Landscape Research
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/clar20

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Published online: 29 May 2013.

To cite this article: Thanasis Kizos, Tobias Plieninger & Harald Schaich (2013): "Instead of 40 Sheep there are 400": Traditional Grazing Practices and Landscape Change in Western Lesvos, Greece, Landscape Research, DOI:10.1080/01426397.2013.783905

To link to this article: http://dx.doi.org/10.1080/01426397.2013.783905

Landscape Research, 2013
http://dx.doi.org/10.1080/01426397.2013.783905

"Instead of 40 Sheep there are 400": Traditional Grazing Practices and Landscape Change in Western Lesvos, Greece

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ABSTRACT *In the semi-arid zones of the Eastern Mediterranean, husbandry of sheep and goats has been an integral part of livelihoods and survival strategies since the Neolithic, but underwent major changes after approximately the 1960s. In this paper, we analyse the landscape changes that were induced by the following increase of sheep numbers and the underlying socio-economic and biophysical driving forces in an insular semi-arid locality of the Eastern Mediterranean, Western Lesvos, Greece. Thirty-four sheep farmers were surveyed and secondary sources such as agricultural statistics and regional literature were analysed. The findings indicate a transition from an agrosilvopastoral system strongly dependent on local ecosystem services to a market economy with intensified animal production that has brought a significant loss of traditional ecological knowledge. This loss is expressed in the simplification of current management practices in comparison to former ones. The causes of the resulting intensification and environmental degradation are mostly economic (low incomes from farming) and social (inability to manage collectively common resources). The landscape changes recorded are less arable land and more grazing lands in a time frame stretching back to the 1960s.*

KEY WORDS: traditional ecological knowledge, agroforestry, silvopastoral, landscape change, Mediterranean, Western Lesvos

1. Introduction

Mediterranean vegetation and landscapes have been shaped by domesticated animals over thousands of years (Blondel, 2006). A long-held view had been that widespread and long-lasting 'overexploitation' of natural resources through grazing in the Mediterranean had left behind 'ruined landscapes' (Grove & Rackham, 2001) of wastelands, devastated forests and degraded soils. But in the past 15 years, fundamentally opposed perspectives on the role of animals on Mediterranean ecosystems and landscapes have

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emerged. For example, Perevolotsky and Seligman (1998) argued in a seminal paper that traditional grazing was far from being destructive to the environment, but in fact an efficient and ecologically sound form of land use that generates resilient ecosystems with a high species diversity, productivity and utility to society. This view has been supported by the emerging revaluation of 'traditional ecological knowledge' (TEK)[1] that is assumed to increase the capacity of social-ecological systems to deal with crises and to maintain resource flows in changing and uncertain conditions (Gómez-Baggethun *et al*., 2010; Olsson & Folke, 2001). It has been frequently demonstrated that traditional ecological knowledge is critical to the survival and future well-being of traditional societies worldwide (e.g. Berkes *et al*., 2000; Diaz *et al*., 2011; Moreno-Calles *et al*., 2010; Olsson & Folke, 2001; Parrotta & Agnoletti, 2007). In developed countries, the conservation of traditional knowledge may support rural development, local quality of life, and especially the conservation of biodiversity that has been generated by human influence on the landscape (Parrotta & Agnoletti, 2007). In Europe, the idea of traditional knowledge found some echo in the notion of 'traditional cultural landscapes', which although criticised for conveying an alleged impression of stability in landscape histories (Renes, 2011) has been widely used in landscape studies and management (Antrop, 1997; Palang *et al*., 2006). Traditional cultural landscapes in Europe are typically "derived from historic—frequently family and/or subsistence-style—farming methods where the dominant cultural landscape characteristics are the result of a traditional or locally adapted approach to management" (Cooper *et al*., 2007, p. 29). Characterising landscape features are 1) the existence of high aesthetic and cultural values; 2) the pursuit of a broadly traditional or locally adapted approach to management; 3) the presence of features, whose distribution is regionally and/or locally specific, which contribute to the landscape's aesthetic qualities and to its ecological integrity (Cooper *et al*., 2007; Moreira *et al*., 2006). In Europe, 'hotspots' of traditional cultural landscapes occur in areas of geographic, economic, infrastructural, political, or cultural isolation, in geographical settings difficult for agriculture, and in regions where inhabitants are ethnically and/or socially different from the national mainstream (Solymosi, 2011).

The question of whether traditional ecological knowledge has persisted in animal husbandry is of major interest, as livestock raising in dryland ecosystems has experienced major changes since the 1960s, albeit with important spatial and temporal differences according to local and national contexts. Throughout Mediterranean Europe, there was a comprehensive land use transition from formerly complex and multifunctional agrosilvopastoral land use systems to simplified and intensified forms of livestock husbandry (Rescia *et al*., 2010). Examples of affected landscapes include pastoral and forestry mountain landscapes in inland Greece, small-scale hamlet landscapes in northeastern Portugal, and the montado and dehesa landscapes in southern Portugal and Spain (Kizos, 2008; Pinto-Correia & Vos, 2004; Schaich *et al*., 2004). The simplification of localised multifunctional land use systems to intensive livestock grazing is believed to shift rangeland ecosystems from equilibrium states and to initiate processes of soil, vegetation and biodiversity degradation (Bakker *et al*., 2005; Giourga *et al*., 1998; Iosifides & Politidis, 2005; Plieninger *et al*., 2010). What has hardly been considered so far are the potential implications of the land use transition in the Mediterranean on the body of traditional ecological knowledge (Plieninger *et al*., 2011). This study aims to reveal the social-ecological complexities that the transformation of livestock husbandry imposed on Mediterranean land uses and landscapes through a case study in

a semi-arid locality on an island, Lesvos, Greece, fairly typical of the Eastern Mediterranean. We analyse the specific changes in management practices and landscapes that followed the increase of sheep numbers from the 1960s onwards from the perspective of farmers and other local stakeholders. We hypothesise that the transition from an agrosilvopastoral system strongly dependent on local ecosystem services to a market economy with intensified animal production has brought a significant loss of cultural legacies, traditional ecological knowledge and landscape management. We focus our analysis on the spheres of ecological knowledge-based management practices to reduce the inherent complexities of the traditional ecological knowledge concept (Berkes *et al*., 2000).

