Landscape changes in Europe

upscaling results from case studies and cross-region comparisons: Deliverable No: 1.4.

Kristensen, Søren Bech Pilgaard; Busck, Anne Gravsholt; Corsor, Georgia; Gaube, Veronika; Pavlis, Evangelos; van der Sluis, Theo; Terkenli, Theano; Vdineanu, Anghelu

Publication date:
2013

Document version
Peer reviewed version

VOLANTE

VISIONS OF LAND USE TRANSITIONS IN EUROPE

EC Contract Ref: FP7-ENV-2010-265104

Deliverable No: 1.4

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Due date of deliverable:	August 2013
Actual submission date:	August 2013
Version:	V 1.0

Main Authors:	Søren Bech Pilgaard Kristensen, Anne Gravsholt Busck, Georgia Cosor, Veronika Gaube, Evangelos Pavlis, Theo van der Sluis, Theano S.Terkenli, Angheluţă Vădineanu
Reviewers:	Pia Frederiksen

Keywords	case studies

COOPERATION

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Executive summary

Rural landscapes in Europe fulfill a range of important functions, spanning from agricultural production and ecosystem services to societal services. These services depend highly on the dynamics of land use change in rural landscapes. Common for these dynamics is the importance of the individual land owner who plays a crucial role for land management on private properties. Workpackage 1 in the VOLANTE project studied land owners' decision-making process, to improve our understanding of the drivers of land use change in different rural areas in Europe.

Workpackage 1 used six case studies in Austria, Denmark, Italy, Greece, Romania and the Netherlands to collect the empirical data for the analysis. Each case study consisted of a questionnaire survey investigating changes in production, land use and farm income between 2002 and 2012 with a total of 437 land owners in 7 case areas and follow-up interviews with purposively selected subsample. The case areas represented important land use dynamics and trajectories in Europe, ranging from peri-urban to marginal agricultural landscapes.

This deliverable reports on the results of the research undertaken by Workpackage 1. It supplements previous deliverables by placing the results in a multi-scale European perspective through the comparison of results between case studies and with national and EU level results.

Multi-scale level perspective on land use intensity: The work conducted in WP1 and presented in this report has illustrated the diversity of European landscapes and land use dynamics through case studies which represent important land use trajectories. In order to place the findings in a national and European perspective, the results of three land use intensity indicators elaborated by workpackage 3 (forest harvest intensity, cropping intensity, grazing intensity) were compared at case area, national and EU level. The analysis showed that the case areas in general were representative of the national situation. Heerde and Reichraming contain proportionally larger forest areas and have higher forest harvest intensity values than the Netherlands and Austria respectively while the same areas contain much fewer (none) areas which were predicted to have multiple cropping seasons between 2000-12. Most case areas were predicted to have limited suitability for livestock and this also reflected the average situation for the respective countries.

Land use changes

One third of all land owners had been engaged in a variety of landscape activities between 2002 and 2012. Around one fifth of the respondents had engaged in activities leading to an extensification of land use (afforestation, change from crop land to permanent grassland or perennial crops, establishment of landscape elements) while only 6% had engaged in activities leading to an intensification of land use (cultivation of nature areas, removal of landscape elements). Proportionally more full-time farmers had engaged in activities leading to intensification of land use than other types of land owners. However, they were consistently responsible for the largest area affected by all types of landscape activities, including those leading to extensification of land use and creation of new landscape elements. Land owners from the peri-urban case area were the most active in terms of landscape activities.

Information from a sub-sample primarily in the Roskilde case area suggests that the desire to improve the qualities of the property appears to be the single most important motive, as 79% of the landowners agree somewhat strongly or strongly with this statement. These considerations cover concerns to improve the nature content on the property (eg. habitat values or opportunities for recreational hunting), amenity or environmental values (eg. reduced nitrate leaching from afforested areas as compared to crop land).

Use of schemes under the EU Rural development program

About 40% of the land owners who had extensified land use had received subsidies as part of EU rural development program and many land owners stated that scheme participation was primarily economically motivated. Qualitative information from in-depth interviews adds further insights to this result. Some land owners indeed stated that economic compensation from scheme participation was a major incentive while others state that the amounts earned are so small that they are not a fundamental driver.

Agricultural production and diversification

Between a quarter and a third of the respondents were full-time farmers (depending on typology). This reflects the overall pattern of farm structure in the European Union. One fifth of all properties had diversified the income base to include other gainful activities, which span from direct marketing of farm produce to agrotourism, horse-riding stables and renting out of buildings as storage or production space. These land owners will most likely base their decision making process on other production factors than those directly linked to traditional agricultural production.

Intensification and extensification of agricultural production

The general trend is that production intensity remained unchanged between 2002 and 2012 for the majority of land owners. Apart from this dominant trend, more land owners reported increase than decrease in crop yields and proportion of cultivated area on the farm. In contrast, more land owners reported a decrease than increase in livestock stocking rate and use of agro-chemicals. The latter was strongly seen in Roskilde and Heerde, which are located in countries with a long history of national environmental policies on the use of agro-chemicals. The increase in the use of agro-chemicals was only found in Romania and reflects the “catching up” of Romanian farmers to the levels of their European colleagues.

Policy implications: The findings underline the necessity to develop flexible policy measures which can be adapted to and implemented in a variety of contexts. Land owners with limited engagement in full-time agriculture do not respond to policy signals and incentives the same way as traditional full-time farmers do. In particular, EU agricultural policy and rural development programs need to reflect the decreasing importance of traditional agricultural production as income source and employment provider in many regions of Europe. Some land owners stated the lack of information about Agri-environmental schemes as a reason for non-participation, indicating the need to use alternative information channels to reach land owners who are not targeted by traditional advisory and information services.

1. Introduction

European landscapes provide important services to the citizens of Europe, ranging from the traditional production services (food, fiber) to ecosystem and socio-economic services. Agricultural land use plays a major role on the types and quality of these services, and landscape diversity is highly dependent on agricultural land use and production. Several trends characterise the development of European landscapes in recent decades, as highlighted by the State of the European Environment report in 2010. On a European scale, the most significant land cover changes between 2000 and 2006 were a modest increase in artificial area (urban areas and infrastructure) by 3.4%, and much smaller increase in forest area (0.1%). Arable land and permanent crops decreased by 0.2 % and pastures and mosaics by 0.3 %. Land with semi-natural vegetation, open spaces and wetlands also decreased in area (EEA, 2010). The main pattern, as observed by Rienks (2008), is a polarisation between areas and regions with either marginal or intensive agricultural production. In brief, areas where agriculture is declining and which experience field abandonment and bush encroachment are often found in Southern Europe while areas with intensive agricultural production are found in Northern Europe (Rienks, 2008). A mix of these dynamics characterizes many of the former East European countries. These macro-level changes are the result of many local and regional development trends which are caused by the interaction of multi-level drivers and factors. They may result in relative stability in some areas and hot-spots of land use change in other areas (Rounsevell et al, 2012).

Factors operating at different temporal and spatial levels interact to produce a variety of rural landscapes (Bender et al., 2005; Burgi et al., 2004; Fresco & Kroonenberg, 1992; Ruiz & Domon, 2009; Swetnam, 2007; Van Eetvelde & Antrop, 2004). EU policies and legislation constitutes an important macro-level driver, due to the importance of the CAP policy for agricultural land use and increasingly also for nature management (in conjunction with EU environmental directives, such as the Habitats Directive, Water Framework Directive, Nitrate Directive). In addition, economy and market, transport and infrastructure, as well as technology and land improvement constitute other important drivers of land use change (Kristensen et al. 2009).

At the local level, the individual land owner plays a crucial role in the process of landscape management and transformation. Through land use changes on rural properties, European land owners become instrumental in securing sustainable land use – or the opposite. Land owners act on the basis of a range of exogenous macro-level factors mentioned above in combination with a number of local factors. These are often categorised as endogenous farmer factors (eg. education, succession status, age) and farm factors (eg. farm size, farm type, tenure, and dependency on farm income) (Mills, et al, 2013).

The interaction of local and external drivers of change cannot easily be detected from general statistics and land cover information and requires focused case studies to identify and describe the drivers of land use change in different regions and landscapes. In this report, we present central findings from Work Package 1 research activities within the broader framework of the VOLANTE research project. The research activities aimed at investigating the patterns of land use and landscape changes in different rural landscapes and the decision making process behind these changes from the perspective of local land owners.

The research was based on six case studies in the following seven case areas:

1. Roskilde Municipality (30 km from Copenhagen, Denmark): An intensive crop producing municipality undergoing rapid transformation due to its peri-urban location. Responsible partner: UCPH.
2. Reichraming municipality in Eisenwurzen, Alpine Region in Austria: A rural municipality with a large forest cover undergoing simultaneous land abandonment and agricultural intensification. Responsible partner: UNIKLU.
3. Stăncuţa and Răteşti municipalities, representative of the rural South-East part of Romania: Agricultural areas undergoing large transformation since 1990 as a result of post-socialist land use change processes. Responsible partner: UNIBUC.
4. Aegean Islands, Greece, focusing on the Southeastern part of the island of Lesvos, which is an agricultural landscape affected by low-volume tourism and recreation and the associated functions and lifestyles. Responsible partner: University of the Aegean.
5. West Mediterranean agricultural landscape. Portofino Regional Park (30 km from Genova, Italy). A case of a valuable landscape undergoing transformation as a result of abandonment of traditional agriculture, forestry and tourism development. Responsible partner: ALTERRA.
6. Heerde Municipality, IJssel Valley (NL). Agricultural landscape under urban pressure. Responsible partner: ALTERRA.

The characteristics of the case areas are discussed further in section 3.1 and appendix A.

The present report focuses on differences between case areas as well as the representativity of the results in a European context. In addition, it incorporates qualitative information from follow-up interviews with selected land owners. The aim is to provide a synthesis of the results gained from the research and their implications for EU level land use policy formulation, as well as their relevance for other VOLANTE work packages. The report is the final deliverable from VOLANTE Work Package 1 and supplements the previous deliverables as follows:

- D1.1: An overview of previous research undertaken by WP1 partners in the case areas, with a comprehensive presentation of agricultural systems, demography, planning systems in the areas, as well as methodological aspects (availability of maps, databases, spatial and temporal scale of previous research).
- D1.1A: A focused presentation of main drivers of land use and landscape change, illustrating the different landscape trajectories in each area. The report is based on previous research and highlights the role of major land use actors and drivers of land use change.
- D1.2: A presentation of empirical results from a questionnaire survey with 437 landowners in the case areas in February-March 2012. The survey dealt with issues related to land owners' decision making processes: agricultural system, level of participation in landscape activities, role of other gainful activities and use of schemes and subsidies.
- D1.3: A thematic and comparative analysis of the results presented in D1.2. The report highlighted differences between different landowner types with respect to the level of participation in landscape activities, the role of other gainful activities, the use of schemes and subsidies, intensification and/or extensification of agricultural production.

2. Conceptual framework

We have analysed the impact of land owners' decision making on landscape changes with inspiration from the actor-network school of thought (Law & Hassard, 1999; Law & Callon, 1989). This approach has been used as a conceptual foundation for studies of the interaction between different types of actors in rural settings (individuals, private companies and institutions) and their environment. It gave rise to such concepts as "farming styles" in rural sociology and stresses the role of individual strategies and plans for farm development as a result of local "endogenous" factors rather than a passive response to exogenous factors (Long &van der Ploeg, 1994a, 1994b; Whatmore 1994; Robinson, 2004). On a more abstract level, it can therefore be seen as a reaction and partly rejection of the structuralist approaches which have often been employed to explain agricultural development (Robinson, 2004).

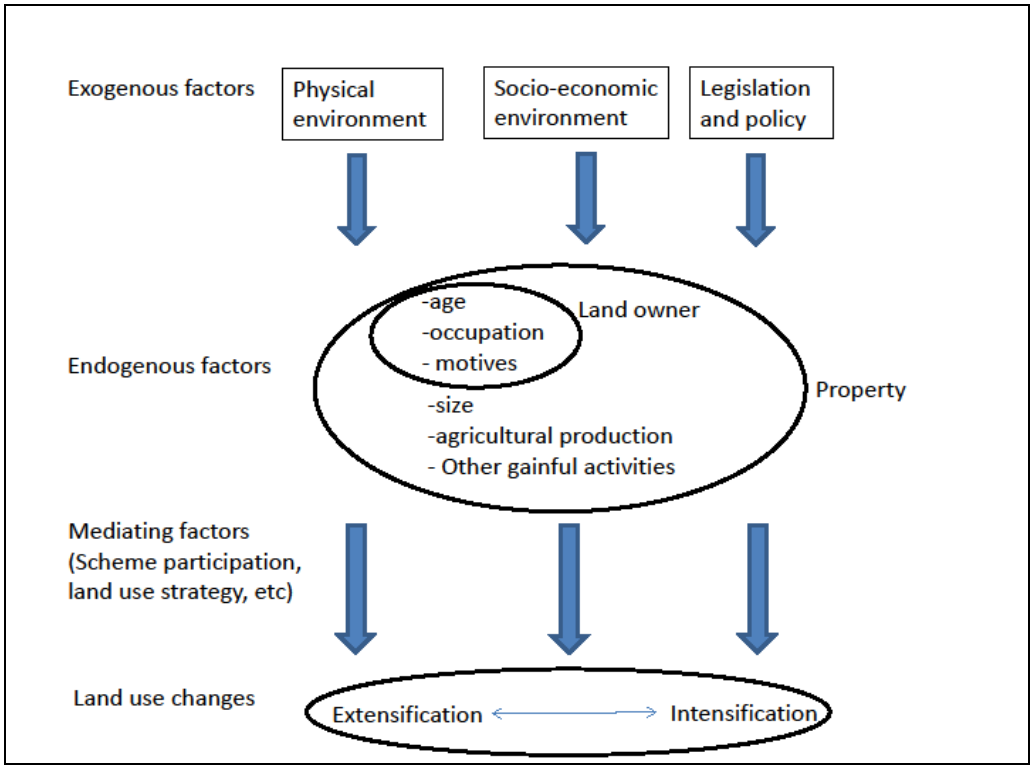

Figure 1. Concepts and themes investigated by VOLANTE Work Package 1.

Figure 1 describes the relationship between the different elements and themes studied by VOLANTE Work Package 1 from an actor-network perspective. Following this line of thought, the land owner is assumed to be pursuing his/her strategy for the farm (eg. full time intensive farming or extensive hobby farming with the main source of income from off-farm work). This strategy is formulated on the basis of endogenous factors, consisting of land owner characteristics (eg. age, motives for property purchase, education, succession plans, prior knowledge of farming) and property characteristics (eg. size, type of agricultural production and other gainful activities). The strategy is influenced by a number of exogenous factors (eg. agricultural potential, distance to urban areas, local job market, agricultural and environmental policies and subsidy schemes). While these factors play an important role in conditioning the strategies and land owners decision-making, we consider them first and foremost to be framework conditions, rather than the cause of

a predictable outcome. The land owner plays a crucial role in responding to and choosing between different options to select the one which is most optimal from his/her perspective. Based on this decision, the land owner will engage in activities (production, recreation, conservation) which have direct and indirect land use and landscape impacts. These activities are mediated by different instruments and processes which influence the types and strength of the land use impacts (eg. some land owners may decide to make use of agro-environmental schemes which reduce the amount of cropland while others decide not to engage in such schemes because they need the area for feed production). The result of these land use activities will either be an intensification or extensification of the existing situation. These changes may be analysed at different spatial levels, ranging from a single plot or field to the property and from there extrapolated to different administrative levels (eg. municipality). They may be studied at different temporal scales, from a "snapshot" showing the current situation to a longer period spanning years or decades. When assessing the impact of different land use changes, the increase in spatial and temporal scale adds complexity to the study: simultaneous land use activities on different fields may lead in either "direction" and consecutive land use changes on the same field may also do so. In this project, we studied land use changes at the field or plot level and aggregated the individual changes on the case area level (sample).

3. Methods

3.1 Questionnaire survey and sample selection

In all areas, a questionnaire survey with selected landowners was conducted in February-March 2012. Sample selection differed between areas on the basis of data availability, agricultural register access and administrative set-up. The questionnaire was administered as a face-to-face enquette, except in Reichraming where they were completed by the respondents themselves. See deliverable D1.2 for more details.

3.2 Landscape trajectories of case areas

The case areas represent important land use change types in Europe and represent a cross-section spanning from peri-urban to marginal rural landscapes (Figure 2). The key features and land use trajectories represented by the case areas are summarised in the following section.

Figure 2. Location of WP1 case areas.

Peri-urban landscapes: Depending on planning regulation, peri-urban landscapes may be a complex mix of agricultural and urban elements, with industrial sites and residential areas intermixed with the features of a "traditional" agricultural landscape or it may maintain the appearance of an agricultural landscape (limited construction of non-agricultural buildings, mandatory agricultural land use, absence of urban infrastructure and features). In the latter version, the only urban characteristics may be in the form of non-agricultural economic activities in former farm building or fields and change of population composition (Busck et al., 2006; Meeus & Gulinck, 2008; Præstholm & Kristensen, 2007; Zasada, 2011). The most striking feature of the latter areas is therefore a "hidden" urbanisation of the landscape, as urbanites move to these areas in search of green and natural environment and farms are converted from full time agricultural production to residential use, occasionally with hobby farming. The remaining full time farms may either buy or rent land

from the hobby farms and the area may therefore experience a polarisation between fewer and bigger full time farms and a large number of small part-time or hobby farms or properties where no farming takes place and which are mainly purchased for residential purposes or for other gainful activities such as workshops or storage. These landscapes have been characterised as being the most dynamic landscapes, located on the fringe between urban and more traditional landscapes and giving rise to innovative, contrasting and sometimes conflicting land use and production (Antrop, 2000, 2004). For example, the proximity to urban areas may generate demand for recreational areas and activities (eg. hiking and camping facilities, dog training and horse riding), niche production (eg. berry-picking and roadside sale of farm produce) and may thus stimulate the survival of agricultural production which would otherwise be unprofitable. In contrast, the noise and smells associated with conventional agricultural production may entail conflict between the existing farm population and the newcomers. Some of the newcomers may have a very specific land use strategy, involving extensification of land use (afforestation, pond digging) for amenity purposes. The most classical example of a peri-urban landscape among the WP1 case areas is ***Roskilde municipality***, Denmark, which is located 30 km from the capital of Denmark, within the Greater Copenhagen City region. At the same time, the municipality is home to Roskilde, the 10th largest city in Denmark, which is also responsible for generating local peri-urban dynamics. Similar characteristics are also found in ***Heerde municipality***, which is located 18 km from Zwolle and serves as a commuter area. The beautiful landscape which includes the nearby Veluwe National Park and the IJssel River has attracted many new residents (Koomen et al, 2007; Hauser, 2012).

