



LAND TENURE AS A FACTOR UNDERLYING AGRICULTURAL LANDSCAPE CHANGES IN EUROPE: A REVIEW*

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Land tenure is generally considered to be an important factor affecting farming, landscape, and rural development. This paper reviews selected case studies to identify how land tenure influences agricultural landscape changes in Europe. We identified how land tenure information was transformed into variables, grouping these variables into general thematic categories: (1) land rights variables based on references to the type of stakeholders and duration of land occupancy, (2) land structure variables describing general land structure, and (3) behavioural variables dependent on stakeholders' attitudes, perceptions, and personal values. Each thematic category can be defined on three spatial levels: parcel or production block, stakeholder, and landscape. The results show that the tenure factor is not frequently included into landscape-change studies. When a land tenure factor was part of a given study, it either played a minor role among other drivers of landscape change or, if it influenced significant landscape changes, it had only locally specific effects. Moreover, there were studies with contradictory results and so it is difficult to generalize specific findings. Nevertheless, land tenure is frequently discussed within landscape-change research in relation to land abandonment as well as green services and their connection with the European Union's Common Agricultural Policy.

property rights; landowner; landscape pattern; fragmentation; homogenization; land tenure security



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INTRODUCTION

Since the 1950s, land tenure has been a crucial topic for the Food and Agriculture Organization (FAO) of the United Nations which in this respect focuses on various aspects of improving rural development and increasing land tenure security. 'Land tenure is the relationship ... among people, as individuals or groups, with respect to land. ... Rules of tenure define how property rights to land are to be allocated within societies. In simple terms, land tenure systems determine who can use what natural resources for how long, and under what conditions' (FAO, 2002). Frequently complicated land tenure issues are usually discussed in association with the issues of food security, poverty alleviation, or rural development. From this perspective, it might seem that only countries in the Global South, areas with violent conflicts, and countries with rapidly growing populations are endangered, as most scientific studies concerning land tenure security are carried out in such areas as Africa (Simbizi et

al., 2014), Asia (Wannasai, Shrestha, 2008), Central America (Assies, 2009), and South America (de Souza, 2001). This is a deceptive impression, however, inasmuch as land tenure security issues concern also European countries.

Within Europe, this could be incorrectly perceived to be a peripheral topic as the matter could be considered resolved as part of completed land reforms (Sikor et al., 2009) and sufficiently controlled by market and political mechanisms (Forbord et al., 2014). Even in Europe, however, land tenure issues are still an important topic, and particularly in connection with the effort to improve the agricultural sector and support increased quality of life in the countryside while providing better protection of natural resources and the landscape as a whole (FAO, 2003). It is necessary to bear in mind that even though agriculture is no longer the main source of economic output in Europe (averaging 1.9% of GDP during 1995–2009 in the EU28), rural land still remains the most dominant land use type in Europe, with more than 77%

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of the EU being classified as rural (47% as farmland and 30% as forest) (European Commission, 2015). Even though some studies have demonstrated that land tenure rights and security are among the factors influencing landscape structure (Sklenicka, Salek, 2008; Sklenicka et al., 2014), as well as the method and intensity of its use (Kuemmerle et al., 2008), the question remains as to how these results can be generalized to study changes in the agricultural landscape.

In recent decades, the European agricultural landscape has been rapidly changing due to the competing processes of homogenization and fragmentation (Jonngan, 2002). The causes of this landscape polarization, although obvious on a different spatial scale, are primarily not solely natural processes but mainly human activities (Anrop, 1998). These changes are most frequently caused by farming intensification or extensification (Feranec et al., 2010; Van Vliet et al., 2015) due to differences in traditional agricultural practices and environmental factors (e.g. topography, soil, climate) (Primdahl, 1999). As a key actor in the agricultural landscape, the farmer and his or her decisions affect not only productive rural areas but all landscape types (Stoate et al., 2009; Primdahl et al., 2013). This, in turn, has great implications for biodiversity, cultural heritage, recreation, and other functions (Primdahl et al., 2013). Management method is closely tied to land tenure rights and tenure security and so we regard it as important to focus on studies examining land tenure and its influence on agricultural landscape changes.

This review is focused on land tenure as an underlying driver of ongoing agricultural landscape changes in Europe. The first part of the study deals in a wider context with the topic of land property rights in Europe followed by an explanation of landscape polarization in agricultural land patterns. The second part of the study analyzes case studies that report on land tenure in relation to agricultural land changes in Europe. We analyze selected studies identified in the systematic review published by Van Vliet et al. (2015) on the topic of the manifestations and underlying drivers of agricultural land changes in Europe, in order to answer the following main research questions: How is the land tenure factor transformed into empirically measurable variables in connection with landscape changes? Is it possible based on the case studies' results to determine whether a given type of land tenure relationship drives landscape change in any specific direction? If we identify this direction, what is the relationship between land tenure and landscape changes?

Land tenure rights – who has control over agricultural land in Europe?

