ISSN 1821-1046
UDK 630

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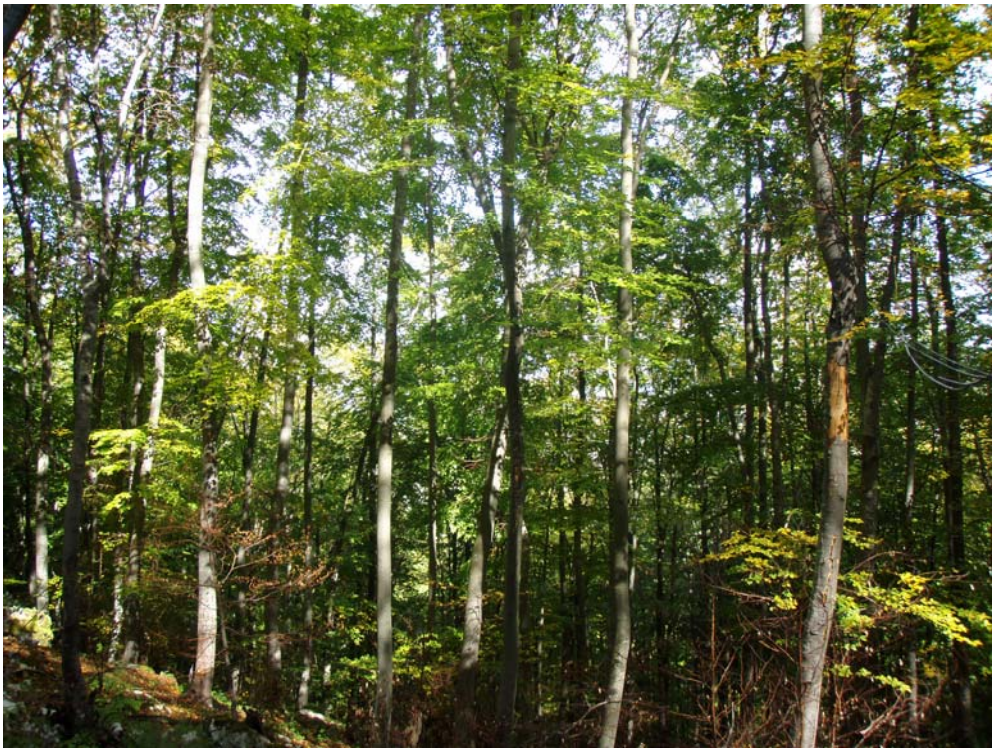

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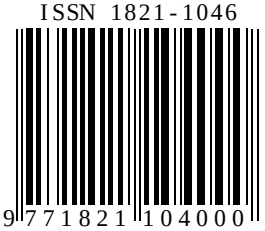
ISSN 1821-1046



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BELGRADE BEOGRAD
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Institute of Forestry
Belgrade, Serbia

Izdavač
Institut za šumarstvo
Beograd, Srbija

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Printed in
150 copies

Tiraž
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Printed by
Klik print
Beograd

Štampa
Klik print
Beograd

Belgrade, 2009

Beograd, 2009

Cover Page: Author of the Photos Mara Tabaković-Tošić, Ph.D.
Naslovna strana: Autor fotografije dr Mara Tabaković-Tošić

CIP – Каталогизација у публикацији
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SUSTAINABLE Forestry : collection = Održivo šumarstvo = zbornik radova / glavni i odgovorni urednik Mara Tabaković-Tošić. –2009, T. 59/60– . – Beograd (Kneza Višeslava 3) : Institut za šumarstvo, 2009- (Beograd: Klik print). – 24 cm

Godišnje. – Je nastavak: Zbornik radova – Institut za šumarstvo = ISSN 0354-1894
ISSN 1821-1046 = Sustainable Forestry
COBISS.SR-ID 157148172

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INSTITUTE OF FORESTRY • BELGRADE
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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **001.8 : 004.738.5 : 630*176.1 Fraxinus ornus L.=111**
Review paper

EXPLORATION OF *FRAXINUS ORNUS* L. BIBLIOGRAPHIC DATA USING PRINICIPAL COMPONENT ANALYSIS (PCA)

Srđan BOJOVIĆ[1], Biljana NIKOLIĆ[2],
Slobodanka MITROVIĆ[3], Petar D. MARIN[4]

Abstract: *Bibliographic data of manna ash were analyzed in order to find out at the first sight the direction of the research on the species which would serve as the model for further investigations on different plant species. By finding out the direction of the previous researches, it becomes easier for us to select the direction of the future ones. By using references from the data base "Scopus" obtained in the last ten years we noted the frequency of the key words for domains of research. PCA analysis showed that the previous researches conducted on Fraxinus ornus were mainly aimed at the studies of the ecological aspect, chemical composition and stress and to a lesser extent at genetic variability and hybridization. We suggest more genetic investigations of this species in the future.*

Key words: Flowering ash, crni jasen, PCA, references, data records, genetics

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ISTRAŽIVANJE BIBLIOGRAFSKIH PODATAKA ZA (PCA)

Izvod: *Bibliografski podaci o crnom jasenu su analizirani sa ciljem da se na prvi pogled uoči pravac istraživanja vrste, kako bi mogao poslužiti kao model za buduća istraživanja na različitim biljnim vrstama. Na osnovu utvđenog pravca prethodnih istraživanja postaje nam lakše da izaberemo pravac budućih. Koristeći reference iz baze podataka "Scopus" za poslednjih deset godina ustanovili smo frekvencije ključnih reči po oblastima istraživanja. PCA analiza je pokazala da su se prethodna istraživanja Fraxinus ornus uglavnom odnosila na proučavanja sa aspekta ekologije, hemijskog sastava i stresa, a u manjem obimu na proučavanje genetičke varijabilnost i hibridizacije. Sugerišemo više genetičkih istraživanja na ovoj vrsti u budućnosti.*

Ključne reči: Flowering ash, crni jasen, PCA, reference, podaci, genetika

1. INTRODUCTION

To make progress in research, the first step is bibliographics data searching. The bibliographics data are generally very extensive, and in them is not easy to find the basic guidelines of the research. Researchers need to be familiar with the research already being conducted within different areas as well as current research gaps. Based on this information (e.g. from journals), deficits in our research area can be identified and directed.

It is possible to analyse datasets by different multivariate methods, traying to identify sources of variability and groupings in the data. Theoretical base of PCA is very well known (Krzanowski, 1988; Falissard, 2005, etc.). Multivariate methods, especially PCA were very often used in investigation of diversity and taxonomy of plants (Dodd et al., 1993; Bojović et al., 2000a, 2005; Slavkovska et al., 2001; Nikolić et al., 2007, 2008, 2009; Kapetanos et al., 2008, etc).

2. MATERIAL AND METHODS

Bibliographic references of *Fraxinus ornus*, obtained from "Scopus" data base during the past ten years (2008-1999), were summarized by keywords in different areas of research.

In processing data by Principal component analysisis (PCA) (factors: a – areas of research; b – bibliographic references) we used statystical program "Statoscope"*.

3. RESULTS AND DISCUSSION

We defined 17 areas of research as folowing (a1-a17):

(a1) Chemical composition
(a2) Wood properties
(a3) Pollen characteristics
(a4) Stress
(a5) Anatomy
(a6) Pests and diseases
(a7) Adaptability
(a8) Reforestation
(a9) Etnobotany
(a10) Sexuality
(a11) Genetic variability
(a12) Physiology
(a13) Hybridization
(a14) Ecology
(a15) Climate change
(a16) Morphology and
(a17) Seed properties

Obtained bibliographic references (cca 31) of *Fraxinus ornus* L. were signed as folowing:

(b1)
De Micco, V., Aronne, G. i Baas, P. (2008). Wood anatomy and hydraulic architecture of stems and twigs of some Mediterranean trees and shrubs along a mesic-xeric gradient. *Trees - Structure and Function*, *22(5),* 643-655.

(b2)
Primorac, L., Bubalo, D., Kenjerić, D., Flanjak, I., Pirički, A.P. i Mandić, M.L. (2008). Pollen spectrum and physicochemical characteristics of Croatian Mediterranean multifloral honeys. *Deutsche Lebensmittel-Rundschau 104(4),* 170-175.

(b3)
De Micco, V. i Aronne, G. (2007). Combined histochemistry and autofluorescence for identifying lignin distribution in cell walls. *Biotechnic and Histochemistry, 82(4-5),* 209-216.

(b4)
Chiatante, D., Scippa, G.S., Iorio, A.D., De Micco, V. i Sarnataro, M. (2007). Lateral root emission in woody taproots of *Fraxinus ornus* L. *Plant Biosystems, 141(2),* 204-213.

(b5)
Ma, J. i Zhang, X.-G. (2007). Two new species of *Sporidesmium* from Yunnan, China. *Mycotaxon, 101,* 73-76.

(b6)
Muzzi, E. i Fabbri, T. (2007). Revegetation of mineral clay soils: Shrub and tree species compared. *Land Degradation and Development, 18(4),* 441-451.

(b7)
Kültür, S. (2007). Medicinal plants used in Kirklareli Province (Turkey). *Journal of Ethnopharmacology, 111(4),* 341-364.

(b8)
Verdú, M., Spanos, K., Čaňová, I., Slobodník, B. i Paule, L. (2007). Similar gender dimorphism in the costs of reproduction across the geographic range of *Fraxinus ornus*. *Annals of Botany, 99(1),* 183-191.

(b9)
Španjol, Ž., Barčić, D., Rosavec, R. i Ugarković, D. (2006). Ameliorative role of Aleppo pine (*Pinus halepensis* Mill.) in the regeneration of climatozonal vegetation. *Periodicum Biologorum, 108(6),* 655-662.

(b10)
Verdú, M., González-Martínez, S.C., Montilla, A.I., Mateu, I. i Pannell, J.R. (2006). Ovule discounting in an outcrossing, cryptically dioecious tree. *Evolution, 60(10),* 2056-2063.

(b11)
Solymosi, K. i Böddi, B. (2006). Optical properties of bud scales and protochlorophyll (ide) forms in leaf primordia of closed and opened buds. *Tree Physiology, 26(8),* 1075-1085.

(b12)
Heuertz, M., Carnevale, S., Fineschi, S., Sebastiani, F., Hausman, J.F., Paule, L. i Vendramin, G.G. (2006). Chloroplast DNA phylogeography of

European ashes, *Fraxinus* sp. (Oleaceae): Roles of hybridization and life history traits. *Molecular Ecology, 15 (8),* 2131-2140.

(b13)
De Mei, M. i Di Mauro, M. (2006). Study of some characteristic Mediterranean vegetation species best suited for renaturalization of terminal-phase municipal solid waste (MSW) landfills in Puglia (Southern Italy). *Acta Oecologica, 30(1),* 78-87.

(b14)
Chiatante, D., Iorio, A. D., Sciandra, S., Scippa, G. S. i Mazzoleni, S. (2006). Effect of drought and fire on root development in *Quercus pubescens* Willd. and *Fraxinus ornus* L. seedlings. *Environmental and Experimental Botany, 56(2),* 190-197.

(b15)
D'Alessandro, C. M., Saracino, A. i Borghetti, M. (2006). Thinning affects water use efficiency of hardwood saplings naturally recruited in a *Pinus radiata* D. Don plantation. *Forest Ecology and Management*, 222*(1-3),* 116-122.

(b16)
Verdú, M., Montilla, A. I. i Pannell, J. R. (2004). Paternal effects on functional gender account for cryptic dioecy in a perennial plant. In *Proceedings of the Royal Society* (B: Biological Sciences 271), London, 2017-2023.

(b17)
Takos, I. A. i Efthimiou, G. S. (2003). Germination results on dormant seeds of fifteen tree species autumn sown in a Northern Greek nursery. *Silvae Genetica, 52(2),* 67-71.

(b18)
Nardini, A., Salleo, S., Trifilò, P. i Lo Gullo, M. A. (2003). Water relations and hydraulic characteristics of three woody species co-occurring in the same habitat. *Annals of Forest Science, 60(4),* 297-305.

(b19)
Chiatante, D., Sarnataro, M., Fusco, S., Di Iorio, A. i Scippa, G. S. (2003). Modification of root morphological parameters and root architecture in seedlings of *Fraxinus ornus* L. and *Spartium junceum* L. growing on slopes. *Plant Biosystems, 137(1),*47-55.

(b20)
Kalapos, T. i Csontos, P. (2003). Variation in leaf structure and function of the Mediterranean tree *Fraxinus ornus* L. growing in ecologically contrasting habitats at the margin of its range. *Plant Biosystems, 137(1),*73-82.

(b21)
Iossifova, T., Vogler, B. i Kostova, I. (2002). Escuside, a new coumarin-secoiridoid from *Fraxinus ornus* bark. *Fitoterapia, 73(5),* 386-389.

(b22)
Oddo, E., Saiano, F., Alonzo, G. i Bellini, E. (2002). An investigation of the seasonal pattern of mannitol content in deciduous and evergreen species of the Oleaceae growing in northern Sicily. *Annals of Botany, 90(2),* 239-243.

(b23)
Oddo, E., Sajeva, M. i Bellini, E. (2002). Seasonal pattern of mannitol and malate accumulation in leaves of two manna ash species (*Fraxinus ornus* L. and *F. angustifolia* Vahl) growing in Sicily. *Plant Biosystems, 136(1),*29-34.

(b24)
Kostova, I. (2001). *Fraxinus ornus* L. *Fitoterapia, 72(5),* 471-480.

(b25)
Radoglou, K. i Raftoyannis, Y. (2001). Effects of desiccation and freezing on vitality and field performance of broadleaved tree species. *Annals of Forest Science, 58(1),* 59-68.

(b26)
Piasentier, E., Bovolenta, S. i Malossini, F. (2000). The *n*-alkane concentrations in buds and leaves of browsed broadleaf trees. *Journal of Agricultural Science, 135(3),* 311-320.

(b27)
Tognetti, R., Cherubini, P. i Innes, J. L. (2000). Comparative stem-growth rates of Mediterranean trees under background and naturally enhanced ambient CO_2 concentrations. *New Phytologist, 146(1),* 59-74.

(b28)
Guarrera, P. M. (1999). Traditional antihelmintic, antiparasitic and repellent uses of plants in Central Italy. *Journal of Ethnopharmacology, 68(1-3),* 183-192.

(b29)
Dommée, B., Geslot, A., Thompson, J. D., Reille, M. i Denelle, N. (1999). Androdioecy in the entomophilous tree *Fraxinus ornus* (Oleaceae). *New Phytologist, 143(2),* 419-426.

(b30)
Tognetti, R., Longobucco, A. i Raschi, A. (1999). Seasonal embolism and xylem vulnerability in deciduous and evergreen mediterranean trees influenced by proximity to a carbon dioxide spring. *Tree Physiology, 19(4-5),* 271-277.

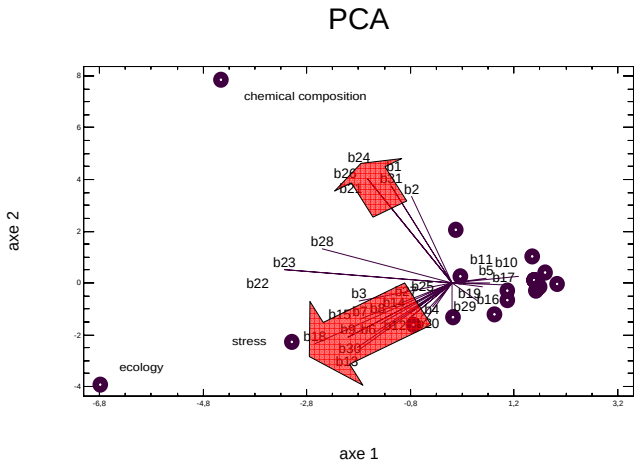
(b31)
Iossifova, T., Vogler, B., Klaiber, I., Kostova, I. i Kraus, W. (1999). Caffeic acid esters of phenylethanoid glycosides from *Fraxinus ornus* bark. *Phytochemistry, 50(2),* 297-301.

In the multivariate statystical analysis (PCA, see Graph 1) we regarded the bibliografic references as characteristics, and domains as elements (the columns) and concluded that

(1) the reseaches of the ecological aspect, chemical composition and stress were the most distinctive and that

(2) the biggest group of the journals (to which the largest number of the leading international journals also belong) have focused their attention on ecology (biogeography) and stress.

Graph 1. *Graphical vizualization of PCA results in the plan of the first two axes: 31 bibliographics data (b1-b31) refers to 17 area of research.* ● *- Area of research*

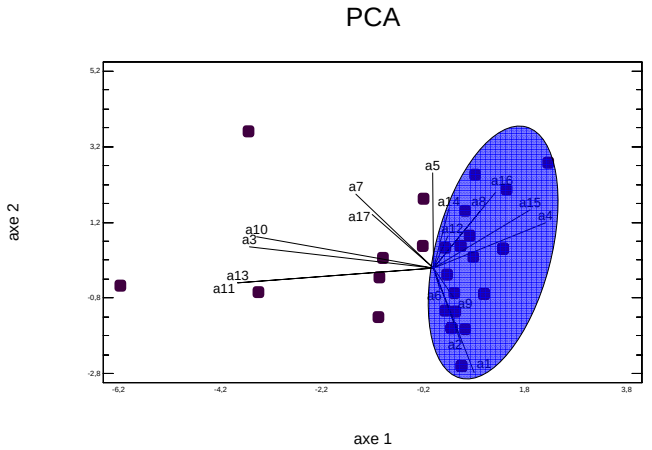


Reversely, when the bibliografic references were regarded as elements (rows), and the domains as characteristics, we found situation presented in Graph 2, and concluded that

(3) the most pieces of information on *Fraxinus ornus* were obtained from “hunger information“ on the genetic variability and hybridization and that

(4) the most papers (>50%) were from the domain of ecology (biogeography), chemical composition and stress.

Graph 2. *Graphical vizualization of PCA results in the plan of the first two axes: 17 area of research (a1-a17): (a1) Chemical composition, (a2) Wood properties, (a3) Pollen characteristics, (a4) Stress, (a5) Anatomy, (a6) Pests and Diseases, (a7) Adaptability, (a8) Reforestation, (a9) Etnobotany, (a10) Sexuality, (a11) Genetic variability, (a12) Physiology, (a13) Hybridization, (a14) Ecology, (a15) Climate change, (a16) Morphology and (a17) Seed properties, refer to 31 bibliographics data.* ■ *– Bibliographics data*



Relatively small number of references about flowering ash were found in the "Scopus" data base in the last ten years. Additional references could be also found in some national journals, project reports, proceedings or for some older sources (Bojović et al. 1997, 1998, 1999, 2000b,c, 2003, etc.), as well as from other data bases (Wallander, 2008). It seems that it was the same situation with references of *Fraxinus excelsior* L. and *Fraxinus angustifolia* Vahl. from the same data base in the last ten years. Large number of references in the group of fields of genetics, ecology, sistematics and evolution (at least 17 and 10, respectively) were found (references were not presented).

4. CONCLUSION

Relatively small number of references with *Fraxinus ornus* were published in the last ten years. On the other hand, some more were not very well known as they had been published in journals or other sources of lesser international significance. According to results of PCA we recommend the researches of flowering ash towards styding of it's genetic variability and hybridization in the future since they were scarce in the last period. Furthermore, the researches could be directed towards a domain which had not been the object of study so far.

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Slobodanka MITROVIĆ, Petar D. MARIN

Summary

Researchers need to be familiar with the research already being conducted within different areas as well as current research gaps. Based on this information (e.g. from journals), deficits in our research area can be identified and directed. The aim of this paper is to find out the direction of the previous researches and the possible direction of the future researches on *Fraxinus ornus* L. more easily and quickly. In the "Scopus" data base 31 bibliographic references about flowering ash in the past ten years were reported. According to their keywords they were grouped in 17 research areas and analyzed by multivariate statystical method PCA. On the base of the obtained results it was concluded that: (1) the reseaches of the ecological aspect, chemical composition and stress were most distinctive, (2) the biggest group of the journals focused their attention on ecology (biogeography) and stress, (3) the most pieces of information on *Fraxinus ornus* were obtained from "hunger information" on the genetic variability and hybridization, and that (4) over 50% of papers are from the domain of ecology (biogeography), chemical composition and stress. Obviously, some articles or reports about flowering ash are not always available because they were published in different literature sources of lesser international significance. According to results of PCA we recommend the researches of flowering ash towards styding of it's genetic variability and hybridization in the future since they were scarce in the last period. Furthermore, the researches with *Fraxinus ornus* could be directed towards a domain which had not been the object of study so far.

ISTRAŽIVANJE BIBLIOGRAFSKIH PODATAKA ZA *FRAXINUS ORNUS* L. PUTEM ANALIZE GLAVNIH KOMPONENTI (PCA)

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Rezime

Istraživači bi trebalo da budu upoznati kako sa već obavljenim istraživanjima u različitim oblastima tako i sa trendovima u istraživanjima. Na osnovu tih informacija (iz časopisa, na primer) nedostaci u našem polju istraživanja se mogu identifikovati i usmeriti. Cilj ovog rada je da se što lakše i brže odredi pravac prethodnih i mogući pravac budućih istraživanja kod *Fraxinus ornus* L. U bazi podataka "Scopus" u poslednjih deset godina nalazi se 31 bibliografska referenca o crnom jasenu. Prema ključnim rečima one su grupisane u 17 polja istraživanja i analizirane multivarijacionom statističkom metodom PCA. Na osnovu dobijenih rezultata zaključeno je: (1) da se

najviše razlikuju istraživanja ekologije, hemijskog sastava i stresa, (2) da je najveća grupa časopisa usmerila svoju pažnju ka ekologiji (biogeografiji) i stresu, (3) da je najveci deo informacija dobijen na osnovu nedostajućih podataka za geneticku varijabilnost i hibridizaciju i da (4) preko 50% članaka je iz oblasti ekologije (biogeografije), hemijskog sastsava i stresa. Očigledno je i da neki članci ili saopštenja o crnom jasenu nisu uvek dostupni jer su publikovani u različitim literaturnim izvorima manjeg međunarodnog značaja. Na osnovu rezultata PCA preporučujemo buduća istraživanja crnog jasena u pravcu proučavanja njegove genetičke varijabilnosti i hibiridizacije, jer su ona u poslednje vreme bila oskudna. Istraživanja *Fraxinus ornus* bi se, takođe, mogla usmeriti i u do sada neistražena područja proučavanja.

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INSTITUTE OF FORESTRY • BELGRADE
INSTITUT ZA ŠUMARSTVO • BEOGRAD

SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*114.449.8 : 630.233] : 630*174.1 Alnus glutinosa Gaertn.=111**
Original scientific paper

THE MICROORGANISMS POPULATION SIZE OF THE SOIL ORGANIC LAYER AND CHARACTERISTICS OF THE LITTERFALL OF THE COMMON ALDER (*ALNUS GLUTINOSA* GAERTN.) ON THE RECLAIMED MINE SOIL OF MINING-ENERGY-INDUSTRIAL COMPLEX "KOLUBARA"

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Abstract: *The researches were conducted in three common alder monocultures, established by the deposition of the waste-rock fom the open-pits of the lignite mines. The total annual yield of the litterfall, organic carbon and nitrogen, phosphorous, and potassium was studied. The ratio C/N and the hydrolyzed nitrogen forms were determined. In the organic soil layers and surface layers of soil covered by the common alder the seasonal dynamics of the number od the saprophytic microorganisms, which have the important role in the nitrogen cycle in the forest ecosystems, was studied.*

Key words: common alder, litterfall, organic soil layer, saprophytic microorganisms, plant assimilatives.

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BIOGENOST ORGANSKE PROSTIRKE I KARAKTERISTIKE LISNOG OPADA CRNE JOVE (*ALNUS GLUTINOSA* GAERTN.) NA DEPOSOLIMA REIK "KOLUBARA"

Izvod: Istraživanja su izvršena u tri monokulture crne jove, podignutim na deposolima nastalim odlaganjem jalovine sa površinskih kopova rudnika lignita. Ispitivan je ukupan godišnji priliv lisnog opada, organskog ugljenika i azota, fosfora i kalijuma. Određen je C/N odnos i hidrolizujući oblici azota. U organskoj prostirci i površinskim slojevima zemljišta pod kulturom jove ispitana je sezonska dinamika brojnosti saprofitnih mikroorganizama koji obavljaju važnu funkciju u kruženju azota u šumskim ekosistemima.

Ključne reči: Crna jova, lisni opad, organska prostirka, saprofitni mikroorganizmi, biljni asimilativi

1. INTRODUCTION

The reclaimed mine soils formed by the deposition of the waste-rock from the open-pits of the lignite mines in the Kolubara basin have a deep solum, and in regard to the deposition patterns are the mosaics of the different lithologic layers of the different texture and mineralogical composition. The physical and chemical, as well as microbial characteristics of these reclaimed mine soils were studied by numerous authors (Stojanovic et al. 1977; Antonovic et al. 1978; Antonovic et al. 1984; Veselinovic et al. 1984; Rasulic 1997; Schmidt, Veselinovic 1997; Schmidt, Miletic 1997, Drazic 1997; Miletic 2004, Miletic, Radulovic 1995). All these authors mention that the greatest problems are posed by the unfavourable chemical characteristics of the anthropogenic soils formed in this way. It mainly refers to the complete lack of humus and nutrients, which also implies the complete lack of organic nitrogen forms, from which the forms that are available to the plants are released. For the majority of the oligotrophic forest species the poor supply with the phosphorous and potassium forms, which are available to the plants, poses a smaller problem, since these elements are still present in the available forms. The source of these forms is parent rock, and under the influence of the agents of the mineral decomposition on the soil surface these elements which are unavailable to the plants turn into the forms which are available to the plants.

The growth and development of growth of the forest trees, which also means the production of wood volume, depend upon the nutrition of the forest trees. The main limiting factor for the growth and development of the forest trees on the reclaimed mine soils of the Mining-Energy-Industrial Complex "Kolubara" is the lack of nitrogen in the soil.

The effectiveness of the reforestation depends upon the applied reforestation technology, i.e. upon the used organic fertilizers. It mainly refers to peat, which is introduced to the planting pits during the reforestation, and by which the certain quantity of the ogranic nitrogen is also introduced. The further nutrition of the forest trees by nitrogen depends on the established balance of the cycle of this element in the artifically established ecosystem. During the early years of the development of the forest plantations the quantity of the nitrogen which circulates in the artifically established ecosystem is small.

The forest species which can use the atmospheric nitrogen by the symbiotic nitrogen fixation do not have any difficulties in the nutrition by nitrogen. The litterfall of the trees which use the atmospheric nitrogen is always rich in this element of nutrition, which is deficient on the reclaimed mine soils. By the processes of the biodegradation of the organic nitrogen (aminisation, amonification, nitritation, and nitration) under the influnce of the saprophytic microorganisms the organic nitrogen forms convert into the mineral forms NH_4^+ and NO_3^- (Savic, Jekic 1975), which are available to the plants, and can be used by the species which cannot use the atmospheric nitrogen by the symbiotic nitrogen fixation.

The common alder is the species with the ability of the symbiotic nitrogen fixation (Blom et al. 1981). This paper is aimed at the study of the possibilities of the use of the common alder in the mixed cultures, which by the production of the litterfall rich in the nitrogen could improve the nutrition of the other, more economically beneficial tree species by this missing element in the soil.

2. METHODS

The characteristics of the litterfall of the common alder aged 11, 15, and 16, were studied on the reclaimed mine soils of the Mining-Energy-Industrial Complex "Kolubara". Only the newly-formed litterfall, which was transported to the soil surface in the year of the research, was studied. In order to prevent the mixing of the one-year-old litterfall with the organic soil organic layer i.e. the mixing with the older litter, the litterfall was collected in the wooden boxes, which were introduced in the plantations prior to the phenophase of the leaf loss.

In the litterfall collected in this way by the analysis of the ash obtained by the dry burning the following macro elements of the nutrition were determined: the total phosphorous coloriometrically, the total potassium flame-photometrically, the total calcium and magnesium complexometrically (Dzamic et al. 1996). The content of the total nitrogen was determined by the use of Kjeldahl's method, and the content of the total nitrogen by Ansttet's method,

modified by Punomarjeva and Nikolajeva (Ponomareva, Plotnikova 1975). From the hydrolyzed nitrogen forms the total hydrolyzed, ammonium, amino-acidified, and hexosamine nitrogen forms (Black et al. 1965) were determined.

In the horizon of the organic soil layer the number of the physiological soil microorganisms, which have a role in the dynamics and balance of the nitrogen cycle in the forest ecosystems, was determined. The number of the amonifying microorganisms on MPA, the total number of the microorganisms on the soil agar and the number of fee nitrogen fixing on Krasilnikov's agar were determined.

3. RESULTS AND DISCUSSION

The litterfall is the most important source of the organic carbon for the forest soils. Along with the litterfall, nitrogen and other nutrients are transported to the soil surface (Rodin, Bazilevič 1965; Nordén 1994). The production of the litterfall on the soil surface under the common alder cultues is high. The measured quantities of the litterfall under the common alder monocultures range from 1,775.50 to 2,612.5 kg of the completely dry nutrients per a hectare. This wide range of the produced litterfall on the soil surface is the result of site and stand conditions.

In contrast to the total quantity of the common alder litterfall, the chemical characteristics of it are much more equalized. The content of the total nitrogen in the litterfall is 2.4 %, and its annual yield on the soil surface under the monocultures is 51.57 kg/ha (Table 1). This quantity of nitrogen is in the harmony with the quantity of the mineral fertilizer NPK 15:15:15 - 343.8 kg. The mineralisation of the organic nitrogen in the oxidative environment occurs as the oxidation process, and in the anoxidative as the hydrolytic process (Tesic, Todorovic 1997).

The greatest part of the total nitrogen from the common alder litterfall is not subject to hydrolysis, i.e. the oxidative conditions are needed for the mineralisation of it. There is also a great quantity of hydrolyzed nitrogen which can also decompose in the anaerobic conditions. The amino acid nitrogen is the most common form of the hydrolized nitrogen, and it is followed by ammoniacal nitrogen. The ratio of carbon to nitrogen is very narrow, i.e. 12.72. It is the precondition for the fast mineralisation of the nutrient and the conversion of all organically-bound plant assimilatives from the soil organic layer into the mineral forms, as well into the forms which are available to the plants. The annual quantity of total nitrogen which common alder plantations transports by the litterfall to the soil in the research area is higher than the quantity transporeted by black locust (Miletic 2004), which is also the species with the ability to use the atmospheric nitrogen. In addition, the ratio of carbon

to nitrogen of the common alder litterfal is narrower in comparison with the black locust litterfall.

Table 1. *The characteristics of the litterfall of the common alder*

	% in litterfall	kg/ha		% in litterfall	kg/ha
Nutrient	90.47	1987.30	Ash	9.53	206.70
Total C	30.25	659.79	Total K_2O	3.08	69.82
Total N	2.40	51.57	Total P_2O_5	0.21	4.57
Hydrolyzed N	0.87	19.21	Total CaO	4.03	87.43
NH_4-N	0.22	4.95	Total MgO	1.68	37.88
Hexosamine - N	0.07	1.41	C/N = 12.72		
Amino acid -N	0.42	9.63			
Non-hydrolyzed N	1.54	32.36			

Besides the high quantity of nitrogen, the common alder leaves contain the high quantities of the other macro elements of the nutrition. By the production of the litterfall the common alder transports the greater quantities potassium to the researched reclaimed mine soils. The quantity of potassium which the common alder monocultures annually produce on the soil is greater in comparison with the quantity of potassium under the linden and black locust plantations, and considerably greater in comparison with the quantities under the conifer species plantations (Miletic 2004). The studied plantations averagely transport 69.8 kg K_2O/ha on the soil surface. The common alder averagely transport 4.57 kg/ha of phosphorous, 87.43 kg/ha of calcium, and 37.88 kg/ha of magnesium to the soil surface by the leaf litter.

The great quantity of the litterfall produced by the common alder forms the horizon of the soil organic layer, which is the strongest in the autumn, after the phenophase of the leaf fall (O1 sub-horizon). From the next spring the organic soil layer is subject to the rapid mineralisation, as a result of the narrow ratio of carbon to nitrogen. In the autumn period, at the beginning of phenophase of the leaf fall, the soil organic layer is interrupted, and mainly made of the plant material produced by the other, native species. The coarse wooden fragments of the soil organic layer are also present, and to a lesser extent the common alder leaves as well.

In the spring the number of the amonifying microorganisms in the soil organic layer, and in surface soil, which is 2 cm deep, is significantly greater than the number of the other physiological groups of the saprophytic microorganisms (Table 2). The basic energy material for this physiological group of the soil microorganisms are the proteins from the soil organic layer. The nitrogen in the ammonia form is released as the product of their activity. In the winter all the processes of decomposition decelerated to a great extent, or

even completely stopped, owning to the low temperature. As a result, in the spring the soil organic layer is still rich in the protein nitrogen, preserved from the autumn period. It causes the considerable increase of the number of the amonifying microorganims in the soil organic layer and surface soil layer, in comparison with the total number of the microorganisms on the soil agar and the number of free nitrogen fixing.

Table 2. *Seasonal dynamics of the number of the basic physiological groups of the soil microorganisms in the soil under the common alder plantations (1,000 mo/1g zemlje)*

Depth cm	Spring	Summer	Autumn	Average	σ	V
Amonifying microorganisms on MPA agar						
Olfh	2,468.4	83.3	4,771.7	2,441.2	2,344.3	96.0
0–2	438.0	149.0	505.2	364.1	189.3	52.0
2–7	2,483.5	95.0	52.6	877.0	1,391.4	158.7
The total number of the microorganisms on the soil agar						
Olfh	647.4	8.3	13420.5	4,692.1	7,565.8	161.2
0–2	94.4	175.0	446.0	238.5	184.2	77.2
2–7	611.1	221.0	85.9	306.0	272.7	89.1
Free nitrogen fixing on Erzbi's agar						
Olfh	447.7	1,166.7	8,526.0	3,380.1	4,470.9	132.3
0–2	128.9	40.0	122.4	97.1	49.6	51.0
2–7	485.2	39.5	54.2	193.0	253.2	131.2

In the spring the total number of the microorganisms on the soil agar are the second-largest physiological group on the soil agar by the number. These microorganisms use the mineral forms of the plant assimilatives, mainly nitrogen, for the synthesis of their own cell substances.

The free nitrogen fixing are the third-largest physiological group by the number. These microorganisms use the nutrients of the wide C/N ratio as the energy material, and are satisfied with the small quantities of the nitrogen from the nutrient, which they decompose by the biochemical processes, and are able to use the atmospheric nitrogen as well.

In the summer in the soil organic layer the number of the amonifying microorganisms and total number of the microorganisms on the soil agar decreases to a great extent. It is partly the result of the low moisture of the soil and soil organic layer, and partly the result of the lower quantities of the protein nitrogen, which is decomposed as early as in the spring. The smaller number of the amonifying microorganisms, which use the proteins as the energy material, caused the reduction of the production of the mineral forms of nitrogen in the soil organic layer. As a result, the number of the microorganisms, which are formed on the soil agar and which use the mineral forms of nitrogen, decreased. In the summer the nutrient produced by the other, native species, and coarse wood fragments, is dominant in the soil organic layer. The vascular and

mechanical tissues containing the small quantities of nitrogen mainly originate from the common alder leaves.

Due to the change of the composition of the soil organic layer the number of the fee nitrogen fixing significantly increases. Owning to the activity of the fee nitrogen fixing, which use the atmospheric nitrogen for their own needs, the C/N ratio of the soil organic layer becomes narrower, since by dying of them the nutrients rich in this element are transported.

In the autumn the condition of soil moisture and soil organic layer is improved and at the same time the new litterfall, i.e. fresh energy material for the saprophytic microorganisms, is transported to the soil. The population size of all physiological groups extremely increases. A dominant physiological group is the total number of the microorganisms on the soil agar.

The total number of the microorganisms on the soil agar is the dominant physiological group in the soil organic layer under the common alder plantations in the average annual number of the soil microorganisms. These microorganisms induce the environment trophication and high quantities of the plant assimilatives which are available to the plants. The increase in the total number of the microorganisms on the soil agar in the comparison with the number of the amonifying microorganisms point to the fact that in the horizon of the soil organic layer the decomposition processes is more dominant than the processes of the humus synthesis, as well as to the fact that the decomposition results in the end products, and that the plant assimilatives occur in the mineral forms.

Nitrogen is biologically accumulated in the humus materials in the soil, by creation of the first phase of mature humus, which occurs as a result of the mutual syntesis of amino acids and hynones (Kononova 1963). The amino acids are formed as the intermediate product of the decomposition of the proteins, and hynones (aromatic compounds) as the intermediate product of the decomposition of the organic compounds which do not contain nitrogen, as well as a result of the activity of the microorganisms. These elements are the nitrogen and carbon components of the humus. The humic acids are formed by the further polymerization of the stage prior to humus formation (Kononova 1963).

The narrow C/N ratio of the common alder litterfall causes the transformation of the greatest part of the carbon by the oxidation processes in CO_2, which is the end product of the decomposition of the nutrient. By the biochemical processes the insufficient quantities of the carbon components, which would bound with the nitrogen components in the initial stages of the humus formation, are formed. By contrast, there is a surplus of the nitrogen components which occur during the decomposition of the soil organic layer under the common alder monocultures. The amino acids, formed by the

processes of the degradation of proteins influenced by the proteolytic ferments (aminization) are subject to the further biodegradation.

By the influence of the amonifying microorganisms and their ferments of deaminases and desamidases convert, by the activity of amines and amides, into NH_4 form (Savic, Jekic 1975). In the neutral and alkaline environments, as well as under the favourable oxidation conditions, the ammonia nitrogen is subject to the nitrification processes (Savic, Jekic 1975, Tesic, Todorovic 1988), i.e. under the influence of the nitrificators by the activity of nitrites turn into the nitrates. Since the reaction of the soil solution to all three sample plots under the studied common alder cultures is neutral, and the conditions of the aeration of the soil solum are good (Miletic 2004), it can be expected that the significant part of the mineral nitrogen on the studied soil will occur in the nitrate form as well.

The rapid mineralisation of the organic nitrogen is not favourable for the ecosystem as a whole. The mineral forms of nitrogen are very mobile and are quickly lost from the soil. The ammonia nitrogen is subject to volatisation (evaporation) from the neutral and alkaline enviroments, such as the studied deposols. Nitrates, the salts of the nitric acids, are very water-soluble and mobile. By the descendent flows these elements are transported in the deeper parts of the soil solum, even out of reach of the root systems of the forest trees. Together with NO_3^- anion the carrying cations (Ca, Mg, K, NH_4, etc.), which are also important elements of the nutrition of the forest trees, are transported to the deeper parts of the solum. According to Savic and Jekic (1975) nitric acid is the main chemical agent of the processes of the extraction in the neutral and alkaline soils. In the deeper parts of the solum, in the anoxidative environment, under the influence of anaerobic and facultatively anaerobic bacteria are reduced to the molecular nitrogen.

