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The impact of transhumance abandonment on land use changes in Mount Pindos (Greece)

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Abstract. Transhumance was one of the main income sources for the inhabitants of Avdella village in Mount Pindos, until a few decades ago. This land use management created a mosaic of different ecological habitats. However, due to urbanization and technology evolution, transhumance was reduced, leading to significant changes for the mountainous grasslands. The purpose of this paper was to determine the changes in vegetation during the period 1983-2003, using landscape metrics. Metrics were calculated with Patch Analyst (ArcGIS) in order to assess human impact on biodiversity and landscape characteristics. The analysis showed that changes in land cover during 1983-2003 were the result of transhumance decline and the abandonment of intensive human activities. Landscape metrics indicated expansion of forests and shrublands and reduction of grasslands due to the reduction of grazing animals. The landscape in Avdella tends to become more fragmented and land use patch distribution more uneven. Landscape metrics imprinted in detail the change of the landscape during the period of investigation.

Keywords. Landscape metrics – Geographical Information Systems (GIS) – Grazing animals.

L'impact de l'abandon de la transhumance sur l'utilisation des sols dans les montagnes de Pindos (Grèce)

Résumé. *La transhumance était l'une des principales sources de revenus pour les habitants du village de Avdella au Mont Pindos, il y a quelques décennies. Cette gestion de l'utilisation des terres a créé une mosaïque de différents habitats écologiques. Cependant, en raison de l'urbanisation et de l'évolution technologique, la transhumance a été réduite, ce qui conduit à des changements importants pour les prairies de montagne. Le but de cette étude était de déterminer les changements dans la végétation de 1983 à 2003, en utilisant des indicateurs paysagers. Des métriques ont été calculées avec Patch Analyst (ArcGIS) afin d'évaluer l'impact humain sur la biodiversité et les caractéristiques du paysage. L'analyse a montré que la baisse de la transhumance et l'abandon des activités humaines intensives, de 1983 à 2003, ont eu comme résultat les changements de la couverture terrestre. Les métriques paysagères ont indiqué une expansion des forêts et de la végétation arbustive et une baisse des pâturages en raison de la diminution des animaux de pâturage. Le paysage de Avdella tend à devenir plus fragmenté et la distribution d'utilisation des terres plus inégale. Les métriques paysagères ont imprimé en détail le changement du paysage au cours de la période d'enquête.*

Mots-clés. *Métriques paysagères – Systèmes d'Information Géographique (SIG) – Animaux au pâturage.*

I – Introduction

Transhumance is the vertical movement of livestock farmers with their animals from mountainous to lowland grasslands during winter and vice versa, during summer (Susmel *et al*., 2004). It has created many habitats with special characteristics in the Mediterranean region (Grove *et al*., 1993). Transhumance on Mts Pindos formed a diverse mosaic of land uses and provided habitat for various species of plants and animals, thus having an impact on ecological functions and biodiversity (Ispikoudis, 2004).

During the last decades, the grasslands of Greece have changed profoundly due to urbanization, technological advancement and different management policies in combination with climate change (Karatassiou *et al*., 2014). Moreover, transhumance is gradually replaced by semi-extensive livestock farming where animals graze around the sheds (Sidiropoulou *et al*.,

2015). As a result, many landscape changes occurred and the abandoned grasslands continue their ecological succession to climax communities (Vrahnakis *et al*., 2005).

Landscape metrics are a set of structural parameters which are used to estimate the interactions between landscape spatial configuration and ecological processes (Turner, 1990). Spatial configuration refers to the spatial character and arrangement, position, or orientation of patches, e.g. the basic units of the landscape which are defined as relatively homogeneous areas that differ from their surroundings (McCarigal and Marks, 1995).

Landscape metrics were used in the present research in order to determine changes in land use/cover caused by pastoralism abandonment in Avdella village on Mount Pindos during the period 1983-2003.

II – Materials and methods

The study area is Avdella village, 40°01′ N 21°07′ E, at 1300 m asl altitude, located on Mount Pindos in North-West Greece and Avdella covers 4,345 ha. The vegetation zone is Vaccinio-Picetalia, and many rare species of flora and fauna occur in the area. In Avdella village, livestock farmers used grasslands for animal grazing from spring until late summer and in autumn they moved towards the Thessalian plain.