Land tenure comprises a comprehensive network of interwoven relationships among all stakeholders

in the study area. Given that the property owner does solely possess rights to land, but so do other interested parties (e.g., tenants, local people, institutions) whose interests may overlap, complement one another, or even compete, the concept of “a bundle of rights” is discussed. A single parcel can be bound by various rights, such as the right to sell, lease, or use that parcel or simply a right to pass through the landscape. Such rights can be established formally or informally and shared among individual users or groups of users (FAO, 2002). Agricultural land tenure varies among and even within countries, but generally it is categorized as private, communal, open access, or state (FAO, 2002). To acquire relevant information about land tenure rights as constituting an important key to understanding and explaining landscape changes in rural regions (Primdahl, 1999), we need to know details about all of the stakeholders connected with agricultural land.

In Europe, most owners have the right to decide about the use of a specific parcel – whether they use it themselves or leave their land fallow, whether they sell the parcel or grant the right to farm to third parties based on a lease contract or oral agreement. In the latter case, they become absentee landowners who for various reasons do not themselves farm but still retain ownership of the lands (Plieninger, 2006; Petrzalka et al., 2013). The reasons for such landowner behaviour include an inefficient land market, due to which one might wait for a more advantageous time in order to sell (Bańskí, 2011; Sklenicka et al., 2013). This situation occurs especially in countries within Central and Eastern Europe, where leasing of land frequently is the sole possibility for existing farmers to expand the land they farm (Bańskí, 2011) as well as for new entrants to come into the agricultural sector if they do not have sufficient capital to purchase new land or if no land is available for purchase. Leasing is predominant, too, because in comparison to purchasing it is a relatively rapid method of consolidating farmland (Amblard, Colin, 2009; Dramstad, Sang, 2010). For this reason, there are increasing numbers of land tenants – stakeholders, who cultivate land that they do not own (Primdahl, 1999). Therefore, knowledge about the type of stakeholders who have controlling rights to agricultural land (Van Doorn, Bakker 2007; Petrzalka, Marquart-Pyatt, 2011) and about their decision-making behaviour (Primdahl, 1999) is very important if we wish to determine how significantly they influence the shape of landscape.

How can land tenure influence the agricultural landscape structure?

Landscape polarization in the agricultural spatial pattern, such as landscape fragmentation and homogenization, is often caused by farming practices and specific

interrelations among different groups of stakeholders and their rights. As the term land fragmentation is often used in different contexts, it may have various meanings and multiple dimensions. Consequently, there has never been a single commonly accepted definition (Hartvigsen, 2014). In this review, we specifically focus on farmland fragmentation, which began drawing attention of policymakers and researchers already after World War II (Binns, 1950) because of its assumed negative consequences for agriculture. Although there was intense multidisciplinary debate mainly in the early 1980s on the question of whether or not farmland fragmentation is a problem (King, Burton, 1982, 1983; Bentley, 1987), this still continues until the present day (Van Dijk, 2003; Demetriou, 2014; Hartvigsen, 2014; Sklenicka et al., 2014). Comprehensive reviews of the benefits and disadvantages of land fragmentation, particularly from the perspective of agriculture, have been published by such authors as Bentley (1987), Van Dijk (2003), and recently Demetriou (2014). The study of Van Dijk (2003) constitutes one of the best attempts to describe land fragmentation in a comprehensive way, especially from the perspective of land tenure rights.

Van Dijk (2003) distinguishes four types of land fragmentation: (1) fragmentation of land ownership, (2) fragmentation of land use, (3) separation of ownership and land use, and (4) internal fragmentation. Ownership fragmentation is understood to be a degree of spatial division in the ownership pattern that leads to reducing larger ownership parcels to smaller ones together with an increase in the numbers of owners and of parcels (Sklenicka, Salek, 2008). In the case of agricultural land, land use fragmentation depends on the spatial arrangement of units managed as separate production blocks. Although land use pattern is to a certain extent associated with the distribution of land ownership parcels, there can be a considerable difference between these two layers that leads to the separation of ownership and land use. This can be seen in a situation where parcels belonging to several owners are rented and managed by an individual user as a unified production unit due to the fact that the parcels are not individually viable for use by their owners (Sklenicka et al., 2014). Finally, internal fragmentation refers to a situation within a farm whereby a single farming operation manages numerous spatially separated parcels (Van Dijk, 2003).

Land fragmentation types vary across European countries. While West European countries are concerned in particular about land use and internal fragmentation (Demetriou, 2014), Central European countries mainly suffer from another fragmentation types – ownership fragmentation and the separation of ownership from land use (Van Dijk, 2003; Sklenicka et al., 2014). The latter fragmentation type frequently

leads to landscape homogenization as small ownership parcels unsuitable for efficient farming by the owners themselves are frequently leased to larger entities that through leasing combine the parcels into large production blocks. This process has been termed the ‘Farmland Rental Paradox’ (Sklenicka et al., 2014). Because it is connected to many negative effects, including social and economic impacts (change in rural character, growth of large agricultural companies at the expense of small and medium farms) and environmental impacts (diversity losses at the ecosystem level, increased erosion risk, decreased aesthetic value of the landscape), it is even considered a new form and cause of land degradation. It is therefore essential to evaluate agricultural landscape changes in connection with land tenure in a comprehensive way.

