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Degraded Land and Sustainable Bioenergy Feedstock Production

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Content

1 Bioenergy from Degraded Land and Abandoned Farmland

As a part of the overall debate on the sustainability of bioenergy and biofuels, the greenhouse gas (GHG) balance of bioenergy has become an issue of intense discussion by media, science, business, and politics.

This is driven by the increasingly acknowledged necessity to limit the use of fossil fuels, and to reduce GHG emissions from deforestation and other land-use change, as potential negative impacts of human-induced climate change are severe[1].

In that regard, the interest is in bioenergy systems which offer a high potential for net GHG emission reductions without inducing risks of indirect land-use change through displacement. Bioenergy feedstocks from organic wastes and residues from agriculture, forestry, industry and households are prime options for this, as they have very low GHG profiles, and no displacement risk.

Other possibilities are the cultivation of bioenergy feedstocks on (for economic, political or social reasons) **abandoned** farmland, and especially on **unused degraded** land (OEKO 2006; Searchinger 2008).

The **key aspect is that there is no current cultivation on these lands.**

Still, such lands may be sensitive to cultivation, or extensively used by local people, and at least some of these areas might harbor high biodiversity and should belong either to Protected Areas or other biodiversity-relevant land.

Last but not least, the (partial) regeneration of degraded land toward natural habitats may be more beneficial to society than using such land for bioenergy feedstock production.

With that in mind, the lands being either abandoned or degraded must be evaluated with respect to their potential for sustainable use. Their use for bioenergy production is not “per se” a sustainable option.

Thus, a careful definition and identification of degraded land and abandoned farmland is an important step towards a potential sustainable use of such lands as prior bioenergy feedstock production areas.

[1] see for climate change impacts IPCC (2007); for food security FAO (2008), and for biodiversity CBD (2008).

2 Overview of Land Categories

This section gives an overview of common definitions for different land categories, and their relationship, transitions and intersections of categories is discussed.

2.1 Definitions of Land Categories

2.1.1 Used and Unused Land

Used land and **unused** land refer to a gradual change from intensely used land towards land that is not influenced by any (anthropogenic) land-use form. Agriculture and forestry as well as infrastructure can clearly be considered as "use" of land to meet humans needs (food, feed, fibre, fuel, etc.), whereas **extensive** land-use forms (e.g. collection of medicinal plants or sporadic hunting, shifting cultivation with long periods of fallow) make it difficult to decide up to which use-intensity land is still considered as "unused" (OEKO 2008).

Land that is "unused" today can be grouped in two main categories:

- Areas of undisturbed wildlife, from rainforests to desserts, where no land use took place for an extended period ("long time", i.e. several decades). Though often used, a clear definition of this category is missing and should be linked to existing classification systems like Global Land Cover 2000 and GlobCover (announced for summer 2008).
  For biodiversity reasons and ecosystem services, land of this category may in general be excluded from biomass cultivation - at least, its use needs to go along with sound landscape planning.
- Abandoned land where former land-use activities have been given up (e.g., abandoned industrial sites, plantation, silvicultural land, and farmland).
  Abandoned farmland or other still-productive land will be in the focus for production of biomass.

Approaches that map the suitability of land for cropping systems (e.g., van Velthuizen et al 2007) are an option to address the potential use of land. Such data sets are well defined and scientific sound, but they cannot give answers to questions on current and historical land use.

2.1.2 Abandoned Farmland

Abandoned farmland is land – within a cultural landscape (Schäfer 1992) – that was previous used for agriculture or pasture, but that has been abandoned and not converted to forest or urban areas (Field et al. 2007). The agricultural activities have been stopped for economical, political or environmental reasons, e.g. set-aside-land (politically) or degraded farmland (environmentally) (OEKO 2008).

On marginal land agriculture *can* be given up for economical reasons (Schroers 2006). But this definition is not exact as it ignores subsistence agriculture (see Section 2.1.4).

Abandoned farmland should not be mixed up with *fallow*. The latter describes the temporary suspension of cultivation for one or several vegetation periods to achieve a recovery of soil fertility (Schäfer 1992). Fallow is a part of crop rotation. It is often difficult to differentiate old fallows by remote sensing – and even by field surveys –

from natural vegetation or abandoned land. In general, abandoned land is very difficult to map, and uncertainty for abandoned area estimates with probably 50% or more are substantial (e.g. data set HYDE-3, Field et al. 2007).

