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Trade-offs of European agricultural abandonment

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ABSTRACT

Agricultural land abandonment is a policy challenge, especially for areas with unfavorable conditions for agriculture and remote and mountainous areas. Agricultural abandonment is an important land use process in many world regions and one of the dominant land use change processes in Europe. Previous studies have shown that abandonment can have both positive and negative effects on several environmental processes, influenced by location and scale. Preferred policies and management of these areas are debated given concerns for the loss of (traditional) agricultural landscapes and potential impacts on biodiversity and ecosystem services. We present a European-scale impact assessment of the possible effects of agricultural abandonment, based on eight indicators that are on the forefront of the agricultural abandonment debate. Using a multi-scale modelling approach, we expect between 71.277 and 211.814 km^2 of agricultural abandonment in 2040. Impacts on the indicators and trade-offs between the impacts are spatially variable. A typology of typical trade-off bundles at a 1 km^2 resolution resulted in four typical trade-off clusters. All clusters identified are characterized by a loss of agriculture-related values, such as agro-biodiversity and cultural heritage. For two clusters, this was accompanied by positive effects on indicators such as carbon sequestration, nature recreation and mammal habitat suitability. Overall, our results indicate that location and scale are key to assess the trade-offs originating from agricultural abandonment in Europe. Identification of typical trade-offs bundles can help to distinguish potential desirable outcomes of agricultural abandonment and assist in targeting measures to areas that face similar management challenges.

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1. Introduction

While competition for farmland is globally on the rise, simultaneously the process of agricultural abandonment has shown an increased trend since the 1950s (Cramer et al., 2008). Agricultural abandonment is an important land use process in many world regions and one of the dominant land use change processes in Europe (Grau and Aide 2008; Prishchepov et al., 2012; Keenleyside and Tucker 2010). The process of agricultural abandonment is a complex and multi-dimensional process (Munroe et al., 2013), which often can be described as a situation were "[the] human control over land (e.g. agriculture, forestry) is given up and the land is left to nature" (FAO, 2006a). While the process of agricultural abandonment seems contrasting to the required increase in agricultural production, it is often closely related to intensified land uses in more suitable areas and results from different physical, environmental, social and economic factors in an increasingly globalized agricultural economy (Rey Benayas et al. 2007; Verburg et al. 2013a,b). Agricultural abandonment in marginal areas can be viewed as an example of land sparing, as agricultural activities are concentrated through intensification elsewhere or displaced to other world regions, driven by economic or other factors, while marginal areas are abandoned (Wentworth 2012).

Measurement and study of abandonment areas is complicated due to different definitions, lack of consistent measurement across the EU and the difficultly of detecting agricultural abandonment by remote sensing data (Keenleyside and Tucker 2010; Verburg and Overmars 2009). While the current extent of abandonment is unknown (Pointereau et al., 2008), European agricultural statistics and land cover maps show a clear decrease of agricultural areas in the past decades, especially for extensive and small-scale agricultural systems (Pinto Correia 1993; Renwick et al., 2013; Fuchs et al.,

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2015), and modeling studies predict significant levels of agricultural abandonment in Europe over the next 20–30 years (Renwick et al., 2013; Verburg and Overmars, 2009).

Recent studies on agricultural abandonment in Europe showed that agricultural abandonment primarily occurs in less productive areas, remote and mountainous regions and areas with soil erosion or unfavorable climatic conditions for agriculture (Rey Benayas et al., 2007; Keenleyside and Tucker, 2010). Secondary drivers of agricultural abandonment include rural depopulation and regional specific factors regarding land ownership and tax regimes (Rey Benayas et al., 2007; Keenleyside and Tucker 2010; MacDonald et al., 2000). While both primary and secondary drivers refer to inadequate agricultural incomes and abandonment of marginal areas, it should be noted that there are different trajectories of agricultural abandonment, including abandonment of non-marginal areas. An example is the abandonment of agricultural land around cities related to urban sprawl, that is often driven by increasing land prices and fragmentation of farms (e.g. Grădinaru et al., 2015; Paül and Tonts 2005).

An important regional event which triggered agricultural abandonment was the collapse of the Soviet Union in the 1980′s, leading to widespread agricultural abandonment in Eastern Europe due to poorly established property rights and problems with land ownership (Kuemmerle et al., 2008; Hartvigsen, 2014). Agricultural policies also play an important role, as abandonment often occurs in areas where the land productivity does not provide an adequate income for farmers. Even with the support of subsidies such as the Less Favored Areas (LFA) support and agri-environmental payments, which are part of the rural development pillar of the Common Agricultural Policy (CAP), agriculture in these areas is often not competitive. Proposed plans to reduce support for agriculture and to decouple support from production within the CAP were therefore highly debated within the EU, as member states feared that this could lead to several risks, including the abandonment of production (Renwick et al., 2013).

