Bulgarian Journal of Agricultural Science, 20 (Supplement 1) 2014, 105–109
Agricultural Academy

ECOLOGICAL STATUS OF XEROTHERMIC OAK ECOSYSTEMS – SCI "ZAPADNA STARA PLANINA I PREDBALKAN"

N. GEORGIEVA* and M. LYUBENOVA
Sofia University "St. Kliment Ohridski", Faculty of Biology, Department of Ecology and Environmental Protection, BG – 1164 Sofia, Bulgaria

Abstract

GEORGIEVA, N. and M. LYUBENOVA, 2014. Ecological status of xerothermic oak ecosystems – SCI "Zapadna Stara planina I Predbalkan". *Bulg. J. Agric. Sci.,* Supplement 1: 105–109

The publication presents investigation on ecological status of xerothermic oak ecosystems in SCI "Zapadna Stara Planina i Predbalkan" (BG0001040). The reproductive capacity of tree layer and health status of forest communities are evaluated. The indicators, set out in forest monitoring, are assessed such as: defoliation and discoloration of the crown, damage coefficient of forest ecosystems, chemical analysis of soil, mulch and litter-fall (as a nutrient reserve for plant communities) and intensity of biological cycle.

The investigated xerothermic oak ecosystems still are in a good ecological status according to the obtained data and calculated indices. Nevertheless a couple of negative trends are obtained: low average age of seedlings, low survival rate, turfing in herbaceous layer and increasing number of dried trees number.

Key words: ecological status, oak ecosystems, protected zone
Abbreviations: SCI – site of community importance, IAS – integral assessment scale, DBH – diameter of breast height, H – height

Introduction

The resilience and adaptability of ecosystems to climate changes and increased human impact are of great importance for consideration of conservation activities and ecological management of protected Natura 2000 sites. The monitoring of natural processes in forest ecosystems, creation of database for various structural and functional parameters and their comparison with previous studies may support the studies on natural systems dynamics and modelling, as well as the prediction of future changing in ecosystem proceses.

The xerothermic oak forests are an element of the potential vegetation of Bulgaria and thus contribute to the biological (structural and functional) diversity of the Bulgarian vegetation. These forests are tolerant to the periods of droughts similar to those observed in recent years. The oak forests are also a source of traditional for the country ecosystem services because of their location near the settlements. Therefore their proximity to anthropogenic areas makes them subjected of intensive exploitation. The majority of communities today are of high-rotation coppice class and in process of degradation. Their future existence is a contemporary problem for forestry and for the diversity of Bulgarian flora and vegetation.

Object and Methods

SCI "Zapadna Stara planina i Predbalkan" (BG0001040) is located in the Western Balkan Mountains and Forebalkan (mountains Vrashka chuka, Babin nose, Belogradchik garland, Shiroka Mountain, etc.). The climate is temperate continental with large range of seasonal temperature (t_{min} = 0 – (–1.5)°C in January; t_{max} = 22–24°C in July) and average monthly rainfall (P) of 750–1000 mm. (Velev, 2002).

*E-mail: g.nadezhda@yahoo.com

The variation of temperature and precipitation of two climatic stations in the area is shown on Figure 1. There was a different extended to both climatic stations periods of drought (respectively two months – July and September and 4 months from June to September) in 2012 – Figure 1 (A_1 and A_2). In 2012 the annual course of temperature is maintained but the average monthly temperatures were higher from March to December and lower from January to February in comparison to the other years (Figure 1 – B_1 and B_2). The annual course of precipitation shows a strong variation of the years under review, especially for Belogradchik. It can be noted a general increase in precipitation in January 2012, shifting rainfall maximum in May 2007 and 2012 and others compared to other years under consideration (Figure 1 – C_1 and C_2) (NIMH-BAS).

The zone refers to hydrologic region with temperate continental climatic impact. Rivers are with spring maximum and autumn (August/September) minimum and snow-rain feeding. The rainfall (snow/rain) is essential for the water collateralization of ecosystems in SCI. (Jordanova, 2002).