In the soil organic layer under the studied common alder monocultures in the spring the organic forms of nitrogen are intensively converted into in the mineral forms, which are available to the plants, since the amonifying microorganisms is the dominant physiological group of the soil microorganisms, and this process is immediately followed by the microorganisms on the soil agar, which use the products of the decomposition of the amonifying microorganisms. As early as in the summer the lack of the nitrogen is clearly visible, since the fee nitrogen fixing is the dominant group in the soil organic layer.

The release of nitrogen by the common alder monocultures is not balanced over the year, since there is no high rate of the humus synthesis. Humus is the only stable and long-lasting source of nitrogen and other nutrients for the taller plants. The decomposition of humus idecelerates, which also implies the harmonized release of the mineral forms of nitrogen over the year. As a result of the decelerated decomposition of the less water-soluble materials,

such as humus, there are no greater losses of the nitrogen or the other elements of the nutrition, as in the case of the rapid decomposition of the nutrient of the untypical nature to the end products of the decomposition.

4. CONCLUSION

The large quantity of the nutrients circulated in the artifically established common alder stands on the reclaimed mine soils of the Mining-Energy-Industrial Complex "Kolubara". The litterfall of the common alder contains the great quantities of the macroelements of the nutrition, particularly the large quantities of nitrogen. The great part of the soil organic layer decomposes to the end products under the influence of the saprophytic microorganisms, and only to a lesser extent it is transformed in the humus. The fast decomposition of the soil organic layer implies the conversion of the plant assimilatives from the organic forms into the forms which are available to the plants. Under the common alder monocultures the release of the mineral forms of nitrogen from the soil organic layer is most intensive in the spring, whereas it significantly decreases as early as in the summer. It is proved by the decrease of the number of the microorganisms which use the mineral forms of the nitrogen (amonifying and minerological), as well as by the increase of the number of the microorganisms which use the atmospheric nitrogen (fee nitrogen fixing).

In contrast to the common alder monocultes, which produce the litterfall of the narrow C/N ratio, the mixed cultures of it in combination with the species which produce the litterfall of the wider C/N ratio can provide the various energy material for the saprohytic microorganisms. The presence of the common alder litterfall in the soil organic layer under the mixed cultures can intensify the processes of the decomposition of the soil organic layer, which is produced by the other species, and which is of the wider C/N ratio. The decomposition of the other species, with the simultaneous decomposition of the common alder leaf litter, enables the formation of the sufficient quantities of the carbon and nitrogen components for the intensive processes of the synthesis of the mature humus.

Humus is the stable and long-lasting source of the nutrients for the forest trees. The formation of the greater quantities of humus under the mixed plantations will enable the more equalized release of the nutrients over the whole vegetation period. When applied in the mixed plantations on the deposols which do not contain the organic matter, which also implies that they are devoid of nitrogen, the common alder can significantly improve the nutrition of other tree species in the plantation.

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THE MICROORGANISMS POPULATION SIZE OF THE SOIL ORGANIC LAYER AND CHARACTERISTICS OF THE LITTERFALL OF THE COMMON ALDER (*ALNUS GLUTINOSA* GAERTN.) ON THE RECLAIMED MINE SOIL OF MINING-ENERGY-INDUSTRIAL COMPLEX "KOLUBARA"

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Sumary

In the studied common alder cultures (*Alnus glutinosa* Gaertn.) it was reported that this species transports to the soil the litterfall rich in the nutrients which these species use in the nutrition. In the litterfall of the common alder the extremely high quantities of nitrogen were reported, which is the result of its’ ability to use the atmospheric nitrogen by the symbiotic nitrogen fixation. Nitrogen is the basic missing elements of the nutrition on the reclaimed mine soils of the studied area. Along with nitrogen, the common alder transports the high quantities of other macroelements of

nutrition to the soil. The soil organic layer, formed under the common alder cultures, is subject to the fast decomposition under the influence of the saprophytic microorganisms. The soil organic layer decomposes to a great extent to the end products, and to a lesser extent is transformed into the humus. It implies the fast conversion of the nutrients from the organic forms into the forms which are available to the plants. As a result of the high quantities of nitrogen and other nutrients in the litterfall of the common alder, as well as because of the rapid decomposition of the soil organic layer formed by this litterfall, the common alder used in the mixed plantations can significantly improve the nutrition of other tree species, and enable the formation of the great quantities of humus, which is the more stable and long-lasting source of the nutrients for the plants.

BIOGENOST ORGANSKE PROSTIRKE I KARAKTERISTIKE LISNOG OPADA CRNE JOVE (*ALNUS GLUTINOSA* GAERTN.) NA DEPOSOLIMA REIK "KOLUBARA"

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Rezime

U ispitivanim monokulturama crne jove (*Alnus glutinosa* Gaertn.) konstatovano je da ova vrsta donosi na površinu zemljišta lisni opad bogat hranljivim materijama koje biljke koriste u ishrani. U opadu crne jove konstatovane su izuzetno velike količine azota, što je posledica njene sposobnosti da koristi atmosferski azot simbiotskom azotofiksacijom. Azot je osnovni nedostajući element ishrane na deposolima istraživanog područja. Pored azota crna jova donosi na površinu i visoke količine drugih makroelemenata ishrane. Organska prostirka koja se formira pod kulturama jove podleže brzom razlaganju pod uticajem saprofitnih mikroorganizama. Organska prostirka se većim delom razlaže do krajnjih produkata, a samo manjim delom transformiše u humus. To podrazumeva brzo prevođenje hranljivih materija iz organskih u biljkama pristupačne oblike. Zbog visokih količina azota i drugih hranljivih materija u lisnom opadu crne jove, kao i zbog veoma brzog razlaganja prostirke koju ovaj opad obrazuje, crna jova primenjena u mešovitim kulturama u značajnoj meri može da popravi ishranu drugih vrsta drveća i obezbedi stvaranje većih količina humusa koji predstavlja stabilniji i dugotrajniji izvor hranljivih materija za biljke.

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*18 : 630*176.1 Alnus glutinosa (497.11-14)=111**
Original scientific paper

THE ASSOCIATIONS OF MARSH BLACK ALDER FORESTS IN SOUTHWESTERN SERBIA – ALLIANCE *ALNION GLUTINOSAE* (MALK. 29) MEIJER DREES 1936

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Abstract: *This paper presents the research results of the marsh black alder forests in Southwestern Serbia, i.e. in Pester Plateau, in which these associations are located. The site conditions in which these forests grow, parent rock, the soil characteristics and basic assumptions on the climate parameters necessary for the survival of these forests are presented. Two associations from this alliance were researched: black alder forest with tufted hairgrass and black alder forest with wood avens on the neogene sediments. The floristic composition, bilogical spectrum and spectrum of the floral elements are presented.*

Key words: black alder, Southwestern Serbia, tufted hairgrass, wood aven, pseudogley.

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ZAJEDNICE MOČVARNIH ŠUMA CRNE JOVE U JUGOZAPADNOJ SRBIJI – SVEZA *ALNION GLUTINOSAE* (MALK. 29) MEIJER DREES 1936

Izvod: *U radu su prikazani rezultati istraživanja močvarnih šuma crne jove u jugozapadnoj Srbiji, odnosno na Pešterskoj visoravni, gde se i nalaze ove zajednice. Prikazani su uslovi staništa u kojima se nalaze ove šume, geološka podloga, karakteristike zemljišta i osnovne postavke o klimatskim parametrima neophodnim za opstanak ovih šuma. Istražene su dve asocijacije iz ove sveze: šuma crne jove sa visokim busom i šuma crne jove sa zečjom stopom na neogenim sedimentima. Prikazan je floristički sastav, biološki spektar i spektar flornih elemenata.*

Ključne reči: crna jova, jugozapadna Srbija, visoki bus, zečja stopa, pseudoglej.

1. INTRODUCTION

The black alder occupies the lower warm oak altitudinal range near the brooks and rivers, or in the vicinity of the stagnant water. In Pester Plateau the black and grey alder forests account for 400 ha, and are located at the altitudes from 1,000 to 1,200 meters. Jovanovic, B. et al. (1997) considers such a great complex to be very interesting, and it is mainly covered by black alder forests. The fact that its wide sites appear at extremely high altitudes, i.e. in the oroclimatogenic altitudinal range of beech, fir, spruce and little-leaf decidious trees (*Alnus incana, Betula pubescens, Betula pendula, Populus tremula, Sorbus aucuparia, Salix* sp.) needs to be explained. It can be safely assumed that black alder spread to these altitudes in the post glacial climatic optimum, i.e. in the Atlantic period. According to Fukarek (1969), black alder appears at the altitudes above 1,000 meters, only in the narrow zone in the vicinity of Perucica brook. In Serbia only one black alder association with spruce in Mitrovac, located at the altitudes from 1,065 m to 1,082 m, the association *Omorikae-Piceeto-Alnetum glutinosae* Col. et Gig. (Colic, Gigov, 1958) (quoted by Jovanovic, B. et al, 1983), was studied in a great detail.

2. IMPORTANCE AND AIM OF THE RESEARCH

The research is important because it is aimed at the study of the condition of these forests the site conditions of which are peculiar, and they greatly differ from the conditions in which black alder forms the natural stands at other sites. The researches should provide the base for the special forest

management treatment, which should be different from the previous ones. It is necessary to single out the whole complex of these forests in the Pester Plateau and subject to the special protection regime, as the protected natural area, because of its peculiarities and in the aim of the its preservation.

3. METHOD OF WORK

For the determination of the **soil characteristics** in the forest associations the sufficient number of the pedological profiles, in the places where the phytocoenological records were taken, was analyzed. The soil types were determined based on the soil classification (Skoric, Filipovski, Ciric, 1985). The soil characteristics of the sites on which this association appears were researched, but on the soils with such characteristics other black or grey alder associations occur as well, and they are the subject of other papers. The table with the soil characteristics of the whole locality was presented in the previous papers, which treat the forest vegetation of Stavljanska breza site.

For the determination of the characteristics of the soil samples the following laboratory methods were used:

- Mechanical composition of the soil was determined by the international Pipet B method, and the texture classes of fine soil by Fere's triangle;
- Sum of the absorbed base cations and hydrolytic acidity were determined by Kapenn's method, and the acidity of the soil which is water-soluble by KCL electrometrical method as well;
- Content of the total humus was determined by Tjurin's method;
- Content of the total nitrogen was determined by macro-Kjeldahl method;
- Available forms of phosphorous and potassium in the soil were determined by Al-method.

The **recent forest vegetation** was studied based on the principles and methods of the French-Swiss school of Braun-Blanquet (B r a u n - B l a n q u e t , J., 1928, 1921), which is typical and generally accepted in the phytocoenological researches in this country.

The starting point for the study of the vegetation was the collection of the phytocoenological records, which included the basic characteristics of the sites, floristical content, composition and site conditions. The initial researches were conducted in 1997, and the detailed studied in 2007, by which the results of the previous ones were confirmed.

4. RESULTS OF THE RESEARCH

The marsh associations of black alder in Mt.Tara and Pester Plateau, along with the partial floristical similarity, mainly differ in the site genesis, and particularly by the site conditions, soil, parent rock, and climate. The associations in Mt. Tara have the relict character. The association *Deschampsio-Alnetum glutinosae* in Stavljanska breza is the association of the primary character, which differs (Jovanovic et al. 1983), by the origin, ecological conditions and floristical composition, from the previously described similar black alder associations. The very name of this site is also peculiar. Undoubtedly, it refers to the double named toponym (Jovanovic, B. et al., 1983), which has been explained above. The very name reminds to the fact that in this place the birch forests were present, and were destroyed by man. The association *Geo-Alnetum glutinosae montanum* occupies the greatest area of this complex of alder forests. This phenomenon in Pester was explained by Jovanovic, B. et al., 1983, according to Sinicin (1967), who claimed that black alder forests spread to the highest altitudes in the climatic optimum, i.e. in the Atlantic stadium. The subsequent flactuations in the climate was not unfavourable to such a great extent to prevent the survival of the black alder in the relatively cold mountain climate in the vicinity of Sjenica. They report that the current black alder site was separated from the conifers (spruce, Scots pine) by the secondary sucession and little-leaf decidious trees (*Alnus incana, Betula pubescens, Populus tremula, Salix* sp.) when they retreated due to the climate change.

These researches proved that the results of the previous studies of the association in this area, which implied that the highest percentage of this area is covered by pseudogley, whereas the smaller micro-depressions near the brooks are covered by marsh-gley soil.

The higher quantity of precipitation, which is typical for the humid areas, is in this place compensated by the long presence of the snow (most frequently it lasts for 96 days), as well as by the small intensity of evaporation, due to the severe, cold and long winter and extremely low temperatures typical for other months. The long presence of snow and the gradual melting of it is the precondition for the relatively long and humid pedoclimate. This fact, in the combination with the above factors, was crucial for the wide spread of the pseydogley in the conditions of the mountain, relatively dry climate (Jovanovic et al., 1983).

4.1 Black alder forests with tufted hairgrass on the neogene sediments Ass. *Deschampsio-Alnetum glutinosae montanum* Jov. et. Vuk. 1983

The stands of this association are located along the basins and brooks on the flat or gently-inclined terrains of the northen and eastern exposures, at the altitudes from 1,000 to 1,050 m (Jovanovic, B. et al., 1983).

In regard to the floristical composition, this association is considerably poorer than the other alder forests. It is the result of the constant, multi-annual grazing, which started as early as in the first spring days and of the real attack of the cattle on the living world of the sites on which this association appears. In the tree layer the black alder is dominant, whereas the shrub layer is poorer, due to the fact that it is used by the rural population for the construction of fences and other purposes. In the shrub layer along with the black alder the following species were registered: *Rhamnus frangula, Viburnum opulus* and *Corylus avellana*.

In the ground flora layer the influence of the following species was registered: *Ranunculus repens, Lysimachia nummularia, Oxalis acetosella, Solanum dulcamara, Lycopus europaeus, Deschampsia caespitosa, Poa palustris, Glyceria plicata, Agrostis alba, Carex leporina, Filipendula ulmaria, Athyrium filix-femina*, etc.

According to Jovanovic, B. et. Al., the soil covered by this association is the marsh -gley character, with the profile composition At-Gso-Gr, which is for a long or short time over-damped by the complementary water (ground, lateral). In the profile of these soils, which are up to 1m deep, most frequently three zones can be singled out. In the deeper part of the profile, below 30 cm, which is constantly saturated with water, the processes of reduction are dominant and the typical reduced-gley horizon (Gr), which is bluish and of the heavy mechanical composition, is formed.

4.2 Association of black alder with wood aven on the neogene sediments Ass. *Geo-Alnetum glutinosae montanum* Jov. et. Vuk. 1983

The association of black alder with wood aven *Geo-Alnetum glutinosae montanum* in this area was described by Jovanovic et al. (Jovanovic, B. et al., 1983), on the Stavljanska breza site. The occurrence of the hybrid alder, the intermediate form between white and black alder (*Alnus hybrida*), points to intermediate character of this association between two associations of alders, marsh and alluvial (*Alnion glutinosae* and *Alnion glutinosae-incanae*).

4.2.1 Range, position in the research area and site conditions

The stands of the association *Geo-Alnetum glutinosae montanum* occupy the greatest area of Stavljanska breza site. They are located at the plateaus above the right bank of Vapa river, in the east to Stavlje. These terrains are gently sloped, with the gentle crests and curves, which have steep slopes only in the vicinity of the little brooks. Their current condition is somewhat more favourable than in the period when it was reported by Krstic (1956), which is the result of the greater protection, as well as of the decrease in the rural population, which devastated these forests. Between the groves of these forests the rural pastures are located, and abandoned rural fields are located on the slopes.

The forests of this association are located between the forest gaps and the areas which are turned into the meadows aimed at grazing. The black alder mainly appear in the smaller group and mounds. This association occupies flattened position and gentle slopes, at the south exposures. In regard to the altitudinal zone, it it located at the altitudes from 1,050 to 1,150 meters (Jovanovic, B. et al.). The records were taken at the altitudes from 1,050 to 1,100 meters, at the western and south-southeastern exposures. The terrain inclination on which the observed stands are located ranges from 5 to 10°. The parent rock on this terrain also refers to the neogene sediments: gravel-sands and clays. The clay is most frequently found in the layer up to 1.5 meters. Above this layer the neogene sediments of the different origin and composition, which participated in the formation of the soil, and with the lighter texture, are deposited.

The pseudogley on this site is of the lighter mechanical composition with the profile composition E/g-g-C. These pseudogleys are from 80 to 90 cm deep, up to the gravel-sand layer. In regard to the texture characteristics, A horizons are the sandy clay, and loam, and the low g horizon is clay. A horizon is not so potent; from 0 to 8 cm deep, whereas the very potent A3/g up to 70 cm layer appears, with the rust stains, which are the result of the oxidation-reduction processes. In regard to the acidity, the soils are acidified, and pH in water ranges from 4.3 to 4.9, and in KCl the pH value ranges from 3.3 to 3.9. The soil is very rich in nitrogen, whereas it is poor in humus. In addition, the quantities of the available forms of phosphorous is low, whereas there is the moderate potassium availability.

4.2.2 Floristical composition and structure

The floristical composition and structure is presented in the phytocoenological table 1. The phytocoenological table contains 73 plant species: 2 tree species, 6 shrub species and 65 species which occur in the layer

of the ground flora. In the layer of the ground flora the ferns and moss do not appear, but only the angiosperms. Some phytocoenological records contain from 42 to 61 species, which means 50 species in average. Undoubtedly, if it were not for the constant impact of the grazing on these sites, more forest species which occur in the alder forests, and, less meadow species would be present in the association. In this association the ground flora occurs only between the rows of trees. This layer is every year under the great influence of the grazing and subject to the permanent destruction. The smaller number of the species managed to survive and they as a rule do not finish their annual development cycle. In this regard, its current layer cannot be treated as suitable under such conditions, but as the degradation phase which is the result of the permanent grazing.

Life form spectrum – biological spectrum

The biological spectrum of the association is presented in the Table 1. The site on which the association of black alder and wood aven is not extreme, but the adverse effect of the felling and grazing did not significanly eliminated species of some life forms. The high percentage of the hemicryptophytes (71%) – the species which are well-adapted to the winter coldness and which are in winter protected by the snow, that is abundant in this area. There are significantly lower percentage of the other life forms. The low percentage of phanerophytes (9%) is the result of the extremely low percentage of nanophanerophytes. It can be said that the percentage of geophytes is low (4%), given the characteristics of the soil which is very humid for most part of the year, but the percentage of it is significanly lower than the percentage of the grey and black alder on this site, due to the drier soil conditions and more degraded stands. The chamephytes account for 4%, and all the representatives of herbaceous chamephytes are reported. There is a significant percentage of terophytes/ chamephytes, as well as terophyte-chamephyte species, i.e. 4%, as a result of the stands with the open canopies.

Table 1. *Spectrum of the life forms of the plants in the association Geo-Alnetum glutinosae montanum Jov. et. Vuk. 1983*

Life forms							
Phanero-phytes	**Nanophane-rophytes**	**Woody chamephytes**	**Herbaceous chamephytes**	**Chemicry-ptophyte**	**Geophytes**	**Terophytes**	**Terophytes/ chamephytes**
P	np	dc	zc	h	g	t	th
6%	3%	0%	4%	71%	4%	7%	4%
9%		4%					

Spectrum of the floral elements

The spectrum of the floral elements of this association is presented in the Table 2.

Table 2. *The spectrum of the floral elements of the association Geo-Alnetum glutinosae montanum Jov. et. Vuk. 1983*

THE GROUP OF THE FLORAL ELEMENTS	Number of plants	Percentage		Floral elements	Number of plants
FLORAL ELEMENTS OF THE NORTHEN REGIONS	1	2%	2%	Boreal	1
MID-EUROPEAN	15	33%	33%	Mid-European	2
				Sub-Mid-European	12
				Alpine-Carpathian	1
Sub-Mediterranean			4%		
East-Sub-Mediterranean	1	2%		East-Sub-Mediterranean	1
Balkan and Balkan-Apennine	1	2%		Sub-Illyrian	1
PONTIC-CENTRAL-ASIAN			4%		
Pontic	2	4%		Sub-Pontic	1
				Pontic-Pannonian	1
EURO-ASIAN FLORAL ELEMENTS	18	39%	39%	Sub-South-Siberian	2
				Euro-Asian	10
				Sub-Euro-Asian	6
CIRCUMPOLAR AND COSMOPOLITES	8	17%	17%	Circumpolar	6
				Cosmopolitan	2
TOTAL:	46	100%	100%	TOTAL:	46

It can be observed that in this association there are not many individual floral elements, which is the result of the very floristic poverty. In regard to the collective floral elements, the Euro-Asian floral elements is the greatest group in this association (39%), as the element of the contrastive climate. The high percentage of the Mid-European floral elements (33%), as well as the high percentage of the circumpolar elements (17%) point to the significant impact of the colder northen regions. The lower percentage of the Sub-Mediterranean (4%) and Pontic-Central-Asian floral elements (4%) also points to this fact.

The mesophilic plants (of Mid-European and Sub-Atlantic floral elements) account for 33%, the plants of the xerophilic character (Pontic, Sub-Mediterranean, Balkan floral elements, as well as the floral elements of the desert regions) account for 8%, whereas the plants of the wide ecological altitudinal range (Euro-Asian and cosmpolitan floral elements) account for as much as 39%. The frigophilic plants (floral elements of the northen regions and circumpolar floral elements) account for 14%.

The following individual types of the altitudinal range are mainly represented by the plant species: Sub-Mid-European (12), Euro-Asian (10), Sub-Euro-Asian, and Circumpolar (6), whereas the other individual types of the

altitudinal range are represented by a very small number of species. It can be said that this association belongs to the Mid-European-Euro-Asian-Circumpolar type.

4.2.3 Layers

The black alder is the dominant species in the association Geo-Alnetum glutinosae montanum Jov. et. Vuk. 1983, whereas only the individual trees of grey alder are reported. There is a low canopy closure, and it ranges from 0.4 do 0.5. The average heights of the stands range from 8 to 9 m, and the average diameters from 12 to 15 cm. The stand condition is characterized by the mainly curved, underveloped trees, which are frequently rot. The dimensions of the trees are smaller than in the black alder and grey alder forests which appear on the slopes with the higher inclinations and on sheltered positions. Owning to the high vigour of coppices, the new black alder trees develop from the mounds from the lateral side, and the distance between the trees frequently ranges from 0.2 to 4 meters. Such condition of population size, canopy coverage and degree of alliance was marked with 4.4 or with 3.3.

In the second layer the following species are dominant: *Alnus glutinosa, Prunus spinosa, Crataegus monogyna, Evonymus europaeus*, whereas the following species are registered by one record: *Frangula alnus, Rosa agrestis* and *Juniperus communis*. In the layer of ground flora the great number of species occur in more records: *Oxalis acetosela, Ajuga reptans, Achylea millefolium, Alchemilla vulgaris, Bellis perenis, Cirsium acaule, Cynosurus cristatus, Festuca heterophylla, F. ovina, F. vallesiaca, Fragaria vesca, Geum urbanum, Leontodon autumnalis, Molinia coerulea, Plantago altissima, Poa anua, Potentilla reptans, P. erecta, Prunella vulgaris, Trifolium repens*. There is also a lower percentage of the following species: *Agrostis alba, Anthoxantum odoratum, Carduus crispus, Cerastium glomeratum*, etc. The total of 24 species of ground flora are registered by one record.

The results of the previous researches (Jovanovic et al., 1983) showed that in the shrub layer the following species were dominant: *Rhamnus frangula, Crataegus monogyna, Juniperus communis, Corylus avellana*. In the layer of the herbaceous species the following species are dominant: *Lysimachia nummularia, Oxalis acetosella, Fragaria vesca, Ranunculus repens, Ajuga reptans, Geum urbanum, Nardus stricta, Potentilla erecta*. The following species which are typical for the black alder forests with the higher degree of canopy closure are not reported: *Deschampsia caespitosa, Poa palustris, Myosotis palustris, Caltha palustris, Galium palustre*. The absence of these species can be explained by the fact that these flattened terrains on which the association appears were subject to the more intensive felling by the population from the neighbouring areas, since they were more accessible to the tree felling

and extraction, which led to the creation of greater forest gaps and occurrence of the meadow plants. The authors state that based on the characteristics of the association and soil it can be safely assumed that some other types of forests used to be present. The black alder invaded the sites of some other deciduous-conifer forests.

5. CONCLUSION

1. The highest percentage of the marsh black alder forests in Southwestern Serbia appears on the pseudogley, whereas only the smaller micro-depressions are found near the brooks, on the marsh-gley soil. The higher quantity of precipitation, which is typical for the humid areas, is in this place compensated by the long presence of the snow as well as by the small intensity of evaporation.
2. The black alder forest with the tufted hairgrass on the neogene sediments ass. *Deschampsio-Alnetum glutinosae montanum* Jov. et. Vuk. 1983 occurs along the crests and brooks, on the flat or gently-inclined terrains of the north and east exposures, at the altitudes from 1,000 to 1,500 meters (Jovanovic, B. et al., 1983).
3. The stands of the association *Geo-Alnetum glutinosae* occupy the greatest area of the site Stavljanska breza. The stands are located at the plateaus above the right bank of Vapa river. These terrains are gently sloped, with the gentle crests and curves, which have steep slopes only when they are in the vicinity of the little brooks. The forests of this association are located between the forest gaps and the areas which are turned into the meadows for the grazing. The black alder mainly appears in the smaller group and mounds.
4. The biological spectrum of the association *Geo-Alnetum glutinosae montanum* shows the high percentage of hemicryptophytes (71%) - the species which are well-adapted to the winter cold and which are in winter protected by the snow which is abundant in this area. There are significantly lower percentage of the other life forms.
5. The mesophilic plants account for 33%, the plants of the xerophilic character account for 8%, whereas the plants of the wide ecological altitudinal range (account for as much as 39%. The frigophilic plants account for 14%.

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THE ASSOCIATIONS OF MARSH BLACK ALDER FORESTS IN SOUTHWESTERN SERBIA – ASSOCIATION *ALNION GLUTINOSAE* (MALK. 29) MEIJER DREES 1936

Ljubinko RAKONJAC, Mihailo RATKNIĆ, Milorad VESELINOVIĆ, Aleksandar LUČIĆ, Vladan POPOVIĆ

Summary

The highest percentage of the marsh black alder forests in Southwestern Serbia is located on pseudogley, whereas only the smaller micro-depressions near the brooks are found on the marsh-gley soil. The higher quantity of precipitation, which is typical for the humid areas, is in this place compensated by the long presence of the snow, as well as by the small intensity of evaporation.

The black alder forest with the tufted hairgrass on the neogene sediments ass. Deschampsio-Alnetum glutinosae montanum Jov. et. Vuk. 1983 occurs along the crests and brooks, on the flat or gently-inclined terrains of the north and east exposures, at the altitudes from 1,000 to 1,500 meters (Jovanovic, B. et al., 1983).

The stands of the association Geo-Alnetum glutinosae occupy the greatest area of the site Stavljanska breza. The stands are located at the plateaus above the right bank

of Vapa river. These terrains are gently sloped, with the gentle crests and curves, which have steep slopes only when they are in the vicinity of the little brooks. The forests of this association are located between the forest gaps and the areas which are turned into the meadows for the purpose of grazing. The black alder mainly appears in the smaller group and mounds. The biological spectrum of the association *Geo-Alnetum glutinosae montanum* shows the high percentage of hemicryptophytes (71%) - the species which are well-adapted to the winter cold and which are in winter protected by the snow which is abundant in this area. There are significantly lower percentage of the other life forms.

The mesophilic plants account for 33%, the plants of the xerophilic character account for 8%, whereas the plants of the wide ecological altitudinal range (account for as much as 39%. The frigophilic plants account for 14%.

ZAJEDNICE MOČVARNIH ŠUMA CRNE JOVE U JUGOZAPADNOJ SRBIJI *ALNION GLUTINOSAE* (MALK. 29) MEIJER DREES 1936

Ljubinko RAKONJAC, Mihailo RATKNIĆ, Milorad VESELINOVIĆ, Aleksandar LUČIĆ, Vladan POPOVIĆ

Rezime

Najveći deo površina močvarnih šuma crne jove na području jugozapadne Srbije nalazi pod pseudoglejem, a samo manje mikrodepresije pored potoka pod močvarno-glejnim zemljištem. Veća količina padavina, koja je karakteristična za humidne oblasti, kompezira se ovde dugotrajnim zadržavanjem snežnog pokrivača i malim intenzitetom isparavanja.

Šuma crne jove sa visokim busom na neogenim sedimentima ass. Deschampsio-Alnetum glutinosae montanum Jov. et. Vuk. 1983 javlja se duž uvala i potoka na ravnom ili blago nagnutom terenu severnih i istočnih ekspozicija, na 1000̄1050 m nadmorske visine (Jovanović, B. et al., 1983).

Sastojine zajednice Geo-Alnetum glutinosae montanum imaju najveću površinu na lokalitetu Štavljanske breze. Sastojine se nalaze na uzvišenjima iznad desne obale reke Vape. To su zatalasani predeli sa blagim kosama i prevojima, koje samo u blizini malih potoka imaju nešto strmije strane. Šume ove zajednice nalaze se između progala i zalivađenih površina koje služe za ispašu. Crna jova se obično nalazi u manjim grupama i humkama. Biološki spektar asocijacije Geo-Alnetum glutinosae montanum pokazuje visoko prisustvo hemikriptofita (71%)¯ vrsta koje su dobro prilagođene zimskim hladnoćama i koje zimi štiti sneg koga na ovom području ima u izobilju. Svi ostali životni oblici su znatno manje zastupljeni.

Mezofilne biljke učestvuju sa 33%, a biljke kserofilnog karaktera zastupljene su sa 8%, dok su biljke široke ekološke amplitude zastupljene sa velikim udelom od 39%. Frigorifilne biljke zastupljene su sa 14%.

Phytocoenological table 1.

Association Geo-Alnetum glutinosae montanum Jov. Et Vuk. 1983

The ordinal number of the record	**1**	**2**	**3**	**Percentage**
The number of the record (field mark)	123	124	120	
Date of recording	27.7.97	25.7.97	25.7.97	
Site	Stavljanska breza			
Size p.p. (m^2)	700			
Altitude (m)	1070	1080	1085	
Exposure	West	J-JI		
Inclination (°)	8	10		
Parent rock	Grevel, sand, and clay			
Soil	pseudogley			
I LAYER				
Canopy	**0.4-0.5**	**0.5**	**0.5**	
Height –average (m)	**8**	**9**	**8**	
Diameter -average (cm)	**10-12**	**10-12**	**10**	
Distance (m)	**0.2-4**	**1-4**	**0.3-4**	
Alnus glutinosa	4.4	4.4	3.3	V
Alnus incana	+.1	+.1		IV
II LAYER				
Canopy	**0.1**	**0.1**	**0.2**	
Average height (m)	**1.5**	**1.5**	**2**	
Alnus glutinosa	1.1	+.1	1.1	V
Crataegus monogyna	1.1	+.1	2.2	V
Evonymus europaeus	+.1	+.1	+.1	V
Prunus spinosa	+.1	1.1	1.1	V
Frangula alnus	+.1	+.1		IV
Juniperus communis	+.1		+.1	IV
Rosa agrestis	+.1		1.1	IV
III LAYER				
Canopy	**0,7**	**0,7**	**0,6**	
Achillea millefolium	+.1	+.1	1.1	V
Ajuga reptans	1.2	1.1	+.1	V
Alchemilla vulgaris	1.1	+.1	+.1	V
Bellis perennis	+.1	1.1	+.1	V
Cirsium acaule	+.1	+.1	+.1	V
Cynosurus cristatus	1.1	+.1	1.1	V
Festuca heterophylla	+.1	1.1	1.1	V
Festuca ovina	+.1	+.1	1.1	V
Festuca vallesiaca	1.1	+.1	1.1	V
Fragaria vesca	1.2	1.1	+.1	V
Geum urbanum	+.1	+.1	+.1	V
Leontodon autumnalis	+.1	+.1	+.1	V
Molinia coerulea	2.3	1.2	1.1	V
Oxalis acetosella	1.2	1.1	+.1	V
Plantago altissima	+.1	+.1	+.1	V
Poa annua	1.2	1.2	1.1	V
Potentilla erecta	+.1	+.1	+.1	V
Potentilla reptans	+.1	+.1	+.1	V
Prunella vulgaris	1.1	+.1	+.1	V
Trifolium repens	1.1	1.1	1.1	V

The ordinal number of the record	1	2	3	Percentage
The number of the record (field mark)	123	124	120	
Date of recording	27.7.97	25.7.97	25.7.97	
Site	Stavljanska breza			
Size p.p. (m^2)	700			
Altitude (m)	1070	1080	1085	
Exposure	West	J-JI		
Inclination (°)	8	10		
Parent rock	Grevel, sand, and clay			
Soil	pseudogley			
Agrostis alba	1.1	1.1		IV
Anthoxantum odoratum	+.1	1.1		IV
Brachypodium silvaticum	1.1	+.1		IV
Carduus crispus	+.1	+.1		IV
Cerastium glomeratum	+.1		+.1	IV
Crepis paludosa	+.1	+.1		IV
Dactylis glomerata		+.1	+.1	IV
Deschampsia flexuosa	1.2	1.1		IV
Galium aparine	+.1	+.1		IV
Galium mollugo		+.1	+.1	IV
Geum montanum	+.1	+.1		IV
Hieracium transsilvanicum	1.1	1.1		IV
Leontodon crispus	+.1	+.1		IV
Leucanthemum vulgare	+.1	+.1		IV
Lysimachia nummularia	1.1	+.1		IV
Medicago sativa	+.1		+.1	IV
Minuartia glomerata	+.1	+.1		IV
Nardus stricta	+.1	+.1		IV
Ranunculus sardous	+.1	+.1		IV
Taraxacum officinale	1.1	+.1		IV
Thymus serpyllum		+.1	1.1	IV

The following species were registered by one phytocoenological record:
Alchemilla glabra +.1 (120), Anemone nemorosa +.1 (120), Angelica sylvestris +.1 (123), Campanula patula +.1 (123), Cirsium eriophorum +.1 (123), Galium rotundifolium +.1 (123), Hieracium levigatum +.1 (120), Lamium galeobdolon +.1 (123), Leontodon hispidus +.1 (120), Lolium perenne 1.1 (123), Luzula luzuloides +.1 (123), Melandrium rubrum +.1 (120), Mycelis muralis +.1 (123), Pedicularis baumgarteni +.1 (123), Peucedanum carvifolia +.1 (123), Plantago argentea +.1 (120), Plantago lanceolata +.1 (123), Plantago major +.1 (123), Prunella grandiflora 1.1 (123), Stachys officinalis +.1 (120), Trifolium diffusum 1.1 (123), Veronica acinifolia +.1 (120), Viola mirabilis +.1 (120) i Viola odorata +.1 (123).

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*18 : [630*176.1 Betula L.+630*176.1 Populus tremula L. (497.11-14)=111**
Original scientific paper

COMMON ASPEN AND BIRCH FORESTS IN PESTER PLATEAU

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Abstract: *The disappearance of the forests at the global level points to the seriousness of the problem and requires the urgent application of the measures aimed at ending of the degradation and devastation of the current forest ecosystems. The concept of the ecocentric (or biocentric) use of the resources implies that the ecosystem is the complexity of the living organisms and is valuable in itself because it treats in other way the needs of humans and their attitude towards nature. This paper is based on the Concept of the sustainable development and focused on the smaller territorial units (areas). The common aspen and birch forests in Pester plateau (Southwestern Serbia) were researched. These researches are aimed at the definition of the condition of the natural resources of forests and forest ecosystems and their use based on the principles of the sustainable development.*

Key words: common aspen and birch forests, G1.95, sustainable use, natural resources

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ŠUME JASIKE I BREZE NA PEŠTERSKOJ VISORAVNI

Abstract: *Nestajanje šuma u svetskim razmerama ukazuje na ozbiljnost problema i zahteva hitno preduzimanje mera na zaustavljanju degradacije i devastacije postojećih šumskih ekosistema. U konceptu ekocentičnog (ili biocentričnog) korišćenja resursa ekosistem predstavlja kompleksnost živih organizama i ima svoju vrednost sam po sebi zato što razmatra na drugi način potrebe ljudi i njihov odnos prema prirodi. Rad bazira na Konceptu održivog razvoja i usredsređen je na manje teritorijalne celine (područja). Istraživanje je obavljeno u šumi jasike i breze na Pešterskoj visoravni (jugozapadna Srbija). Cilj ovih istraživanja je da se definiše stanje prirodnih resursa šuma i šumskih ekosistema i njihovo korišćenje na principima održivog razvoja.*

Ključne reči: šume jasike i breze, G1.95, održivo korišćenje, prirodni resursi

1. INTRODUCTION

The disappearance of the forests at the global level points to the seriousness of the problem and requires the urgent application of the measures aimed at the stopping of the degradation and devastation of the current forest ecosystems. The concept of the ecocentric (or biocentric) use of the resources implies that the ecosystem is the complexity of the living organisms and is valuable in itself because it treats in other way the needs of humans and their attitude towards nature. The way in which nature creates and maintains the ecosystems is respected. The ecosystems protects, maintains and regenerates the functions of the natural ecosystems which also implies the use of all goods and services for the satisfaction of the human needs on the stable permanent bases. The ecological processes in the ecosystems are favoured, since they satisfy the economic needs of the society, which does not include the industrial use. The integral part is the care for the soil, water, biodiversity and biomass. The achievement of these goals is based on the ecological, socio-demographic and economic criteria. This paper is based on the Concept of the sustainable development and focused on the smaller territorial units (areas).

2. MATERIAL AND METHOD

The common aspen and birch forests in Pester plateau (Southwestern Serbia) were researched. The pedological characteristics were researched based on the pedological profiles, and the soil types were determined based on the soil classification (Skoric, Filipovski, Ciric, 1985), as well based on the EUNIS classification. For the determination of the species the following sources

were used: “Flora of Federal Republic of Serbia“ (1970-1986), “Ikonographie der flora des südöstlichen Mitteleuropa” (Jávorka, S., Csapody, V., 1979), “Ikonographie der flora des südöstlichen Mitteleuropa” (Jávorka, S., Csapody, V., 1979), “Flora and vegetation of Mt. Golija and Mt. Javor“ (Gajic, M., 1990) and “Flora of the National Park Tara“.