Figure 3. Intensive dairy farming in Heerde Municipality, NL.

Figure 4. Peri-urban land use in Roskilde Municipality, DK.

Marginal Alpine landscapes: The challenges of accessibility and cultivation in mountainous areas have long been recognized in European agricultural policy, where subsidy schemes for upland areas was among the first CAP subsidy schemes. The Alpine landscapes of Austria represent the specific challenges associated with this type of landscape. Previous production methods were very labour intensive and not very productive and many areas therefore only have marginal agricultural potential (Gaube et al, 2009; Singh et al, 2010). Several villages and communities are faced with depopulation as farms close and young people move away in search of employment. At the same time, many of the biodiversity values associated with these extensive farming systems and the semi-natural landscape elements associated with them (mountain meadows) are under risk of extinction due to field abandonment and forest regrowth. The Austrian

government recognized this challenge and created the “Öpul Program”, a comprehensive agri-environmental scheme dating back before EU accession, which rewards farmers for management of the semi-natural landscape elements. In some areas, special interests may support local communities and farming systems (organic production, special animal breeds) or production may change from full-time to part-time production if nearby jobs are available. ***Reichraming municipality*** represents a typical example of a marginal agricultural landscape in the Alpine region, where the proximity of a major town has given new opportunities to a struggling area. At the same time, it is an area where change is necessary, if it is to survive in the future.

Figure 5. Intensive cultivation in Stăncuţa municipality, Romania.

Figure 6. Land use in marginal Alpine landscape Reichraming Municipality, Austria.

Marginal Mediterranean areas: Many regions in the Mediterranean area face challenges similar to those found in the Alpine regions. Old-fashioned and labour intensive farming systems have made production unattractive and decreasing commodity prices on typical Mediterranean products (olives, fruits, wine) have made production even more unprofitable. These problems have been exacerbated by difficult natural conditions (hilly terrain, dry to semi-arid climate and poor soils) and small farm units often measuring less than 5 ha, which make it unattractive for young people to engage in full-time farming (Terkenli, 2012; Kizos et al., 2009). Farming therefore often faces a succession-crisis, as current farmers are old and no one from the younger generation wants to take over. As a consequence, many small communities face population decline as young people look elsewhere for employment. In some areas, tourism is an option for employment and even for other on-farm gainful activities, if accommodation and catering are relevant. Some areas may contain large nature values which are protected as national parks or other designations and while this may attract tourism, it can also entail conflicts with traditional agricultural production if conservation interests conflict with production interests. The former municipality of Mytiline in Greece (***South-eastern Lesvos Island***) and ***Portofino Regional Park*** in Italy represent the challenges and characteristics of Mediterranean marginal areas. Both areas are characterised by extensive and classical farming systems (terraced, perennial crops, such as olives and wine and the “Coltura promiscua” system in Portofino), both are located within international tourist destinations Lesvos Island (Mediterranean destination with alternative, low-volume tourism revolving around gastronomy, nature, and culture) and Portofino (high-end tourism in fashionable and iconic landscape). In addition, agricultural production is characterised by old farmers and limited profitability making investments difficult (Pedroli & van der Sluis, 2000; Pedroli et al, 2012).

Figure 7. Semi-abandoned olive grove, Lesvos, Greece.

Figure 8. Bush encroachment, Portofino, Italy.

Former socialist landscapes: During the Soviet period, collective farming dominated the rural landscapes of all former East-European countries. Land improvement and large scale production created mono-functional landscapes characterized by large field units where little nature was left. Following the collapse of the Soviet system in 1989, these landscapes have experienced massive transformation. An important challenge was the redistribution and privatisation of land and other assets formerly owned by the collective farms. This turned out to be a protracted and complex process, which took longer than anticipated in most countries and left large areas uncultivated as long as the ownership situation was unclear (Holt-Jensen & Raagmaa 2010). In addition, the inefficient farm technology and land use patterns made agriculture unprofitable in many areas. As a consequence, crop land area declined in many countries, fields were abandoned and regrowth caused an increase in forest areas. In contrast, in areas were ownership was identified and farmers were able to take over assets from former collective farms, large scale production, with even more intensive farming practices than in the past, using modern technology, was established. In several areas, foreign investors brought capital and equipment to renovate and expand previous production. ***The Romanian case (Stăncuţa and Răteşti municipalities)*** exemplify these landscapes which have experienced massive socio-economic transformation in the last decades (Vadineanu et al, 2003; Kuemmerle et al, 2009). These areas are located in the fertile Danube inland delta and are not currently dominated by the processes of land abandonment and bush encroachment found in other areas, although this was common in the 1990s. In the case of Stăncuţa, an Italian agro-investor has restored and expanded a rice production scheme and is now cultivating 3500 ha and several other farms measuring more than 2000 ha are found in the area. In contrast, former collective farm workers or local citizens who have received land under the privatization scheme or from land restitution process cultivate small farms measuring less than 5 ha. It is therefore representative of the diversity and challenges associated with the polarisation of the farm structure between large scale modern farm companies and very small subsistence farms which should more rightly be called “peasant farming”.

The case areas used in Work Package 1 cover many but not all types of rural landscapes and land use change situations in Europe. The most conspicuously absent landscape type is a conventional, highly productive agricultural landscape, such as in the Paris Basin or Po Basin. However, Stăncuţa and Răteşti, Heerde and Roskilde municipalities all contain large proportions (especially in terms of area) of

conventional agricultural production. In the case of Roskilde, it is home to the most fertile soils in Denmark and utilized for highly specialised crop production. Key characteristics of the land use and agricultural systems for each case area are further presented in Annex 1.

4. Results

This section presents the key results of WP1 research. Sections 4.1 to 4.3 describe the case areas at different spatial perspectives (local area-national-EU) while the most central results from the research on land owner's decision making process and land use changes is presented in sections 4.4 to 4.7. More details can be found in deliverables D1.2 and D1.3.

4.1 Case areas seen in relation to their local area

It is pertinent to assess how representative the case studies are for the local areas they are located in. This can be done using different indicators. In this paper, we examine the representativity by comparing the distribution of farm size in the sample in the case area (CA) and in the administrative unit (AU) where it is located (normally a municipality) (Table 1). Sample size varies from one-third to all registered farms in most case areas. Due to the numerous small farms in the Lesvos case area, the sample only corresponds to 2% of all farms in the former Mytiline municipality. Smaller farms are somewhat over-represented in Roskilde and under-represented in the other case areas. These differences are due to differences in sampling techniques. In addition, definitions in official statistics may in some cases differ. This may explain why the Lesvos case study contains a higher proportion of larger farms than the administrative unit it is located in, as other research found that official statistic included absentee-landlords and persons registered as farmers without being active farmers (Kizos et al.,2010). Similarly, all respondents in Roskilde are legally obliged to use the property for agricultural purposes, but their farm may be too small to be included in the official agricultural census, which stipulates a minimum size of 5 ha (or equivalent "production-size").

Table 1.Representativity of case study samples (CA) compared to farm population in respective administrative units/municipalities (AU). .

Case area	Roskilde (DK)		Reichraming (AU)		Stăncuţa & Răteşti (RO)		Lesvos (GR		Portofino (I)		Heerde (NL)	
	CA	AU	CA	AU	CA	AU[1]	CA	AU	CA	AU	CA	AU
N	93	236	73	71	109		90	4.142	25		47	124
Census age (Year)		2010		1999		2010		2009				
total area (ha)	4261		4121		8284		845		42		1020	
No of farms, 0-10 ha (%)	45	33	11	35	69	95	72	96	100	n.a	53	n.a
No of farms, 10-50 ha (%)	33	44	53	40	19	5	24	4	0		36	
No of farms, > 50 ha (%)	22	23	36	25	12		4		0		11	

[1]Based on data from Stăncuţa municipality.

4.2 Case areas in a European context

The environmental and socio-economic diversity of Europe greatly influences the potential for agricultural production and subsequently the diversity and dynamics of land use changes. Different projects have classified rural landscapes based on different parameters (eg. land use, urban/rural land use, economic and demographic characteristics) (Busck et al, 2006; Meeus, J.H.A. , 1995; Madsen, et al., 2010; Primdahl and Swaffield, 2008; Rienks, 2008) and there is widespread consensus that these classifications are complex as rurality is a multi-dimensional concept (van Eupen et al, 2012). The recent FARO project classified European

rural landscapes into three broad categories based on environmental conditions and socio-economic indicators (accessibility to cities and Economic density (GDP/km2) (van Eupen et al., 2012, Verburg et al., 2010).

The environmental information was derived from the map of Environmental Zones (EnZs) by Metzger et al (2005a, b) which is based on environmental variables (eg. climatic data, topography). The 13 environmental Zones have been aggregated into five Aggregated Geographical Zones (AGZs) and shown with a spatial resolution of NUTS 3 in Figure 9.

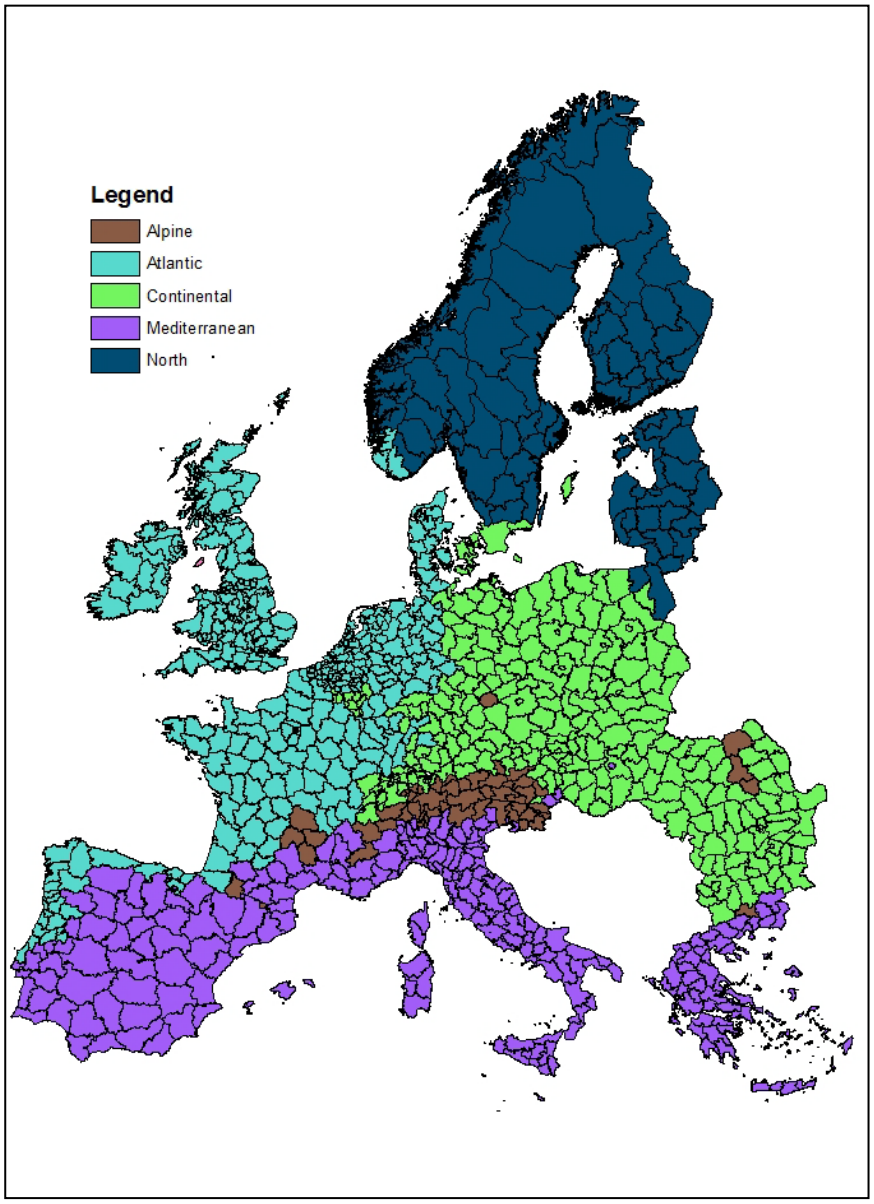

Figure 9. Aggregated Geographical Zones (AGZs). Source: Metzger et al.(2005a, b); van Eupen et al. (2012).

The socio-economic indicators “Accessibility to cities” (Time to services/km2) and “Economic density“(Euro/km2) had been found to be highly correlated with a number of variables that express socio-economic gradients in rural Europe (van Eupen et al, 2012). Accessibility to cities was based on the travel

time to different sized European cities (with populations ranging from 25.000 to 750.000 inhabitants, since urban areas of different sizes offer different services and facilities to rural areas). It should be noted that the socio-economic indicators were calibrated to the levels found within different NUTS3 regions of Europe to reflect the variety of economic conditions across Europe. Thus, the threshold delimiting areas with low and medium economic density was 10 times higher in the Atlantic Central Zone than in the Alpine North Zone. Differences in the two socio-economic indicators were used to divide rural Europe into areas with low, medium and high values in a 3x3 matrix (eg. High accessibility and Low economic density) and later aggregated into three types of rural zone for simplification and comparability with other classifications (Figure 10):

- Peri-urban: Located adjacent to the larger urban centres. These are rural areas with the largest population density and high levels of GDP. These are good locations for the tertiary sector resulting in a relatively small agricultural share of the total GDP.

- Rural: The population density is lower than in the peri-urban zone. Incomes are average but there are wide geographical differences. Large proportion of land is used for agricultural production. By definition, these areas have a medium or higher value on each of the socio-economic indicators but are never statistically high on both.

- Deep rural: The zone has a low or average value for each of the socio-economic indicators but never average or low on both indicators. In general, this zone it the most remote from urban regions, has the lowest population density and the lowest average income.

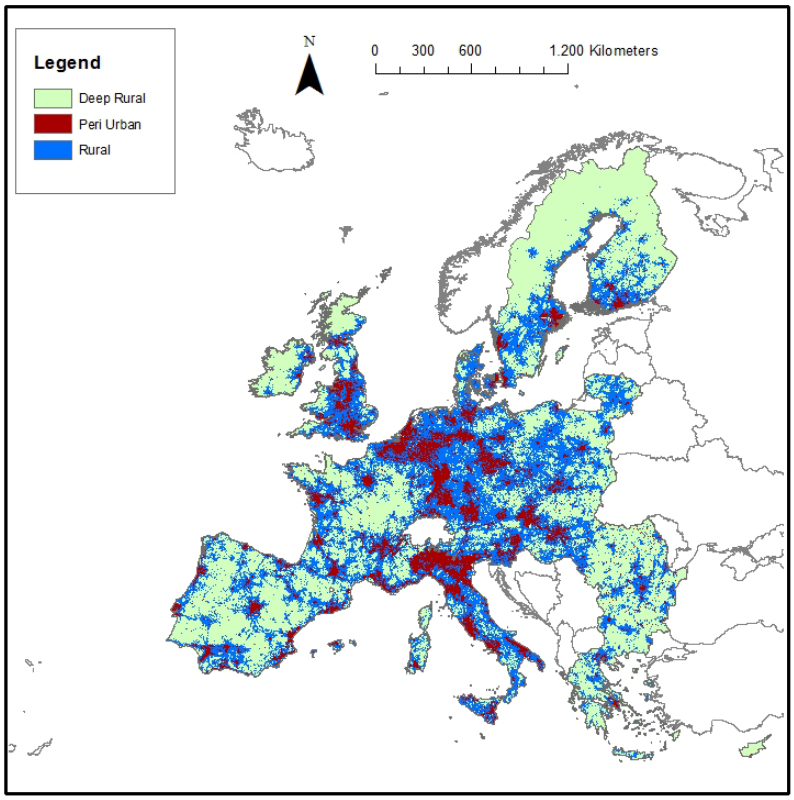

Figure 10. FARO Typology of rural areas in Europe. Source: Metzger et al.(2005a, b); van Eupen et al. (2012).

