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Plant diversity in suburban Mediterranean ecosystems: The case of “Sheikh Sou”, Thessaloniki, Greece

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Abstract. Mediterranean ecosystems have traditionally developed through human intervention. Especially the ones located near urban areas, have been imposed to various changes resulting from restoration practices such as reforestation, land use change, fire etc. effecting vegetation structure and diversity. The aim of this paper was to study the effects of various human-caused perturbations on plant cover and species diversity and composition in suburban Mediterranean ecosystems. The research was conducted in the “Sheikh Sou” suburban park of Thessaloniki, North Greece. Three different human-caused perturbations have occurred in the suburban ecosystem of “Sheikh Sou” represented by: i) abandoned arable field ii) postfire natural revegetation and iii) pine plantation. Plant cover was recorded on three experimental sites using the line point method and species richness, Shannon-Wiener diversity index and evenness were calculated. The three experimental sites had high plant cover; however the dominant plant group differed among the experimental sites. Abandoned arable field appeared higher plant diversity and evenness, while postfire natural revegetation and pine plantation had vertical plant stratification. Our results suggest that human-caused perturbations in suburban Mediterranean ecosystems affect differently the structure of the plant community and species diversity. In suburban Mediterranean ecosystems proper management actions should be taken in order to preserve a diverse mosaic of vegetation types.

Keywords. Pine plantation – Fire – Field abandonment – Plant cover – Shannon-Wiener index.

La diversité végétale dans les écosystèmes méditerranéens de banlieue: Le cas de "Cheikh Sou" Thessalonique, Grèce

Résumé. Les écosystèmes méditerranéens se sont traditionnellement développés sous l'influence de l'intervention humaine. Ceux situés à proximité des zones urbaines ont particulièrement subi des modifications résultant de pratiques de restauration, du changement d'utilisation des terres, ainsi que d'incendies, etc. affectant la structure et la diversité de la végétation. Le but de cette étude était d'étudier les effets des diverses perturbations d'origine humaine sur le couvert végétal, sur la diversité des espèces et sur la composition des écosystèmes méditerranéens de banlieue. La recherche a été menée dans le "Cheikh Sou" parc naturel de Thessalonique, au nord de la Grèce. Trois différentes perturbations d'origine humaine ont eu lieu dans l'écosystème suburbain de "Cheikh Sou": i) abandon de terres arables, ii) repousse naturelle de la végétation et iii) plantations de pins, suite à un incendie. La couverture végétale a été enregistrée sur chaque site expérimental en utilisant la méthode ligne-point. La diversité des espèces, l'indice de diversité de Shannon-Wiener ainsi que la régularité ont été calculés. Les trois sites expérimentaux avaient une importante couverture végétale, mais le groupe végétal dominant différait selon les sites expérimentaux. Les champs arables abandonnés ont montré une plus grande diversité et régularité végétale, tandis que la revégétalisation naturelle et les plantations de pins post-incendie faisaient apparaître une stratification végétale verticale. Il est conclu que les perturbations causées par l'homme dans les écosystèmes méditerranéens de banlieue affectent différemment la structure des plantes et la diversité des espèces. Dans les écosystèmes méditerranéens suburbains, des mesures de gestion appropriées devraient être prises afin de préserver les diverses mosaïques de types de végétation.

Mots-clés. Plantations de pins – Incendies – Abandon des terres – Couverture végétale – Indice de Shannon-Wiener.

I – Introduction

Mediterranean ecosystems have traditionally developed through human intervention (Naveh and Lieberman, 1984). This is especially true as far as the suburban Mediterranean ecosystems are concerned. The latter are of great importance as they offer multiple ecosystem services such as protection from air and water pollution, human recreation, aesthetic value of the landscape and enhanced natural biodiversity (McKinney, 2008). None the less, suburban environments have been imposed to various changes resulting from restoration practices such as reforestation, land use changes, fire etc. affecting their vegetation structure and diversity (Papanastasis and Chouvardas, 2005; Papanastasis *et al.*, 2015).

“Sheikh Sou” is a suburban ecosystem forming a park that is surrounding the city of Thessaloniki, North Greece. It was originally a typical Mediterranean rangeland that was reforested in the mid 30’s with pine plantation for protection purposes. After a destructive fire in 1997 (18 years ago), almost the 60% of the area was burned (Kallidromitou, 2015). Furthermore, many arable fields have been abandoned, due to socio-economic changes, following the general trend of land use changes in Greece (Papanastasis, 2007). The aim of this paper was to study the effects of the various human-caused perturbations on plant cover and species diversity and composition in suburban Mediterranean ecosystems.

