LANDSCAPE CHANGE IN MEDITERRANEAN FARMLANDS: IMPACTS OF LAND ABANDONMENT ON CULTIVATION TERRACES IN PORTOFINO (ITALY) AND LESVOS (GREECE)

THEO VAN DER SLUIS[1], THANASIS KIZOS [2], BAS PEDROLI [1]

[1]*Alterra Wageningen UR, Wageningen, NL, email: theo.vandersluis@wur.nl*
[2]*Department of Geography, University of the Aegean, Mytilini, Greece*

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ABSTRACT

The Mediterranean landscape has been rapidly changing over the past decades. Many regions saw a population decline, which resulted in changing land use, abandonment of marginal lands and colonisation by shrubs and tree species. Typical features like farming terraces, olive yards, and upland grasslands have been decreasing over the past 50 years. This results in a declining biodiversity and loss of traditional Mediterranean landscapes. In this paper we assess the landscape changes that took place in two areas, in Portofino, on the Italian Riviera, and Lesvos, a Greek island near the Turkish coast. We compared land use maps and aerial photographs over the past decades to quantify the land use changes in these two areas. Additional information was acquired from farmers' interviews and literature. We found that changes are related to societal changes in the appraisal of agricultural land uses, and to the urban expansion, tourism and recreation. These diffuse processes are a result of policy measures and autonomous societal transformations. This is confirmed by the results of two interview surveys: between 1999 and 2012 agricultural land use in Portofino regional Park and buffer zone further marginalised, and the associated landscape changes are perceived as a substantial loss of character and identity. This problem is emblematic for large parts of the Mediterranean. Comparing different landscapes reveal similar processes of landscape change, which can be related to similar driving forces. Based on such comparisons, we learn about possible trajectories of change, and ask for a comprehensive approach to land use management.

Keywords: cultural landscape, land use, terraces, biodiversity, driving forces

INTRODUCTION

The Mediterranean region is well known for its high biodiversity (Aronson et al., 1998; Scarascia-Mugnozza, Oswald, Piussi, & Radoglou, 2000). With 25,000 plant species and 770 vertebrate species the Mediterranean Basin is one of the 25 hotspots worldwide for biodiversity (Myers, Mittermeier, Mittermeier, da Fonseca & Kent, 2000). The high biodiversity is a result of the long history of human influence (Hubert, 1991), to such an extent that entire vegetation communities are kept in a state that it suits man (Farina, 2006). A number of land management systems have contributed to this, some related to cereals – fallow – grazing, others with permanent crops (mostly olives and vines), with grazing systems and agroforestry. The recent collapse of the agro-silvo-pastoral system, however, has resulted in major changes in plant communities (Médail & Quézel, 1999). This has led to

a homogenisation of floral and faunal communities and thus a loss of biodiversity. The increasing dominance of forest species in silvo-pastoral systems may lead to a rapid decline of species diversity (Gondard, Romane, Grandjanny, Li, & Aronson, 2001; Pedroli, Tagliasacchi, Van der Sluis, & Vos, 2013).

Although Mediterranean landscapes were never static, the rate of change has rapidly increased over the past decades. Many regions saw a population decline, which resulted in changing land use, abandonment of marginal lands followed by colonisation of shrubs and tree species. As a result of agricultural policies and opportunities elsewhere, people are abandoning rural areas (Caraveli, 2000), and farming is marginalised. Marginalisation of farming ("a process driven by a combination of social, economic, political and environmental factors, by which certain areas of farmland cease to be viable under an existing land use and socio-economic structure", Beaufoy et al., 1994) may lead to different strategies, or responses from farmers, such as change of land use, e.g. from crops to grassland or forests or buildings; reduced inputs, stocking densities, maintenance of infrastructure ('extensification'); restructuring of farming, farms being taken over by other farmers (enlargement); contraction of the farming system, intensification in places, abandonment elsewhere; or complete land abandonment.

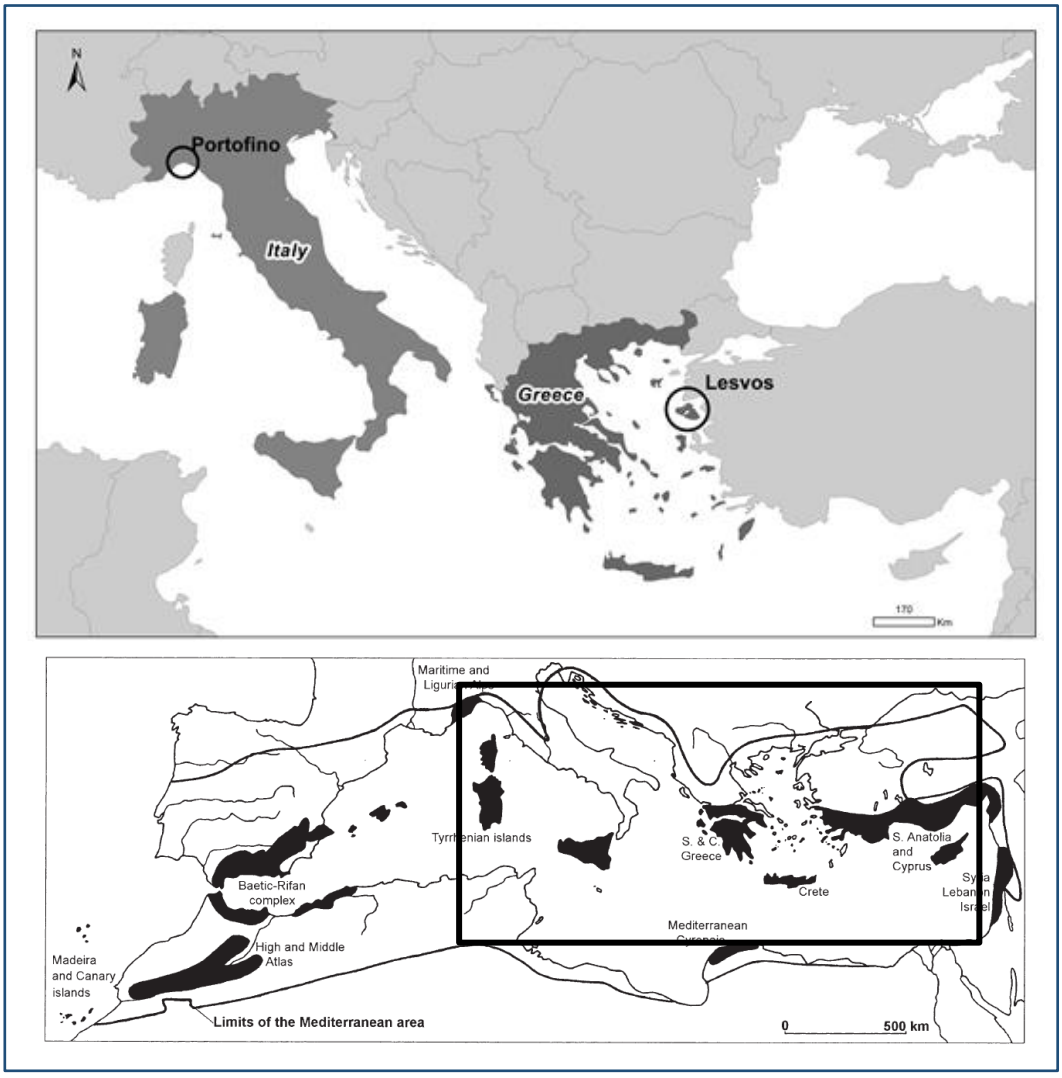
Farina (2006) describes the Mediterranean landscape as a 'historically fragmented landscape'. The recent degradation of landscape and nature values (Aronson et al., 1998; Zavala & Burkey, 1997), leads to changes in the human-perceived scenic value of the land mosaic. This problem is rampant in many parts of Europe today (Conacher & Sala, 1998). Due to land abandonment former mosaic landscapes change into homogeneous forested areas (Baudry, 1991), often resulting in irreversible ecological changes. The farming systems often "represent very old biological adjustments and equilibria that include complex food webs, migration patterns and symbionts etc. representing delicate balances" (Bernáldez, 1991). Land abandonment is the third-most important factor for decline of threatened plant species in Europe (OECD, 1997). Intensification with industrial arable plants or permanent crops is another development typical of many level areas suitable for irrigation. As a result the productivity and stability of Mediterranean ecosystems is threatened and therefore measures are required (Etienne, in Aronson et al., 1998).