The overlay of the case areas and the rural typology shows the diversity of landscapes covered by the case areas in a national and European perspective (Table 2). The peri-urban character of ***Roskilde*** is very strong, even seen in a national context. ***Reichraming*** in Austria exhibits both rural and Deep rural features, with the latter being the most dominant and more so than for Austria as a whole. The Romanian case represent a mosaic, as ***Răteşti*** is a mostly rural area and appears to have a higher development level (economic density/accessibility) than ***Stăncuţa*** which is a largely deep rural area and more resembles the national situation. ***Lesvos*** is predominantly rural, reflecting the average conditions of economic density and accessibility but some areas also exhibit deep rural characteristics. ***Portofino*** stands out very strongly as a peri-urban area in the FARO typology, which can be explained by proximity to large town and a highway. However, access to the case area is difficult, the Regional Park designation restricts agricultural activities and the area shares many characteristics with marginal agricultural areas (aging population, lack of investments, etc). The small area of the Portofino case area (20 km^2) makes it difficult for the FARO typology to capture these subtle but significant differences in spatially related drivers. For these reasons, we will consider the case area as marginal/deep rural, even if the FARO typology, which uses a coarser geographical resolution, designates it as peri-urban. Despite its proximity to neighboring towns, ***Heerde*** is strongly characterized as a rural area. This resembles the generally high population density in the Netherlands and the dense network of urban centers.
In general, the overlay of the FARO typology with the case areas confirms the initial classification of the land use dynamics in the case area described in section 3.1. Differences relate to the rather coarse census statistics which is the source of the economic density information and the differences in the size of the case areas, which range from 20 km^2 to 250 km^2.

Table 2. Classification of case areas using FARO typology (%).

	Peri[1] Urban	Rural	Deep Rural	All[2]
EU	12	37	51	100
Denmark	10	55	35	100
Roskilde	**93**	5	2	100
Austria	22	50	28	100
Reichraming	0	43	**57**	100
Romania	5	28	67	100
Răteşti	4	**90**	7	100
Stăncuţa	1	2	**97**	100
Greece	4	30	66	100
Lesvos	7	**70**	23	100
Italy	32	47	21	100
Portofino[3]	**95**	5	0	100
Netherlands	36	55	8	100
Heerde	4	**96**	0	100

[1] See text for definitions.
[2] Only rural areas are included.
[3] See text for discussion of the Portofino classification.

4.3 Case areas in a multi-scale VOLANTE perspective

One of the VOLANTE research objectives is to identify and describe land use changes at the European level. This is done through research at multiple temporal and spatial scales and involves empirical data, modelling, and scenario-building. Workpackage 3 is concerned with the analysis of land use and land use intensity changes at different temporal and spatial scales based on remote sensing products and statistical data derived from various sources such as forestry and agricultural census. Deliverable 3.1 presents a range of intensity indicators which are expressed in maps showing recent changes in agriculture and forest systems at the European scale with a focus on land use intensity (many with a 1 km spatial resolution) (Kuemmerle et al. (2012). In this section, we examine three land use related indicators, which express different production intensity levels (forest harvest intensity and agricultural land use intensity (which builds on cropping intensity) and grazing intensity) for each case study area and in comparison with the respective country level as well as the EU-level.

Forest harvesting intensity

Forests are an important land use type in Europe covering 37% of its terrestrial surface and with large differences between countries and regions. However, forest areas grew steadily during the last decades with 0.37% per year and in particular with 0.1% between 2000 and 2006 (EEA, 2010; Forest Europe et al. 2011). Forests are important suppliers of timber for construction, paper, and other industrial uses and fulfil important ecosystem services (eg. water filtration and carbon sequestration). The intensity of use has been estimated by running a linear regression model for average forest harvesting rates (m3/ha) from 2000-2010 on a set of environmental, infrastructural, and socio-economic variables. The resulting relationship between target and explanatory variables was used to predict a suitability map, which, in turn, was utilized to spatially allocate wood harvest at the pixel level (1km2). It should be noted that the values for non-forest areas were set to 0 (not NA) for all variables before running the regression and the prediction and allocation procedures.

The resulting suitability map for the period 2000-2010 on a European level is shown in Figure 11. The map shows large areas of predicted high forest harvesting suitability in much of Central Europe, the Baltic countries and Southern Scandinavia. In contrast, low harvesting suitability is predicted in Southern Europe (Spain, Italy) and South East Europe (Greece, Romania, Bulgaria).

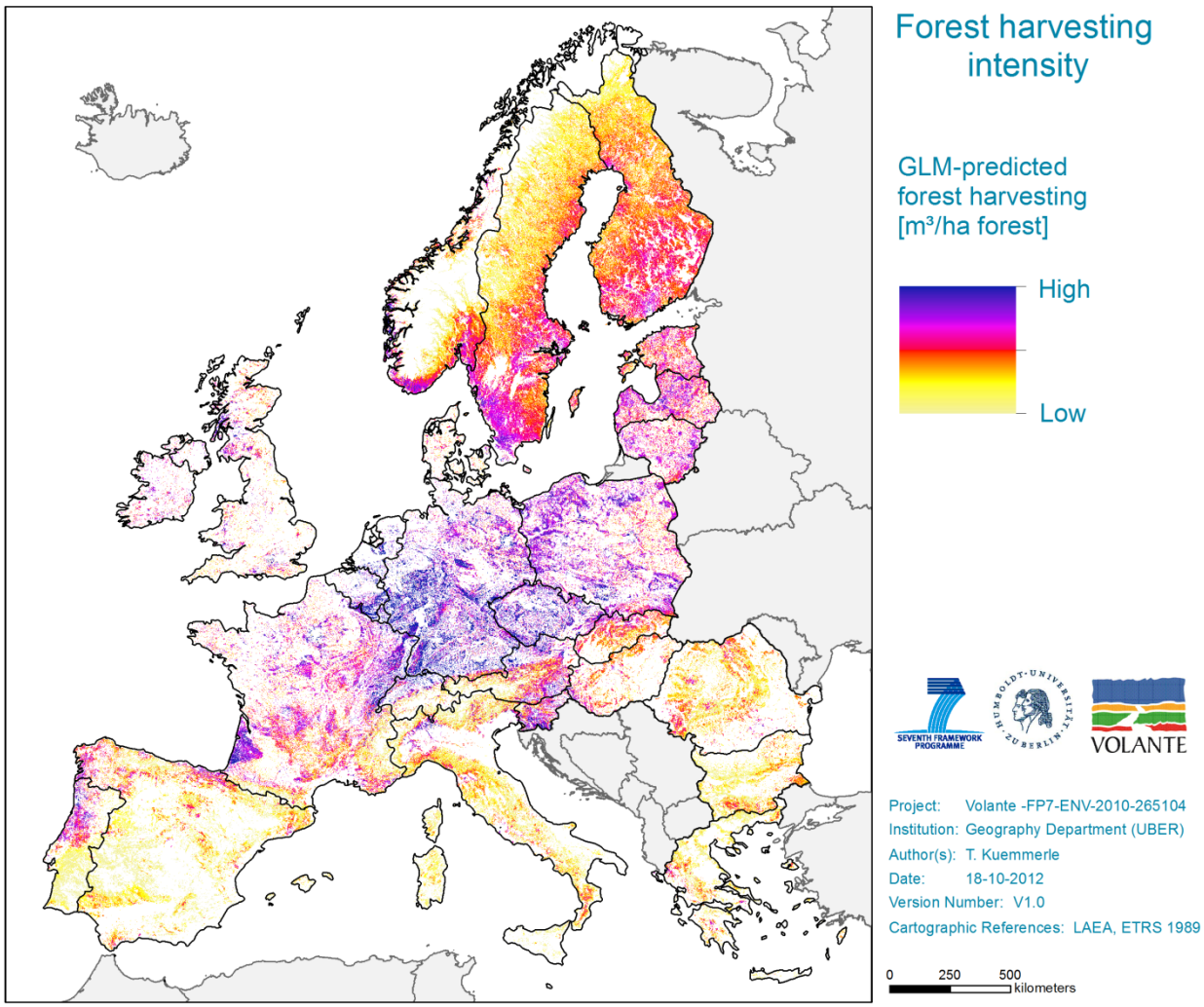

Figure 11. Predicted harvest intensity in 2010. Source: Kuemmerle et al. (2012).

The case areas contain a varying forest area which is reflected in Figure 12 showing the frequency of different (potential) forest harvest values. Inspection of the data behind the figure (pixel values in the attribute table of the raster map for each case area) reveals that the Portofino data is based on only 1 km2 which deviates considerably from the survey information (70% forest). This is due to geographical discrepancies between different map sources and this information is therefore omitted from the analysis.

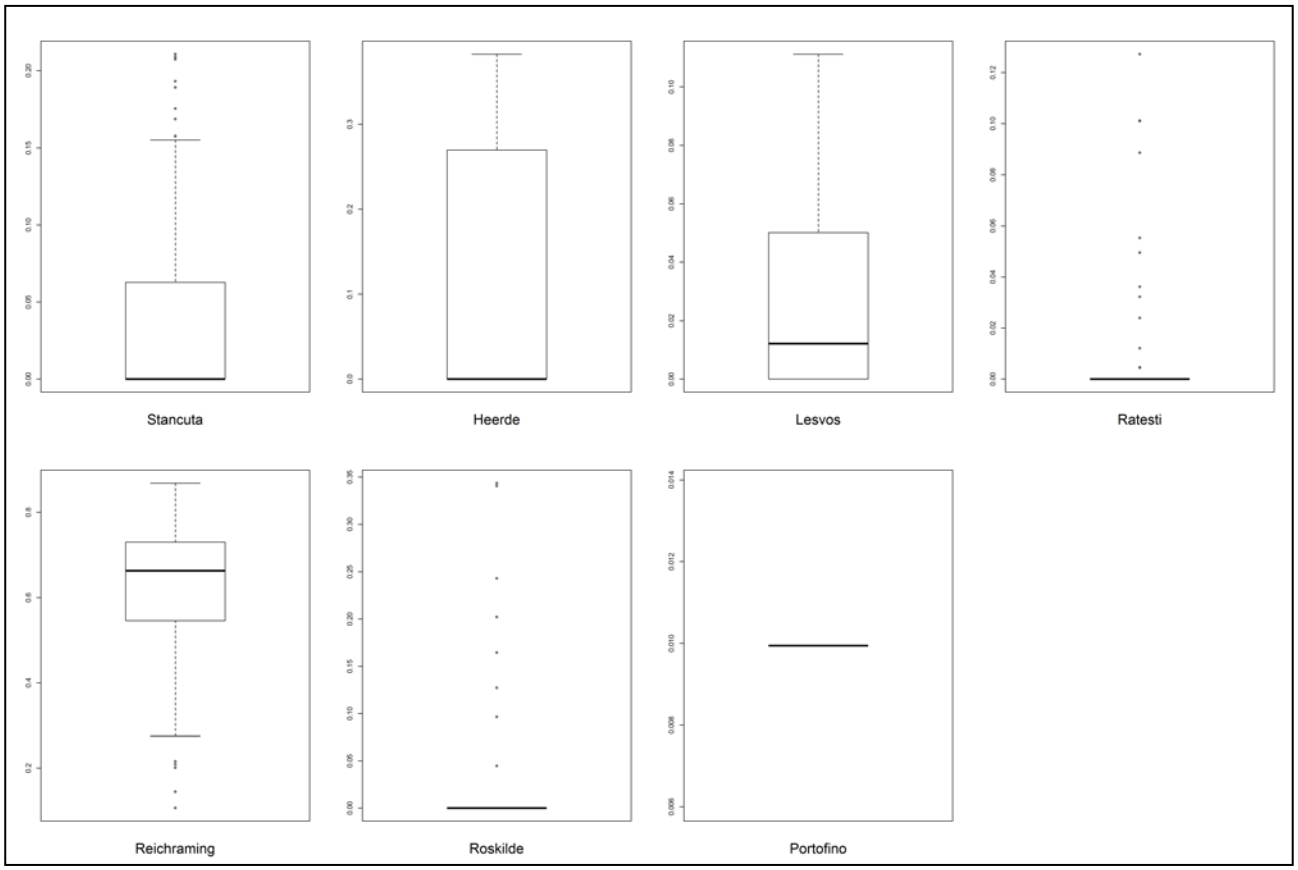

Figure 12. Boxplots of predicted harvest values in 2010. Values are in 1000 m3 wood harvested. Values for Portofino are uncertain due to a poor geographic fit of data sources. Calculation: Christian Levers (2013).

Figure 12 shows the distribution of predicted wood harvest values in each case area. Values on the x-axis vary between areas. For all areas, except Reichraming which has 80 % forest cover, modest median values are found (between 0 and 10 m3/km2). The intensively cultivated landscapes of ***Răteşti*** and ***Roskilde*** resemble each other, with very limited forest areas and hence a distribution of median, upper and lower quartile values close to 0.0 m3/km2. Small and isolated forest areas are shown as outliers, and reach values of 120 m3/km2 (***Răteşti***) and 350 m3/km2 (***Roskilde***). ***Stăncuţa*** contains more forest area and, although median values are as low as in ***Răteşti*** and ***Roskilde*** (close to 0.0 m3/km2), upper quartile level reaches 60 m3/km2. ***Heerde*** contains significant forest areas in the Veluwe forest, and although median values for this predominantly arable case area are close to 0.0 m3/km2, upper quartile values reach 250 m3/km2. ***Lesvos*** has large proportion of forest area and this leads to a higher median value than the other case areas (10 m3/km2) but moderate upper quartile values (45 m3/km2). This distribution reflects the uniformity of the land cover. As expected, ***Reichraming***, where the forest area is significant in terms of area and economic importance, has the highest median value (close to 650 m3/km2) and upper quartile values (close to 750 m3/km2).

Three of the case areas have higher potential forest harvest values than the countries they represent (***Heerde, Lesvos, Reichraming***), which reflects a proportionally larger forest areas or forest productivity of these areas than the country as a whole (Annex 2). ***Roskilde*** and the Romanian case areas are intensively cultivated areas and have less forest harvest intensity values than the countries they are located in. Due to

the uncertainties described above, it is not possible to compare ***Portofino*** with Italy. Only ***Heerde*** and ***Reichraming*** have forest intensity values which were above the general trend for Europe (Annex 2).

Cropping intensity

Crop rotations and the frequency of cropping are important indicators to assess the intensity of cropland management. This indicator provides information on the cropping intensity of arable land by separating single cropping and multi-cropping areas on an annual basis for the years 2001-2011. It is based on MODIS remote sensing data and data from the CORINE2000 land cover map. All MODIS pixels falling in cropland classes in the CORINE2000 land cover map were assessed and the results were calculated for ~ 232 m resolution.

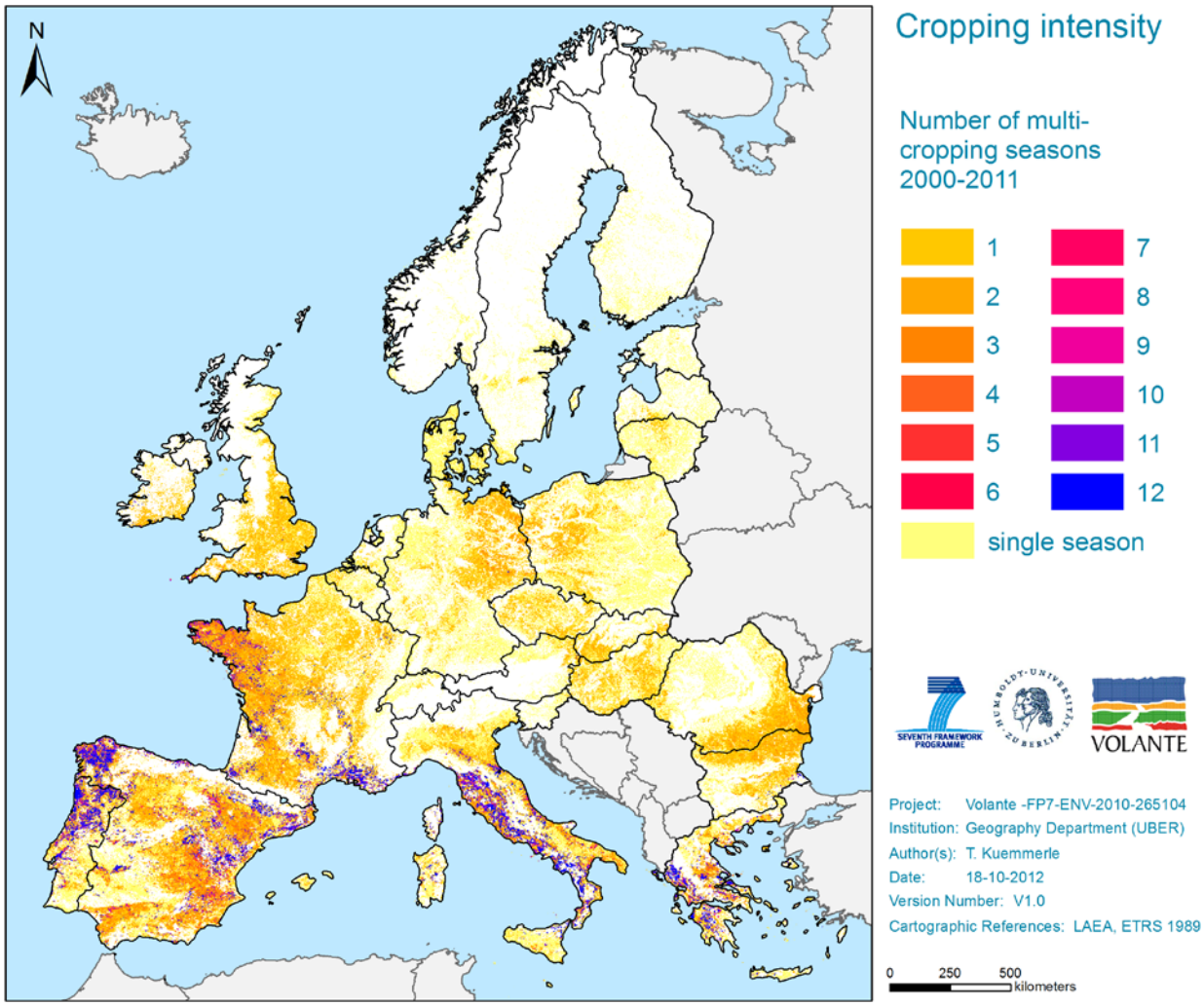

Figure 13. Cropping intensity (areas with multi-cropping seasons 2000-2011). Source: Kuemmerle et al. (2012).