The land use/cover map of 1983 was based on aerial photographs from the National Cadastre and Mapping Agency S.A. (NCMA S.A., 1945) (scale 1:5000). The land use/cover map of 2003 was based on satellite images from Google Earth™ 6.0. Data were imported in ArcGIS ™ 9.3.1 (ESRI, 2011) and the following landscape metrics were calculated, using Patch Analyst Extension (McCarigal and Marks, 1995): a) Patch density, size and variability metrics: Number of patches (NumP), Mean patch size (MPS), b) Edge metrics: Edge density (ED) c) Shape metrics: Mean shape index (MSI) and d) Diversity metrics: Shannon's diversity index (SDI), Shannon's evenness index (SEI).

The number of grazing animals and the population of the village were retrieved from the Hellenic Statistical Authority (H.S.A, 1978; 1998). There are no statistical data about the number of grazing animals for 1981, thus, the data from 1971 were used.

III –Results and discussion

Silvopastoral systems, forests and shrublands increased by 0.94%, 4.78% and 0.69% respectively around Avdella village, while grassland decreased by 6.72% (Fig. 1). These land use changes were the result of demographic and agricultural evolution of the area. The village of Avdella never had permanent residents, with the exception of two or three families.

Livestock farmers moved to the Thessalian plain during winter and returned to the village in the summer. Although traditional transhumance still exists, the number of grazing animals, mainly sheep and goats, has decreased significantly (Table 1). The increase in cattle number has small impact on the landscape since they are mostly for dairy production and rarely graze outdoors. This gradual abandonment of transhumance, therefore the decrease of sheep and goats, combined with the relocation of many villagers to urban areas led to the undergrazing of grasslands. Conclusively, shrubs invaded grasslands and forest and silvopastoral systems increased (Mitka, 2009).

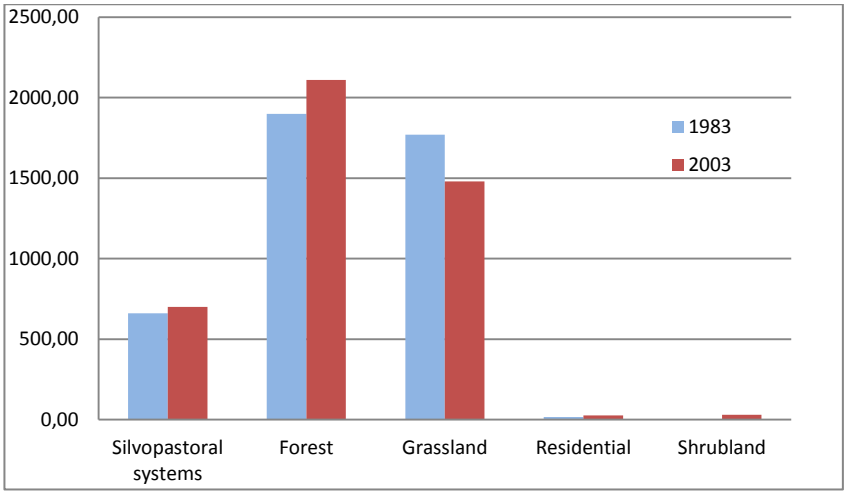

Fig. 1. Land use/cover changes in Avdella between 1983-2003.

Table 1. Livestock in Avdella village (Hellenic Statistical Authority, 1978).

Years	Cattle	Sheep	Goats
1971	14	12,061	3,291
2010	228	4,879	200

The increase in number of patches (NumP) suggests the breaking of vegetation areas into smaller parcels and in combination with the decrease of mean patch size (MPS) indicate an increase in landscape fragmentation (Table 2) (Sidiropoulou, 2011). Shannon's diversity index (SDI) remains almost the same, therefore landscape diversity is maintained (Caballero *et al.,* 2009). Shannon's evenness index (SEI) however decreases, resulting to a more uneven distribution of land use patches. Mean shape index (MSI) values indicate a decrease of patch shape complexity, which is an eminent result of the reduction of grazing animals (Mitka, 2009).

Table 2. Changes in landscape metrics, as calculated by Patch Analyst

Landscape Metrics	1983	2003
NumP	64,00	78,00
SDI	1,03	1,07
SEI	0,74	0,66
MSI	1,93	1,72
ED	76,31	78,22
MPS	67,89	55,71

IV – Conclusions

The present study showed that the landscape of Avdella village became more fragmented, as a result of transhumance abandonment. Without the intense human presence and with decreased grazing intensity, grasslands continued their ecological succession to shrublands. Forests and silvopastoral systems also increased but the distribution of land use types became more

uneven. Landscape metrics provided useful insights on land use changes in Avdella during 1983-2003 and can be used as an effective manner of monitoring landscape fragmentation and diversity.

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