2. Materials and Methods

2.1. Study Area

The case study area is the western part of Lesvos Island (Figure 1, eastern Aegean, Greece), of 899.5 km^2, or 55% of the total area of the island and 26% of the total population of the island, covering 25 settlements (Table 1). Geomorphologically, it is a hilly area with steep to moderate slopes made of acid volcanic parent rocks, with stony and shallow soils described as Typic Yerochrept, Lithic Xerochrept, and Lithic Xerorthent (Kosmas *et al*., 2000). Unlike the eastern part of the island where olive plantations dominate the landscape (Kizos & Koulouri, 2006), in the western part shrublands, open forest areas, pine forests, some olive groves and arable land are the most important land

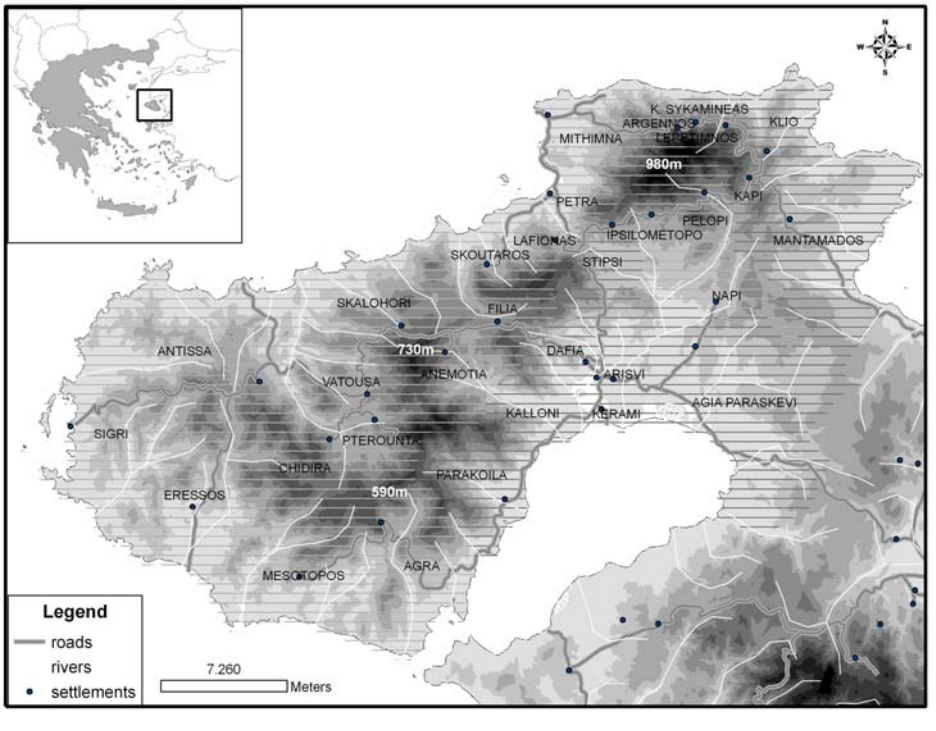

Figure 1. Location of the study area and the case study settlements on Lesvos.

Table 1. Selected indicators of the settlements in the case study area on Lesvos

	Farms		UAA		Arable land			Grazing lands			Tree crops
Settlement	*N* (2000)	% 1961–2000	*N* (2000)	% 1961–2000	% of UAA (1961)	% of UAA (2000)	% 1961–2000	% of UAA (1961)	% of UAA (2000)	% 1961–2000	% 1961–2000
Agia Paraskevi	584	-41.5	63 836.2	32.7	31.2	6.6	-72.0	38.2	46.2	60.3	110.9
Napi	126	-23.2	17 402.5	141.1	36.9	0.5	-96.8	42.6	81.2	359.7	114.6
Eresos	290	-59.9	41 108.5	-49.4	5.7	2.1	-81.3	91.1	93.6	-48.0	-30.5
Antissa	350	-52.4	51 601.3	-13.2	13.4	2.1	-86.6	73.4	85.0	0.5	3.4
Vatussa	129	-57.6	11 862.5	-4.9	24.7	0.6	-97.7	62.4	79.7	21.5	60.4
Mesotopos	203	-44.2	24 517.0	-15.5	10.6	3.9	-68.8	88.2	94.0	-10.0	138.6
Pterounta	40	-61.5	5850.5	19.3	14.4	1.9	-84.0	72.1	86.4	42.9	9.5
Sigri	82	-36.9	13 922.3	-26.0	9.4	5.4	-57.4	86.5	85.7	-26.6	2.4
Hidira	109	-35.5	31 989.0	90.2	8.9	0.0	-99.8	85.6	92.6	105.8	162.3
Kalloni	897	-37.1	43 348.7	-31.4	19.6	16.9	-41.0	43.2	31.5	-50.0	0.5
Agra	204	-32.7	36 221.5	16.1	9.3	0.9	-89.1	88.1	93.1	22.7	248.0
Anemotia	194	-45.2	20 135.0	53.8	13.5	0.2	-97.8	50.7	69.5	110.8	34.6
Skalohori	168	-57.7	21 313.0	-13.4	26.8	2.6	-91.6	64.8	85.7	14.6	24.9
Filia	192	-52.5	21 294.0	8.2	28.1	0.2	-99.3	54.9	73.2	44.3	81.7
Mantamados	364	-45.7	31 275.0	13.2	26.8	0.0	-100.0	44.1	66.1	69.5	34.5
Kapi	200	-20.3	8198.7	18.1	37.7	0.2	-99.4	22.5	42.4	122.3	73.5
Klio	165	-38.2	6457.0	-31.6	32.7	1.0	-98.0	18.2	28.4	6.6	0.4
Pelopi	162	-21.4	22 562.0	43.7	27.3	0.2	-99.1	62.1	88.5	104.8	69.0
Mithimna	180	-37.9	12 302.5	-51.1	21.0	0.8	-98.1	71.5	87.5	-40.2	-21.2
Argenos	94	3.3	8901.5	12.0	24.2	0.6	-97.4	60.9	76.8	41.3	70.6
Lepetimnos	33	-56.0	1956.0	-9.9	44.7	0.0	-100.0	11.8	39.2	200.8	26.6
Sikaminea	84	-57.1	3707.1	-3.3	18.1	0.0	-100.0	20.8	49.9	131.8	-16.1
Petra	423	-51.9	18 525.6	-3.1	41.1	1.7	-95.9	20.8	53.1	147.2	17.1
Stipsi	356	-31.5	24 745.4	25.6	36.6	0.0	-100.0	29.1	61.2	164.1	46.4
Ipsilometopo	37	-54.9	2570.5	-64.9	30.5	0.4	-99.6	61.0	85.8	-50.6	-42.1
Total case study area	5666	-43.9	545 603.3	-5.1	19.7	3.1	-85.0	62.3	72.1	9.9	36.8

Sources: 1961: ESYE (1964); 2000: ESYE (2001), calculations by the authors.