The vast majority of areas classified as multi-cropping seasons only experienced one multi-cropping season out of the 12 years (72%). These could be areas where a catch-crop was planted after harvesting the main crop (typically cereals) as part of a crop rotation. Only 9% of the multi-cropping areas were predominantly

multi-cropping areas, having been cultivated multiple times in 9 out of the 12 seasons. These areas are located on the Iberian Peninsula, in Southern France, throughout Italy and Greece.

The distribution of areas with multiple cropping seasons reflects the overall pattern (Table 3). The two Romanian case areas have the largest number of areas with multiple cropping seasons (in particular ***Stăncuţa***), and they resemble the national pattern, with a predominance of areas which experienced 1 multiple cropping season 2000-11. In contrast, ***Lesvos*** and ***Portofino***, which are also located in countries with significant proportions of multiple cropping seasons, do not reflect these patterns at all, as they each contain very few areas where multiple cropping seasons have been predicted. Denmark has a predominance of areas with one multiple cropping season 2000-11 and this is also the case for ***Roskilde*** (again, very few areas in fact are predicted as such in Roskilde). No areas were predicted to have had multiple cropping seasons in ***Reichraming*** or ***Heerde***.

Table 3. The distribution of cells with different number of multiple cropping seasons, 2000-11.

	Frequency of cells with given number of multiple cropping seasons (MCS) 2000-11 (%)												Total MCS cells, 2000-11
	1	2	3	4	5	6	7	8	9	10	11	12	Number
Europe	72	16	3	1					1	1	3	4	3608818
Denmark	97	3											5061
Roskilde	100												38
Austria	90	9	1										8598
Greece	62	16	3	1				1	1	3	5	7	125549
lesvos	57	43											7
Romania	90	10											260017
Răteşti	100												126
stancuta	92	8											528
Italy	59	16	3	1				1	2	4	7	9	263594
Portofino	33										50	17	6
the Netherlands	97	3											2458

Grazing intensity

Livestock production is an important element in the farming systems in Europe, with large financial and environmental impacts. Traditionally, livestock production was an integral part of the local land use system with important feedback loops between nutrient cycles within arable and livestock production. In the past decades, livestock production has become increasingly decoupled from the local land use system, and instead depend on global processes and flows. For example, Denmark annually imports 300.000 Tons of soya as cattle feed supplement. Maps showing the spatial distribution of livestock in 2000 were prepared based on consistent regional livestock statistics. Five different livestock types were considered: dairy cattle, beef cattle, sheep, pigs, and poultry. Different approaches were used to distribute livestock based on land-related suitability rules for herbivores (dairy cattle, beef cattle, sheep) and monogastrics (pigs and poultry). In addition, statistical analyses were used to test how much of the present day European livestock distribution could be explained by a set of socio-economic and biophysical location factors. Figure 14 shows the herbivore map as a summation of the categories dairy/beef cattle, sheep.

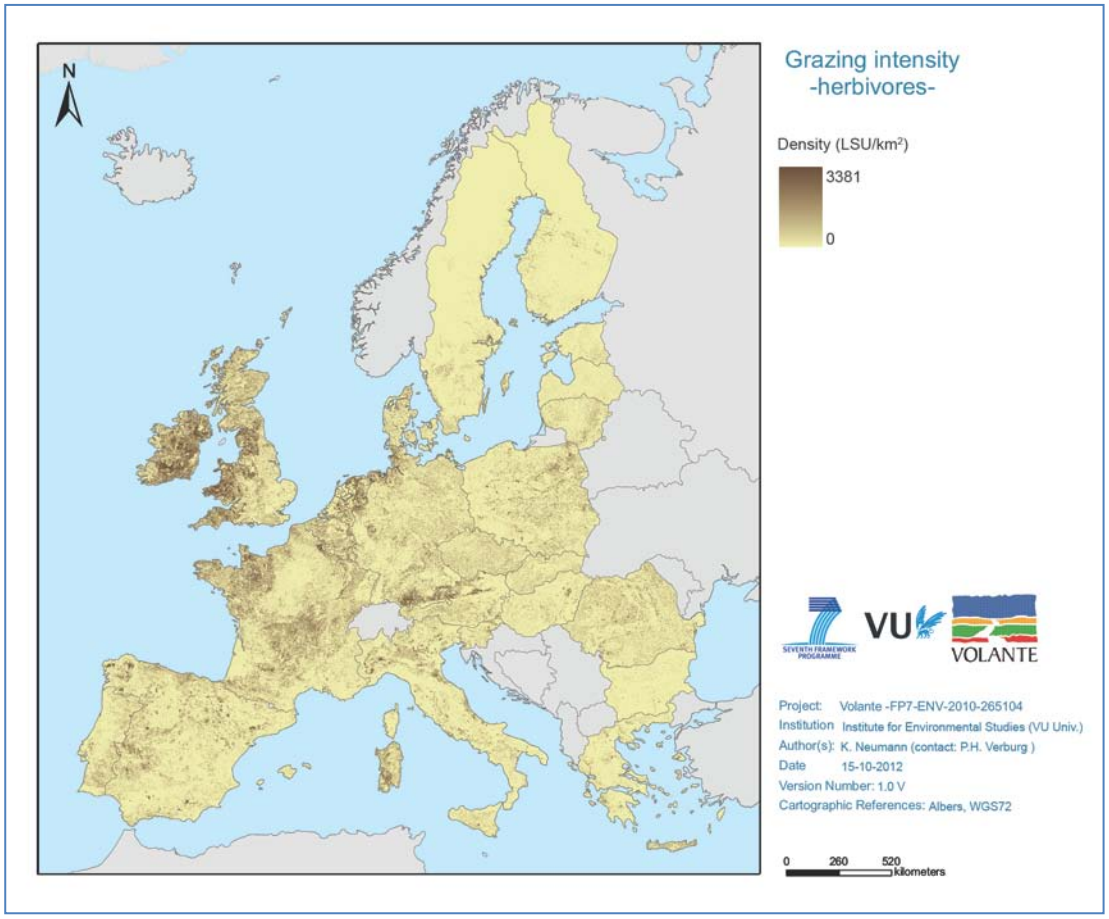

Figure 14. Predicted herbivore map as a summation of the categories dairy/beef cattle, sheep in 2000. Source: Kuemmerle et al. (2012).

The comparison of herbivore livestock density boxplots for the case areas indicate that herbivore livestock in general was not too important (or the areas not predicted to be very suitable) in 2000. Thus, all areas had a median value of 0, indicating a limited livestock density (Figure 15). However, in the case of herbivores (dairy cattle, beef cattle, sheep), ***Heerde*** appears to have had a significant cattle production, as indicated by and upper quartile values of 200 LSU/km2. Survey data confirm that dairy production was important around 2000 (and the highest of all the case areas) and was severely impacted by the Foot and Mouth disease in 2001 (a reduction from 1400 dairy cattle in 2001 to 1150 dairy cattle in 2012 on the farms involved in the survey). For all other areas, predicted suitability for herbivores is limited and only a few areas (shown as outliers) were suitable. In ***Stăncuţa***, ***Răteşti*** and ***Roskilde***, predicted livestock density reached between 200-500 LSU/km2 for these scattered areas, whereas they reached more modest density values in ***Reichraming*** and ***Lesvos*** (< 100 LSU/km2).

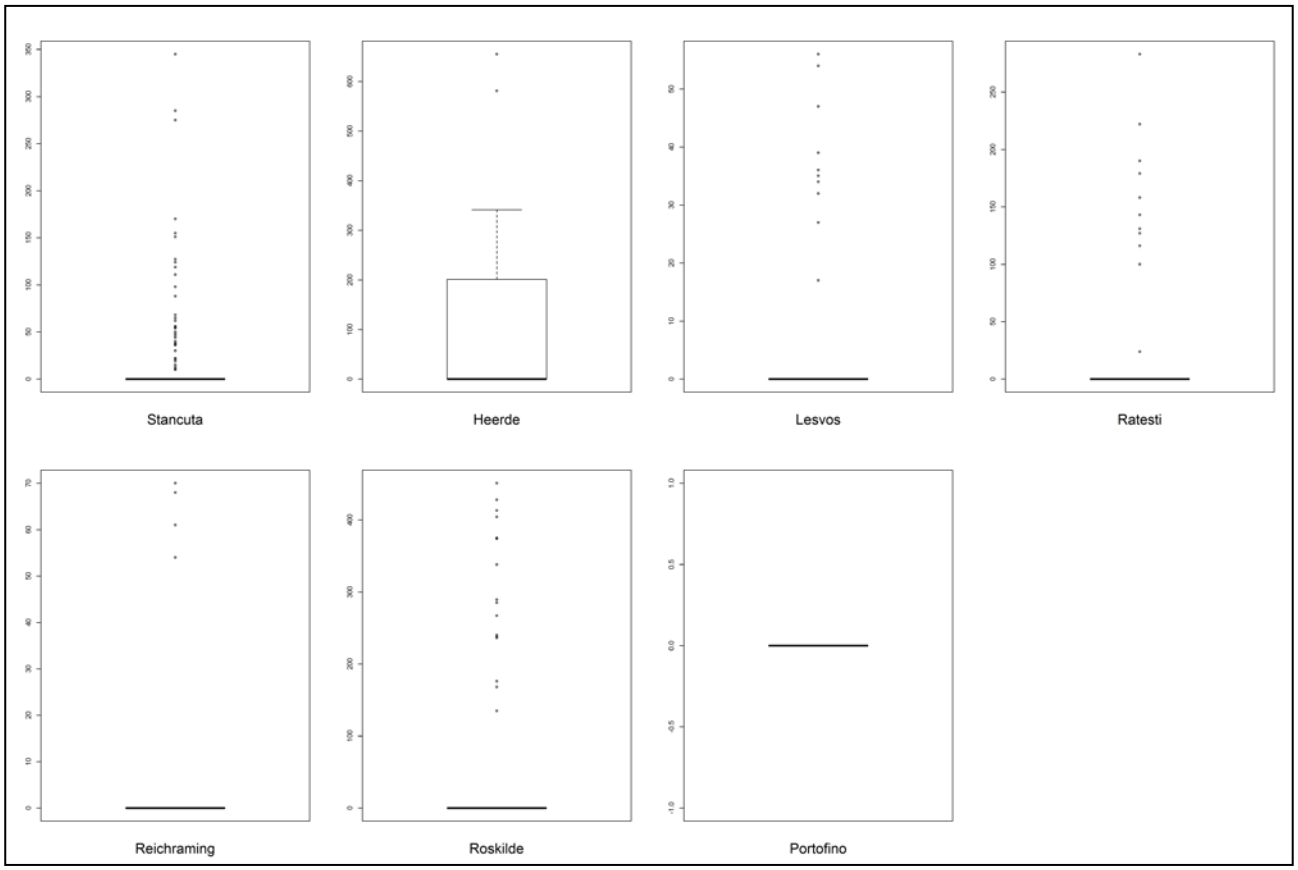

Figure 15. Boxplots of predicted Herbivore livestock density in the case areas in 2000. Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.

When comparing with the national level, a similar pattern is found: the Netherlands is the only country with an upper quartile value of 100 LSU/km2 (Annex 2). The results therefore suggest that the case areas reflected the national situation well in 2000 in terms of herbivore livestock density.

A similar situation is found for monogastric livestock density in 2000. All areas had a median value of 0, indicating a limited livestock density (Figure 16). For ***Reichraming, Lesvos and Portofino***, no areas were predicted as suitable for pig or poultry production. Survey data indicates that there was in fact a small pig production in ***Reichraming*** which involved 41 respondents, but this amounted to little more than subsistence production (5-10 pigs per respondent). A certain pig production was predicted for Roskilde and the Romanian case areas, with upper quartile values of 50-100 LSU/km for ***Stăncuţa*** and ***Răteşti*** and 250 LSU/km for ***Roskilde***.

Comparing these results with the national situation, it seems that ***Roskilde*** reflects the average situation in Denmark well, whereas livestock density in ***Stăncuţa*** and ***Răteşti*** was proportionally higher than the average situation in Romania (Annex 2).

It should be noted that the methodology behind the spatial distribution of livestock density was found by the authors who developed it to be most fitting at the European level and for certain countries and regions (Neumann et al, 2009). For example, the spatial distribution of livestock distribution in Denmark could not be predicted very well, which indicates that a number of additional (socio-economic) factors also have an

important impact on livestock distribution. Finally, it should be noted that the maps refer to conditions in 2000.

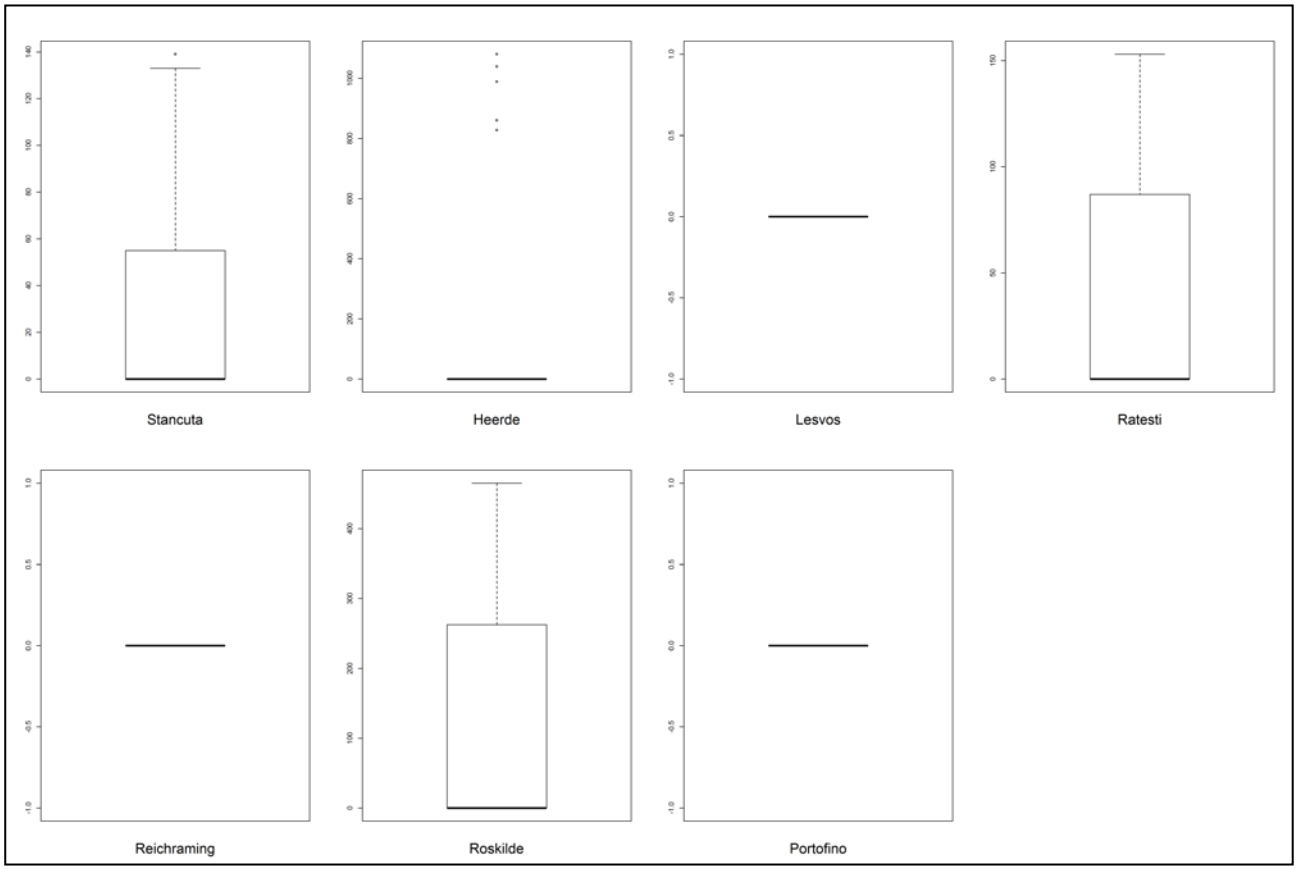

Figure 16. Boxplots of predicted monogastric livestock density in the case areas in 2000. Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.

In summary, the comparison of intensity indicators between case areas and with results at the national and EU scale show that the case areas indeed represent a range of landscape dynamics and, to a large degree, are representative of the national situation. Heerde and Reichraming contain proportionally more forest areas and have higher forest harvest intensity values than the Netherlands and Austria respectively while the same areas contain much fewer (none) areas which were predicted to have multiple cropping seasons between 2000-12. Livestock density varied considerably between areas and, in most cases, reflected the national situation. However, the small size of the case areas and the type of areas affected by the intensity indicators must be kept in mind when interpreting these results.

4.4 Land use changes

The work package investigated the land use changes in the case areas through a questionnaire administered to 437 respondents. The respondents were asked about the land use changes they had undertaken between 2002 and 2012 which had either led to an extensification or intensification of land use on the property. The changes (for the remainder of the report: landscape activities) were divided into those involving an *area* (eg. a field or a forest) and those involving a *linear* or a *point* feature (eg. a hedgerow or a pond).

Seen across all case areas, a third of all respondents had been involved in landscape activities, with more activities leading to an extensification of land use than an intensification of land use (Table 4). However, large differences were also found between areas. Very few land owners had participated in landscape activities in Portofino and the Romanian case areas.

Table 4. Number of landowners involved in different types of landscape activities. Each landowner has only been counted once, regardless of the number of activities undertaken per category.