Abandonment of agriculture can have positive and negative outcomes, although these consequences differ per location and scale (Rey Benayas et al., 2007; Munroe et al., 2013). Currently, no scientific consensus regarding the most favorable management of abandoned land exists in Europe (Agnoletti 2014; Schnitzler 2014). In literature often the loss of agro-biodiversity and species richness in landscapes with long histories of management is cited (Rey Benayas et al., 2007; Agnoletti 2014). This often relates to species-rich habitats such as low intensity croplands or mosaic areas and meadows (see for example Laiolo et al., 2004; Dauber et al., 2006; Baur et al., 2006). This reduction of land use mosaics and consequently of landscape heterogeneity is also associated with fire risk, especially in the Mediterranean region (Höchtl et al., 2005; Viedma et al., 2006; Moreira et al., 2001). The loss of mosaic landscapes and traditional cultural landscapes has also an important societal consequence, as these areas are associated with historical values, cultural heritage (‘sense of place’), aesthetic values and often attract tourism (Navarro and Pereira 2012; Antrop, 2005; Plieninger et al., 2006). The case of erosion is an example of the diverse and location specific impacts of agricultural abandonment, which can have both negative and positive impacts depending on the local circumstances. Local increase of soil erosion (e.g. by break down of conservation structures; Lesschen et al., 2008) and the possible reduction of water stocks at the watershed scale (Andréassian, 2004; Robinson et al., 2003) are mainly reported in dry regions (Rey Benayas et al., 2007).

Positive outcomes associated with agricultural abandonment are related to the effect of revegetation and succession. Often mentioned is the general increase in vegetation density and biomass, although the speed is highly variable between different environments (Rey Benayas et al., 2007). Revegetation generally increases carbon sequestration, by means of woody biomass increase and a net soil organic carbon (SOC) gain on former arable land (Schulp et al., 2008). On former SOC-rich grasslands, the net SOC can be negative or remains equal (Bárcena et al., 2014). Other biophysical benefits from revegetation include increased hydrological regulation and erosion reduction (overview in Rey Benayas et al., 2007; Munroe et al., 2013). Biodiversity is also related to the increase in woody vegetation, but its role is dependent on the local habitat, as abandonment can both increase or decrease local habitat diversity (Hall et al., 2012; Queiroz et al., 2014). In general, species adapted to open spaces will disappear, while species related to shrub, forest and soil fauna are favored (e.g. Kardol et al., 2005; Sirami et al., 2008). In case of species-rich woody vegetation, this will lead to an increase in biodiversity (Rey Benayas et al., 2007), although intermediate stages of natural succession are vulnerable to invasive species (Stoate et al., 2009). Further succession stages with establishment of strong native species could, however, lead to a decrease in invasion level compared to the previous landscape (Chytrý et al., 2012). Within conservation literature, especially in Europe, agricultural abandonment is mentioned as a potential source for the development of large-scale natural areas, sometimes with the possible development of wilderness areas (Navarro and Pereira 2012; Ceauşu et al., 2015; Keenleyside and Tucker 2010; Bowen et al., 2007; Herzog and Schüepp, 2013). The idea that unproductive and abandoned land can serve as new wilderness areas (“rewilding”), i.e. self-sustaining ecosystems close to the “natural state” often supported by (re-)introduction of large herbivores and habitat protection for carnivores and other species (Navarro and Pereira 2012; Brown et al., 2011), is expressed often and is backed by different conservationist groups (e.g the “Rewilding Europe” initiative). While rewilded areas can provide new forms of recreation and tourism (e.g. hunting, bird watching; Kaczensky et al., 2004), the concept of wilderness (Lupp et al., 2011) and rewilding is often criticized by the public, especially by local populations that might be adversely affected. Wilderness is still often associated with being a hostile and dangerous environment and linked to the loss of economic stability within a region (Enserink and Vogel 2006; Bauer et al., 2009; Wilson, 2004).

Different case studies of agricultural abandonment have shown that the process of agricultural abandonment is not a linear process, but that it includes different transitional stages (e.g. Meyfroidt and Lambin 2008). Most importantly, local and temporal differences can lead to different trajectories and long-term outcomes (Munroe et al., 2013; Verburg et al., 2010). These different trajectories combined with the spatial heterogeneity of environmental conditions in many regions lead to the assumption that the different positive and negative outcomes related to environmental consequences of agricultural abandonment differ per location and scale (Ramankutty and Rhemtulla, 2012; Chazdon, 2008). While this is discussed in several studies (MacDonald et al., 2000; Navarro and Pereira 2012; Höchtl et al., 2005), the role of the spatial context related to abandonment trade-offs is often ignored. No larger-scale overview of the possible effects of agricultural abandonment with a spatial component is published to this date.

The objective of this paper is to characterize the spatial diversity in trade-offs of potential agricultural abandonment for the European Union (EU-27) in the next decades at a high spatial resolution. The analysis of the trade-offs is based on the areas identified to be at risk for agricultural abandonment under different scenarios of land use change for the period of 2000–2040. Here, we specifically focus on agricultural areas that are either abandoned of have already undergone further succession towards semi-natural area or forest in 2040. Trade-offs as a result of agricultural abandonment are assessed for eight indicators, selected based on the current scientific discussion on abandonment impacts. A typology of typical trade-off bundles is developed, to give insight on how these impacts

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