In this paper we compare two different Mediterranean landscapes, the ones of Portofino in Italy and of Lesvos Island in Greece (Figure 1). In these cases the dominant driving forces of landscape change in the region today are represented: abandonment and urban sprawl (including tourism uses). Although these landscapes seem apart, agro-climate, landscape genesis and farming practices are quite similar, and olive cultivation links them, as olive trees and vine cultivation on a larger scale were re-introduced on Lesvos under the Genovese Gatellouzi rule (1354-1462). Portofino is less than 30 km from Genoa, where the olive tree (with the Taggiasca and Lavagnina varieties) was probably introduced and diffused in medieval times by the Benedictine monks of the San Fruttuoso monastery not far from Portofino.

The trajectories of farming and landscape management in the countries of the case study areas of this paper, Italy and Greece, were similar. In Italy, inaccessible and rural agricultural lands were abandoned over the past 50 years (Van der Sluis et al., 2013). Forests, which had an important role for provision of firewood and charcoal for cities, were also less intensively managed, along with Chestnut plantations (*Castanea sativa*) which provided in staple food for the poorer peasant population (Vos & Stortelder, 1992). Also labour intensive practices such as maintenance of terraces and dry stone walls, or livestock herding and transhumance decreased or were abandoned. This caused changes in landscapes, typical features like farming terraces, olive yards, and upland grasslands have been decreasing over the past 50

years. This results in a declining biodiversity and loss of traditional landscapes, typical for the Mediterranean region. Similarly, in Greece several spatial and thematic processes are recognised as important for changing rural landscapes (Kizos & Vlachos, 2012): the first is the intensification of farming in favoured areas, especially the plains; the second is tourist-urban-industrial sprawl mostly in peri-urban areas, coasts and along roads that takes up good farmland, but also results in the break-up of the landscape; and the third is land abandonment, evident in mountain areas and islands. Remaining farms are typically small, extensive and multi-functional.

Fig. 1: Location of the study areas and location of the 10 biodiversity hotspots in the Mediterranean, based on plant endemism and richness (from Médail&Quézel, 1999)



An important characteristic of many Mediterranean landscapes are the terraces. Cultivation terraces are artificial, level surfaces used for cultivation on sloping terrain, in the Mediterranean usually supported by a stone wall (Petanidou et al. 2008) and sustaining a variety of different land uses, including perennial crops and arable crops. Terraces support a number of different ecosystem services, including soil erosion prevention, less surface water runoff, increase of soil depth and moisture, and they also often characterise the landscape. They have been used in the Mediterranean since the Neolithic by many different societies and cultures (Simon & Nixon, 2005), but their dating is not always easy or feasible. The various types of building material, frequency of maintenance, building craftsmanship and subsequent use determine to a large degree the state of these terraces (Pedroli et al., 2013, 447-469).

To this background the paper aims to answer the following questions:

- How is the landscape history of the two case areas reflected in land use change of the last decades?
- What is the impact of changing land management on landscape character and diversity, focussing on a particular feature of the landscape that these areas have in common: cultivation terraces.
- How can production functions be maintained, and which effective strategies and future pathways can be followed to conserve valuable cultural landscapes such as these in the Mediterranean.

To this end, we have utilised already existing material to compare developments and impacts of land management practices (including their abandonment). Most of the material is already published, and is complemented by unpublished material and our own personal experience on the localities, land management and cultivation terraces.

METHODS AND MATERIAL

Study areas

The two study areas that we compare are located on the Mediterranean coast (Figure 1 and Table 1): Portofino is situated in Liguria Region; Lesvos is one of the largest Aegean islands near the Turkish coast. Both areas are in or directly adjoining a biodiversity hotspot (Figure 1, after Médail & Quézel, 1999).

Portofino

The picturesque former fishermen's village Portofino is a famous tourist attraction on a small peninsula near Genoa, Italy. Most of the peninsula is since 1935 part of the Parco del Monte di Portofino, which since 1977 has the status of a Regional Nature Park. The people live mostly outside the park area, except for Portofino village which is fully located within the park. The total protected area is 1056 ha. A main feature of the peninsula is the steep south-faced ridge that rises from sea level up to Monte di Portofino (610 m). The geology, microclimatic variations together with the various expositions and slopes of the place, has decisively determined its vegetation differentiation (Gentile, Barberis, Menozzi, & Zanoni, 2004). There are two major geological formations in the area: the Portofino conglomerate is overlying the Monte Antola limestone. Most common are natural vegetation types: apart from the macchia-covered south slopes, most part is forested, and some 20 % of the area has an agricultural function. The climate is mild Mediterranean, the mean temperature ranges from 13.5-15.5 degrees, with an average rainfall of 1227 mm.

