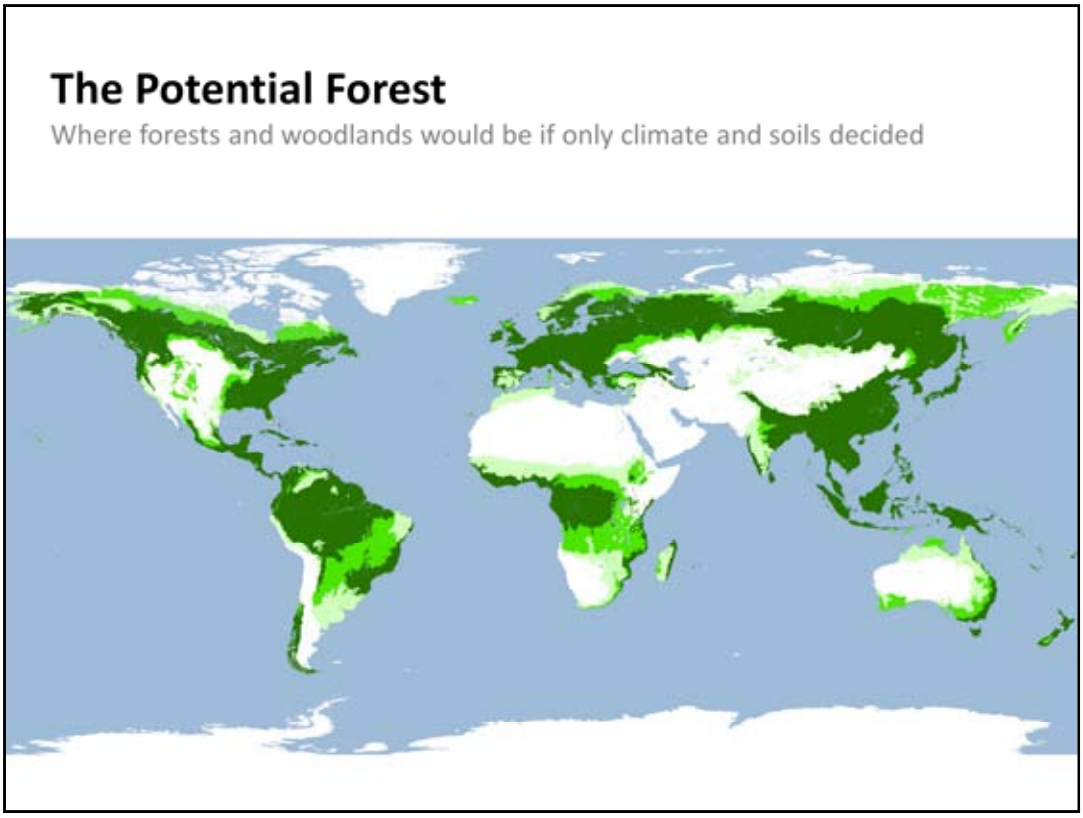
A conceptual framework for degradation and restoration.

•The X axis shows increasing biodiversity and ecosystem functionality.
•The Y axis shows increasing human benefits (ecosystem services)

•**Primary ecosystems** are high on intactness and also provide ecosystem services
•**Production ecosystems** have reduced biodiversity but enhanced human benefits
•**Degraded ecosystems** are low on both biodiversity and human benefits

•Degraded systems be **restored** – meaning that they move toward increasing biodiversity and naturalness but also toward more ecosystem services
•Degraded systems can also be **rehabilitated** into production systems – meaning that they improve significantly in terms of human benefits but not necessarily in terms of biodiversity/naturalness
•Production systems can also be **re-converted** – meaning that they increase in naturalness/biodiversity but eventually lose some of their ability to produce benefits for humans

•All of these transitions imply **trade-offs**, although there are most likely also no-regret cases in which degraded systems can be modified to enhance both biodiversity and human benefits.

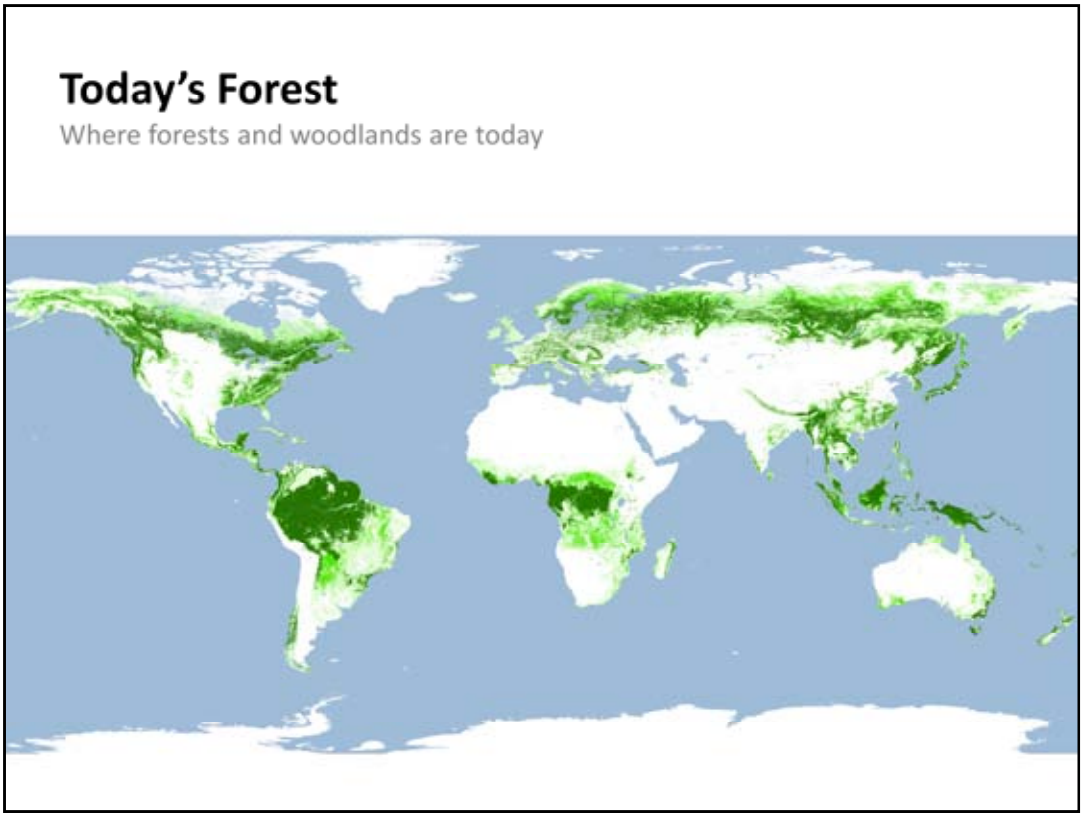


In order to extract useful services, people have modified and converted ecosystems. An example of this is the global extent and density of forests.