The spectra of the floral elements were processed in accord with the systematization of the floral-geographical elements by Gajic (Gajic, 1980, 1984). The biological spectra of the plants were processed by Kojic et al. method (Kojic, M. et al., 1997). The basic types of the life forms were classified by Raunkiaer’s method (Raunkiaer, 1934). The area covered by forests and forest stands, the classification of the areas per types of the stands, the wood volume and volume increment were analyzed. The percentage of the trees with a diameter up to 30 cm in the total volume was particularly analyzed.

3. THE RESEARCH RESULTS

By EUNIS classification birch forests belong to:

G1 – BROADLEAF DECIDUOUS FORESTS

G1.9 – Forests with birches <*Betula*>, common aspen <*Populus tremula*>, Europen rowen <*Sorbus aucuparia*> or common hazel <*Corylus avellana*> which do not occur on marshy terrains

G1.95 – Common aspen forests <*Populus tremula*> and birch forests <*Betula*> with elders <*Sambucus*>

The equivalent association: ***Populeto-****Betuletum* Glisic (1950), 1975

The association of common aspen and birch is widely spread on the silicate acid parent rocks, on the poor skeletal soils. It occurs in the altitudinal range of beech, logging units, forest gaps and burnt areas. It is scattered throughout Pester Plateau and occurs without the greater joint complexes. In Lisa and Planina it appears as the form of the development of the forest vegetation on the sites of the previously cleared beech forests. The zone of the smaller stands was reported in Sugubine and Fijuljame, in Divlja Rijeka, where it is spread on the sites of the former pastures. From Lopiz to Uvac and Gonj Village, it appears in the smaller groups, alternating with the areas covered by pure birch, on the sites in the vicinity to brooks and small rivers, with sufficient humidity in summer months as well. From Grac to Zabren, on the barren limestone terrains, this association was not reported. It appears in the direction

to Bare, in the stands which are more subject to felling, where it creates high stands with the closed canopy. The stands of this association are best expressed in the beech-fir forest in the vicinity of Jasikovac to Bare with the greater canopy gaps. In addition, it appears in the forest preserves in Tomov Gaj and the parts of Stavalj in the direction to Stavljanske Breze. It appears on the deeper soils in Budjevo, but also on the shallower soils of Zminjaca.

These forests often forms the mosaic pattern with the common hazel, but they avoid the steep slopes on the shallower soils. On the deeper soils they also occur on the highly-inclined slopes. In Uvac valley it condescends to the river bank where it was reported on the deeper pseudogley. On the higher positions with the greater inclinations above Vapa (in Tomov Gaj) it occurs in the form of the high stands with closed canopy in the groups of common hazelnut trees in the underwood layer. It mainly occupies the colder positions, such as in Sugubine, on the acid soils of the sands. It appears more frequently in the sheltered places and river valleys, with the sufficient humidity, which are not subject to strong winds and which are characterized by more favourable air circulations, in comparison to the open and warmer exposures with the lack of humidity. The common aspen and birch forests most frequently occur on the neogene sediments, gravels, sand, and clay sandstones. This association mainly appears on the distric cambisols, but it also occurs on pseudogleys on the terrains in the vicinity of brooks and little rivers, up to the colluvium at the higher altitudes in Mt. Javor. It is located at the altitudes from 1,000 to 1,400 metres on the colder exposures (northen, northeastern), but sometimes it also occurs on the warmer, southern exposures, in the vicinity of brooks on the deeper soils, from terrains with the small inclination angle (in Tomov Gaj) to the highly-inclined terrains (40^0) on the warmer slopes of Ogorijevac. The district cambisols are up to 70 cm deep, whereas the pseudogleys are up to 90 cm deep. In regard to the mechanical characteristics, these soils are sandy loam, loam, and the pseudogleys in the lower horizons of the clays.

The total of 139 plant species were reported: 13 tree species, 10 shrub species, and 116 species which appear in the layer of the ground flora.

Floristical composition of common aspen and birch forests

Acer pseudoplatanus L., *Aegopodium podagraria* L., *Ajuga reptans* L., *Alchemila vulgaris* L., *Anthemis arvensis* L., *Aremonia agrimonoides* (L.) DC, *Asarum europaeum* L., *Astrantia major* L., *Betula pendula* Roth., *Brachypodium silvaticum* (Huds.) P.B., *Bromusarvensis* L., *Calamagrostis arundinacea* (L.) Roth., *Campanula patula* L., *Campanula persicifolia* L., *Carex silvatica* Huds., *Centaruea jacea* L., *Centaurea montana* L., *Cephalanthera alba* (Cr.) Simk., *Cephalanthera rubra* (L.) Schr., *Chaerophyllum aureum* L.

Clematis alpina (L.) Mill., *Corylus avelanna* L., *Crataegus monogyna* Jacq., *Crepis biennis* L., *Crepis mollis* (Jacq.) Asch., *Dactylis glomerata* L., *Dactylorhiza incarnata* (.) Soo, *Dactylorhiza sambucina* (L.) Soo, *Danaa cornubiensis* (Torn.) Burn., *Danthonia provincialis* Lam.et DC, *Daphne blagayana* Fray., *Daphne laureola* L., *Daphne mezereum* L., *Deschampsia flexuosa* (L.) Tr., *Digitalis ambigua* Murr., *Digitalis viridiflora*, *Doronicum columnae* Ten., *Dryopteris filix-mas* (L.) Schot., *Epipactis latifolia* (L.) All., *Eryngium palmatum* Vis.et. Panč., *Euphorbia amygdaloides* L., *Evonymus verrucosus* Scop., *Fagus silvatica* L., *Festuca amethystina* L., *Festuca heterophylla* Lam., *Festuca valesiaca* Schl., *Filipendula ulmaria* (L.) Max., *Fragaria vesca* L., *Frangula alnus* Mill., *Galium cruciata* (L.) Scop., *Galium purpureum*, *Galium silvaticum* L., *Galium vernum* Scop., *Galium verum* L., *Gentiana asclepiadea* L., *Geranium phaeum* L., *Geranium robertianum* L., *Geum rivale* L., *Geum urbanum* L., *Glechoma hirsuta* W.etK., *Helminthia echioides* (L.) Gartn., *Hieracium bauhini* Schult., *Hypericum maculatum* Cr., *Hypericum perforatum* L., *Juniperus communis* L., *Knautia arvensis* (L.) Coult., *Laser trilobium* (L.) Borkh., *Leontodon crispus* Vill., *Leontodon hispidus* L., *Lilium martagon* L., *Lonicera caprifolium* L., *Lotus corniculatus* L., *Lunaria rediviva* L., *Luzula campestris* (L.) Lam.et DC, *Luzula luzulina* (Vill.) Tore et Sar., *Luzula luzuloides* (Lam.) Dan., *Lysimachia nummularia* L., *Maianthemum bifolium* (L.) Schm., *Medicago orbicularis* (L.) All., *Melampyrum pratense* L., *Melissa officinalis* L., *Melittis melissophyllum* L., *Mercurialis perennis* L., *Paris quadrifolia* L., *Peucedanum alsaticum* L., *Peucedanum carvifolia* Vill., *Phyteuma spicatum* L., *Pirus piraster* Burg., *Plantago media* L., *Poa trivialis* L., *Polygala major* Jacq., *Polygonatum verticillatum* (L.) All., *Polypodium vulgare* L., *Populus tremula* L., *Potentila erecta* (L.) Raucsh., *Potentilla heptaphylla* Jusl., *Potentilla inclinata* Vill., *Potentilla recta* L., *Primula veris* Huds., *Prunela vulgaris* L., *Prunus avium*, *Pteridium aquilinum* (L.) Kuhn., *Quercus petraea* (Matt.) Lieb.,*Rhamnus falax* Boiss., *Ribes alpinum* L., *Rosa micrantha* Borr., *Rosa pendulina* L., *Rumex acetosa* L., *Salix capreae* L., *Sanicula europaea* L., *Selinum carvifolia* L., *Serratula tinctoria* L., *Seseli annum* L., *Silene nutans* L., *Silene roemeri* Friv., *Silene viridiflora* L., *Solidago virga-aurea* L., *Sorbus aucuparia* L., *Stachys alpina* L., *Stachys officinalis* (L.) Trev., *Stachys silvatica* L., *Stellaria holostea* L., *Thalictrum aquilegifolium* L., *Thymus jankae* Čel., *Tilia cordata* Mill., *Trifolium hybridum* L., *Trifolium montanum* L., *Trifolium pratense* L., *Vaccinium myrtillis* L., *Veratrum album* L., *Veronica chamaedrys* L., *Veronica officinalis* L., *Veronica urticifolia* Jacq., *Vicia cassubica* L., *Vicia grandiflora* Scop., *Viola alba* Bess., *Viola odorata* L., *Viola silvestris* Lam., *Waldstenia geoides* Willd.

The high percentage of hemicryptophytes is reported (56.12%), which is the result of the aggravated life conditions for the plants of the altitudinal

zone in which this association appears. The relatively sufficient percentage of geophytes (15.83%) points to the favourable edaphic conditions (humidity, structure, and soil depth). There is a significant percentage of the phanerophytes and nanophanerophytes (16.54%). Chamaephytes account for 5.04%, terophytes for 2.88%, and terophytes/chamaephytes for 3.60%. In regard to the biological spectrum this association can be defined as the hemicryptophyte-phanero-phyte.

The Mid-European floral elements, which in combination with the Eur-Asian account for the great part of the spectrum (60.71%), are most common. The real Sub-Mediterranean floral elemens account for 5.71%.The floral elements of the northern regions (5.00%) circumpolar and cosmopolites (7.86%), account for 12.86%, which is significant and points to the colder conditions in which this association occurs. The Pontic-Central-Asian floral elements account for 9.29%, and Sub-Atlantic for 4.29% (Table 1).

Table 1. *Spectrum of the floral elements in common aspen and birch forests*

The name of the group of the floral element	Floral element	Percentage %	
1 FLORAL ELEMENTS OF THE NORTHEN REGIONS			
Arctic floral elements			
Boreal floral elements	Sub-boreal	0.71	
	Sub-boreal-European –West Siberians	0.71	
	Sub-boreal-circumpolar	2.86	
	Boreal-Eur-Asian	0.71	4.99
2 MID-EUROPEAN FLORAL ELEMENTS			
Mid-European	Mid-European	12.86	
and European	Sub-Mid-European	21.43	
	Alpine- Carpathian	0.71	
	Sub-Mid-European-Sub-Mediterranean	0.71	35.71
3 SUB-ATLANTIC FLORAL ELEMENTS			
Sub-Atlantic and Atlantic	Sub-Atlantic-Sub-Mediterranean	3.57	
4 SUB-MEDITERRANEAN FLORAL ELEMENTS			
Sub-Mediterranean	Sub-Mediterranean	5.71	
East-Sub-Mediterranean	East-Sub-Mediterranean	1.43	
	Sub-Euxian	0.71	
Balkan and	Sub-Illyrian	0.71	
Balkan-Apenninian	Moeasian-Dacian	0.71	
	Moeasian-Sub-Dacian	0.71	
	Illyrian – Scardo-Pindic	0.71	
	Mid-Balkan-Central-South Apenninian	0.71	
	Balkan	0.71	
	Sub-Balkan-Apenninian	0.71	12.82
5 PONTIC-CENTRAL ASIAN FLORAL ELEMENTS			
	Pontic-Central Asian	0.71	
	Sub-Pontic-Central Asian	2.86	
Pontic	Sub-Pontic	2.86	
	Pontic-Sub-Mediterranean	0.71	
	Pontic-East-Sub-Mediterranean	2.14	9.28
6 EUR-ASIAN FLORAL ELEMENTS			
	Sub-South Siberian	2.86	
	Eur-Asian	12.86	

The name of the group of the floral element	Floral element	Percentage %	
	Eur-Asian-African	0.71	
	Sub-Eur-Asian	9.29	25.72
7 CIRCUMPOLAR AND COSMOPOLITAN FLORAL ELEMENTS			
	Circumpolar	3.57	
	Sub-circumpolar	2.14	
	Cospomolites	2.14	7.85

This is a bi-dominant association; in all layers of trees and shrubs the common aspen and birch are dominant. The degree of the crown covered area ranges from 0.4 to 0.8. The tree height depends on the degree of the stand preservation and ranges from 7.5 to 25.0 m. The average diameter of the trees of the first layer ranges from 15 cm on the slopes of Uvac and Sugubine to 30 cm in the stands in T. Gaj and Sugubine. The stands which are least preserved appear in the vicinity of the rural meadows and pastures, since they were damaged by the neighbouring rural population. Along with the common aspen and birch, the following species occur in the tree layer: *Pyrus pyraster, Fagus moesiaca, Acer pseudoplatanus, Quercus petraea, Tilia cordata*. In the shrub layer the common hazel is dominant. Along with it, the following species appear: *Crataegus monogyna, Prunus avium, Rosa pendulina, Evonymus verrucosus, Juniperus communis, Lonicera caprifolium*. There are also the invidual trees of the following species: *Acer pseudoplatanus, Frangula alnus, Ribes alpinum, Rosa micrantha, Salix capraea, Rhamnus falax*. The layer of the ground flora is not abundant. The ground flora coverage ranges from 0.30 to 0.35.

Ecological indexes of the common aspen and birch forests

There are the following values of the ecological indexes of the common aspen and birch forests:

- For the humidity the average value is 2.77 (from 2.74 to 2.86);
- For the chemical reaction of soil the average value is 3.08 (from 2.67 to 3.34)
- For the nutrients the average value is 2.58 (from 2.35 to 2.76)
- For the light the average value is 3.14 (from 3.00 to 3.29)
- For the temperature the average value is 3.14 (from 2.97 to 3.31)

Medicinal plants in common aspen and birch forests

The total of 54 species of medicinal plants was reported in the common aspen and birch forests, i.e. 41.0% of the total number of species (Table 2).

In the first category 12 plant species were reported, i.e. 8.6%. *Quercus petraea* is put in circulation, and there are no limits to the collection of it. There are legal limits for the quantity of the other species which can be collected over a year. The species *Veratrum album* is incorporated in the Red Book and the collection of it is prohibited.

In the second category 3 plant species, or 2.1% were reported. All reported species are in circulation, whereas the control and circulation of *Solidago virga-aurea* is controlled.

Fourteen species, or 10.1% belong to the third category. The species *Ajuga reptans, Glechoma hirsuta, Melittis melissophyllum i Populus tremula* have not been put in circulation. The species *Daphne mezereum, Fagus silvatica, Polypodium vulgare* are in circulation. The collection and circulation of the following species from this category of healing rate are controlled: *Gentiana asclepiadea, Geranium robertianum, Potentila erecta i Asarum europaeum*, which is characterized by the ocassional and uneven collection. *Daphne blagayana* is on the Red List and the collection of it is strictly limited.

In the fourth category of the healing rate 11 plant species, or 7.9%. were reported. There are no legal limits in regard to the quantity of the species *Acer pseudoplatanus, Plantago media and Sorbus aucuparia* which can be collected on the natural sites. The collection and circulation of the species *Corylus avelanna, Digitalis ambigua, Fragaria vesca, Galium verum and Veronica chamaedrys* are controlled. The species *Euphorbia amygdaloides, Prunus avium i Stachys officinalis* have the important role in the traditional folk medicine.

In the fifth category 17 species or 12.2% were determined. There are no limits in regard to the circulation of the species *Filipendula ulmaria and Potentilla recta,* the collection and circulation of *Alhemila vulgaris* are controlled, whereas the other species did not have an important role in the economy, except for the use in the folk medicine.

Table 2. *Medicinal plants in common aspen and birch forests*

Species	Category of healing rate	Status	
Betula pendula Roth.	I	Order	In circulation
Crataegus monogyna Jacq.	I	Order	In circulation
Dryopteris filix-mas (L.) Schot.	I	Order	In circulation
Hypericum perforatum L.	I	Order	In circulation
Juniperus communis L.	I	Order	In circulation
Melissa officinalis L.	I	Order	In circulation
Primula veris Huds.	I	Order	In circulation
Quercus petraea (Matt.) Lieb.	I		In circulation
Sanicula europaea L.	I	Order	In circulation
Tilia cordata Mill.	I	Order	In circulation

Species	Category of healing rate	Status	
Vaccinium myrtillis L.	I	Order	In circulation
Veratrum album L.	I	Red Book, decree, order, IUCN extremely endangered and vulnerable	Prohibited
Rumex acetosa L.	II		In circulation
Solidago virga-aurea L.	II	Order	In circulation
Veronica officinalis L.	II		In circulation
Ajuga reptans L.	III		
Asarum europaeum L.	III	Order, occasional and uneven collection	In circulation
Daphne blagayana Fray.	III	CL, the collection is strictly limited	In circulation
Daphne mezereum L.	III		In circulation
Fagus silvatica L.	III		In circulation
Gentiana asclepiadea L.	III	Order	In circulation
Geranium robertianum L.	III	Order	In circulation
Geum urbanum L.	III	Order	In circulation
Glechoma hirsuta W.etK.	III		
Melittis melissophyllum L.	III		
Polypodium vulgare L.	III		In circulation
Populus tremula L.	III		
Potentila erecta (L.) Raucsh.	III	Order	In circulation
Viola odorata L.	III		
Acer pseudoplatanus L.	IV		In circulation
Corylus avelanna L.	IV	Order	In circulation
Digitalis ambigua Murr.	IV	Order	In circulation
Euphorbia amygdaloides L.	IV		
Fragaria vesca L.	IV	Order	In circulation
Galium verum L.	IV	Order	In circulation
Plantago media L.	IV		In circulation
Prunus avium	IV		
Sorbus aucuparia L.	IV		In circulation
Stachys officinalis (L.) Trev.	IV		
Veronica chamaedrys L.	IV	Order	In circulation
Aegopodium podagraria L	V		
Alchemila vulgaris L.	V	Order, rare collection	In circulation
Centaruea jacea L.	V		
Daphne laureola L.	V		
Doronicum columnae Ten.	V		
Filipendula ulmaria (L.) Max.	V		In circulation
Frangula alnus Mill.	V		
Galium vernum Scop.	V		
Lilium martagon L.	V		

Species	Category of healing rate	Status	
Lonicera caprifolium L.	V		
Lotus corniculatus L.	V		
Lysimachia nummularia L.	V		
Paris quadrifolia L.	V		
Peucedanum carvifolia Vill.	V		
Potentilla recta L.	V		U prometu
Prunela vulgaris L.	V		
Pteridium aquilinum (L.) Kuhn.	V		
Salix capreae L.	V		
Thalictrum aquilegifolium L.	V		
Trifolium pratense L.	V		

Fruit trees in common aspen and birch forests

Common aspen and birch forests are relatively rich in fruit trees. The presence of the following species were reported: *Pirus piraster, Corylus avellana, Crataegus monogyna, Juniperus communis, Vaccinium myrtillis, Sorbus aucuparia, Frangula alnus, Lonicera caprifolium, Rhamnus falax, Ribes alpinum and Fragaria vesca.*

Honey plants in common aspen and birch forests

In common aspen and birch forests 53 honey plants were reported, out of which 8 woody, 12 shrub, and 33 herbaceous species. The average honey yield of the association is 2.96 (Table3).

Table 3. *Honey plants in common aspen and birch forests*

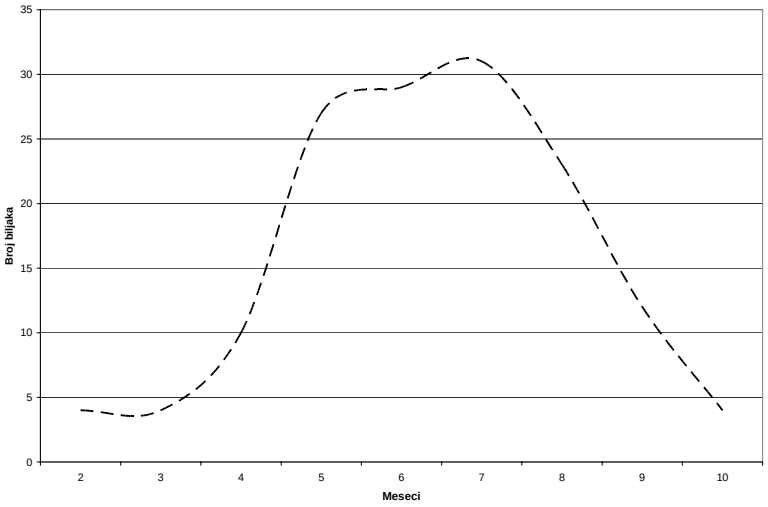
	Species	Months								
		2	3	4	5	6	7	8	9	10
Trees										
Tilia cordata Mill.	D4					1	1			
Prunus avium	D4					1	1	1	1	
Quercus petraea (Matt.) Lieb.	D3				1					
Populus tremula L.	D3	1	1							
Sorbus aucuparia L.	D2				1					
Betula pendula Roth.	D2			1	1					
Fagus silvatica L.	D2				1					
Acer pseudoplatanus L.	D2			1	1					
Shrubs										
Corylus avelanna L.	Ž4	1								

	Species	Months								
		2	3	4	5	6	7	8	9	10
Salix capreae L.	Ž4		1	1						
Rosa pendulina L.	Ž4				1	1				
Crataegus monogyna Jacq.	Ž3				1	1				
Frangula alnus Mill.	Ž3				1	1	1	1		
Ribes alpinum L.	Ž3			1	1	1				
Evonymus verrucosus Scop.	Ž3			1	1					
Vaccinium myrtillis L.	Ž2				1	1				
Daphne blagayana Fray.	Ž2					1	1			
Daphne mezereum L.	Ž2	1	1	1						
Daphne laureola L.	Ž2	1	1	1						
Clematis alpina (L.) Mill.	Ž2						1	1		
Herbaceous plants										
Stachys officinalis (L.) Trev.	Z4						1	1		
Veronica chamaedrys L.	Z4			1	1	1				
Centaruea jacea L.	Z4					1	1	1	1	1
Filipendula ulmaria (L.) Max.	Z4					1	1	1		
Thalictrum aquilegifolium L.	Z4				1	1	1			
Campanula persicifolia L.	Z4					1	1			
Centaurea montana L.	Z4							1	1	1
Stachys alpina L.	Z4						1	1	1	
Stachys silvatica L.	Z4					1	1	1	1	
Trifolium hybridum L.	Z4				1	1				
Trifolium montanum L.	Z4				1	1	1	1		
Veratrum album L.	Z3						1	1		
Solidago virga-aurea L.	Z3						1	1	1	
Ajuga reptans L.	Z3				1	1	1			
Gentiana asclepiadea L.	Z3						1	1	1	1
Digitalis ambigua Murr.	Z3					1	1	1	1	
Lysimachia nummularia L.	Z3				1	1	1			
Potentilla recta L.	Z3				1	1	1			
Prunela vulgaris L.	Z3						1	1		
Astrantia major L.	Z3				1	1	1	1		
Geum rivale L.	Z3			1	1					
Phyteuma spicatum L.	Z3					1	1			
Polygala major Jacq.	Z3						1	1		
Vicia grandiflora Scop.	Z3				1	1				
Fragaria vesca L.	Z2				1	1				
Hypericum perforatum L.	Z2						1	1	1	
Melissa officinalis L.	Z2					1	1	1		

	Species	Months								
		2	3	4	5	6	7	8	9	10
Primula veris Huds.	Z2			1	1					
Plantago media L.	Z2				1	1	1	1	1	
Aegopodium podagraria L	Z2				1	1	1			
Lilium martagon L.	Z2						1	1		
Lotus corniculatus L.	Z2				1	1	1	1	1	1
Knautia arvensis (L.) Coult.	Z2				1	1	1	1	1	

The highest percentage of the honey plants in blossom was reported in July, but the percentage of it in May, June, July, and August, is the precondition for the long-lasting bee pasture (Graph 1).

Graph 1. *The number of honey plants in common aspen and birch forests which blossom over a year*



Wood resources of common aspen and birch forests

Common aspen and birch forests occupy an area of 251,22 hectares. Tall forests account for 11.8%, whereas the coppice stands occupy the remaining area. The devastated coppice stands of common aspen and birch account for 6.6%. The total volume is 3,704 m^3, and the volume of tall forests is 1060 m^3, i.e. it accounts for 3.1% of the total volume. The trees with the diameter up to 30 cm account for 77.5% (Table 4.).

Table 4. *Wood resources of common aspen and birch forests*

Area (ha)	Total volume (m^3)	Volume by diameter degrees										Volume increment (m^3)
		< 10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	>90	
Tall devasted common aspen and birch forests												
29.56	1060	1060										24.2
Coppice forest of common aspen and birch												
205.05	32225	1840	13006	9827	5202	1971	381					877.3
Devasted coppice forest of common aspen and birch												
16.61	419	419										4.0

4. DISCUSSION

Given the fact that by the multi-century destruction of the plant resources in Pester Plateau their condition has been endangered, it directly refers to the socio-demographic status of the population. These researches are aimed at the definition of the condition of the natural resources, determination of the priorities of the activities for the elimination of the unfavourable conditions, which should be followed by the determination of the measures for the improvement of their condition. By the achievement of the aims of the research of the sustainable use of the plant resources of Pester Plateau the bases for the following projects are set: Implementation of the European standards and models and for the creation of the methods of the registration of the plant resources; Creation of the strategical frame for the sustainable management by the renewable resources based on the principles of the sustainable development and previous degree of the study of the current natural resources; Preservation and increase of the ecological, biological, climate, socio-cultural and economical contributions to the use of the plant resources; Environmental protection, social and spiritual function and value of natural ecosystems, which are achieved by: establishment, extension, and suitable management by the protected areas and associations, preservation of forests in the representative ecological systems and regions, preservation and management of the game, gene pool preservation, methods of support and maintance of the sustainable use of the biological resources and preservation of biodiversity; Support and improvement of the national programs of reforestation and reclamation of the degraded sites, establishment of the new and improvement of the current forests of different purposes, in order to reduce the pressure on the current forest ecosystems; To base the concept of the planning of the permanent management by the renewable resources on the criterium – the presevation of the environmental quality, which means that the economic use of the renewable plant resources must not mitigate the numerous ecological functions, and the preservation and enrichment of the site biodiversity; To create the conditions for

the establishment of the elements of the sustainable agricultural production; To preserve and improve the biodiversity.

5. CONCLUSIONS

- Common aspen and birch forests occur as the stage of the progression sucession, on the former pastures and meadow when the zoo-anthoropogenic influences are no longer present.
- By EUNIS classification, these associations belong to broadleaf decidious forests (G1.95 – Common aspen forest <*Populus tremula*> and birch <*Betula*> with elders <*Sambucus*>).
- The most frequent soils are district cambisols, whereas colluviums and pseudogley are less frequent.
- The total of 139 plant species were reported: 13 tree species, 10 shrub species and 116 species which occur in the ground flora layer.
- The average value of the ecological indexes for humidity is 2.77, for chemical reaction of soil 3.08, for nutrients 2.58, for light 3.14, and for the temperature 3.14.
- Fifty-four species of the registered plant species are medicinal plants, i.e. 41.0%, out of which 12 species belong to the first class, 3 species to the second class, 14 species to the third class, 11 to the fourth class, and 17 species to the fifth class of the healing rate.
- Common aspen and birch forests are relatively rich in fruit trees. The presence of the following species were reported: *Pirus piraster, Corylus avellana, Crataegus monogyna, Juniperus communis, Vaccinium myrtillis, Sorbus aucuparia, Frangula alnus, Lonicera caprifolium, Rhamnus falax, Ribes alpinum and Fragaria vesca.*
- In common aspen and birch forests 53 honey plants were reported, out of which 8 woody, 12 shrub, and 33 herbaceous species. The average honey yield of the association is 2.96. The highest percentage of the honey plants in blossom was reported in July, but the percentage of it in May, June, July, and August, is the precondition for the long-lasting bee pasture.
- Common aspen and birch forests occupy an area of 251,22 hectares. Tall forests account for 11.8%, whereas the coppice stands occupy the remaining area. The devastated coppice stands of common aspen and birch account for 6.6%. The total volume is 3,704 m^3, and the volume of tall forests is 1,060 m^3, i.e. it accounts for 3.1% of the total volume. The trees with the diameter up to 30 cm account for 77.5%

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COMMON ASPEN AND BIRCH FORESTS IN PESTER PLATEAU

Mihailo RATKNIĆ, Ljubinko RAKONJAC, Milorad VESELINOVIĆ, Sonja BRAUNOVIĆ, Svetlana BILIBAJKIĆ, Vladan POPOVIĆ

Summary

Common aspen and birch forests occur as the stage of the progression sucession, on the former pastures and meadow when the zoo-anthoropogenic influences are no longer present. By EUNIS classification, these associations belong to broadleaf decidious forests (G1.95 – Common aspen forest <Populus tremula> and birch <Betula> with elders <Sambucus>). The most frequent soils are district cambisols, whereas colluviums and pseudogley are less frequent.The total of 139 plant species were reported: 13 tree species, 10 shrub species and 116 species which occur in the ground flora layer.The average value of the ecological indexes for humidity is 2.77, for chemical reaction of soil 3.08, for nutrients 2.58, for light 3.14, and for the temperature 3.14. Fifty-four species of the registered plant species are medicinal plants, i.e. 41.0%, out of which 12 species belong to the first class, 3 species to the second class, 14 species to the third class, 11 to the fourth class, and 17 species to the fifth class of the healing rate. Common aspen and birch forests are relatively rich in fruit trees. The presence of the following species were reported: *Pirus piraster, Corylus avellana, Crataegus monogyna, Juniperus communis, Vaccinium myrtillis, Sorbus aucuparia, Frangula alnus, Lonicera caprifolium, Rhamnus falax, Ribes alpinum and Fragaria vesca.* In common aspen and birch forests 53 honey plants were reported, out of which 8 woody, 12 shrub, and 33 herbaceous species. The average honey yield of the association is 2.96. The highest percentage of the honey plants in blossom was reported in July, but the percentage of it in May, June, July, and August, is the precondition for the long-lasting bee pasture. Common aspen and birch forests occupy an area of 251,22 hectares. Tall forests account for 11.8%, whereas the coppice stands occupy the remaining area. The devastated coppice stands of common aspen and birch account for 6.6%. The total volume is 3,3704 m^3, and the volume of tall forests is 1060 m^3, i.e. it accounts for 3.1% of the total volume. The trees with the diameter up to 30 cm account for 77.5%

ŠUME JASIKE I BREZE NA PEŠTERSKOJ VISORAVNI

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Rezime

Šume jasike i breze javlja se kao stadijum progresivne sukcesije, na nekadašnjim pašnjacima i livadama posle prestanka zooantropogenih uticaja. Po EUNIS klasifikaciji pripadaju širokolisnim listopadnim šumama (G1.95 - Šuma trepetljike <Populus tremula> i breze <Betula> sa zovama <Sambucus>). Zemljišta su distrični

kambisoli, ređe pseudoglejevi i koluvijumi. Konstatovano je 139 biljaka, od čega 13 vrsta drveća, 10 vrsta žbunova i 116 vrsta prizemne flore. Ekološki indesi za vlažnost imaju prosečnu vrednost 2.77, za hemijsku reakciju zemljišta 3.08, za hranljive materije 2.58, za svetlost 3.14 i za temperaturu 3.14. Od ukupno registrovanih biljaka 54 je lekovito, odnosno 41.0% i to: 12 pripadaju prvoj, 3 drugoj, 14 trećoj, 11 četvrtoj i 17 vrsta petoj kategoriji lekovitosti. Šume jasike i breze relativno su bogate voćkaricama. Konstatovano je prisustvo sledećih vrsta: *Pirus piraster, Corylus avellana, Crataegus monogyna, Juniperus communis, Vaccinium myrtillis, Sorbus aucuparia, Frangula alnus, Lonicera caprifolium, Rhamnus falax, Ribes alpinum i Fragaria vesca.* U šumama jasike i breze konstatovano je 53 medonosnih vrsta, od čega 8 drvenastih, 12 žbunastih i 33 zeljastih. Srednja mednost zajednice iznosi 2.96. Broj medonosnih biljaka u cvetu je najbrojniji tokom jula, ali njihova zastupljenost tokom maja, juna, jula i avgusta obezbeđuje dugotrajnu pčelinju pašu. Šuma jasike i breze konstatovana je na 251.22 hektara. Na ovoj površini visokih šuma ima 11.8%, dok su ostale izdanačke sastojine. Devastirane izdanačke sastojine jasike i breze učestvuju sa 6.6%. Ukupna zapremina je 33704 m^3 od čega je, u visokim šumama 1060 m^3, odnosno 3.1%. Stabla sa prečnicima tanjim od 30 cm učestvuju sa 77.5%

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*561.2 : 630*174.7 Pinus nigra Arn.=111**
Original scientific paper

DIAMETER INCREMENT TREND OF THE AUSTRIAN PINE PLANTATIONS IN RAŠKA

Miloš KOPRIVICA[1], Bratislav MATOVIĆ[1], Snežana STAJIĆ[1], Vlado ČOKEŠA[1]

Abstract: *This paper presents the results of the research of the multi-annual trend of the diameter increment of the trees of the middle-aged Austrian pine plantations. The age of the plantations ranges from 35 to 55 years, and the site classes from I-V. The impact of the climate factors and thinning on the trend of the diameter increment for the period 1988-2009 was analyzed. The statistically significant dependence of the diameter increment on the quantity of precipitation was determined, whereas the dependence on the air temperature and thinning is random. The quantity of precipitation over the vegetation season is directly reflected in the diameter increment, whereas the air temperatures and thinning are reflected indirectly. The thinning partially alleviates the adverse effects of the extremely low precipitation and high air temperatures on the diameter increment of the dominant trees. These relations are most clearly expressed in the analysis of the diameter increment of the dominant trees.*

Key words: plantations, Austrian pine, diameter increment, precipitation temperature, thinning.

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The research was partly financed by the Ministry of Science of the Republic of Serbia, within the Project "Changes in the Forest Ecosystems As a Result of the Global Warming" (TR-20052).
Translation: Marija Stojanović

TREND DEBLJINSKOG PRIRASTA CRNOG BORA U KULTURAMA NA PODRUČJU RAŠKE

Izvod: *U radu su izneti rezultati istraživanja višegodišnjeg trenda debljinskog prirasta stabala srednjedobnih kultura crnog bora. Starost kultura je 35-55 godina, a bonitet staništa I-V. Analiziran je uticaj klimatskih faktora i proreda na veličinu i tok debljinskog prirasta. Obuhvaćen je vremenski period od 1988. do 2009. godine. Utvrđeno je da postoji statistički značajna zavisnost debljinskog prirasta stabala od količine padavina, dok je zavisnost od temperature vazduha i izvedenih proreda slučajna. Količina padavina u vegetacionom periodu odražava se direktno na veličinu debljinskog prirasta, a temperatura vazduha i prorede indirektno. Prorede u izvesnoj meri ublažavaju negativne efekte ekstremno niskih padavina i visokih temperatura vazduha na debljinski prirast. Ovi odnosi su najjasnije izraženi u analizi debljinskog prirasta dominantnih stabala.*

Ključne reči: kulture, crni bor, debljinski prirast, padavine, temperatura, prorede.

1. INTRODUCTION

The coniferous plantations have an important place in the Serbian forests. The Austrian pine, spruce and Scots pine plantations are dominant. In the mid-20th century, the great barren areas in the very vicinity of Raska were reforested, mainly by Austrian pine. Later, in the 1980s, the large-scale reforestation of the other parts of Ibarska klisura was conducted (Šmit, S. et al. 1997., Koprivica, M. et al. 1996). Generally speaking, in Serbia the Austrian pine plantations were most frequently established on the low-productivity sites (Koprivica, M., Ratknić, M. 1999., Koprivica, M. et al. 2000., Miletić, Z. et al. 2002., Rakonjac, Lj. et al. 2003).

Since the site conditions change as a result of the global climate change, study of the impact of the climate factors on the forest growth and increment is of the permanent importance. It is particularly significant in the forest plantations, as well as in the anthropogenically formed forest ecosystems (Koprivica, M., Matović, B. 2004).

The adverse effects of the climate and all other abiotic and biotic factors can be alleviated by the preventive action, i.e. by the intensifying professional activities aimed at the improvement of the forest vitality, stability and resistance. In the plantations the best results are obtained by thinning (Vučković, M., Stajić, B. 2003 i 2004).

The diameter increment of trees and stands is used as a reliable indicator of the analysis of the impact of site and stand factors, and particularly

of the applied management methods – thinning. Undoubtedly, the biological position of the tree in the stand, i.e. the crown development and illumination also has the great impact on the diameter increment.

This paper is aimed at the research of the impact of the climate factors and thinning on the diameter increment of the trees in the middle-aged Austrian pine plantations, in order to estimate their development, productivity, quality and vitality.

2. OBJECT OF RESEARCH

The Austrian pine plantations aged from 35 to 55 years, belonging to the site classes I-V, were researched at several sites in the vicinity of Raška. Twenty permanent sample plots were set in 1998, on which two mensurations were performed, in 1998 and 2003. However, in 2007 the great wildfire broke out, in which the forest plantations covering an area of 75 hectares were destroyed, i.e. two previously set sample plots. In addition, two sample plots have been destroyed by the construction of the forest roads, by the attack of the bark beetles, and due to the heavy snow. Therefore, sixteen sample plots were used for this research.

The sample plots are the located at the altitudes ranging from 450 to 680 meters, with the exception of two sample plots, located at the 1,100 meters above the sea level. The terrain slope ranges from 8 to 33 degrees, and the northern exposure is dominant. The most sample plots are located on the eutric rankers on the ultrabasites, and only one sample plot is located on the acidified brown podzolic soil on the pyroclastic materials. The sites at which the studied Austrian pine plantations are located mainly refer to the natural oak sites: *Quercetum deleschampii sepentinicum* and *Quercetum montanum poetosum nemoralis*. Only one researched plantation is located on the beech site: *Fagetum mesiacae montanum* (K o p r i v i c a , M. et al. 2002).

3. METHOD

On the sample plots in September 2009 the trees were measured and their quality was assessed. The diameter at the breast height of all trees was measured, and the quality of them was estimated, by the use of the Oxford classification. The tree heights and diameter increment were measured on half of the trees. The applied methodology was specially designed for these purposes (K o p r i v i c a , M. et al. 2008).

In the aim of the determination of the diameter increment trend of the Austrian pine for the period 1988-2009 the trees were cored by the Presler

increment borer. The data on the diameter increment of the trees were accurately measured and processed in the laboratory of the Institute of Forestry. The total of 280 trees were analyzed (seven three-year periods).