Table 2. Selected indicators for the case study settlements and the area

Settlement	Population 2001	Population change 1961–2001 (%)	Farmers > 65 in 2001 (% of farmers)	Grazing land 2001 (%UAA)	Number of sheep 2001	Number of sheep change 1961–2001(%)	Number of goats change 1961–2001(%)	Sheep per farm 2001
Filia	690	-53.7	45.3	73.1	8064	103.1	88.0	79.8
Kapi	641	-37.2	39.5	42.4	6264	357.6	85.8	87.0
Mesotopos	981	-36.8	18.2	94.0	9168	65.7	320.2	54.6
Napi	268	-54.5	56.3	81.2	6140	158.1	-36.5	104.1
Case study area (25 settlements)	23 467	-39.0	37.7	72.1	240 600	165.1	142.8	93.1

Source: agriculture and animal husbandry census of 1961 and 2001, processed by the authors.

cover groups. Land cover varies from northwest to southeast, influenced mainly by precipitation differences as well as land management (Symeonakis *et al*., 2012): a) the eastern zone with more rainfall (560.5 mm in Agia Paraskevi with 16.1°C air temperature from 2003–2004 to 2009–2010), mostly covered by maquis,[2] olive trees and farmland, with minimal presence of phrygana;[3] b) the intermediate zone with greater presence of pine trees and crops, combined with extensive areas of maquis and olive trees (511mm and 14.8°C in Pterounda from 2003–2004 to 2005–2006); c) the western zone with scarce rainfall (431.4 mm and 17.6°C in Sigri from 2007–2008 to 2009–2010), mostly covered by phrygana scrub and minimal presence of pine, olive trees, maquis and crops. The area can be considered as typical of a wide range of north-eastern Mediterranean semi-dry areas regarding rainfall and shallow soils.

The case study area had lost 39% of its 1961 population by 2001 (some settlements lost more than 60%; Tables 1 and 2). With some exceptions of settlements with tourism development, this trend is still continuing (-5% between 2001 and 2011 according to the temporary results of the 2011 census). In most settlements farmers represent more than half of the economically active population. The population is mainly aged with a high percentage of inactive population (> 60% in most settlements). Farmers are also aged: in two-thirds of the settlements more than 33% of farmers are older than 65 years, in some more than 50%.

These aged farmers cannot be considered as active farmers. Most of them keep small farms for home consumption and their practices are different from those of younger, more active and 'professional' farmers.

2.2. Research Approach and Data Analysis

The analysis is based on secondary and primary sources of data. The former include official census data for agriculture and animal husbandry, available at the settlement level from 1961 as well as a review of the literature from the area and similar areas (Bakker *et al*., 2005; Beopoulos & Vlahos, 2004; Giourga *et al*., 1998; Grove & Rackham, 2001; Iosifides & Politidis, 2005; Kizos & Koulouri, 2006; Kosmas *et al*., 2000; Pinto-Correia & Vos, 2004; Plieninger *et al*., 2011; Tragellis, 1999). Previous data are not available at a comparable spatial level (they are available either at the island level for 1928, or at the level of three 'provinces' that do not correspond with the case study area for 1951) or do not go into the necessary detail for land uses, e.g. the 1951 census). Data before the annexation of Lesvos in the Greek State in 1912 from Ottoman archives are not available (for an exception at the *kaza* level which again does not correspond with modern administrative levels, see Karidis & Kiel, 2000). These data were used along with other local sources (mostly Grigoriou, 1952 and Evangellou, 1933) to get an overall picture. This information was complemented with primary research via interviews with 34 farmers from four settlements of the area conducted in June and July 2010 (Figure 1 and Table 1). The selection of the settlements was based on statistical data of sheep farms, sheep numbers and land use. Settlements in the north-central part of the island (Figure 1) are less dependent on sheep farming, as many olive groves are found. Settlements in the western part are on the contrary much more dependent on sheep husbandry. We selected one of these western settlements (Mesotopos), two neighbouring ones from the north-central part (Kapi and Napi) and one intermediary (Filia), all typical of their localities. An initial contact (an active

Table 3. Selected questions included in the questionnaire

Questions included in the questionnaire
"Identify the size and use of your fields (per field)"
"How many animals do you keep today?"
"Have they changed during the last ten years? Why?"
"Before that? Why?
"Has the use of the fields changed in the past?"
"If yes, from what to what use? When did this change take place and why?"
From a list of practices (ploughing, pruning, grafting, fertilising, irrigating, manuring) "which do you practice today?"
"Which did you practice in the past?"
(In case of changes) "why did you change your (practice)?"
"Do you think that your fields are degraded by grazing? The area?"
(Questions on the family of the farmer, age, occupations of all members on and off the farm)
(General opinion questions)
"Do you have a successor for the farm?
"What do you think is the future of the farm?"

farmer with livestock) was selected in random from the available population at the time of the visits and these first contacts were asked to facilitate contacts to one or two more farmers of the settlement for interviews. These farms cannot be considered as typical of the overall farming population in the settlements in terms of the average age of the farmers (sample farmers are younger on average), or the number of sheep per farm (sample farms are bigger on average), especially for Mesotopos. The reason behind this choice was that a large proportion of the farmers are old and keep small flocks and were considered as retired or 'hobby' farmers, that keep small pieces of land and rent or abandon the rest. The research aimed at those who are more active and professional, since they manage most of the area, they seem to be the future direction of agriculture in the region and their practices are those that matter most for our purposes in examining landscape change and change in traditional practices. The interviews were face to face with the use of a semi-structured questionnaire that left space for the views and perceptions of respondents towards the management of grazing lands (Table 3). Farmers were asked to describe, discuss and justify changes in land uses and practices, including grazing and the size of sheep flocks, typically including a few goats as well. Grazing pressure was calculated in animal units (AU) per ha (one AU corresponds to 0.13 sheep or goats), on the basis of the declared fields and the number of sheep on the farm. Although the definition of 'overgrazing' is ambiguous and depends very much on location, we used the official national limit of 'good grazing practices' for Aegean islands of 1 AU per ha for the definition of appropriate grazing density.[4] For landscape elements, 1960 aerial pictures available from the Army Geographical Service were consulted.