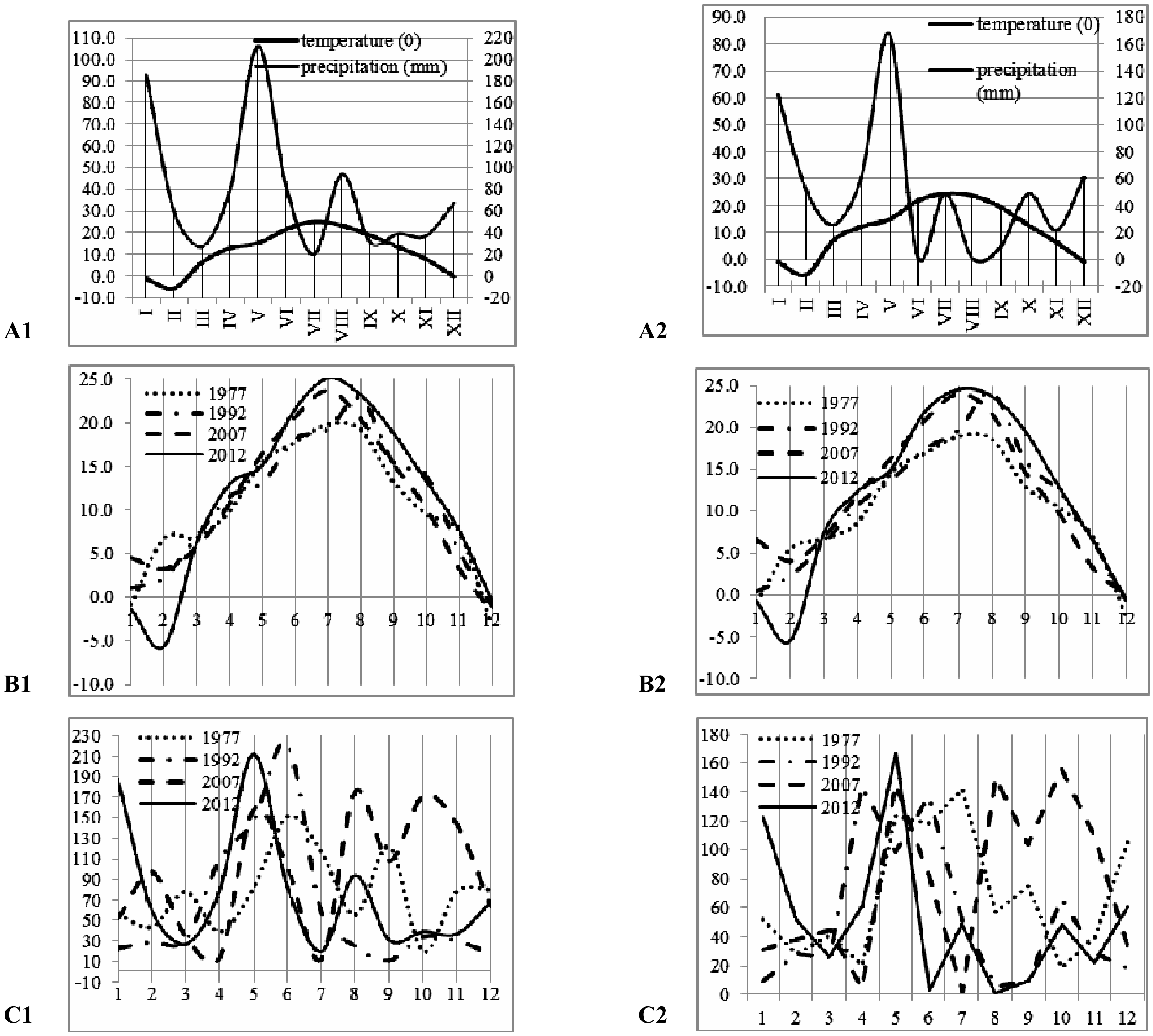

Fig. 1. Average temperatures (T, °C) and precipitation (P, mm) for climate station Varshetz and Belogratchik (398 m and 545 m altitude) – by NIMH-BAS:
***A* – Montly variation in 2012; *B* – Montly variation of T by years; *C* – Montly variation of P by years**

The main soil types are Cambisols and Leptosols (Rendzic and Umbric). The region refers to Carpatho-Danubian soil region (Ninov, 2002). Important for the xerothermic oak forest are the Luvisols, which are located in the lower part of SCI territory.

