Agriculture, Ecosystems and Environment 253 (2018) 113–121

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Research Paper

Assessment of site-specific drivers of farmland abandonment in mosaic-type landscapes: A case study in Vidzeme, Latvia

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ARTICLE INFO

Keywords:
Farmland abandonment
Site scale
Land use change
Autologistic binary regression
Agro-ecological factors
Geographic location factors

ABSTRACT

Farmland abandonment, which causes changes in rural life and farming practices, can be observed throughout Europe. Over the last decades natural afforestation has decreased the area of farmland used for agricultural production, thereby leading to landscape homogenization and polarization. This process is explicitly evident in mosaic type landscapes consisting of highly complex land cover patterns, soil composition and topography. The aim of the study was to determine the site-specific driving forces of farmland abandonment at landscape scale in relation to agro-ecological and geographic factors, in a post-Soviet country in Eastern Europe. An extensive field survey approach with statistical analysis was developed to model landscape change in a case study area in the western part of Vidzeme Uplands, Latvia. The results showed that land quality, proximity to forest edge and distance from farm were strong determinants of farmland abandonment in the mosaic type landscapes and that these parameters can be used to determine probability of occurrence of farmland abandonment. Land quality, a composite indicator, was a robust factor associated with farmland abandonment, in contrast to specific factors like soil texture. The developed model can be employed to assess risk of farmland abandonment in mosaic type landscapes, thus providing valuable information and application as a tool for agricultural policy makers and rural planners.

1. Introduction

Farmland abandonment is a complex process with interlinked economic, environmental and social aspects and is often associated with social and economic problems in rural areas (Terres et al., 2015). It can be defined as the cessation of agricultural activities on a given surface of land (Pointereau et al., 2008), including a change towards less intensive type of land use (Baudry, 1991) and thus elimination or polarization of landscape mosaics and promotion of vegetation homogeneity (Benayas et al., 2007). Farmland abandonment has multiple consequences on ecosystem services, biodiversity and economies (Prishchepov et al., 2013). To understand, manage or prevent farmland abandonment, it is necessary to assess the driving forces (Bürgi et al., 2005).

The concept of driving forces or drivers of landscape change has been evolving over the past two decades and has attained an indispensable position in landscape studies. European scale studies have shown that farmland abandonment occurs in unfavorable agro-ecological conditions, such as steep slopes, high elevations, non-fertile soils and geographically remote locations (MacDonald et al., 2000) and is driven by agricultural marginalization and rural depopulation (Jepsen et al., 2015; Strijker, 2005). However, land abandonment is not always limited to marginal areas (Hatna and Bakker, 2011). National scale studies have shown that distance to settlements as well a lack of finances and farmer motivation (Kristensen et al., 2004; Lieskovský et al., 2015; Müller et al., 2013), rural depopulation (Bell et al., 2009), unfavorable agricultural conditions (Vu et al., 2014) and former land use type (Gellrich et al., 2007) are determinants of farmland abandonment. Regional studies have reported that subsidies and land quality (Alix-Garcia et al., 2012; Vanwambeke et al., 2012), accessibility (Eiter and Potthoff, 2016; Müller et al., 2009), poor soils (Sluiter and de Jong, 2007)as well as isolation and distance to rural centers (Prishchepov et al., 2013) and opening the EU market for former socialist countries (Stoate et al., 2009) are key drivers of farmland abandonment. The few studies conducted at the landscape level have reported that bio-physical variables and farmers' socio-economic position play important roles in rural land use change, including farmland abandonment (Van Doorn and Bakker, 2007). A comprehensive review of farmland abandonment in Europe identified recurrent drivers (Terres et al., 2015, 2013), but was not able to present results for assessing agro-ecological factors that

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https://doi.org/10.1016/j.agee.2017.10.016
Received 16 March 2017; Received in revised form 16 October 2017; Accepted 20 October 2017