[Flip slides back and forth.]

The first slide shows what forests might have been like before the invention of agriculture, if today,s climate had been prevailing through time.

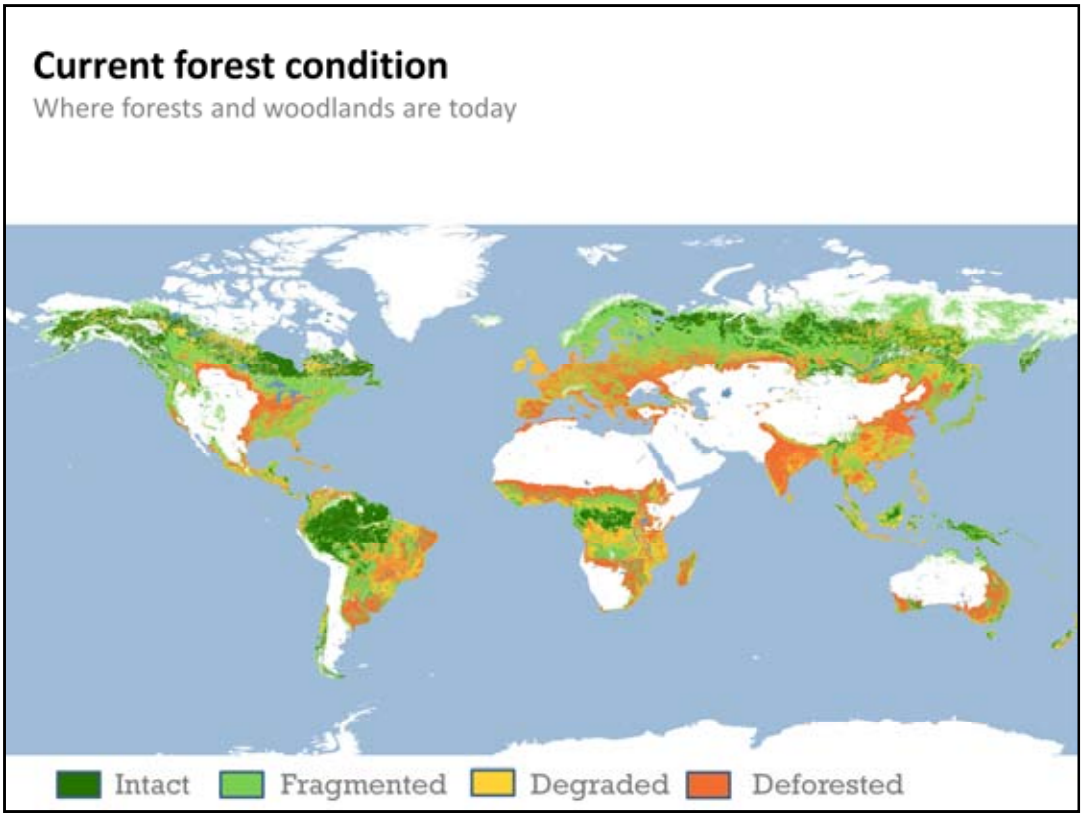
In the past 50 years, humans have transformed ecosystems and landscapes more rapidly and extensively than in any comparable period of time. This has largely been driven by the conversion of primary type ecosystems (e.g. forests, grasslands, mangroves) into productive systems to meet the growing demands of increased population. These activities have contributed to the overall reduction in the complex array of ecosystem services essential to maintain human health and wellbeing, and the planet's life-support systems.



Some of this forest loss can undoubtedly be described as degradation. But what about the conversion of forest into agricultural land, for food production?

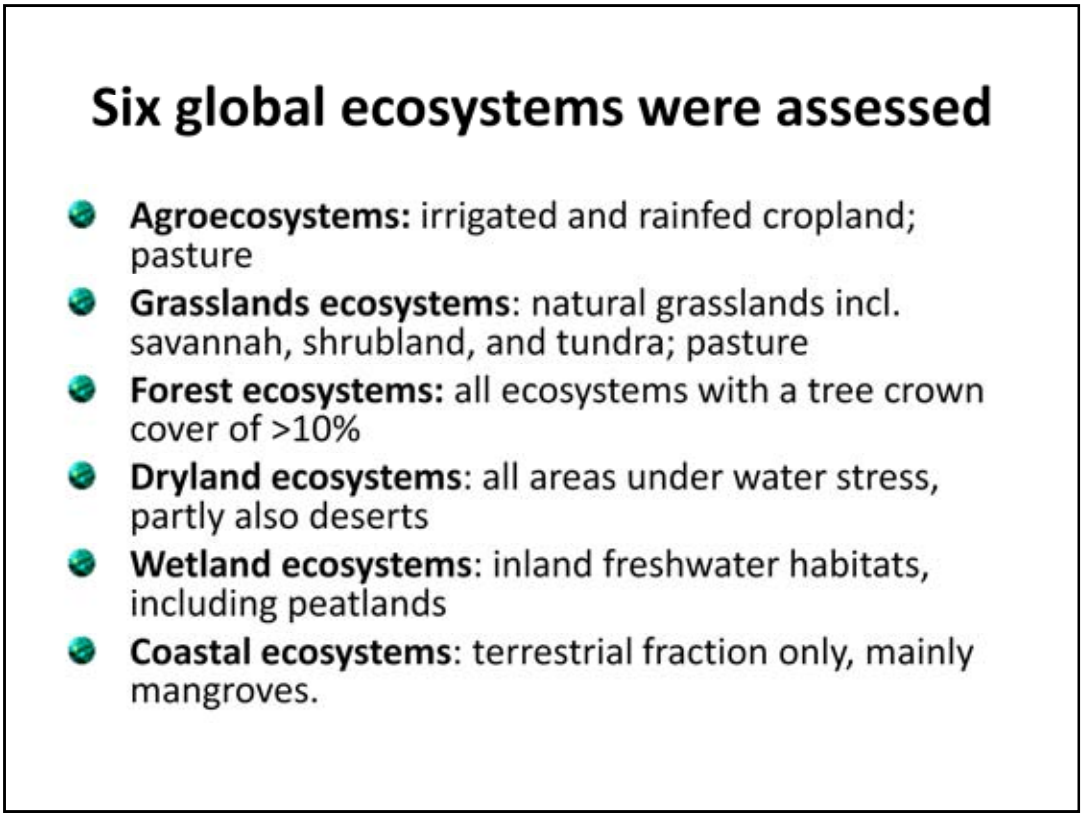
Should we be referring to India and the Netherlands as degraded forests? Or should we consider agroecosystems as a separate, human-made type of ecosystems?