In next phase the trees on the sample plots, were divided into the diameter classes by the current diameter 5 and 10cm wide, and the mean values of the current diameter increment were determined. Finally, the sample plots were grouped into the previosly formed yield classes (K o p r i v i c a , M. et al. 2002., K o p r i v i c a , M., M a t o v i ć , B. 2004). In this way, the increment was assessed, and the diameter increment trend of the depressed (10 cm), co-dominant (20 cm) and dominant (30 cm) Austrian pine trees was determined.

In the aim of the determination of the impacts of the climate factors on the diameter increment of the trees the data obtained by the weather stations in Sjenica and Mt.Kopaonik were used. These stations are the nearest to the object of research which have the climate data for the research period. For the period in which the diameter increment is analyzed (1988-2009) the data on the quantitity of precipitation and air temperature over the year and during the vegetation season were collected. In the aim of the determination of the impact on the thinning on the diameter increment, timing, weight and intensity of the thinning were registered. The thinning was performed on all sample plots over the past ten years. Before this period no thinning was performed.

4. RESULTS

4.1 The diameter increment trend of the Austrian pine plantations

By the preliminary analysis of the diameter increment of the Austrian pine it was determined that the sample plots can be divided into four previosly formed yield classes (K o p r i v i c a , M., M a t o v i ć , B. 2004). However, the certain changes were made and the new distribution of the sample plots by the yield classes is the following:

Yield class	Sample plot	Age	Site class
1	1, 3, 8, 12, 16	57, 53, 55, 55, 55	2, 2, 2, 2, 1
2	5, 15, 18, 19	57, 57, 49, 52	3, 3, 3, 3
3	2, 17	54, 52	3, 4
4	7, 10, 11	37, 37, 36	4, 5, 5

The sample plots 6 and 20 were not grouped into the yield classes, owning to their peculiarity. The sample plot 6 is located on the beech site, the

plantations are 35 years old and the site class is 3. The sample plot 20 is located in the 44-year-old plantations, and the site class 4.

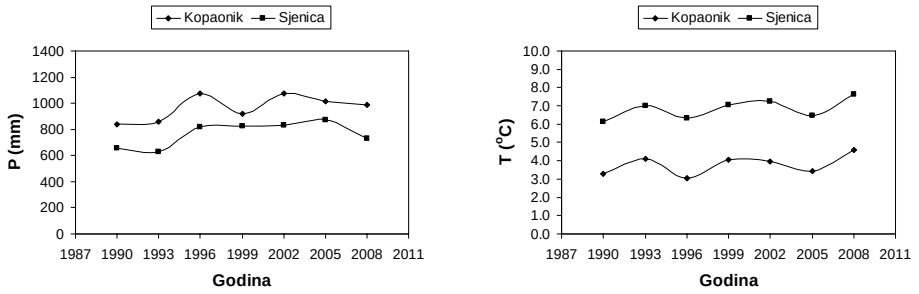
On all sample plots three mensurations have been performed so far: 1988., 2003, and 2009. Results of two mensurations have been presented earlier (K o p r i v i c a , M., M a t o v i ć , B. 2004). The mensuration results in 2009 are presented in Table 1.

In the yield class 1 the mean diameter increased by 1.4 cm in the last six years, whereas the mean height increased by 1.1 m. The number of the trees is less than 62 per a hectare, and basal area, volume and volume increment increased by: 3.1 m^2/ha, 65.1 m^3/ha and 1.3 m^3/ha. The percentage of the volume increment, i.e. the plantation increment intensity, did not change. The concrete comparisons cannot be made for the other yield classes, since the composition of their sample plots changed.

Table 1. *Taxation elements of the yield classes of the Austrian pine based on the mensuration date from 2008.*

Yield class	Age (years)	Site class	Mean diametar (cm)	Mean height (m)	The number of trees (trees/ha)	Basal area (m^2/ha)	Volume (m^3/ha)	Volume increment		Thinnig (years)
								m^3/ha	%	
1	55	I/II	21,6	19,4	1,088	39,8	398,1	7,28	1,83	1999
2	54	II/III	20,2	16,6	1,061	34,2	303,5	6,42	2,11	1999
3	54	III/IV	17,4	15,5	1,349	32,1	281,1	5,16	1,83	2004
4	37	IV/V	12,3	8,9	1,987	23,3	93,2	2,52	2,70	2004

In the aim of the easier study of the annual trends of the quantity of precipitation and air temperature in the period 1988-2009 the data are presented graphically (Graph 1).



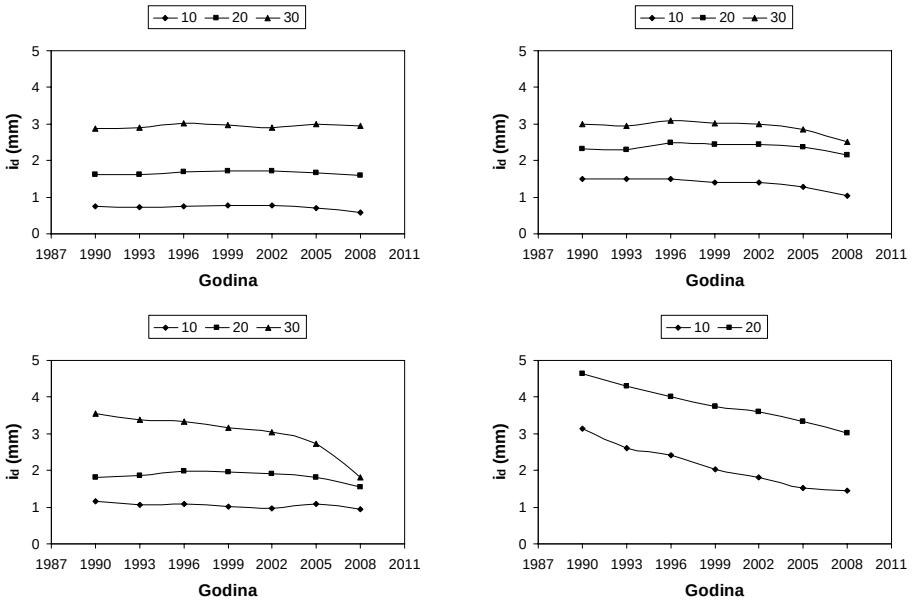
Graph 1. *The average quantity of the precipitation and air temperature in the period 1988-2009*

The data on the current diameter increment, obtained in the three-year period and numerous cored trees, are presented in the Table 2.

Table 2. *Diameter increment of the Austrian pine for the period 1988-2009 (mm/per a year).*

Diametar (cm)	Year						
	2008	**2005**	**2002**	**1999**	**1996**	**1993**	**1990**
Yield class 1							
10	0,57	0,71	0,78	0,77	0,76	0,73	0,76
20	1,59	1,67	1,72	1,72	1,69	1,61	1,63
30	2,95	2,99	2,91	2,97	3,02	2,90	2,88
Yield class 2							
10	1,05	1,28	1,39	1,40	1,50	1,49	1,50
20	2,16	2,36	2,44	2,44	2,48	2,30	2,33
30	2,51	2,85	3,00	3,02	3,10	2,95	3,00
Yield class 3							
10	0,93	1,09	0,97	1,01	1,09	1,07	1,17
20	1,55	1,82	1,92	1,95	1,97	1,86	1,82
30	1,81	2,74	3,04	3,17	3,33	3,37	3,54
Yield class 4							
10	1,44	1,51	1,81	2,03	2,41	2,62	3,15
20	3,02	3,33	3,60	3,75	4,01	4,30	4,64
30	-	-	-	-	-	-	-

In the aim of the better observation of the diameter increment, the data are presented graphically as well (Graph 2).



Graph 2. *The trend of the diameter increment of the Austrian pine trees by the yield classes in the period 1988-2009*

On the Graph 2 the following facts are observed:

* The increase in the diameter of the trees also implies the increase of the diameter increment in all yield classes, regardless of the age of the Austrian pine cultures. The thick (dominant) trees have the highest increment, then the middle-aged (co-dominant) trees, whereas the thin (depressed) trees have the lowest increment.

* In the yield class 1 the diameter increment remains at the same level, with the small oscillations, whereas in the yield classes 2 and 3 over the past six years there was a small decrease in the diameter increment, regardless of thinning. It can be explained by the lower site class, as well as by the delay of the thinning. All the plantations in these yield classes are about 55 years old.

* In the yield class 4 the plantations are located on the lowest site classes, and are about 35 years old. Although the diameter increment is the highest, it has a negative trend. The diameter increment of the trees with the diameter 10 cm and 20 cm is the highest, since these plantations are 20 years younger than the Austrian pine plantations in the first three yield classes.

It should be emphasized that the Austrian pine plantations classified in the first three groups are about 55 years old, that the analyses of the diameter increment started when the trees were 35 years old, and lasted until the trees were 55 years old. In the plantations of the fourth yield class, about 35 years old, the analyses of the diameter increment started when the trees were 15 years old, and lasted until the trees were 35 years old. As a result, in spite of the fact that the researches were conducted in the same period (1988-2009), only the first three yield classes can be compared.

Also, it should be taken into account that the results of the previous researches showed that in these Austrian pine plantations the maximum current diameter increment of the medium trees from the dominant layer in the first three yield classes was reported when the trees were from 10 to 15 years old, whereas in the fourth class the maximum current diameter increment was reported when the trees were from 15 to 20 years old. The annual increment ranged from 6.3 to 11.1 mm (K o p r i v i c a , M. et al. 2002).

Therefore, in the first tree yield classes the period in which the diameter increment was stabilized is analyzed, whereas in the fourth class the period immediately after the culmination of the diameter increment was studied. The negative trend of the diameter increment was expressed in the first three yield classes, when the plantations were 15 to 35 years old, which is mainly the result of the delay in thinning (K o p r i v i c a , M. et al. 2002).

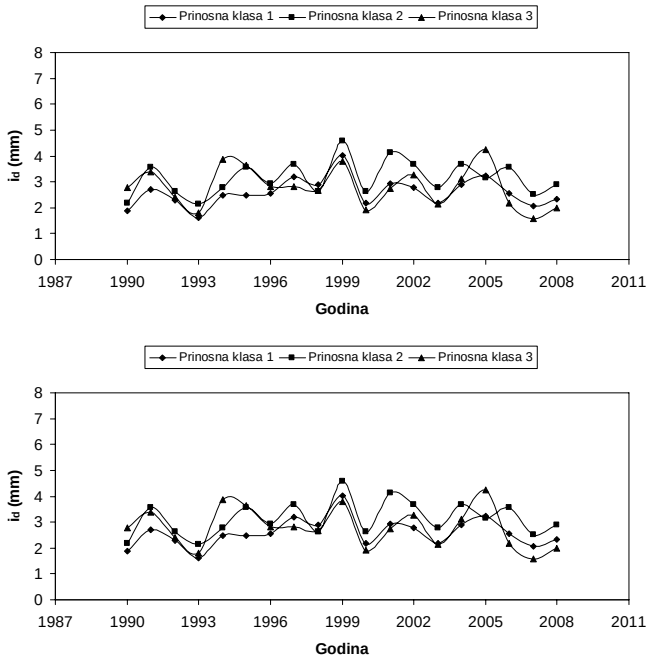
By comparing the Graph 2 and Graph 1 the dependence of the diameter increment on the quantity of precipitation and air temperature can be noticed only partially. Interestingly enough, by our previous researches of the diameter increment, conducted in the same Austrian pine plantations, and on the same

tress, the relation between one dry period (1990-1994) and low diameter increment was more clearly visible (K o p r i v i c a , M., M a t o v i ć , B. 2004).

Given the fact that the same method was applied in these researches, it is hard to explain the fact that the different results were obtained. However, it is probably the result of the fact that the trees moved from the lower to the higher diameter categories, as well as the approximation of the data on the quantity of the precipitation, air temperature, and the diameter increment by three-year periods. The situation is similar to the analysis of the influence of the thinning on the diameter increment of the trees. As a result, the diameter increment of the dominant trees, depending on the quantity of precipitation, air temperature, and thinning, was separately analyzed for every year of the researched period.

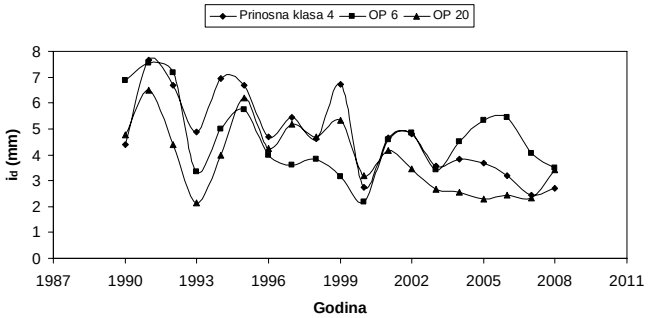
4.2. The diameter increment trend of the Austrian pine dominant trees

On all sample plots one typically dominant tree was selected and the diameter increment was determined for every year of the period 1988-2009. Then, the trees were divided into the yield classes and the average diameter increment was determined. The obtained results of the trend of the diameter increments are presented on the Graphs 3 and 4.



Graph 3. *The diameter increment trend of the Austrian pine dominant trees in the yield classes 1,2, and 3 in the period 1988-2009.*

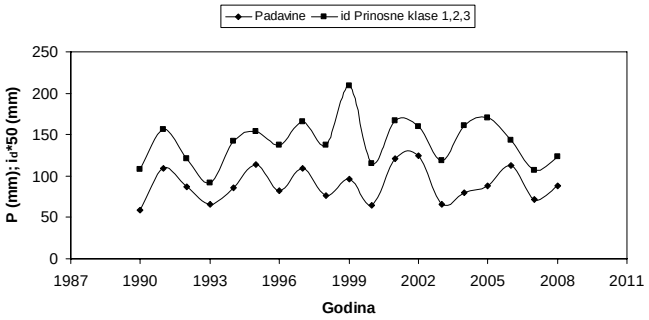
On the Graph 3 it can be noticed that there are no great differences in the diameter increment of the dominant trees of the yield classes 1, 2, and 3. The trend of the increment resembles the sine wave by the form, whereas the maximum and minimum diameter increment occurs in the same years over the research period. It is interesting that the almost identical fluctuations of the increment was also reported during the research of the multi-annual trend of the diameter increment of the dominant 55 years old trees in the Austrian plantations in Mt.Maljen, with the similar site conditions (S t o j a n o v i ć , Lj. et al. 2008).



Graph 4. *The trend of the diameter increment of the Austrian pine dominant trees in the yield class 4 and on the sample plots 6 and 20 in the period 1988-2009.*

In addition, the Graph 4 presents the similar oscillations of the diameter increment of the dominant trees, but of the downward trend, since these Austrian pine plantations are younger than the plantations in the yield classes 1, 2, and 3. On the sample plots 6 and 20 the positive impact of the thinning performed in 2004 on the diameter increment can be partially noticed.

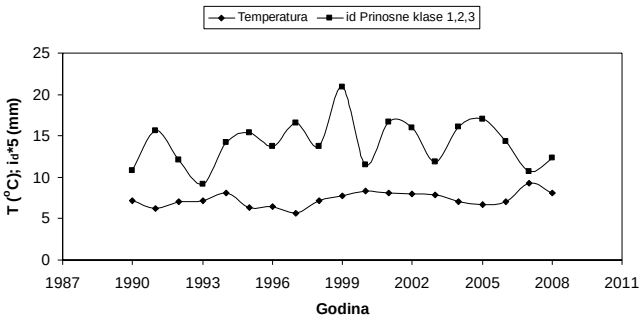
The relation between the diameter increment and climate factors is presented on the Graphs 5 and 6.



Graph 5. *The trend of the quantity of precipitation and the diameter increment of the dominant trees in the yield classes 1,2, and 3 for the period 1988-2009.*

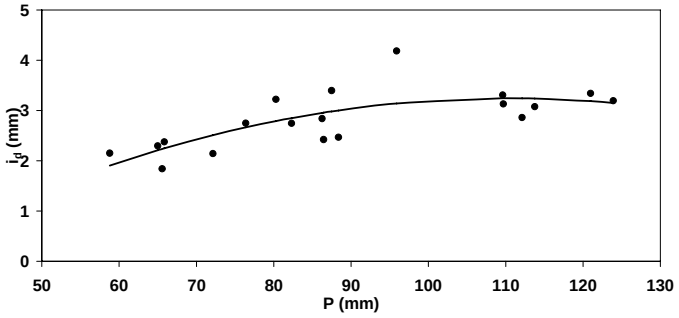
On the Graph 5 it can be observed that there is the almost complete correlation between the trend of the precipitation in the vegetation period, and the trend of the diameter increment of the dominant trees. The quantity of precipitation has a direct influence on the increment. The increase or decrease of the quantity of precipitation in the vegetation season is reflected in the diameter increment in the same year.

On the Graph 6 the significantly lower correlation between the trend of the air temperature in the vegetation period and the trend of the diameter increment of the dominant trees is presented. In this instance the increase or decrease of the air temperature in the vegetation period does not influence the diameter increment. It can be partially explained by the inverse relation between the quantity of precipitation and air temperature in the vegetation season, i.e. by the interaction between these two climate factors.



Graph 6. *The trend of the air temperature and diameter increment of the dominant trees in the yield classes 1, 2, and 3, for the period 1988-2009.*

The relation between the climate factors and the diameter increment of the dominant trees for the period 1988-2009, can be also observed by the application of the regression methods (Graphs 7 and 8).



Graph 7. *The dependence of the diameter increment of the dominant trees from the quantity of precipitation for the period 1988-2009.*

On the Graph 7 it is observed that the increase of the quantity of precipitation in the vegetation season implies the increase of the diameter increment of the Austrian pine trees.

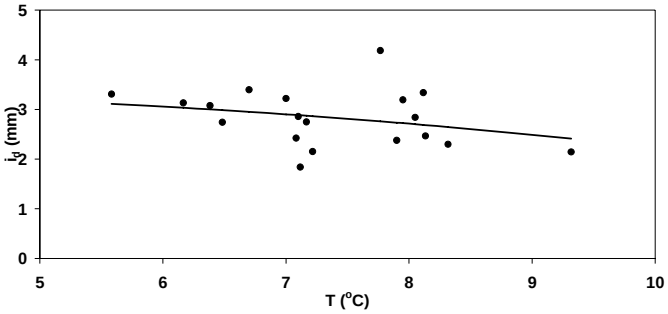
The regression indicators are the following:

$I_d = - 2{,}91215 + 0{,}111718\ P - 0{,}00050685\ P^2$ (1)

$S_e = 0{,}41$ mm, $R^2 = 0{,}5427$, $R = 0{,}7367$

The regression (1) is statistically significant, at the probability level 99%, and variations in the diameter increment was explained by 54.27%, since the relative error of regression is +/- 14.4%.

By the application of the test of the differences among environments (t-test) it was proved that there was a statistically significant difference among the quantity of the precipitation in the dry and rainy years, at the probability level 99%. The mean quantity of precipitation in the dry years is 65 mm, whereas in the rainy years it is 99 mm. Likewise, the statistically significant difference in the diameter increment of the dominant trees was reported, at the probability level 99%. The mean diameter increment in the dry years is 2.16 mm, and in the rainy years it is 3.49. The increment in the dry years decreases by 38%.



Graph 8. *The dependence of the diameter increment of the dominant trees on the air temperatures in the period 1988-2009.*

On the Graph 8 it is observed that by the increase of the air temperature in the vegetation season the diameter increment of the Austrian pine trees decreases.

The regression indicators are the following:

$I_d = 3.39792 + 0.0259409\ T - 0.0138623\ T^2$ (2)

$S_e = 0.58$ mm, $R^2 = 0.0784$, $R = - 0.2800$

The regression (2) is not statistically significant, and the variations in the diameter increment were explained by only 7.84%, and the relative error of regression is +/- 20.3%.

By the application of the test of the differences among environments (t-test) it was proved that there was no statistically significant difference among the air temperature precipitation in vegetation season in the dry and rainy years. The mean air temperatures in the dry years is 7.0^0C, and in the rainy years it is $8.0\ ^0$C.

5. CONCLUSION

Based on the measuring of the Austrian pine plantations in Raška in 2009, and the analysis of the diameter increment of the trees and data on the quantity of precipitation and air temperature for the period 1988-2009, the following conclusions can be derived:

* Over the past six years in the Austrian pine plantations classified in the yield class 1 (55 years old trees and the site class I/II) the mean diameter increases by 1.4 cm, and the mean height increases by 1.1 m. The basal area increased by 3.1 m^2/ha, volume by 65.1 m^3/ha, and the current volume increment by 1.23 m^3/ha. The percentage of the volume increment, i.e. the intensity of the yield of the plantations, did not change (1.82%). In the yield classes 2, 3, and 4, the accurate comparisons cannot be made due to the change in the percentage of the sample plots in them.

* The trend of the diameter increment in the period 1988-2009, by yield classes 1, 2, and 3 showed only insignificant oscillations. The trend line is almost parallel to the x-coordinate for the trees with the diameters 10, 20, and 30 cm (depressed, co-dominant, and dominant). In the yield class 4 the increment trend is linear and downward, which is the result of the age of the plantations, site conditions and delay in the thinning. In the first tree yield classes the plantations are about 55 years old, the site productivity classes I-III, and the thinning was performed late. In the fourth yield class the plantations are about 35 years old, the site classes IV-V, and the first thinning was performed only five years ago.

* The dependence of the diameter increment of the Austrian pine on the annual quantity of precipitation and air temperature, as well performed thinning, did not reflect clearly in the samples of the great number of the analyzed trees by the diameter and yield classes. However, by analyzing the small number of the dominant Austrian pine trees the statistically significant dependence, at the probability level 99%, of the diameter increment on the quantity of precipitation in the vegetation period, was reported. The diameter increment depended on the air temperature in the vegetation season, but the dependence was not

statistically significant. In addition, there was no significant influence of the late thinning on the diameter increment of the dominant trees.

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DIAMETER INCREMENT TREND OF THE AUSTRIAN PINE PLANTATIONS IN RASHKA

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Snežana STAJIĆ, Vlado ČOKEŠA

Summary

The paper presents the research results of the multi-annual trend of the diameter increment of the trees in the Austrian pine plantations, from 35 to 55 years old, and the site classes I-V. The impact of the climate factors and thinning on the trend of the diameter increment for the period 1988-2009 was analyzed. The research was conducted based on sixteen permanent sample plots, set in 1998 in the Austrian pine plantations in Raska. Three periodical mensurations have been performed so far: in 1998, 2003, and 2009. The results of the first two mensurations have been reported earlier. This paper presents some of the research results, in regard to the diameter increment of the Austrian pine plantations, based on mensuration in 2009. The methodology, which was specially designed for these purposes, was used for the collection and procession of the data. The data on the trees on the sample plots were obtained by the accurate measurement, and the quality of them was assessed by the use of the Oxford tree classification. The diameter increment of 280 trees, cored by the Presler increment borer, was analyzed. The data on the quantity of precipitation and air temperature were obtained from the weather stations located in Sjenica and in Mt. Kopaonik, and also refer to the period 1988-2009. The sample plots were classified in the yield classes 1-4. It was determined that there was the statistically significant dependence of the annual diameter increment of the dominant trees from the quantity of precipitation in the vegetation period, whereas the dependence on the air temperature and thinning was random. The quantity of the precipitation in the vegetation season had the strong and direct influence on the diameter increment, whereas the air temperature and thinning had the small and indirect influence. By the increase of the quantity of precipitation, the diameter increment increases parabolically, and by the increase of the air temperature it decreases linearly. The thinning to a certain extent alleviates the adverse effects of the extreme low precipitation and of the high air temperatures on the diameter increment of the trees. However, the dependences are less expressive if the dependence of the diameter increment of the great number of trees of the different yield and diameter classes on the annual quantity of precipitation and on the air temperature per three-year periods are observed.

TREND DEBLJINSKOG PRIRASTA CRNOG BORA U KULTURAMA NA PODRUČJU RAŠKE

Miloš KOPRIVICA, Bratislav MATOVIĆ,
Snežana STAJIĆ, Vlado ČOKEŠA

Rezime

U radu su izneti rezultati istraživanja višegodišnjeg trenda debljinskog prirasta stabala u kulturama crnog bora, starosti 35-55 godina i boniteta staništa I-V. Analiziran je uticaj klimatskih faktora i proreda na veličinu i tok debljinskog prirasta u periodu 1988-2009. godina. Istraživanje je provedeno na bazi šesnaest stalnih oglednih polja, postavljenih 1998. godine u kulturama crnog bora na području Raške. Do sada su izvršena tri periodična premera: 1998. 2003. i 2009. godine. Rezultati prva dva premera saopšteni su ranije. Ovde je dat deo rezultata istraživanja, vezanih za debljinski prirast, o kulturama crnog bora na bazi premera 2009. godine. Za prikupljanje i obradu podataka korišćena je metodika posebno izrađena u ove svrhe. Podaci o stablima na oglednim poljima dobijeni su preciznim merenjem, a njihov kvalitet ocenjen je primenom Oxford-ske klasifikacije stabala. Analizirano je debljinski prirast 280 stabala, bušenih Preslerovim svrdlom. Podaci o količini padavina i temperaturi vazduha uzeti su za meteorološke stanice u Sjenici i na Kopaoniku, takođe za period 1988-2009. godina. Ogledna polja su svrstana u prinosne klese 1-4. Utvrđeno je da postoji statistički značajna zavisnost godišnjeg debljinskog prirasta dominantnih stabala od količine padavina u vegetacionom periodu, dok je zavisnost od temperature vazduha i izvedenih proreda slučajna. Količina padavina u vegetacionom periodu odražava se jako i direktno na veličinu debljinskog prirasta, a temperatura vazduha i prorede slabo i indirektno. Sa povećanjem količine padavina parabolično se povećava debljinski prirast a sa povećanjem temperature vazduha linearno smanjuje. Prorede u izvesnoj meri ublažavaju negativne efekte ekstremno niskih padavina i visokih temperatura vazduha na debljinski prirast stabala. Međutim, ove zavisnosti su slabije izražene.kada se posmatra zavisnost debljinskog prirasta većeg broja stabala različitih prinosnih i debljinskih klasa od godišnje količine padavina i temperature vazduha po trogodinjim periodima.

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*453:595.752 Prociphilus Fraxinifolii Riley (497.2) = 111**
Original scientific paper

PROCIPHILUS FRAXINIFOLII RILEY (*HEMIPTERA, APHIDIDAE, ERIOSOMATINAE*) A SPECIES NEW TO THE BULGARIAN FAUNA

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Abstract: *Prociphilus fraxinifolii Riley (Hemiptera, Aphididae, Eriosomatinae) was observed for the first time in Bulgaria in 2007. This is the third record of the species in Europe. Probably the species was introduced in the country with plant material. It was collected from Sofia on leaves of Fraxinus pennsylvanica Marsh. Colonies of compact aphids were observed from May to the end of October. In the second half of September to the mid of October nymphs, apterae viviparae and winged viviparae females can be seen.*

Morphological description of species and damage is given.

Key words: Hemiptera, Aphididae, Prociphilus fraxinifolii, Bulgaria

1. INTRODUCTION

The species *Prociphilus fraxinifolii* Riley have been described for the first time in 1879 and reported as *Pemphigus fraxinifolii* on *Fraxinus americana* L. (Wilson, Vickery, 1918).

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In Europe the species is reported by Remaudiere and Ripca (2003) in the region of Budapest, Hungary on *Fraximus* sp. The second record in Europe of *Prociphilus fraxinifolii* Ril. and first for Serbia have been made by Petrovic et al. (2007). According to them from May till November colonies of the aphid were observed on *Fraxinus pennsylvanica* Marsh. in Belgrade (New Belgrade, Zemum) and Subotica. In Europe on *Fraxinus excelsor* L. two species can develop successfully - *Prociphilus fraxini* F. (*Prociphilus poschingeri* Holzn; *Prociphilus nidificus* Low) and *Prociphilus bumeliae* Schrk. *(Prociphilus eraticus* Koch; *Asiphum ligustrinellum* Koch.), (Blunck, 1957; Remaudiere, Ripca, 2003; Petrovic, 1998; Petrovic et al. 2007).

In Bulgaria four species from genus *Prociphilus* Koch. are known: *Prociphilus fraxini* F., *Prociphilus bumeliae* Schrk, *Prociphilus pini* Burm.,(*crataegi* Tullgr.); *Prociphilus tataricus* Rup. (Grigorov, 1980). Four species from genus *Prociphilus* Koch. are known from Serbia (Petrovic et al. 2007)- *Prociphilus bumeliae* Schrk, *Prociphilus fraxini* F., *Prociphilus xylostei* de Geeg, *Prociphilus pini* Burm , *Prociphilus fraxinifolii* Ril.

2. INFORMATION

Prociphilus fraxinifolii Ril. was observed for the first time in Bulgaria in 2007. This is the third record of the species in Europe. Probably it was introduced in the country with plant material. The species was collected from Sofia on leaves of *Fraxinus pennsylvanica* Marsh. Colonies of compact aphids were observed from May to the end of October. In the second half of September to the mid of October nymphs, apterae viviparae and winged viviparae females can be seen. Both species *Prociphilus fraxini* F *and Prociphilus bumeliae* Schrk. develop on their primary host *Fraxinus excelstor* L. to the beginning of early summer and then fly to roots of secondary hosts Abies sp. (Blunck, 1957; Wilson, Vickery,1918; Heie, 1980; Petrovic et al. 2007).

Prociphilus fraxinifolii Ril. can be distinguished from *Prociphilus bumeliae* Schrk. and *Prociphilus fraxini* F. by presence of secondary rhinaria on V and VI antennal segments in alate forms.

The species needs future detail study concerning its biology and distribution in the country.

Figure 1. *Damage at the end of summer*

Figure 2. *Colonies of aphids at the begining of October*

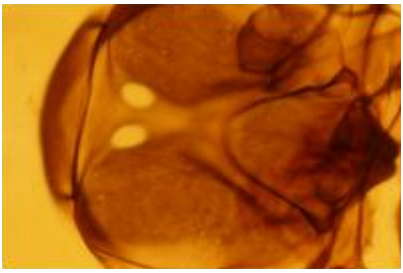

Figure 3. *Wax pore on the thorax viviparae female*

Figure 4. *Tail apterae*

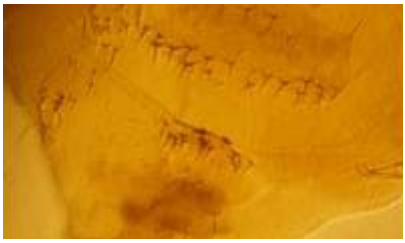

Figure 5. *Genetale plate with tail, segments winged viviparae*

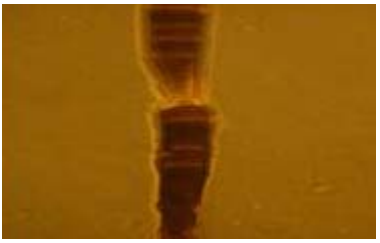

Figure 6. *III-IV anntenal apterae viviparae*

Figure 7. *V anntenal segment with secondary rhinaria*

Figure 8. *VI anntenal segment with secondary rhinaria*

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*161.4 : 582.284.51 Amanita muscaria=111**
Original scientific paper

TESTING OF CERTAIN PHYSIOLOGIC PROPERTIES OF MYCORRHIZAL FUNGUS *AMANITA MUSCARIA* (LINN. EX FRIES)

Vesna GOLUBOVIĆ-ĆURGUZ[1], Vera RAIČEVIĆ[2], Ljubinko JOVANOVIĆ[3]

Abstract: *This paper presents laboratory results of the research on certain physiologic properties of Amanita muscaria (Linn.ex Fries). The MEA, PDA and modified MEA media were used for testing the influences of different media on the growth of mycelia. In order to test the influences of fungicides and heavy metals in medium on the fungus growth we have set the experiments where nutrient media was enriched by fungicides Befungin and Captan FL, or solutions of heavy metals Pb, Cu, Cd, and Zn in three different concentrations (3ppm, 33ppm, and 100ppm).*

Key words: Amanita muscaria, mycelia growth, nutrient media, heavy metals.

ISPITIVANJE NEKIH FIZIOLOŠKIH OSOBINA MIKORIZNE GLJIVE *AMANITA MUSCARIA* (LINN. EX FRIES)

Izvod: *U radu su prezentovani rezultati laboratorijskih ispitivanja nekih fizioloških osobina gljive Amanita muscaria (Linn. Ex Fries)***.** *Za ispitivanje uticaja različitih podloga na porast micelije korišćene su MEA, PDA i modifikovana MEA*

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podloga. Da bi se ispitalo kakav uticaj ima prisustvo fungicida i teških metala u podlozi na rast ove gljive postavljeni su ogledi u kojima je hranljivoj podlozi dodati fungicidi Benfungin i Kaptan FL ili rastvori teških metala Pb, Cu, Cd i Zn u tri različite koncentracije (3 ppm, 33 ppm i 100 ppm).

Ključne reči: Amanita muscaria, porast micelije,hranljive podloge, teški metali.

1. INTRODUCTION

Amanita muscaria (Linn.ex Fries) is a very poisonous fungus of *Amanita* genus, with a wide diffusion area. It can develop in a variety of habitats; it is found in oak, beech and even in coniferous stands. Although, certain fungi types of this genus can form endomycorrhizae, most frequently it forms ectomycorrhizae on the root of various species. Ectomycorhizae is mostly present on forest trees in the areas with moderate climate. It is connected to a number of coniferous species including all genera from *Pinaceace* family, including slightly less deciduous, tropical trees, woody bushes and some grass species (Bruns et al. 2002). The fungi forming ectomycorrhizae belong to the species from *Agaricales* order, (families *Boletaceae, Tricholomataceae, Amanitaceae. Cortinariaceae, Paxilaceae, Gomphidiaceae*), *Gasteromycetes* class and from the subclass of *Deuteromycotina, Ascomycotina* and *Mastigomycotinae* (Agrios, 1997).

Fungus *A. muscaria* biologic properties through laboratory research of certain physiologic properties. These results may be applied in the production process of mycorrhizaed seedlings for afforestation of long deforested terrains, degraded The mycorrhizae presence on the tree seedling root is often the only precondition for seedling survival and growth under unfavorable conditions of the environment (Rudawska et al. 2001). The fungus (mycobiont) contributes to improvement of plant supply with soil nutrients, root mass enhancement (Dahm, 2005), root system protection from pathogens (Marx, 1973). It also helps in absorbing and trans-locating water in plants, drought protection, temperature extremes and the reduction of heavy metal influence on plants (Godbold et al 1998, Rudawska et al 2001).

Therefore, mycorrhizaed plants should be formed in the nursery during production of sowing material. The production of mycorrhizaed forest seedlings is much more expanded across American and European countries (Castellano and Molina, 1993). There are small records on the use of mycorrhizae in forest sowing material production and afforestation in Serbia. Veselinovic and associates (1976) have among the first published the results of artificial inoculation with mycorrhizaed fungi in *Pinus nigra* Arn production. Later, Peno and Veselinovic (1984) have with their papers contributed to the significance of

mycorrhiazeing the root system of *P. nigra* and *P. sylvestris* in afforestating the Ibar gorge.

The aim of this paper is better familiarization with mycorrhizal shallow soils without humus horizon where has the forest micro flora completely disappeared.

1. MATERIAL AND METHOD

We have tested the influence of different nutrient media to the mycelia growth of this fungus, than fungal fermenting activity, firstly, production of oxidase and reductase. In the experimental group we have controlled the present amounts of herbicide and heavy metals in nutrient medium and how much it can reduce this mycorrhizal fungus mycelia growth. All the isolates used in the experiments were developed on the MEA (2%) nutrient media in Petri dishes.

2.1 The mycelia of mycorrhizal fungus growth on different types of nutrient media

The mycelia of mycorrhizal fungus growth was marked on three nutrient media: MEA (malt-extract agar), PDA (potato-dextrose agar), and modified agar medium (Rudawska et al., 2000 cit. Tomaszewski and Wojciechowska, 1974) (55 mM glucose; 14 mM maltose; 6.25 mM NH_4NO_3; 3.7 mM KH_2PO_4; 2 mM $MgSO_4$; 0.15 μM thiamine chloride; 0,02 μM biotin; agar $9gL^{-1}$). All media prepared were spread over in Petri dishes, and after sowing with mycelia fragments placed in thermostat, in no light conditions on 23 $\pm$ 1°C. The mycelia growth was observed for two months, and the measurements of the two crossed diameters were conducted on every other day during the period. The experiment was repeated five times.

2.2 The fungal fermenting activity

The fungal fermenting activity was analyzed by testing the influences of isolated fungi on the media oxidation degree. The Bavenndamm's method, later on elaborated by Davidson et al (1938), was used for testing oxidase. The MEA medium, to which was added 0.5% of gallic or tannic acid was used as a medium. This experiment was repeated five times. The diffusion zone size, color and tone were used as a criterion for grading the oxidase secretion. The oxidase degree, according to Davidson et al, was expressed in the following way:

- negative, lack of brown agar coloration under or around inoculum;
+ light to dark brown diffusion zone, created under the inoculum in colony center visible from the bottom side of the Petri dish; when the colony is not formed the

zone under the inoculum receives brown coloration;

++ light to dark brown diffusion zone, formed beneath the largest part of the colony, but not reaching its borders;

+++ light to dark brown diffusion zone spread on a short distance from the colony edge visible from the upper side;

++++ dark brown diffusion zone, opaque, considerably spreading across the line designating the inoculum zone;

+++++ highly intensive diffusion zone, dark brown, opaque, forming a wide wreath around the colony; usually this strong reaction have those species not grown on the medium with gallic acid added.

According to the colony growth rate on malt-agar medium with 0.5% gallic or tannic acid added, we have determined on the basis of key by Davidson et al the relation to fungi group in the following way:

Negative or non-reacting fungi

Group 1 - mycelia growth in gallic or tannic environment is nearly equal;

Group 2 - growth in gallic environment good, colony diameter longer than the one in tannic acid environment;

Group 3 - good growth in gallic acid environment, there is no growth or is found only in traces in tannic acid environment;

Positively reacting fungi

Group 4 - not growing or growing only in traces on both media;

Group 5 - not growing or growing only in traces in gallic acid environment, mycelia diameter up to 25mm in tannic acid environment;

Group 6 - not growing or growing only in traces in gallic acid environment, growth 25-50mm (after 7 days) in tannic;

Group 7 - Mycelia have similar diameter on both acid environment;

Group 8 - clear growth in gallic acid environment, good growth in tannic acid environment;

Group 9 - good growth in gallic acid environment, not growing or growing only in traces in tannic acid environment; most frequently these fungi are vaguely reacting and for definite results it is necessary to wait 14 days;

Fungi having negative or positive reaction depending on the environment

Group 10 - negative reaction on gallic acid environment, positive in tannic acid environment, with good growth in both.