Two broad time frames were identified during the interviews with the farmers: one that corresponds with most of the land use changes and dates back to the 1950s and 1960s (although the transition seems to be a matter of decades, from the 1950s until the 1970s, and not years) and another that describes more recent changes of the last decade. This time frame is consistent with what is mentioned by Pinto-Correia and Vos (2004) and Blondel (2006) for similar livestock systems in Mediterranean Europe, although regional and national differences are encountered. For our case study area, previous

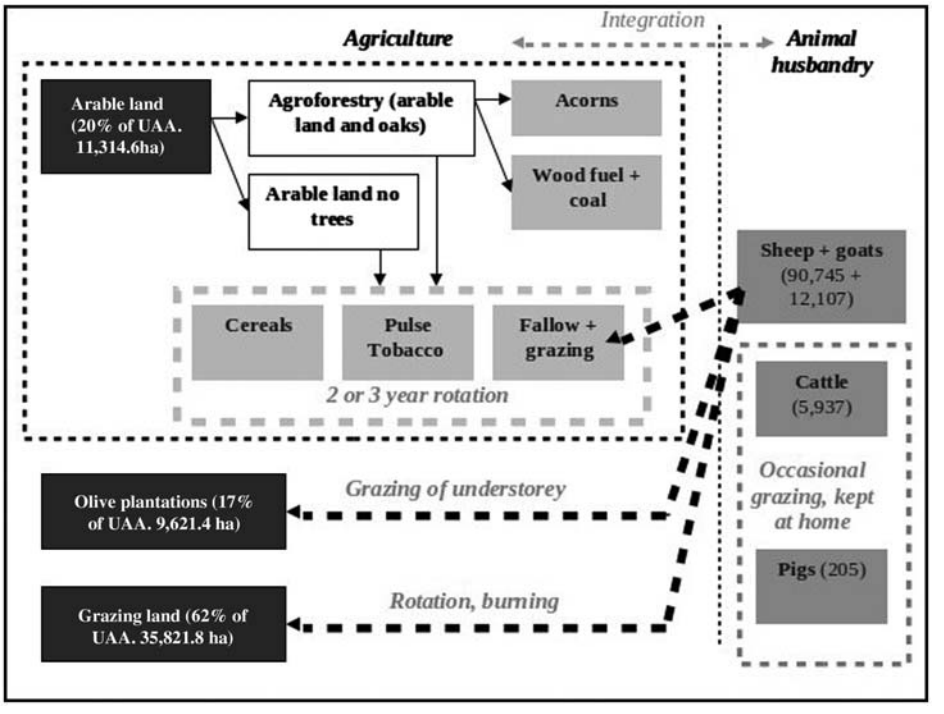

Figure 2. Idealisation of the management system in the area in the 1960s. Source of land use and animals: ESYE (1964), processing by the authors (inspired by Pinto-Correia & Vos, 2004).

changes that were very important for the rest of Greece did not affect the area (e.g. the Agrarian Reform of the 1920s–1932 on Lesvos was implemented only to olive plantations in the eastern part and not grazing lands or the civil war of the late 1940s that devastated many other mountain areas of continental Greece). The only major impact in the past was the population exchange of 1924 between Greece and Turkey as many Muslim inhabitants left the case study area, but the available local evidence (mostly Evangellou, 1933 and Grigoriou, 1952) do not suggest changes in management systems. The 1960s seem to be a convenient mark of changes for two reasons: the population loss of the 1950s (-5% between 1951 and 1961) more than tripled between 1961 and 1971 (-18%) and remained high for the next decade (-9%) and was even higher in rural areas indicating abandonment, while Lesvos was slowly integrated in the national markets, especially for feed that allowed intensification of animal husbandry.

Information for the older time frame was not based on personal experience of our respondents, but on second-hand knowledge from fathers or grandfathers. It therefore was vague and it was impossible to time or pin down changing practices precisely. On the other hand, information on changes in the last decade was much more precise and reliable, but proved to be describing changes of the already established 'new' management system and not changes from the 'old' system to the 'new' one. This can be viewed as a finding itself and is discussed in more detail later on, whilst it has also dictated the choice of treatment of data. The reconstruction of the 'old' system was

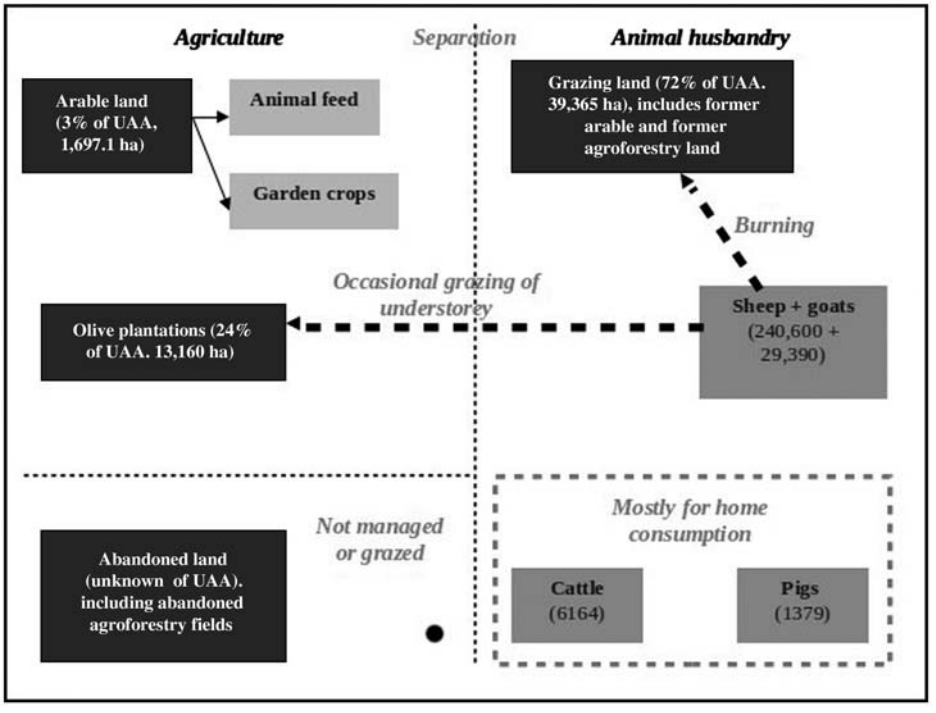

Figure 3. Idealisation of the management system in the area in the 2010s. Source of land use and animals: ESYE (2000), processing by the authors (inspired by Pinto-Correia & Vos, 2004).

therefore based mostly on secondary data. Especially for the landscape elements we used our own knowledge of the area from 1999 onwards, some already published (see e.g. Kizos *et al*., 2010; Kizos & Spilanis, 2004; Plieninger *et al*., 2011) and some unpublished. We compared the data from the secondary sources with the findings for the 'new' systems from the interviews. The graphical depiction of the management systems was inspired by Pinto-Correia and Vos (2004).

3. Results

3.1. Management Practices in Traditional Livestock Husbandry

Agricultural production system

Historic and recent evidence (Beopoulos & Vlachos, 2004; Iosifides & Politidis, 2005; Kizos & Koulouri, 2006; Plieninger *et al*., 2011) indicate that animal husbandry and especially sheep and goat farming have been an integral part of livelihoods in the area. Livestock raising was embedded into management systems that were complex, including grazing, crop cultivation and arboriculture of oaks and olives (Figure 2; compare with Figure 3), with very few external inputs, while the excessive labour migrated seasonally to the Asia Minor coast for harvesting cereals there. The most important products were cereals for human and animal use, milk for cheese, meat and acorns (for the leather processing industry of the island) in a typical subsistence society on the

Figure 4. Landscape near Mesotopos: grazing land in formerly cultivated field with Valonia oaks (*Quercus macrolepis*, *Quercus pubescens*) and astivi scrub (*Sarcopoterium spinosum*) dominating land cover (photo by the authors).

verge of commercialisation, but already linked with external markets for some of its products such as acorns, olive oil, and cheese.