The extent of global degradation will be v ery different depending on how we answer this question. Questions like this point to the crucial importance of the conceptual framework for degradation and restoration.



Lands Where Forests Can Grow – Current Status

A quarter has been deforested, another quarter has been degraded

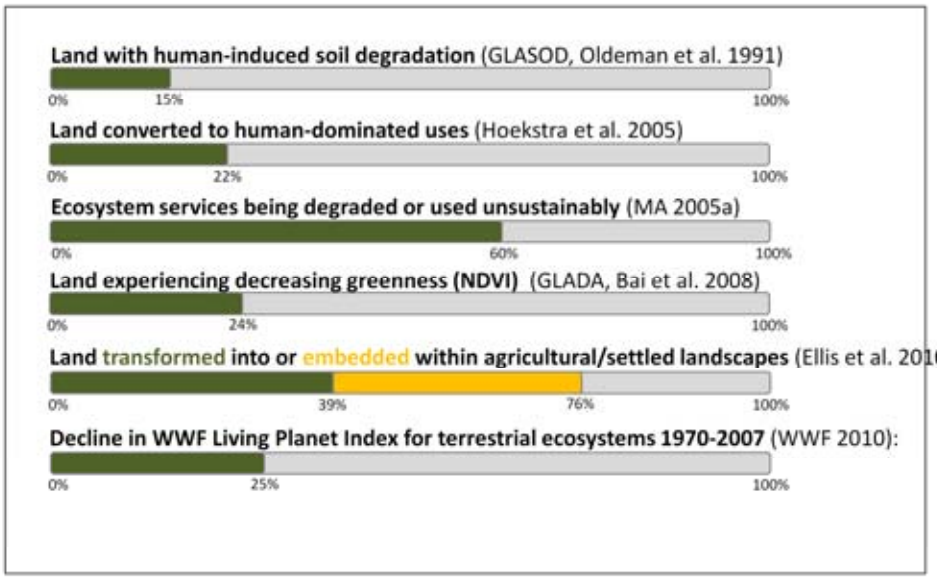


The focus of this review is on terrestrial ecosystems. This excludes all tundra and marine ecosystems but does include mangroves and all types of inland wetlands.

There are many ways to divide ecosystems into different types. We chose the classification used in the Pilot Analysis of Global Ecosystems (PAGE) of the World Resources Institute (WRI) with its 5 units. Because of their particular importance, we have added dryland ecosystems to yield a total of 6 ecosystems.

The review covers the most relevant global assessments on the degradation status of soil, land and ecosystems.

Global



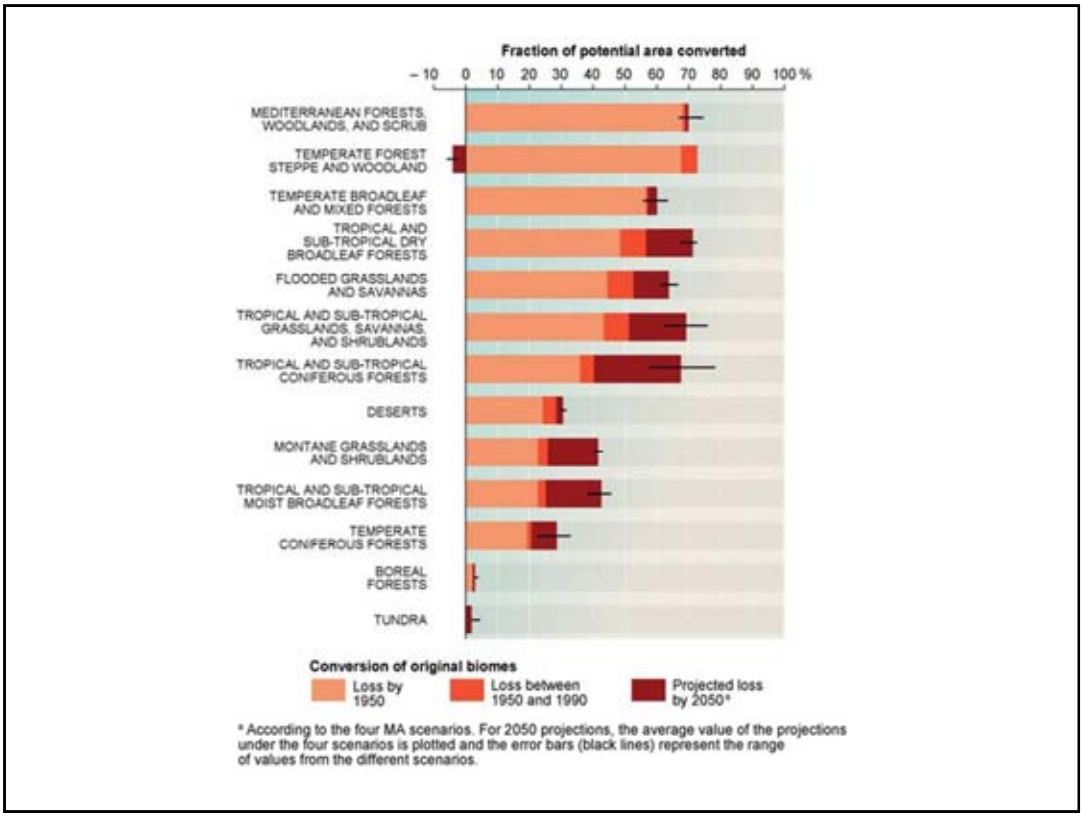
Global assessments largely agree that approximately one-quarter of the world's terrestrial surface has by now been converted to human-dominated land uses. In this process, up to three-quarters may now actually be embedded in biomes dominated by human activities (anthromes), with 60% of the ecosystem services negatively affected to some degree.

The first truly global, land-based assessment was that of GLASOD (Global Assessment of Human-Induced Soil Degradation) for the period 1987-1990. This expert-based approach found that 1,964 Mha, that is, roughly 15% of the terrestrial land surface, or about one-third of the land used for agriculture, were affected by some form of soil degradation.