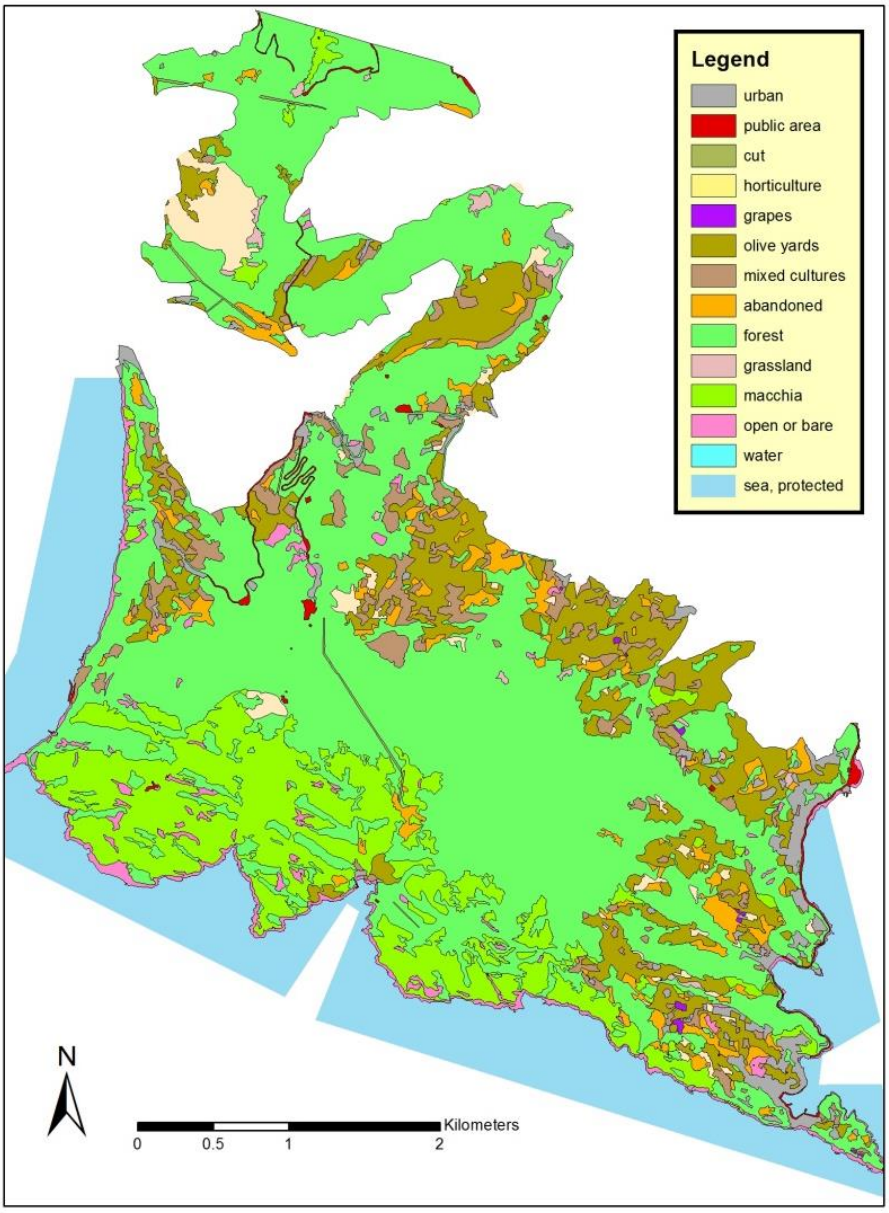
Table 1: The case study areas

	Portofino	Lesvos
Area Size (km2)	42 km2	1,456 km2
Population (2011)	18,000 people	90,000 people
Topography	Mountainous, with 90% sloping land, highest elevation 610m	Hilly, with 70% in sloping land, highest elevation 980m
Climate	Ranging from sub-humid in the South (920 mm precipitation) to damp in the North (1150 mm precipitation)	Ranging from semi dry in the East (400 mm precipitation) to semi wet in the West (600 mm precipitation)
Geology - soils	Dominant is the very hard calcareous Conglomerate (northern slopes) that is overlying the soft clayey limestone (southern slopes).	Ranging from Holocene volcanic material in the west to Mesozoic schist and limestone material in the east
Land use %	Agriculture (total): 365.4 ha (20%) Olive yards 250.0 ha (14%) Other agriculture 115.5 ha (6%) Abandoned 72.4 ha (4%) Infrastructure 67.1 ha (4%) Natural vegetation 1340.9 ha (67%)	Utilized Agricultural Area (UAA): 88155.1 ha Arable land: 2714.6 ha (3,1% of UAA) Tree crops: 41284.8 ha (46.8% of UAA) Grazing lands: 43569.4 ha (49.4% of UAA)
Terraces	Two types: stone walls and embankments. Stone walls are mostly parallel – braided terraces but in some cases half-moon shaped supporting one tree	Three types: (a) parallel – braided terraces with scattered trees in each terrace at irregular spaces; (b) braided terraces with individual terraces around some of the trees on the terrace; (c) individual terraces around trees

The long history of human habitation (from prehistoric times onwards) has shaped the landscape. Apart from a strategic transit harbour, the village of Portofino was since at least Roman times a fishermen's place. From the 16th century onwards multifunctional land use was common. Over the past decades it changed, and tourism, habitation and nature conservation have become important. Less suitable farming areas have been abandoned. Portofino became internationally famous among tourists already more than 100 years ago. Over the recent decades there has been a strong pressure on the coastal area of Italy, a spread of villages and towns due to economic activities as well as tourism occurred with detrimental effects on the coastal zone. Today, it is a well-known resort and an attractive site for the 'rich and famous', for second houses, and for investors to develop facilities for tourism (Cosor et al., 2012; Kristensen et al., 2012a; Kristensen et al. 2012b; Van der Sluis et al., 2013).

Previous research (Van der Sluis et al., 2013; Pedroli et al., 2013) shows that currently farming in the Portofino area has mainly a subsistence character, or represents a part-time activity – both indications of low intensity farming. Agriculture has been widespread in the east of the Park (see Figure 2), in total some 360 ha and in addition some 40 ha of abandoned agricultural areas. In the past the gathering of firewood was definitely one of the main factors determining vegetation patterns in the Mediterranean areas. Wood was the only source of energy for many economic activities until the 19th century. In Italy the trade of charcoal was important for energy supply to all main cities, and was among the major sources of income for the rural population, which was the case on the Portofino promontory as well.

Fig. 2: Vegetation and land use map Portofino for 2010



Chestnut grows mostly on terraces, in oak forests, at more favourable, deep moisture retaining soils on north facing slopes. The Chestnut was intensively managed until the end of the 19th century, but due to the rural exodus as well as decreasing demand for chestnut poles, fruits, charcoal and firewood, plantations were abandoned.

Lesvos

Lesvos is the 2nd biggest island of the Aegean (1,456 km2) with a population of 90,000 people. Its climate is Mediterranean from semi dry in the East (recent volcanic material, 400 mm precipitation) to semi wet in the West (schist and limestone material with 600 mm precipitation). This diversity results in a number of distinct landscape types. Although the number of farms has recently declined, agriculture is still quite important in terms of the jobs and income it provides. The most important agricultural landscapes consist of olive plantations in the eastern part of the island and grazing lands (for sheep) in the west (Kizos et al., 2013). The olive plantations constitute mostly a homogenous landscape, very characteristic for Lesvos and part of its local identity, with most of the trees on small, hilly or mountainous and sloping fields. The number of farms with olive plantations makes up 95% of the total number of farms (more than 15,000), 45% of the total Utilised Agricultural Area (UAA) and roughly 30% of the total area of the island. The olive plantations on slopes steeper than 10–15% are all terraced, either in pocket type (a single terrace in semi-circle around one tree), in parallel-braided type, or often in mixed types (Kizos et al., 2012). The abundance of pocket terraces is a unique characteristic for olive cultivation globally.

Previous research shows that the significance of olive cultivation rose rapidly after the 18th century (Kizos & Koulouri, 2006). But, a number of economic and social changes including a significant rural exodus (-35% from 1951 to 1981 and stabilisation and ageing afterwards) and a recent drop of olive oil prices have caused negligence or abandonment of olive plantations. These plantations are of the "Low-input traditional plantations and scattered trees" category and are managed with few or no chemical inputs, but with a high labour input (Stroosnijder, Mansinho & Palese, 2008). The tree density is low (typically 20 to 50 trees per ha). The management of the understorey rarely involves grazing, more often mowing and/or tillage. Pesticide use is minimal or occasional, irrigation is not usual, although it is becoming common on some fields in level areas. Harvesting is usually performed by hand, or may be left in years of little harvest. Typical yields are in the range of 200 – 1500 kg/ha. Consistency of annual yield is low, due to modest fertilisation and irrigation practices. Labour requirement is very high in harvesting, pruning, maintenance of terraces and walls, scrub control, etc. Neglected plantations are in between cultivation and abandonment, in which little other management is practised besides collecting olives.