2.3 The influence of heavy metals on mycorrhizal fungi mycelia growth

This influence was marked by sowing fungi on standard MEA medium to which, after being sterilized in autoclave, were added solutions of heavy metals Pb, Cu, Cd, and Zn in three concentrations (3ppm, 33ppm, and 100ppm)(Dunabeitia et al, 2004). These solutions were prepared from the salts of these metals in the following compounds $ZnSO_4 \cdot 7H_2O$, $CuSO_4 \cdot 5H_2O$, $CdSO_4 \cdot 8H_2O$ and Pb $(COOH)_2$. The measured pH value for all solutions was 5.5 except for copper solutions pH 4.5. We have observed the mycelia growth and

the values obtained were compared with the growth values on standard MEA medium.

2.4 The influence of fungicides on mycelia growth

Fungicides are applied in nursery production to eliminate pathogenic organisms. Whether their use can have negative influence on the development of mycorrhizal fungi and how great that influence is was examined in laboratory conditions using fungicides Benfungin (Galenika, Belgrade), and Captan FL (Zorka, Sabac) in two concentrations, mostly applied in nurseries.

MEA medium was sown with fragments of the tested fungus, and around them was placed filter paper – three pieces cut in square shapes. Each piece of filter paper was soaked in certain concentration of the same type of fungicide. The growth of the tested mycelia was observed, as well as the reaction around the filter paper. That is a modified method taken from Karadzic's PhD paper (1982).

3. RESEARCH RESULTS AND DISCUSSION

3.1 Effect of different media on mycelial growth

The growth of the mycorrhizal fungi mycelia was observed on three nutrient media. Two standard nutrient media MEA (malt-extract agar), PDA (potato-dextrose agar), and modified agar medium (mod.MEA).

Table 1. *Effect of different media on mycelial growth (mm /1 week)*

Week of growth	Type of media		
	MEA	PDA	Mod.MEA
1	-	-	-
2	-	6.37	-
3	7.88	7.77	18.00
4	7.35	6.53	14.58
5	9.04	7.09	10.00
6	2.29	5.21	7.50
7	6.08	1.70	2.50
8	10.91	2.06	
9	8.79	0.57	
10	4.56	0.42	
11	4.39	0	
12	2.89	0	

The tested mycorrhizal fungus differently reacted to nutrient media used (table 1). The growth in MEA and mod.MEA medium was noted three weeks after sowing, while the fungus began to grow after a week on the PDA

medium. The fungus grew up to the edges of the Petri dish in MEA medium, while the PDA medium did not suit *A. muscaria*, so owing to extremely slow growth it had not managed to fill the Petri dish.

Table 2. *Daily and weekly growth of mycelia A. muscaria on different media*

Type of media	growth of mycelia	(mm)
MEA	Daily	0.98
	weekly	5.35
PDA	Daily	0.02
	weekly	2.69
Mod. MEA	Daily	1.79
	weekly	8.76

A. muscaria did not have a steady growth rate on all media (table 2), the daily growth difference measured ranged from 0.02mm to 1.79mm, on the weekly basis it ranged from 2.69 to 8.76mm. The fungus has filled the Petri dishes in the shortest period on modified MEA medium, so the fastest daily growing rate was recorded (1.79mm), as well as the fastest weekly rate (8.76mm).

3.2 Fungal fermenting activity and medium oxidation degree

Thanks to the synthesis ability of different extra cellular enzymes mycorrhizal fungi can use various energy sources from humus components and plant tissue and in this way provide themselves with nitrogen and phosphorous (Cairney and Burke, 1998).

The research degree of gallic and tannic acid oxidation degree in these media 7 and 14 days after incubation are presented in table 3. After 7^{th} day isolates show slow growth in gallic acid oxidizing it during the process. Tannic acid is faintly oxidized by this fungus and shows faint mycelia growth. After 14 days this fungus shows faint mycelia growth in both gallic and tannic acid. The oxidation intensity of gallic acid is slightly pronounced. The most intensive medium coloration is beneath inoculum, gradually reducing toward the rim of diffusion zone.

Table 3. *Oxidation degree of gallic and tannic acid*

Medium		Reaction	Size of diffusion zone (mm)	Size of Mycelia (mm)	Davidson 's group
Gallic acid	7^{th}day	+++	27,67	<20	4
	14^{th}day	+++	36,67	<20	4
Tannic acid	7^{th}day	+	<20	<20	4
	14^{th}day	++	<20	<20	4

Fungi causing intensive oxidation of gallic and tannic acid are grouped among fungi which are intensively secreting ferments from oxidase group, proving their ability to oxidize lignin and decompose wood (Karadzic, 1986). The wood decomposing fungi (*Hypholoma fasciculare, Phanerochaete velutina*), endomycorrhizal fungi (*Hysterangium setchellii, Lactarius affinis, Lactarius controversus*) and ericoidal mycorrhizae *(Hymenoscyphus ericae*) decompose hydrolyzed polyphenol – protein complex which is built from gallic acid (Bending and Read, 1997; Waterman and Mole, 1994.).

3.3 The influence of heavy metals on fungal growth

Amanita muscaria is tolerant to the presence of tested metals, mycelia has grown on media with metals added in all concentrations. The average daily fungal growth on control medium (MEA) was 0.98mm/day, and on media with presence of heavy metals it varied depending on the metal type and its concentration, so the growth rate doubled in the highest concentrations in the presence of Zn, Pb, and Cd. Cooper had the strongest inhibition influence in 100ppm concentration (table 4).

Table 4 *Effect of heavy metals added to media on the mycelial growth of A. muscaria (mm/1 day)*

Concentrations (ppm)		**Mycelial growth of *Amanita muscaria***
Zn	3	1.90
	33	2.27
	100	1.90
Pb	3	2.27
	33	2.27
	100	2.27
Cu	3	1.90
	33	1.65
	100	0.98
Cd	3	1.90
	33	1.65
	100	1.65
MEA	0	0.98

Similar results have been obtained by Jacob et al (2001) in their research on exposing *P. involutus* mycelia to Cd influence in 0.05ppm concentration in 12 hour time frame. They have proved its tolerance to Cd presence, stating that this type of cell reaction was conditioned by enzyme presence.

Contrary to these results, Dunabeitia et al (2004) have been testing the influence of Pb, Cu, and Cd in three concentrations (3, 33, and 100ppm) in

media on growth of different types of mycorrhizal fungi. The highest influence on growth inhibition was exhibited by Cd, slightly less by Cu and Pb least.

Positive experiences with pure mycorrhizal fungi cultures in elevated heavy metal content conditions in laboratory were confirmed by planting micorrhizaed seedlings on the terrain so the use of these fungi as bio-remedies is recommended (Khan et al, 2000) in polluted soils or as pollution bio-indicators (Leyval et al, 1997). Muzenberger et al (2004) have established that elevated metabolic activity of mycorrhizae conditions good adapting abilities of mycorrhizaed root systems to the extreme soils on recultivated places. Practical application of certain ectomycorrhizal fungi conditioned better seedling development in conditions of elevated content of heavy metal. Fungi developed in soil containing the elevated cooper content adapt in time to these conditions. Comparing laboratory analysis of these fungi against the fungi from non-polluted soil it was concluded that they keep their properties and show tolerance to Cu presence even when they are out of those conditions (Arnebrant et al, 1987).

3.4 Fungicide influence on the *In vitro* colony growth

The experiment control was performed on weekly bases during two months time while the experiment was monitored. Active substances of these fungicides belong to the different chemical groups (Benomyl belongs to benzimidazole group, and Captan is from ftalamide group) and during experiment different types of reactions were recorded depending on the fungicide type and their concentration.

Mycelia has been growing without interference in the presence of Befungin in both concentration, during the entire test period, the same results were recorded in the first (after two weeks) and second control (in the end of the testing period).

The lower concentration of Captan FL influenced *A. muscaria* conditioning mycelia growth reduction. The presence of higher concentration of Captan FL acted in the same way as the lower, only the influence was stronger and formed inhibition zone. Castellano and Molina (1993) and Lazarev (1998) have through research reached the conclusion that certain fungicide types might have a negative influence on mycorrhizal fungi i.e. reducing mycorrhizae development, they have reached the same results with captan based preparations.

The usual pesticide application in nursery production might affect the formation and development of mycorrhizal fungi, influencing mycorrhizal fungi germination, sporangia as well as root colonization (Hetrick and Wilson, 1991). Negative effects of pesticide application are manifested through mycorrhizal

fungi destruction pointing the research in the direction of controlled application of chemical preparations and biological fighting measures.

The application effects of fungicides Benomyl and Captan to the development of mycorrhizal fungi which colonize *Picea sitchensis* and *Fraxinus excelsior* were tested by O'Neill and Mitchell (2000). Benomyl application has 2-3 times influenced the ectomycorrhizal fungi species reduction number on the root, and on the reduced root colonization. Soil fumigation applied in nurseries in order to eliminate pathogenic fungi *Rizoctonia solani, Pythium sp., Fusarium oxysporum* etc. has positive influence on spruce and coast Douglas – fir seedling mycorrhization. These seedlings could be successfully inoculated with mycorrhizal fungus only in those conditions because saprophytic organisms and naturally developed ectomycorrhizae show antagonist properties in introduction of this specie (Tacon et al. 1986). Soil fumigation frequently results in plant growth underdevelopment, as well as in mycorrhizal fungi inoculum destruction. However, if the soil is rich in organic matter the mycorrhizae regeneration on the root of the sown black pine is established by the end of the year after sowing (Veselinovic et al. 1976; Lazarev, 2005). The mycorrhizal seedlings *Pinus elliotti* have, on the soil fumigated with methyl bromide, had higher survival rate, the root was branched better, and the ratio of nitrogen and phosphorous in pine needles and root was more favorable than in non – mycorrhizaed seedlings (Shoulders, 1972).

4. CONCLUSIONS

The results of these researches have led to the following conclusions:

-Mycorrhizal fungus *Amanita muscaria* has been growing in different rates on nutrient media. The fastest daily and weekly growth rates were recorded on modified MEA medium.

-This fungus has shown oxidation of gallic and tannic acid. The gallic acid oxidation intensity was slightly more pronounced.

-Befungin fungicide did not affect the growth of mycelia in both concentrations. Captan FL has equally affected the growth in both concentrations conditioning slower *A. muscaria* mycelia growth rate.

-*Amanita muscaria* is tolerant to the presence of metals tested, thus mycelia grew in media with addition of metals in every concentration.

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TESTING OF CERTAIN PHYSIOLOGIC PROPERTIES OF MYCORRHIZAL FUNGUS *AMANITA MUSCARIA* (LINN. EX FRIES)

Vesna GOLUBOVIĆ-ĆURGUZ, Vera RAIČEVIĆ, Ljubinko JOVANOVIĆ

Summary

Mycorrhizal fungus, *Amanita muscaria,* on modified MEA media grows faster that on the MEA and PDA medium. This fungus is tolerant to the presence of heavy metals (Zn, Cu, Pb, Cd) in three concentrations (3ppm, 33ppm, and 100ppm), mycelia grew in media with addition of metals in every concentration. Befungin fungicide did not affect the growth of mycelia in concentrations 0.04 and 0.06. Captan FL has equally affected the growth in both concentrations (0.2 i 0.3) conditioning slower *A. muscaria* mycelia growth rate.

The A. muscaria colony on the media with the addition of gallicic acid and tannin acid shows a positive oxidase reaction and according to the Davidson key this funfus is classified in the four group.

Based on the results obtained during this research the use of this fungus can be recommended in process of forest sowing material mycorrhization. The presence of fungi in a role of root symbiont in these seedlings helps in overcoming afforestation problems manifested in inability of transplanted plants to use micro and macro elements from soil.

ISPITIVANJE NEKIH FIZIOLOŠKIH OSOBINA MIKORIZNE GLJIVE *AMANITA MUSCARIA* (LINN.EX FRIES)

Vesna GOLUBOVIĆ-ĆURGUZ, Vera RAIČEVIĆ, Ljubinko JOVANOVIĆ

Rezime

Mikorizna gljiva, *Amanita muscaria*, na modifikovanoj MEA ima brži porast micelije u odnosu na MEA i PDA podlogu. Ova gljiva je vrlo tolerantna na prisustvo teških metala (Zn, Cu, Pb, Cd) u tri koncentracije (3ppm, 33ppm, 100ppm), tako da je micelija rasla na podlogama sa dodatkom svih metala u svim koncentracijama. Fungicid Benfungin u koncentracijama 0.04 i 0.06 nije uticao na rast micelije. Kaptan FL je podjednako delovao u obe koncentracije (0.2 i 0.3) uslovljavajući sporiji rast micelije *A. muscaria*.

Micelija *A. muscaria* na podlozi sa dodatkom galne ili taninske kiseline pokazuje pozitivnu oksidacionu reakciju i po ključu Davidsona ova gljiva se svrstava u grupu 4.

Na osnovu dobijenih rezultata u toku ovog istraživanja može se preporučiti primena ove gljive u procesu mikorizacije šumskog sadnog materijala. Kod ovih sadnica, prisustvo gljiva kao simbionta na korenu pomaže u prevazilaženju problema pošumljavanja koje se manifestuje u nemogućnosti presađenih biljaka da koriste mikro i makroelemente iz zemljišta.

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INSTITUTE OF FORESTRY • BELGRADE
INSTITUT ZA ŠUMARSTVO • BEOGRAD

SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*43 (497.11) = 111**
Original scientific paper

WILDFIRES IN SERBIA – CHANCE OR FREQUENT PHENOMENON

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Abstract: *The forest ecosystem is one of the most complex ecosystems on the planet. The various influences cause the destabilization of it, and fire -uncontrolled wildfire is one of the main factors. The wildfires which in the blink of an eye turn the beautiful forests in the fire-ravaged places, bare lifeless areas, and cause damages worth millions to the forest-based economy and disturbances in business, pose a serious, global, social and economic problem which is always relevant. Realizing the gravity of the situation, Directorate of Forests within the Ministry of Agriculture, Forestry and Water Management initiated and entrusted the Institute of Forestry in Belgrade with the task of making the project "Wildfires in Period 2003-2007"in 2007, and some results of it is presented in this paper. In the period 2003-2007 in the forest ecosystems of Serbia 579 wildfires in the area of 9872,80 ha were reported. They were caused mostly by humans, occurred mainly in the parts of the year which are critical for their occurrence, and initiated in the part of the day when it is hardest to extinguish them. The results presented in this paper give the opportunity to the lower organizational units and forest owners to take the appropriate measures of readiness and organization of the wildfire protection on time in the forthcoming years*.

Key words: wildfires, period 2003-2007, Serbia, analysis

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ŠUMSKI POŽARI U SRBIJI – SLUČAJNOST ILI REDOVNA POJAVA

Izvod: *Šumski ekosistem je jedan od najsloženijih na planeti. Razni uticaji izazivaju njegovu destabilizaciju, a vatra-nekontrolisani šumski požar je jedan od glavnih faktora. Požari koji za tren oka divne šume pretvaraju u zgarišta, gole bezživotne površine, a šumskoj privredi donesu milionske štete i poremećaje u poslovanju, predstavljaju ozbiljan i uvek aktuelan globalni društveni i privredni problem. Sagledavajući ozbiljnost situacije, Uprava za šume Ministarstva poljoprivrede, šumarstva i vodoprivrede je 2007. godine inicirala, i Institutu za šumarstvo u Beogradu poverila, izradu projekta "Šumski požari u periodu 2003-2007. godine", a deo rezultata je prezentovan u ovom radu.*

U periodu 2003-2007. godina, u šumskim ekosistemima Srbije zabeleženo je ukupno 579 požara na površini od 9872,80 ha. Većinom ih je izazvao čovek, dešavali su se uglavnom u kritičnim periodima godine za njihovu pojavu, a inicirani su u delu dana kada je gašenje najteže. Rezultati, navedeni u ovom radu pružaju mogućnosti da se u narednim godinama, na nivou nižih organizacionih jedinica korisnika šuma, sprovedu pravovremeno odgovarajuće mere pripravnosti i organizacije protivpožarne zaštite.

Ključne reči: šumski požari, period 2003-2007. godina, Srbija, analiza

1. INTRODUCTION

Wildfires, which in the blink of an eye turn the beautiful forests in the fire-ravaged places, bare lifeless areas, and cause damages worth millions to the forest-based economy and disturbances in business, pose a serious social and economic problem which is always relevant. Alongside material damages owning to the lost wood volume, fire extinguishing expenses, fire sites rehabilitation, and new reforestation, since they destroy the all living things, and disturb the natural beauty of the landscape, which means that they also cause the ecological harm, which is three to ten times greater than the value of the burnt tree.

Wildfires as the unbridled elements of the specific type not only act ultimately destructively on the forests and forest land, but also cause great and irreparable damages to other industrial branches which are directly or indirectly connected to the forest and its complex useful functions (For instance, agriculture, water management, health and recreation tourism, wood industry, traffic, etc).

We must always expect the wildfire occurrence, but at the same time must aspire to reduce the number of them and the loss which they cause.

Wildfires used to be considered the unbridled elements, which irregularly, occur by no definite reason, although it was always known that they cause the catastrophic consequences. However, the history of forestry teaches us that the forests on each continent regularly sustained the consequences of this disaster, and they must have been one of the major causes for the decrease of forest cover to modern insufficient levels. Man over years and decades establish new stands, and then the fire break out which destroy everything "like lightning".

In the multi-decade development of the forestry in our country, the problem of the wildfires has not always been treated with the maximum attention, although the frequency of them made it necessary. Many wildfires which have ravaged through our forests so far and left very hard consequences, point to the fact that they most dangerous and destructive harmful factors, since in the relatively short time can cause vast direct and indirect damages.

Attention and activity, which were expressed in the critical years to a maximum level, as a rule became less intensive in the period when the wildfires occur less frequently. Therefore, it was often the case that we were caught unprepared by the new occurrences of the wildfires and we were not able to tackle it successfully. The fact that the number of the wildfires occurred in the forests of our country was sometimes higher than the permitted level is one more proof of it.

The results of the statistical analysis of the occurrence of the wildfires in Serbia point to the fact that they must be treated as the frequent phenomenon in the forest managements. When we claim this, we always use as the starting point the possibility that every year to come can be critical, i.e. the occurrences of the wildfires can be always expected under the certain weather and other conditions which are favourable to them. The scope of wildfires and levels of damages to a great extent depend upon the organizational and technical readiness of the anti-fire service.

Many areas which are damaged or destroyed by the wildfires are not always completely rehabilitated and as a result often totally or partially lose the forest vegetation. Therefore, this question poses a special problem, since each postponement of the rehabilitation of the fire-damaged areas carries new risks: chaining of damages, occurrence of the secondary harmful factors, barren terrains, investment of the significantly more money, and as a whole putting in jeopardy the possibility of the re-establishment of the original condition.

The etiology of wildfires is diverse. Some causes and agents are peculiar to some regions of our country. The more abundant and diverse wildfires in some place, the more the forests are endangered, wildfires frequent and with the harder consequences.

The increasing number of the wildfires and devastated areas of the forest and forest cultures is above all the consequence of the global warming of

the Earth – unfavourable weather conditions in the last few years, as well as the fast industrialization and urbanization. During the fire season, particularly on weekends, state holidays and vacations, children and adults flock to forests, and thanks to the extensive road networks reach the remotest points, where they can neglectfully cause burning of the surrounding dry grass, litter, dry branches, lying trees, etc.

The ground fire originated in this way can spread over the greater area, unless it is contained on time, as well as to reach the tree crowns, particularly in the case of conifer stands. In addition, the inadequate behaviour of the individual agricultural producers is also a great problem, since they clean the fields prior to spring sowing by burning, which can be the very frequent core of the fire spreading to the forest ecosystems in the vicinity.

The increasing number of the wildfires in the recent years has been the direct result of certain activities in the forestry economy, which has yet to be explained and stressed. It is mainly the result of the rapid increase of the areas covered by conifer cultures (Tabaković-Tošić, 2006). They are most usually established as monocultures in the aim of more economical wood production. Introduction of conifers in the deciduous forests and other types of reforestation, aimed at the protection and improvement of the environment, also increase the danger of wildfires. In this way the new relations of the conifer trees have been established lately, and their spatial arrangement has been altered. Simultaneously, in these areas the appropriate necessary "anti-fire forest arrangement" has not taken place (cuts, belts, etc.) (Rakonjac et al, 2003, Tabaković-Tošić and Lazarev, 2003).

Forest ecosystem is one of the most unstable ecosystems on the planet. The various influences cause the destabilization of it, and fire- uncontrolled wildfire is one of the main factors. Wildfires are global problem, and it can be safely concluded from the great number of the international organizations and projects which deal with them, such as: The Global Fire Monitoring Center (GFMC), International Strategy for Disaster Reduction (US ISDR), UN Office for the Coordination of Humanitarian Affairs (UN-OCHA), UN Environment Programme (UNEP), Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), UN Economic Commission for Europe (ECE) Timber Committee, Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD), Consortium on Natural and Technological Catastrophes, World Institute for Disaster Risk Management (DRM), International Global Atmospheric Chemistry (IGAC), International Union of Forestry Research Organization (IUFRO), Russian Federal Aerial Fire Protection Service, Albert-Ludwigs-Universität Freiburg Germany, Max Planck Society for the Advancement of Sciences, Max Planck Institute for Chemistry, UN – ISDR / GFMC Global Wildland Fire Network – Regional Southeast Europe Wildland Fire Network (FAO - Forestry Department, 2001).

The legal regulation in most of the countries precisely defines the struggle against the wildfires and the role which the institutions have in this struggle. Fire-sites rehabilitation is also prescribed by the law, as the need and obligation with the widely-defined objectives. The consequences of the wildfires are demonstrated over many years, and are sometimes irreparable. Realizing the gravity of the situation, Directorate of Forests within the Ministry of Agriculture, Forestry and Water Management initiated and entrusted the Institute of Forestry in Belgrade with the task of making the project "Wildfires in Period 2003-2007"in 2007, and some results of it is presented in this paper.

2. METHOD

The project task was implemented in several phases and requested the engagement of a great number of scientists and professionals of the different specialties, as well as the use of all readily-available methods for collection, procession, analysis and synthesis of the relevant data, which is in accord with very complex, multidiscipline topic which is dealt with. In the first phase all the wildfires were noted, regardless of the size of the area which they covered in the Republic of Serbia. For the fire-damaged areas all the significant data such as: climate, orographic, phytocenosis, etc. were collected, stand and ecological origins were determined, as well as health condition – occurrences of the herbal diseases and economically harmful insect species. The collection of maps in the electronic form was done for each wildfire and each group of wildfires, i.e. the solid database as the base for the further work by planned segments was formed. The referents for the cultivation and forest protections PE Srbijašume, PE Vojvodinašume, PE NP Fruška Gora, PE NP Tara and PE NP Đerdap were of a great help during the data collection. Therefore, we would like to express our gratitude to them.

3. RESULTS AND DISCUSSION

The frequent occurrence of the wildfires and extreme increase of the fire-damaged areas which were reported worldwide in the last decade are mainly the results of the global change of the climate conditions, such as melting and decrease of the average precipitation, particularly in the periods which are critical to the wildfire initiation. The consequences of such processes in the Republic of Serbia are analyzed by the occurrences of wildfires – number, type and frequency in some seasons and parts of the days, as well as by the size of the fire-damaged area, occurrence of biotic harmful agents, and healing for the period 2003-2007.

3.1 The number of wildfires, size and type of the fire-damaged area

Table 1. *The total number of the wildfires in the period 2003-2007 in the Republic of Serbia*

FOREST USERS	FOREST DISTRICT	Year					Total	
		2003.	2004.	2005.	2006.	2007.	For Forest District	For Forest Estate
PUBLIC ENTERPRISE VOJVODINAŠUME								
FOREST ESTATE BANAT PANČEVO	Zrenjanin	2	-	-	-	6	8	**15**
	Banatski Karlovac			1	-	1	2	
	Vršac	1	-	-	1	2	4	
	Bela Crkva	-	-	-	-	1	1	
Total Forest Estate Banat Pančevo:		**3**	**-**	**1**	**1**	**10**	**15**	
FOREST ESTATE NOVI SAD	Novi Sad	2	2	-	1	-	5	**14**
	Titel	-	-	-	-	2	2	
	Bačka Palanka	3	2	-	-	-	5	
	Futog	-	1	-	-	1	2	
Total Forest Estate Novi Sad:		**5**	**5**	**-**	**1**	**3**	**14**	
FOREST ESTATE SREMSKA MITROVICA	Klenak	1	-	-	-	-	1	**8**
	Kupinovo	-	-	1	-	4	5	
	Višnjićevo	-	-	-	-	2	2	
Total Forest Estate Sremska Mitrovica:		**1**	**-**	**1**	**-**	**6**	**8**	
FOREST ESTATE SOMBOR	Apatin	3	1	-	-	-	4	**22**
	Subotica	-	3	-	4	11	18	
Total Forest Estate Sombor:		**3**	**4**	**-**	**4**	**11**	**22**	
PUBLIC ENTERPRISE VODE VOJVODINE								
	Sombor	-	-	-	-	1	1	**1**
Total Public Enterprise Vode Vojvodine:		**-**	**-**	**-**	**-**	**1**	**1**	
PUBLIC ENTERPRISE NATIONAL PARK FRUŠKA GORA								
Working Unit Sremska Kamenica		6	1	1	-	3	11	**20**
Working Unit Beočin		2	-	2	-	1	5	
Working UnitVrdnik		-		2	-	1	3	
Working Unit Erdevik		-	-	-	-	1	1	
Total Public Enterprise National Park Fruška Gora:		**8**	**1**	**5**	**-**	**6**	**20**	
PUBLIC ENTERPRISE SRBIJAŠUME								
FOREST ESTATE BEOGRAD	Avala	2	-	-	-	3	5	**15**
	Lipovica	-	2		-	-	2	
	Rit	3	-	1	-	4	8	
Total Forest Estate Beograd:		**5**	**2**	**1**	**-**	**7**	**15**	
FOREST ESTATE BORANJA LOZNICA	Šabac	-	1	-	-	1	**2**	**4**
	Mali Zvornik	-	-	-	-	1	1	
	Valjevo	-	-	-	-	1	1	
Total Forest Estate Boranja Loznica:		**-**	**1**	**-**	**-**	**3**	**4**	
FOREST ESTATE SEVERNI KUČAJ KUČEVO	Kučevo	2	1	1	1	7	12	**26**
	Majdanpek	1	-	-	-	3	4	
	Žagubica	1	-	-	1	3	5	

FOREST USERS	FOREST DISTRICT	Year					Total	
		2003.	2004.	2005.	2006.	2007.	For Forest District	For Forest Estate
	Požarevac	-	-	-	-	5	5	
Total Forest Estate Severni Kučaj Kučevo:		**4**	**1**	**1**	**2**	**18**	**26**	
FOREST ESTATE JUŽNI KUČAJ DESPOTOVAC	Jagodina	1	-	1	1	7	10	**48**
	Ćuprija	8	1	-	2	6	17	
	Despotovac	6	3	2	4	4	19	
	Paraćin	-	1	-	-	1	2	
Total Forest Estate Južni Kučaj Despotovac:		**15**	**5**	**3**	**7**	**18**	**48**	
FOREST ESTATE RASINA KRUŠEVAC	Aleksandrovac	1	-	-	-	10	11	**60**
	Brus	7	5	1	1	17	31	
	Ražanj	2	-	1	-	4	7	
	Trstenik	-	2	-	-	5	7	
	Kruševac	-	-	-	-	4	4	
Total Forest Estate Rasina Kruševac:		**10**	**7**	**2**	**1**	**40**	**60**	
FOREST ESTATE GOLIJA IVANJICA	Čačak	1	-	-	-	-	1	**25**
	Ivanjica - Kušići	3	-	1	-	2	6	
	Devići	-	-	1	-	1	2	
	Sjenica	6	1	-	1	8	16	
Total Forest Estate Golija Ivanjica:		**10**	**1**	**2**	**1**	**11**	**25**	
FOREST ESTATE ŠUMARSTVO RAŠKA	Novi Pazar	1	-	-	-	4	5	**19**
	Tutin	-	-	1	1	9	11	
	Raška	-	-	-	2	1	3	
Total Forest Estate Šumarstvo Raška:		**1**	**-**	**1**	**3**	**14**	**19**	
FOREST ESTATE PRIJEPOLJE	Prijepolje	-	-	-	1	-	1	**19**
	Nova Varoš	1	-	-	-	-	1	
	Priboj	5	-	-	1	11	17	
Total Forest Estate Prijepolje:		**6**	**-**	**-**	**2**	**11**	**19**	
FOREST ESTATE UŽICE	Kosjerić	1	1	-	-	1	3	**21**
	Zlatibor	1	1	-	-	2	4	
	Užice	6	-	-	1	7	14	
Total Forest Estate Užice:		**8**	**2**	**-**	**1**	**10**	**21**	
FOREST ESTATE STOLOVI KRALJEVO	Ušće	1	-	-	-	2	3	**9**
	Kraljevo	3	-	-	-	3	6	
Total Forest Estate Stolovi Kraljevo:		**4**	**-**	**-**	**-**	**5**	**9**	
FOREST ESTATE LEPOSAVIĆ	Zubin Potok	1	-	-	-	1	2	**8**
	Leposavić	-	-	-	-	6	6	
Total Forest Estate Leposavić:		**1**	**-**	**-**	**-**	**7**	**8**	
FOREST ESTATE KRAGUJEVAC	Kragujevac	1	-	-	2	10	13	**16**
	Gornji Milanovac	-	-	-	-	3	3	
Total Forest Estate Kragujevac:		**1**	**-**	**-**	**2**	**13**	**16**	
FOREST ESTATE TOPLICA KURŠUMLIJA	Prokuplje	-	-	-	2	26	28	**60**
	Blace	-	-	-	-	2	2	
	Kuršumlija	-	-	-	-	30	30	

FOREST USERS	FOREST DISTRICT	Year					Total	
		2003.	2004.	2005.	2006.	2007.	For Forest District	For Forest Estate
Total Forest Estate Toplica Kuršumlija:		**-**	**-**	**-**	**2**	**58**	**60**	
FOREST ESTATE NIŠ	Aleksinac	6	-	-	1	31	38	**64**
	Niš – Bela Palanka	5	1	1	2	6	15	
	Sokobanja	4	1	-	-	6	11	
Total Forest Estate Niš:		**15**	**2**	**1**	**3**	**43**	**64**	
FOREST ESTATE ŠUMA LESKOVAC	Lebane	6	-	3	-	16	25	**45**
	Medveđa	2	-	1	1	5	9	
	Predejane	1	-	-	-	-	1	
	Vučje	1	-	-	1	5	7	
	Crna Trava	-	1	-	-	-	1	
	Vlasotince	-	-	1	-	1	2	
Total Forest Estate Leskovac:		**10**	**1**	**5**	**2**	**27**	**45**	
FOREST ESTATE VRANJE	Vranje	**-**	**-**	**-**	2	7	9	**24**
	Bosilegrad	**-**	**-**	**-**	-	3	3	
	Bujanovac	**-**	**-**	**-**	-	4	4	
	Surdulica	**-**	**-**	**-**	-	7	7	
	Vladičin Han	**-**	**-**	**-**	-	1	1	
Total Forest Estate Vranje:		**-**	**-**	**-**	**2**	**22**	**24**	
FOREST ESTATE PIROT	Pirot	-	-	2	1	7	10	**10**
Total Forest Estate Pirot:		**-**	**-**	**2**	**1**	**7**	**10**	
PUBLIC ENTERPRISE NATIONAL PARK KOPAONIK								
Total Public Enterprise National Park Kopaonik:		**-**	**-**	**-**	**-**	**-**	**-**	**0**
PUBLIC ENTERPRISE NATIONAL PARK TARA								
Working Unit Mitrovac		-	-	-	-	1	1	**5**
Working Unit Crni vrh		-	-	-	-	1	1	
Privat Forests - Rastište		1	-	-	-	2	3	
Total Public Enterprise National Park Tara:		**1**	**-**	**-**	**-**	**4**	**5**	
PUBLIC ENTERPRISE NATIONAL PARK ĐERDAP								
Working Unit Dobra		2	-	-	-	5	7	**21**
Working Unit Tekija		-	-	-	4	2	6	
Working Unit Donji Milanovac		-	-	-	-	8	8	
Total Public Enterprise National Park Đerdap:		**2**	**-**	**-**	**4**	**15**	**21**	
FACULTY OF FORESTRY – EXPERIMENTAL AREA								
Total Faculty of Forestry :		**-**	**-**	**-**	**-**	**-**	**-**	**0**
S R B I J A		**113**	**32**	**25**	**39**	**370**	**579**	**579**

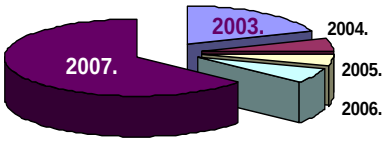
In the Republic of Serbia in the analyzed five-year-period 579 wildfires were reported. The most of them (370) occurred in 2007, then in 2003 (113),

whereas the situations in 2004 (32), 2005 (25) and 2006 (39) were very similar (Table 1).

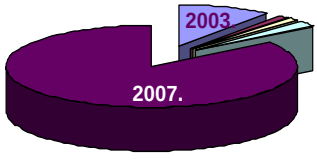
Table 2. *Fire-damaged areas of the forest stands in the period 2003-2007*

FOREST USERS	Fire-damaged area of the forest stands (ha)					Total (ha)
	2003.	2004.	2005.	2006.	2007.	
PUBLIC ENTERPRISE VOJVODINAŠUME						
FOREST ESTATE BANAT PANČEVO	46,40	-	9,00	18,00	618,62	692,02
FOREST ESTATE NOVI SAD	5,94	53,69	-	10,00	2,02	71,65
FOREST ESTATE SREMSKA MITROVICA	1,50	-	2,98	-	33,95	38,43
FOREST ESTATE SOMBOR	9,60	5,13	-	12,03	5,52	32,28
TOTAL PUBLIC ENTERPRISE VOJVODINAŠUME	**63,44**	**58,82**	**11,98**	**40,03**	**660,11**	**834,38**
PUBLIC ENTERPRISE VODE VOJVODINE						
TOTAL PUBLIC ENTERPRISE VODE VOJVODINE	**-**	**-**	**-**	**-**	**2,00**	**2,00**
PUBLIC ENTERPRISE NATIONAL PARK FRUŠKA GORA						
TOTAL PUBLIC ENTERPRISE NATIONAL PARK FRUŠKA GORA	**33,12**	**1,00**	**6,75**	**-**	**9,65**	**50,52**
PUBLIC ENTERPRISE SRBIJAŠUME						
FOREST ESTATE BEOGRAD		3,00	2,50	-	4,75	13,98
FOREST ESTATE BORANJA LOZNICA	-	5,40	-	-	3,65	9,05
FOREST ESTATE SEVERNI KUČAJ KUČEVO	63,85	10,00	60,00	43,00	674,44	851,29
FOREST ESTATE JUŽNI KUČAJ DESPOTOVAC	321,53	10,48	3,69	11,25	710,06	1057,01
FOREST ESTATE RASINA KRUŠEVAC	36,17	11,75	2,00	2,00	232,55	284,47
FOREST ESTATE GOLIJA IVANJICA	81,48	20,00	4,35	0,60	63,29	169,72
FOREST ESTATE ŠUMARSTVO RAŠKA	1,70	-	4,00	8,50	225,39	239,59
FOREST ESTATE PRIJEPOLJE	19,35	-	-	1,50	90,93	111,78
FOREST ESTATE UŽICE	35,35	2,15	-	1,00	69,90	108,40
FOREST ESTATE STOLOVI KRALJEVO	2,20	-	-	-	66,25	68,45
FOREST ESTATE LEPOSAVIĆ	95,03	-	-	-	722,76	817,79
FOREST ESTATE KRAGUJEVAC	5,00	-	-	8,50	87,49	100,99
FOREST ESTATE TOPLICA KURŠUMLIJA	-	-	-	1,05	1921,60	1922,65
FOREST ESTATE NIŠ	139,84	15,20	7,50	1,70	519,82	684,06
FOREST ESTATE	102,50	8,00	16,25	6,50	434,49	567,74

FOREST USERS	Fire-damaged area of the forest stands (ha)					Total (ha)
	2003.	2004.	2005.	2006.	2007.	
ŠUMA LESKOVAC						
FOREST ESTATE VRANJE	-	-	-	5,00	272,74	277,74
FOREST ESTATE PIROT	-	-	3,54	16,50	676,90	696,94
TOTAL PUBLIC ENTERPRISE SRBIJAŠUME	**907,73**	**85,98**	**103,83**	**107,10**	**6777,01**	**7981,65**
PUBLIC ENTERPRISE NATIONAL PARK KOPAONIK						
TOTAL PUBLIC ENTERPRISE NATIONAL PARK KOPAONIK	-	-	-	-	-	-
PUBLIC ENTERPRISE NATIONAL PARK TARA						
TOTAL PUBLIC ENTERPRISE NATIONAL PARK TARA	**0,25**	-	-	-	**55,15**	**55,40**
PUBLIC ENTERPRISE NATIONAL PARK ĐERDAP						
TOTAL PUBLIC ENTERPRISE NATIONAL PARK ĐERDAP	**0,50**	-	-	**68,74**	**879,61**	**948,85**
FACULTY OF FORESTRY – EXPERIMENTAL AREA						
TOTAL FACULTY OF FORESTRY	-	-	-	-	-	-
S E R B I A	**1005,04**	**145,80**	**122,56**	**215,87**	**8383,53**	**9872,80**



Graph 1. *The number of the wildfires in the period 2003-2007*



Graph 2. *The size of the fire-damaged forest areas in the period 2003-2007*

The analysis of the data presented in Tables 1 and 2, as well as in Graphs 1 and 2, lead to the conclusion that by average per a wildfire in 2003 the significantly smaller area was damaged than in 2007 (8.89 ha : 22.66 ha). Averagely, per a wildfire in 2004, 4.56 ha of forest stands were damaged, in 2005, 4.90 ha, and in 2006, 5.53 ha. Generally speaking, in the observed five-year-period there was a positive correlation between the number of wildfires and average fire-damaged area.

Due to the type of the forest ecosystems, there are certain conditions which influence the occurrence, extension and duration of the wildfires, such as the presence of the dry soil cover and type of the density, i.e. inflammability of it.