Hoekstra et al. (2005) proclaimed a "global-scale biome crisis" with habitat conversion exceeding habitat protection by a ratio of 10:1 in more than 140 eco-regions. Their analysis found that globally, 21.8% of land area had been converted to human-dominated uses or production landscapes. Habitat loss had been most extensive in tropical dry forests, temperate broadleaf and mixed forests, temperate grasslands and savannas, and Mediterranean forests, woodlands and scrub. Tundra and boreal forest biomes remained almost entirely intact. As this assessment focused on ecosystem loss and did not account for land degradation in areas that were not converted, these figures represented minimum estimates.

The Millennium Ecosystem Assessment showed that more than two-thirds of the area of two of the world's 14 major terrestrial biomes and more than half of the area of four other biomes had been converted by 1990, primarily to agriculture and livestock production systems.

Making the step from soil to land degradation, Bai et al (2008a) analysed a time series of remotely sensed global trends in "greenness", thereby taking the production function of vegetation – or net primary productivity (NPP) – as a proxy for land degradation.



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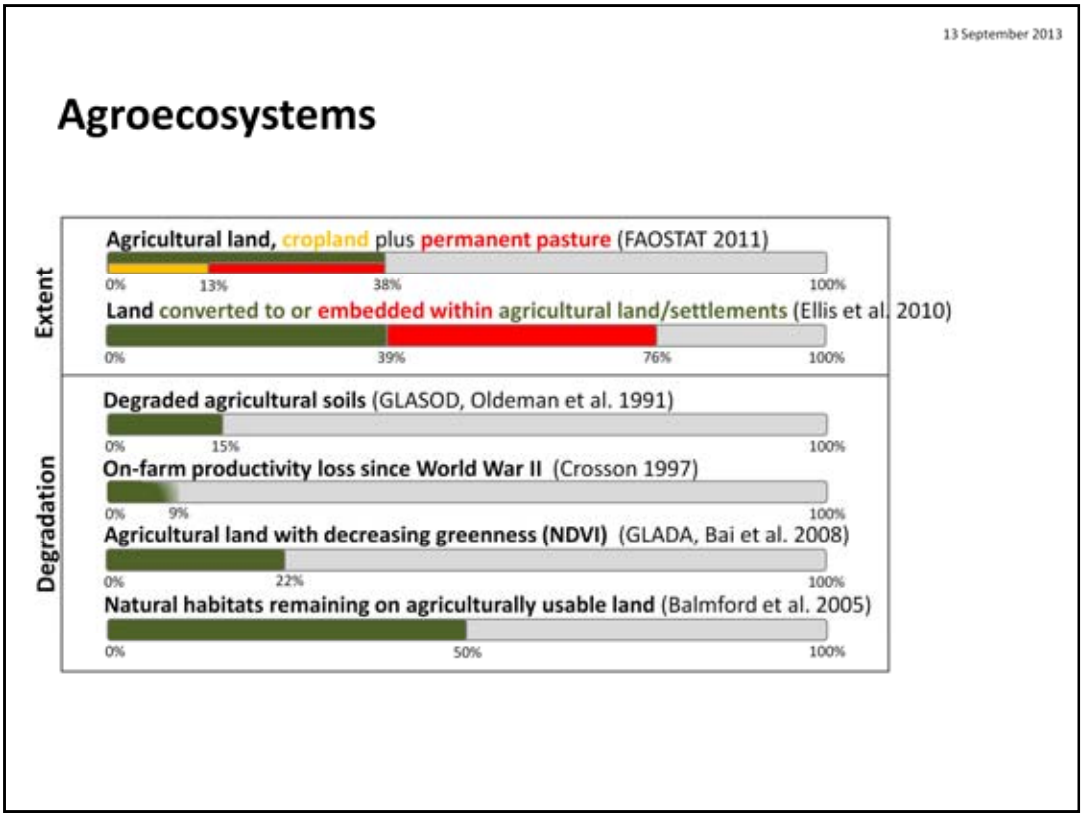
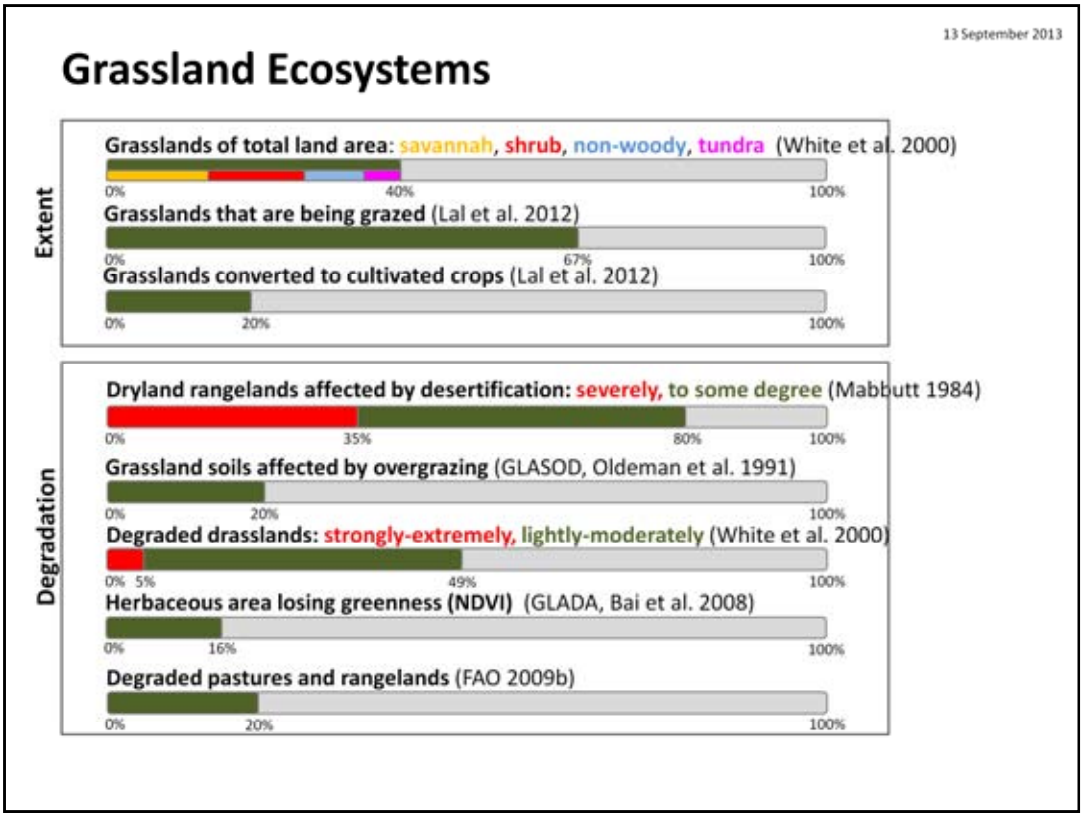


Agroecosystems differ from other ecosystems in that they are the result of conversion, i.e., are "man made". Agro-ecosystems are unique in that their global extent has been increasing – at the expense of other types of ecosystems.