→ *Abandoned Farmland is a land use related term.*

2.1.3 Degraded Land

There can be found several slightly different definitions on degraded land, e.g.:

- Land degradation is a long-term loss of ecosystem function and services, caused by disturbances from which the system cannot recover unaided (UNEP 2007).
- Land degradation is the decline of natural land resources, commonly caused by improper use of the land (Bergsma et al. 1996).

These definitions agree in principle, but there are differences and open ends concerning

- cause of degradation processes: is land degradation only human-induced or both human and naturally induced?
- system recovery – is restoration/succession aided or unaided?
- time horizon: over which period the status of land is observed/considered?

This section only gives a short overview of different land-use categories, the mentioned aspects will be discussed later (see Section 3.2).

Land degradation is often seen “in the eye of the beholder” which emphasizes one or other function (e.g. biodiversity perspective, UN-CBD) or gives preferences to specific biomes (e.g., UN-CCD to drylands). However, all forms of land degradation will ultimately lead to a reduction of soil fertility and productivity. The general effect is reduced plant growth, which in turn causes loss of protective soil cover and increased vulnerability of soil and vegetation to further degradation (El-Beltagy 2000). This leads directly to a possible indicator for land degradation, such as applied in the LADA definition on degraded land:

- **Land degradation is a long-term decline in ecosystem function and productivity** and measured in terms of net primary productivity (Bai/Dent 2006).

→ *The term degraded land is related to land productivity potential.*

2.1.4 Idle Land

The terms unused land and idle land can be used synonymously. Idle land comprises all types of unused land (see above), i.e., abandoned farmland, degraded land, devastated land and waste land as well areas of undisturbed wildlife (OEKO 2008).

→ *Idle land is a term related to the economic potential of land.*

2.1.5 Marginal Land

Marginal land is defined as an area where a cost-effective production is not possible, under given side conditions (e.g., soil productivity), cultivation techniques, agriculture policies as well as macro-economic and legal conditions (Schroers 2006).

In FAO's AEZ methodology, marginal land stands for the land class that has soil, terrain and climatic constrains such that less than 40% of its potential yield for a crop under evaluation can be produced. This means that the extension of mapped marginal land varies with crop selection.

Evidently, the term *marginal land* is applied with strong differences in its meanings. Regarding its economical use it does not factor in subsistence agriculture. Hence, marginal land might supply food, feed, medical plants, fertilizer or fuel to local people, but not through a structured, market-based approach. Further, land classified as marginal is often subject to tenure issues where disputes arise on rights of those who use these areas.

→ *Marginal land is an economic or a suitability term.*

2.1.6 Wasteland

Wasteland refers to land without appreciable vegetative cover or agricultural potential (active dunes, salt flats, rock outcrops, deserts, ice caps, and arid mountain regions; Oldeman et al. 1991). Due to its natural physical and biological conditions wastelands are per se unfavorable for agricultural activities. Within this category, land without appreciable vegetative cover or agricultural potential is included. These areas cannot be cultivated under **any** conditions and, therefore, are not suitable for bioenergy production.

