

Diachronic evolution of grasslands and open shrublands in pastoral landscapes of Greece

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Abstract

In recent years, studies of diachronic evolution have been carried out in several pastoral landscapes of Greece based on aerial photographs. These studies covered a total area of 69,372 ha and included the Kolchiko and Hortiatis watersheds of central Macedonia, the Kopatsari and Askio region of western Macedonia and the valley of Portaikos – Pertouli in Thessaly. This paper aims to review all these studies so that the trends in grassland and shrubland evolution are evaluated. The transformation of these landscapes was evaluated by means of Geographic Informational Systems (G.I.S.) and sequential sets of aerial photographs and orthophotos, covering a period from 1945 to 1998. Changes in grassland pattern were evaluated by the use of landscape metrics. From these studies it became evident that the pastoral landscapes have changed significantly over the last 65 years in terms of land use/ cover structure and landscape pattern. A major trend has been the reduction of the area covered by grasslands in favour of forests, dense shrublands and agricultural lands. Furthermore, a reduction of open shrublands in favour of dense ones was also recorded. Landscape metrics revealed that grassland patches are becoming more fragmented and disperse over the years. The reduction of grasslands and open shrublands represent a major obstacle to employing sustainable practices in livestock husbandry.

Key words: G.I.S., landscape metrics

Introduction

Mediterranean landscapes have significantly changed over the last decades due to land abandonment. In pastoral landscapes, in particular, these changes have usually involved the reduction of grasslands and open shrublands in favor of dense shrublands and forests (Papanastasis and Chouvardas 2005). Their evaluation can be accomplished by remote sensing analysis of satellite images or aerial photographs combined with G.I.S. which have become powerful tools for evaluating landscape changes through time (Farina 2000). Also, diachronic changes in landscape pattern can be easily evaluated with the use of landscape metrics (McGarical and Marks 1995).

Several studies have been carried out over the last years in various areas of central and northern Greece analyzing the temporal changes in pastoral landscapes and relating them with changes in the traditional management

practices of animal husbandry and forestry (Chouvardas 2007, Chouvardas et al. 2009, Siarga 2009, Mitka et al. 2010). The aim of this paper was to review all these studies so that the trends in grassland and shrubland evolution are detected and evaluated.

Materials and methods

Five pastoral landscapes were studied covering a total area of 69.372 ha. They are located in the Kolchiko and Hortiatis watersheds of central Macedonia, the Kopatsari and Askio region of western Macedonia, and the valley of Portaikos – Pertouli in Thessaly (Figure 1). The temporal land use/cover changes were evaluated with G.I.S. on a diachronic set of aerial photographs and orthophotomaps (1945 – 1998). This procedure resulted in the creation of digital diachronic land use/cover data sets in vector and raster format (10x10m) for the time periods: 1945 – 1993 for Kolchiko (Chouvardas 2007) and Hortiatis (Chouvardas et al. 2009), 1963 – 1998 for Kopatsari (Mitka et al. 2010), 1945 – 1997 for Askio (Siarga 2009) and 1945 – 1992 for Portaikos-Pertouli (Chouvardas 2007).

The programme Fragstats v 3.3 was employed to quantify landscape pattern and compare grassland patches in the pastoral landscape through time. Four metrics were included in the study (McGarical and Marks 1995): number of patches (NP) and mean patch size (MPS) as an overall measure of landscape fragmentation, edge density (ED) as a measure of the amount of ecotones (Farina 2000) and interspersed juxtaposition index (IJI) as a measure of patch dispersal. The mathematical formulas of the chosen indices can be found in the Fragstats user manual (McGarical and Marks 1995).

Results and discussion

Five landscape change maps and data sets were created for the time period from 1945 to 1998 (Figure 1). From these maps it is obvious that grasslands decreased in all cases resulting in spatial modification of the respective landscapes.

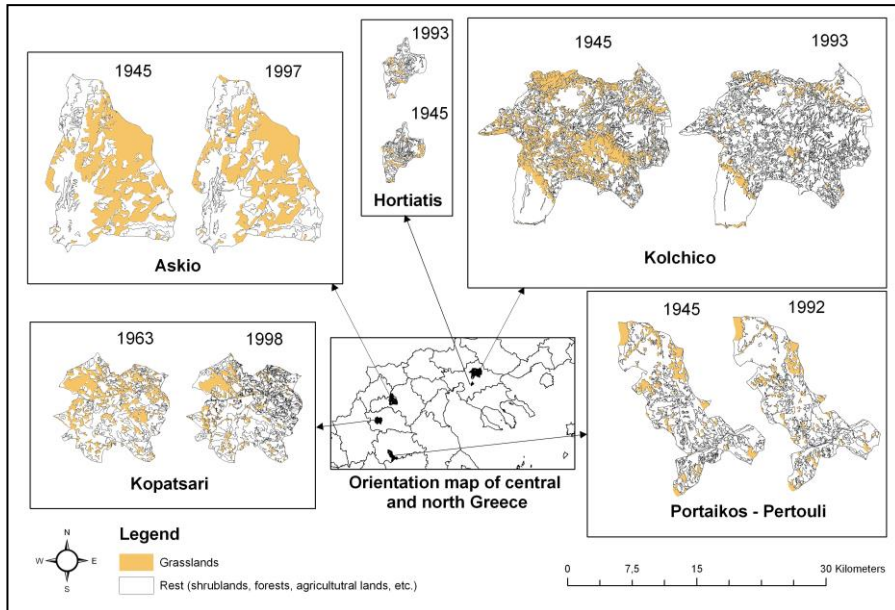


Figure 1. Landscape change map (1945 – 1998) of Greek pastoral landscapes.