Livestock management

In grazing lands, rotational grazing—occasional cultivation of plants grazed on site was practised, along with small-scale transhumance between the western and the eastern parts of the island (Kizos & Koulouri, 2006). One of the most widespread practices, especially in the climatically adverse western part of the island, was—according to farmers—the burning of the grazing lands to 'clean' the fields from *astivi* (*Sarcopoterium spinosum*) that is not palatable for livestock (Figures 4 and 5). This is the only management practice of the traditional system our respondents mentioned which still has some relevance in the current land use system, although they could not provide the time intervals of these burnings, as these seem to depend on the particular field, the degree of *astivi* domination, and the weather.

In the 1960s, according to census data (Table 4) roughly 30% of the 10 106 registered farms on Lesvos held sheep, with an average of 29 sheep per farm and estimated grazing density was around 0.3 AU per ha. As land is mostly in private ownership, there are no records of common management of grazing lands as in other areas of Greece (Kizos, 2008). Livestock herded were almost exclusively sheep and goats of

Figure 5. Landscape between Mesotopos and Filia: overgrazed grazing land with no plant cover, in the background a stand of Valonia oaks (*Quercus macrolepis*, *Quercus pubescens*) and an olive grove (photo by the authors).

local breeds (the Lesvos sheep[5]), which are adapted to local climate and fodder resources with average milk productivity under extensive management (Bitzelis, 2010). There have been seven times more sheep than goats in the study area. The nutritional needs were covered mostly through grasses, either grazed on site, or harvested as hay. Oak and olive branches from pruning were also used during winter, although the dry season (June to September) is the one in which fodder resources are scarce. Only burden animals (oxen, donkeys and mules) were fed with cereals (Tragellis, 1999).

Complementary land-uses

In the 1960s, mixed cultivation in agroforestry systems was common. Crop cultivation showed a pronounced diversification of production and land uses, a combination of intensive and extensive management practices (Beopoulos & Vlahos, 2004). Due to the lack of level ground on the hilly study area, terraces were constructed in arable lands and groves (of oaks and olives) to reduce the gradient of the slopes that were ploughed for cultivation of cereals (mostly barley) or legumes in two or three years of fallow and grazed by sheep during fallow periods. Tobacco was also grown on terraces around the gulf of Kalloni. Typical rotational cycles included biennial or three-year cycles of fallow and/or crop rotation in small parcels (Kizos & Koulouri, 2006). In the 1960s,

Table 4. Comparison of the most characteristic components of the land-use systems of the 1960s and the 2000s on Lesvos

	Land-use system of the 1960s	Changes	Land-use system of the 2000s
Agricultural production	- Complex systems: crop cultivation, grazing and arboriculture of oaks and olives - Very few external inputs, - Grazing lands 62% of UAA, arable land 20% and olive plantations 17%;	- Simplification of the management system - Increase of dependence on external inputs - Increase of grazing lands and olives, decrease of arable land by 85%; farm size increases five times. - Number of farmers - 44%, sheep farmers - 15%	- Simpler systems: grazing separate from crop cultivation, oaks abandoned - External inputs: animal feed, fertilisers - Grazing lands 72% of UAA and olive plantations 24%.
Livestock management	- Sheep husbandry integrated with agriculture - Sheep of local breed - Practices: - Rotational grazing, occasional cultivation, - Small-scale transhumance - Burning of grazing lands - Sheep farmers 30% of total, with 29 sheep on average, seven times more than goats - Dietary needs covered mostly with grasses.	- Gradual separation of sheep husbandry and arable farming - Practices: - Gradual abandonment of rotational grazing. - Gradual abandonment of transhumance - Grazing pressure increases - Share of sheep farmers in total farmer population increases, number of aheep increases more than 100% up from 1961 - Additional feed covers more of dietary needs of animals.	- Sheep husbandry separated from agriculture. - Most of sheep still of local breed, some French breeds introduced - Practices: - Continuous and uncontrolled grazing, some parcels abandoned (of absentee owners). - Burning of grazing lands, with continuous and high grazing pressure (11 AU per ha is sampled farms) - Sheep farmers 45% of total, 93 sheep on average (279 sheep on average for sam-

(*Continued*)

Table 4. (*Continued*).

	Land-use system of the 1960s	Changes	Land-use system of the 2000s
			pled farms in Mesotopos), still eight times that of goats - Additional feed covering up to 90–100% of dietary needs in lactating season
Complementary land-uses	- Combination of intensive and extensive practices - Terraces in arable lands and groves to cultivate cereals or legumes in two or three years of grazed by sheep fallow.	- Gradual intensification of grazing. - Abandonment of rotational systems, conversion of arable fields to grazing lands or animal feed crops; oak fields abandoned or grazed	- Intensive grazing - management intensive - Rotational systems abandoned, all other uses either grazed or abandoned, management of oak trees neglected.
Landscape elements	Mosaic of small parcels, other features: stonewalls enclosures, terraces, storehouses – stables and footpaths	- Landscape elements not preserved except stonewall enclosure - Quality of elements declining	Older elements still present in fields: stonewall enclosure (90% of sampled fields), terraces (50%), storehouse/stable (20%).

Sources: Land-use system of the 1960s: all statistics from ESYE (1964), qualitative information from Kizos and Koulouri (2006); Giourga *et al*. (1998); Grove and Rackham (2001); Kosmas *et al*. (2000); Pinto-Correia and Vos (2004); Tragellis (1999), except burning for which information from interviews has been used.
Land-use system of the 2000s: all statistics for the area and the settlements from ESYE (2001), data on sample farms from interviews.

according to census data (Table 4), arable land and fallow was taking more than 50% of the cultivated area and 20% of the utilised agricultural area (UAA). Grazing land areas were also very important, covering 62% of the UAA. Fifty-eight percent of farms included arable land, with an area of 1.9 ha on average.

Arboriculture was widespread until the late nineteenth and the early twentieth century, with the main tree species growing in these systems having been *Quercus macrolepis*, *Quercus pubescens*, *Castanea sativa*, *Pyrus communis*, and *Prunus dulcis*.

Some olives (*Olea europaea*) could also be found, but olive plantations were usually not mixed with oak fields. Management of trees included tree planting, pollarding, coppicing, producing charcoal and collecting acorns, wild fruit and nuts. The use of oak cupula for extraction of tanning agents and their use in the flourishing tanning industry of the island seems to have led to the expansion of their use at the end of the nineteenth century. Official statistics indicate that 86% of the farms in 1960 had olive groves of 1.1 ha on average.