% of landowners involved (per case area)	Extensification (less intensive land use)	Intensification (more intensive land use)	Establishment of linear or point features	Removal of linear or point features	Sample size per case area
Portofino	8	8	4	0	25
Heerde	17	6	44	10	47
Reichraming	29	27	23	18	73
Romania	13	1	2	0	109
Lesvos	22	9	17	7	90
Roskilde	32	3	37	2	93
All	22	8	21	6	437

4.1.1 Extensification

The most popular activity seen across all the case areas was conversion of land use from annual crops or grassland in rotation to perennial crops. This activity engaged 51 respondents, about 50% of all the landowners who had engaged in some sort of extensification of land use. The total area involved in these activities was 300 ha, with afforestation and perennial crops covering more than two-thirds. In terms of landowner engagement, full time farmers accounted for the largest area (almost 50%). Unsurprisingly, no full time farmers had abandoned agricultural land (Table 5).

Table 5. Extensification of land use. Change from annual crops or grassland in rotation to more extensive land use.

New landscape feature	No. of landowners	FULL TIME	HOBBY	NOT A FARMER	PART TIME	total area
		Area (ha)				
AFFORESTATION(>1 ha)	16	48,5	27	1	35	111,5
PERENNIAL CROPS (fruit orchards, olive groves, christmas trees, willows, grapevines)	51	64,5	8,7	3	46,2	122,4
SMALL THICKETS/BUSHES(<1ha)	15	13,5	1,4	1	4,3	20,2
UNMANAGED LAND (abandonment)	10		19,1		4,9	24
PERMANENT GRASSLAND	8	17,07	1,5	2	2	22,57
All	100	143,57	57,7	7	92,4	300,67

4.1.2 Intensification

The results indicate that 8% of all landowners had been involved in these activities, ranging from 1% in Romania to 27% in Austria (Table 4). The classical type of land use intensification, a change from nature to annual crops or grassland in rotation was the most common activity and had involved 15 landowners, evenly distributed between the case areas (Table 6). Unsurprisingly, full time farmers were responsible for almost half of the area converted from nature to annual crops or grassland in rotation. A change from "nature" (meadows or permanent grassland) to forest had involved 10 landowners.

Table 6. Intensification of land use. Change from nature to annual crops or grassland in rotation.

New landscape feature	No. of landowners	FULL TIME	HOBBY	NOT A FARMER	PART TIME	total area
		Area (ha)				
ANNUAL CROPS	15	27,2	12,5	0	7	46,7
FOREST	10	24		0	4,5	28,5
GRASSLAND IN ROTATION	8	19,2		0	16	35,2
Other	8	12,1		3,3	2,5	17,9
All	41	82,5	12,5	3,3	30	128,3

4.1.3 Establishment of linear and point features

The establishment of linear and point features involved 21% of all the landowners in the survey (Table 4) which is comparable to the proportion involved in landscape extensification. This number covers a range from 2% in Romania to 44% in the Netherlands. Hedgerow planting was the most common activity and corresponded to almost half of all the activities and full time farmers were responsible for about half of the hedgerows planted (Table 7). The building of terraces is only found in Greece and is linked with olive production in mountainous landscapes. The digging or renovation of ponds is virtually only found in Austria (one third of all pond-digging) and Denmark (half of all pond-digging activities). Other activities (planting of single trees, buffer strips along stream, earth dike renovation) are found evenly across all areas.

Table 7. Linear and point features established.

Feature established	No. of landowners	FULL TIME	HOBBY	NOT A FARMER	PART TIME	All
HEDGEROWS (length in meters)	48	13.232,44	2.580	2.900	4.065,7	22.778,14
PONDS (numbers)	28	61	6	4	12	83
TERRACES (ha)	14	1,4	2,1	2,2	13	18,7
OTHERS (single trees, buffer strips along stream, earth dike renovation) (numbers of land owners involved)	19	5	8	1	5	19

4.1.4 Removal of linear and point features

The removal of linear and point features only involved 6% of all landowners, ranging from 0% in Romania to 18% in Austria (Table 4). The dominant activities were removal of hedgerows, which was mainly done by Austrian land owners, who were responsible for 40% of all hedgerow removal (Table 8). The removal of trees and stones was exclusively done in Austria to improve the management of alpine grassland. The removal of terraces only occurred in Greece. Removal of features was often linked with the establishment of new features (Table 7), in which case it was part of a maintenance activity.

Table 8. Linear and point features removed.

Feature removed	No. of respondents	FULL TIME	HOBBY	NOT A FARMER	PART TIME	total
Fruit trees (number)	1				20	20
HEDGEROWS(ha)	2		2		0,3	2,3
HEDGEROWS(length in meters)	10	1.112,44	23		212	1.347,44
OTHER (ha) (trees and stones removed)	8	70,2			40	110,2
OTHER:(number) (oak tree removed)	1	1				1
OTHER (number)	1	0,2				0,2
PONDS (number)	2				1	1
TERRACES (ha)	3		0,4	2	0,2	2,6

4.1.5 Level of land owner involvement in landscape activities

The level of involvement in landscape activities varied considerably for different types of landowners, as indicated in Tables 4 to 8. Table 9 presents the proportion of landowners involved in the different types of landscape activities. Each respondent appears every time he/she has been involved in a landscape activity, thus a particular respondent may appear several times.

Table 9. Proportion of landowners involved in landscape activities

Landscape activity	Full-time			Part-time/hobby			Not a farmer			All
	No.	% of landowners within landscape activity	% of farm group	No.	% of landowners within landscape activity	% of farm group	No.	% of landowners within landscape activity	% of farm group	
Extensification	41	39	25	57	55	28	6	6	9	104
Intensification	24	56	15	15	35	7	4	9	6	43
Establishment of landscape elements	32	30	20	63	58	31	13	12	20	108
Removal of landscape elements	8	36	5	13	59	6	1	5	2	22
All	105	39	64	143	53	69	22	8	34	270

The analysis reveals that full-time land owners were responsible for the largest proportion of the landscape changes in terms of area or length of landscape elements (Table 5-8). This is not surprising, seen from a land management perspective. Full time farmers manage the largest areas and are therefore able to engage in larger projects. However, a more differentiated pattern appears in terms of number of land owners from different land owner types involved in the different types of activities (Table 9). Firstly, as outlined in Table 4, relatively more land owners have extensified than intensified land use (the same is true for establishment vs. removal of landscape elements). Secondly, relatively more part-time and hobby farmers than full-time land owners have extensified land use (55% vs. 39%), while the opposite pattern is seen for intensification of land use (35% vs. 56%). This result confirms what was to be expected, that full-time farmers are more interested in activities leading to an intensification of land use to optimize agricultural production. Non-farmers constitute the smallest segment within both types of landscape activities, which is not surprising given their limited farm size and access to agri-environmental schemes. Thirdly, examination of the proportion of land owners within each category who have participated in the different landscape activities, a similar pattern appears. This is especially true for those activities leading to an intensification of land use, where a larger proportion of the full-time farmers than part-time and hobby farmers participated (15% vs. 7%). The pattern is not quite as clear for activities leading to an extensification of land use (25% vs. 28%). Fourthly, despite the varying proportions of different land owner groups involved in the four types of land use changes, full-time farmers were consistently responsible for the largest area affected by the activities.

4.1.5 Impact and pattern of landscape changes

The overall impact of the landscape changes described above can be assessed in a rough manner by comparing the area and distances of removed and created landscape features. This purely quantitative

assessment indicates that relatively more nature or landscape features have been added to the landscape by landowners than removed by them in the six case areas:

- Creation of 23 km of hedgerows while 1.3 km has been removed.
- Creation of 83 ponds while 1 pond has been removed.
- Extensification of 300 ha of farmland (conversion to "nature") and intensification off 128 ha of "nature" (conversion to annual crops, grassland in rotation or forest).

The analysis has underlined the variety of European landscapes. Many landscape activities were strongly geographically biased:

- The conversion of land use from annual crops or grassland in rotation to perennial crops had strong geographic features. Landowners in the Mediterranean countries typically planted olive groves or fruit orchards, Romanian landowners planted vines while land owners in Denmark planted Christmas trees.
- The building and removal of terraces was only found in Greece and is linked with olive production in mountainous landscapes.
- Hedgerow planting and removal was strongly dominated by landowners from Heerde (NL) and Roskilde (DK). In Roskilde, hedgerows have become popular as a way to improve nature and in Heerde they are traditionally planted to provide a wind break for livestock.

Based on these results, it appears that land owners in peri-urban areas have been the most active land owner group in the last ten years. However, this result should be interpreted in light of a number of factors:

- National legislation and tradition: there is a strong tradition for landscape management in rural areas in Denmark in general, not only in peri-urban areas.
- Current land use system: The cropland area in the Romanian case areas covers a large proportion of the area and there are few opportunities for extensification of land use, in order not to interfere with current agricultural production. At the same time, there are few nature areas left where land use can still be intensified. This may partly explain the limited level of participation by the respondents in these case areas.
- Agricultural system: The extensive agricultural system in Portofino, with a large proportion of perennial crops, does not cater easily for a conversion to eg. afforestation or grassland. These land cover types therefore fall outside the scope of many farms.

The results indicate that a considerable number of European land owners are actively engaged in landscape activities. As will be discussed in greater detail in section 4.5, the access to subsidy schemes plays a considerable motivating role.

4.5 land owners' use of agri-environmental schemes

A major innovation of EU CAP policy since 1992 has been the development of agri-environmental schemes which promote sustainable land use and seek to mitigate the negative impacts of intensive agricultural production. Currently, agri-environmental schemes are part of the Rural Development Program (Pillar 2) of the CAP framework. The current rural development program (2007-13) has devoted nearly 20 billion Euros or 22% of the expenditure for rural development.

We were interested in investigating the extent and patterns of scheme use in the case areas, to illuminate the role they play in the types of landscapes represented by the WP1 case areas.

All in all, 42% of the land owners had received subsidies under the Rural Development Program 2007-2013. The most popular subsidies were area subsidies for the maintenance of olive groves (Lesvos), subsidies for support for less-favoured areas other than mountain areas (Romania) and Subsidies of the Agri-Environmental Programme (Austria) (Figure 17). The schemes implemented vary between countries and the mode of implementation also varies considerably, even for the same scheme (Buller, 2000).

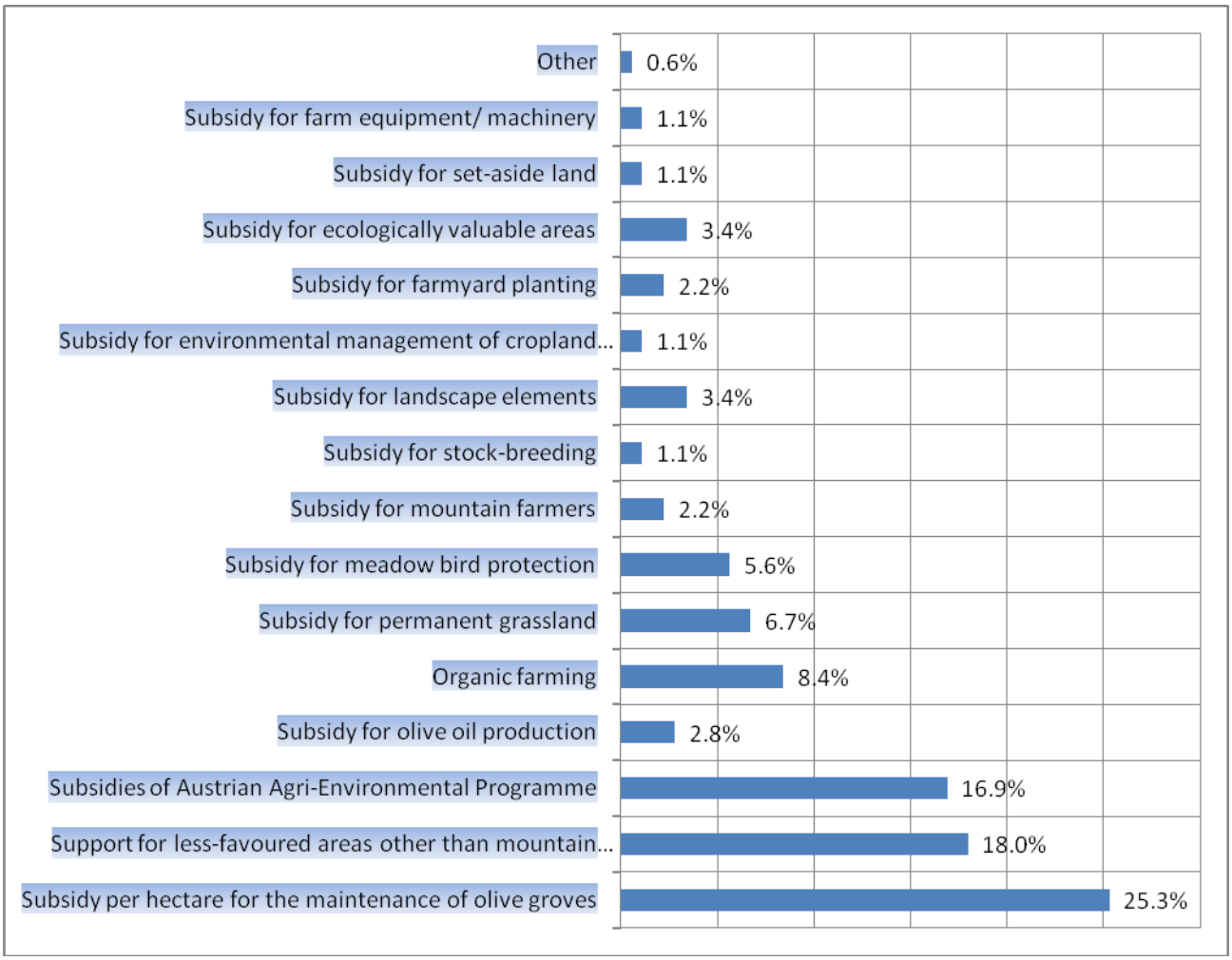

Figure 17. Level of participation in subsidy schemes in percent (N: 178).

Distinct geographical and socio-economic patterns in terms of scheme participation were identified. Subsidy schemes for the support of less favoured areas other than mountain areas concern the Romanian case study, where the great majority of the full time farmers participated. Subsidies per hectare for the maintenance of olive groves and olive oil production concern only Lesvos, where especially non-farmers, but also many hobby farmers, participate. The subsidy for permanent grassland concerns Roskilde, where mostly part-time farmers participate. All the full and part time farmers who use subsidies in Reichraming participate in the Austrian Agri-Environmental Programme (Öpul). Finally, for the Netherlands case study, most prefer to use subsidies for meadow bird protection. A subsidy for organic farming is used in Greece, Austria and Denmark (conversion only), but the number of participants is relatively small.

It should be kept in mind that the scheme requirements vary quite considerably. For example, the subsidy for maintenance of olive groves has few requirements other than the existence of an olive grove on the property while the subsidy for landscape elements (may) require an active effort. Thus, for some subsidies it is easier to comply with the requirements. It is interesting that the vast majority of scheme participants reported that there had not been any land use change as a result of scheme participation. This is most likely linked to the fact that the purpose of many schemes is conservation and preservation, and the lack of land use change can therefore be described as a scheme success. About 10% of the scheme participants had undertaken extensification of land use (conversion from crop land to either grassland or forest) and 12% described the impact of scheme participation as creating a more diversified landscape mosaic, for example through the creation of more habitats.

Concerning the main reasons for use of subsidy scheme, the majority of the respondents referred to farm economic considerations/ gains (e.g. increase income, reduce economic risks, new investments). Concerning the main reasons for not using the subsidy schemes, most of the respondents who did not use subsidies said that this was because they lack areas eligible for subsidies under the agri-environmental schemes. Several full-time farmers mentioned that lack of knowledge or information about scheme was an important reason for non-participation, as well as fear of losing income in case they failed to comply with all requirements. Interestingly, the subsidy level in itself did not seem to be an obstacle for scheme participation, but there were indications that landowners considered the relatively small subsidy to be unattractive in light of the administrative burden and public control it involves. The motives are illustrated by selected land owner interviews (textbox 1).

Textbox 1. Motives for Agri-Environmental Scheme (non-) participation.

"I used to sow a strip of grass and cereals in a field for the wild animals to feed on. However, since a friend of mine had to return a large portion of the Area Payment because the involvement in an AES had reduced the cultivated area, I no longer do that. I am afraid to run into trouble. The EU requirements are simply too strict and inflexible" (Land owner, Roskilde).

"I have been using the AES scheme for many years. I am a hobby farmer and it fits well with my strategy, to increase the amenity value of the property. However, I can understand why large, full-time farms may not want to participate, the payment is too small to compensate for the loss of income from their land" (Land owner, Roskilde).

"The fact that I am a part-timer and (maybe, more or less) a hobby farmer is the main reason why I do not have enough information about the schemes and why I am not into subsidy schemes. Besides, the economic incentive is too small, since my expenditure on agriculture is large" (Land owner, Lesvos).

"I like nature, and I'm happy to do something for the animals, but all those papers you have to fill in for just a few Euros, and people come checking what you are doing on your land. It is just not worth it, I won't apply for the money if I plant some trees." (Land owner Heerde).

4.6 Multifunctionality and diversification of income sources

In the past decades, the number of persons working full-time on farms in the EU has been drastically reduced, and 83% of the family labour force were only working part-time on the farm in 2002 (Linares, 2003). In many cases, economic circumstances have forced land owners to supplement income with off farm income or to diversify production on the property into non-agricultural activities, also called Other

Gainful Activities (OGA). Both of these types of development lead to a more multifunctional production pattern, as opposed to the traditional agricultural production strategy which has clear land use implications. Part-time farmers may need to pursue special strategies to be able to accommodate both on- and off-farm employment (eg. a simple rather than a complex crop rotation, no animals to reduce labour use and thus less need for feed crops). Properties with OGA activities may devote buildings or land to these activities and thus introduce alternative types of land use. Due to its land use implications, we assessed the different levels of engagement in agriculture in the case areas as well as the extent of OGA on the properties.

