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Forcing Germany's renewable energy targets by increased energy crop production: A challenge for regulation to secure sustainable land use practices

Gerd Lupp[a,*], Reimund Steinhäußer[b,1], Anja Starick[c,2], Moritz Gies[b,1], Olaf Bastian[b,1], Juliane Albrecht[b,1]

[a] Schlossstrasse 8, 79211 Denzlingen, Germany
[b] Leibniz Institute of Ecological Urban and Regional Development (IOER), Weberplatz 1, 01217 Dresden, Germany
[c] Leibniz Centre for Agricultural Landscape Research (ZALF), Eberswalder Straße 84, 15374 Müncheberg, Germany

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ABSTRACT

According to European and German energy policies, the proportion of energy crops is to increase significantly in the coming years to meet the ambitious goals for renewable energies. Stimulated by the German Renewable Act (EEG), this has lead to a strong increment of energy crop, cultivation, especially maize for biogas production. The increased cultivation of energy crops can lead to severe negative impacts on ecosystem services (ES). Therefore, there is a necessity for a better regulation of bioenergy production. In our paper, we analyze possible impacts of an increased biomass production on ES and look at instruments to better regulate energy crop cultivation in Germany. We assess legal instruments, the EEG, how spatial planning might contribute for a better steering and in which way the Common Agricultural Policy of the European Union influences framing practices in energy crop cultivation. It can be stated that the steering effects of many legal instruments are extremely weak to secure sustainability and ES. We can demonstrate that there is a necessity for precise minimum standards to be applied effectively at the local level. Also there is a strong need for tools and instruments to gain a spatial dimension for regulating bioenergy production.

Introduction

Land management faces huge challenges to regulate the often competing demands for limited resources and to secure their sustainable use. One sign of increasing pressure on natural resources and non-sustainable land use practices can be seen in the dramatic loss of biological diversity in recent years, not only in Africa, South America or Asia, but also in Central Europe (MEA, 2005; BMU, 2007). Land use management has to be improved significantly in order to achieve the goals set under the Convention on Biological Diversity (CBD), and to halt the loss of biodiversity and degradation of ecosystem services. The increasing use of biomass for energy purposes is a prime example of the controversy around increasing sustainability in land use practices. In the light of European and German renewable energy targets and action plans (e.g. BMELV and BMU, 2009), the cultivation of energy crops in agricultural production is intended to increase significantly in coming years, in addition to solar power and wind energy, in order to achieve these ambitious goals. The target for renewable energy by 2020 is 20% of the total energy consumption for the EU (Commission of the European Union, 2007). The growth in the biomass sector is to contribute to these goals, largely with respect to the 10% goal for the transport sector and to the provision of heat. In order to meet these targets, the cultivation of biomass for energy production would have to double in the coming years (Commission of the European Union, 2005; Kavalov and Peteves, 2005).

To reach the political goals set for bioenergy in 2020, between 21% (Agentur für Erneuerbare Energien, 2013) and 30% (SRU, 2007) of German agricultural area would have to be used exclusively for producing biomass for energy purposes. This cultivation of energy crops and woody biomass already has large effects on the ecosystems and landscapes in Germany. By 2012, energy crops already have been cultivated on 2,124,500 ha and on more than 17.6% of Germany's agricultural land. The most important crops in 2012 were rapeseed for biodiesel and blending fossil fuels on 913,000 ha (though it is a negligible share in the transport sector) and

* Corresponding author. Tel.: +49 7666 3701.
E-mail addresses: luppg@gmx.de (G. Lupp), r.steinhaeusser@ioer.de (R. Steinhäußer), starick@zalf.de (A. Starick), m.gies@ioer.de (M. Gies), o.bastian@ioer.de (O. Bastian), j.albrecht@ioer.de (J. Albrecht).
[1] Tel.: +49 35146790.
[2] Tel.: +49 33432 820.

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various crops for biogas production on 962,000 ha (FNR, 2012), the largest share is maize for biogas production, cultivated 800,000 ha (Deutscher Bauernverband, 2012). Energy derived from biomass had a share of 6.1% in the electricity production (mainly biogas), 10.1% in the heating sector (mainly woody biomass) and 5.5% in transportation (mainly rape oil and ethanol derived grain and sugar beet) according to Agentur für Erneuerbare Energien (2013). The extent of the cultivation of energy crops and silage maize varies significantly by region. According to Deutsches Maiskomitee (2012) in most districts in eastern Germany, maize covers around 20% of the agricultural land, while in some districts of Lower Saxony, such as Ammerland and Wesermarsch, intensive livestock farming meant that there was already intense cultivation of maize for fodder before the bioenergy boom. The biogas plants led to a further increase in maize cultivation, so that it covered more than 70% of the farmland in some of these districts in 2011 (Deutsches Maiskomitee, 2012).