METHODS

Case study evidence

The analytical part of this study is focused on the role of land tenure in agricultural landscape changes within relevant case studies in Europe. Case selection was based on a review published by Van Vliet et al. (2015) on the topic of the manifestations and underlying drivers of agricultural landscape changes in Europe. The review by Van Vliet et al. (2015) was designed and reported according to the PRISMA statement which is an evidence-based minimum set of items for reporting in systematic review and meta-analyses. The review includes a supplementary material with a detailed case study evidence which enabled us to identify the case studies using the land tenure factor. Its authors gathered and concisely documented 137 case studies. We made these studies the starting point for our analysis, because their focus meets the general requirements we had established for the present study: the studies are located in Europe, focused on agricultural landscape changes after 1945, written in English, and reported in peer-reviewed publications selected through a systematic search on Web of Science. Out of the 137 cases documented by Van Vliet et al. (2015), we selected only 24 studies that put into context landscape changes and land tenure as an underlying factor. Only these studies included land tenure factor as a measurable variable in analysis or discussion. Where selected studies were prepared so as to compare landscape development in separate study areas (Fjellstad, Dramstad, 1999) or different countries (Kuemmerle et al., 2008), they were, similarly as in the original aggregate study by Van Vliet et al. (2015), maintained as independent cases with the same identification codes and therefore we analyzed 27 case studies in total.

Selected characteristics of the case studies

First, we described the case studies according to their general characteristics, such as the size and location of the study area, temporal scale of analysis, underlying driving forces, and data used for analysis. The selected case studies were unevenly distributed across Europe. They are set in 17 countries. Study areas ranged from 3 to 8900 km², with a median of 252 km² (Fig. 1).

The temporal scale of analysis is based on the total period length and the number of time steps for which changes were analyzed. If they examined landscape changes between two different time points, it means only one time step. The total time periods studied ranged from 3 to 155 years with a median of 35 years. The temporal scale of all cases is presented in Fig. 2. Although the case studies focused specifically on landscape changes after 1945, in 3 studies (Bender et al., 2005; Schneeberger et al., 2007; Parcerisas et al., 2012) the studied period started prior to this year and the longest time horizon was 150 years (1850–2000). Although most studies (19 cases out of 27) observed changes only in one time step (between the start and end year), there were several studies (8 cases) considering rates of change for more than two time steps (with a maximum of 11 time steps).

The driving forces underlying landscape changes were categorized using the classification of Van Vliet et al. (2015). These authors distinguished

among categories of demographic drivers, economic drivers, technological drivers, institutional drivers, sociocultural drivers, and location factors. The studies used combinations of various driving factors, most frequently institutional and location factors, as shown in Table 1.

We then added an additional category to describe land tenure data sources in subcategories, such as land registers, topographic maps, statistical census data, direct surveys, and historical documents. In the reviewed case studies, the authors frequently (in 19 out of 27 cases) supported the landscape-change analysis using data acquired by direct surveys that included fieldwork, participatory methods, and especially interviews and questionnaires among farmers and other participants. Therefore a separate category for the type of direct survey (interviews, questionnaires, not specified) and the type of survey informants was included into our case study evidence. In most cases (11 of 19 cases) farmers participated in the surveys, but in several studies (8 cases) also local non-farming residents or nonresidents were included in the surveys.

We created a classification of specific characteristics of land tenure approach to describe how land tenure factors were implemented in the case studies. Two subcategories were distinguished: informative studies (8 cases) and empirical studies (19 cases). While informative studies only mentioned land tenure as a driver of landscape changes but did not analyze it directly, empirical studies analyzed the impact of land