According to the quantity and content of the initial burning material (type of tree), climate, soil and exposition, the areas covered by forests are

classified into four groups according to the endangerment level:

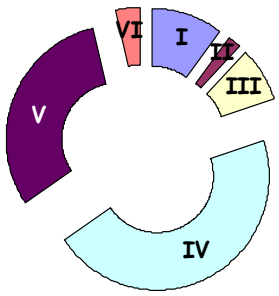
- areas of extreme endangerment
- areas of very high endangerment
- areas of high endangerment
- areas of the low endangerment

In regard to only type of the tree, forest ecosystems in Republic of Serbia were classified by the appropriate levels of endangerment by the wildfires in the following way:

- first level: stands and cultures of pines and larch trees
- second level: stands and cultures of spruce, fir and other conifers
- third level: mixed stands and cultures of deciduous and conifer trees
- fourth level: stands and cultures of oak and hornbeam
- five level: stands of beech and other deciduous trees
- sixth level: shrubberies and glades

For the each level of endangerment, according to the Law on Forests, on the common and specific bases, as well as by the programs of management, the measures aimed the protection from the wildfires, the most important of which are preventive ones, are prescribed.

Graph 3. *Fire-damaged forest areas from some levels of the endangerment by wildfires*



The forest cover in Serbia is 27 %, or 2.3 million ha. Around 56% of this area, 60% of the volume, and 62.5% of the volume increment are state-owned, i.e. 44% of the area, 40% of the volume, and 37. 5% of the volume increment are state-owned.

The percentage of the type of trees in the total volume is: beech 47%, oak 25%, poplar 1%, other deciduous trees 16%, spruce 5%, fir 3%, pine 2%, and the other conifers 1%. In this paper all the wildfires which occurred in the forest stands which are state-owned, and the smaller number of the stands which private-owned, are analyzed. It was not possible to obtain the accurate data on the forests in the private-owned forests in some regions of Serbia, but the general indicators point to the fact that the situation was similar as in the state-owned forests.

In the observed five-year-period, 41.14 % of the fire-damaged area of the forest stands is of the IV level of the endangerment by the wildfires, 29.87% is of the V level, 9.94% is of the I level, 7.50% is of the III level, and 1.81 % of the II level (Graph 3). When it is compared with the percentage of some species in the aforesaid total wood volume, the ratio is following: oak stands 29.87%:25%, beech and other deciduous trees stands 9.94%:64%, conifer trees 19.25%:11% (Table 3, Graph 3).

Table 3. *Fire-damaged areas of the forest stands in the period 2003-2007 within the appropriate levels of endangerment by wildfires*

FOREST USERS	N / P (ha)	Type of the wildfire										
		I	II	III	IV	V	VI	I/II-V	IV-I	I/V	I-II	IV-V
PUBLIC ENTERPRISE VOJVODINAŠUME												
FOREST ESTATE BANAT PANČEVO	N	-	-	1	-	12	2	-	-	-	-	-
	P (ha)	-	-	449,46	-	233,06	9,50	-	-	-	-	-
FOREST ESTATE NOVI SAD	N	-	-	-	-	14	-	-	-	-	-	-
	P (ha)	-	-	-	-	71,65	-	-	-	-	-	-
FOREST ESTATE SR. MITROVICA	N	-	-	-	6	2	-	-	-	-	-	-
	P (ha)	-	-	-	34,93	3,50	-	-	-	-	-	-
FOREST ESTATE SOMBOR	N	10	-	3	1	7	-	-	-	-	-	-
	P (ha)	3,64	-	11,55	5,00	12,09	-	-	-	-	-	-
TOTAL PE VOJVODINAŠUME	**N**	**10**	**-**	**4**	**7**	**35**	**2**	-	-	-	-	-
	P (ha)	**3,64**	**-**	**461,01**	**39,93**	**320,30**	**9,50**	-	-	-	-	-
PUBLIC ENTERPRISE VODE VOJVODINE												
TOTAL PE VODE VOJVODINE	**N**	**-**	**-**	**-**	**-**	**1**	**-**	-	-	-	-	-
	P (ha)	**-**	**-**	**-**	**-**	**2,00**	**-**	-	-	-	-	-
PUBLIC ENTERPRISE NATIONAL PARK FRUŠKA GORA												
TOTAL PE NP FRUŠKA GORA	**N**	**2,5**	-	**-**	**1**	**15,5**	**1**	-	-	-	-	-
	P (ha)	**5,90**	-	**-**	**4,70**	**39,17**	**0,75**	-	-	-	-	-
PUBLIC ENTERPRISE SRBIJAŠUME												
FOREST ESTATE BEOGRAD	N	6	-	-	1	8	-	-	-	-	-	-
	P (ha)	2,98	-	-	1,50	9,50	-	-	-	-	-	-
FOREST ESTATE BORANJA LOZNICA	N	3	-	-	-	1	-	-	-	-	-	-
	P (ha)	3,65	-	-	-	5,40	-	-	-	-	-	-
FOREST ESTATE SEVERNI KUČAJ	N	6,83	-	-	0,5	14,33	2,33	2	-	-	-	-
	P (ha)	41,70	-	-	11,00	538,17	172,77	87,65	-	-	-	-
FOREST ESTATE JUŽNI KUČAJ	N	8	1	-	14	24	-	-	1	-	-	-
	P (ha)	148,91	1,00	-	482,33	392,77	-	-	32,00	-	-	-

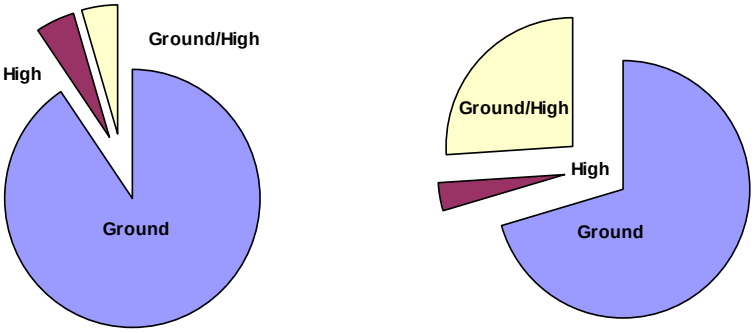
FOREST USERS	N	Type of the wildfire										
	P (ha)	I	II	III	IV	V	VI	I/II-V	IV-I	I/V	I-II	IV-V
FOREST ESTATE RASINA KRUŠEVAC	N	7,33	2,33	-	32,5	15,83	1	-	-	1	-	-
	P (ha)	35,31	32,20	-	152,22	39,74	15,00	-	-	10,00	-	-
FOREST ESTATE GOLIJA IVANJICA	N	8	2	1	6	3	1	-	-	-	3	1
	P (ha)	56,62	2,40	10,00	39,80	6,60	15,00	-	-	-	31,20	8,10
FOREST ESTATE ŠUMARSTVO RAŠKA	N	3,5	11,5	-	2,5	1,5	-	-	-	-	-	-
	P (ha)	143,21	49,10	-	38,08	9,20	-	-	-	-	-	-
FOREST ESTATE PRIJEPOLJE	N	8	2	-	4	3	1	1	-	-	-	-
	P (ha)	13,90	1,45	-	56,52	24,91	5,0	10,00	-	-	-	-
FOREST ESTATE UŽICE	N	15	-	1	4	-	-	-	-	-	-	1
	P (ha)	49,15	-	2,00	57,20	-	-	-	-	-	-	0,05
FOREST ESTATE STOLOVI KRALJEVO	N	4	-	-	2	-	-	-	3	-	-	-
	P (ha)	12,00	-	-	1,20	-	-	-	55,25	-	-	-
FOREST ESTATE LEPOSAVIĆ	N	2	-	1	3	-	-	2	-	-	-	-
	P (ha)	2,60	-	95,03	712,16	-	-	8,00	-	-	-	-
FOREST ESTATE KRAGUJEVAC	N	N	5,83	-	-	8,33	1,83	-	-	-	-	-
	P (ha)	P (ha)	35,10	-	-	35,53	30,36	-	-	-	-	-
FOREST ESTATE TOPLICA	N	8	-	-	50	-	2	-	-	-	-	-
	P (ha)	14,85	-	-	1887,8	-	20,00	-	-	-	-	-
FOREST ESTATE NIŠ	N	24,5	5	-	13,5	12	9	-	-	-	-	-
	P (ha)	59,22	25,20	-	97,45	447,17	55,02	-	-	-	-	-
FOREST ESTATE ŠUMA LESKOVAC	N	19,5	2	-	15,5	6	1	-	-	-	-	1
	P (ha)	36,48	5,51	-	435,60	12,15	8,00	-	-	-	-	70,00
FOREST ESTATE VRANJE	N	9	2	1	7,5	4,5	-	-	-	-	-	-
	P (ha)	71,34	10,50	118,00	55,00	22,90	-	-	-	-	-	-
FOREST ESTATE PIROT	N	5,33	0,75	-	0,58	3,33	-	-	-	-	-	-
	P (ha)	280,20	15,60	-	6,17	394,97	-	-	-	-	-	-
TOTAL PE SRBIJAŠUME	**N**	**136**	**34,41**	**4**	**156,58**	**104,82**	**19,16**	**5**	**4**	**1**	**3**	**3**
	P (ha)	**972,12**	**177,52**	**225,03**	**4034,03**	**1939,01**	**321,15**	**105,65**	**87,25**	**10,00**	**31,20**	**78,15**
PUBLIC ENTERPRISE NATIONAL PARK TARA												
TOTAL PE	**N**	**-**	**1**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**

FOREST USERS	N	Type of the wildfire										
	P (ha)	I	II	III	IV	V	VI	I/II-V	IV-I	I/V	I-II	IV-V
NP TARA	P (ha)	-	1,00	54,25	-	-	0,15	-	-	-	-	-
PUBLIC ENTERPRISE NATIONAL PARK ĐERDAP												
TOTAL PE NP ĐERDAP	N	-	-	-	4,33	15,33	1,33	-	-	-	-	-
	P (ha)	-	-	-	279,63	648,22	21,00	-	-	-	-	-
S E R B I A	N	149	36	10	170	172	26	5	4	1	3	3
	P (ha)	981,66	178,52	740,29	4358,29	2948,70	353,09	105,65	87,25	10,00	31,20	78,15

Table 4. *Areas of the forest stands endangered by the ground and high wildfires in the period 2003-2007*

FOREST USERS	Type of the wildfire						Total	
	Ground		High		Ground/High			
	N *(%)*	ha *(%)*	N *(%)*	ha *(%)*	N *(%)*	ha *(%)*	N	ha
FOREST ESTATE BANAT PANČEVO	14 *(93,3)*	242,56 *(35,1)*			1 *(6,7)*	449,46 *(64,9)*	15	692,02
FOREST ESTATE NOVI SAD	14 *(100)*	71,65 *(100)*					14	71,65
FOREST ESTATE SR. MITROVICA	8 *(100)*	38,43 *(100)*					8	38,43
FOREST ESTATE SOMBOR	22 *(100)*	32,28 *(100)*					22	32,28
PUBLIC ENTERPRISE VODE VOJVODINE	1 *(100)*	2,00 *(100)*					1	2,00
PE NP FRUŠKAGORA	20 *(100)*	50,52 *(100)*					20	50,52
FOREST ESTATE BEOGRAD	15 *(100)*	13,98 *(100)*					15	13,98
FOREST ESTATE BORANJA	3 *(75,0)*	6,97 *(77,0)*	1 *(25,0)*	2,08 *(23,0)*			4	9,05
FOREST ESTATE SEVERNI KUČAJ	22 *(84,6)*	500,49 *(58,8)*			4 *(15,4)*	350,80 *(41,2)*	26	851,29
FOREST ESTATE JUŽNI KUČAJ	46 *(95,8)*	1007,02 *(95,3)*	2 *(4,2)*	49,99 *(4,7)*			48	1057,01
FOREST ESTATE RASINA	59 *(98,3)*	280,97 *(98,8)*	1 *(1,7)*	3,50 *(1,2)*			60	284,47
FOREST ESTATE GOLIJA	22 *(88,0)*	118,52 *(69,8)*	3 *(12,0)*	51,20 *(30,2)*			25	169,72
FOREST ESTATE ŠUMARSTVO	8 *(42,1)*	32,0 *(13,4)*	9 *(47,4)*	85,06 *(35,5)*	2 *(10,5)*	122,53 *(51,1)*	19	239,59
FOREST ESTATE PRIJEPOLJE	18 *(94,7)*	110,38 *(98,7)*	1 *(5,26)*	1,40 *(1,3)*			19	111,78
FOREST ESTATE UŽICE	21 *(100)*	108,40 *(100)*					21	108,40
FOREST ESTATE STOLOVI	5 *(55,6)*	2,5 *(3,6)*	1 *(11,1)*	1,00 *(1,5)*	3 *(33,3)*	64,95 *(94,9)*	9	68,45
FOREST ESTATE LEPOSAVIĆ	3 *(37,5)*	458,00 *(56,0)*	1 *(12,5)*	95,03 *(11,6)*	4 *(50,0)*	264,76 *(32,4)*	8	817,79
FOREST ESTATE KRAGUJEVAC	15 *(93,7)*	100,74 *(99,7)*	1 *(6,3)*	0,25 *(0,3)*			16	100,99
FOREST ESTATE TOPLICA	52 *(86,6)*	1216,90 *(63,3)*	1 *(1,7)*	0,20 *(0,01)*	7 *(11,7)*	705,55 *(36,7)*	60	1922,65
FOREST ESTATE NIŠ	62 *(96,9)*	659,06 *(96,3)*	2 *(3,1)*	25,00 *(3,7)*			64	684,06
FOREST ESTATE ŠUMA LESKOVAC	41 *(91,1)*	553,94 *(97,6)*	4 *(8,9)*	13,80 *(2,4)*			45	567,74
FOREST ESTATE VRANJE	23 *(95,8)*	273,94 *(98,6)*	1 *(4,2)*	3,80 *(1,4)*			24	277,74
FOREST ESTATE PIROT	6 *(60,0)*	124,42 *(17,8)*	1 *(10,0)*	15,20 *(2,2)*	3 *(30,0)*	557,32 *(80,0)*	10	696,94

FOREST USERS	Type of the wildfire						Total	
	Ground		High		Ground/High			
	N (%)	ha (%)	N (%)	ha (%)	N (%)	ha (%)	N	ha
PE NP TARA	3 *(60,0)*	0,40 *(0,7)*	1 *(20,0)*	1,00 *(1,8)*	1 *(20,0)*	54,00 *(97,5)*	5	55,40
PE NP ĐERDAP	21 *(100)*	948,85 *(100)*					21	948,85
TOTAL	**524**	**6954,92**	**30**	**348,51**	**25**	**2569,37**	**576**	**9872,80**



a) **b)**

Graph 4. *The number of wildfires (a) and fire-damaged area (b) within the different types of the wildfires in the period 2003-2007*

3.2 Annual dynamics of the occurrence of the wildfires

The occurrence of the wildfires in the forest mainly depends upon the weather conditions and humidity of the burning material. Since these factors continue to alter over the year, there is different number of wildfires which can occur in some months.

They can occur in each month, but according to the analysis of the results of the fifty-year monitoring three critical periods can be singled out. The first of them is the early spring (from March to mid-April), second one is summer (from mid-July to late August), and third one is in the autumn (from the early September to mid-October).

The condition favourable to the occurrence of the spring wildfires is the certain quantity of the dry litter such as branches and twigs, which are easily inflammable and very prone to combustion, in the forest stands. In this period the precipitation is lower, the strong winds are frequenter, the snow melts, the burning material is scarce with the humidity. In addition, it is the beginning of the season of the agricultural activities, the plots are cleaned out of the weeds and other waste materials. The agriculturists tend to burn them collected in a

heap. However, due to air circulations the flame originated in this way is most occasionally spread to the forest stands in the vicinity.

In the following period the conditions are less favourable to the occurrence of the wildfires due to vegetation thriving and plant material development, which is resistant against burning and combustion (green grass, new succulent young leaves on the trees and bushes), and spring rains are more frequent.

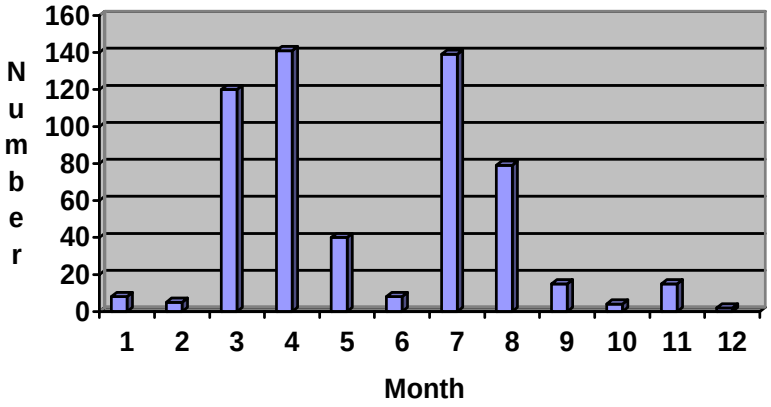
July and August are characterized by the high air and soil temperatures, low relative humidity, and thereby the lack of precipitation, ripening and drying of the grass vegetation, but also by the abrupt occurrence of the greater number of people (wildfire initiators) who visit forests (tourists, hikers). The similar situation is reported to the mid-October. As the year approaches the end, the conditions for the occurrence of the wildfires become less favourable.

Table 5. *Annual dynamics of the occurrence of the wildfires in the period 2003-2007*

FOREST USERS	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
PUBLIC ENTERPRISE VOJVODINAŠUME												
FOREST ESTATE BANAT	1	1	4	3	1	-	5	-	-	-	-	-
FOREST ESTATE NOVI SAD	-	-	6	-	1	-	1	4	1	-	1	-
FOREST ESTATE SR. MITROVICA	-	1	1	1	-	2	1	2	-	-	-	-
FOREST ESTATE SOMBOR	-	-	2	9	5	1	2	1	2	-	-	-
PUBLIC ENTERPRISE NATIONAL PARK FRUŠKA GORA												
PE NP FRUŠKA GORA	2	1	5	8	-	-	1	1	1	-	1	-
PUBLIC ENTERPRISE SRBIJAŠUME												
FOREST ESTATE BEOGRAD	-	-	3	4	-	-	6	1	1	-	-	-
FOREST ESTATE BORANJA	-	-	1	-	-	-	3	-	-	-	-	-
FOREST ESTATE SEVERNI KUČAJ	-	-	7	8	1	-	6	2	-	1	1	-
FOREST ESTATE JUŽNI KUČAJ	1	-	7	8	3	-	11	15	1	2	-	-
FOREST ESTATE RASINA	-	-	18	12	1	-	16	9	1	1	2	-

FOREST USERS	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
FOREST ESTATE GOLIJA	-	-	4	6	7	-	5	1	-	-	1	1
FOREST ESTATE RAŠKA	-	-	1	5	1	-	4	6	1	-	1	-
FOREST ESTATE PRIJEPOLJE	-	-	5	7	3	-	1	1	-	-	-	-
FOREST ESTATE UŽICE	-	-	3	3	1	1	8	2	3	-	-	-
FOREST ESTATE STOLOVI	-	-	3	-	1	-	3	1	-	-	1	-
FOREST ESTATE LEPOSAVIĆ	-	-	2	-	-	-	5	1	-	-	-	-
FOREST ESTATE KRAGUJEVAC	-	-	3	1	-	1	10	-	-	-	1	-
FOREST ESTATE TOPLICA	-	-	9	21	-	-	19	11	-	-	-	-
FOREST ESTATE NIŠ	1	1	8	20	13	2	5	11	2	-	1	-
FOREST ESTATE ŠUMA	2	-	7	11	1	1	14	6	1	-	2	-
FOREST ESTATE VRANJE	-	1	15	5	1	-	1	-	1	-	-	-
FOREST ESTATE PIROT	1	-		3	-	-	6	-	-	-	-	-
PUBLIC ENTERPRISE NATIONAL PARK TARA												
PE NP TARA	-	-	-	-	-	-	1	4	-	-	-	-
PUBLIC ENTERPRISE NATIONAL PARK ĐERDAP												
PE NP ĐERDAP	-	-	6	6	-	-	5	-	-	-	3	1
S E R B I A	**8**	**5**	**120**	**141**	**40**	**8**	**139**	**79**	**15**	**4**	**15**	**2**

2 wildfires in Forest Estate Prijepolje and 1 in Public Enterprise Vode Vojvodina without date.



Graph 5. *Annual dynamics of the occurrence of the wildfires in the period 2003-2007*

The practical significance of the knowledge on the annual dynamics of the occurrence of the wildfires is reflected in the possibility of applying timely and appropriate measures of readiness and organisation of the fire protection in the forest management units and directorates.

3.3 Annual dynamics of the occurrence of wildfires for the five-year period

The factors which influence the combustion, in 24 hours, are subject to certain oscillations. Therefore, the intensity of the wildfire sustain great changes and has four phases.

*Phase A - time: 10-18 hours (*This is the warmest part of the day. All factors which are relevant to the development of wildfires are expressed to a maximum – low humidity and high air temperature, the strongest sunlight, wind, dry burning material, sparks and twinkles are formed and fly around... In this phase, the wildfires are most resistant to containing in its all main points.)

Phase B - time: 18-04 hours (When the evening comes, the wind is more still, air cools, relative humidity increases, burning material absorbs humidity from the air. These changes become more intensive at night, until 4 a.m, when the conditions for the fire extinguish are most favourable).

*Phase C - time: 04-06 hours (*Upon the gradual decrease of the intensity of burning at night, the fire intensifies again. The greatest result of the activities aimed at containment of wildfires in the forest can be achieved in period 18-06 hours.)

*Phase D - time: 06-10 hours (*In this period small pockets begin to emit smoke, smoldering fire turns into flame and advances at a fast pace. Separate, isolated parts of the wildfire connect and form single fire front. The wind is

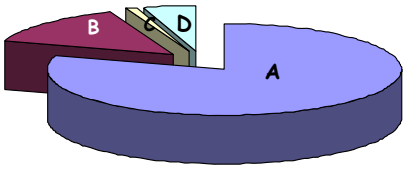
greater, humidity decreases, the air temperature becomes higher. The extingushing conditions get worse. Since 8 to 10 a.m. the wildfire again enters its most dangerous A phase.)

Table 6. *Annual dynamics of the occurrence of the wildfires in the period 2003-2007*

Forest Estate	phase A 10-18 hours	phase B 18-04 hours	phase C 04- 06 hours	phase D 06-10 hours	Unknown time
PUBLIC ENTERPRISE VOJVODINAŠUME					
BANAT PANČEVO	6	1	-	-	8
NOVI SAD	10	1	-	-	3
SREMSKA MITROVICA	2	2	-	-	4
SOMBOR	16	2	-	1	3
PUBLIC ENTERPRISE NATIONAL PARK FRUŠKA GORA					
FRUŠKA GORA	1	-	-	1	18
PUBLIC ENTERPRISE SRBIJAŠUME					
BEOGRAD	1	-	-	-	14
BORANJA LOZNICA	3	-	-	-	1
SEVERNI KUČAJ	4	2	-	2	18
JUŽNI KUČAJ	3	1	-	-	44
RASINA KRUŠEVAC	40	5	-	2	13
GOLIJA IVANJICA	18	2	-	-	5
RAŠKA	8	-	-	-	11
PRIJEPOLJE	-	-	-	-	-
UŽICE	-	-	-	-	-
STOLOVI KRALJEVO	7	-	-	-	2
LEPOSAVIĆ	4	-	-	-	3
KRAGUJEVAC	10	3	-	-	3

Forest Estate	phase A 10-18 hours	phase B 18-04 hours	phase C 04- 06 hours	phase D 06-10 hours	Unknown time
TOPLICA KURŠUMLIJA	25	7	1	3	24
NIŠ	37	6	1	2	18
ŠUMA LESKOVAC	-	-	-	-	45
VRANJE	16	2	1	2	3
PIROT	-	-	-	-	10
PUBLIC ENTERPRISE NATIONAL PARK TARA					
TARA	-	-	-	-	**5**
PUBLIC ENTERPRISE NATIONAL PARK ĐERDAP					
ĐERDAP	3	4	-	-	14
S E R B I A	**214**	**38**	**3**	**13**	**269**

Graph 6. *Annual dynamics of the occurrence of the wildfires in the perios 2003-2007*



The greatest number of the wildfires in the observed five-year-period is initiated in the phase A, i.e. when the conditions for the fast and successful containment are most favourable. The initial time is not known for 269 wildfires, but it can be concluded indirectly that most of them occurred in this part of day, since it was reported that they were mostly caused by man, during the agricultural works.

3.4 Initiators of the wildfires in the observed period

The analysis of the initiators of the wildfires is necessary in order to determine the level of the danger of the re-occurrence of them, but also enables the correct estimation of the target groups which should be educated in this area.

a) Human activity

Agriculturalists: The private-owned soil is to be found in almost all management units in the area covered by forests in Serbia. By doing preparatory agricultural activities (clearance, grass removal and burning) and other ones, the population in the vicinity of the forests pose the permanent and great danger because they might cause wildfires.

Collectors of the forest fruits: In the fire season many people and children go to the forest in order to collect different forest fruits (fungi, strawberries, black berries, dog-roses, medicinal plants). During their stay, due to carelessness and neglectfulness they can cause wildfire by a non-extinguished cigarette or making an open fire.

Medical and hiking tourism: The most of the weekend vacation areas are situated in the very vicinity of the forest stands. Very often, by neglectfulness, by burning of waste material which cannot be safely removed, the wildfire which easily spreads to the surrounding area is caused. There are numerous examples of this, and one of the most recent is the neglectfulness of the weekenders in the area of Zavoj Management Unit (Forest Estate Pirot) in 2007. On that occasion uncontrolled burning of litter caused the burning of dozens hectares of pine cultures. The hotel guests practically spend every day out of their rooms, in the forests, where they walk and sunbathe all day. The critical periods are weekends and state holidays, when a great number of motorized hikers come to one-day or two-day excursions. This group of the potential initiators of wildfires is very dangerous, since they penetrate deep in the forest, where they make fire for the preparation of food, which they place next to the trees. They also frequently leave non-extinguished embers behind, which in the combination with the weak air circulation can blaze up fire and spread it to the areas in the vicinity.

Hunters and fishermen: The hunters and fishermen which live nearby, cross and move through the forest can also cause wildfire, either by making an open fire in order to prepare food, or by throwing away the non-extinguished cigarettes.

Electrification and railway traffic: The high voltage and low voltage spark of electrical network, as well as train sparking produced when they pass through forest areas, can sometimes cause wildfires.

b) Natural disasters

Storm and thunder: Electrical discharge in the atmosphere are particularly dangerous in the hilly-mountainous areas and places where the individual trees are very high and abundant and as a result dominate the area and are often the target of the flesh of lightning.

Table 7. *Initiators of the wildfires in the period 2003-2007*

Forest users	Initiators of the wildfires											
	Man		Thunder		Electrical line and train		Transferred		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Banat Pančevo									15	100	15	100
Novi Sad	10	71,4							4	28,6	14	100
Sremska Mitrovica	2	25,0							6	75,0	8	100
Sombor	1	4,6							21	95,4	22	100
PE VodeVojvodine	1	100									1	100
PENP Fruška Gora									20	100	20	100
Beograd	12	80,0							3	20,0	15	100
Boranja Loznica	2	50,0							2	50,0	4	100
Severni Kučaj	20	76,9							6	23,1	26	100
Južni Kučaj	34	70,8							14	29,2	48	100
Rasina Kruševac	50	83,3							10	16,7	60	100
Golija Ivanjica	19	76,0							6	24,0	25	100
Šumarstvo Raška	8	42,1			1	5,3	2	10,5	8	42,1	19	100
Prijepolje	10	52,6	1	5,3	2	10,5			6	31,6	19	100
Užice	16	76,2	3	14,3					2	9,5	21	100
Stolovi Kraljevo	9	100									9	100
Leposavić	4	50,0			3	37,5			1	12,5	8	100
Kragujevac	4	25,0			2	12,5			10	62,5	16	100
Toplica Kuršumlija	55	91,7							5	8,3	60	100
Niš	63	98,4							1	1,6	64	100
Šuma Leskovac	40	88,9							5	11,1	45	100
Vranje	20	83,3							4	16,7	24	100
Pirot	9	90,0							1	10,0	10	100
PE NP Tara	3	60,0	2	40,0							5	100
PE NP Đerdap									21	100	21	100
Total	**391**	**67,9**	**6**	**1,0**	**8**	**1,4**	**2**	**0,3**	**169**	**29,4**	**576**	**100**

By the analysis of the data presented in Table 7, we come to the dismal conclusion that man, in regard with the wildfires, is the most important destructor of the forest stands in Serbia. Undoubtedly, humans caused 399 (69.3%) wildfires, and probably the majority of the ones the causes of which are unknown (169 or 29.4%). Agricultural works aimed at the preparation for sowing, which are in Serbia still performed in a rather primitive way, by burning the remains of the previous crops, are dominant in the human activities. In only six cases nature exhibited its capricious manners. Two wildfires in the observed period started in Kosovo and spread to the areas in the vicinity.

3.5 Wildfires and biotic causes of the damages

Wildfires in the conifer cultures and stands are by its character and harmful effects more significant then these in the deciduous ones. The wood in the fire-damaged areas burn quickly, which leads to the disappearance of the original stand. Upon cleaning and rehabilitation, it is necessary to conduct reforestation, in order to provide conditions for the re-establishment of the natural harmony. Under the current conditions, the fire-damaged areas are mainly healed, i.e. reforested by the Austrian and Scotch pines. There are two main types of the pine cultures: cultures established in the typical upper forest zone of conifers and these established on the untypical habitats, mainly the habitats of oak and other deciduous trees, in the valleys. Artificially established stands in the lower forest zone are developed by the ecological conditions which greatly differ from these in the upper zone. The health condition of the seedlings and cultures in the fire-damaged areas to a great extent depends on the presence of the biotic harmful factors, mainly on phytofag organisms.

The increase in the number of species and plentitude of some groups of phytofags is mainly the consequence of the formation of the greater number of ecological niches in the fire-damaged areas. It mainly refers to the feeding and availability of the appropriate type of food. In the fire-damaged areas the great quantities of the dry and partially burnt wood, which serves as the perfect base for the development of the significant insect species, mainly from order *Coleoptera*, i.e. families *Cerambycidae*, *Buprestidae* and *Scolytidae*, remain. The succession of the species of phytofag insects occur in the partially burnt parts of the trees, which depends on the remaining plant cover and measures which are taken and aimed at rehabilitation.

In the places where the wildfire destroy forest vegetation, grass plots with the important participation of the indigenous deciduous tree types, spontaneously conquering their natural habitats, re-establish. The altered content of phytocenosis causes the important changes in zoocenosis as well, which is reflected in the succession of the species which are typical for the open habitats and the feeding of which is related to the plant species, of which the newly-formed phytocenosis is made. Entomofauna in these communities differs greatly from the one in the areas where cleaning has not been conducted and in which a lot of dry and partially-burnt dry trees and twigs remain, and by its content and plentitude, is very similar to the entomofauna from the surrounding area which is not fire-damaged. In such ecosystems the presence of the species from families *Chrysomelidae* and *Curculionidae*, since the feeding of them is mainly based on leaf consumption, is reported.

In the areas in which cleaning was performed, in the forms of the sanitary felling and re-establishment of the forest order, in the places where the branches and felled wood material were collected, xylofag insects develop.

The partially-burnt trees are favourable to the large-scale multiplication of the species which are both typical and non-typical for the areas with such conditions.

The wildfires and extreme temperature which is emitted by fire influence the soil, by transforming and reducing the organic and non-organic matter, particularly influencing the reduction of the microbial activity of soil microorganisms.

During the wildfire a great quantity of organic compounds is emitted: hydrocarbons, polycyclic aromatic hydrocarbons (PAH), phenol derivatives and solid substances (soot, tar). A part of them remain in the soil where they become part of the matter flow chain by the bioaccumulation of the absorbed toxins in the soil, water and living organisms, as well as by increasing of the pollution concentration in food chain, and reduction of the physiological activities of plants.

After rehabilitation and reforestation, young plants are particularly sensitive and the vitality of them is very endangered, since the environmental conditions, particularly soil conditions differ greatly from the conditions in the facilities in which the seedlings were produced had at their disposal all the conditions which are necessary for the normal, undisturbed development. Owing to a decrease in vitality, they become liable to the influence of the numerous harmful biotic factors, which are present in this and the surrounding area. By the application of the selected measures of care and protection, their vitality should be raised to the appropriate level and it should be enabled to them to grow and develop until they reach the appropriate vitality, which is important to the survival of the newly-established cultures.

4. CONCLUSION

The data on the dynamics of the wildfires in Serbia and some regions of it published in the domestic scientific press or presented at various consultations and seminars, leads to the clear conclusion that this occurrence cannot be considered occasional anymore.

The frequent occurrence of the wildfires and extreme increase of the fire-damaged areas, which were reported worldwide in the last decade, are mainly the results of the global change of the climate conditions, such as melting and decrease of the average precipitation, particularly in the periods which are critical to the wildfire initiation.

In the Republic of Serbia in the period 2003-2007, 579 wildfires were reported. The most of them (370) occurred in 2007, then in 2003 (113), whereas the situation in 2004 (32), 2005 (25) and 2006 (39) are very similar. Averagely, per a wildfire in 2004, 4.56 ha of forest stands were damaged, in 2005, 4.90 ha,

and in 2006, 5.53 ha. Generally speaking, in the observed five-year-period there was a positive correlation between the number of wildfires and average fire-damaged area.

In the observed five-year-period, 41.14 % of the fire-damaged area of the forest stands is of the IV level of the endangerment by the wildfires, 29.87% is of the V level, 9. 94% is of the I level, 7.50% is of the III level, and 1.81 % of the II level (Graph 3). When it is compared with the percentage of some species in the aforesaid total wood volume, the ratio is following: oak stands 29.87% :25%, beech and other deciduous trees stands 9.94%: 64%, conifer trees 19.25% : 11%.

The annual dynamics of the occurrence of the wildfires in Republic of Serbia in period 2003-2007 is identical with the 50-year average and is a perfect proof of the justifiability of emphasizing the aforesaid critical periods. The majority of the wildfires were initiated in phase A, i.e. at the time when the conditions for the fast and successful containing of them are least favourable. The initial time is not known for 269 wildfires, but it can be concluded indirectly that most of them occurred in this part of day, since it was reported that they were mostly caused by man, during the agricultural works.

By the analysis of the data presented in this paper, we come to the dismal conclusion that man, in regard with the wildfires, is the most important destructor of the forest stands in Serbia. Undoubtedly, humans caused 399 (69.3%) wildfires, and probably the majority of the ones the causes of which are unknown (169 or 29.4%). Agricultural works aimed at the preparation for sowing, which are in Serbia still performed in a rather primitive way, by burning the remains of the previous crops, are dominant in the human activities. In only six cases nature exhibited its capricious manners. Two wildfires in the observed period started in Kosovo and spread to the areas in the vicinity.

Wildfires in the conifer cultures and stands are by its character and harmful effects more significant then these in the deciduous ones. The wood in the fire-damaged areas burn quickly, which leads to the disappearance of the original stand.

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WILDFIRES IN SERBIA – CHANCE OR FREQUENT PHENOMENON

Mara TABAKOVIĆ-TOŠIĆ, Miroslava MARKOVIĆ, Snežana RAJKOVIĆ, Milorad VESELINOVIĆ

Summary

Wildfires used to be considered unbridled elements, which irregularly, occur by no definite reason, although it was always known that they cause the catastrophic consequences. However, the history of forestry teaches us that the forests on each continent regularly sustained the consequences of this disaster, and they must have been of the major causes for the decrease of forest cover to modern insufficient levels.

In the multi-decade development of the forestry in our country, the problem of the wildfires has not always been treated with the maximum attention, although the frequency of them and scope of the damages which they caused made it necessary.

The greatest attention and maximum activities in the struggle with wildfires were most usually exhibited in the critical years, when they frequently occurred. Nevertheless, our attention became less intensive in the period when the wildfires occur less frequently, and as a result were often caught unprepared by the new occurrences of the wildfires and unable to tackle it successfully. The fact that the number of the wildfires occurred in the forests of our country was sometimes higher than the permitted level and show tendency of the permanent growth, is one more proof of it. The data on the dynamics of the wildfires in Serbia and some regions of it published in the domestic scientific press or presented at various consultations and seminars, leads to the clear conclusion that this occurrence cannot be considered occasional anymore.

The frequent occurrence of the wildfires and extreme increase of the fire-damaged areas, which were reported worldwide in the last decade, are mainly the results of the global change of the climate conditions, such as melting and decrease of the average precipitation, particularly in the periods which are critical to the wildfire initiation.

In the Republic of Serbia in the period 2003-2007, 579 wildfires were reported. The most of them (370) occurred in 2007, then in 2003 (113), whereas the situation in 2004 (32), 2005 (25) and 2006 (39) are very similar. Averagely, per a wildfire in 2004, 4.56 ha of forest stands were damaged, in 2005, 4.90 ha, and in 2006, 5.53 ha. Generally speaking, in the observed five-year-period there was a positive correlation between the number of wildfires and average fire-damaged area.

In the observed five-year-period, 41.14 % of the fire-damaged area of the forest stands is of the IV level of the endangerment by the wildfires, 29.87% is of the V level, 9. 94% is of the I level, 7.50% is of the III level, and 1.81 % of the II level (Graph 3). When it is compared with the percentage of some species in the aforesaid total wood volume, the ratio is following: oak stands 29.87%:25%, beech and other deciduous trees stands 9.94%: 64%, conifer trees 19.25%:11%.

The annual dynamics of the occurrence of the wildfires in Republic of Serbia in period 2003-2007 is identical with the 50-year average and is a perfect proof of the justifiability of emphasizing the aforesaid critical periods. The majority of the wildfires were initiated in phase A, i.e. at the time when the conditions for the fast and successful containing of them are least favourable. The initial time is not known for 269 wildfires, but it can be concluded indirectly that most of them occurred in this part of day, since it was reported that they were mostly caused by man, during the agricultural works.

By the analysis of the data presented in this paper, we come to the dismal conclusion that man, in regard with the wildfires, is the most important destructor of the forest stands in Serbia. Undoubtedly, humans caused 399 (69.3%) wildfires, and probably the majority of the ones the causes of which are unknown (169 or 29.4%). Agricultural works aimed at the preparation for sowing, which are in Serbia still performed in a rather primitive way, by burning the remains of the previous crops, are dominant in the human activities. In only six cases nature exhibited its capricious manners. Two wildfires in the observed period started in Kosovo and spread to the areas in the vicinity.