In plant – geographical aspect the zone belongs to European deciduous forest region (Bondev, 2002). Xerothermic oak forests occupy 0.4% of territory of SCI. In the tree layer of the studied ecosystems *Quercus frainetto* Ten. and *Q. cerris* L. dominate. *Crataegus monogyna* Jacq., *Cornus mas* L., *Ligustrum vulgare* L., *Euonymus europaeus* L. prevail in the shrub layer and *Helleborus odorus* Waldst. et Kit., *Carex caryophyllea* Latourr, *Dactylis glomerata* L., *Poa nemoralis* L. and *Lathyrus niger* (L.) Bernh. are the dominant plants in the herb layer (Georgieva et al., 2013; Lyubenova et al., 2009).

For the purposes of conducted research four sampling areas (SA) of xerothermal oak forest vegetation with the area of 0.25 ha for each of them were selected. Ecological status of the studied vegetation was assessed by following characteristics – tree layer indicies, reproductive capacity of the forest (on 10 plots of 0.25 m^2 in every SA and application of Nestorov scale; Kostov and Stiptzov, 2004), reserves of biomass and quantity of chemical elements in the litter-fall (10 litterfall traps of 1 m^2 in every SA) and mulch (10 plots of 0.25 m^2 in every SA), also the intensity of biological cycle (Lyubenova, 2009a). The tree layer state is characterized by the following indicies: canopy, density, average DBH and average H of trees, discoloration and defoliation of the crowns, damage ratio of the forest and by integral scale (ICP Forest 2010, Mirchev et al., 2000). The IAS have 5 levels of assessment: 1 – very good; 2 – good; 3 – medium; 4 – bad; 5 – dead. They respond to persentage of defoliation and decolorization of tree crown (1 – 0–10%; 2 – 10-25%; 3 – 25–60%; 4 – 60–99%; 5 – 100%).

Chemical analysis (C – by Turin, N – by Keldal; P, K, Ca, Mg, Fe, Mn, Zn and Cu – by AAS, BNS EN ISO 11885; Allen, 1989) were carried out at the Institute of Forestry, BAS.

Results and Discussion

The average density of tree layer is 867 n.ha^{-1} and it varies from 776 to 980 n.ha^{-1} respectively in SA 4 and SA 2 (Table 1). The average canopy is 0.7 with variation from 0.5 in SA 4 to 0.9 in SA 2. The communities with canopy of 0.5 are very open forests, which were under the huge human impact. The DBH and high of tree layer have average value as DBH – 21.3 cm (min 4.4 cm; max 36.2 cm); H – 22.5 m (min 5 m; max 27 m).

The average percent of dry trees in tree floor is 22.9% (minimal in SA2 and maximal in SA3). There is the discoloration only in two of sampling areas. The average damage coefficient is 16.2%, i.g. it is under 30% that shows a good healthy status of the forest. According to the integral ICP scale, the communities reffers to 1–2 degree, e.g. there are in very good and good state (Table 1).

Very good natural potential of regeneration by the Nestorov scale is observed – average density of tree seedlings is over 10000 n.ha^{-1} (Tables 2 and 3). They are with 10 m average height and 2 years average age. Average ratio between the number of tree seedlings and the number of shrub seedlings is 23, as the highest value is in SA1 and the lowest in SA3. The average percent of turfing is 39.6. The turfing is over 50% for the half part of investigated area (SA2 and SA3).

The average amount for litter-fall is 3.8 t.ha^{-1} (Figure 2) and it is the highest one in SA1. The estimated value responds to the published one for European deciduous forests (4.51 t.ha^{-1}; Melovski, 1995). The average mulch stock is