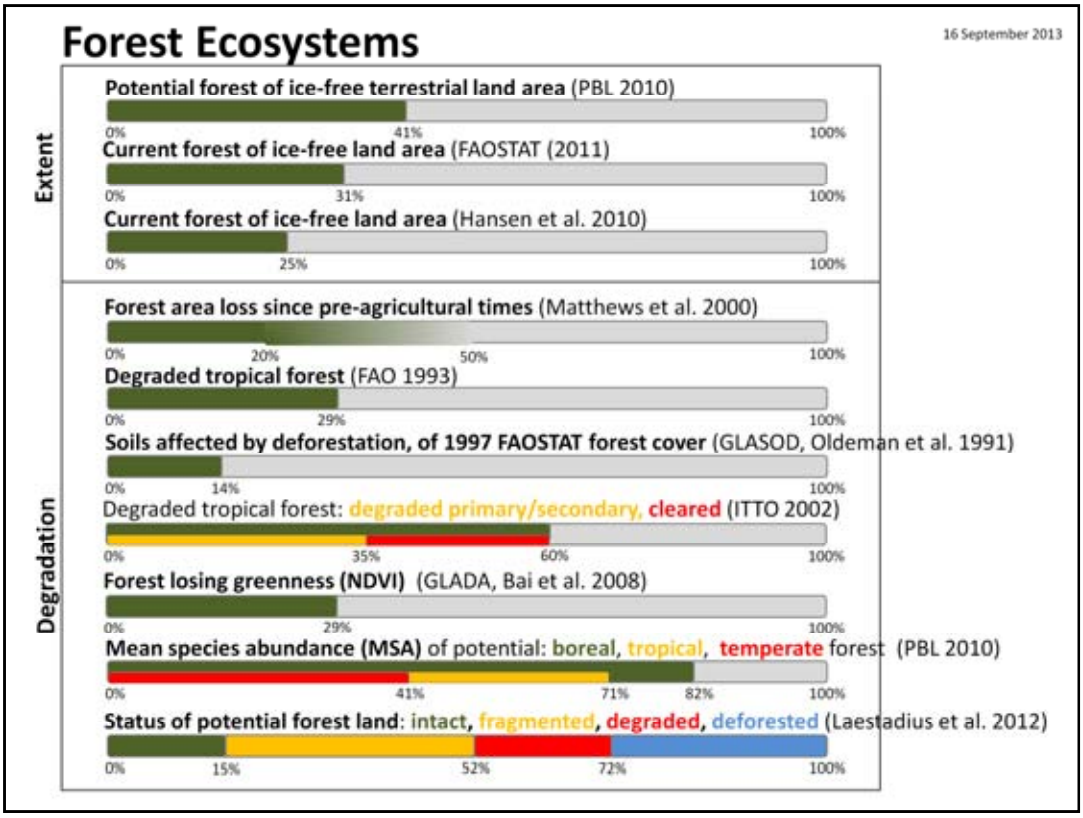
The conversion of forest and grassland ecosystems to agriculture (agro-ecosystems) has had significant impacts on the provision of all ecosystem services. It is estimated that more than one-third of the word's surface is now covered by actively managed systems, and in this process at least the same amount has been embedded into managed landscapes.

The degradation of agro-ecosystems , in the form of nutrient mining, soil erosion or salinization, affects an estimated 20% of the total managed area and contributes to productivity losses, hunger, and poverty.

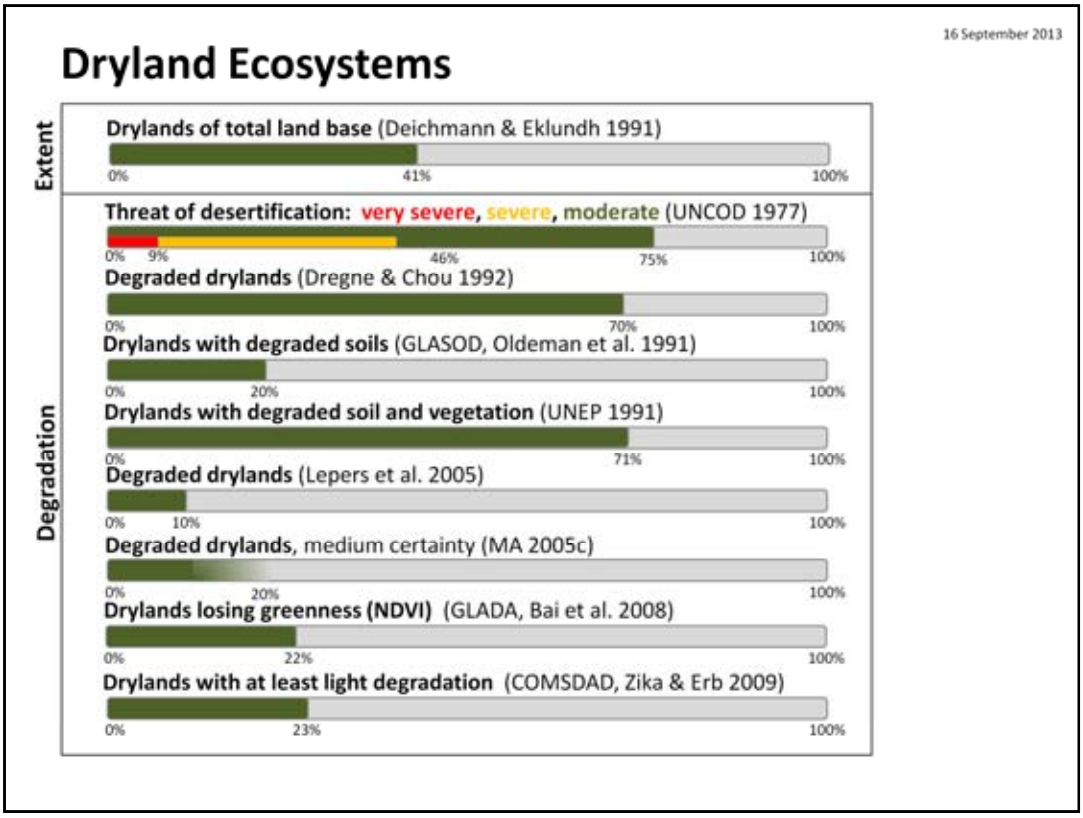
Since the onset of the Neolithic revolution, forests have been in decline. Wood et al (2000) estimate that about 30% of the potential area of temperate, subtropical, and tropical forests has been converted to agriculture. Analogous estimates exist for grassland ecosystems, of which around 20% are thought to have been converted to cultivated crops (Lal et al. 2012).