4.6.1 Level of engagement in agriculture

We used two approaches to assess the owners' level of engagement in agriculture.

- *Self-assessment*: the respondent was asked whether he/she considered his/herself to be a full-time, part-time, hobby or non-farmer.
- *Owner and family use of time on agricultural activities*: The respondent reported the time spent on agricultural activities on the property for different family and non-family workers. In addition, the size of production, its economic importance and age of the workers was also taken into consideration to enhance the comparability of the classification. Based on this information, the following categorisation was done:
    - Full-time: the owner (or another family member) used 100% of his/her time on agricultural activities on the property.
    - Part-time: the owner (or another family member) used 50-99% of his/her time on agricultural activities on the property.
    - Hobby: the owner (or another family member) used 1-49% of his/her time on agricultural activities on the property.
    - Non-farm: the owner (or another family member) used 0% of his/her time on agricultural activities on the property.

In most cases, it was quite straightforward to categorise the respondents based on these criteria. If several family members spent time on agricultural activities on the property, the status of the person spending the most time was used. In certain special cases, such as the case of pensioners, a re-classification was done, to reflect the reduced economic performance of the farm and the (generally) smaller role of income from agricultural activities in the total household income.

When comparing the two approaches, we found that the full-time farmer accounted for 38% or 26% of the respondents and that part-time and hobby farmers were the biggest group (either 48% or 57% of the respondents) and non-farmers constituted the smallest group (either 15 % or 17% of all respondents) (Table 10). The differences between the two classifications were mainly due to the re-classification of pensioners and many respondents in Roskilde who claimed to be part-time farmers, yet used less than 50% of their time on agricultural activities.

Looking at differences between the case areas, there is generally agreement between the two types of categorization, especially if the part-time and hobby farmers are considered as one group (Table 11). The Romanian case areas stand out with almost three times as many part-time and hobby farmers according to the time reported spent on the property on agricultural activities compared with the respondents' self-assessment (59% vs. 20%). A large number of respondents in these case areas had declared themselves to

be full-time farmers (many of them pensioners), but lacked many of the characteristics according to information from other indicators. Furthermore, the four respondents in Portofino who had declared that they considered themselves to be full-time farmers were considered as part-time or hobby farmers according to the limited importance of agricultural income in the household budget. In addition, the proportion of landowners who were not involved in agricultural production is larger in Roskilde, when considering the new parameters.

Table 10. Level of engagement in agriculture (%), N: 437.

Level of engagement in agriculture	"Own-assessment"	Time spent on agricultural activities
Full-time	38	26
Hobby	17	32
Part-time	31	25
Non-farmer	15	17
Total	100	100

The proportion of full-time farmers varies considerably between the case areas (Table 11). In the marginal Mediterranean areas, they are a clear minority, especially if we consider the classification based on time used in agricultural activities on the property. This is to be expected in areas where farm profitability is limited. It is therefore surprising that full-time farmers constitute the largest proportion of land owners in the marginal Alpine area, which also faces economic challenges. The explanation is the diversification of income sources, where involvement in OGA and off-farm income besides agricultural production is common. In addition, the agricultural system (a high proportion of dairy cattle rearing) requires constant labour input and is less compatible with part-time and hobby farming. In peri-urban landscapes, there are few full-time farmers, as many land owners use the property for non-agricultural activities or purely as a residence. This explains the large proportion of non-farmers in Roskilde. The Heerde case area exhibits similar characteristics although not as extreme as seen in Roskilde. Thus, one third of the land owners are engaged in full-time farming. See Annex 1 for further details on the differences in land use and agricultural systems in the case areas.

Table 11. Level of engagement in agriculture per case area (%), N: 437.

Land owner type	Roskilde (DK) (N:93)		Reichraming (AU) (N:73)		Stancuta & Ratesti (RO) (N:109)		Lesvos (GR) (N:90)		Portofino (I) (N:25)		Heerde (NL) (N:47)	
	own-assess.	time agri.	own-assess.	time agri.	own-assess.	time agri.	own-assess.	time agri.	own-assess.	time agri.	own-assess.	time agri.
Full-time farmer (%)	15	12	56	52	71	32	13	8	16	0	36	36
Hobby farmer (%)	8	39	0	8	6	11	38	54	28	64	38	51
Part-time farmer (%)	49	14	44	40	14	48	19	6	52	28	23	11
Not a farmer (%)	28	35	0	0	9	9	30	32	4	8	2	2
Total (%)	100	100	100	100	100	100	100	100	100	100	100	100

4.6.2 Other gainful activities on the property

The survey investigated the types and frequency of OGA on the farm properties. The results indicate that OGA is the fourth most important source of income and is found on 22% of all properties (Table 12). Looking closer at the types of activities, they span from direct marketing of farm produce to agro-tourism, horse-riding stables and renting out of buildings as storage or production space. Most land owners use buildings for OGA activities and only a small number of land owners use land for OGA purposes (eg. horse-riding, camping).

A large proportion of non-farmers and part-time farmers engage in these activities (34% of both land owner types) while they appear to be least popular among hobby-farmers (typology is based on self-assessment by land owners). This may be due to a lack of property and land and a greater focus on involvement in other income generating activities (off-farm activities, pensions). Looking at the frequency of land owners involved in OGA, part-time farmers constitute the largest group (40% of all land owners involved in OGA).

Table 12. Different landowner types involvement in income generating activities (as a proportion of landowners in specific group and type of income activity).

INCOME TYPE	FULL TIME		HOBBY		NOT A FARMER		PART TIME		Total
	% of group	% of income type	% of group	% of income type	% of group	% of income type	% of group	% of income type	All landowners with income type
FARM INCOME	87	44	60	14	51	10	79	33	323
OTHER GAINFUL ACTIVITIES	21	30	16	11	34	19	34	40	95
OFF-FARM INCOME	26	20	59	20	55	17	68	43	213
PENSIONS	42	41	48	21	37	14	32	25	170
SUBSIDIES	17	41	12	13	3	3	23	43	69
Other	2	100	0		0		0		3

The comparison of OGA involvement in different case areas reveals a strong geographic pattern. The majority of landowners in Roskilde are involved in OGA (58%) and constitute almost half of all landowners involved in OGA (48%) (Table 13). This result indicates that land owners in peri-urban areas are more likely to engage in OGA as the location offers markets and business opportunities.

Table 13. Landowner involvement in income generating activities in different case areas (as a proportion of landowners in each case area and type of income activity).

INCOME TYPE		FARM INCOME	OTHER GAINFUL ACTIVITIES	OFF-FARM INCOME	PENSIONS	SUBSIDIES	Other	Total
Roskilde (DK)	% of landowners in area	88	58	65	28	3	0	93
	% of income type	25	48	28	15	4	0	
Reichraming (AU)	% of landowners in area	67	34	40	18	59	4	73
	% of income type	15	22	14	8	61	100	
Stăncuţa & Ratesti (RO)	% of landowners in area	94	3	37	58	3	0	109
	% of income type	32	3	19	37	4	0	
Lesvos (GR)	% of landowners in area	46	21	54	43	21	0	90
	% of income type	13	17	23	23	27	0	
Portofino (I)	% of landowners in area	16	16	56	48	8	0	25
	% of income type	1	4	7	7	3	0	
Heerde (NL)	% of landowners in area	96	17	47	36	0	0	47
	% of income type	14	7	10	10	0	0	
Total	(N)	324	113	214	170	70	3	

4.7 Processes of intensification and extensification of agricultural production

The dynamics of agricultural production have direct and indirect impact on land use patterns and changes. Contradictory trends characterise the changes in recent decades in Europe. Environmental legislation has increasingly affected the level of agro-chemicals use, eg. through the EU nitrate directive. In addition, economic conditions affect the profitability of production and through that the use of agro-chemicals. In areas where agricultural production is less profitable, land owners may decide to reduce the use of agro-chemicals. In contrast, many full-time farms in post-socialist regions have introduced modern farming systems since 1989 which may imply higher levels of agro-chemicals use. At the local level, land owners decision to pursue either an **intensification or extensification** strategy is influenced by endogenous factors (farm system, family situation, choice of income sources). We investigated the processes of intensification

and extensification of agricultural production in the case areas trough the changes in level of intensity for selected production characteristics (crop yield, livestock numbers, use of fertilizer and pesticides, share of cropland). Respondents in the 6 case areas were asked to indicate whether the trend between 2002-2012 had been a decline (extensification), stability (unchanged) or increase (intensification) for these production factors. The response was not quantitative and the results should therefore be considered as indicative rather than absolute values. Note that respondents were not involved in all activities, for that reason the totals differ for the different indicators.

4.7.1 General trend

The general trend is that production intensity remained unchanged for the majority of land owners for each indicator (Table 14). Apart from this dominant trend, more land owners reported increase rather than decrease in crop yields and proportion of cultivated area on the farm. In contrast, more land owners reported a decrease rather than an increase in livestock stocking rate and use of agro-chemicals (Table 14).

Table 14. Change in agricultural production intensity indicators, 2002-2012.

Intensity indicator	Decrease	Unchanged	Increase	Total
Crop yield (t/ha)	39	163	78	280
Cultivated area/Total area (%)	34	212	45	280
Nitrogen use (kg N/ha)	94	183	39	316
Pesticide use	72	192	38	302
Stocking rate (no. of livestock/ha)	77	148	49	274
Total	316	898	249	1452

4.7.2 Trend per case area

When we analysed the patterns for each of the six countries, no clear tendencies or geographic patterns emerged (Table 15).

Changes were very limited for both ***Lesvos*** (G) and ***Portofino*** (I). The main crop is olives in both areas, which are grown in a traditional system without much use of fertilizer and pest control. In addition, only few respondents consider themselves as full time farmers (4 out of 25 farmers in Portofino, 12 out of 90 in Lesvos) and most farmers are old, which does have consequences for their enthusiasm and interest in an intensification of the agricultural system. In Lesvos there is a decrease in crop yield (12 out of 21), which is, besides the reasons stated above, also attributed to lack of agricultural education and support, pests and droughts.

Heerde (Nl) was one of the first areas with a large outbreak of Foot and Mouth Disease in the Netherlands in 2001, resulting in the destruction of the entire livestock herd. At that point in time, several farmers stopped with livestock rearing. In addition, many small farms have reduced production and a few big farms have taken over smaller farms. This is visible in the livestock numbers which decreased in 22 out of 42 cases. This is also reflected in the farm size which decreased (in 10 cases), remained stable (15) or increased (15). Many older farmers are close to the end of their active farming career and therefore winding down their farming activities.

In ***Reichraming*** (A), the crop yield, cultivated area and stocking rate increases. This is explained by the economical drivers, which force farmers to intensify production.

The two areas in Romania (***Stancuta*** and ***Ratesti***) show an increase in crop yields, fertilizer use and pesticides, and a decrease in stocking rate. The large scale cropland abandonment which characterised the land use situation of the 1990s (Kuemmerle, 2009) was not observed in the data for the past 10 years. The increased use of agro-chemicals is explained by the transformation from the collective farm system to a modern agricultural system with increased use of inputs. The decrease in stocking rate is also caused by the shift in farming system as many small-scale farms have given up livestock production. An increase in yield in 34 cases (out of 97) seems modest. This may be related to the limited experience with farming, as a result of the collectivisation which took place in 1962. Despite the increased use of inputs, the yields appear not (yet) to have increased correspondingly.

The Fisher exact test (threshold 0.05) was used to test which countries differed in pattern. The data for Italy were omitted since there were too few observations of change. We tested two factors: the difference in percentage unchanged versus decrease/unchanged/increase, as well as the difference in percentage decrease, versus decrease/increase (so, omitting all cases of no change) (Table 16).

Table 15. Change in agricultural production intensity indicators per case area, 2002-2012

Crop_yield	Decrease	Increase	Unchanged	All	%Unchanged	%Decrease
Reichraming	3	20	35	58	60.3	13.0
Roskilde	11	8	40	59	67.8	57.9
Lesvos	11	5	4	20	20.0	68.8
Heerde	11	8	23	42	54.8	57.9
Romania	2	34	61	97	62.9	5.6
Portofino	1	3	0	4		
All	39	78	163	280		
Cultivated area	Decrease	Increase	Unchanged	All	%Unchanged	%Decrease
Reichraming	2	19	35	56	62.5	9.5
Roskilde	14	3	46	63	73.0	82.4
Lesvos	2	5	20	27	74.1	28.6
Heerde	12	5	25	42	59.5	70.6
Romania	3	11	86	100	86.0	21.4
Portofino	1	2	0	3		
All	34	45	212	291		
Nitrogen use	Decrease	Increase	Unchanged	All	%Unchanged	%Decrease
Reichraming	11	4	44	59	74.6	73.3
Roskilde	40	1	22	63	34.9	97.6
Lesvos	13	4	28	45	62.2	76.5
Heerde	19	2	26	47	55.3	90.5
Romania	11	28	63	102	61.8	28.2
Portofino	0	0	0	0		
All	94	39	183	316		
Pesticide use	Decrease	Increase	Unchanged	All	%Unchanged	%Decrease
Reichraming	6	6	48	60	80.0	50.0
Roskilde	31	1	28	60	46.7	96.9
Lesvos	9	2	29	40	72.5	81.8
Heerde	16	2	24	42	57.1	88.9
Romania	9	27	63	99	63.6	25.0
Portofino	1	0	0	1		
All	72	38	192	302		
Stocking rate	Decrease	Increase	Unchanged	All	%Unchanged	%Decrease
Reichraming	8	22	32	62	51.6	26.7
Roskilde	20	11	31	62	50.0	64.5
Lesvos	1	1	3	5	60.0	50.0
Heerde	22	5	15	42	35.7	81.5
Romania	24	8	67	99	67.7	75.0
Portofino	2	2	0	4		
All	77	49	148	274		

This analysis showed not significant differences between the countries for the different factors. This shows for example that the pattern in crop yield Austria and Romania is similar, versus Denmark/Greece/The Netherlands. For cultivated area this shows Austria/Greece/Romania versus Denmark/The Netherlands. Overall we can see that Austria and Romania show similar patterns of change, as do Denmark, Greece and the Netherlands.

Table 16. Fisher exact test, patterns of similarities/divergence between countries

Factor		
Crop yield	Austria/Romania	Denmark/Greece/The Netherlands
Cultivated /Total area	Austria/Greece/Romania	Denmark/Netherlands
Nitrogen use	Romania	Austria/Greece/Denmark/Netherlands
Pesticide use	Austria/Romania	Greece/Denmark/Netherlands
Stocking rate	Austria	Greece/Denmark/Netherlands/Romania

5. Discussion and conclusion

The case studies conducted in WP1 have documented the large diversity of European landscapes and land owners. The results further illustrate the diversity of the factors which influence land use decision-making processes. Seen in a rural dynamics perspective, most results were derived from areas with marginal potential for agriculture or peri-urban areas while areas with very intensive agriculture or where agriculture plays a dominant economic role are less well represented. The key results can be summarized as follows:

5.1 results

Multi-scale level perspective on land use intensity: The work conducted in WP1 and reported in this report has illustrated the diversity of European landscapes and land use dynamics through the case studies which represent important land use trajectories. In order to place the findings in a national and European perspective, the results of three land use intensity indicators elaborated by workpackage 3 (forest harvest intensity, cropping intensity, grazing intensity) were compared at case area, national and EU level. The analysis showed that the case areas in general were representative of the national situation. Heerde and Reichraming contain proportionally larger forest areas and have higher forest harvest intensity values than the Netherlands and Austria respectively while the same areas contain much fewer (none) areas which were predicted to have multiple cropping seasons between 2000-12. Most case areas were predicted to have limited suitability for livestock and this also reflected the average situation for the respective countries.

Land use changes: About one third of all respondents had engaged in landscape activities during the ten years examined. There was considerable variation in the proportion of land owners engaged in the different types of activities, but generally more were engaged in activities leading to an extensification of land use and the area affected by these activities was also greater. As could be expected, a higher proportion of full-time farmers than other land owner types had engaged in activities leading to an intensification of land use while the opposite was true for those leading to an extensification of land use. Nevertheless, full-time landowners were consistently responsible for the largest area (or length of landscape elements) affected by all types of landscape activities, including those leading to extensification of land use and creation of new landscape elements.

Use of schemes: About 40% of the land owners who had extensified land use had received subsidies as part of EU rural development scheme and many land owners stated that scheme participation was primarily economically motivated. Qualitative information from in-depth interviews adds new light to this finding. Some land owners indeed stated that economic compensation from scheme participation was a major incentive while others state that the amounts earned are so small that they are not a fundamental driver. It is likely that other circumstances (farmers' general economic situation and farm strategy) influence the perception of the importance of any financial incentives for scheme participation). Information from a sub-sample (55 landowners, primarily in Roskilde) suggests that the desire to improve the qualities of the property appears to be the single most important motive, as 79% of the landowners agree somewhat strongly or strongly with this statement. These considerations cover concerns to improve the nature content on the property (eg. habitat values or opportunities for recreational hunting), amenity or environmental values (eg. reduced nitrate leaching from afforested areas as compared to crop land).

Agricultural production and diversification: Between a quarter and a third of the respondents were full-time farmers (depending on typology). This reflects the overall pattern of farm structure in the European Union. One fifth of all properties had diversified the income base to include other gainful activities, which span from direct marketing of farm produce to agrotourism, horse-riding stables and renting out of buildings as storage or production space. These land owners will base their decision making process on other production factors than those directly linked to traditional agricultural production.