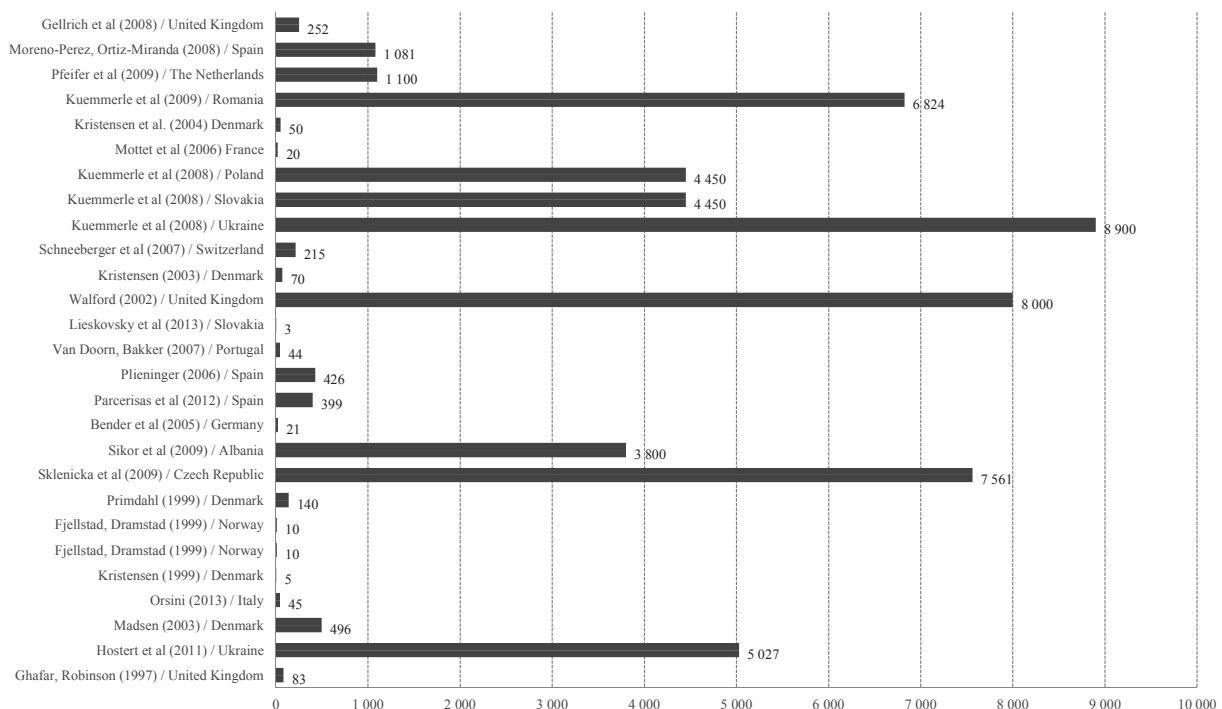


Fig. 1. Spatial scale of case studies based on the total area of study sites (km²)

Table 1. Driving factors used in case studies categorized according to Van Vliet et al. (2015). Percentages indicate the proportion of cases using the given factors

Driving factors	Description	Cases (<i>n</i> = 27) (%)
Demographic	land change is associated with population characteristics	(<i>n</i> = 6) 22%
Economic	land change is associated with such characteristics as globalization of agricultural markets, employment, labour requirements, and market prices	(<i>n</i> = 14) 52%
Technological	land change is associated with such factors as drainage, irrigation, availability of new breeds, and mechanization	(<i>n</i> = 6) 22%
Institutional	land change is associated with such characteristics as land consolidation processes, subsidies, tenure security, land use planning, and political shifts	(<i>n</i> = 22) 81%
Sociocultural	land change is associated with such societal demands as landscape aesthetics and the natural environment	(<i>n</i> = 5) 19%
Location	land change is associated with such factors as topography (slope, elevation), soil and climate characteristics, and accessibility patterns	(<i>n</i> = 18) 67%

tenure using some measurable land tenure variables. For example, land ownership pattern can be transformed into such variables as mean parcel size, proportion of owned land, and proportion of land owned by different types of owners. Even though nearly all of the studies defined their own variables directly corresponding to their research purposes and depending on data availability; these variables display similar characteristics for comparison. For example, variables are often quantified at a given spatial level, such as parcel, farm, or case study areas. Some variables better express the relationships among various stakeholder groups (e.g. owners vs tenants), while others only provide broad information as to agricultural land distribution. These 19 empirical studies were therefore further analyzed so as to determine not only their spatial and thematic levels but also whether specific land tenure can be related to certain landscape changes.

RESULTS

Spatial level and thematic category of land tenure variables

To answer how land tenure was transformed into measurable variables in case studies, we created a classification with variables grouped into three general thematic categories: (1) land rights variables based on references to stakeholder type and duration of land occupancy; (2) land structure variables describing general structure based on the number and size of parcels or production blocks, number of parcels per holding, and so on; and (3) behavioural variables dependent on stakeholders' subjective attitudes, perceptions, and personal values. Within these categories, we identified that the variables could then be defined in the classification on three spatial levels: (1) parcel or production block, where the studied characteristics were defined for individually owned parcels or utilized

production blocks; (2) stakeholder, where the studied characteristics were related to the stakeholder type (i.e., farmer, owner, tenant, agricultural holding, farm); and (3) landscape, where variables were integrated across an entire landscape unit (e.g. a group of farms, municipality, region, state). An example of variables for combination in different thematic categories and on different spatial levels is shown in Table 2.

We identified in reviewed studies that land rights variables comprise the type of stakeholder, land occupancy, its duration, and the way in which this relationship arose. These variables reflect who has the right to the land parcel or production block, how strong is this right, how long it lasts, or how the rights of various stakeholders interweave. The stakeholder typology is frequently based on a classification of basic groups: owners vs tenants and private vs state-owned. A number of studies examined changes in the landscape in relation to stakeholders whose typology is based on ownership type at an institutional scale. The results also show that land structure variables are based on such factors as the size and shape of parcels or production blocks as well as the size, number, and spatial distribution of agricultural holdings. As parcel or production block is the basic spatial unit, these variables serve primarily as the computational basis for tenure variables at other scales. These broad variables express only the general structure of agricultural holdings or farmland but do not provide detailed information on land tenure relationships. They can be obtained from land registers, national agricultural censuses, and other statistical databases (e.g. EUROSTAT). The last identified group were behavioral variables which are based on attitudes, perceptions, and personal values of individual stakeholders. Data can be acquired through sociological research, which is frequently conducted among farmers, landowners, and local residents.

The results of this review show that land tenure variables are not used equally at all spatial and thematic levels. While some variables were used frequently, others were used only rarely, as shown in Table 3.