RESEARCH APPROACH - MATERIAL

For Portofino, land use was recorded from aerial photographs for 1936, 1954, 1974, 1991, and 2000 from Ercoli et al. (2001). The 2011 situation was derived from aerial photography as well. A landscape ecological survey was done, which included field work during 1999, 2000 and 2001, and description of 140 sites. Old farmers (30) were interviewed in 1999 about their (former) land use and land use constraints, and the survey was repeated in 2012. The description of terraces is derived from Pedroli et al. (2013), and is based on mapping from aerial photographs and field inventories of the terraces in the area. Based on this a typology of terraces and infrastructure was prepared, and the state of maintenance was mapped.

For Lesvos, the materials used for the analysis include official statistics from the Greek Statistics Office (EL.STAT.) from past censuses of agriculture and animal husbandry and population censuses; land cover data from the CORINE data base, and published research (Kizos & Koulouri, 2006; Kizos et al., 2010; Kizos et al., 2011) that includes interviews with farmers on land management and landscape practices. They also include the personal observations of the authors on the island, including terraces' styles and land management.

An analysis of landscape change was performed in ArcGis10 (ESRI 2011) to quantify conversion of land from appr. 1975 onwards, marking the start of the EEC. The material for the two areas differs and is not always directly comparable, reflecting different statistical data availability and previous research on each locality. Nevertheless, despite this diversity, we have attempted to focus on the similarities and compare and discuss the situation, rather than provide separate accounts of landscape history only. The ultimate goal is to shed some light on the impact of changing land management on landscape character and diversity, focussing on a particular landscape feature: cultivation terraces.

RESULTS

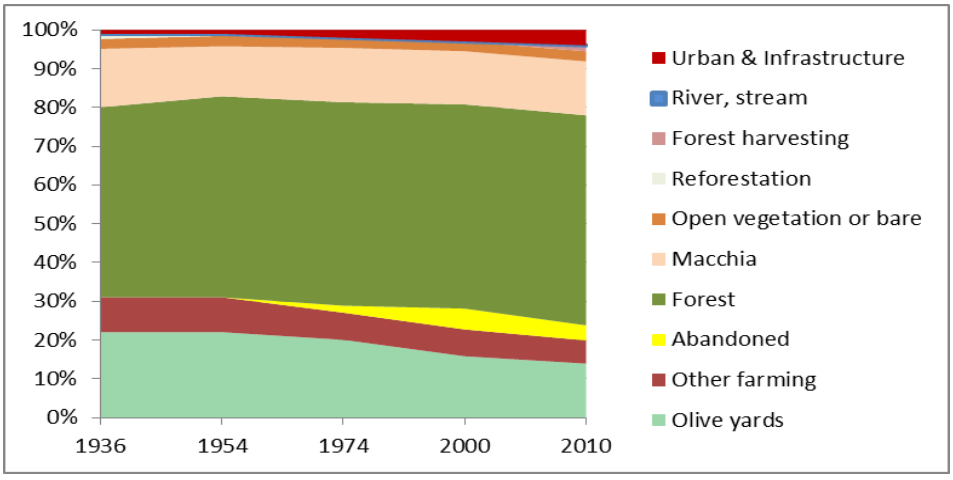
Land cover and landscape change and their driving forces

Land use and landscape changes in Portofino

Farming in the Portofino area is mainly for subsistence or as a part-time activity – a characteristic of low-intensity farming. The area is considered as a small-scale farming region (Beaufoy et al., 1994) with low intensity farming (the term "low-intensity farming" is used for those farming systems with a reduced use of external resources, especially fertilisers and agrochemicals). In Portofino, agriculture has been widespread to the east of the Park, amounting to about 150 ha inside the park. In the East about 50 % of the land was cultivated, shown by the terraces and orchards (partly abandoned). In the past there were also terraces to the western side, but these have been abandoned and are now totally eroded. Grazing appears to be historically limited in this area (Mosconi, 2000) and today it is no longer permitted inside the Park. In 2010 there are only small vineyards left, garden-like, all situated on the east-side of the promontory, in total not more than a few hectares.

The land uses and landscapes of 1936 appear to be well-managed, all suitable agricultural land was intensively used and properly maintained. There were no signs of abandonment yet, and olive plantations and 'coltura mista' (mixed culture of permanent and annual crops) were widespread (Ercoli et al., 2001). The decline of farming coincided with land abandonment which started in the 1950s. Abandonment seems to fluctuate around 80-100 ha and abandoned land tends to gradually develop into natural vegetation, which category consequently increases over time (Figure 3).

Fig. 3: Changing land use in Portofino area, for the period 1936-2010



Over time farming marginalises and has almost vanished from the area: it decreased by 40%, from more than 600 ha in 1936 to a mere 324 ha in 2010 (Figures 3 and 4). In the period 1974-2000 in total 34% land cover changed. The classification differed over the years, which makes some changes hard to detect, most conversion occurs between agricultural crops. The conversion table (Table 2) shows vegetation cover in 1974 (lines) and 2000 (columns) and changes between these two periods. Some 302 ha of olive yards remained stable, whereas some 16 ha was 'abandoned', 17 ha turned into forest and 29.5 ha changed into farmland. Some 56 ha of macchia developed into forest, however, 206 ha was classified as grassland, which may be due to fires which destroyed the macchia and gave an appearance of open grassland. A recent development is that some old abandoned farmland is used again and terraces are restored, houses renovated, often by people not originally from this area. A relatively new way of small scale farming are vegetable gardens, typically located close to the house or the settlement. It is a type of mixed crops or mixed farming with orchards, fruit, some vegetables and often wheat or alfalfa. This category is too small to be represented in the graphs.

Fig. 4: Decline of farming in Portofino area, for the period 1936-2010

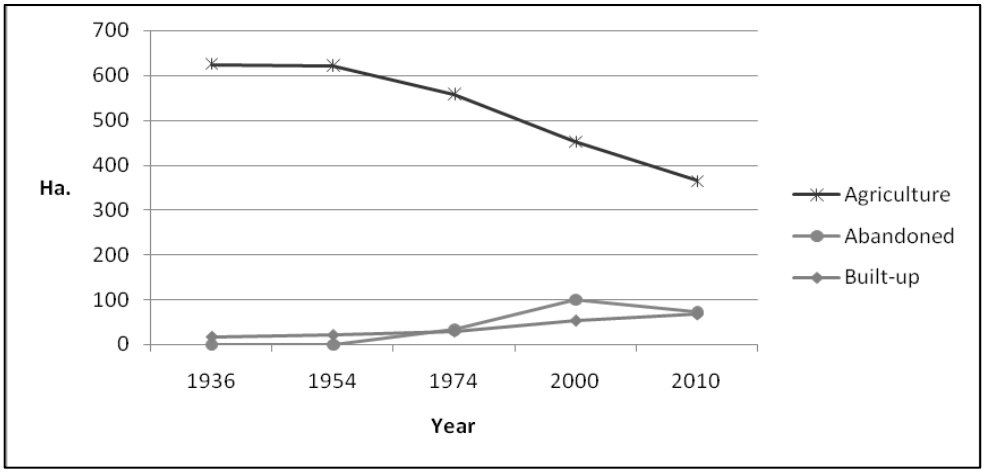


Table 2: Portofino land use change, comparison 1980 (rows) with 2000 (columns) (ha). It show how land cover changed over time.
For example, olive groves were 373 ha in 1980, and in 2000 some 2.8 ha changed into 'build-up area', i.e. olive groves were converted in housing area.