Landscape elements

Written records and the aerial pictures suggest that the landscape was a mosaic of relatively small in size parcels, especially close to the settlements and in the limited level areas, along with abundant features such as stonewall enclosures, terraces, threshing floors, storehouses—stables and footpaths, some of which were paved (Figures 4–6 present some of these elements as they can be seen today). Artificial water ponds (some with stone walls) and wells were also common, providing water for the livestock. These traditional agrosilvopastoral systems were not static in terms of the areas they covered or the management practices applied, as the managed areas seem to have expanded and contracted according to population changes. Grazing lands on the hills were of bigger size and the landscape was less a mosaic and more uniform, separated by stone wall enclosures.

3.2. Management Practices in Current Livestock Husbandry

Agricultural production

From 1961 to 2000, the number of farms was reduced by 44%, but sheep farms decreased only by 15%, raising the importance of sheep farming in the case study area. Today sheep farms make up 45% of the total number of farms.[6] Unlike agriculture, livestock husbandry is characterised by an increasing number of professional farmers and not part-timers and hobby farmers (Figure 3). Farm size in the case study area in 2000 is five times greater than that of 1961, mostly due to the increase of grazing lands (14.4 ha on average per farm) and olive groves (2.6 ha per farm). A notable feature of farms is that all comprise more than one field (6.2 on average in 2000) and these fields can be located in great distances. The most important product of the case study area today is milk, used for making cheeses (Ladotyri Lesvos PDO [Protected Designation of Origin], Feta PDO, Kaseri PDO, Graviera and Kefalograviera). The prices are set by a small number of cheese makers (24, four of which buy as much as 80% of the total milk; Vakoufaris, 2010) and these prices have been more or less stable over the last decade (at 0.88€/kg of milk in 2010, compared to prices close to 1€/kg for continental Greece). Subsidies are very important for incomes and amounted to €3035 per farm annually from the Single Farm Payment scheme (SFP)[7] and €2960 per farm annually from compensatory payments from the Less Favoured Areas (LFAs) scheme.[8]

Livestock management

Grazing lands take up 72% of the UAA and olive plantations 24%. The number of sheep during this time has increased up to five times (Table 1). The number of sheep per farm has increased to 93 for the area in 2000, but as high as to 279 per farm for

the farms sampled in Mesotopos, with an increase of up to 10% in the past 10 years. Most of the sheep today are still of the local breed (Bitzelis, 2010, raises the number to 200 000), but French breeds have also been imported and are common in some of the level areas around the Kalloni Gulf. The number of sheep is still eight times higher than that of goats. Other livestock species (cattle and pigs) have been increasing, but are fed and kept in small plots or in the stables and do not compete with sheep for grazing lands.

According to our respondents, current grazing is concentrated on parts of the grazing lands, usually those closer to roads and water, it is largely uncontrolled, continuous and not seasonal. Other parcels, mostly belonging to absentee owners, seem to be far less intensively grazed or completely abandoned. Forage traditionally provided by agrosilvopastoral systems has been replaced with imported animal feed. The burning of the grazing lands also changed, as today burned grazing lands are not left ungrazed. Combined with a continuous and high grazing pressure, this is a particularly destructive practice, as burned areas are not protected from erosion and eventually *astivi* dominates the landscape again. Grazing practices are simple in theory as sheep browse through the grazing lands and are supplied with additional feed that may cover up to 90–100% of their dietary needs in the lactating season. But the choices of farmers vary: not all fields are grazed with equal intensity and sheep are moved from field to field at irregular time intervals that depend on the weather, the fodder provided by the field, the need for other practices (e.g. pruning or picking the olives in the olive fields that are grazed), the size of the farm and the herd, or the proximity of the fields to roads. This makes the calculated grazing pressure for the sampled farms an average, at 11.0 AU per ha, which is very high considering the adverse climatic, soil and vegetation conditions of the area. The most marginal localities suffer more, with 13.4 AU per ha in Mesotopos[9] ("yes there is overgrazing, instead of 40 sheep there are 400 in the field", recognised a Mesotopos farmer). The issue of the ownership of the fields was also mentioned by our respondents. Although all sampled farms were inherited by parents or grandparents, the increased number of sheep has made many to seek more grazing lands. When these are not available (and they rarely are in the western part), they use communal grazing lands, with low rents, but also with a low sense of managing them properly.

Complementary land uses

According to official statistics, arable land decreased from 1961 to 2000 by 85% in the case study area and by 98% in the four case study settlements, while olive plantations and grazing lands increased. These changes mark the fundamental transition of management systems in the area: for the sampled farms, legumes (10 fields), cereals (27 fields), tobacco (five fields) and 15 small fields of vines converted to grazing lands; or cereals (15 fields) to not harvested animal feed (to be grazed on site). On the remaining cultivations, changed management practices were reported: ploughing in the past was for rainfed cereals, pulses and tobacco, while today it is for pump water irrigated animal feed and garden crops in small fields in level areas. Only some of these small animal feed fields (10 fields mainly with alfalfa) have not changed along with small fields of garden crops close to the settlements. Together with the increase of animal flocks, these changes indicate the fundamental farm structure changes of the sampled farms: most of the farms are now covered by grazing lands (more than 80% of their total area,

compared to 40% in the past). Most of the conversions of croplands to grazing lands are described by farmers as "they were not taken care of, animals were left to roam free in them", or "we put the animals in" suggesting a former different management regime, but also a devaluation of grazing lands compared to arable land, oaks and olives.

The use of acorns was subsequently replaced by manufactured and imported substitutes in the leather industry, so that oak woodlands lost part of their value. Official statistics stopped recording the extent of oak woodlands and their acorn production after the 1930s. Today, these woodlands are either grazed or abandoned, and the management of trees (e.g. pruning, harvesting of acorns) and fields (e.g. maintenance of terraces and stone walls) is largely neglected.

Landscape elements

Although many land uses have been abandoned, many elements of the land-use system of the 1960s are still present (Figures 4 and 5). Almost 90% of the fields of sampled farms have a stonewall enclosure, especially grazing lands and slightly less than 50% "braided style" terraces (Grove & Rackham, 2001; Figure 6). In 20% of the fields a small or bigger storehouse or stable was present. The small size of parcels close to the settlements and in level areas has been retained, along with the uniform landscape of grazing lands in the hills. However, the quality of these elements is declining. In stonewalls wire has been added on top of the wall (Figures 5 and 6) and the masonry is

Figure 6. Landscape close to Sigri: overgrazed and treeless grazing land in formerly cultivated field with braided style terraces and a stonewall enclosure in the foreground (photo by the authors).

not maintained, all terraces are abandoned and gradually collapsing and most of the old-style buildings are either in disrepair or new elements have been added, such as concrete and metal. Land cover has also changed from arable land to phrygana scrub and oak cultivation has ceased. Although the villages themselves have not been expanding much, in coastal areas second homes or tourism buildings have replaced fields. These changes have not transformed the landscape radically, as the 1960 aerial pictures demonstrate, but older elements have been replaced by new ones.