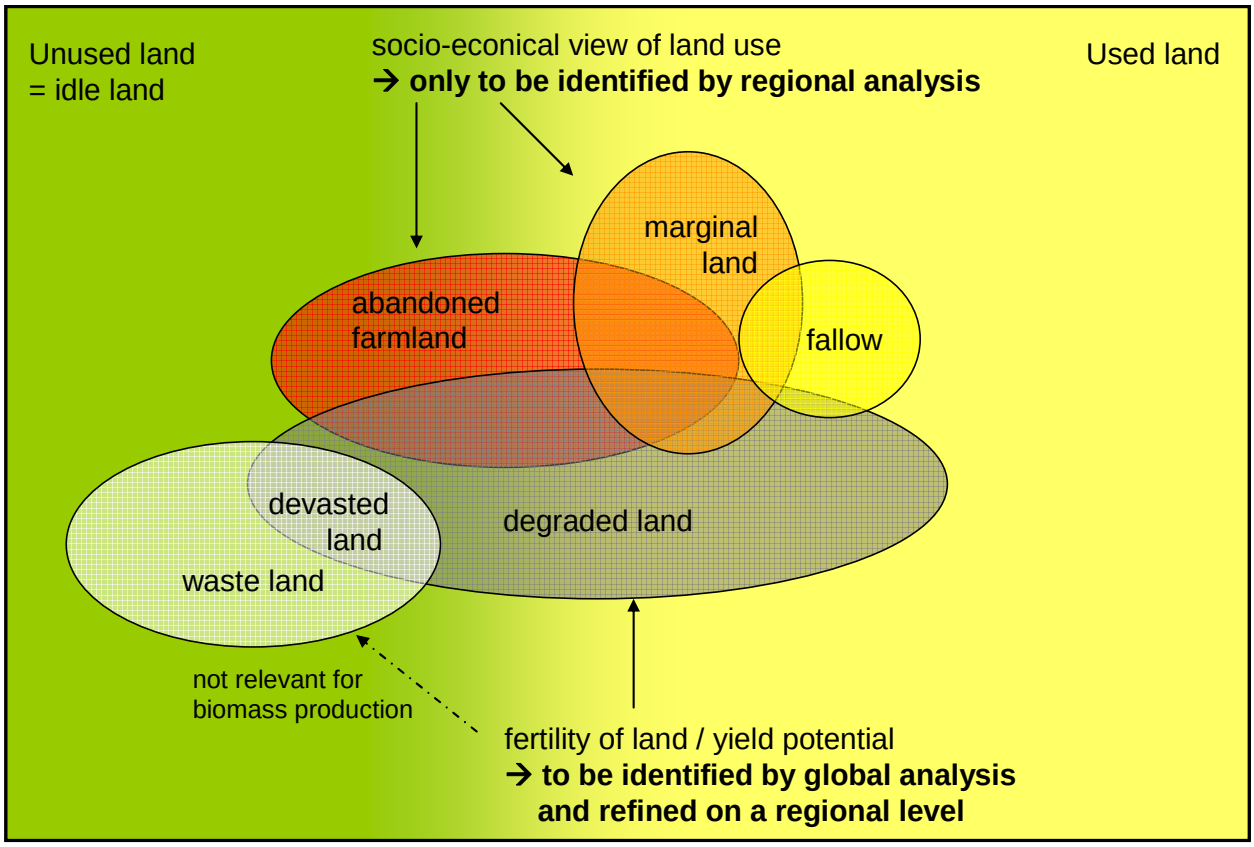
In the GLASOD map, six types were recognized: active dunes, salt flats, rock outcrops, deserts, ice caps and arid mountain regions.

→ *The term waste land is related to land productivity potential.*

2.2 Relationship of Land Categories

The following figure summarizes relationships and overlap of land categories.

Figure 1 Methodical approach to identify land categories and their relationship



Source: Öko-Institut

As mentioned above the cultivation of biomass on degraded land or abandoned farmland has the **potential** to safeguard against negative indirect land-use change effects from bioenergy development.

A first step in this direction would be the identification of degraded land on a **global level**.

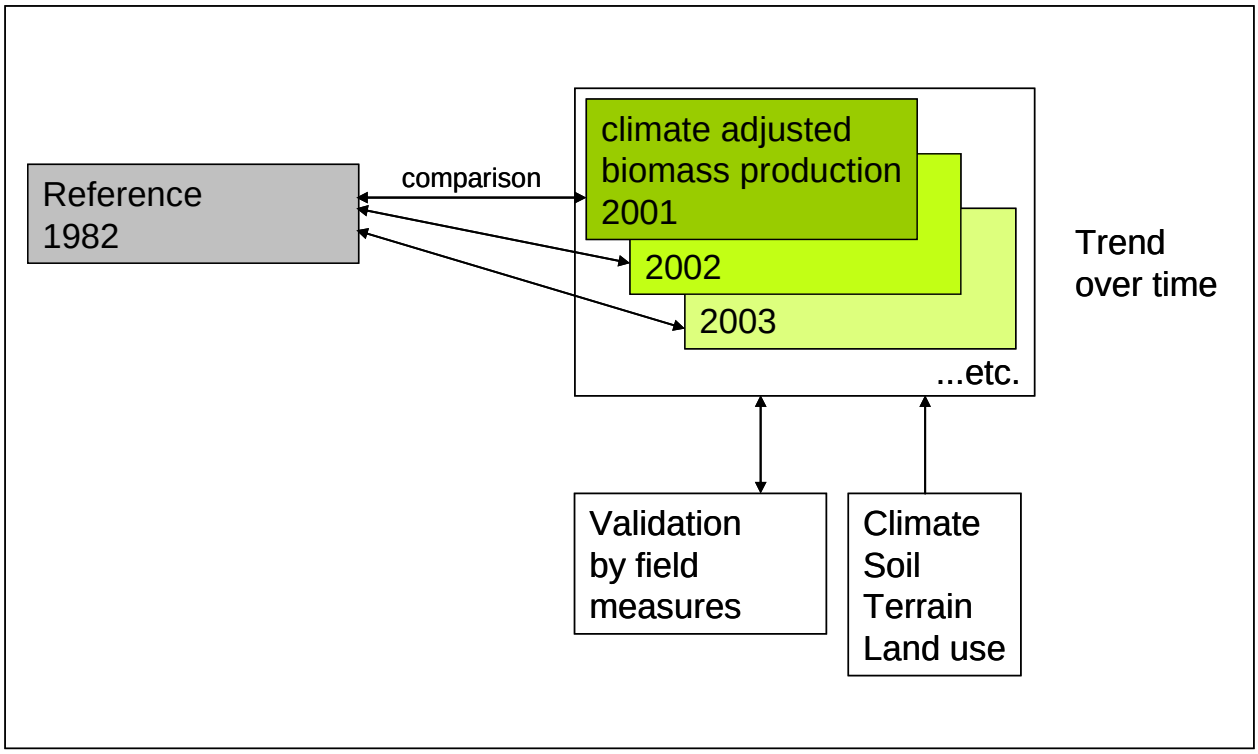
In following steps, a further differentiation of degraded land has to be carried out concerning biodiversity, and land use has to be delivered on the **regional level** (for example abandoned farmland, contribution to food supply or high nature value and neighborhood to undisturbed wildlife etc.).