	Built-up area	Public area	Power lines	Agricultural area	Horticulture	Vineyards	Olive yard	Abandoned	Forest	Grassland	Macchia	Sparse vegetation	SUM
Built-up area	15.10	-	5.70	-	-	0.32	0.06	-	0.12	-	0.14	-	21.44
Public area	0.08	3.05	-	-	-	0.03	-	-	0.20	-	-	-	3.36
Power lines	-	-	0.13	-	-	-	-	-	0.11	0.05	-	-	0.29
Agricultural area	3.05	0.07	3.46	-	11.22	45.55	29.45	4.63	9.00	0.67	0.73	-	107.81
Horticulture	-	-	-	-	-	-	-	-	-	-	-	-	-
Vineyards	-	-	-	-	-	-	-	-	-	-	-	-	-
Olive yard	2.86	0.06	3.58	-	7.46	32.65	302.76	6.90	14.61	2.29	0.23	-	373.40
Abandoned	-	-	0.08	-	1.53	1.54	15.98	5.76	4.17	1.70	-	-	30.75
Forest	2.64	0.61	5.12	-	2.90	2.43	17.24	0.94	900.88	43.17	3.08	0.08	979.10
Grassland	-	-	-	-	1.03	-	0.34	-	8.05	10.18	-	-	19.61
Macchia	-	-	-	-	-	0.09	0.06	0.07	55.96	206.38	0.56	-	263.12
Sparse vegetation	0.06	0.10	0.17	-	0.04	-	0.04	-	1.09	1.74	27.77	-	31.03
SUM	23.78	3.94	18.25	0.00	24.18	82.61	365.94	18.29	994.18	266.18	32.51	0.08	

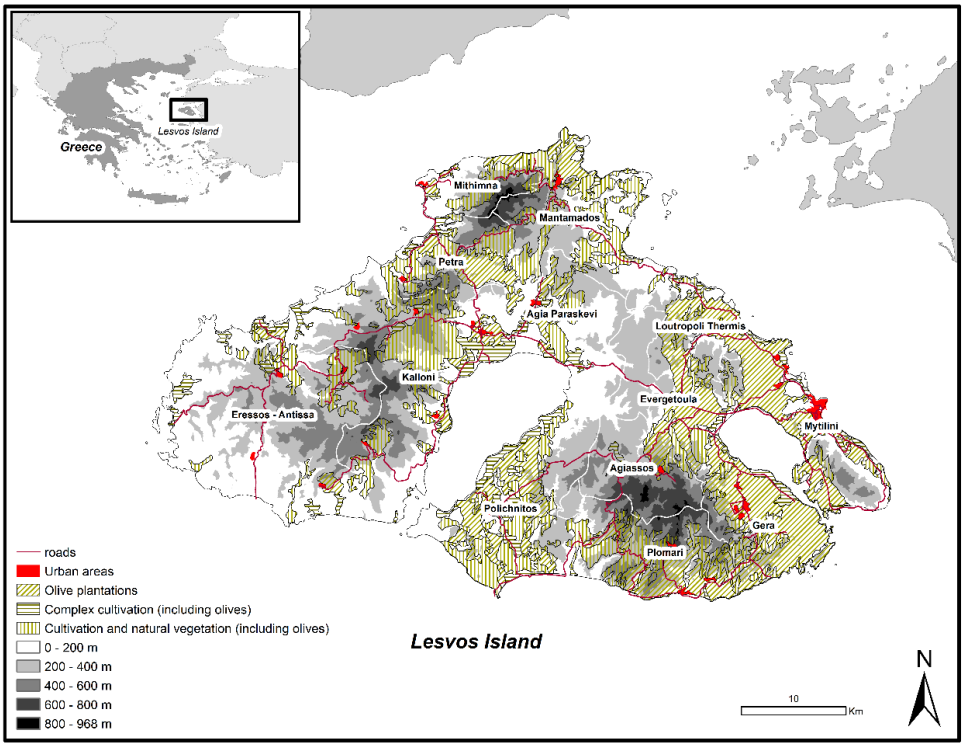
Table 3: Lesvos land conversion, comparison 1981 (rows) with 2004 (columns) (ha). Statistics are for Eastern Lesvos only.

	Airport	Bare ground	Brush	Built up	Coniferous forest	Crops	Grassland	Marsh	Not classified	Olive yard	Sparse con. forest	SUM
Airport	23	-	-	-	-	-	-	-	-	-	-	23
Bare ground	-	148	-	-	-	-	-	-	-	-	-	148
Brush	-	2	811	1	-	-	1	-	-	0	-	815
Built up	-	-	0	418	-	-	0	-	-	6	-	424
Coniferous forest	-	-	-	8	2,690	-	0	-	2	0	-	2,701
Crops	-	-	-	27	-	437	-	-	0	0	1	466
Grassland	-	0	-	3	-	-	564	-	15	0	-	582
Marsh	-	-	-	-	-	-	-	39	-	-	-	39
Not classified	-	-	-	3	-	1	1	-	59	2	0	66
Olive yard	-	-	0	181	31	18	3	-	1	5,156	-	5,390
Sparse conif. forest	-	-	-	-	-	-	-	-	-	-	201	201
SUM	23	150	812	648	2,721	456	570	39	77	5,167	201	10,865

Land use and landscape changes on Lesvos

For Lesvos, a number of changes in farmland use is evident in the second half of the 20th century. As Table 2 and Figure 5 demonstrate, most olive plantations are found in the eastern part of the island, in six former Municipalities (currently the whole island is one Municipality) where the share of tree crops (practically all olives) in the Utilised Agricultural Area (UAA) is higher than 80%. Overall, the decrease of UAA in this period is driven mostly by the decrease of arable land that has increased the share of olives from 39.4% of the UAA in 1961 to 46.8% in 2000. Olive plantations are nominally decreasing by 1.7% in this period, although many more plantations are neglected, but still considered as farmland by their owners. A detailed assessment of land use change for Eastern Lesvos from 1981 to 2004 shows very little change, only 3%. However, the conversion taking place is mostly from olive groves into build-up area (181 ha, see Table 3), or into cropland (18 ha) and coniferous forest (31 ha). Also some 27 ha of cropland converted into build-up areas.