Intensification and extensification of agricultural production: The general trend is that production intensity remained unchanged between 2002 and 2012 for the majority of land owners. Apart from this dominant trend, more land owners reported increase than decrease in crop yields and proportion of cultivated area on the farm. In contrast, more land owners reported a decrease than increase in livestock stocking rate and use of agro-chemicals. The latter was strongly seen in Roskilde and Heerde, which are located in countries with a long history of national environmental policies on the use of agro-chemicals. Furthermore, many land owners in Roskilde were hobby and part-time land owners with a "lifestyle" agricultural strategy which include reduced use of inputs. The increase in the use of agro-chemicals was only found in Romania and reflects the "catching up" of Romanian farmers to the levels of their European colleagues.

Policy implications: The findings underline the necessity to develop flexible policy measures which can be adapted to and implemented in a variety of contexts. The case areas vary in terms of agricultural potential, rural-urban linkages, demographic composition and level of economic development. These differences create a diversity of settings, where conditions and subsidies related to agri-environmental scheme participation will either seem attractive or prohibitive. In addition to these differences, it is likely that land owners with limited engagement in full-time agriculture will not respond to policy signals and incentives the same way as traditional full-time farmers do. In particular, EU agricultural policy and rural development programs need to reflect the decreasing importance of traditional agricultural production as income source and employment provider in many regions of Europe. Several land owners stated the lack of information about Agri-environmental schemes as a reason for non-participation, indicating the need to use alternative information channels to reach land owners who are not targeted by traditional advisory and information services. As a majority of land owners only manage small areas, new forms of scheme participation could be explored, eg. pooling of land and resources to divide investments and management efforts between more landowners and securing significant environmental impacts.

5.2 Methodological perspectives

The research undertaken by Work Package 1 has given a lot of insights into the land use decision making processes of land owners in different European landscapes. In addition, it has identified research themes and concepts which require further attention when undertaking Pan-european research in landscape and land owner themes.

Study of landscape and land use changes

The study of landscape and land use changes requires reflection not only on the agricultural systems but also on the potential for land use changes in a given area. In other words, it is necessary to contemplate

what constitute the “boundary conditions” for the array of potential land use changes to assess what could be expected to occur and shed light on what conditions facilitate or hinder land use changes.

1**) Is land available?** Large farms in principle possess larger areas which can be used for different types of land use changes (eg. Extensification from annual crops to permanent grassland). However, large farms are typically full-time farms where financial costs of extensification of land may be much more prohibitive than for land owners who have other sources of income and very often have smaller farm areas. In addition, many small “lifestyle” farms are more likely to have extensification of land use as a strategy for the property. However, small farms do suffer from the lack of area, and may simply not have enough available land to allow extensification of land.

2) Which land use changes are relevant (from a physical environmental perspective)? Some land use changes are more adapted to certain natural environmental conditions. For example, hedgerow planting in the form of shelterbelts is a frequent practice in the windy North-European countries, including The Netherlands and Denmark. Land use practices aimed at water management (eg. creation of dikes or maintenance of waterways and canals) are closely linked with areas of reclaimed land, such as large areas of the Netherlands.

3) Will land use changes fit with current production system? Several studies have shown that compatibility with existing farm practices greatly facilitates some landscape changes. Thus, increased permanent grassland areas could be easier to implement on properties with grazing animals. Afforestation is more compatible with arable farms, where areas for afforestation are available or in areas where there is a strong incentive for afforestation (eg. Austria) than on properties with perennial crops, such as in the olive and wine producing regions of the mediterranean countries. Land use changes implemented as part of AES are a particular case, as they may come with strict management requirements (eg. mowing dates on permanent grassland, choice of species, levels of agro-chemical inputs). Some landowners consider these requirements to be incompatible with their current practices and therefore decide not to implement the changes (DEFRA, 2013).

4) What land use changes are socially acceptable (in terms of tradition and legislation)? Some forms of landscape activities are part of a century old tradition which may over time have acquired new meaning, as the example of the bocage landscapes of western France illustrates. The management of pollarded hedgerows is a century old tradition which has over time shifted importance to become a carrier of regional identity rather than to fulfill the original purpose to supply building and fencing material. During the 1960s and 1970s, many land use changes in Europe were aimed at increasing production even at the detriment of the environment (loss of wetland and natural habitats) and reflected the drive for modernisation and industrialisation which characterised that epoch. These policies were slowly reversed in the 1980s and 1990s, among other through the introduction of AES as part of the CAP policy, when environmental concerns became more evident and the agricultural sector lost its economic importance.

5) Which land use changes are economically viable? Many land use changes were traditionally undertaken as part of a predominantly agricultural production strategy (eg. afforestation to provide timber and firewood, hedgerows as shelterbelts, permanent grassland for grazing areas). With the introduction of AES, the purpose is frequently to improve public goods (reduce negative impacts of agricultural production, improve biodiversity) which may not have a direct positive impact on the private economy of the

landowner. It has always been necessary for landowners to balance costs and benefits of land use changes against each other, but this has become a more complex calculation with the introduction of these publically initiated projects which are not necessarily conceived (or fully financed) by the owner of the property where they are implemented.

6) Are land use changes acceptable to the personal characteristics and ambitions of the land owner?
Apart from the financial calculations, land owners also base their decision on whether to undertake land use changes on their compatibility with other interests. Farmar-Bowers & Lane (2009) describe different "lenses" of decision making that potential land use changes are filtered through, among these are intrinsic interests (do they comply with aesthetic or moral values?) family considerations (do they fit with the life stage of the land owners and household) and personal skills and knowledge (does the land owner know how to undertake these changes and – very relevant in this age of CAP-dominated agricultural policy – is external support available?). Several studies have highlighted the importance of intrinsic interest (eg. appreciation of nature, aesthetic and moral considerations) in determining whether or not to implement land use changes (DEFRA, 2013; Ingram et al. 2013).

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Annex 1. Land use and agricultural systems in 2002 and 2012

The case areas represent very diverse agricultural systems, which is evident from the land use pattern in each area (Table 1). Both Roskilde and Stancuta & Ratesti (RO) are intensively cultivated with mostly annual crops and very small forest or permanent grassland areas. In contrast, Lesvos and Reichraming both have small areas cultivated with annual crops. In Lesvos, the dominant land use is permanent tree crops (olive trees) while in Reichraming it is forest and permanent grassland. Heerde has the highest proportion of permanent grassland (77%), which is used for dairy cattle grazing, and only an intermediate area cultivated with crops in rotation (21%). Portofino (I) resembles Lesvos in terms of a large area planted with permanent tress crops (fruit orchards) but has more diverse land use patterns with some areas covered with crops, forests and permanent grassland. In general, the trend in land use change since 2002 has been "more of the same". For example, while forest and permanent grassland areas are the predominant land use classes in 2012, these areas had also experienced substantial growth between 2002 and 2012 (8% and 14% respectively). Land use classes that had experienced drastic changes were often small areas where small changes had a large impact (eg. the forest area in Stăncuţa & Ratesti (RO) grew by 6000% from 0.1 ha to 6 ha between 2002 and 2012). The diversity of land use classes is important when examining the types of landscape changes undertaken by landowners between 2002 and 2012. It illustrates the main land use structure in each case area and hence helps to explain the most likely changes, which might lead to an alteration of the dominant land use classes.

Table 1. Land use in case areas in 2012 (area: % of total area) and change in area since 2002 (change: % difference to area in 2002).

	Roskilde (DK)		Reichraming (AU)		Stancuta & Ratesti (RO)		Lesvos (GR)		Portofino (I)		Heerde (NL)	
	area	change	area	change	area	change	area	change	area	change	area	change
Crops[1]	82	-3	8	30	99	10	1	1	14	2	21	48
Forest	4	85	56	8	0	6000	0	0	13	0	1	20
Non-woody natural vegetation[2]	3	30	0	0	0	0	21	0	0	0	0	0
Others[3]	4	2	2	4	0	4	0	0	0	0	1	106
Permanent grassland (not in rotation)	6	33	32	14	1	-33	14	0	16	0	77	13
Permanent tree crops[4]	1	34	1	9	0	-24	64	1	52	0	1	-55
Woody energy crops	0	300	1	107	0	150	0	0	5	0	0	0
Total area	100	2	100	12	100	9	100	1	100	0	100	18

[1](includes grass in rotation), [2] (eg. sparse maquis), [3](farmyard, buildings, garden, roads,etc), [4](olive, grapevines, Christmas trees).

Farm structure

The differences in land use patterns in the case areas reflect the diversity of agricultural or land use systems found in the areas (Table 2). Differences in farm size reflect the importance of agriculture in the case areas in general and in the households represented in the survey in particular. In the Mediterranean case areas (Lesvos and Portofino), farms are very small and in the case of Portofino almost 50% measure less than 1 ha, as properties in general are small and land has been rented out to other farmers. The opposite is true for the other case areas, where mid-size to large farms (> 50 ha) account for between 11% and 36%. The Romanian case area has the most polarized farm size structure, with a vast majority of small farms (69% < 10 ha) and a relatively small group of large farms which manage 91% of the agricultural area included in the survey. The large farms manage around ¾ of the agricultural area in both Roskilde and Reichraming but only half of the area in Heerde (NL).

Reichraming is the only area with a majority of full time farmers (according to time used on agricultural activities). Roskilde and Lesvos have comparable proportions of non-farmers. In Roskilde, they normally correspond to respondents who only use the property for residential purposes or have rented out all land to other farmers. They may use the property themselves for Other Gainful Activities (OGA) or rent out buildings for this purpose. In contrast, the non-farmers in Lesvos will not use the property as residence (especially not the more remote locations) or for production purposes. The property may have been inherited and still maintain some olive trees, but there is no other use of crops than subsistence use.

The vast majority of properties in Roskilde are used for OGA (61%), which can be attributed to the peri-urban location which makes surplus farm land and buildings attractive for enterprises and storage. This contrast with other areas such as Lesvos, Portofino and Heerde which also have a large proportion of part-time and hobby farmers. In the Mediterranean case areas, the properties are typically located at some distance from towns and are not used for residences. Furthermore, the local economy does not create an incentive to use the premises for OGA (in Portofino, some agro-tourist enterprises are found but not very commonly). In Heerde, the distance to neighbouring towns does not make it attractive to use the property for other uses.

Reichraming has a large proportion of organic farms (34%), which is much higher than in other areas. This is motivated by the long tradition for environmental programs in the Austrian rural areas and the attempt to stimulate local economic growth in marginal agricultural areas, such as Reich by introducing alternative production (the rearing of game for meat is another example).

Livestock rearing is particularly common in Reichraming and Heerde. The proportion of farms with grazing animals (cattle, horses, goats) is particularly interesting, as these animals require grazing area (Neumann et al., 2009). Grazing animals may therefore have a direct impact on land use patterns, not least grassland management. A further breakdown of animal types indicate that a majority of properties in Reichraming have dairy cattle (70%) as do half of the farms in the Romanian case areas and Heerde.

To summarize the presentation of land use and agricultural systems in the case area, it is seen from Table 1 and 2 that the main production in Roskilde and the Romanian case areas is arable production (82% and 99% of land use respectively) while the dominant production in Reichraming is forest (56% of land use) and dairy

cattle rearing. In the Mediterranean case area, the main production is small-scale perennial crop production (mainly olives). The main production in Heerde is dairy production, but the area is also characterized by many part-time farms. The largest share of organic farms is found in Reichraming and the largest proportion of farms with OGA in Roskilde.

Table 2. Agricultural characteristics of the case areas.

Case area	Roskilde (DK)	Reichraming (AU)	Stancuta & Ratesti (RO)	Lesvos (GR)	Portofino (I)	Heerde (NL)
N	93	73	109	90	25	47
Total area (ha)	4261	4121	8284	845	42	1020
Average farmsize (ha)	47	56	76	9	2	22
Farms with 0-1 ha (%)	7	3	7	4	48	0
Farms with 1-10 ha (%)	38	8	62	68	52	53
Farms with > 50 ha (%)	22	36	12	4	0	11
Area managed by farms > 50 ha (%)	79	74	91	32	0	46
Full time farmer (%)	12	52	32	8	0	36
Part-time/hobby farm ((%)	53	48	59	60	92	62
Not a farmer (%)	35	0	9	32	8	2
Farms where farm income >75% of household income	4	7	26	3	4	26
Crop production mainly for subsistence use (>75% of crops/production)	0	14	13	42	88	4
Properties with OGA (%)	61	10%	3%	22%	16%	17%
Organic farms (%)	3	34	1	13	0	0
Properties with grazing animals (%)	38	96	52	30	8	87
Properties with dairy cows (%)	0	70	51	3	0	43

Annex 2. VOLANTE intensity indicators at national and EU level.

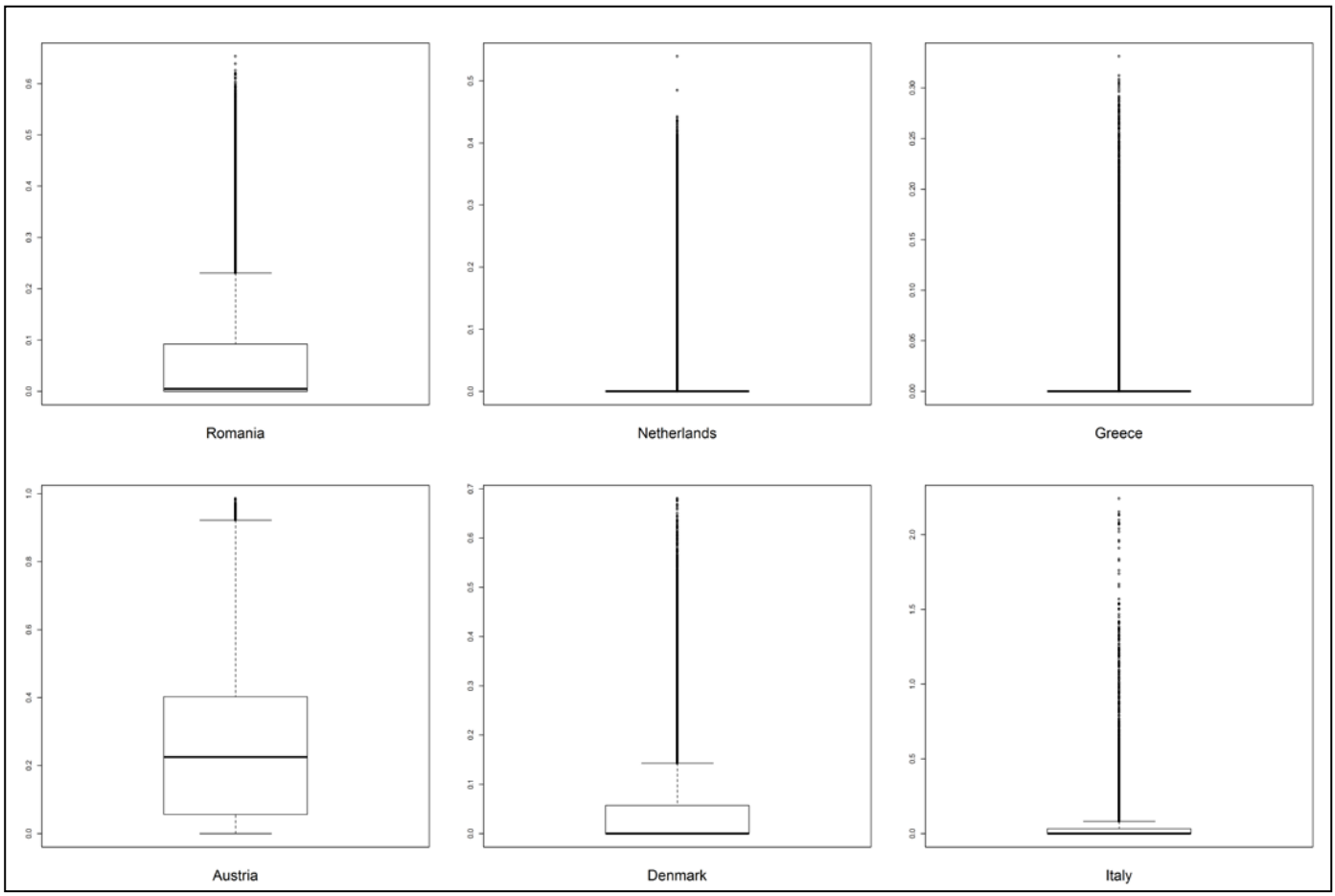

Figure 1. Boxplots of predicted forest harvest intensity in 2010. Values are in 1000 m3 wood harvested. Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.