From the temporal digital data sets, two tables were created showing the diachronic evolution of grasslands (Table 1) and shrublands (Table 2) of the five pastoral landscapes. It is clear from table 1 that there was a significant decrease of the area covered by grasslands in all landscapes during the time period 1945 -1998, namely by 78% in Kolchico, 45% in Hortiatitis, 49% in Kopatsari, 14% in Askio and 23% in Portaikos – Pertouli. Grasslands in Kolchiko, Hortiatitis and Kopatsari were mainly transformed into shrublands, agricultural lands and forests, while in Askio and Portaikos – Pertouli they were mainly transformed into shrublands and forests. The much higher grassland reduction in Kolchiko, Hortiatitis and Kopatsari may be explained by the fact that a significant part of grasslands was transformed into arable land compared to Askio and Portaikos-Pertouli. This trend of grassland reduction is expected to continue in the near future as a projection model for Kolchiko predicted (Chouvardas and Vrahnakis 2009).

Table 1. Diachronic evolution of grasslands (ha) in Kolchiko, Hortaitis, Askio and Portaikos-Pertouli pastoral landscapes.

	1945	1960/1963	1992/1993	1997/1998	2013 ¹
Kolchiko	5861,43	4446,61	1280,70	–	55,00
Hortiatis	227,34	–	125,02	–	–
Kopatsari	– ²	2875,10	–	1454,09	–
Askio	8410,49	7930,82	–	7214,56	–
Portaikos	– 1687,22	1516,75	1373,44	–	–
Pertouli				–	–

¹ Future projection model for Kolchiko landscape (Chouvardas and Vrahnakis 2009)

² Not recorded

As far as shrublands are concerned, table 2 shows that the total shrublands area of the pastoral landscapes (except Kopatsari landscape that had a limited area of shrublands) generally increased from 1945 to 1997, by an average rate of 19%. Looking at the three cover classes, however, it is obvious that the open cover class reduced by 25% as in grasslands. On the contrary, the medium and dense classes increased impressively (by 50.12% and 94.07%, respectively).

Table 2. Diachronic evolution of shrublands (Ha) in Kolchiko, Hortaitis, Askio and Portaikos-Pertouli pastoral landscapes.

Open shrubland		Medium shrubland		Dense shrubland	
1945	1992-1997	1945	1992-1997	1945	1992-1997
4215,30	3158,93	2959,70	4443,24	1290,59	2504,70

These results show that grasslands and open shrublands are at a risk of becoming extinct in the Greek pastoral landscapes, suggesting that direct measures should be taken in order to preserve and restore these two important pastoral resources. Grassland and open shrubland preservation is considered necessary for sustaining extensive livestock husbandry (Chouvardas and Vrahnakis 2009).

The estimation of landscape metrics for grassland patches revealed a temporal (1945 – 1998) decrease of MPS and an increase of IJI values for all pastoral landscapes (Table 3).

Table 3. Landscape metrics values (grassland class) from 1945 to 1998 in Kolchiko, Hortaitis, Askio and Portaikos-Pertouli pastoral landscapes.

	NP ^a		MPS ^b (ha)		ED ^c (m/ha)		IJI ^d (%)	
	1*	2**	1	2	1	2	1	2
Kolchiko	177	68	33,16	18,84	55,96	12,04	80,03	86,33
Hortaitis	19	12	11,98	10,45	37,44	20,79	70,53	74,18
Askio	23	29	365,75	248,79	17,69	18,49	76,99	83,34
Kopatsari	102	97	28,19	14,99	41,17	32,50	58,10	64,58
Portaikos – Pertouli	48	61	35,16	22,51	18,75	17,58	52,48	54,22

^aNumber of Patches, ^bMean Patch Size, ^cEdge Density, ^dInterspersion Juxtaposition Index. *1 means 1945 for Kolchiko, Hortiati, Askio and Portaiko-Pertouli and 1963 for Kopatsari. **2 means 1992 for Portaikos – Pertouli, 1993 for Kolchiko and Hortiatis, 1997 for Askio and 1998 for Kopatsari.

This trend of change in relation with the grassland area reduction (Table 1) suggests that grassland patches are becoming more fragmented and disperse over the years and, therefore sparser and isolated. Grassland edges showed a great reduction of their values (ED, Table 3) in most of the pastoral landscapes (except Askio), indicating the negative effect (ecotone reduction) that temporal transformations had in grassland structure. Finally, the temporal evolution of grassland patches (NP, table 3) showed that only two landscapes (Askio and Portaikos –Pertouli) had their numbers increased, probably due to the relatively lower reduction of their grassland area (Table 1).

According to Papanastasis and Chouvardas (2005), changes in the traditional management practices in animal husbandry and forestry are the main cause of changes in Mediterranean pastoral landscapes. Development planning must take into consideration the trends recorded in this study. Grassland and open shrublands are two natural recourses that are considered necessary for the sustainable development of livestock husbandry, for ecological integrity and for the social benefits that the people expect from these landscapes.

Conclusions

1. There has been a constant reduction of the area covered by grasslands and open shrublands in the pastoral landscapes of Greece since 1945 that is expected to continue in the near future.
2. There is a shift of shrublands from sparser to denser cover classes.

3. Grassland patches in the pastoral landscapes are becoming more fragmented and disperse over the years.
4. The reduction of grasslands and open shrublands represent a major threat to a sustainable livestock husbandry based on natural grazing resources.

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