Fig. 5: Land cover and terraces expansion on Lesvos



Abandonment and loss of olive plantations is higher in the municipalities where olives dominate, elsewhere some arable land was replaced with olives, especially in the 1970s and 1980s (the remaining arable lands were converted to grazing lands, Kizos et al., 2013). The decrease of olives (and UAA in general) is in general much lower than would be expected considering the decrease of the numbers of farms in the same period. The overall decrease of farms was 42.7% and the decrease of the numbers of tree farms 41.3%, slightly lower in the olive dominated parts of the island but still very important. This decrease meant that the

average size of the olive farms nearly doubled from 1.6 to 2.7 ha, but with significant internal differences: few very big farms and many small.

What is not recorded in the official data is abandonment and negligence ratios of olive plantations. This is a slow process and it is estimated that it may take 30 -50 years (depending on moisture mostly) for the field to become "re-wilded". But even in such cases, a clearing of the understorey and pruning of the olive trees is enough to make the field productive again (see Kizos & Koulouri, 2010 for examples). Fields in sloping or remote areas are more prone to abandonment, but in general it is the age or the willingness of the farmer and his/her family that determines which fields will be abandoned and which not. The symbolic value that farmers attach to "their" olive plantations is another important factor, according to Kizos at al. (2012) they are considered as a family asset. Another development not visible in Table 4 is urban expansion. Although official data indicate an increase of 2.1% in the last 2 decades, this increase is very unequally distributed over the area and concentrated around the town of Mytilini and in tourism developed coastal areas.

Therefore, the actual landscape changes on Lesvos, and especially in part dominated by olive plantations, are rather limited in the last decades. Despite the decrease of the numbers of farmers by more than 40%, land cover did not change much. This is related to the particular land use and the slow rate of change, at least for a time period of decades, as discussed in this paper.

Cultivation terraces

Cultivation terraces are among the most characteristic features of Mediterranean landscapes. The terraces as well as the landscape in the two case study areas have suffered from negligence during the past decades. This is discussed in the following paragraphs.

Portofino area

Although the first terraces may date back to prehistoric and Roman times, documentation of large scale terracing dates from the Middle Ages on the south side of Portofino. San Fruttuoso Abbey and other churches were at the time a driving force behind terrace construction (Pedroli et al., 2013). The maximum extent was reached during the 19th century, and during the 20th century terraces were constructed on the higher south-eastern slopes for reforestation purposes (Figure 6), visible on aerial photographs from 1936. Within Liguria Region more than 20% of the territory is terraced (Brancucci & Paliaga, 2006). The structure of the terraces would depend on the slope inclination, the geological and morphological characteristics which define lithology, rock outcropping formation, detritus layer and soil depth (Pedroli et al., 2013; Figure 7). The slope's inclination would define the height and width of the terrace.

Two types of terraces are found (see Figure 8 for examples): stone-walls and embankments. The dry-stone walls are either with a "loose matrix" (*muri secci*), i.e. walls which are not cemented, and more recently cement walls have appeared near houses and roads. The second type, embankment systems are earthen walls which are mostly more gently sloping than stone walls and either placed on a rock foundation or on the soil (Figure 7E). Their distribution can be more or less regular, depending on the slope morphology. The embankments require much less laborious manual work than the dry-stone walls. Also an 'intermediate type is observed, mostly in the Chestnut cultivation system, the lower part consisting of stone walls, with an earth embankment on top (*muri di sottoscarpa*).

Fig. 6: The state of terraces in Portofino in the year 2000

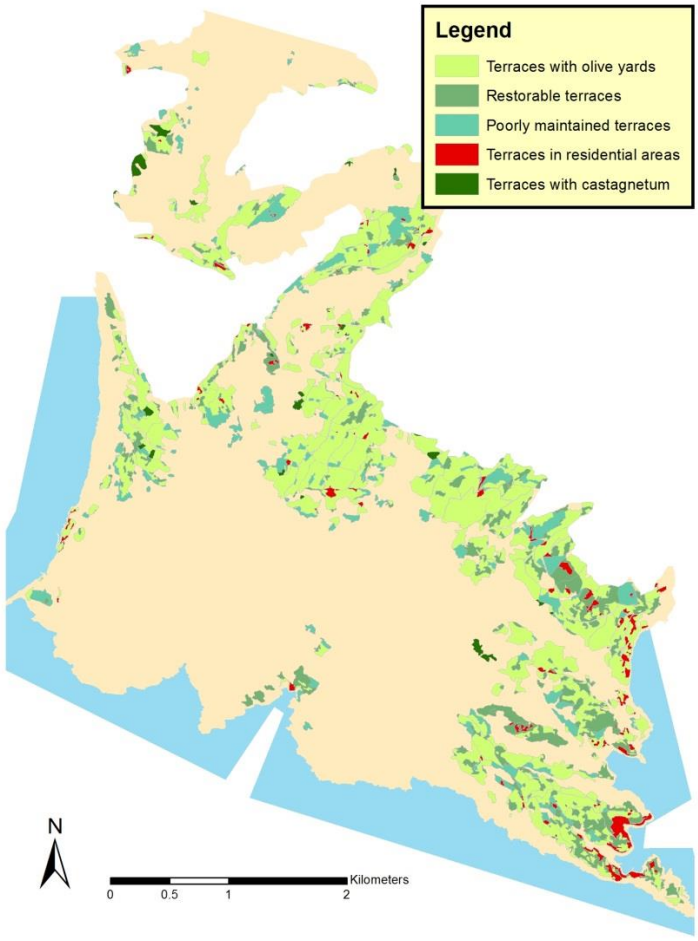


Fig. 7: Terrace types (B to E) and processes of collapse (1 to 7) (Brancucci &Paliaga, 2006)

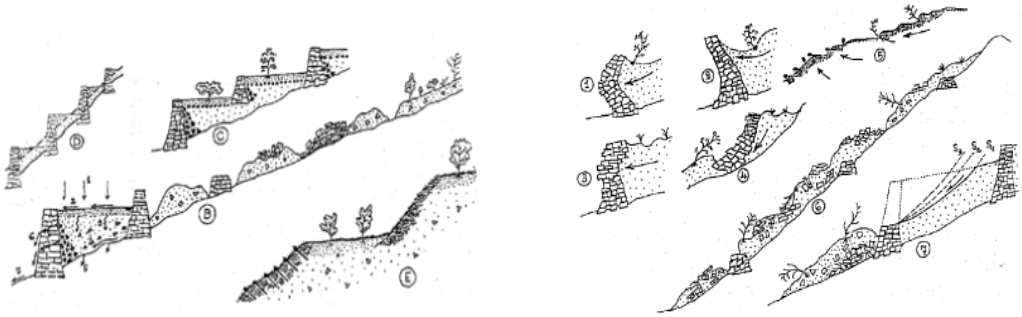


Fig. 8: Pictures of terraces from Lesvos and Portofino:

Lesvos A

Portofino A

Lesvos B

Portofino B

Lesvos C

Portofino C

Lesvos D

Portofino D

Lesvos A: Mixed masonry of schist with later limestone addition near Mytilini; Lesvos B: Olive nets on very well preserved individual limestone terraces near Agiassos; Lesvos C: Braided limestone terraces near Mytilini; Lesvos D: braided terraces with volcanic material near Kalloni; Portofino A: Embankments with oliveyards; Portofino B: Supporting dry stone wall in undefined bond using blocks and elements from weathered conglomerate; Portofino C: Olive harvest at a small farmstead near Nozarego; Portofino D: Gentle terraced slope with low embankments, material originating from marl-limestone rock types.

