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Discussion

Current European policies are unlikely to jointly foster carbon sequestration and protect biodiversity

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ABSTRACT

The extension of forest area is a globally accepted tool to offset CO_2 emissions from deforestation and the combustion of fossil fuels. The common assumption is that in addition to the perceived climate benefits increasing forest area will also support biodiversity, thus making afforestation a “win-win scenario”. Based on the existing scientific evidences, we show that joined climate and biodiversity benefits are strongly context-dependent and that the outcome of afforestation is often highly questionable. In Europe, grasslands managed at low intensity contribute substantially to biodiversity conservation and carbon storage. However, many of these grasslands have been lost due to abandonment and subsequent spontaneous succession towards woody vegetation, or due to land use intensification. Moreover, grasslands are the ecosystems most often deliberately afforested in the context of EU carbon-centered policies that may thus counteract biodiversity conservation programmes. By reviewing the main EU policies targeting forests and grasslands, we found a striking ambivalence between policies and funding schemes addressing grassland conservation on the one hand (e.g. Habitats Directive, green payments within the Common Agricultural Policy) and those supporting afforestation on the other (e.g. rural development funds). We suggest three measures towards a better harmonization of the European Union policies that target forest and grassland ecosystems: (1) promoting the alignment of the decisions taken across different policy sectors; (2) focusing on the whole range of ecosystem services and biodiversity issues rather than on carbon management only; (3) valuing systems managed at low-intensity for their multifunctionality.

1. Introduction

Climate change and biodiversity loss are two global crises that are often addressed through policies targeting land-use planning in forestry and agriculture. Recently, the global area of temperate forests has been stable or even increasing. Even though this trend is often perceived as creating co-benefits for carbon sequestration and biodiversity conservation (Lin et al., 2013; MEA, 2005), this assumption often remains unassessed. It is therefore important to consider the land-use processes through which the forest increase is occurring and to explore the full range of their implications for both carbon cycling and biodiversity (Bremer and Farley, 2010).

In the temperate zone, forest and grassland ecosystems are often spatially contiguous and tightly linked by successional dynamics. Semi-natural grasslands are usually colonized by woody vegetation once abandoned (hereafter: natural expansion of forest) or are converted to forest through the deliberate planting of trees (hereafter: afforestation). Although both ways of forest expansion have important implications for carbon cycling and biodiversity, there is a weak integration of research on forests and grasslands, as well as of research on carbon sequestration and biodiversity. For example, studies listed in the Web of Science (accessed in May 2016) considering carbon and biodiversity in both forest and grasslands (forest + grassland + management + carbon + biodiversity) are

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far less numerous ($n = 64$) than those focused solely on either forests (forest + management + carbon + biodiversity; $n = 787$) or on grasslands (grassland + management + carbon + biodiversity; $n = 206$).

Of those studies assessing carbon or biodiversity in forest and grasslands, many assessed the effects on biodiversity of either natural expansion of forest or afforestation. Both processes may have diverging outcomes especially depending on the land cover type on which they occur, with highly detrimental effects especially in grasslands. Indeed, when abandoned, semi-natural grasslands often face a strong decline in plant species richness (Uchida and Ushimaru, 2014), in contrast with what was found for other categories of agricultural land use (Plieninger et al., 2014). The same is true for afforestation, with grasslands globally being the land cover type on which afforestation has the most negative outcome for plant species richness (Bremer and Farley, 2010). In certain cases, even when degraded pastures dominated by exotic species are afforested, no significant increase in biodiversity may occur (Bremer and Farley, 2010). If considering all pastures as a single category, afforested areas at the global scale were found to support higher species richness only for few taxonomic groups (herptiles and birds, but not for mammals, invertebrates and plants) and, more importantly, positive effects on biodiversity were found only in the pastures with no remnant natural vegetation (Felton et al., 2010).

Regarding carbon sequestration, forest expansion undoubtedly increases biomass carbon stocks, but a range of studies have also demonstrated that, in pastures, this may lead to declining soil organic carbon by changes in the fine root dynamics (Barcena et al., 2014). Indeed, as a consequence of natural expansion of forests, soil organic carbon losses were found to even offset the increase in plant biomass carbon even after 30 to 100 years in a US region with annual precipitation between 700 and 1000 mm (Jackson et al., 2002). Similarly, a global meta-analysis on the effects of afforestation indicates a net decline in soil carbon stocks after changes from pastures to forest plantation, especially in moist regions (annual precipitation >1200 mm) and if conifer trees are planted (Guo and Gifford, 2002). Likewise, a synthesis for Northern Europe found no significant increase in the carbon stored in soils even 30 years after the afforestation of pastures (Barcena et al., 2014). Overall, the often assumed general co-benefits of increased carbon stocks and biodiversity protection appear questionable where grasslands are converted to forests.