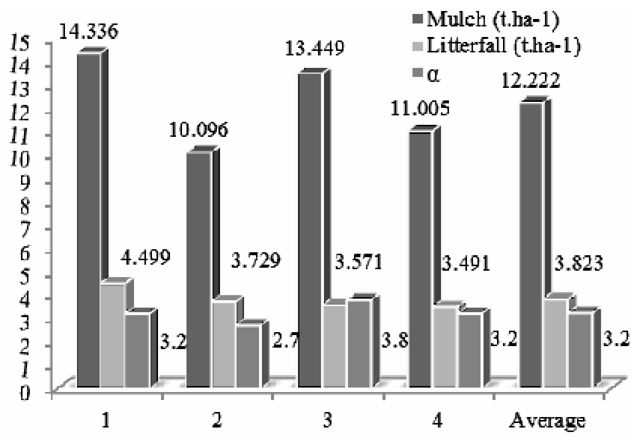

Fig. 2. The mulch reserves, yearly litter-fall (t.ha^{-1}) and α – coefficient of studied forest communities

Table 1

Measured tree layer indices

SA	Density, n.ha^{-1}	Dry trees, %	Defoliation, %	Discoloration, %	Damage coefficient	Integral scale
1	864	26.6	14.5	–	17.2	1 – very good
2	980	19.6	11.5	–	13.4	1 – very good
3	848	37.7	16.7	40	18.6	2 – good
4	776	27.7	13.6	20	15.7	2 – good

Table 2

Number of the occurring trees and shrubs species (n.ha^{-1})

SA/ Species	1	2	3	4
Quercus frainetto Ten.	341 000	–	1000	201 111
Quercus cerris L.	13 000	96 000	48 000	44 444
Carpinus orientalis Mill.	–	3000	4000	–
Carpinus betulus L.	–	–	–	1111
Acer campestre L.	–	–	–	2222
Fraxinus ornus L.	–	12 000	27 000	–
Sorbus torminalis (L.) Crantz	–	–	5000	–
Sorbus aucuparia L.	–	–	4000	–
Total	354 000	111 000	89 000	248 889

Table 3

Assessment of regeneration capacity of forest communities

SA	Trees, n.ha^{-1}	Age, years	H, m	Shrubs, n.ha^{-1}	Age, years	Trees/Shrubs, ratio	Turfing, %
1	1 416 000	2	10.4	12 000	2	118	8.6
2	444 000	1	9.6	28 000	2	16	57.7
3	356 000	2	13.0	36 000	3	10	57.7
4	896 000	2	6.9	60 000	3	15	34.2
Average	778 000	2	10.0	34 000	3	23	39.6

Table 4

Average content of macro-and micronutrients (kg.ha^{-1}, %) in the mulch and litter-fall of studied forest communities

Fraction/Element	C	K	Ca	Mg	N	P	Fe	Mn	Zn	Cu	Total
Mulch	4.742	0.271	1.446	0.239	0.073	0.093	0.971	0.330	0.006	0.003	8.172
%	58.02	3.31	17.69	2.92	0.89	1.14	11.89	4.04	0.07	0.03	100.00
Litter-fall	2.132	0.247	0.409	0.072	0.029	0.040	0.013	0.089	0.001	0.001	3.032
%	70.30	8.15	13.48	2.37	0.96	1.33	0.41	2.93	0.04	0.03	100.00
α	2.2	1.2	3.4	3.3	2.5	2.2	77.2	3.7	4.6	5.0	2.7

12.2 t.ha^{-1} and it is the highest one in SA1 and lowest one in SA2. The average litterfall-mulch coefficient (α) is 3.2, which defines the rate of biological turn-over intensity from 6 degree. This degree is representative for the deciduous forest of temperate climatic zone – (Lyubenova, 2009).

The average total reserves of nutrients in mulch and litter-fall are respectively 8.172 and 3.032 kg.ha^{-1} (Table 4). Macronutrients form respectively 83.98% and 96.59% of their total reserves in mulch and litter-fall. According to the percentage participation in the common stocks, studied macronutrients of both factions – mulch and litter-fall form the following decreasing sequence: C > Ca > K > Mg > P > N and the sequence of trace elements is respectively: Fe > Mn > Zn > Cu. The ball of intensity of biological turn-over of elements is 6 as α – coefficient varies within 2.2–5.0, except K (intensive turn-over, ball 7) and Fe (stagnant turn-over, ball 2). According to its content in the mulch and litter-fall, Ca is one of the leading element in biological turn – over. Calcium type of biological cycle is typical for the temperate climatic zone (Lyubenova, 2009).