Wildfires in the conifer cultures and stands are by its character and harmful effects more significant then these in the deciduous ones. The wood in the fire-damaged areas burn quickly, which leads to the disappearance of the original stand.

ŠUMSKI POŽARI U SRBIJI – SLUČAJNOST ILI REDOVNA POJAVA

Mara TABAKOVIĆ-TOŠIĆ, Miroslava MARKOVIĆ,
Snežana RAJKOVIĆ, Milorad VESELINOVIĆ

Rezime

Šumski požari su ranije uglavnom smatrani stihijama, koje se javljaju samo od slučaja do slučaja, neredovno, mada se uvek znalo da tada nose katastrofalne posledice. Međutim, iz istorije šumarstva poznato je da su šume svih kontinenata redovno trpele od ove nepogode, te je ona sigurno izvršila jedan od najvećih uticaja na drastično umanjenje procenta šumovitosti na današnje nedovoljne razmere.

U višedecenijskom razvoju šumarstva naše zemlje, problem šumskih požara nije uvek postavljen i rešavan sa maksimalnom pažnjom, mada su njihova učestalost i razmeri šteta to nužno zahtevali.

Najveća pažnja i puna aktivnost u borbi protiv šumskih požara ukazivana je najčešće u kritičnim godinama, kada su njihove pojave bile izuzetno brojne. Međutim, pozornost je obično popuštala u periodima kada su oni bili ređi, pa se često i dešavalo da nas nove pojave šumskih požara, zateknu nespremne da im se na vreme i uspešno suprotstavimo. To potvrđuje i činjenica da se požari u šumama naše zemlje još uvek javljaju u nedozvoljeno visokom broju, i čak imaju tendenciju permanentnog porasta.

Prema podacima o dinamici pojava šumskih požara u Srbiji i pojedinim njenim regionima, publikovanim u domaćoj stručnoj štampi ili prezentiranim na raznim savetovanjima i seminarima, jasno se može zaključiti da se ova pojava više ne može smatrati povremenom.

Protekle decenije učestalost šumskih požara i enormno povećanje opožarenih površina, prvenstveno su rezultat globalne promene klimatskih uslova u smislu otopljavanja i umanjenja prosečnih vrednosti padavina, posebno u kritičnim periodima za inicijaciju požara.

U području Republike Srbije u periodu 2003-2007. godina, evidentirano je 579 šumskih požara na površini od 9872,80 ha. Najviše (370) ih se desilo 2007. godine, zatim 2003. (113), dok su 2004. (32), 2005. (25) i 2006. (39), približno jednake. Prosečno u jednom požaru u 2003. godini opožarena je znatno manja površina nego u 2007. (8,89 ha : 22,66 ha). Po jednom požaru, 2004. oštećeno je 4,56 ha šumskih sastojina, 2005. - 4,90 ha i 2006. godinie 5,53 ha. Uopšteno gledano, u posmatranom petogodišnjem periodu broj požara je bio u pozitivnoj korelaciji sa prosečnom opožarenom površinom.

U posmatranom petogodišnjem periodu, 44,14% opožarene površine šumskih sastojina su iz kategorije IV stepena ugroženosti od požara, 29,87% iz V stepena, 9,94% iz I, 7,50% iz III i 1,81% iz II. Kada se ovo uporedi sa procentualnim učešćem pojedinih vrsta u gore navedenoj ukupnoj drvnoj zapremini,odnos je sledeći: sastojine hrasta 29,87% : 25%, sastojine bukve i ostalih lišćara 9,94% : 64%, sastojine četinara 19,25% : 11%.

Godišnja dinamika pojave šumskih požara u području Republike Srbije u periodu 2003-2007. godina, u potpunosti je identična sa pedesetogodišnjim prosekom i

savršeno potvrđuje opravdanost izdvajanja pomenutih kritičnih perioda. Najveći broj inicirano je u fazi A, odnosno u vreme kada su uslovi za njihovo brzo i uspešno suzbijanje najnepovoljniji. Za 269 šumskih požara se ne zna tačno inicijalno vreme, ali posredno, može se zaključiti da se i većina njih desilo u ovom periodu dana, budući da je evidentirano da ih je, uglavnom, izazvao čovek obavljajući razne poljoprivredne radove.

Analizom podataka navedenih u ovom radu, dolazi se do poražavajućeg zaključka da je čovek, kada su u pitanju šumski požari, najznačajniji destruktor šumskih sastojina u Srbiji. Apsolutno sigurno, on je prouzrokovao 399 (69,3%) požar, a verovatno i najveći broj onih za koje se ne zna uzrok (169 ili 29,4%). Radovi u poljoprivredi, koji se u Srbiji još uvek obavljaju na, kada je u pitanju priprema za setvu, dosta primitivan način paljenjem ostataka prethodnih useva, imaju dominantni položaj u okviru ljudskih aktivnosti. U samo šest slučajeva priroda je ispoljila svoju čudljivost. Dva požara u posmatranom periodu su prenešeni sa Kosova.

Požari u četinarskim kulturama i sastojinama su po svom karakteru i štetnosti značajniji od onih u lišćarskim. Drvo na opožarenim površinama brzo i lako izgara, pa su u njima uglavnom svi imali karakter visokog, a što je imalo za posledicu nestajanje prvobitne sastojine.

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*443.3 + 630*453] : 582.632.2 Fagus (497.11) = 111**
Original scientific paper

THE HEALTH CONDITION OF BEECH FORESTS ON ICP SAMPLE PLOTS IN SERBIA

Zlatan RADULOVIĆ[1], Slobodan MILANOVIĆ[1]

Abstract: *The beech is the most widely distributed tree species in the Republic of Serbia. The beech forests account for 47.11% of the total forest area in Central Serbia. The beech is present on 51 sample plots out of 125 plots which were set. The percentage of the beech which is present on the sample plots is 40.8%, i.e. 30.4% of the total tree number. By the research conducted on beech forest mycoflora the presence of 21 fungi species was noted. Nectria coccinea, Nectria ditissima, Fomes fomentarius and Hypoxylon deustum, cause the greatest economic damage of all the reported species. The most significant insect species characteristic for Fagus genus were analyzed: Cryptococcus fagisuga, Orchestes fagi, Phyllaphis fagi and Mikiola fagi.*

Key words: beech, sample plots, plant diseases, pests

ZDRAVSTVENO STANJE BUKOVIH ŠUMA NA BIOINDIKACIJSKIM TAČKAMA U SRBIJI

Izvod: *Bukva je u Srbiji najrasprostranjenija vrsta drveta. U ukupnoj površini šuma u središnjoj Srbiji bukove šume učestvuju sa 47,11%. Od 125 postavljenih bioindikacijskih tačaka bukva je prisutna na 51 tački. Izraženo procentualno, bukvu srećemo na 40,8% bioindikacijskih tačaka, odnosno njeno učešće je 30,4% ukupnog*

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broja stabala. Istraživanjima mikoflore bukve na bioindikacijskim tačkama zabeleženo je prisustvo 21 vrste gljiva. Od svih konstatovanih vrsta najveće ekonomske štete nanose Nectria coccinea, Nectria ditissima, Fomes fomentarius i Hypoxylon deustum. Od insekata analizirane su najznačajnije vrste karakteristične za rod Fagus i to Cryptococcus fagisuga, Orchestes fagi, Phyllaphis fagi i Mikiola fagi.

Ključne reči: Bukva, bioindikacijske tačke, biljne bolesti, štetočine

1. INTRODUCTION

The total forest area in Serbia is 2,412,940ha, which accounts for 27. 3% of the forest cover. The beech is the most dominant species in the forests, accounting for 60% per volume. The beech coppice and brush forest account for 52.56% of the total beech forest area in Central Serbia, as reported by Medarević et. al (2004). The largest area is managed by Public Enterprise "Srbijašume"(340,028ha), out of the total beech forest area (372,000ha) in Central Serbia and Vojvodina. The Public Enterprises of national parks manage the area of 26,529ha, Public Utilities Enterprise "Beli Izvor" manages 4,486ha, the Faculty of Forestry 1,472ha, and Public Enterprise "Vojvodinašume" manages 85ha. According to Medarević et. al (2003), the beech and beech stands dominate in Severnokučajski (70%), Jablanički (65%), Timočki (61.4%), Rasinski (59.6%), Južnomoravski (56.9%), Juznokučajski areas (60.8%), National Park Đerdap (55.1%) and Public Utilities Enterprise "Beli Izvor" (57%).

The existing 16km plot grid was reconstructed in Serbia in 2003, within the framework of ICP Forest. During 2005 new sample plots were set on 4km grid. The beech is present on 51 out of 125 sample plots which were set, i.e. there are 869 beech trees out of 2,860 trees. The percentage of the beech on the plots is 40.8%, i.e. 30.4% of the total tree number. The spatial arrangement of the sample plots on which beech is presented in Picture 1.This grid of plots served us for more detailed monitoring of beech forest health condition.

The presence of 142 phytophagous insects was reported by the research conducted by Mihajlović (2005). The majority of species (119) regularly exists in low numbers or has no greater significance. Seventeen species belong to a much larger group, the numbers of which are higher, and can cause lesser economic damage. The smallest number (6) of species belongs to the group of pests which can cause considerable damage during the multiplications of them Mihajlović (2005).

This paper analyzes the presence of species characteristic of *Fagus* genus *Cryptococcus fagisuga*, *Orchestes fagi*, *Phyllaphis fagi,* which by the significance belong to the group of the first class pests and *Mikiola fagi*, which belongs to the second group of pests (Mihajlović, 2003).

2. MATERIAL AND METHOD

The research of mycoflora and selected dangerous insects was conducted by the examination of all trees on the plots. All parasitic and saprophytic fungi were recorded on standing trees, as well as in the branch litter and stumps. The fungi were mostly identified by the appearance of the fruiting bodies and the type of rot caused by the fungi. In other cases samples were taken for the laboratory and fungi were isolated by the standard laboratory techniques. After isolation of pure cultures, fungi were identified by using keys described by Stalpers (1978). The presence of selected insects was determined based on the presence of different development stages for every tree inspected. The appearance frequency of analyzed pests per tree was obtained by dividing the number of trees where the presence of the concrete pest was registered with the number of the beech tree trunks inspected. The appearance frequency of the analyzed pests on the sample plots (experimental areas) was obtained by dividing the number of the sample plots on which the pest was registered with the number of analyzed plots. All beech trees and sample plots with beech trees were researched.

3. RESULTS AND DISCUSSION

In the sample plots on which beech is present the presence of 21 fungi species was recorded. The largest number of species is recorded on trees and branches, whereas on the leaves and roots the presence of one species was recorded. The research results are presented in the following table.

Table 1. *The fungi recorded on the sample plots*

Fungi name	Damage	No.pos.point
Apiognomonia errabunda (Rob.ex Desm.) Höhnel	Dots along the nerves	8
Armillaria spp.	Rot in root and butt end	6
Daedaleopsis confragnosa (Bolt.ex Fr.) Schroet	White rot	1
Dyatripe disciformis (Hoff.ex Fr.) Fr.	Weakness parasite	1
Fomes fomentarius (L.ex Fr.) Kickx	White dote rot	13
Hypoxylon deustum (Fr.) Petrak	White stem base rot	8
Pleurotus ostreatus (Jacq.ex Fr.) Kummer	White dote rot	1
Trametes hirsuta (Wulf.ex Fr.) Pilat	White rot and discoloration	1
Trametes versicolor (L.ex Fr.) Lloyd	White rot	6
Trametes gibbosa (Pers.ex Fr.) Fr.	White rot	5
Stereum insignitum Quélet	White rot	2
Xylaria polymorpha (Pers.ex St.Amans) Grev.	White rot	2
Schizophyllum commune Fr.	White rot and discoloration	7
Pholiota adiposa (Fr.) Kummer	White rot and false heart	3
Hypoxylon fragiforme (Pers.ex Fr.) Kickx	Discolaration and sapwood fustiness	5
Nectria coccinea (Pers.ex Fr.) Fr.	Bark necrosis	9
Nectria ditissima Tul.	Canker wounds	5

Fungi name	Damage	No.pos.point
Nectria cinnabarina (Tode ex Fr.) Fr.	Bark necrosis	6
Nectria galligena Brest.	Canker wounds	7
Laetiporus sulphureus (Bull.ex Fr.) Murr.	Brown, prism-like rot	2
Ganoderma applanatum (Pers. ex Wallr.)Pat.	White rot in the stem base	2

Eight species, out of all registered, are developed as parasites on beech and they cause greatest damages. The group consists of *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* and *Apiognomonia errabunda*. According to Karadžić and Milijašević (2004) these fungi belong to the first group due to the damage they cause.

Nectria coccinea (Pers.ex Fr.) Fr. is one of the most dangerous species attacking the beech; In the association with insect *Cryptococcus fagi* Bear. (= *C. fagisuga* Lind.) it causes beech bark disease. This disease was recorded in Serbia for the first time in 1983 (Marinković, Karadžić, 1985). This disease, as stated by Karadžić and Milijašević (2004), tends to spread in high forests, as well as in low forests, but the damages are higher in coppice stands.

Besides this fungus, *N. ditissima* Tul. and *N. galligena* Brest are often found on the beech and they cause bark necrosis and canker wounds. According to Lazarev (1984) *N. ditissima* is frequently found in beech coppice forests, and the attack intensity is strongest in the coppice forests on shallow limestone terrains. *N. galligena* prevails in seed stands, and various *Nectria* species can often be found on the same tree. In that case, *N. ditissima* causes canker and curls of the branches, *N. galligena* causes tree canker, and *N. cocinea* causes bark disease of the tree (Lazarev, 2005).

Species *Fomes fomentarius*, *Hypoxylon deustum* and *Ganoderma applanatum* cause the rot of living trees, whereas *F. fomentarius* and *G. applanatum* are often found on the trees of the seed origin. *H. deustum* is found in the stem base and is the main cause of tree decay in coppice forests.

Studying the influence of tree lesions and age on the beech false heart size, Karadžić (1981) stated that *H. deustum* and *Pholiota adipose* are most frequently isolated fungi. These fungi are frequent in the so-called radial, star-like, fan-like and other eccentric shapes of false heart.

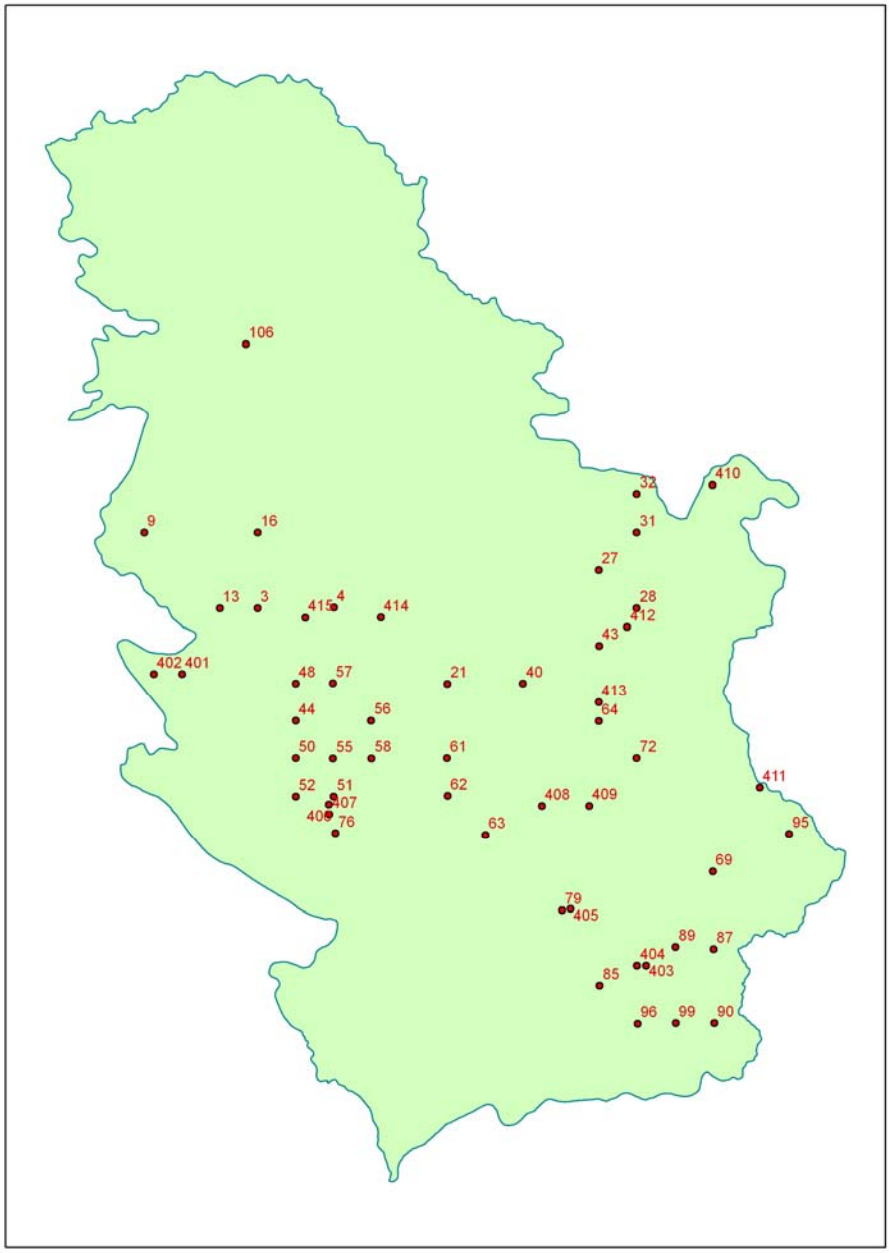


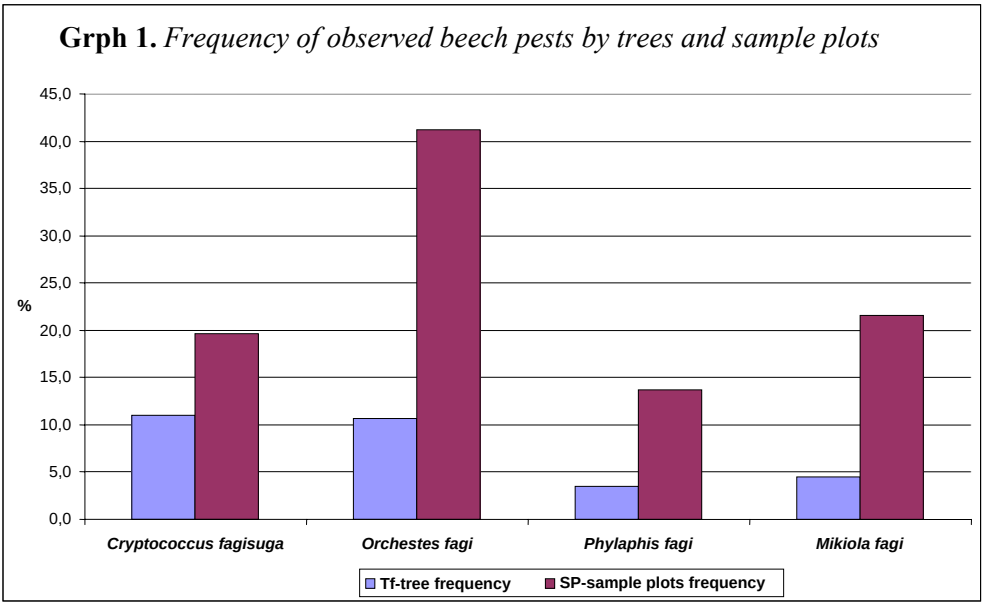
Chart 1. *Spatial distribution of ICP sample plots with beach*
(Autor slike: Marković Nenad)

Apiognomonia errabunda (Rob.ex Desm.) Höhnel is found on leaves and causes dots along the nerves and leaf defoliation. It can cause greater damage only on young trees.

Other species *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* and *Laetiporus sulphureus* are developed as weakness parasites and attack physiologically weakened trees. Most of these species continue to develop on the dead tree. Other stated species belong to the category of saprophytes and have no significance in beech forest decay.

Cryptococcus fagisuga Lind. (Homoptera, Cryptococcidae) is present in beech stands where together with fungus *Nectria coccinea* causes the beech bark disease. This species has not yet been sufficiently studied and its natural enemies, which could be used in biological struggle to a great extent, are unknown. There are indications that our beech (*Fagus moesiaca*) is more resistant than *F. sylvatica*, so we have to pay special attention to this species in the future, especially if we have in mind the area on which beech forests are spread. Suppression by chemical solutions is recommended but with restrictions, on small areas, during a heavy attack and in facilities of special significance. For this purpose solutions based on mineral oils can be used. The species *Cryptococcus fagisuga* was found on 10 out of 51 sample plots, where beech presence was recorded, i.e. on 96 out of 869 trees. The presence of this pest was reported on 11% of trees and in 19.6% of the sample plots Chart 1).

Grph 1. *Frequency of observed beech pests by trees and sample plots*



Orchestes fagi L. (Coleoptera, Curculionidae), miner of beech leaves, can considerably reduce the increment during the heavy attack, and predisposes the attacked trees to the attacks of weakness parasites and secondary pests. One larva is capable of damaging from 1/5 to ½ of a leaf (Mihajlović 2008). Under heavier attack we can find more larvae on a leaf, so this species can lead to complete defoliation of some trees, as well as to defoliation of whole beech forest complexes. Species *Orchestes fagi* was found on 21 out of 51 sample plots where beech presence was recorded, i.e. on 93 out of 869 trees. The presence of this pest was reported on 10.7% of trees and on 41.2% of sample plots (Figure 1).

Table 2. *Presence of analyzed beech pests on the sample plots*

Analyzed pests	Number of			
	Positive trees	Trees inspected	Positive sample plots	Sample plots inspected
Cryptococcus fagisuga	96	869	10	51
Orchestes fagi	93	869	21	51
Phyllaphis fagi	30	869	7	51
Mikiola fagi	39	869	11	51

Phyllaphis fagi L. (Homoptera, Callaphidae), beech leaf louse is very common species in our beech forests. Owing to the intensive juice absorbing, during heavy attack, it can lead to physiologic weakening of the whole plant and withering of some shoots. The large parts on the nutrients not used by lice are secreted into the environment in the form of honey dew. Recent studies show that a louse can absorb the assimilation amount daily, for the production of which the foliage of 5-20cm^2 is needed (Tjallingii, 2006). Therefore, the influence of this species on the increment should not be neglected. Species *Phyllaphis fagi* were found on 7 out of 51 bio-indication points where the beech presence was recorded, i.e. on 30 out of 869 trees. The presence of this pest was noted on 3.5% of trees and on 13.7% of the sample plots (Figure 1).

Mikiola fagi Htg. (Diptera, Cecidomyiidae) is present in natural beech stands of different age. Under the heavier attack it can physiologically weaken beech trees and predisposes them to the attacks of secondary pests and weakness parasites. Any special measures of fighting other than cultivation ones are not recommended. Species *Mikiola fagi* were found on 11 out of 51 sample plots where beech presence was recorded, i.e. on 39 out of 869 trees. The presence of this pest was reported on 4.5% of trees and on 21.6% of sample plots (Figure 1). The research results of presence of these beech pests on the sample plots are presented in Table 2.

4. CONCLUSION

By the the inspection of the sample plots on which beech is present, the presence of 21 fungi species was noted. *Fomes fomentarius* was recorded on 13 sample plots, *Nectria coccinea* was noted on 9 points, and the presence of *Hypoxylon deustum* and *Apiognomonia errabunda* was recorded on 8 sample plots each. However, these fungi are of different economic significance.

Eight species, out of all registered, are developed as parasites on beech and they cause greatest damages. The group consists of *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* and *Apiognomonia errabunda*.

Nectria coccinea (Pers.ex Fr.) Fr. is one of the most dangerous species attacking the beech, and in association with insect *Cryptococcus fagi* Bear. (= *C. fagisuga* Lind.) it causes beech bark disease.

Besides this fungus, *N. ditissima* Tul. and *N. galligena* Brest are often found on the beech and they cause bark necrosis and canker wounds. *N. ditissima* is frequently found in beech coppice forests, as well as *H. deustum* which is found in the stem base and represents the main cause of tree decay in coppice forests.

N. galligena, F. fomentarius and *G. applanatum* are often found on the trees of the seed origin. *Apiognomonia errabunda* can cause greater damage only on young trees.

Other species *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* and *Laetiporus sulphureus* are developed as weakness parasites and attack physiologically weakened trees. Most of these species continue to develop on the dead tree. Other stated species belong to saprophytes and have no significance in beech forest decay.

The following significant pests found in beech forests were analyzed in a detail:

Cryptococcus fagisuga was found on 10 out of 51 sample plots where beech presence was recorded, i.e. on 96 out of 869 trees. The presence of this pest was reported on 11% of trees and on 19.6% of the sample plots.

Orchestes fagi was found on 21 out of 51 sample plots where beech presence was recorded, i.e. on 93 out of 869 trees. The presence of this pest was reported on 10.7% of trees and on 41.2% of the sample plots.

Phyllaphis fagi was found on 7 out of 51 sample plots, where the beech presence was recorded, i.e. on 30 out of 869 trees. The presence of this pest was noted on 3.5% of trees and on 13.7% of the sample plots.

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Summary

The existing 16km plot grid was reconstructed in Serbia in 2003, within the framework of ICP Forest. During 2005 new sample plots were set on 4km grid. The beech is present on 51 out of 125 sample plots which were set, i.e. there are 869 beech trees out of 2,860 trees. The percentage of the beech on the sample plots is 40.8%, i.e. 30.4% of the total tree number. The research of mycoflora and selected dangerous insects was conducted by the examination of all trees on the sample plots. All parasitic and saprophytic fungi were recorded on standing trees, as well as in the branch litter and stumps. The fungi were mostly identified by the appearance of the fruiting bodies and the type of rot caused by the fungi. In other cases samples were taken for the laboratory and fungi were isolated by the standard laboratory techniques. After isolation of pure cultures, fungi were identified by using keys described by Stalpers (1978).

The presence of selected insects was determined based on the presence of different development stages for every tree inspected. The appearance frequency of analyzed pests per tree was obtained by dividing the number of trees where the presence of the concrete pest was registered with the number of the beech tree trunks inspected. The appearance frequency of the analyzed pests on the sample plots (experimental areas) was obtained by dividing the number of sample plots on which the pest was registered with the number of analyzed sample plots. All beech trees and plots with beech trees were researched.

By the inspection of the sample plots on which beech is present, the presence of 21 fungi species was noted. *Fomes fomentarius* was recorded on 13 sample plots, *Nectria coccinea* was noted on 9 points, and the presence of *Hypoxylon deustum* and *Apiognomonia errabunda* was recorded on 8 sample plots each.Eight species, out of all registered, are developed as parasites on beech and they cause the greatest damages. The group consists of *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* and *Apiognomonia errabunda*.

Other species *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* and *Laetiporus sulphureus* are developed as weakness parasites and attack physiologically weakened trees. Most of these species continue to develop on the dead tree. Other stated species belong to saprophytes and have no significance in beech forest decay.

The following significant pests found in beech forests were analyzed in a detail:

Cryptococcus fagisuga was found on 10 out of 51 sample plots where beech presence was recorded, i.e. on 96 out of 869 trees. The presence of this pest was reported on 11% of trees and on 19.6% of the sample plots.

Orchestes fagi was found on 21 out of 51 sample plots where beech presence was recorded, i.e. on 93 out of 869 trees. The presence of this pest was reported on 10.7% of trees and on 41.2% of the sample plots.

Phyllaphis fagi was found on 7 out of 51 sample plots, where the beech presence was recorded, i.e. on 30 out of 869 trees. The presence of this pest was noted on 3.5% of trees and on 13.7% of the sample plots.

Mikiola fagi was found on 11 out of 51 sample plots where beech presence was recorded, i.e. on 39 out of 869 trees. The presence of this pest was noted on 4.5% of trees and on 21.6% of the sample plots.

ZDRAVSTVENO STANJA BUKOVIH ŠUMA NA BIOINDIKACIJSKIM TAČKAMA U SRBIJI

Zlatan RADULOVIĆ, Slobodan MILANOVIĆ

Rezime

U Srbiji je tokom 2003. godine, u okviru programa ICP Forest, izvršena rekonstrukcija postojeće 16 km mreže bioindikacijskih tačaka. Tokom 2005. godine postavljene su nove tačke na 4 km mreži. Bukva je prisutna na 51 od ukupno 125 postavljenih bioindikacijskih tačaka, odnosno sa 869 od ukupno 2860 stabala. Izraženo procentualno, bukvu srećemo na 40,8% bioindikacijskih tačaka, odnosno njeno učešće je 30,4% ukupnog broja stabala. Istraživanja mikoflore i izabranih štetnih insekata bukve vršena su pregledom svih stabala na bioindikacijskim tačkama. Evidentirane su sve parazitske i saprofitske gljive kako na dubećim stablima tako i na ležavinama i panjevima. Određivanje gljiva je najčešće vršeno na osnovu izgleda plodonosnih tela i tipu truleži koji gljiva izaziva. U ostalim slučajevima uzimani su uzorci za laboratoriju i izolacija gljiva je vršena standardnim laboratorijskim tehnikama. Posle izolovanja čistih kultura, gljive su identifikovane korišćenjem ključeva opisanih od Stalpers-a (1978). Određivanje prisustva izabranih vrsta insekta vršeno je na osnovu prisutva različitih razvojnih stadijuma za svako pregledano stablo. Frekvenca pojave analiziranih štetočina po stablima je dobijena deljenjem broja stabla na kojima je registrovano ptrisustvo konkretne štetočine sa brojem pregledanih bukovih stabla. Frekvenca pojave analiziranih štetočina po bioindikacijskim tačkama (oglednim površinama) je dobijena deljenjem broja bioindikacijskih tačaka na kojima je registrovana štetočina sa brojem

analiziranih tačaka. Istraživanjima su bila obuhvaćena sva bukova stabla i bioindikacijske tačke koje imaju bukova stabla.

Pregledom bioindikacijskih tačaka na kojima je zastupljena bukva ustanovljeno je prisustvo 21 vrste gljiva. Na 13 tačaka je zabeleženo prisustvo *Fomes fomentarius*, na 9 *Nectria coccinea* a na po 8 tačaka *Hypoxylon deustum* i *Apiognomonia errabunda*.

Od svih konstatovanih vrsta 8 se parazitski razvija na bukvi i one i izazivaju najveće štete. U ovu grupu spadaju vrste *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* i *Apiognomonia errabunda*.

Ostale vrste *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* i *Laetiporus sulphureus* razvijaju se kao paraziti slabosti i napadaju fiziološki oslabela stabla. Većina ovih vrsta nastavlja sa razvojem i na mrtvom drvetu. Ostale navedene vrste spadaju u saprofite i nemaju značaj u propadanju bukovih šuma.

Vrstu *Cryptococcus fagisuga* nalazimo na 10 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 96 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 11 % stabala i 19,6 % tačaka.

Vrstu *Orchestes fagi* nalazimo na 21 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 93 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 10,7 % stabala i 41,2 % tačaka.

Vrstu *Phyllaphis fagi* nalazimo na 7 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 30 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 3,5 % stabala i 13,7 % tačaka.

Vrstu *Mikiola fagi* nalazimo na 11 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 39 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 4,5 % stabala i 21,6 % tačaka.

Reviewer:
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INSTITUT ZA ŠUMARSTVO • BEOGRAD

SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **316.485.6 : [630*9 + 502.1=111**
Original scientific paper

QUALITATIVE APPROACH IN CONFLICT RESEARCH - FORESTRY vs. NATURE PROTECTION -

Radovan NEVENIĆ, Zoran PODUŠKA, Ilija ĐORĐEVIĆ, Renata GAGIĆ[1]

Absract: *Requirements for the use of the natural resources are often in conflict with the aspirations for nature protection. The reforestation is always the focus of the public, journalists, experts and researchers, and frequently the obstacle to the nature conservation. Thus, it is needed to to identify, explore and explain the essential conflict situations and manage the conflict. The scientific research methods include the research procedures, criteria, and tools that provide the facts, laws and accurate results of the scientific research.*

This paper presents the qualitative research methods of defining and managing conflicts in the sector of forestry and nature protection.

Key words: conflict, qualitative research, forestry, nature protectiont

KVALITATIVNI METODOLOŠKI PRISTUP U ISTRAŽIVANJU KONFLIKTA U SEKTORU ŠUMARSTVA I ZAŠTITE PRIRODE

Izvod: *Zahtevi za korišćenjem prirodnih resursa često su u suprotnosti sa težnjama za konzervacijom prirode. Seče šuma uvek su u fokusu javnosti, novinara,*

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stručnjaka i istraživača. Često su predstavljene negativno naspram težnji za zaštitom prirode. Svako neslaganje oko načina korišćenja prirodnih resursa vodi konfliktnoj situaciji. Ovako bitne konfliktne situacije potebno je identifikovati, istražiti, objasniti. Konfliktom je neophodno upravljati. Naučno istraživački metodi obuhvataju upravo takve istraživačke postupke, kriterijume i alate koji obezbeđuju utvrđivanje činjenica i zakonitosti i daju pouzdane rezultate naučnih istraživanja.
U ovom radu biće predstavljen kvalitativni metodološki pristup istraživanju konflikta u sektoru šumarstva i zaštite prirode.

Ključne reči: *konflikti, kvalitativna istraživanja, šumarstvo, zaštita prirode*

1. INTRODUCTION

The natural resourses are the wealth of the mankind and the attributes of the economic, social, political and culturological systems of each country. The forests are the renewable natural resources, which perform numerous functions, that are complementary. However, there are also the functions which are mutually antagonistic.

The most frequent functions, which are mutually antagonistic, are the production and protection functions. The need for the use of the forest resources during and after the economic and political crises poses a threat to the sustainability and permanence of the forest management. The production function imposes the dominant one. The forests should be used in such a manner and to such an extent which will enable the preservation of their biological diversity, the improvement of their productivity level, the ability of regeneration, vitality, as well as their ability to perform the present and future ecological, economic and social functions. These requirements are the subject of the strategies and laws from the domains of forestry and environment. The numerous legal and sublegal acts inevitably lead to the sector cohesion, but also to the collision. In addition, the influence of the local population and non-governmental organisations, was well as the impact on the forest owners and beneficiaries should be also take into account. The collision between the forestry sector and nature preservation is often presented in a negative way, and the cohesion is based on the institutional cooperation. The new participants in the processes of the environmental protection join with the old ones, and form united front of sometimes non-critical views of the common need of the market for the forest products.

The increasing number of the proponents of the environmental protection can project an image that the business is based on the use of the natural resources. Therefore, it is necessary to identify the ecological, economic, social, and political problems which cause the conflict situations between the domain of forestry and nature protections.

The conflict is inextricably bound to the human interaction, and it occurs in almost every environment. The confict situations are characterized by the essence of conflict, the processes in the conflict situation, and the relations among the participants in the conflict (Walker G., i Daniels S., 1997). The natural resources are the frequent cause of the conflict. The reasons for this situation can be found in the social and cultural heritage and environment, economic and political situation, as well in the differences in the human understanding and expections.

2. THEORETICAL APPROACH

Theory definies the conflict in the different ways, using the different terms to explain the word "conflict". The terms such as: struggle, pressure, opposition, aspirations, convictions, interaction, cooperation, rivalry, competition, are frequently used in the defining of the conflict situation (Table 1).

Table 1. *Conflict definitions*

Authors	Definition	Key words
Deutch, 1973	The conflict occurs in all places where the activities which are not well-balanced take place... where the oppossing side disturbs, diminishes, prevents, or in some other way makes the activities of the other opposing side less effective.	Disturbance Prevention Efficiency
Wall, 1985	The conflict is the process in which two or more participants are trying to thwart someone else's aims... the conflicts have the easily recognisible elements, such as: mutual dependence, different aims, differences in the understanding.	Aims Dependence Understanding
Pruit and Rubin, 1986	The conflict implies the divergence of interests or the conviction of the opposing sides that the current aspirations cannot be simultenously achieved.	Aspirations Conviction Simulanteously
Conrad, 1990	The conflict is the communicative interaction of the persons who are dependent on each other and who feel that their interests are incompetible, inconsistent, or under pressure from others.	Communication Dependence Pressure
Tjosvold and Van de Viert, 1994	Conflict – incompatible activity – occurs during cooperation and due to the mutual competition... the sides in the conflict maintain cooperation and fight againsts the competition.	Competition Cooperation Incompatibility
Fogel, Poole and Stutman 1997	The conflict is the interaction of the participants who depend on each other, have the inconsistent goals and disturb each other in achievement of their goals.	Interaction Dependence Inconsistency

Source: (Walker G., Daniels S., 1997)

The theory of Walker and Daniels (1997) states that each conflict is the combination of three main elements: **essence** of conflict, **course or process** of conflict, and the **relation** between the participants. These elements of conflict also occur during the conflict management, and are called "progressive triangle". The content and process are the tangable elements of conflicts,

whereas the relations are based on the personal way of the understanding things. The elements of conflict are presented in the Table 2. The meaning, key words, and questions are attributed to each element of conflict (Niemela J., 2005).

Table 2. *The elements of conflict*

Elements of conflict	Meaning	Entries of the elements of conflict
Content	The content or the essence is the controversial issue of the conflict and the tangible element of the conflict situation.	Who? What? Where?
ourse of conflict	It points to way in which the conflict has taken place and includes the rules and regulations which the sides in conflict have to obey.	How? To whom? Rules
Relations	The mutual relations of the participants in the conflict are determined by the influence, trust, power, authority, respect	Responsibility, Power, Management, Strenght, Authority, Influence, Degree of Independence, Degree of connection

In order to study the conflict in the domain of forestry in Serbia, the theoretical frame is found in the progressive triangle of the elements of conflict (Walker G., Daniels S., 1997), in regard of the economic, institutional, culturological and social aspects (Helström E., 2001). The Figure 1 presents the theoretical frame which can be used in the study of the conflict in the domain of forestry.