Almost all terrace walls are linear, only on the southern side at San Fruttuoso we observe half-moon walls (*muri a lunetta*) which support only one tree. There are variations in form and shape of the walls. Important factors are the lithological material, which depends on the geology and geometrical characteristics of the available rock type. The walls from Portofino Conglomerate are more irregularly formed than the walls build from rather square blocks of Monte Antola Limestone.

The current abandonment of terraces might have started around the early 1950s, judging from the vegetation that has established itself on the former terraces. In total 65% of the terrace area is still recognisable and in fair shape (Table 5, Figure 6). Some 30% is not in good shape (restorable or poorly maintained). A small proportion is located in residential areas. The different terrace types as well as the processes which may lead to their collapse are presented in figure 7 (after Brancucci & Paliaga, 2006).

Lesvos area

Terraces in olive plantations on Lesvos can be classified according to their type, the building material and the style of masonry. There are three types, as described by Kizos et al. (2010): (a) parallel – braided terraces with scattered trees in each terrace at irregular spaces; (b) braided terraces with individual terraces around some of the trees on the terrace; (c) individual terraces around all trees. Out of these three, the last one has been constructed for olives and the date of the terraces coincides with that of the oldest trees in the plantation.

The building material comes from the different substrates upon which olive plantations are grown (Kizos et al., 2010): limestone (Figure 8, Lesvos, A, B and C), which provides heavier building stones that can be carved to fit exactly and make the best walls; schist (see Figure 8, Lesvos A), which provides lighter stones, that come typically in slabs, are easily eroded and make walls that are easier to break; and volcanic rocks (andesite and trachite in olive growing areas, Figure 8, Lesvos D) which are relatively light and many are rounded, they are harder to carve and the walls built with such rocks are of inferior quality compared to those made with limestone, but generally better than those made with schist. Finally, there are three or four types of masonry which are related with the materials used: individual terraces are typically lower than the other types and are made with schist and less often with limestone, especially in the Plomari and Gera areas (Figure 5). Limestone is used for all types of terraces, and can be relatively high. Around the town of Mytilini they are made in a very distinctive and robust style of a trapeze with a very large base compared to the stem of the terrace. Terraces with volcanic rocks have two or three distinct styles, one around the Mandamados area, where larger boulders are embedded in the walls and the craftsmanship is of high quality, and another one in the Polihnitos area where terraces are made in the same style as stonewall enclosures, with smaller and carved stones. Around the plain of Kalloni a third style can be seen, lower in height and of lower quality terraces, many of which are in bad shape, due to the uncontrolled grazing as well. The total extent of the terraces on Lesvos is unknown, but a rough estimation based on slope gradient and land cover provides a figure of 52% of the total olive plantations.

The state of terraces today can only be roughly estimated. Previous research indicates that the maintenance of terraces is not considered a priority for most farmers. In fact, Kizos

et al. (2010) claim that part-time farmers more frequently maintain their terraces, at least partly.

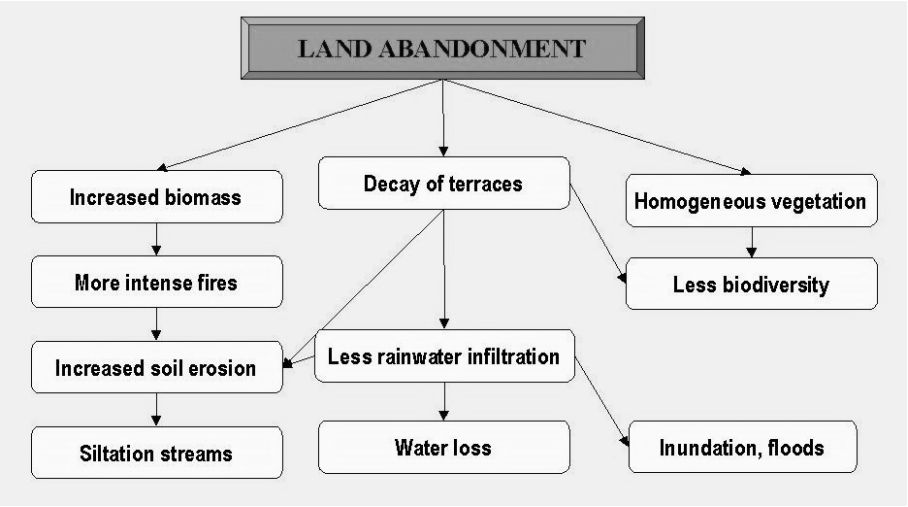
DISCUSSION

Landscapes change continuously. The two landscapes studied here represent two different Mediterranean trajectories of rural landscape change: (a) tourism (and urban) development that places stress on land values and causes widespread changes on landscape structure and functions; (b) abandonment of farming - part time farming of permanent crops and a slow change of the landscape towards more natural vegetation. The case of olives in both studied landscapes is typical of the second trajectory. These olives are low intensity systems and since they are very well adapted to the local climate, their abandonment changes the landscape in a rate that is not easily witnessed by annual observations, or even over decades. Other types of change, such as tourism or urban sprawl, are much more rapid. In the end, dramatic changes of society and economy over a period of 50 – 60 years have left only a small footprint on the landscape (e.g. on Lesvos the population has decreased by 35% and the town of Mytilini has nearly tripled in size). This "landscape legacy" (Plieninger et al., 2011) of olive plantations does not mean that this change is "positive" in economic, ecological and/or symbolic terms (see Kizos & Koulouri, 2010 for a discussion on these services), but it emphasises that proper consideration of diverging change rates is vital for understanding and managing landscape change and its environmental impacts.

Land abandonment has different impacts: the landscape changes, slope stability is altered, and also the diversity will be affected. The landscape changes from a cultural landscape with dispersed houses and farms with olive yards and gardens into a landscape where natural processes dominate. In a decade the fields will overgrow, followed by decay of infrastructure such as houses and terraces. If the terraces are well constructed they can be rather persistent, but the stability differs. Also, impact of livestock and wildlife can speed up the decay. Grazing livestock can damage the stone walls, as well as the grubbing behaviour of wild boars. In particular on steep slopes the risks of collapse of terraces are profound. The decay of terraces and the absence of management also leads to a dense, homogeneous vegetation cover, which results in less biodiversity. The increased biomass is prone to fires, which are difficult to control and can have severe impacts by burning of trees and destruction of the soil structure. Also this process may lead to increased soil erosion and siltation of streams (see Figure 9). This results in landslides, as well as inundations and floods, affecting houses and the landscape (Galve et al., 2014).

Some features of the landscape are less prone to change than others, due to their nature or due to the type of changes that affect a landscape for a particular period. Cultivation terraces are labour intensive to construct and may prove extremely persistent especially when the land they are located in is abandoned. This is demonstrated by the case studies presented in this paper. Although different driving forces were involved, the immediate change was similar for one type of transition: abandonment. Abandonment has affected land cover and the landscape in Portofino more than in Lesvos due to the particular land cover: olive plantations generally change very little for the time periods examined here, even when abandoned.

Fig. 9: Chain of events leading to marginalization of agriculture, loss of biodiversity, land degradation.