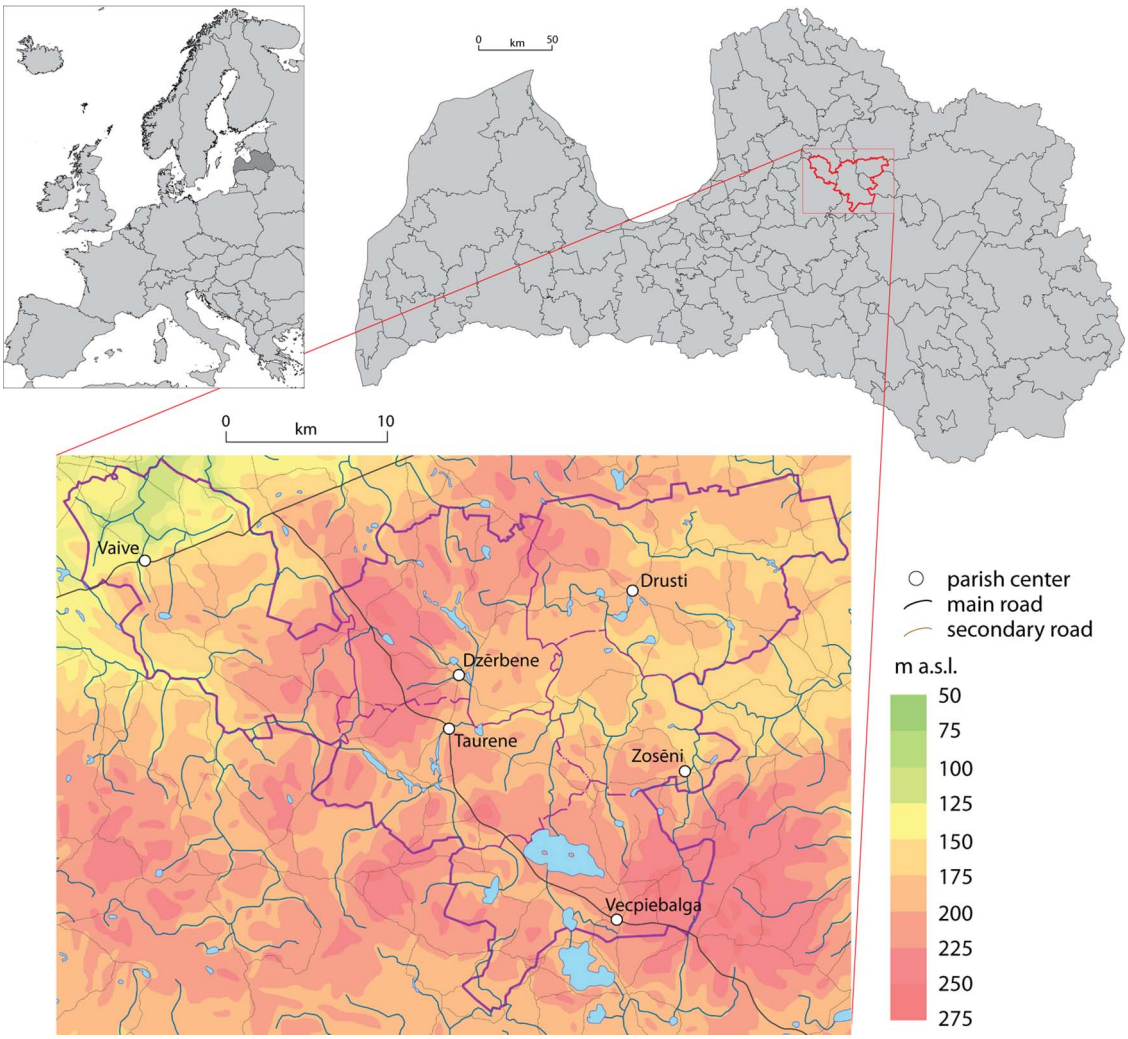

Fig. 1. Study area.

can act as restrainers or catalysts of farmland abandonment, likely due to the large spatial scale employed. Studies at the landscape level in post-Soviet landscapes have been few (Lieskovský et al., 2015; Nikodemus et al., 2005; Vinogradovs et al., 2016; Zarina, 2010) and often have been methodologically complicated due to the complex ownership pattern, land use patterns inherited from the Soviet period and scarcity of precise land use data. In many post-Soviet European countries, after the collapse of the Soviet system, restitution or privatization of farmland resulted in a high number of small farms as well as great fragmentation of estates (Platonova et al., 2007). Thus, cadastral parcel size and previous land use patch size might be variables associated with farmland abandonment.

Terres et al. (2015) indicated that the main constraint to studying farmland abandonment at the landscape level was lack of data on farmland abandonment. The aim of the present study was to develop a model to assess site-specific drivers of farmland abandonment in mosaic-type landscape (matrix of forest land interspersed with patch elements of arable lands, grasslands, lakes, wetlands, etc.) in a post-Soviet country. We used extensive field survey and collection of data on spatially explicit site-specific factors related to agro-ecological conditions, and geographic location and cadastral parcel size and previous land use patch size. We use two autologistic binary regression (ABR) models to assess effect of each spatial determinant separately and in relation with others to determine main drivers of farmland abandonment. In the analysis of farmland abandonment, we also studied determinants of the so-called semi-abandonment, where management of farmland was performed in a non-productive manner (Zariņa et al., 2017) to receive single area payments (SAP). The study was conducted both for a large area (713.7 km^2) and its subdivision into six smaller territorial units, to determine robustness of the model and explanatory factors.

2. Materials and methods

2.1. Study area

The study area (Fig. 1) is located in the western part of Vidzeme Uplands. The study area has a comparatively temperate and rainy climate with an average temperature of 16.5 °C during the warmest month and −6 °C during the coldest month. Annual precipitation is 750–850 mm, of which about 500 mm falls in the summer (Krauklis, 2000). The area is located in the Hemiboreal forest zone, where woodlands are dominated by coniferous tree species (*Pinus sylvestris* and *Picea abies*) mixed with deciduous tree species like *Betula pendula, Populus tremula, Alnus glutinosa* and *Alnus incana*, and to a lesser extent with *Quercus robur* and *Fraxinus excelsior* (Hytteborn et al., 2005). There is a large variety of soil groups (Arenosols, Podzols, Cambisols, Retisols, Luvisols, Stagnosols and Gleysols) that have developed on glacial till, glaciofluvial and glaciolacustrine deposits (loamy sand, sandy clay, loam, clay, gravel, sand) and Histosols on peat deposits (Kasparinskis and Nikodemus, 2012). The landscape of the study area consists of diverse mosaic-type elements; the dominant features are mixed forests, agricultural lands, shrub-lands (including abandoned farmland), water