Table 2. Examples of variables on different thematic categories and spatial levels

Spatial level	Thematic categories		
	land rights variables	land structure variables	behavioral variables
Parcel or production block level	land tenure rights (e.g. owner/ tenant) related to individual parcel or production block duration of land ownership/ lease of individual parcel or production block	size of individual parcel or production block shape of individual parcel or production block	importance of land tenure rights for individual parcels or production blocks
Stakeholder level (owner, tenant, farmer, agricultural holding, etc.)	percentage of owned/rented land for individual stakeholder duration of land ownership/ lease for individual agricultural holdings	number of parcels/ production blocks belonging to individual farmers utilized area belonging to agricultural holdings	importance of land tenure rights for stakeholders
Landscape level (group of farmers, municipality, region, state, etc.)	proportion of publicly/ privately owned land in region percentage of rented land in municipality	minimum/maximum farm size in country, region number of stakeholders in region average holding size in country	importance of interaction with other stakeholders perception of surrounding landscape structure

Role of land tenure as the driver of agricultural landscape changes

We summarized the results of the selected studies to determine whether specific land tenure variables might be related to certain landscape changes, especially landscape polarization. Landscape changes were studied from different disciplinary backgrounds, which influenced the methodology and data sources used in the case studies. Most frequently (23 cases) the studies evaluated changes in landscape spatial pattern in terms of its composition or configuration. Five cases evaluated changes in land management intensity, which included an increase or decrease in land use management (e.g. increase in livestock density, mechanization). Eight cases monitored changes in agricultural land use activity manifested as changes toward more intensive or extensive land use. Five cases dealt with change in farm specialization and diversification, which are directly reflected in land management. Out of 27 cases, 19 applied more than one data set to describe landscape characteristics.

We determined that land tenure as a factor underlying landscape changes was most frequently investigated in relation to land abandonment. Although there were studies with contradictory results, the factors considered as important causes of land abandonment and reforestation included land ownership and land use pattern fragmentation, uncertain land tenure, and land reforms. As we described in the Introduction, land fragmentation needs to be investigated in its all aspects: ownership fragmentation, fragmentation of land use, separation of ownership and land use, and internal fragmentation. However, the reviewed studies

about agricultural landscape changes describe land fragmentation incompletely and the topic is often marginal.

The results of the selected studies further indicate that land tenure is frequently discussed together with green services in agricultural landscapes and their connection with the European Union's Common Agricultural Policy (CAP). Sustainable agriculture provides also environmental values by conserving ecosystems (Van Huylenbroeck et al., 2007) and green services which are non-commodity goods of farming such as landscape stability, biodiversity, and wildlife habitat maintenance (Pfeifer et al., 2009). The CAP should stimulate stakeholders with additional subsidies to adopt green services in the agricultural land they utilize. For this reason, a number of case studies dealt with the questions like which stakeholder groups were active in preserving or renewing stabilizing features in a landscape, what were their reasons for this action, and whether they were doing so or wanting to do so voluntarily or only with financial support.

DISCUSSION

Role of land tenure as the driver of agricultural landscape changes

If we consider land tenure as the driver of agricultural landscape changes, fragmented ownership structure and delays in land consolidation were important determinants of abandonment and reforestation for example in the study by Gellrich et al. (2008) because the land consolidation process took more

Table 3. List of case studies using described variables, sorted by thematic group and spatial level

Spatial level	Thematic group		
	land rights variables	land structure variables	behavioural variables
Parcel or production block	Bender et al., 2005 Mottet et al., 2006	Bender et al., 2005 Sikor et al., 2009	not used
Stakeholder	Kristensen, 2003 Kristensen et al., 2004 Kuemmerle et al., 2008 Madsen, 2003 Moreno-Perez, Ortiz-Miranda, 2008 Mottet et al., 2006 Orsini, 2013 Pfeifer et al., 2009 Plieninger, 2006 Primdahl, 1999 Sikor et al., 2009 Van Doorn, Bakker, 2007 Walford, 2002	Fjellstad, Dramstad, 1999 Kristensen, 2003 Moreno-Perez, Ortiz Miranda, 2008 Mottet et al., 2006 Orsini, 2013 Pfeifer et al., 2009 Plieninger, 2006 Sikor et al., 2009 Van Doorn, Bakker, 2007 Walford, 2002	Pfeifer et al., 2009
Landscape	Madsen, 2003 Parcerisas et al., 2012 Van Doorn, Bakker, 2007	Fjellstad, Dramstad, 1999 Kristensen, 2003 Madsen, 2003 Moreno-Perez, Ortiz-Miranda, 2008 Orsini, 2013 Parcerisas et al., 2012 Plieninger, 2006 Primdahl, 1999 Sikor et al., 2009 Van Doorn, Bakker, 2007	Madsen, 2003; Pfeifer et al., 2009

than 30 years and resulted in tenure uncertainty. Land reforms and tenure insecurity were also among important factors influencing abandonment in the studies by Kuemmerle et al. (2008, 2009). However, Sikor et al. (2009) did not find a relationship indicating that highly fragmented ownership would be a major cause of abandonment. Those authors claimed that the rate of abandonment was the highest in the villages with the lowest fragmentation and highest migration as producers often stopped cultivating some parcels because they found it more attractive to allocate their labour and capital to non-farming activities. In an unstable socioeconomic environment, local residents preferred a strategy of farming on a diverse set of agricultural parcels and used also parcels less suitable for farming. It appears that land abandonment also relates to farm size and farming intensity, as Kristensen et al. (2004) found higher rates of land abandonment on small extensive farms. In addition, landowner type appears to be an important determinant of abandonment and reforestation as each type of landowner decides in a different way about land management (Primdahl, 1999; Van Doorn, Bakker, 2007). The results of the study by Van Doorn, Bakker (2007) indicated that the higher the probability a landowner was 'retired' or 'diversified' (characterized by a variety of activities), the greater was the probability of land abandonment. They also proved that the

'absentee' landowners practice a rather stable way of agriculture. 'Absentee' landowners want from tenants to maintain their arable land without many land use transitions (e.g. afforestation, regeneration of montado).