II – Materials and methods

The research was conducted in the “Sheikh Sou” suburban park of Thessaloniki located at the uphill part of the city of Thessaloniki, North Greece. Three different human-caused perturbations have occurred in the suburban ecosystem of “Sheikh Sou” (arable field abandonment, fire and reforestation with pine plantation) represented by: (i) abandoned arable field more than 10 years ago, (ii) postfire natural revegetation after the 1997 fire and (iii) pine plantation that was never burned. On each experimental site, three transects (20 m long each) were established. Plant cover was recorded along each transect using the line-point method (Cook and Stubbendieck, 1986). Species overlapping in each point were also recorded (multiple contacts) and species composition was calculated. The recorded species were classified into five a priori groups: trees, shrubs, grasses, legumes, forbs and their contribution in each transect was calculated. Furthermore, species richness, Shannon-Wiener diversity index and evenness (Magurran, 2004) were calculated for each transect. Data were analysed using one way ANOVA. Duncan multiple range test was applied to detect the differences among the means at a 0.05 level of significance. All analyses were carried out using the software package SPSS (SPSS for Windows, release 22.0; SPSS, Inc., Chicago, USA).

III – Results and discussion

High plant cover, reaching more than 80%, was recorded for all the experimental sites (Table 1). Pine plantation had the highest tree cover, while postfire natural revegetation the highest shrub cover. Shrubs were absent from the canopy cover of the abandoned field and covered a very small area in the pine plantation but no significant differences were found. Furthermore, herbaceous species cover was significantly higher in the abandoned field, followed by postfire natural revegetation and lowest in the pine plantation. On the other hand, litter and bare soil had a mean cover of 8% and 7.9% respectively in all sites and did not differ significantly among them. Similar results have been reported by Chirino *et al.* (2006) and Papadimitriou *et al.* (2013).

The contribution of the five a priori groups in each experimental site is shown in Table 2. Grasses and legumes had significantly higher representation in the abandoned field. They have been found to be also reduced in the case of pine plantations by other researchers (Chirino *et al.*, 2006; Papadimitriou *et al.* 2013), though Papadimitriou *et al.* (2004) reported grasses as a

persistent group among abandoned fields and shrublands. In addition, forbs contributed by a mean of 15% of species composition in all sites without significant differences. Shrubs and trees representation was higher in the postfire natural revegetation and the pine plantation respectively, following the same trend as in the case of plant cover (Table 2). On the contrary, shrubs contribution was almost absent in the abandoned field and the pine plantation and trees totally absent in the abandoned field and the postfire natural revegetation.

Table 1. Mean plant cover (%) of the three experimental sites in the “Sheikh Sou” suburban park

Experimental site	Trees	Shrubs	Herbaceous species	Litter	Bare soil
Abandoned arable field	0.00b ¹	0.00b	86.33a	3.00a	10.67a
Postfire natural revegetation	0.00b	69.00a	11.00b	11.00a	9.00a
Pine plantation	78.33a	0.67b	7.00c	10.00a	4.00a

¹Different letters in the same column indicate significant differences ($p \leq 0.05$).

Table 2. Mean contribution (%) of the various a-priori groups to the three experimental sites in the “Sheikh Sou” suburban park

Experimental site	Grasses	Legumes	Forbs	Shrubs	Trees
Abandoned arable field	53.24a ¹	23.45a	23.31a	0.00b	0.00b
Postfire natural revegetation	7.66b	0.40b	8.01a	83.93a	0.00b
Pine plantation	11.35b	0.69b	13.81a	2.29b	71.86a

¹Different letters in the same column indicate significant differences ($p \leq 0.05$).

All three diversity indices followed the same trend (Table 3). Species richness, Shannon-Wiener diversity index and evenness were higher in the abandoned field and lower in the other two sites. These results indicate that abandoned field was more diverse and abundance was evenly distributed among the species. On the other hand, postfire natural revegetation and pine plantation appeared vertical plant stratification due to the presence of shrub and tree stratum respectively. These results come in agreement with other researchers that found higher species diversity in abandoned fields (Papadimitriou *et al.*, 2004) and lower in pine plantations (Chirino *et al.*, 2006; Alrababah *et al.*, 2007).

Table 3. Mean values of species richness, Shannon-Wiener diversity index and evenness of the three experimental sites in the “Sheikh Sou” suburban park

Experimental site	Species richness	Shannon-Wiener (H)	Evenness (J)
Abandoned arable field	16.33a ¹	2.27a	0.81a
Postfire natural revegetation	9.33b	1.24b	0.55b
Pine plantation	10.33b	1.08b	0.46b

¹Different letters in the same column indicate significant differences ($p \leq 0.05$).

IV – Conclusions

Our results suggest that human-caused perturbations in suburban Mediterranean ecosystems affect differently plant community structure and diversity. Arable field abandonment results in

high plant diversity, while natural revegetation with shrubs and pine plantation leads in a vertical vegetation structure. In suburban Mediterranean ecosystems proper management actions should be taken in order to preserve a diverse mosaic of vegetation types.

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