This is true for their terraces as well. Literature suggests that their preservation is related with their functional role in the productive and land management systems in an area (Petanidou et al., 2010). When this function is lost due to economic or land use changes, they are considered either as an obstacle (e.g. in grazing lands on Lesvos; see Kizos et al., 2013) or at best as something of no "value". Kizos et al. (2010) have found that "hobby" or part time farmers more often recognise the symbolic (and environmental) value of the terraces.

If we compare the current – and possibly future – use of the terraced, cultural landscapes, we see that in Portofino the decline of farming has come to what seems to be an 'end' stage: very little is used for commercial farming, most in fact is still maintained for horticultural purposes or as garden. Lesvos clearly hasn't reached such a stage yet, but there seem to be tendencies in the urban sprawl occurring, and more esthetical functions developing here. Comparison of the land use change trajectories can provide these insights, and can serve as a model to actively intervene in landscape development, to maintain productive, cultural and aesthetic qualities of the landscape.

Driving forces of Mediterranean rural landscape change

Although landscapes are dynamic and change continuously under the influence of different driving forces, the rate of change can differ significantly. Bürgi et al. (2004) identify five major types of driving forces: socioeconomic, political, technological, natural, and cultural, with strong linkages, dependencies and feedback loops over "several temporal and spatial levels" and with different rates of change. They also separate "primary, secondary, and tertiary driving forces, and "intrinsic and extrinsic driving forces". Intrinsic driving forces act locally, and are influenced by local actions and people and may include both social and economic factors. Extrinsic driving forces include broad processes such as globalisation, climate change, urbanisation, EU policies (especially the CAP).

Mediterranean landscapes are strongly influenced by natural and cultural drivers. According to Horden & Purcell (2000) varying precipitation even in short distances, seasonal differences in precipitation patterns with intra- and inter- annual variability, stress periods (dry summers) and especially stress years, together with periodical droughts and the intense

geomorhoplogy and relief result in a number of different "microecologies". Despite different power and political structures throughout history, the navigable sea resulted in an extensive trading network. This resulted in three basic principles that shape land management systems in the Mediterranean region: diversification (for land uses to reduce risk), redistribution (to proximate and more distant markets) and storage (to smooth out annual or seasonal differences).

Permanent crops such as olives and vines characterise market economies in the Mediterranean as their products cannot be used for subsistence, but are sold in (proximate or distant) markets to buy cereals and other staples (Horden & Purcell, 2000). The two case studies in this paper are rather typical examples: for Lesvos, the rise of the demand of olive oil in the 18th century, the prices of olive oil in the international market and the growth of commerce, have been major driving forces for landscape change towards olive plantations, and cultivation terraces are a "side-effect" of this change. Grapes are less important today given that prices are currently low and the crop is labour intensive (Mosconi, 2000; Stobbelaar et al., 2000).

The rate of change increases for the Mediterranean and the case study landscapes in the second part of the 20th century. Social driving forces are the decreasing attractiveness of farming as a livelihood compared to services, the increased importance of second - holiday homes, and the quality of life offered in cities. Economic driving forces include the low profitability and productivity of farming, new transport infrastructure and especially roads, the rise of tourism as an economic activity, but also the increasing importance of EU level agricultural policies which have altered rapidly many landscapes (Benoit & Comeau, 2005; Caraveli, 2000; OECD, 1997). The results are different spatially and thematically and three important processes stand out today as changing Mediterranean rural landscapes: intensification, tourist-urban-industrial sprawl and abandonment. The economic crises seems to affect Portofino less than Lesvos, which may relate to the dependency of the people on the land and its resources. In Greece people returned to the countryside, exploit the olive yards for fire wood which is seen from cutting and pruning trees. In Portofino the landscape is more a cultural landscape, which attracts visitors to the park.

Intensification and professionalisation of farming in favoured areas, especially the plains, is characterised by the growing size of owned and leased land of farms, typically with industrial arable crops, garden crops, olives, and to a lesser degree tree plantations. This intensification is based on mechanisation but also on the availability of cheap immigrant labour in the past 20 years. The resulting landscapes are homogenous monocultures, but with smaller fields than equivalent European areas (Kizos & Vlachos, 2012). The tourist-urban-industrial sprawl is evident mostly in peri-urban areas, along coasts and roads. Farmland in these areas is very expensive and this sprawl takes up high quality farmland, but also results in the break-up of the landscape. Abandonment is evident in mountain areas, less productive areas and islands and results in a gradual return to a more natural vegetation, especially in mountain areas. Remaining farms are typically small, extensive and multi-functional. At the same time, landscape features are neglected or destroyed, often leading to the degradation of landscape and nature values (Aronson et al., 1998; Zavala & Burkey, 1997), and land abandonment is mentioned as the third most important factor for the decline of threatened plant species in Europe (OECD, 1997).

In the case study landscapes, intensification was not feasible due to the geomorphology (few level areas, sloping lands) and the lack of natural resources, including soils and available water. Abandonment and tourism driven urban sprawl are the two processes that the two areas share, albeit with different intensities and extent: tourism is much more important in Portofino than Lesvos, while abandonment has affected bigger areas on Lesvos.

CONCLUSIONS

This paper shows that landscape history is to a limited extent reflected in land use change of the last decades. Especially in olive plantations there is a considerable time lag between the abandonment and the complete disappearance of the olive trees. Olive yards are apparently very persistent to lacking maintenance.

However, the impact of changing land management on landscape character and diversity is well reflected in part of the cultivation terraces: depending on the type of terrace, they are very vulnerable to degradation due to erosion, to destabilisation due to disturbance by wild boars or grazing animals, and to landslides due to unbalanced drainage of precipitation water.

The last research question of this paper how production functions can be maintained, and which effective strategies and future pathways can be followed to conserve valuable cultural landscapes such as these in the Mediterranean, is more difficult to answer. We observed that processes in both landscapes are similar, often as a result of similar drivers. The disappearance of farming in Portofino has resulted to some extent in a loss of values and functions. The marginalisation of farming results in both areas in a rural exodus, but also in physical deterioration of terraces and the general landscape, with a loss of all its support functions. In Lesvos this advanced stage has not been reached yet, we should therefore ensure that here and in similar landscapes, measures are taken to retain the inherent qualities of Mediterranean landscapes. Landscape governance can include measures under the Common Agricultural Policy or Natura 2000 to maintain and promote farming (which will also be in line with the European Landscape Convention) and retain valuable landscape features such as farming terraces.

In conclusion, landscape change in the Mediterranean is more complex than simple frameworks of "urbanisation and coastalisation – abandonment of hilly areas" (see Benoit & Comeau, 2005) suggest. There is a number of reasons for that. One is related with the geographical diversity of the region, which has resulted in a variety of different land management systems in the past, many of which respond differently in similar driving forces. Another is the characteristics of the nature of the Mediterranean: Blondel & Aronson (1995) and Grove & Rackham (2001) among many others stress the resilience of Mediterranean flora in relation to disturbances (natural or human induced). Another reason, suggested by the findings of this paper, is the type of land use, which often seems to imprint a legacy on the landscape that changes very slowly. This is important in terms of managing Mediterranean landscapes and some of its most characteristic features, such as cultivation terraces. We hope that this paper will lead toward a deeper understanding of such processes, which may ultimately help to conserve and revitalise such landscapes.

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