4. Discussion

4.1. Impacts and Drivers of Land Use Change

The comparison of the farming systems of the 1960s and the 2000s shows fundamental changes in management practices and consequently in the agricultural landscape: a complex system of multiple uses integrating animal husbandry with agriculture was succeeded by a much more intensive and simpler one that separates livestock husbandry, crop cultivation, and agroforestry (Table 4, Figures 2 and 3). Driven by changes in the agricultural policies and technologies and the production for the common agricultural market of the EU (especially the adoption of its system of subsidies in form of livestock payments per head) many branches of the traditional complex land use system became uncompetitive in Western Lesvos and the land use system was simplified by focusing on sheep husbandry. The landscape changes recorded in the study area show that the traditional mosaic of landscape elements and uses has made way for a much more uniform landscape, as the cultivated, set aside and grazed fields are replaced by grazing lands. The change in practices as well, for example, the abandonment of oak management due to the loss of acorn value, reinforces this trend. These processes can be similarly observed on other Greek islands (e.g. Syros in Detsis *et al*., 2010; Sifnos in Tzanopoulos & Vogiatzakis, 2011).

Soils in the area have been lost in many parts or have been severely degraded by the intensification of grazing practices and the simplification of the whole land use system. Kosmas *et al*. (2000) found that the land use changes in the area over the last decades of the twentieth century brought significant soil losses, the higher being recorded in the western part of the island. Bakker *et al*. (2005) claim that erosion was one of the main driving forces for land use change in the area and some soils are in high danger of desertification. Plieninger *et al*. (2011) reported a negative association between grazing intensity and oak regeneration and identified intensified livestock grazing, the abandonment of crop fields and the loss of importance of the tree layer in the last 50 years as the major drivers of vegetation change and the loss of significance of tree regeneration for the farmers.

Livestock are the cause of change, either their increase or their decrease in case of a few farms. Additional to land cover changes and soil degradation, the rising number of sheep and goats—as a result of the aforementioned economic changes—and their hardly controlled herding practices steadily reduce the quality of landscape elements such as terraces, stonewalls, etc. The economic interest of farmers to conserve those valuable elements in terms of cultural heritage preservation and wildlife habitat conservation is very low, as they lost their functional role they had in the traditional land use system. Their decrease in some localities and farms changes again land cover and increases

shrub and scrub encroachment. These results confirm the gradual but sweeping changes of many Mediterranean lands from the 1950s to the 1970s (Pinto-Correia & Vos, 2004): complex and multifunctional agrosilvopastoral land use systems were simplified to a pure livestock raising system, with some slowly decaying remnants in the landscape.

The land use changes recorded correspond to the official records: less arable land and more grazing lands and set a time frame for these changes that stretches back to the 1960s, especially changes from arable lands to grazing lands. The justifications of these changes seem to suggest a hierarchy of land use value held by the farmers: grazing lands are placed on the lower end of value and arable land and groves are considered of higher value. Conversion to grazing lands is described as something that reduces the quality of land, reducing land management practices for farmers to a minimum ("we let the animals in the field" is a typical answer). Even fields with oaks that today are considered as trees of no value are estimated 'better' and more valuable than a pure grazing land without overstorey. This fact might be related to the value of acorns and the management practices oak trees required to harvest these acorns in the traditional system, but probably also due to the observations of farmers that field with groves provide ecosystem services like soil conservation or water regulation. This devaluation of grazing lands could be linked to overgrazing, in the sense that because the land loses part of its value (economic, symbolic and environmental value), farmers can now overuse it, something which would not be the case otherwise. We are not suggesting that this is a principal cause for the intensification of sheep farming, overgrazing and landscape change, since that is clearly economic. However, in a land use system reliant to a large extent on the input of additional feed for animals, good farm stewardship with regard to fields, soils and natural resources and the proper livestock management are of no significance and do not economically matter. Good farm stewardship in regard to fields, soils and natural resources and a proper livestock management simply do not play a role and does not economically matter, again as a result of broader economic changes.

The current livestock management system is to a large extent motivated by agricultural subsidies (Beopoulos & Vlahos, 2004). Sheep farmers tend to increase the size of their herd to compensate for the loss of income per animal from the steady prices of milk they receive. Subsequently, they become more dependent on animal feed and they rely largely on subsidies. The introduction of the SFP has not altered yet these practices much, since the establishment of the 'rights' that each beneficiary is entitled to is based on historical records and the system seems to be 'locked in' (Briassoulis, 2004). This appears to be a response to the marginal conditions: since little else is available, the intensification of sheep husbandry, however radical, becomes the choice for increasing incomes, especially considering the rather supportive policy environment that links the size of the herd with the subsidy. This pattern appears to be common in similar marginal areas, both in the Mediterranean and elsewhere (Detsis *et al*., 2010; Diaz *et al*., 2011; Olarieta *et al*., 2008; Otero *et al*., 2013; Tzanopoulos *et al*., 2011). The availability of relatively cheap feed was the key factor in this line of reasoning. The current economic crisis (not considered by our respondents important at the time of the interviews) seems to be another key development that may transform the livestock management system. The need to pay in cash for feed, while cheese-makers pay farmers with a six- to 12-month delay, has created an economic deadlock that has driven many farmers to despair and led to fewer animals, although the pattern is not yet clear.

4.2. Traditional Ecological Knowledge: Loss and Recreation

Our findings illustrate that a major part of localised traditional ecological knowledge (TEK) on managing the land has been lost, and a standardised and largely uncontrolled form of land use has been introduced. Thus, the complex land use system adapted to the dynamic nature of the environmental conditions, where the landscape is managed to support multiple species, was abandoned. The knowledge connected to this kind of system and hence the way to cope with landscape and environmental dynamism was lost by the transition from a subsistence management and a production for local markets (as most farmers made their own cheese) to a livestock producing market economy producing for national and global markets. This loss of TEK is reinforced by the trend of rural depopulation in Western Lesvos and a lack of complementary income opportunities from tourism or industry.