To examine agricultural landscape changes in a comprehensive way, we need to use appropriate indicators that express all aspects of land fragmentation: ownership fragmentation, land use fragmentation, separation of ownership and use, and internal fragmentation (Van Dijk, 2003). Studies frequently describe land fragmentation only incompletely. For example, area per landowner is the most commonly used fragmentation indicator in Central European studies (Van Dijk, 2003), but ownership distribution alone does not provide a complete picture of fragmentation. As the main problem in Central Europe is separation of ownership and land use (Van Dijk, 2003; Sklenicka et al., 2014), information about not only landowners but also land operators is essential.

The results indicate that land tenure is frequently discussed together with green services (e.g. biodiversity and wildlife habitat maintenance) in agricultural landscapes. It was determined that at a general level land tenure (e.g. the duration of ownership) significantly influenced landscape changes, including creation and removal of such habitats as hedgerows (Kristensen et al., 2004). Although a longer ownership duration is generally considered to mean an increased interest in

preserving landscape structures (Wilson, 1997), the study by Kristensen et al. (2004) determined just the opposite tendency among stakeholders in Denmark, where hedgerow renewal on farmland was performed by younger farmers with shorter ownership durations. The explanation probably relates to the farmers' age, as young farmers are better adjustable to a rapidly changing environment than the old. The same conclusion was reached by Pfeifer et al. (2009), who stated that higher level of education together with larger farm size increases the probability of introducing green services to agricultural land. The CAP's new trends in agricultural subsidies – from production- to land-based subsidies and to more agro-environmentally friendly approaches (Mouysset, 2014) – may encourage many stakeholders to consider the landscape as a 'living place' rather than only a production area (Primdahl, 1999), and this approach influences ongoing landscape changes.

Spatial level and thematic category of land tenure variables

In relation to spatial level and thematic category of land tenure connected with landscape changes, the variables most frequently omitted were behavioural. Behavioural variables express how farmer's decisions have a direct and intentional influence on landscape management, as well as other indirect impacts on the landscape (Primdahl et al., 2013). These were used marginally only at the stakeholder (Pfeifer et al., 2009) and landscape (Madsen, 2003; Pfeifer et al., 2009) levels. This is surprising inasmuch as determining the attitudes of farmers in particular provided an important source of data in most studies. At the stakeholder level on the farm scale, for example, Pfeifer et al. (2009) addressed the role of location in farmers' decision making, which has implications for a landscape change. Among other farm characteristics, the authors used the farm style factor, which includes also 'ownership' as preoccupation with the importance farmers attached to their own land. Another example is seen in the work of Walford (2002), who investigated the responses of large-scale commercial farmers to agri-environmental schemes and the farmers' willingness to participate voluntarily in environmental or conservation programs. However, these surveys mostly did not concern land tenure issues. It seems that the most frequently omitted spatial level was that at the parcel or production block, despite that it can provide the most detailed information on land tenure relationships and their influence on landscape change. Such detailed information is relevant for planning processes and nature conservation in changing cultural landscapes (Gellrich et al., 2008) and it is necessary for examining the spatial characteristics of parcels or production blocks, land tenure's spatial

distribution across the landscape, and land fragmentation (Sklenicka et al., 2014).

On the other hand, the land rights variables were identified at all spatial levels (parcel, stakeholder, landscape). For example, Mottet et al. (2006) referred to development in different types of occupancy and assessed land tenure rights for each parcel as owner-occupancy or tenancy (with a lease contract or oral agreement). Among case studies reviewed, only Mottet et al. (2006) distinguished land occupancy type on the parcel level. Another aspect related to land tenure rights is the duration of land occupancy. This variable can be related to the individual parcel or production block, as was done in such studies as that by Bender et al. (2005), who evaluated the duration of land ownership and its continuity for each parcel. Kristensen (2003) and Kristensen et al. (2004) also examined the variable duration of ownership, but that was in relation to the agricultural holding as a whole. In reality, this variable relates only to the duration of farming on agricultural holdings as it does not distinguish whether the stakeholders farm on land they own or lease.

The typology of stakeholders was studied for example by Moreno-Perez, Ortiz-Miranda (2008) who focused on the proportion of leased or owned land (fully owned, with half ownership, rented), as did Walford (2002), who also classified farms into three groups according to the proportion of land leased or owned by stakeholders: owner-occupied, mixed tenure occupation, and rented. Other studies created more complex stakeholder typologies based on the characteristics of farming individuals and entities as actors in the agricultural landscape. For example, Kristensen (2003) categorized farms into groups with similar characteristics using multivariate analysis based on a range of socioeconomic and production-related parameters. Among other factors, that author took into account the importance of farm income, which was reflected in the owner occupation category (full-time farmers, part-time farmers, hobby farmers, and pensioners). A similar factor occurred in other studies, e.g. by Kristensen et al. (2004) and Primdahl (1999).