The German Biomass Action Plan (BMELV and BMU, 2009) names climate protection and creating added value at the regional level as the main benefits to be achieved by an increase in the amount of biomass used for energy production, but also states such environmental and sustainability aspects as protecting biodiversity, soil fertility, pollution control and water quality to be considered. The demand for plant biomass offers new opportunities for agriculture and forestry. New markets can emerge, such as for thermal utilization of forest residues, roadside vegetation and landscape management actions (Wachendorf et al., 2008). Seen as per se sustainable in the last decade, the bioenergy sector has received considerable governmental support in many countries. However, conflicts between the different objectives of bioenergy development, ecosystem and biodiversity protection as well as landscape issues in particular become more and more obvious (Bruell, 2007). Despite their possible contribution to a reduction of greenhouse gas emissions, a non-selective and unregulated cultivation of crops cultivated for energy production has negative impacts not only on biodiversity, but can also lead to soil erosion, nutrient spill-overs and negative impacts on landscape aesthetics (Bastian et al., 2006; Herrmann and Uckert, 2009).

In our paper, we assess the impacts of political goals for energy crop production on land use and the effect of regulation to secure sustainability. We analyze the impacts of energy crop production on landscape using the concept of ecosystem services (ES) based on a literature review and own analyses of the legal framework, planning and financial incentives related to bioenergy production and regulating farming practices. We therefore describe the concept of ES and its relevance in the context of sustainable land use management first. We then scope relevant regulatory instruments for energy crop production using the example of the German Federal Free State (Bundesland) of Saxony. We present the most relevant instruments at the European, national and state levels relevant for energy crop production and their effect for the sustainable cultivation of energy crops. We analyze, whether ES, and minimum standards for them, have been considered, and we evaluate the capability of the identified instruments for spatial regulation to promote sustainable land use practices.

The concept of ecosystem services (ES) and sustainable land use

The concept of ecosystem services (ES) describes the benefits mankind obtains from ecosystems. ES are also defined as direct and indirect contributions of ecosystems to human well-being (De Groot et al., 2002). The attractiveness of ES is based on the integrative, interdisciplinary and transdisciplinary character, linking environmental and socio-economic aspects by involving both natural and social scientific perspectives and approaches (Müller and Burkhard, 2007). Its great political relevance has been expressed e.g. in the Millennium Ecosystem Assessment (MEA, 2005) and in TEEB (2009). The application and assessment of ecosystem services (ES) is seen as an innovative way towards sustainable land use (e.g. Weith et al., 2010). The ES concept stresses the essential relevance of ecosystem structures and processes to human well-being. In recent years, it has received much attention in the political context (MEA, 2005; TEEB, 2009) as well as in the research community (Fisher et al. 2009; Gomez-Baggethun et al., 2010). Due to the widespread use of the term, there is no clear, common and broadly accepted definition of it (Grunewald and Bastian, 2010; Bastian et al., 2012).

We prefer a trinomial classification of ES. The breakdown into productive (economic), regulatory (ecological) and socio-cultural functions or services (Bastian, 1991, 1998; Bastian and Schreiber, 1999) has the advantage that it can be linked to both fundamental concepts of sustainability, economic and social development categories. This is in line with OECD (2003), who proposed three similar categories of ES as well. Mainly to avoid double-counting, supporting services should be seen as those ecological processes which underlie the functioning of the ecosystem. Their value is reflected in the other three types of services (Burkhard et al., 2009).

For the methodological operationalization, we particularly address the factual, active or passive utilization of ES by human beings and adapt methods of the landscape potential approach, which has been developed in close interaction with the ES concept and has in its particular form been conceptualized and applied by German geographers and landscape ecologists since the 1960s. It has proved to be an appropriate tool in planning and research practice to tackle complex spatial and landscape issues, and it allows a differentiated reference to space and a systematic analysis of the landscape situation (von Haaren and Albert, 2011; Grunewald and Bastian, 2010; Bastian et al., 2012).

Impacts of an increased biomass production on ES

The rapid development of energy crop cultivation, and its effects on crop rotations and on the crops raised, has caused both negative and positive impacts on ES. In the literature, the pros and cons of increased cultivation of energy crops, especially maize, are being discussed extensively. Many studies reviewed by Cherubini and Strømman (2011) show a significant net reduction in greenhouse gas emissions and fossil energy consumption when bioenergy replaces fossil energy. According to their conclusions, the soil and water cycles, biomass production basing on perennial crops or material from landscape management (grasses, herbaceous plants, and wood) allows minimize inputs like fertilizing, tilling or herbicide use. Short rotation coppices can increase structures in intensively used agricultural areas and provide space for nesting birds (Liesebach and Mulsow, 2003), and even Red List species (Burger, 2006). They may also increase scenic qualities and contribute to a green infrastructure (Londo et al., 2004) in agricultural landscapes.

On the other hand, the increased competition between energy crops and the production of food and fodder can be observed (Bringezu and Steger, 2005). Higher food prices lead to higher land costs, which in turn lead to higher energy crop production costs (Ericsson et al., 2009). Energy crops can threaten and counteract sustainable development, especially in such environmental aspects as the protection of biodiversity, soil fertility, pollution control and water conservation (Lee et al., 2008; Greiff et al., 2010). It can lead to uniform and monotonous landscape structures and can change the landscape character dramatically, for instance when