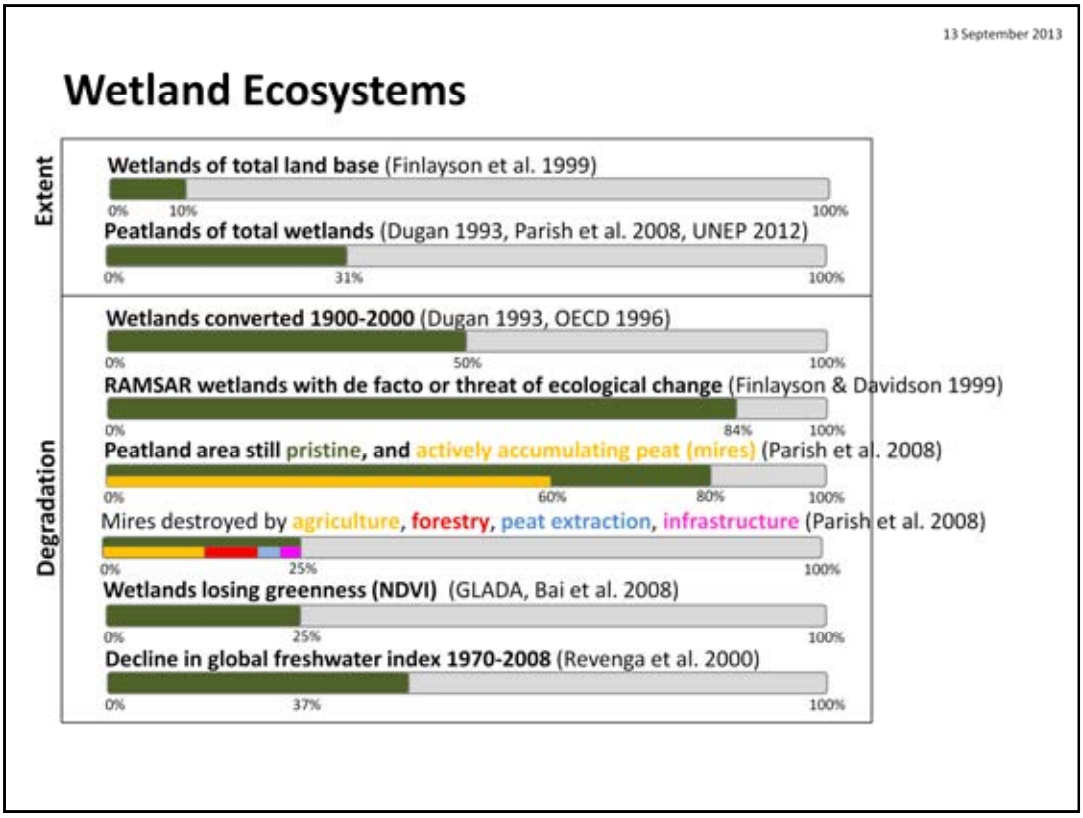
One-fifth of the world's grasslands have been converted to cropland, and more than two thirds are currently being used for grazing. Up to half of the existing grassland area appears to be at least lightly degraded with 5% strongly degraded.



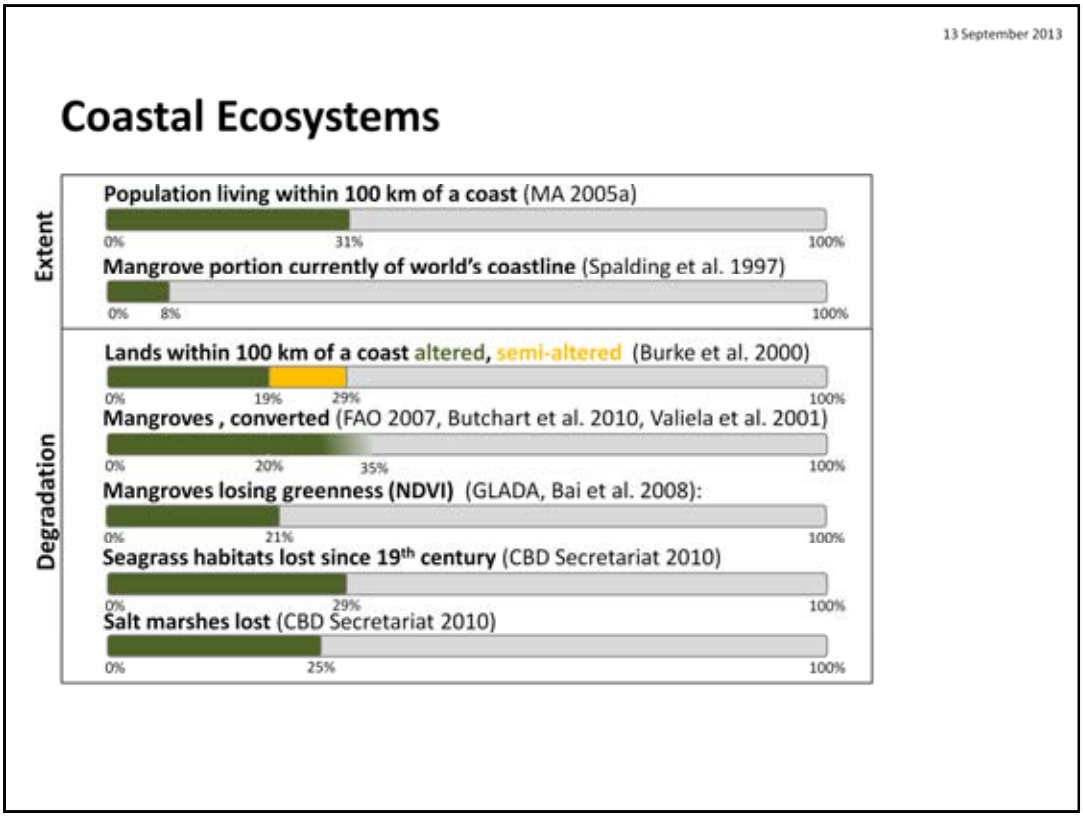
Forest ecosystems could currently potentially cover around 50% of the earth's surface. Deforestation has reduced forest cover by about one-third while another third is considered to be degraded. Annual rates of conversion and loss are currently 0.4% in tropical forests, only slightly balanced by increases in forest cover in temperate and boreal areas.



