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Is energy cropping in Europe compatible with biodiversity? – Opportunities and threats to biodiversity from land-based production of biomass for bioenergy purposes

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ABSTRACT

Based on literature and six country studies (Belgium, Denmark, Finland, Netherlands, Sweden, Slovakia) this paper discusses the compatibility of the EU 2020 targets for renewable energy with conservation of biodiversity.

We conclude that increased demand for biomass for bioenergy purposes may lead to a continued conversion of valuable habitats into productive lands and to intensification, which both have negative effects on biodiversity. On the other hand, increased demand for biomass also provides opportunities for biodiversity, both within existing productive lands and in abandoned or degraded lands. Perennial crops may lead to increased diversity in crop patterns, lower input uses, and higher landscape structural diversity which may all have positive effects on biodiversity.

In production forest opportunities exist to harvest primary wood residues. Removal of these forest residues under strict sustainability conditions may become economically attractive with increased biomass demand.

An additional biomass potential is represented by recreation areas, road-side verges, semi-natural and natural areas and lands which have no other use because they have been abandoned, polluted or degraded.

Whether effects of cropping of biomass and/or removal of biomass has positive or negative impact on biodiversity depends strongly on specific regional circumstances, the type of land and land use shifts involved and the associated management practices in general. However, it is clear that in the six countries studied certain types of biomass crops are likely to be more sustainable than others.

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1. Introduction

1.1. Policy environment and perspectives for renewable energy

The EU Directive on the promotion of the use of energy from renewable sources 2009/28/EC [1] sets an overall target of 20% renewable energy to be reached by 2020, and a 10% target for renewable energy sources including biofuels in total final energy used for transport. The Directive is accompanied by an obligatory sustainability scheme to be applied for all imported and domestic biofuels in vehicles. Following an assessment of the sustainability requirements for the use of solid and gaseous biomass sources (SEC (2010) 65), the Commission has provided member states with recommendations on content of national sustainability criteria for solid biomass [2]. These recommendations are currently (2012) being assessed, evaluating whether mandatory standards are needed (at the moment of writing this paper, the outcome of the assessment was not yet known). The main reason for accompanying these targets with sustainability schemes is to ensure that biomass production does not counteract the very aim of the climate and energy package, namely mitigating climate change by reducing greenhouse gas (GHG) emissions. The second aim is to avoid negative effects on biodiversity, freshwater availability and other ecosystem services.

The European Sustainable Development Strategy (SDS) emphasises the importance to combat a further decline of biodiversity, to sustainably manage natural resources and to stop climate change [3]. According to the EU SDS these objectives should be integrated in *all* policies of the EU including the energy, agricultural and forest sector. The proposed sustainability criteria point specifically at biodiversity, greenhouse gas emissions and energy conversion efficiency, as well as monitoring the origin of biomass.

The three types of energy for which biomass can be used – transport fuel, electricity and heating/cooling – use different (while overlapping) types of biomass and therefore translate into different land uses. In the case of transport fuel, it is commonly accepted, given the current state of fuel conversion technology, that until 2020 almost all primary biofuel feedstock will come from crops used for ethanol and biodiesel production. These are mainly rotational crops commonly grown on traditional arable farms. They include starch crops (e.g. wheat, potatoes, grain maize, barley and rye), sugar crops (e.g. sugar beet, sweet sorghum) and oil crops (e.g. oilseed rape, sunflower, soy-bean). The clear target of 10% of renewable energy sources in total final energy used for transport by 2020 can be translated into areas of these crops relatively easy. As from 2015 to 2020 it can be expected that efficient 2nd generation techniques will be developed for converting ligno-cellulose (woody or grassy) crops and by-products into transport fuels (see e.g. [4]). Part of the biomass for biofuels can also come from forestry, nature conservation areas and other land use categories. In agriculture the main crops delivering ligno-cellulose material are short rotation coppice crops like willow and poplar or perennial grasses like *Miscanthus*, switchgrass, reed canary grass (*Phalaris arundinacea*) or giant reed (*Arundo donax*).

In the case of electricity, the targets that exist until 2020 are more difficult to connect directly to future agricultural land use, because of the wide range of renewable energy sources that could be used. Wood biomass is generally the most important source, but feedstock for electricity generation can come from agricultural crops like short rotation coppice and perennial grasses, or it can be wastes or by-products from agriculture, forestry and other industries, urban waste or imported pre-prepared fuel.

1.2. Sustainability and biodiversity effects of bioenergy harvesting

Although it is difficult to estimate the exact area of land required for bioenergy crops, it is clear that the pressure on land will increase strongly under a growing biomass demand [5]. This may cause adverse effects on biodiversity as it may lead to the further intensification of existing land uses, both in agricultural and forest lands, but also the conversion of non-cropped biodiversity-rich land into cropped or forested area [6]. The conversion of e.g. biodiversity-rich grasslands is meant to be prevented by the sustainability scheme for biofuels introduced by the EU Renewable Energy Directive. There is an increasing resistance against using existing arable land for the production of biomass at the expense of food and feed production [7], since it can induce substantial negative environmental effects [8]. Food security, especially in developing countries, may be affected, and bioenergy production may push food and feed production into uncultivated areas causing loss of valuable natural habitats (e.g. tropical rain forest and savannah) and to tremendous releases of greenhouse gases (GHGs) from soils [9,10]. This could also be a consequence of the EU countries increasingly relying on imported biomass for bioenergy.

In the last few years there is an increasing number of scientific papers discussing effects of biomass energy cropping on biodiversity: [6,11–18]. The general mechanisms influencing biodiversity when affected by the multitude of bioenergy cropping systems can briefly be characterised as follows. Intensification as brought about by converting long-term or permanent crops into annual management and harvest practices is detrimental [14,15]. Introducing energy cropping into an existing intensive cropping system with annuals will generally benefit biodiversity if the energy crop is multiannual [14]. This will enhance biodiversity provided that management does not counteract by increasing pesticide use or harvest disturbance. There will always be some species benefitting from land use management, but the loss of habitat diversity will be more pronounced than the gain in such opportunistic species. As management practices are composed of a range of techniques the particular combination finally determines the net impact on biodiversity. This includes practices at the landscape level such as maintaining corridors, hedgerows, etc. [19,20]. Also soil organic stocks are affected, as was demonstrated for *Miscanthus* [21].

1.3. Focus of the paper

Given the above considerations, it is clear that for reaching the proposed renewable energy targets in a sustainable way, land resources need to be identified that can be used for biomass