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Abolition of set-aside schemes, associated impacts on habitat structure and modelling of potential effects of cross-farm regulation

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ABSTRACT

In intensively farmed regions, habitat fragmentation represents a major pressure on biodiversity. Depending on its spatial setting, set-aside land can increase size and connectivity of habitats and thus counteract fragmentation. In 2008, the EU-wide set-aside obligation was suspended and a large proportion of set-aside land was re-cultivated. With Denmark as case we apply an indicator to measure the effect of set-aside land on spatial structure of semi-natural habitats in term of habitat size and connectivity. Furthermore, we model effects of a hypothetical spatial regulation, where set-aside land with the greatest benefit for habitat structure is retained as uncultivated, while set-aside land with the least effect is re-cultivated. The model is applied to individual farms and to farm agglomerations of increasing sizes, enabling us to explore potential effects of cross-farm regulation. The novelty of our approach is the application of observed land-uses changes for modelling a hypothetical regulation working on a range of spatial scales. Results show that after abolition of set-aside schemes the effect of set-aside land on habitat structure was more than halved. Modelled spatial regulation considerably reduces impacts. Effects increase with increasing size of farm agglomerations. However, marginal benefits become negligible at agglomeration sizes over 36 km^2.

1. Introduction

In regions dominated by agriculture, semi-natural habitats, which are closely linked to extensive land use, are central to biodiversity, here defined as diversity and abundance of wild plant and animal species. Historically, expansion of arable land has led to dramatic declines and spatial fragmentation of semi-natural habitats. In Denmark, since the early 1950s, the area of semi-natural habitats decreased by more than 50% (Levin and Normander, 2008) and as a consequence insufficient patch sizes and spatial fragmentation of semi-natural habitats are recognized as a major pressure on biodiversity (Bruun, 2001; Ministry of Economic and Business Affairs, 2009; Normander et al., 2009; OECD, 2007; Wilhjelm Committee, 2001). Similar tendencies have been shown for other European countries (Aviron et al., 2007; Benton et al., 2003; Burel and Baudry, 1995; Hietala-Koivu, 1999; Ihse, 1995; Ludwig et al., 2009; Robinson and Sutherland, 2002; Smith et al., 2005).

Empirical research has shown that habitat size and spatial connectivity between habitats, is of major importance to biodiversity (Delattre et al., 2010; Hendrickx et al., 2007; Kruess, 2003; Laube et al., 2008; Olff and Ritchie, 2002; Stefanescu et al., 2004; Tews et al., 2004). Spatial indicators (also termed landscape metrics) are mathematical calculations based on spatial data (maps) and are used to describe the spatial characteristics of land-use types in terms of size, shape and spatial configuration (Chow et al., 2005; Gergel and Turner, 2002; Levin et al., 2008; Lovett et al., 2005; Turner, 1989; Turner and Gardner, 1991). Spatial indicators are widely used as surrogates or indicators for biodiversity (e.g. Gardner and Engelhardt, 2008; Hendrickx et al., 2007; Laube et al., 2008). If applied to time series of spatial data, these indicators can be used as tools to describe impacts of land-use change on biodiversity (Billeter et al., 2008; Levin and Brandt, 2006; Levin et al., 2008).

Studies show that set-aside land benefits biodiversity in farmed landscapes (Berger et al., 2006; Boutin, 2002; Christal et al., 1997; Crabb et al., 1998; Herkert, 2009; Institute for European Environmental Policy, 2008; Kleijn and Báldi, 2005; Macdonald et al., 2007; Stadler et al., 2007; Van Buskirk and Willi, 2004). Due to its extensive management, set-aside land provides shelter, feeding and nursery functions for flora and wildlife. If located adjacent or close to existing habitat patches, set-aside land can increase patch sizes and connectivity between existing habitat patches.

In order to limit crop production, in the early 1990s the EU introduced a mandatory requirement for farmers to set-aside agricultural land. As a consequence, in the last decade, approx. 6% of all agricultural land has been set-aside EU-wide. At the beginning of 2008 set-aside schemes were suspended as a response to rising prices for agricultural products. In EU 27 about 20%

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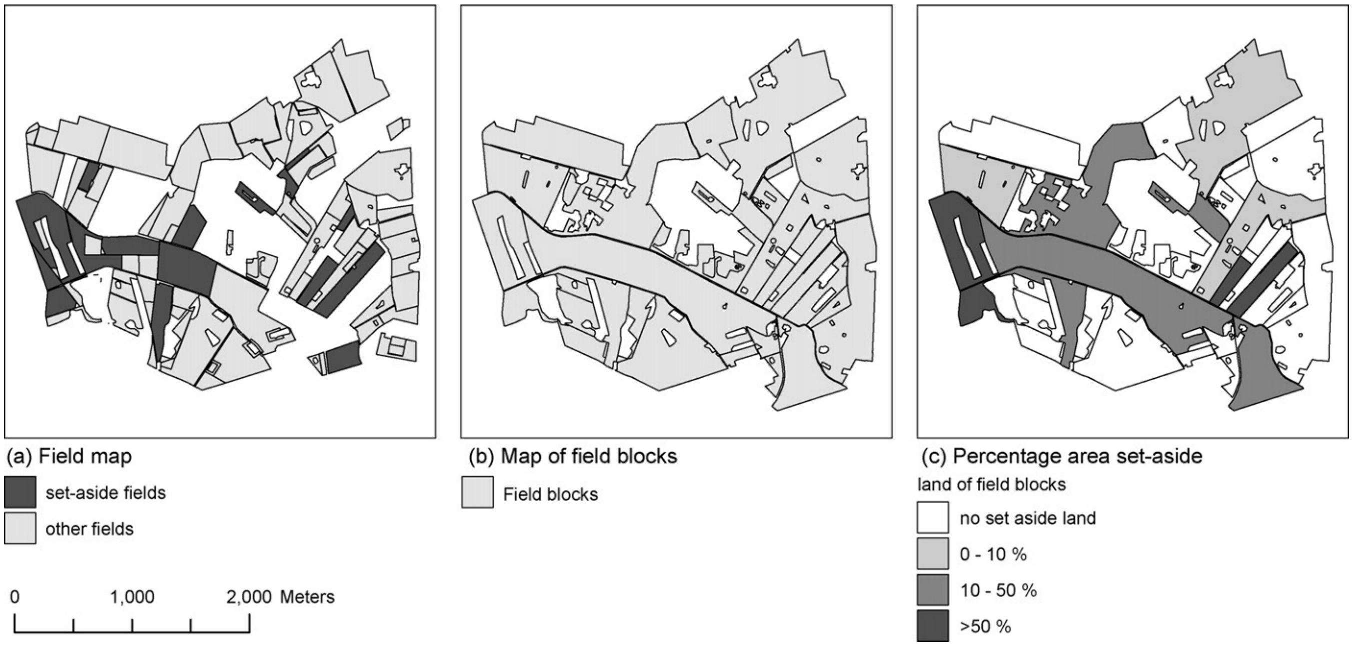