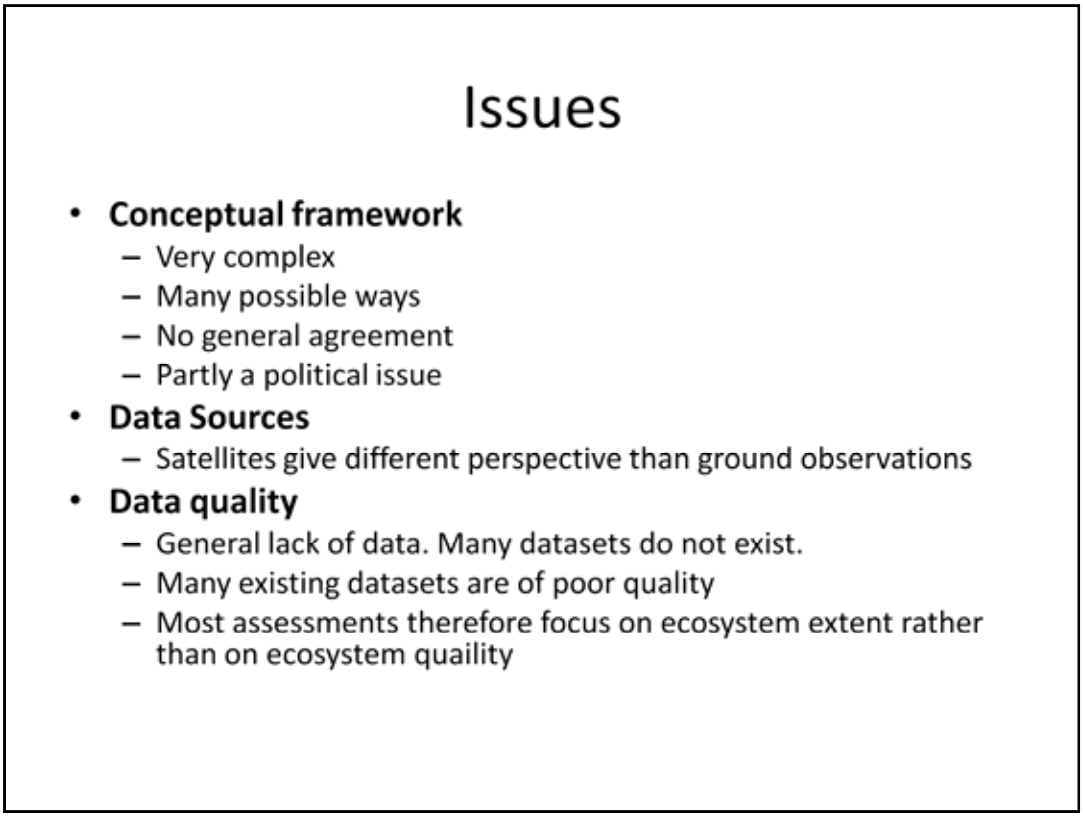
More than two billion people depend on the world's arid, semi-arid and dry sub-humid lands for their livelihoods. Despite the implications for food security, climate change and human settlement, only a few exploratory global assessments of the extent of dryland degradation are available. While most assessments agree that between 15-25% of drylands are degraded, the harmonization of results is difficult due to the different methodologies employed.



Wetlands cover 10% of the terrestrial land surface, nearly one-third being peatlands. Assessments point to the substantial conversion of wetlands of up to 50%, with approximately 25% of peat-producing mires destroyed. Up to 85% of internationally important wetlands have undergone or are currently undergoing ecological change. In this process, agriculture is the biggest driver.



Nearly one-third of humanity lives within 100 km of a coast, and one-third of coastal lands are considered semi-altered or altered. At least one-fourth of mangrove ecosystems have been converted globally, and an equally high percentage appears to be degrading. Similar figures exist for seagrass habitats and coastal marshes.



All estimates of degradation depend entirely on the underlying conceptual framework. There is great complexity in this. Many ways are possible and justifiable. But they are not necessarily compatible with each other. For example, should the Netherlands be classified as converted forest land (”a sustainably lost forest”) or as an agroecosystem? Choices of this kind are political rather than scientific.

Different data sources give a different perspectives. Older assessments of degradation tend to use ground observations. Newer assessments use satellite observations. These perspectives are very different and this shows in the assessment results.

The quality of data is generally poor or even very poor. Many desirable datasets simply do not exist. Even if there was clarity and agreement on the coonceptual framework, it would not be possible to arrive at a high accuracy estimate of the extent of degraded lands.

Most assessments focus on the extent (i.e. the boundaries) of different ecosystems, rathern than on their quality (what is going omn within their boundaries). Conversion is easier to define and detect than degradation.

"Best guess" estimates

Major ecosystem type	Extent former [Mha]	Extent current [Mha]	Conversion [Mha]	Conversion [%]*	Degradation current rate [%]	Degradation fraction [%]	Wilderness [Mha]	Wilderness [%]*
Agro-ecosystems	0	4,900 a)	-4,900	-	n/a	15-25 b)	-	-
Grasslands	6,200 c)	5,200 d)	+1,000	16%	n/a	20-35 e)	3,400-4,200	55-67
Forests	5,500 f)	3,900 g)	+1,600	29%	-0.2 h)	30-60 i)	1,600-2,700	28-50
Drylands	5,100 j)	5,100	- k)	-	n/a	15-25 l)	-	-
Wetlands	2,600 m) peat: 500 n)	1,300 o) 400 p)	1,300 100	50% 25%	n/a -0.1	25 q) 20-25	1000 280-300	38 56-60
Coastal cosystems r)	24 s)	18 t)	6	33%	-1.0 u)	21 w)	13	53
Total	19,424	20,418						