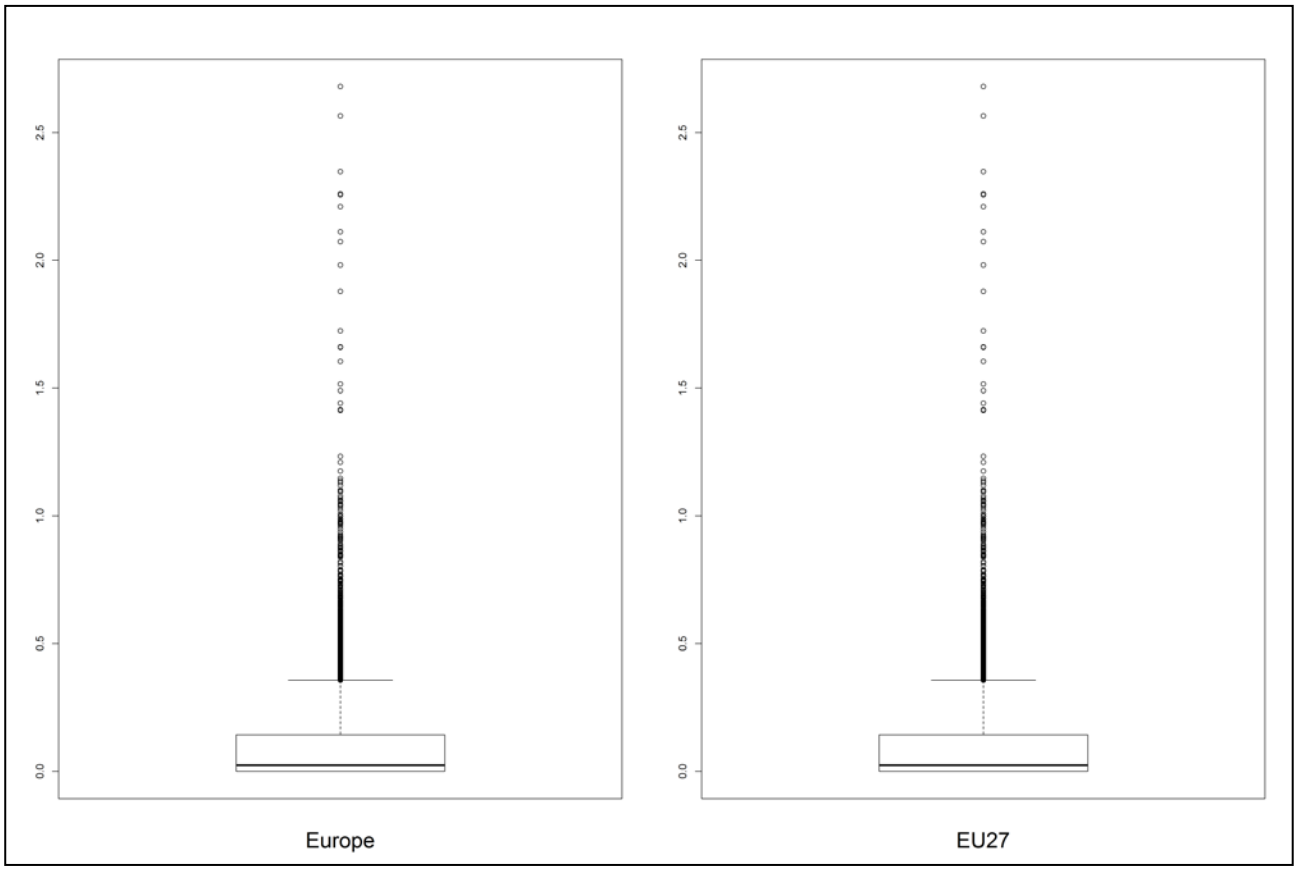

Figure 2. Boxplots of predicted harvest intensity in 2010. Values are in 1000 m3 wood harvested. Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.

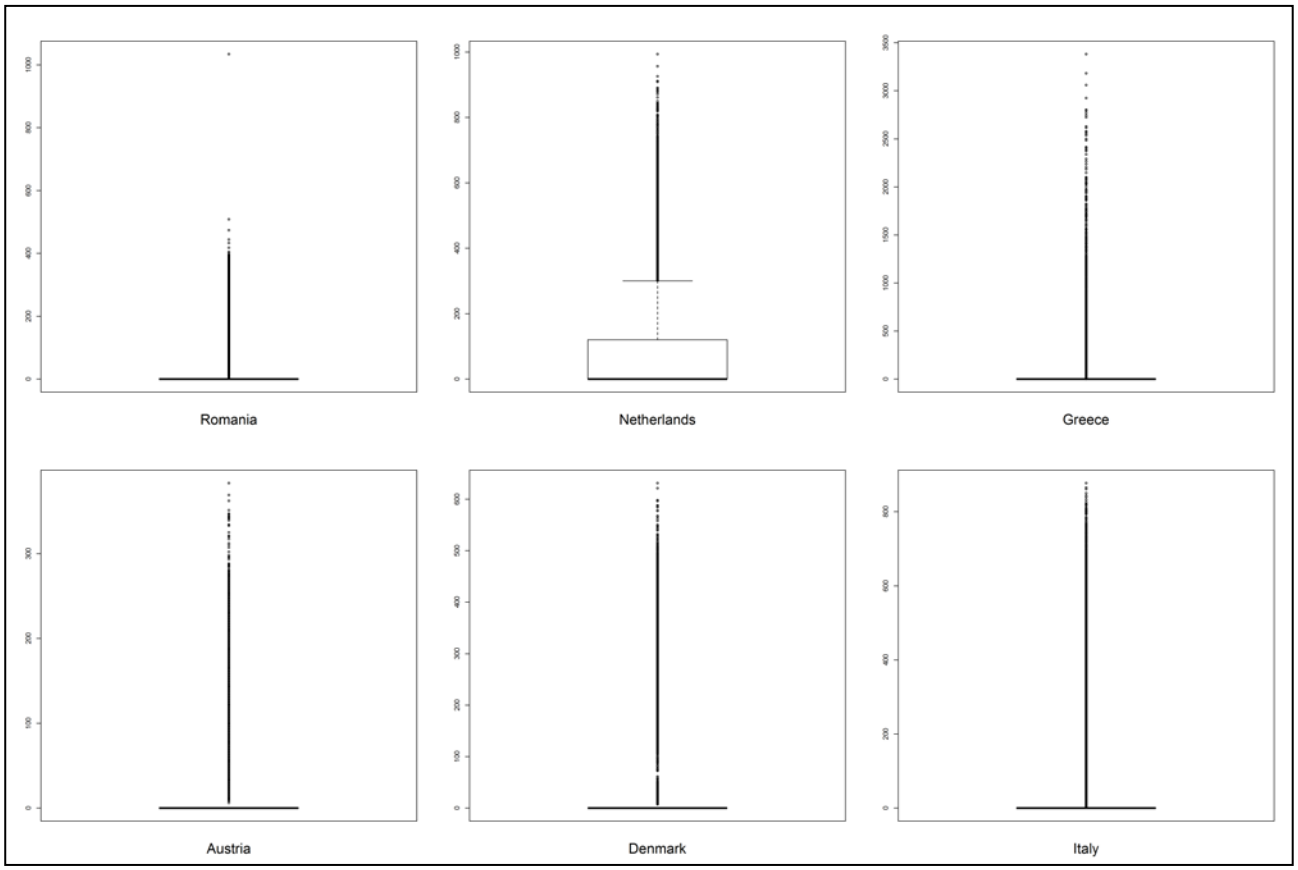

Figure 3. Boxplots of herbivore livestock density in the countries in 2000. Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.

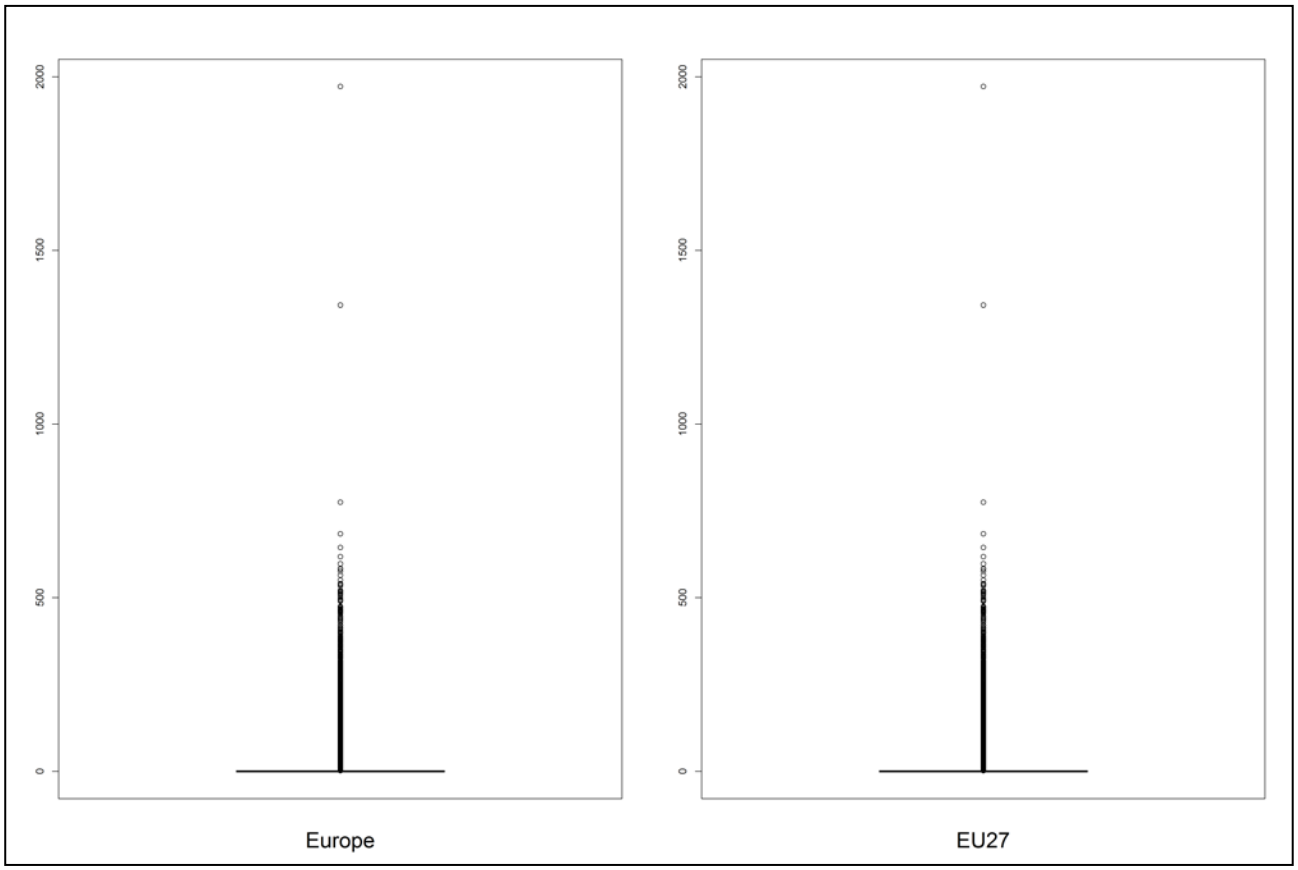

Figure 4. Boxplots of herbivore livestock density in Europe in 2000. Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.

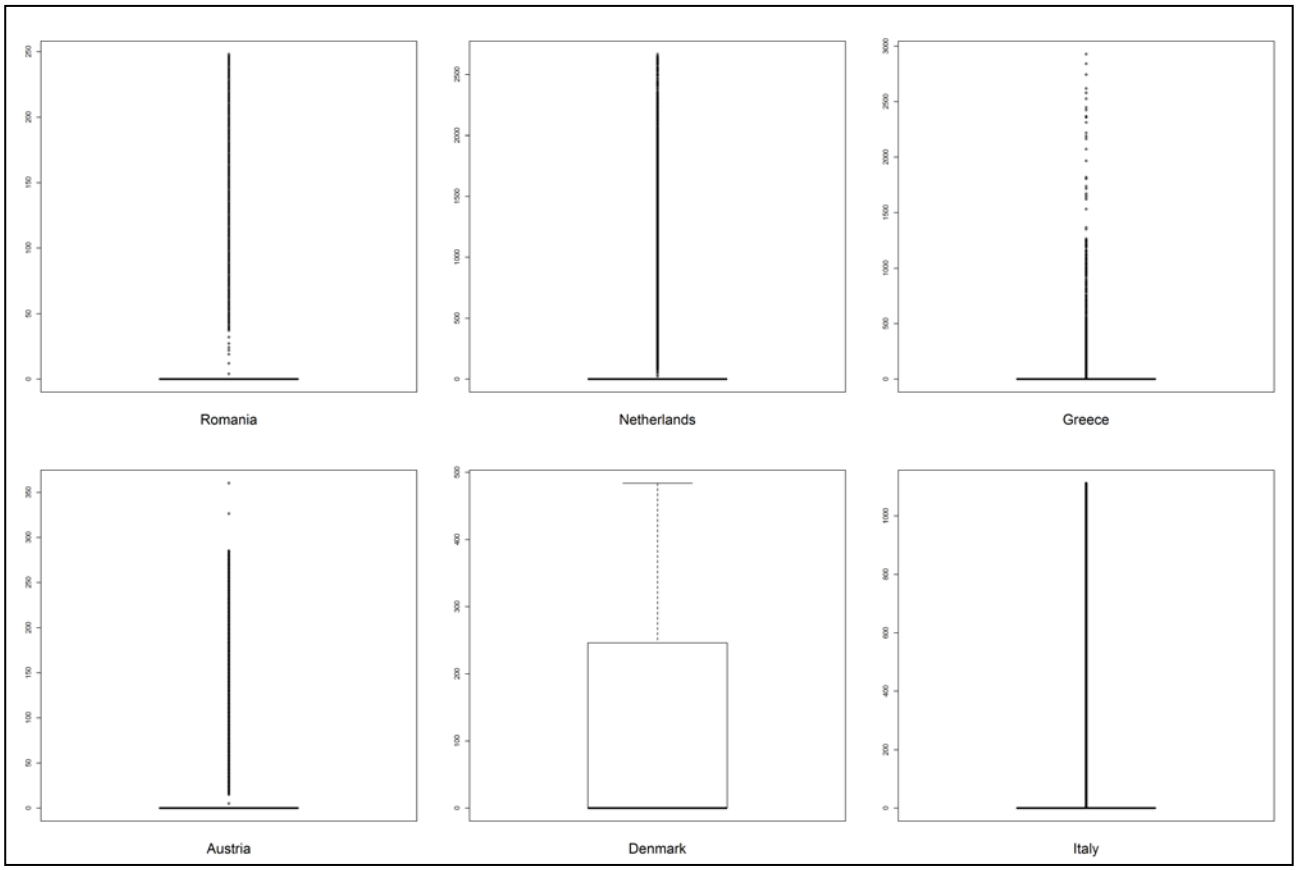

Figure 5. Boxplots of monogastric livestock density in the countries in 2000 (LSU/km2). Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.

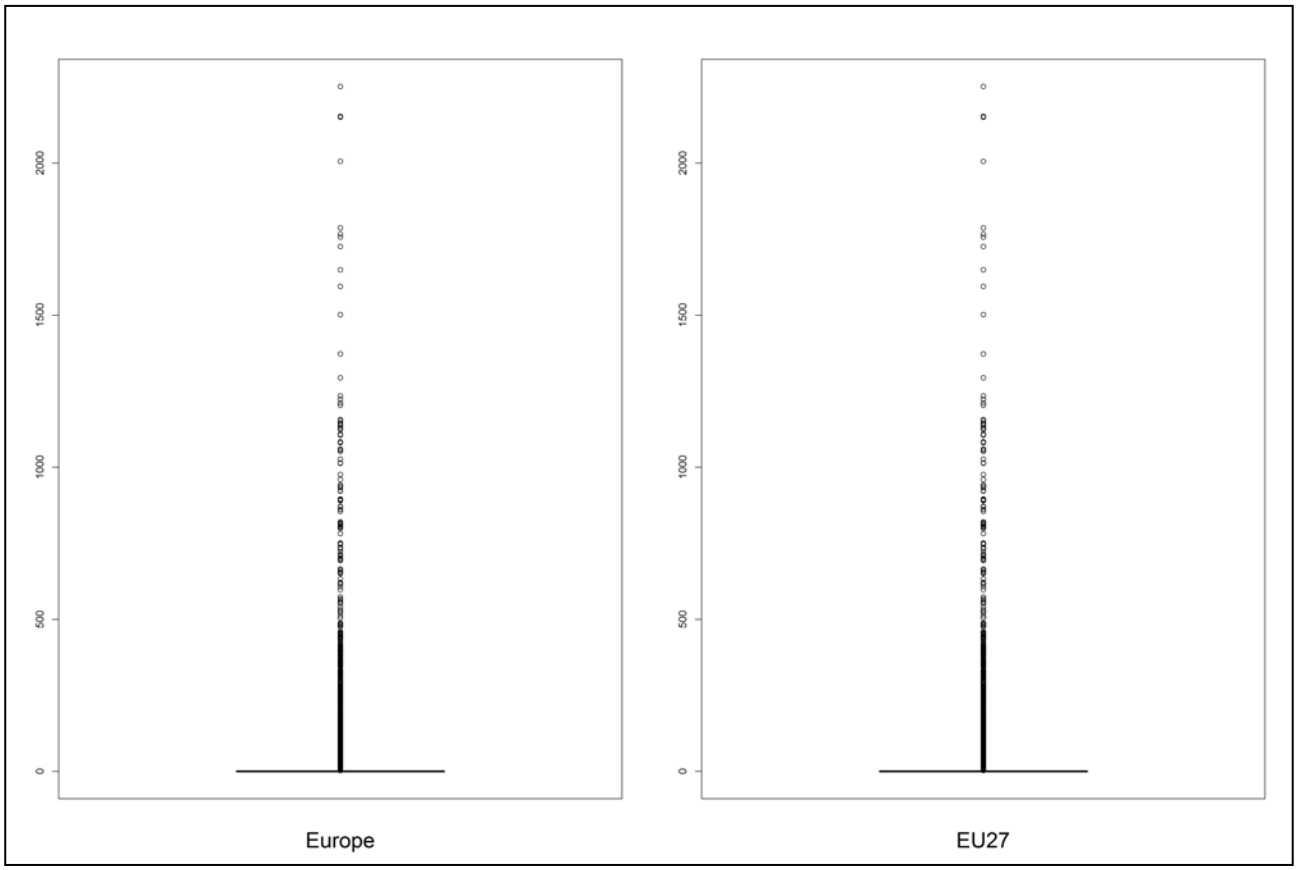

Figure 6. Boxplots of monogastric livestock density in Europe in 2000 (LSU/km2). Calculation: Christian Levers (2013). See Kuemmerle et al. (2012) for details.