A good example to verify that the loss of traditional management practices means also a loss of adaptive capability of land users to cope with changing environmental conditions is the treatment of the unpalatable scrub *astivi* on the farmland. Farmers try to repel it by using fire while grazing intensity remains high. This response promotes soil erosion, infertility and reduces the domination of the scrub for a few years only. However, even if some of our respondents realise that what they do now is unsustainable, none of them even considered changing the grazing regime or thought of alternative management practices in the former land use system, where the scrub was not dominating whole parcels as they seem to have lost most of such alternative and localised management knowledge. Traditional management of *astivi* was related to ploughing the fields (the ones that were cultivated in the past) and burning, but also linked with much lower grazing densities that reduce its dominance significantly, as some ungrazed spots in the area demonstrate today. Therefore the rediscovery of TEK and the integration of at least some management practices of the traditional system might help to build up adaptive management approaches to face land use induced environmental problems or climate change effects (Berkes *et al*., 2000).

In the presence of strong economic drivers in the form of the actual agricultural support systems and in the absence of strong cultural traditions and institutions in Western Lesvos the loss of TEK on traditional grazing and land use practices is visibly documented by the decaying cultural landscape elements (terraces, stonewalls, buildings, etc.). However, we were able to detect signs of awareness among our respondents, specifically in the way they regard the traditional agrosilvopastoral system. This was expressed by ascribing more value to oak grazing lands when speaking of them and by recalling some of the old land use traditions like ploughing, pruning, etc. Additionally, at least some of them also mentioned implicitly the growing importance of regulation and cultural ecosystem services in an environment of increasing overgrazing-induced erosion, loss of fertility, loss of cultural heritage and landscape aesthetics. Rerouting detrimental grazing practices by the rediscovery of TEK and the implementation of some of its elements in the current land use system seems possible (Olsson & Folke, 2001)—as long as there are old farmers and contemporary witnesses of the traditional land use practices or other local organisations, managers or researchers (Moreno-Calles *et al*., 2010)—through changes in economic incentives (e.g. agroenvironmental schemes fostering traditional practices). Reinforcement of local and regional institutions and conservation policies which take over a human-in-nature perspective by the revaluation

of traditional resource uses (Gomez-Baggethun *et al*., 2010) and are oriented towards cultural landscape restoration criteria (Moreira *et al*., 2006) may also play a role. Policies can also play a role here: the funding of locally targeted and voluntary practices over the compulsory level of good farming practices could help in re-establishing sounder management practices. Additionally, rising world-market prices for livestock feed and fodder and the ongoing economic crisis have brought forward a simple economic driver that either forces farmers to reduce flocks (abandonment is a less likely choice since with a current unemployment rate in Greece of more than 20% no other occupations are available) or urges them to try to 'squeeze' more feed out of their grazing lands. Obstacles to overcome when implementing a more resilient and sustainable land use system on the basis of TEK are the rise of awareness among the farmers (Plieninger *et al*., 2004), the scepticism of farmers towards the introduction of 'new ways' of land use (Pannell, 1999) and the increase of local public support and acceptance for changes of the cultural landscape triggered by the implementation of a 'new' land use system (Schaich, 2009).

5. Conclusion

What traditional ecological knowledge has remained in the area until today? It would seem that there is not much left and that the current management knowledge is quite one-dimensional, offering few opportunities and including only the intensification paradigm currently applied. Local farmers seem to be familiar only with this way of managing land and with the landscape that results from these practices. It seems that even the landscape change that the intensification of sheep farming has brought is not evident to most of them, even if they acknowledge some of its consequences, such as soil erosion as a result of heavy grazing or the loss of trees. This is reflected in the absence of alternatives offered or sought by them and institutions or stewards which could have helped to secure TEK against the economic driving forces of a transition to a national and international market economy. The findings underline a number of social-ecological complexities that the transformation of livestock husbandry imposed on the particular land uses and landscapes. Although the area is typical of north-eastern Mediterranean semi-arid localities, the particularities of the transition do not allow generalisations and the findings remain those of a case study, although similar trajectories have been documented elsewhere (Otero *et al*., 2013).

One of these social-ecological complexities that come out as important from this case study is that the driving forces behind landscape change and environmental degradation are economic, not in the sense that a profitable economic activity overuses the resources of an area, but in the sense that a barely viable economic activity (especially without the various subsidies) overuses the fragile and limited resources to make ends meet. In this context, solutions have to be economically oriented as well. Farmers and stakeholders do not seem to realise this fact, or at least they are reluctant to express publicly views that acknowledge the problem of extreme grazing intensities. This, in their view, would be self-defeating, as they may subsequently be deprived of the livestock subsidies, on which their farm economy critically depends. TEK-related land use systems could be a tool for the recreation of important ecosystem services or the conservation of biodiversity and in this sense agro-environmental schemes in the EU must also

include economical incentives via payments for such practices. But, the outlook may not be so bleak. A number of economic changes were responsible for the ultimate loss of TEK. Another recent set of changes, the ongoing economic crisis has revealed the dead ends of the current way of managing herds. In recent discussions with sheep farmers, some already consider reducing sheep numbers as a response to growing feed prices and lack of credit and a policy that could provide incentives towards such choices might be able to spur changes.

Notes

1. Defined as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including human) with one another and with their environment" (Berkes, 2008, p. 7).
2. According to Blondel and Aronson (1999), maquis shrubland formations occur around the Mediterranean Basin with a wide variety of names such as *macchia* in Italy or *matorral* in Spain and include evergreen shrubs such as *Cistus creticus*, *Quercus coccifera*, and *Pistacia lentiscus* in the case study area.
3. Phrygana scrub comprises evergreen spiky perennials of lower stature and complexity than maquis such as *Sarcopoterium spinosum* in the area (Blondel & Aronson, 1999).
4. More details and the official documents are available (in Greek only) in the web space of the Greek Ministry of Rural Development and Food: www.minagric.gr
5. Although Bitzelis (2010) mentions also local goat breeds, he asserts that these claims lack documentation until today.
6. Although the average age of census farmers is not known, the average age of the sampled farmers is 49 years (only 15% older than 65) and almost all are exclusively "professional" sheep farmers.
7. All farmers are eligible for the SFP, with set amounts according to historic production (the so-called 'eligible' number of sheep for which each farmer receives payments provided he/she can prove enough grazing lands, owned or rented) and land data from 1999 – 2001, with an average pay of €2,436 per farm for the island.
8. Compensatory payments are only for full time farmers, younger than 65 and farmers with an average payment of €2,342 per farm for the island. Seventy percent of recipients of LFAs for the whole island are located in the study area.
9. The calculated pressure from official data stands at 0.7 AU per ha in 2000, compared to 0.3 AU per hectare in the 1960s. This difference between the densities in sampled farms and the overall average can be attributed to: (a) that sampled farms are "professional" and therefore have more sheep and higher densities, (b) that the average density from the census data is calculated with the use of the total area of grazing lands per settlement and since there are grazing lands that are not grazed, the actual density is underestimated. A previous unpublished research in Filia in 2008 that selected farmers in random, came up with only a few "professional" farmers and the rest were part-timers or retired with reduced animal numbers and unused grazing lands.

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