Conclusion

The investigated xerothermic oak ecosystems are in a good ecological status according to the obtained data and calculated indices for tree layer (regeneration capacity, mulch and annual litter-fall reserves, intensity and chemistry of biological turn-over). Nevertheless a couple of negative trends have been established: low average age of seedlings, e.g. low survival rate; turfing in herbaceous layer for about the 50% of communities; trend of xerophytisation in the part of studied area – increasing number of shrub seedlings, degradation of tree layer and increasing of dried trees; the high content of Mn (over 0,05 g.kg^{-1}) and Fe (over 0,1 g.kg^{-1}), also the little higher content of Cu (over 0,006 g.kg^{-1}) in plant mass due to environmental burden and human influence; the very low intensity of biological turn-over of Fe and high intensity – of K.

The results of recent study are structural and functional characteristics of xerothermic oak forests in SCI BG0001040. These forests are important for the biodiversity of our country and they are a part of the non-priority Natura 2000 habitat 91M0 Pannonian-Balkanic turkey oak-sessile oak forests. The established negative trends can be dangerous for the existence and sustainable functioning of oak ecosystems. The management of this resource is required reporting of identified trends and creation of effective management plan for this forest and for the entire protected zone.

Acknowledgements

The research is carried out under the projects: Functional researches of xerothermic oak ecosystems in SCI "Zapadna Stara Planina i Predbalkan" – Contract №21/15.04.2013 and "Application of information technology for forest ecosystem modeling as an approach for developing dynamic global vegetation models" – Research Fund of the Ministry of Education financed by COST – Contract № DKOF 7 RP 02/21/13.10.2010

References

Allen, St., 1989. Chemical analysis of ecological materials. (Second edition) Blackwell Sciantific Publications, Oxford, 368 pp.

Bondev, I., 2002. Geobotanic regioning. In: I. Kopralev (Editor) Geography of Bulgaria. Physical and Socio-economic Geography, ForCom, Sofia, pp. 336–357 (Bg).

Georgieva, N., K. Pachedjieva and M. Lyubenova, 2013. SCI "Zapadna Stara planina i Predbalkan" – floristic studies on xerothermic oak forests. *Bulgarian Journal of Agricultural Science*, **19** (2): 218–221.

ICP Forest, 2010. Forests manual.

Jordanova, M., 2002. Hydrological Regioning. In: I. Kopralev (Editor) Geography of Bulgaria. Physical and Socio-economic Geography, ForCom, Sofia, pp. 242–246 (Bg).

Kostov, G. and V. Stiptsov, 2004. Educational Manual on Common Forestry. Sofia, pp. 61–78 (Bg).

Lyubenova, M., 2009. Functional Biocenology. An-Di, Sofia, pp. 24–90 (Bg).

Lyubenova, M., 2009a. Manual of Functional biocenology. An-Di, Sofia, 130 pp (Bg).

Melovski, L., L. Grupche, M. Mulev, L. Derlieva, 1995. Annual litterfall in oak ecosystem of *Q. fr.* and *Q. cer*. in National park "Galichiza", I Amount and dynamic of liter-fall of upper tree layer. *God. zb., Biol*.: pp. 49–66 (Mk).

Mirchev, S., M. Lyubenova, A. Shikalanov, N. Simeonova, 2000. Dendrochronology. Pensoft, Sofia, pp. 80–84 (Bg).

Lyubenova, M., R. Tzonev and K. Pachedjieva, 2009. Floristic investigation of Quercus cerris and Quercus frainetto communities in Bulgaria. Biotechnol. & Biotechnol. EQ 23/SE, special edition/on-line, 23: pp. 314–317.

NIMH – BAS – Climatic date from climatic station of Vyrshetz and Belogradchik (1977; 1992; 2007; 2012)

Ninov, N., 2002. Soils. In: I. Kopralev (Editor) Geography of Bulgaria. Physical and Socio-economic Geography, ForCom, Sofia, pp. 277–311 (Bg).

Velev, S., 2002. Climatic regioning. In: I. Kopralev (Editor) Geography of Bulgaria. Physical and Socio-economic Geography. ForCom, Sofia, pp. 155–157 (Bg).