3 Degraded Land

3.1 Identification Procedure of Degraded Land by Existing Models/Data

The Global Assessment of Land Degradation and Improvement (GLADA) project attempts to identify the status and trend of land degradation. For this hot spots and status of land degradation is identified by trend analysis of the last 25 years' biomass production which is derived from satellite measurements by means of changes in net-primary production (NPP). Since biomass production depends on several factors other factor (soil, climate, land cover, cultivation practices) a negative trend in NPP does not necessarily indicate land degradation. Especially in dry lands, precipitation is a dominant growth factor. Therefore, in the GLADA approach biomass productivity was climate adjusted by a combined index for rain use efficiency.

Figure 2 Relationship of land categories to each other and methodical approach to identify land categories



Source: Öko-Institut

As can be seen in the figure above, a **reference date** is needed to determine a trend of net primary (biomass) production over time. The definition of this date depends on available satellite data – for the GLASOD and GLADA data, it is 1981/82. Therefore, areas of historical land degradation that took place in many regions in the world like the Mediterranean or West Asia cannot be identified by this method.

Box: Some Details on Existing Databases on Degraded Land (GLASOD, GLADA)

For a global identification of degraded land it is necessary to know where and to what extend GIS-based data on land cover and land use are available from which degraded land can be derived. The following description of the existing data is based on UNEP (2007) and Nachtergaele (2005):

Until today, the only comprehensive source of information about land degradation has been the Global Assessment of Human-induced Soil Degradation (GLASOD), which assessed the severity and kind of land degradation for broadly defined landscape units at a scale of 1:10 million. Data with higher resolution are available for Central and Eastern Europe (SOVEUR) and for south-east Asia (ASSOD).

A new, quantitative global assessment has started under the GEF/UNEP/FAO project Global Land Degradation Assessment in Drylands (GLADA) – GLADA is embedded in the wider LADA program. In GLADA, preliminary work has been undertaken to improve the GLASOD data. However GLASOD only considered degradation and results are based on (often a single) expert option. In contrast, LADA looks at the integrated effect of degradation on vegetation, soil and water resources via remote sensing techniques as well as expert knowledge on national and local scale.

Nearly 60 countries have produced in lesser or greater detail an overview of the status, causes, and impacts of land degradation nationally. Currently validations for Kenya, North China and Bangladesh are underway.

Results:

18 per cent of land degradation by area is associated with cropland, 25 per cent is in broad-leaved forests and 17 per cent in boreal forests (this is consistent with trends in forest degradation). This preliminary analysis will need to be validated on the ground by the country-level case studies.

4 Specification of Degraded Land to Grow Bioenergy

In the context of the identification of degraded land for sustainable bioenergy production by GIS-based models, a detailed definition is essential that specifies the type of degraded land that should be used..

As mentioned above, there are still some questions to be dealt with.

Specifications are needed for the following issues:

- What are reasonable reference data to determine degradation? This depends on available satellite data, e.g., 1981/82 for GLASOD and GLADA, until today.
- Who to achieve connectivity to existing data?
- What is the cause of degradation? Should bioenergy production focus on human-induced degraded land only (arable land and pasture, but also logged forests, overgrazed savannas…)?
- How to minimize competition with other land-use forms? Should only unused degraded land be considered?
- How to avoid negative impacts on biodiversity? Which degraded areas are relevant for the protection of biodiversity?
- Does biomass production on land under consideration halt ongoing regeneration, and would its conversion to natural habitats be a more beneficial use than bioenergy production?

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