A number of studies also examined changes in the landscape in relation to stakeholders whose typology is based on the ownership type at an institutional scale. For example, Kummeler et al. (2006) classified ownership into two classes: state owned and privately owned by individuals or legal entities. That study was carried out in such countries as Poland, Ukraine, and Slovakia, where essential economic and political transitions resulted in changes in land tenure rights. For this reason, Kummeler et al. (2006) examined differences in abandonment of agricultural land during the period when land was managed by state-controlled policy and during the period of traditional market economy. As Pfeifer et al. (2009) stated,

for modelling changes in the agricultural landscape the stakeholder scale was used the most frequently because at this level it is possible to identify not only the factors describing land rights and land structure, but also the factors that can explain farmers' decision making. This level not only serves to capture the actual level of decision making, but it also enables representation of the heterogeneity of landowners within a certain area. Our results support these statements, as we identified land tenure variables in case studies most frequently at the stakeholder level in the category of land rights variables.

Land structure variables should be closely connected with land rights variables as noted by several authors (Van Dijk, 2003; Demetriou et al., 2013), especially due to the fact that current land rights variables show additional significant weaknesses. In particular, they ignore such spatial characteristics as parcel shape (Demetriou et al., 2013). This was confirmed also in our results as the issue of parcel shape or spatial arrangement was not analyzed in any of the reviewed studies. These characteristics together with parcel availability influence farming, and so there are efforts to create more comprehensive indices for evaluating land fragmentation. New instruments such as LandSpaCES are appearing and being applied when planning land consolidation that endeavours to mitigate farmland fragmentation (Demetriou et al., 2012). However, this approach is very demanding in terms of input data, and so research data and models are often chosen arbitrarily based on practical needs rather than according to theoretical considerations (Hersperger et al., 2010).

Obstacles in the studies about agricultural landscape changes

The availability and quality of land tenure data at appropriate scales can be an important obstacle to use land tenure variables at different spatial and thematic levels. Although data availability is generally improving, limiting factors can be seen in purchase prices; lack of spatial, temporal, and thematic resolution; and inconsistencies between various datasets. Especially for landscape-change research taking in longer time periods, there are scarcely any spatially explicit databases available that are consistent over time (Schneberger et al., 2007). An important source of data is land registers, which are databases used to register land tenure rights on a parcel or production block level. An effective approach can be to use cadastral data along with remote-sensing data because the evaluation of land-register maps together with aerial photographs gives a higher degree of resolution (Bender et al., 2005). Although land registration has received a great deal of attention (Paulson, Patsch, 2015), the situation in many countries remains unsatisfactory and land register quality varies

considerably among countries. Information is frequently recorded in separate databases, is outdated, and does not exist in digital form, and the registers are not flexible. Maintaining registers properly is a matter of trust, understanding their purpose, and adequate investment into their operation (Haldrup, Stubbjær, 2013). Moreover, land tenure rights are often not registered because they are based on various types of informal agreements (Mottet et al., 2006; Sikor et al., 2009). As a result, researchers cannot always rely on the information available in these databases and must frequently acquire data directly for their research purposes.

Because of data limitations, such researchers as Kristensen et al. (2004), Moreno-Perez, Ortiz-Miranda (2008), and Orsini (2013) have also carried out in-depth interviews with selected representatives and farmers to gather relevant information. Case studies analysis proves that direct surveys based on fieldwork, participatory mapping, interviews, and questionnaires constitute an important data source. Traditionally, accurate ground data from fieldwork is used for validation purposes when processing remote-sensing data (Kuemmerle et al., 2008, 2009), but field data may also provide information on parcel ownership (Kuemmerle et al., 2009) as well as land occupancy, current and past land use, and management practices (Mottet et al., 2006; Sikor et al., 2009). Although these methods may be seen as risky because they depend on informants' memories, the study by Mottet et al. (2006) indicated that the information was apparently reliable when compared to that from other data sources. Sometimes these methods can be the only possible way to acquire data. Moreover, they offer valuable insight into stakeholders' perceptions and decision-making behaviours.

Processes in the landscape have various time and spatial dynamics, therefore, the results of landscape-change analyses are scale dependent (Simova, Gdulova, 2012) and it is difficult to generalize observations determined at a micro (parcel or production block) level to the macro (landscape) level and *vice versa*. It would be ideal to use hierarchical evaluation carried out simultaneously on all spatial and thematic levels, but this is very demanding in terms of time, costs, and technology. Nevertheless, we did identify several studies which carried out analyses at different levels. For example, Gellrich et al. (2008) investigated reforestation at parcel and landscape levels. Lieskovsky et al. (2013) not only studied vineyard abandonment in Slovakia on a national level, but they also conducted a case study on the local level that provided more detailed information about vineyard abandonment, its driving forces, and residents' perceptions. Comprehensive information was gathered through such means as interviews with landowners and local residents. Another example is Sikor et al. (2009), who combined several analyti-

cal approaches to analyze the dynamics underlying cropland abandonment. They used remote-sensing analysis, comparative village studies based on in-depth interviews, and regression analysis of a large village sample.