Fig. 1. Assessing percentage area set-aside land. (a) Agricultural registers contain information on land use (set-aside fields coloured in dark grey). Each agricultural field has a reference to a field block (b). (c) Calculated percentage area of set-aside land within each field block.
Source: Ministry of Food, Agriculture and Fisheries (2007).

of all set-aside land was taken into cultivation as an immediate response to the suspension (Eurostat, 2009). In Denmark the share of set-aside land of all agricultural land declared in EU subsidy schemes was more than halved from app. 6% in 2007 to 3% in 2008 (Kristensen and Pedersen, 2009). In spite of considerable attention focused towards the potential negative environmental impacts involved (Danish Society for Nature Conservation, 2007; Faculty of Agricultural Sciences, 2007a,b; Hansen, 2008; Institute for European Environmental Policy, 2008; Pagh Bertelsen et al., 2008), re-cultivation of set-aside land was not regulated.

Several studies focus on the modelling of agricultural land-use dynamics with the aim to assess consequences and options for biodiversity and other environmental functions (e.g. Freyer et al., 2010; Holzkämper et al., 2006; Münier et al., 2004; Topping et al., 2003; Uthes et al., 2009; Verburg et al., 2009). However, a principal problem posed when modelling agricultural land use to maintain and manage biodiversity is that habitat extent rarely matches the extent of individual farms (Franks and Mc Gloin, 2007; Gottfried et al., 1996). Habitat patches often cross the boundaries of individual farm units, and it is generally underlined that instead of management at the level of individual farms; cross-farm and cross-boundary cooperation is required (Drechsler and Wätzold, 2009; Firbank, 2005; Franks and Mc Gloin, 2007; Lant et al., 2005; Rickenbach and Reed, 2002; Tscharntke et al., 2005). Few attempts to develop tools which facilitate cross-farm cooperation exist. Parkhurst et al. (2002), Parkhurst and Shogren (2007) introduce the concept of the agglomeration bonus, which is paid to a landowner if he allocates uncultivated land adjacent to uncultivated land belonging to a neighbour. Furthermore, Goldman et al. (2007) show how three different ecosystem services (pollination, hydrologic services and carbon sequestration) can be enhanced through coordinated management across-farm boundaries. However, central to both attempts is that they have been developed based on stylized landscapes.

The central aims of this paper are: first, to develop a spatial indicator, which enables an estimation of how set-aside land impacts the spatial structure of semi-natural habitats. Second, to model cross-farm regulation of set-aside land at different spatial scales in order to explore potential effects on the spatial structure of habitats. We combine observed land-use changes, i.e. the abolition of set-aside schemes in 2008, with a hypothetical situation, i.e. a spatial regulation of the re-cultivation of set-aside land. In Section 2 we outline the datasets used and the methodology applied. In Section 3 we present the outcomes of our analyses, which in turn are further examined in Section 4.

2. Methods

2.1. Data

2.1.1. Agricultural registers

The agricultural information presented in this study is derived from agricultural registers (Ministry of Food, Agriculture and Fisheries, 2007, 2008), maintained in compliance with the European Commission's 1992 reforms (Commission of the European Communities, 1992a,b) and requirement to set up an Integrated Administration and Control Systems (IACS) database. Data on land-use type is reported annually with reference to the specific field unit for which agricultural subsidy applications are made and also contains unique spatial references to larger units (field block) within which the field is located and to the farmer who manages the field. Field blocks are spatial aggregations of a maximum of 10 fields and have well-defined physical borders. The agricultural register contains a total of approx. 700,000 agricultural fields, constituting approx. 95% of all agricultural land in Denmark (Levin, 2007; Nyholm Poulsen et al., 2002). In 2007 and 2008 the registers contained 248 land-use classes. For this study, we use two land-use classes: ordinary set-aside land and set-aside land in marginal zones, for which subsidies were suspended in 2008. Land with 20-year set-aside contracts as well as set-aside land directed to environmental schemes is not included. Furthermore, set-aside land, which is located within semi-natural habitats, is excluded. Fig. 1 illustrates an example of how we calculate percentage area of set-aside land within field blocks.