In Europe, semi-natural grasslands have been created and maintained over centuries of low-intensity management, such as livestock grazing or mowing. Today they support extremely high biodiversity (Dengler et al., 2014; Chytrý et al., 2015), and significant amounts of soil carbon (Lugato et al., 2014). Due to environmental, demographic, economic and political changes, land management in Europe has caused major fluctuations in the relative proportion of forests and grasslands (Fuchs et al., 2015; Kaplan et al., 2009; Munteanu et al., 2014). While forest extent reached a low-point in many European regions from the 18th to the early 20th century (Kuemmerle et al., 2015), the abandonment of semi-natural grasslands and the expansion of forest have been among the dominating land-use trends in Europe during the last century (Jepsen et al., 2015). For this reason, policies promoting forest expansion at the expense of remaining semi-natural grasslands may risk the overall reduction of biodiversity in the European Union (EU).

Here we synthesize the existing evidence on the contribution of EU forests and grasslands to carbon storage and biodiversity conservation, and hypothesize that the limited attention paid to the potential conflicts between carbon management and biodiversity conservation in the scientific community will be reflected in European policies. Where such conflicts exist, they may reduce the overall effectiveness of the EU policies, and are likely to be propagated into the national policies of the individual EU member states. Finally we outline a way to alleviate the existing conflicts and therefore to better balance carbon management and biodiversity conservation in European grasslands.

2. Forests and grasslands for carbon storage and biodiversity conservation

Together, forests and grasslands cover >50% of the EU land area and host the vast majority of Europe's terrestrial biodiversity (Fig. 1). According to the European Habitats Directive (92/443/EEC), which has been the cornerstone of biodiversity conservation in Europe since 1992, approximately 17% of the forest and 14% of grassland areas are designated as Natural Habitat Types of Community Interest, and a third of this area as Priority Habitat Types (Fig. 1).

Considering the role played by forests in offsetting CO_2 emissions, the past two decades may be viewed as remarkably positive for Europe. First, mainly due to a socio-economic transformation of rural areas, EU-27 forests underwent a 12.9 million hectare (Mha) expansion on abandoned agricultural land between 1990 and 2015 (Forest

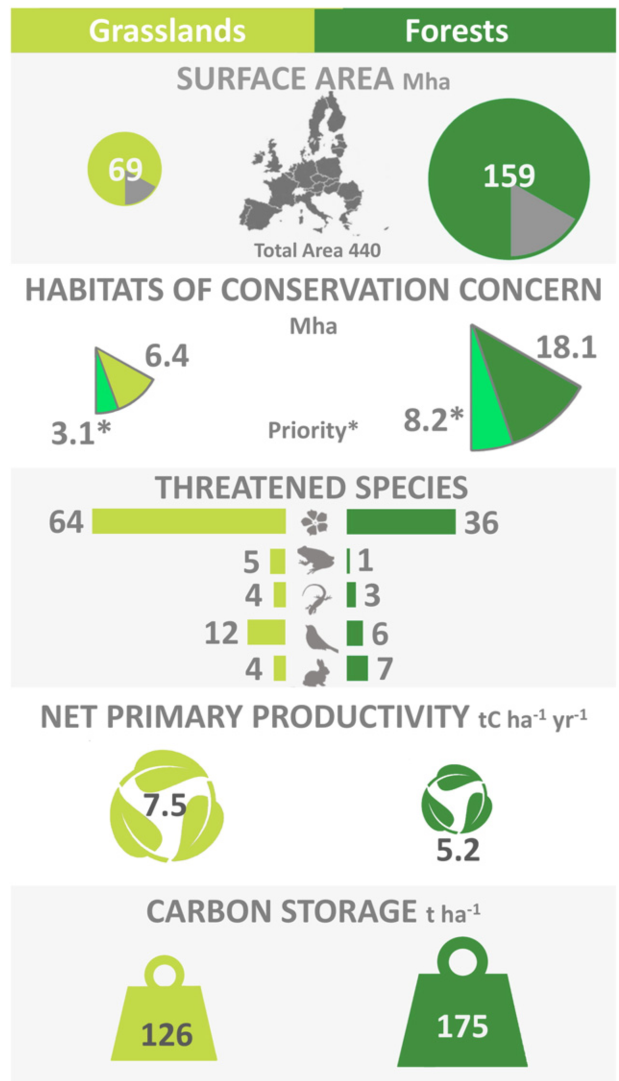

Fig. 1. Role of European grasslands and forests in biodiversity conservation and carbon sequestration. Surface areas are derived from FAOSTAT and Forest Europe (2015); habitat areas from EIONET (http://bd.eionet.europa.eu/article17/index_html/habitatsreport); number of threatened species from EEA (2010) except for vascular plants whose assessment was performed only on those species listed in European and international policy instruments (Bilz et al., 2011); Net Primary Productivity is based on Schulze et al. (2009); Carbon Storage is taken from Pan et al. (2011) for forests (biomass, deadwood, litter and soil); for grasslands, we only report soil carbon (Lugato et al., 2014) with the carbon contained in live biomass estimated as 3.0–4.5 t C ha^{-1} yr^{-1} (see Ruesch and Gibbs, 2008). All data refer to the EU-27 except for Net Primary Productivity (EU-25), Carbon Storage for grasslands (EU-28 plus 6 non-member states) and forests (41 European countries).