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* of former extent

a) Following FAOSTAT; b) With GLASOD at the lower and preliminary GLADIS data at the higher end; c) Calculated from current extent and conversion estimates; d) Following White et al. (2000); e) With FAO 2009b at the lower end, and a compromise between GLASOD and White et al. (2000) at the higher end; this is supported by FAO (2010c); f) Following PBL (2010) and Lal (2012); g) Following FAOSTAT; this is for forest ecosystems, not forest landscapes; h) FAO (2001), calculating with a total forest net change of -9.4 Mha/yr; rates of gross tropical losses are in the order of -0.4% per year; i) With GLADA at the lower and Matthews et al. (2000) at the higher end; j) Total dryland extent according to the aridity index (Deichmann & Eklundh 1991); k) The areal extent of the drylands remains constant over time; l) With consideration of Lepers et al. (2005) on the lower end, and GLADA & COMSDAD at the higher end; m) Calculated from current extent and conversion estimates; n) Following Finlayson et al. (1999); o) Calculated from current extent and a conversion estimate of 25% (Parish et al. 2008); p) Following Dugan (1993), Parish et al. (2008), UNEP (2012); q) Solely relying on GLADA; r) Mangroves only; s) Calculated from current extent and a conversion estimate of one third (Valiela et al. 2001); t) Following Spalding et al. (1997); v) Following FAO (2007); w) Solely relying on GLADA.

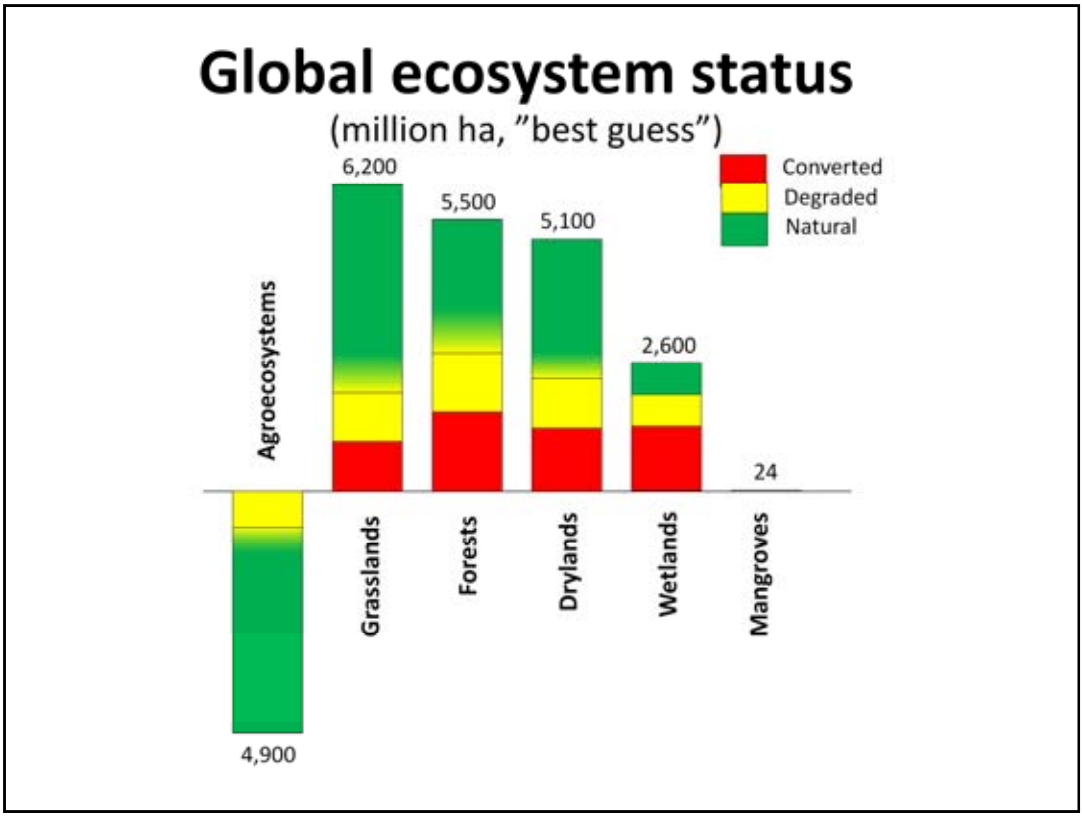
Methods and assumptions used to derive at current and former ecosystem extents are provided in the footnotes.

The major ecosystems overlap. Their total extent exceeds 100% of total terrestrial land surface. The sum of *current* extents (3rd column in Figure 12), e.g., is 20,418 Mha, approx. 1.5 times the terrestrial surface area.

It is interesting to note that the total of former extent estimates is 19,424 Mha, approx. 1,000 Mha (5%) lower than the sum of current extents. This can be mainly – but not exclusively – due to:
(1) "Former" extents are not derived in the same way for all ecosystems. For forest ecosystems, the value is a modelling result and reflects potential forest cover under present climatic conditions, not "former" ones. For grasslands and wetlands, the former extent was derived by multiplying the current extent with the inverse of respective conversion estimates. This approach is problematic as two uncertain estimates are multiplied with each other.
(2) The conversion estimates for grasslands and/or wetlands might be too low.
(3) The time dimension of what is "former" might vary between ecosystems. Most estimates refer to a "pre-Neolithic stage"; but people began altering plant and animal communities for their own benefit earlier than that, so that a value other than "0" is imaginable for the "former" extent of agroecosystems.

Ecosystem **conversion** has been calculated as the differences between modelled or calculated *former* extents and associated *current* extents. In case of agroecosystems conversion does not apply, and in case of dryland ecosystems no conversion rates can be determined because of their static extent.

Most of the existing data on **degradation** refer to changes in the extent of ecosystems rather than in their quality. In combination with the absence of an agreement on what



Overview: Globally, it has been estimated that half of the global wetlands has been converted with a quarter of the remainder being degraded. The world's forests are close to these figures, whereas the planetary damage done to grasslands appears somewhat lower.

Agroecosystems represent a man-made conversion of lands that were originally part of another ecosystem. This is the reason why the agroecosystem bar is going down instead of up

These figures are based on published assessments. They are very uncertain because of
- Lack of agreement on definitions
- Poor data

These findings represent the first step in a long-term, iterative process of assessing the scope of land and ecosystem degradation and the potential for restoration and rehabilitation.

This is a global map. It uses only global datasets and its purpose is to show a global picture. It points to areas where restoration opportunities are more likely to be found.

Yet, at the national level, this map is not good enough. It doesn't have enough detail and it lacks a number of important datasets, e.g., tenure arrangements.

Each country must go through its own process of assessing its restoration opportunities.