The mentioned examples represent applications of the so-called multi-hierarchical and multidisciplinary approach, which is very desirable since it can provide the most comprehensive perspective in landscape-change research. Integrating data from both the natural and social sciences is a basic necessity for building a realistic simulation of future landscape development (Vogt et al., 2002). However, as B ü r g i et al. (2004) state, we must not forget that such a simulation must be constructed on solid conceptual backgrounds. If it is not, then this fact can negatively affect an individual study and particularly the interpretation and generalization of its findings. The fact that social and natural sciences are based on diverse approaches, analytical methods, and scarcely comparable data sources hampers communication among researchers with different disciplinary backgrounds (Hersperger et al., 2010). Among other factors, the reasons can include confused and inaccurate terminology. For example, such words which may be used as ‘farmer’, ‘household’, ‘farm’, and ‘owner’ may but do not necessarily express the same meaning. When vague descriptions are used, comparability with other research results may be limited. A farmer may be a landowner, but he or she also may only be leasing the land. If we want to study what farming methods owners and lessors use, as was done by such authors as Sklenicka et al. (2015), it is necessary to distinguish between these terms. More uniform terminology and more precise definitions of terms would facilitate interdisciplinary communication among such diverse researchers as landscape planners, landscape ecologists, sociologists, and economists whose cooperation is essential for studying landscape changes and applying research results into practice. This also would simplify comparing various case study results.

Limits of our review

One can find today a great number of case studies examining landscape changes in relation to diverse driving forces. Recently a number of meta-studies (e.g. Van Zanten et al., 2014; Jepsen et al., 2015; Van Vliet et al., 2015) aggregating case study findings about driving forces and synthesizing their evidence have emerged. Such studies can be used as starting points for a further more detailed study of selected driving forces, just as in our case of land tenure. As a factor underlying landscape changes we based our work on the meta-study by Van Vliet et al. (2015). We are aware, however, that this approach has certain limitations, such as due to the fact that there may be also other research studies focused on the topic of

land tenure in relation to landscape changes. As this review focused only on changes in the agricultural landscape in Europe, it did not include studies carried out on other continents and for other land use types (e.g. Nagaike, Kamitani, 1999; Sorice et al., 2014). We also did not include studies carried out at a single time point (e.g. Sklenicka, Salek, 2008; Sklenicka et al., 2014, 2015) because, even though they had examined landscape structure in relation to land tenure, these did not examine landscape changes.

Although the summary of case study results shows that land tenure influences landscape change to a certain extent, these results are difficult to generalize for several reasons. First, the low number of cases integrating land tenure into analyses of landscape changes indicates that researchers do not pay much attention to the topic. The land tenure factor was included as a measurable variable in analysis or discussed in only 24 out of the 137 case studies identified by Van Vliet et al. (2015). Second, when the land tenure factor was a part of a study, it seemed not to have a significant effect on landscape changes due to its minor role among other drivers. One of the most relevant research problems when endeavouring to link land tenure to landscape dynamics is that there are many other factors influencing land use and land management. For example, the study by Pfeifer et al. (2009) used a farm style factor that included the importance of “ownership” as a reflection of farmers’ attachment to their own land. However, this factor was not significant in the study, and so it was not interpreted further. Third, although the land tenure factor determined changes in landscape or management practices, the results were scarcely comparable among studies due to the local scale or specific research approach. Studies sometimes arrived at conflicting conclusions, as seen in such studies as those by Gellrich et al. (2008) and Sikor et al. (2009). While fragmented ownership structure increased abandonment in France (Gellrich et al., 2008), it was connected to low abandonment in Albania (Sikor et al., 2009).

CONCLUSION

Land tenure can be transformed into measurable variables on different thematic and spatial levels, but in the studies of landscape changes not all levels receive the same attention. An obstacle seems to lie in the availability and quality of land tenure data at appropriate scales. The number of land tenure variables used in the case studies indicates that stakeholder level is the most important spatial level in models, as the farmer is considered to be a key actor in the agricultural landscape. Our study revealed that land tenure was most frequently investigated in relation to land abandonment and the green services of the Common Agriculture Policy (CAP), but the resulting findings

are difficult to generalize. Among the main reasons were that only a low number of case studies integrated land tenure into their analyses, its influence was not significant, or the results were scarcely comparable among studies because of locally specific conditions.

Landscape changes are studied from different disciplinary backgrounds, and that influenced the methodology and data sources used in the case studies reviewed. In conclusion, greater attention needs to be devoted in future research to the parcel or production block level because it enables to analyze also the spatial character of individual parcels and the spatial arrangement of land tenure relationships across the landscape. Furthermore, better integration of multidisciplinary and multi-hierarchical methods using a social and geographic approach is broadly needed. Such studies can bring more comprehensive information as to landscape changes and improve the decision-making abilities not only of land operators regarding soil protection and sustainable rural development, but also of policymakers for implementing research outcomes into environmental policy within a multilevel governance system.

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