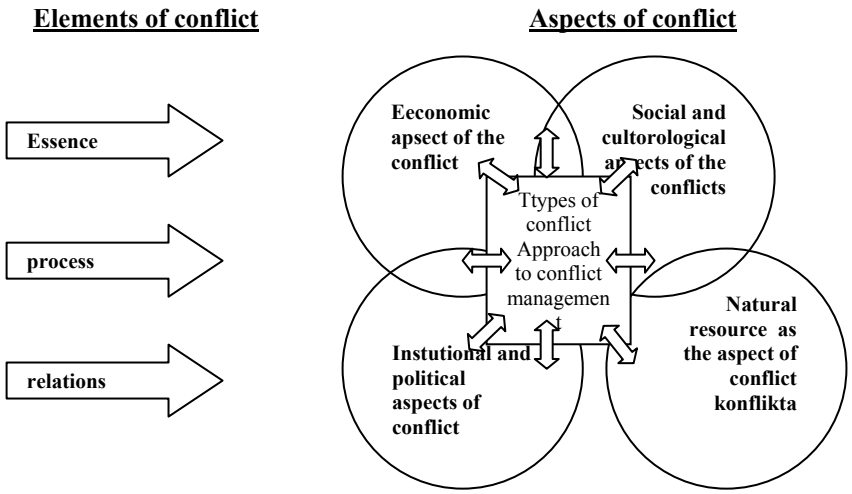


Figure 1. *The theoretical frame of the research of conflict in the domain of forestry.*

The theory shows that economic aspects, culturological views, and the sector policies have a role in the conflict settlement, but also in the creation of the conflict situation, respectively. The conflict situation has three elements: content, course, and the relations, based on which the cause of the conflict, the participants in the conflicts, and the relation between them can be analyzed. The different aspects of the conflict influence the approach to the conflict management. The complex relations are often the obstacle to the solution of the problem, but at the same time serve as a base for the establishment of the mediation, by preventing the further escalation.

3. METHOD

The conflicts in the domain of forestry were researched within the FOPER[1] project, by using the qualitative methodological approach. The qualitative approach was used during the study of the conflict situations in the National Park "Fruska gora". This national park was selected due to the numerous legal and sublegal acts, which directly refer to the management to the national park, as well as the property relations. The Law on Restitution (Official Gazette of the Republic of Serbia, 46/06), which guaranteed the restitution of the forest to the Serbian Ortodox Church and monasteries, was adopted in 2006. There are 17 monasteries in Mt. Fruska Gora which claim the forests occuping an area of tens of thousands hectares.

The privately-owned forests and forest land occupy an area of 291 hectares of the National Park "Fruska gora" (Special Management Plan, 2006). Seventy-seven members of the Forrest Association "Beocin" from Beocin village, are the owners of these forests and forest land. During the qualitative reseach the problem was analysed subjectivelly, based on the individual interviews and available literature.

The qualitative research is the research process aimed at the understanding of the studied problems from the several perspectives. By the qualititive approach the observed problem is described. The study is conducted in the natural environment, in the aim of the forming of the complex image of the phenomenon which is being researched. The qualitative research approach is analyzed in the Table 3.

[1] FOPER – Forest Policy and Economical Education and Research, project aimed at the strengthening of the capacities in the domain of forestry policy and economies in the Balkan countries

Table 3. *The analysis of the qualitative research approach*

	Qualitative approach
Purpose	To describe and explain the processes and relations
Scientific concluding	Induced. Generates the hypothesis
Sample size	Small sample
Number of the obtained pieces of information /answers	Many
Type of analysis	Subjective interpretation
Approach to problem	In depth, concrete
Probability of repetation	Low
The method of data collection	By recording by voice recorder or writing down the interview in the previously prepared form

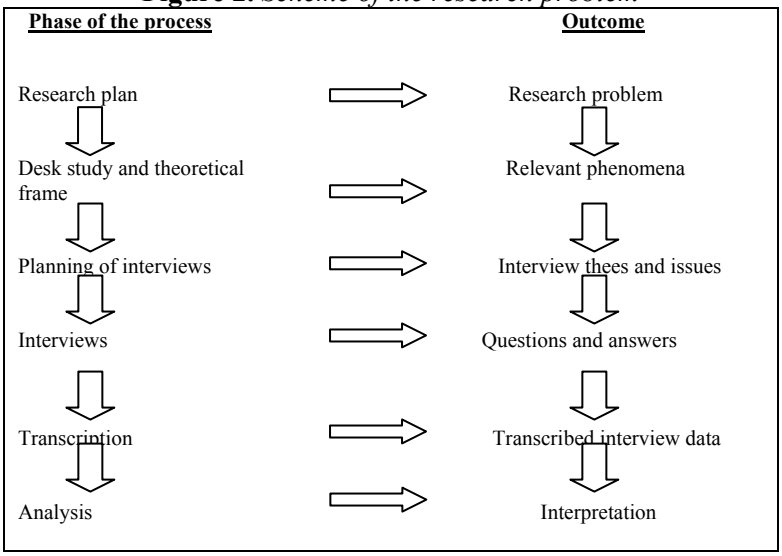
(source Nauman W.L., 2004)

The qualitative research refers to the collection, analysis, and interpretation of the data by observing the human actions and words. In contrast to the quantitive research, which refer to the counting and measuring of the objects, the qualitative researches analyze the meanings, terms, definitions, characteristics, metaphors, symbols and descriptions of the objects. The qualitative research is much more subject than quantitative. It is mainly used for the individual and group interviews with the aim of the collection of the primary data. The qualitative researches are concrete, descriptive, and analyze the problem in depth and in small-sample settings. The interviews were conducted with a few representatives of the target groups. The interview is the complex and altered social process which takes place between two human beings and cannot be repeated (Walker R.,1985).

During the research of the conflict between the domain of forestry and nature protection by the quantitative methodological approach the general scientific method of modelling was used (Sesic B., 1984). The professional and scientific literature, as well as the sources obtained from the Internet, were used as the source of the data. The literature and data are mainly analyzed by the use of the following special scientific methods (Mihajlovic D., 2004): analytical-syntethic method, the method of abstraction and concretization, the method of generalisation and specialisation, the method of classification, and the methods of induction and deduction.

The qualitative research has the clearly defined phrases and corresponding results. The Figure 2 presents the phases of the research process.

Figure 2. *Scheme of the research problem*



The phases are planned in a great detail, and there are the corresponding results of each phase.

4. RESULTS

In forestry, as mainly nature scientific discipline, there is the increasing need for the socio-economic researches, which is the result of the fact that man is inextricably bound to nature. The increasing impact of the society and economy on the environment promotes the socio-economic researches. The socio-economic researches are the set of methods which the research scientists systematically apply in order to gain knowledge on the society based on the scientific facts. These researches are aimed at the creation of the study of men, their needs, behaviour, beliefs, interactions and institutions. Given the fact that many decisions made by the political leaders are not followed by the adequate social researches, it is needed to point to the researches by the qualitative methodological approach (Nauman W.L., 2004). Each research should be followed by the research project. By meeting the requirements of all phases of the research process and monitoring of it, the expected results are obtained.

Research plan – The research topic is defined by the ordered regional[1] research of the conflicts in the domain of forestry. Based on the defined research topic the research plan, generated by the research problem, is made.

[1] Within the FOPER project the research of the conflict in the domain of forestry was financed

Gaining knowledge on the theory of research problem The available scientific and professional literature and the sources obtained from the Internet were researched. By styding the results of the theory the relevant situation with the elements of conflict in the National Park „Fruska gora“ was recognized. All participants of conflicts were identified. The direct participants in the conflict are:

- National Park ”Fruška Gora”, as the Public Enterprise, which manages the protected nature reserve based on the Law on National Parks (Official Gazette of the Republic of Serbia 39/93), i.e. Nature on Nature Protection (Official Gazette of the Republic of Serbia, 36/09);
- The Forest Association ”Beocin“, as the specific form of the cooperation between the owners of the privately-owned forests. The members of the Forest Association are the allied owners of the forests covering an area of the National Park “Fruska Gora“ (The Special Forest Management Plan, 2006).
- The Institute for Nature Conservation of Serbia, as the unique institution in the Republic, the main task of which is to preserve and improve the condition of the national nature reserves. The indirect participants in the conflict are:
- The Ministry of Forestry, Agriculture, and Water Management and the Ministry of Environment and Spatial Planning, as the executive authority which creates and implements the laws and strategies.

The elements which define the conflict among the participants are:

- **The essence of conflict:** The disagreement about the manner in which the meadow, covering an area of 17 hectares, is managed. The meadow is privately-owned by the Forest Association “Beocin“. It is located in the protected zone of the National Park “Fruska gora“, in the vicinity of the regional “Partisan Road“. The owners are required to manage the meadow in a sustainable manner. This obligation is imposed on them by the Institute for Nature Conservation, as the answer to the appeal which the Forest Association made to the Institute for Nature Conservation and the management of the National park and which refers to the ability to manage the meadow in this way, so that both owners and visitors can benefit from it. The meadow is a favourite picnic area of the citizens of Novi Sad. On the other hand, it is the site of numerous protected and rare herbaceous species. It can be noticed that in this instance the requirements for the economic benefit clashes with the requirement for the complete conservation of the private ownership within the National Park. The management of the National Park offered the service of the maintenance of the meadow. The price of the service was much higher than the financial solvency of the Forest Association. Therefore, the limit of the right to use the private

ownership was imposed, and in turn the expensive service of the maintenance was offered.

- **The process of the conflict:** The process domain of the conflict is characterized by the activities which enable the refoms in the legislation. The creation of the Law on Forests, which takes into account the private ownership, is under way. The Law on Nature Conservation, by the positive intepretation of which the "compensation for the deprivation or the limiting of the right of the usage" of the private ownership in the protected zones is enabled, is adopted. There are the clearly visible changes in the manner in which the private ownership in the National Park "Fruska gora" is managed, and the plan for the management of the Forest Management Unit "Forest Association" – Beocin, owned by the Forest Association from Beocin village, is made in 2007.
- **Relations among the participants:** The Ministry of Agriculture, Forestry and Water Management, the Ministry of Environment and Spatial Planning, the Institute for Nature Conservation of the Republic of Serbia, Regional Department for Environment Protection and Sustainable Development, Forest Association „Beocin", local governments, and academic and scientific-research organisations, are involved in the management and use of the National Park "Fruska Gora". It was concluded that the participants slowly and safely project an image of their communication as advanced. The conflict is in the latent phase, hidden from public view. The participation of the political parties in the management of the natural resources is clearly visible. The relation element of the conflict is the integral part of the conflict management, and it is expressed by: mediation, dialogue, cooperation, and education.

There are following aspects of conflict: institutionally-political aspect, economic, social, and culturological aspect. In addition, the conflict can be viewed in regard to the natural resources. The natural resource can be under the protection regime, or under the regular management regime.

In regard to policy making, the conflict is observed as the disagreement over the determinants (criteria and priorities) of the political decisions (Walker Daniels 1997). The conflict is associated with the lack of information, disinformation, and the different interpretations of the available data. It was reported that the sides in the conflict had the different rating scale of the information and attitudes. For instance, some phenomena are considered to be rational by some people, but they are considered to be irrational by others.

Many conflicts between the forestry and nature protection are caused by the economy. The owners or users of the natural resources claim that they are entitled to offer their ownership to the market, regardless of the category of protection.

The categorization and structure of the protected areas are the frequent topics of the debates, but at same time the sources of the numerous conflicts.

It is hard to estimate and compare the social and culturological benefits of forests with the economic benefit. The forest is traditionally of great importance to the owner or community. The forest is inherited, but rarely sold. The issues of the ownership and the right of usage is the frequent cause of the conflict. The tradition, as the part of the sociological and culturological aspects of the natural resources management, is clearly visible in the behaviour of all acters.

After the recognition of the relevant situation and defining the elements and participants in the conflict, based on the principles of the qualitative methodological approach, the study case was selected as the technique for the data collection. The case study method[1] implies the use of the scientifically formulated occurrence model as a starting point and leads to the reconstruction of the current or to the construction of the new model (Miljevic M., 2004). The study case is the concrete, descriptive method, and analyzes the problem in depth.

Interview planning – In harmony with the research process, and after the observation of the elements and participants in conflict, the specification of case stydy, which refers to the research questions, theoretical frame, hypotheses, population, and the size of the sample, as well as to the time needed for the research, is made.

The specification of case study is also called “case study protocol“ (Miljevic M., 2004). The integral part of the protocol is also the form with the questions which the examiner will put to the examinee.

The questions are focused on the previously defined topic, and the participants in the interview are informed in advance about the topic of the interview, and the agreements about the time, place and duration of the interview are made.

The reseach refers to the analyses of the type and intensity of conflict, as well as the precondition for the conflict situation settlement. Along with the characteristics and elements of conflict, it is needed to define the participants in conflict and their mutual relations. The participants in conflict are characterized by the attitude towards problem, authority, power, and status in the decision-making process. The research is focused on the study of the connections and relations between the participants in conflict. Therefore, all processes are inter-related and dynamic. Based on these requirements, the questions are formulated. The questions are classified as main and auxiliary. The main questions should raise the answers on the essence, processes and relations in the conflict situation. If the examinee does not provide the sufficient scope of information to

[1] In the methodological literature the terms "case method" and "case analysis" are mentioned

the questions, the attititudes on the missing information about conflict are initiated by the secondary questions.

The interview should be planned so that the three surveys of the basic data, based on the answers of the examinee, are formed:

1) The chronology of events;
2) The survey of the most important actors;
3) The survey of the possible and available sources of data, particularly written ones, out of which some are also collected.

The interview plan resulted in the creation of the forms with questions. The examinees are selected by the principle of general knowledge, i.e. by the method of "snowball" sampling[1].

Conducting an interview – The interview as the technique of the collection of the primary data was selected. By the definition: "The interview or scientific conversation is the technique of data collection by the direct oral or personal communication of the research scientist and examinee" (Milevic 2004). The interview as the research instrument is conducted personally. The examiner and examinee participate in the individual interviews. The interview requires the direct and mutual activity and interaction. The answers of the examinees are recorded by the voice recorder.

The questions in the interview are aimed at the more efficient discovery of the facts and personal opinions of the examinees about the certain topic. In regard to the very technique of conducting an interview, it is needed to respect certain rules, such as:

- Respecting the scheduled time, place, and duration of the interview;
- Positive attitude of the research scientist towards the examiner and topic;
- Suitable clothes and tidy appearance;
- The examinee should not be interrupted often, but the examiner should direct the course of the interview in a subtle way;
- The examinee should not feel as being interrogated, but as an expert;
- Check the functionality of the voice recorder, batteries and memory in advance;
- The informal conversations should be held after the interview, but these conversations should be used for the resolving of the ambiguities.

The participants in the interview, i.e. the examinee first answer to the common questions. The aim of the interview is the identification and definition of the opinions and views of the topic, as well as the determination of the level of connection based on research sample.

[1] "Snowball method" – It is used in the aim of the finding of the most adequate examinees. The claim for the selection of the examinees is made to the person who is in charge of the company or organisation : (to minister, director of the National Park or of the State Enterprise, or the president of the Association) who nominate their associates who are most acquainted with the topic.

The quality of answers and results directly depends on the skill and experience of the examiner. Along with the common questions, the auxiliary questions, aimed at finding the data which were omitted by the examiner.

The answers to the questions which were put are obtained as a result of interview.

Transcription – The recorded interviews are later transcripted, i.e. transformed into the textual form, in the logically and gramatically correct form.

Analysis – During the research, the content, form and manner in which the messages are exchanged, i.e. the exchange of the opinions between the examiner and examinees, are studied. By analyzing the answers, the information of the attitudes of the examinees is obtained.

The following elements are analyzed: objectivity of the attitude, content, scope, and authenticity of the attitude. The direction of the examinees to the positive or negative attitudes is reported. It is important to classify the attitudes as the "initiative" or "confrontation". The intensity of the attitude pointed to the fact that the conflict is in the latent phase, "hidden from public view". Based on the criterion of attitude stability, it was concluded that the members of the same side in the conflict are not homogenous, but they have the variable characteristics of the interrelations. Some attitudes have the form of the momentary reaction to the question.

Interpretation - Result of the analysis was the interpretation of the obtained answers. The answers, which were interpretated, were divided into several categories. The categories of the answers were collected by the certain element of conflict and are presented in Table 4.

Table 4. *Categories of the answers by the elements of conflict*

Answer categories	Elements
LEG – Legislation: Owning to the numerous laws and sublegal documents the implementation of the Law on Forests, Law on Environment Protection, and Law on National Parks, etc, is hindered.	**Substance of conflict**
ECON – Economic aspect: Economic aspect is particularly emphasized by the members of the Forest Association „Beocin", since the members consider that they are deprived of the possibility to use their own ownership. The State Enterprise National Park "Fruska gora" is focused on the forest in the protected nature reserve as the source of income. The economic aspect is stated as the essence of conflict.	
CONS – Conservation requirements within National park. These requirements are imposed by the Law on National Parks and Law on Environment Protection, i.e. by the Law on Nature Conservation. The Institute for Nature Conservation is the initiator of the conservation. In spite of the fact that these requirements are prescribed by the law, they are often in the collision of both the trustees of the National Parks, and the owners of the private properties. In contrast to this requirement, there is the economic aspect of National Park management (ECON). The conservation requirements are used as the arguments by all sides in the conflicts.	
PRIV – Valuation of the private ownership of forests and forest land. It is the essential element of conflict. As the owners very well know the value of their own property, they expect to gain the adequate income. However, they are omitted from the participation process during the creation of managing plans. They are proud of their property, traditionally bound in the Association and focused on the forest as the source of income. They consider the limit of the use and imposing of the additional costs as the pressure on personality, family, and community as the	

Answer categories	Elements
negation of the traditional values.	
UT – utilisation: the processes which influence the utilisation of forest and forest land. There are numerous legal and sublegal documents which affect the National Park management. The economic benefit is in collision with the requirement for conservation. The usage refers to the felling and creation of logs and fuel wood. The profit obtained in this way is not sufficient for the functioning of National Park and Forest Association. Therefore, the participants expect the procedure changes to take place, which will be beneficial to all. These expectations were submitted to the responsible ministries, and partly to the local government.	**Process**
PLAN – the visible changes in the private ownership management. The Plan of Managing Forest Management Unit "Forest Association", was adopted in 2006.	
REF – reformative approach to the legislation in domains of forestry and nature protection. The need and will for the improvement of the sector legislation is clearly visible. By improvement and synchronisation of the legislation many conflict situations will be prevented. The Ministry of Agriculture, Forestry and Water Management, has initiated the process of adoption of the new sector laws. The right of the private property is clearly recognized in the Law Draft.	
COOP – cooperation. The horizontal cooperation of the Ministry of Agriculture, Forestry and Water Management and Ministry of Environment Protection is clearly visible, but the synchronized legislation has not been adopted yet. The cooperation of the management of National Park and Forest Association, based on the mutual respect, with the visible relation of the stronger and more powerful side to the weaker side, is well-expressed The cooperation of the management of the National Park and Institute for Nature Conservation is at the high professional level, but the each side favourises its position. There is the expressive need for profit in the management of the National Park, whereas the Institute for Nature Conservation has the conservation approach to the National Park management. The relation between the Institute for Nature Conservation and Forest Association is characterized by the complete trust and respect. The Association consults the Institute about the problem of the sustainable use of the meadow. The Institute issues the abiding prescription about the way in which the meadow is preserved. The implementation of this rule requires the considerable financial means, but does not direct Association to the positive decrees which can promote the use of the sustainable private ownership management. These rules are listed in the Law on Environmental Protection (Article 63), and the compensation for deprivation or limitation of the use of the private property in the protection zone is anticipated.	**Relations**
COMM – mutual communication is emphasized as the key to the conflict management. The members of the Forest Association have the impression that they have been omitted during the planning and decision-making in the National Park. The management of the National Park laconically speak about the communication with the members of the Forest Association, and claim that "there are no problems with them".	
TRAD – traditional values are reflected in the attitudes of the management of the National Park, as well as in the attidues of the members of the Forest Association. The examinees from the National Park use the phrases about the "necessity and superiority of the forestry profession in the protected nature reserves management", since "only the foresters have the sufficient scope of knowledge and skills", which can be appropriately used in the nature reserve management. The members of the Forest Association "Beocin" emphasize the multicentury tradition of forest and forest land management. They are proud of their forest and the chronology of the creation of the stable Association.	

By the interpretation of the answers the categories of the answers, which point to the element of conflict and to the aspects of conflict situtation, were defined. The model of the conflict situation in the National Park "Fruska gora" is presented on the Graph 3. By stating the elements of conflict, but from different aspects, the role of the participants in conflict, is presented.

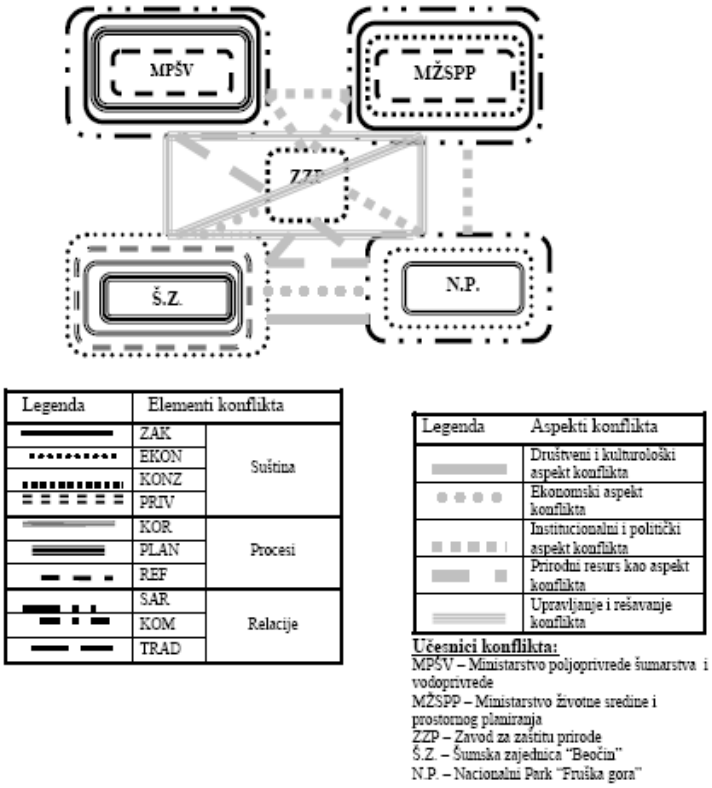


Figure 3. *Participants, elements and aspects of conflict*

5. CONCLUSION

By using the qualitative research method, the case study and interview, as the techniques of the data collection, were selected. The interviews in the qualitative research are based on the relation between of the examiner and examinee. The examiner is the person who creates their own frame of values and beliefs, constructs the meanings and explaines the events in their environment, based on the real life.

During the interview the research scientist is faced up with the following questions: How much direct/indirect should I be?; Is is appropriate to always put the open questions? It is desirable to disagree with the opinion of the examinee? However, the structure of the examination in the qualitative research is not rigid, and the research scientist should bear in mind that there are broad questions, which might not always bring the crucial conclusions, but enable the

creation of the atmosphere in which the examinees will feel comfortable, and gain the expression that their opinion and experience are respected and valued. The situations, in which the examinees gain the impression of being interrogated, should be neglected. There are no rules on the use of the open and general questions, or on the use of main or secondary questions 5, or on the disagreement over the expressed attitudes, in the personal interviews. This decision is made by the research scientist, and it is based on the relation which it built with the examiner. Sometimes it is possible to debate in the manner "pro and cons", or discuss some topic with someone more than it is usual. It is important to have the clear objectives of the interview. The aim is to recognize whether the theories or values of the persons who were interviewed respond to the research question based on the accepted theory.

The method of the case study undoubtedly has the important advantages in practice. The concept on the reseach of the totality based on the individual elements has an important advantages over other methods. The research scientist is directed to the various sources and data. By the method of case study the individual cases, small groups, i.e. units, or the very organisation, are researched. The method of case stydy can be used for research of the past, current and future cases. The method of case study can be used for various purposes – scientific (used for the scientific orientiation, description, classification, discovery, explanation, anticipation), educational, and practical.
The problem, i.e. the subject of research should be topical, very important, or typical phenomenon. By rule, the selected phenomenon is researched in the environment in which at a certain moment it is most expressive or typical, by some characteristics.

As in all other researches, in the initial stage, the scientific fond is used and the previous data on the sources of data and very phenomenon are collected, so that the project of research can be made. The available written information from the professional and scientific magazines are used for data collection. By the personal contacts with the experts and well-informed persons the direct insight in the situation at the scene where it takes places is obtained. Based on the statement of the examiner and avaliable literature, the image on the chronology of events, survey of the most important acters, and their mututal relations, is formed. The theory and pieces of information which were collected are varified by the interview. The examinees are selected by the principle of the knowledge of the certain subjects. The processesion, analysis and synthesis of data lead to the descriptive version of the report. The report is made of the chronology of events and their description, as well of interpretation of the answers, without taking stances or expressing opinions. The method of case study is not only very favourable and efficient in the researches conducted in depth and for mainly scientific purposes, but very applicable in the action research, for the revision, and operative policy, as well. During the research

process the scientists use different scientific-research methods and techniques. As a result of the scientific-research methods, the science is the human activity directed towards gaining new knowledge on the reality. In order to ensure the objective authenticity of the obtained results, it is needed to apply the known and verifiable research methods (Neuman W.L., 2006). The selected qualitative research methods enable the authentic presentation of the research results.

The synergy of the nature and social sciences and their scientific methods enables the gaining authentic, or probable knowledge on the natural resources and human impact on the forest ecosystems and environment.

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QUALITATIVE APPROACH IN CONFLICT RESEARCH - FORESTRY vs. NATURE PROTECTION -

Radovan NEVENIĆ, Zoran PODUŠKA, Ilija ĐORĐEVIĆ, Renata GAGIĆ

Summary

The conflict is inextricably bound to the human interaction, and it occurs in almost every environment. The confict situations are characterized by the essence of conflict, the processes in the conflict situation, and the relations among the participants in the conflict. The natural resources are the frequent cause of the conflict. The reasons for this situation can be found in the social and cultural heritage and environment, economic and political situation, as well in the differences in the human understanding and expectatitions.

The conflicts in the domain of forestry were researched by using the qualitative methodological approach. The qualitative approach was used during the study of the conflicts in the National Park "Fruska gora". During the qualitative research method the problem was analyzed subjectively, based on the individual interviews and available literature.

In forestry, as mainly nature scientific discipline, there is the increasing need for the socio-economic researches, which is the result of the fact that man is inextricably bound to nature. The social researches are the set of methods which the research scientists systematically apply in order to gain knowledge on the society based on the scientific facts. These researches are aimed at the creation of the study on men, their needs, behaviour, beliefs, interactions and institutions. Given the fact that many decisions made by the political leaders are not followed by the adequate social researches, it is needed to point to the researches by the qualitative methodological approach.

KVALITATIVNI METODOLOŠKI PRISTUP U ISTRAŽIVANJU KONFLIKTA U SEKTORU ŠUMARSTVA I ZAŠTITE PRIRODE

Radovan NEVENIĆ, Zoran PODUŠKA, Ilija ĐORĐEVIĆ, Renata GAGIĆ

Rezime

Konflikt je neodvojivi deo ljudske interakcije, dešava se u gotovo svim okruženjima. Konfliktne situacije karakteriše suština konflikta, procesi u konfliktnoj situaciji i relacije među učesnicima konflikta. Prirodni resursi čest su objekat konflikta. Razloge nalazimo u socijalnom i kulturnom nasleđu i okruženju, ekonomskoj i političkoj situaciji, razlikamo u ljudskim shvatanjima i očekivanjima.

Istraživanja konflikata u sektoru šumarstva sprovedena su putem kvalitativnog metodološkog pristupa. Kvalitativni pristup je korišćen tokom studije slučaja o konfliktima u Nacionalnom parku „Fruška gora“. Prilikom kvalitativnog istraživačkog pristupa problem je analiziran subjektivno, na osnovu individualnih intervjua i postojeće literature.

U šumarstvu, kao prevashodno prirodnoj naučnoj disciplini, sve više je prisutna potreba za socioekonomskim istraživanjima. Razloge nalazimo u neraskidivom odnosu čoveka i prirode. Sve veći uticaj društva i ekonomije na životnu sredinu podstiče primenu socioekonomskih istraživanja. Socijalna istraživanja su skup metoda koje istraživači sistematski primenjuju da bi proizveli znanja o društvu koja su zasnovana na naučnim činjenicama. Imaju za cilj izradu studije o ljudima, njihovim potrebama, ponašanju, verovanju, njihovim interakcijama i institucijama. S ubeđenjem da mnoge odluke političkih lidera nisu ispraćene adekvatanim društvenim istraživanjima, potrebno je ukazati na istraživanja putem kvalitativnog metodološkog pristupa.

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
COLLECTION 59-60, 2009 ZBORNIK RADOVA 59-60, 2009

UDK **630*64/*68 + 630*907.11 (497.11-751.2 Fruška Gora)=111**
Original scientific paper

REFLECTION OF DIFFERENT FINANCING MECHANISMS WITHIN THE NATIONAL PARK "FRUŠKA GORA"

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Abstract: *In this paper different financing mechanisms are analyzed in the case of National Park "Fruška Gora". Aspect of financing protected areas is one of the raising issue in current environmental policy. In recent years, due to the revival of economic situation and influence of international surrounding, some progress has been made. The principle research objective of this paper is the analysis of management aspects of national park with its financing, and analysis of financing possibilities at the present and foreseeable future level. Current law legislation defines seven groups of financing instruments. This financing mechanisms are going to be investigated through the application of the mechanisms defined in publication Financing Species Conservation (Koteen, 2004). National Parks, comparing to other protected areas, have one huge advantage. Through establishment of Public Enterprise they have sort of financial autonomy. This autonomy is illustrated through there ability to obtain funds both from internal and external sources.*

Keywords: National park, protected areas, financial instruments, environment.

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RAZMATRANJE RAZLIČITIH MEHANIZAMA FINANSIRANJA U OKVIRU NACIONALNOG PARKA "FRUŠKA GORA"

Izvod: *U ovom radu analizirani su različiti mehanizmi finansiranja u okviru Nacionalnog parka "Fruška Gora". Odnos prema finansiranju zaštićenih prirodnih dobara je tema koja je, u poslednje vreme, vrlo aktuelna u oblasti politike zaštite životne sredine. S obzirom na oporavak ekonomske situacije, kao i uticaj međunarodnog okruženja, zadnjih godina je učinjen određeni napredak na ovom polju. Osnovni cilj ovog rada je analiza upravljanja Nacionalnim parkom sa aspekta njegovog finansiranja, kao i analiza finansijskih mogućnosti u sadašnjosti i bliskoj budućnosti. Sadašnja zakonska regulativa definiše sedam grupa finansijskih mehanizama i oni su razmatrani kroz primenu mehanizama definisanih u publikaciji Finansiranje zaštite vrsta (Koteen, 2004). U poredjenju sa ostalim zaštićenim prirodnim dobrima, Nacionalni park, u našim uslovima, ima prednost što se kroz osnivanje javnog preduzeća ostvaruje izvesna finansijska autonomnosti, koja se ilustruje njegovom sposobnošću da prikupi istovremeno interna i eksterna sredstva.*

Ključne reći: Nacionalni park, zaštićena prirodna dobra, mehanizmi finansiranja, životna sredina

1. INTRODUCTION

Protected areas (PA) are defined as a) a unique area, rare in its species, phenomenon or with small geographic dispersion; b) typically representative of its species or phenomenon in special place or time and c) preserved in the context of its originality. In 1996, the global system comprises some 30.000 sites covering an area of 13.2 million square kilometers (Eagles, 2002). Today protected areas cover more then 20 million km^2 of the global land surface, roughly 12 percent (Chape et al., 2005). Total protected areas in Serbia are 6.6% of the country's territory, while until 2012 plan is to increase this area to 12 percent. There are 5 national parks, 14 parks of nature, 74 natural reserves, 18 protected landscapes, 42 cultural-historical landscapes and 328 monuments of nature.

The law on nature protection (LNP) from 2009 defines National park as follows: "A National park (NP) is an area with a large number of diverse natural ecosystems of national importance, prominent landscape features and cultural heritage in which man lives consistent with the nature, intended for preservation of existing natural values and resources, the total landscape, geological and biological diversity, and satisfaction of scientific, educational, spiritual, aesthetic, cultural, tourism, health and recreational needs and other activities in

accordance with the principles of nature protection and sustainable development (Official Gazette no. 36/09).

1.1. Study area

The National Park "Fruška Gora" (NPFG) is one of the five national parks which are recognized by the new LNP and it represents an area with unique flora and fauna, rich of different historical and cultural monuments. The area of the national park was managed as an economic forest till 1948, since then Fruška Gora was proclaimed as an area of special interest in Pannonia lowland. The Government of NR „Serbia" established the organization „Public recreation area" with the aim to improve it as a recreation and resting site. The law on proclamation of Fruška Gora for National park (Official Gazette no. 15/65) established the borders of the NP (24 302 ha), while the law on National parks (Official Gazette no. 39/93) increase this area to 25 393 ha (this law is still valid in the part that describes area and borders of NP).

2. METHODOLOGICAL APPROACH TOWARD THE RESEARCH

This is applied research oriented toward the improvement of the current situation with the following main objectives: a) to address concrete problems; b) to offer possible solutions; c) to enhance nature protection; and d) to apply different financing mechanisms. The primary target groups are: a) decision-makers within the park area and the state administration (Ministries for agriculture, forestry and water management (MAFWM), Ministry for environment and spatial planning, Institute for Nature Protection etc.; b) managers and employees in the NP; c) researchers; d) local communities; e) non-governmental organizations and other stakeholders involved in the work of NP.

The method of research is both descriptive and explorative. The research is based on a case study approach dealing with a concrete situation at a determined period of time, and has analytic discretion to the researcher (Neuman, 2006). Qualitative method in the form of in-depth interviews is used in order to conduct interviews. The interviews were designed to gather qualitative rather than quantitative information (Kostas Papageorgiou, Ioannis N. Vogiatzakis, 2006) from protected area managers. Concerning the sample, a non-probability sampling-purposive or judgmental method is used.

Considerable amount of fieldwork, written data sources (published and unpublished documents, company reports, non-governmental reports, and newspaper articles) and related ongoing research were used as a complementary literature.

3. RESULTS

The LNP represents an "umbrella law" that regulates protection and conservation of nature, biological, geological and landscape diversity as a part of environment. Its also partly sets the institutional framework in which national parks are managed, since some new acts are going to be established concerning there management

The National Park "Fruška Gora" has been established in 1965 and from that time different state institutions have been in charge of there activities. Today law on nature protection recognizes a Public Enterprise as the institution which manages this protected area The same law defines seven groups of financing mechanisms: a) revenues from budget of state, autonomous province or units of local government; b) fond for environmental protection (FEP); c) fee for use of protected area; d) revenues generated in the performing activities and managing PA; e) funds provided for the implementation of programs, plans and projects in the field of nature protection; f) donations, grants and assistance and g) other sources in accordance with the law. Beside this law, today the domain of nature protection is regulated indirectly by a number of laws and bylaws, and directly with specific regulative documents. Altogether there are more then 130 different regulative norms applicable.

In the part below some new financing mechanism are going to be explained in order to combine them with the actual situation in NP management as well as with possible legal financing sources, prescribed by the LNP, that can be used.

Internal and external sources of funding will be explained in this part. Financing mechanisms of protected forest areas should be more diversified and totally used. The quantity and quality of the collected funds is also very important. In order to secure the long term planning in the NP and diversified mechanisms from the LNP, the following categorization is applied. These financing mechanisms are grouped in six parts: 1) government revenue allocation; 2) grants and donations; 3) tourism revenues; 4) real estate and development rights; 5) resource use fees; 6) for profit investments. Financial mechanisms that are already used, as well as those that could potentially be used, have been retained. The data's are collected based on interview results which were made in NPFG, Ministry for environment and spatial planning (MESP), MAFWM and Provincial Secretariat (PS). In the table 1 six types of financing mechanisms are showed with there subcategories explained in the section below.

Government revenue allocation: This groups include mechanisms as direct allocation from budget, government taxes, tax deduction schemes, lottery revenues, premium priced motor vehicle plates, wildlife stamps, debt relief programs and environmental fund. Allocation of funds from the budget already

exist, and this is done in cooperation between different state institutions. A special government tax is levied through MESP and MAFWM but funds collected in this way are used not only for protected areas but for different purposes. In this moment support exist from Provincial Secretariat and MESP. The other five mechanisms are not used and the current law regulation does not recognize them as possible source for financing NP management. Environmental fund as such exist, as a part of MESP, and some funds were used in previous years.

Grants and donations: Donation or grants can be managed by agencies, domestic or international foundations, conservation trust funds, non-governmental organization (NGO) or by private sector. None of these five instruments are used. There are a few domestic foundations but their interest is not in this area and a trust funds as such does not exist. Trust fund could be a good instrument in cooperation with FEP. There are some indicators which could change this situation since cooperation with some embassies exist and IUCN is planning projects in cooperation with United Nation Development Pogramme.

Table 1. *Overview of financing mechanism, results and sources of revenues*

FINANCING MECHANISMS	Results		Source of revenue
	Presently obtained mechanisms	Possible succeeding mechanisms	
1. Government revenue allocation			
a) Direct allocation from government budget	Yes		Government budget revenues
b) Government taxes	Yes		Tax payers
c) Tax deduction schemes	No	Yes	Investors
d) Lottery revenue	No	Not applicable	Gamblers
e) Premium priced motor vehicle license plates	No	Yes	Vehicle owners
f) Wildlife stamps	No	Yes	Postal customers, hunters, fishers
g) Debt relief programs	No	Yes	International organizations, Donors
h) Environmental fund	Yes		Government budget revenues
2. Grants and donations			
a) Multilateral and bilateral agencies	No	Not applicable	Donor agencies
b) Foundations	No	Yes	Individuals,Coorportions
c) Conservation trust funds	No	Yes	Multi-source
d) Non-governmental organizations	No	Yes	Multi-source
e) Private sector	No	Not applicable	Investors
3. Tourism revenues			
a) Protection area entry fees	No	Yes	Visitors to park
b) Recreational fee	Yes		Different services within the NP
c) Airport passenger fee and hotel taxes	No	Yes	Tourists

FINANCING MECHANISMS	Results		Source of revenue
	Presently obtained mechanisms	Possible succeeding mechanisms	
d) Voluntary contribution by tourists	No	Yes	Tourism operators and tourists
e) Revenues from tourism operators	Yes		
4. Real estate and development rights			
a) Real estate tax surcharges for conservation	No	Yes	Property owners
b) Conservation concession	Yes		Investors
c) Conservation easement	No	Yes	Environmental fund
5. Resource use fee			
a) Wood extraction	Yes		Wood products
b) Eco labeling	No	Not applicable	Wood and non wood products
c) Recreational fishing	Yes		Associations or individual fishers
d) Hunting license fees and fines from illegal activities	Yes		Associations or individual hunters
e) Right of way fees for main roads and telecommunications	Yes		Corporations and individuals
g) Hydroelectric and thermoelectric power revenues	No	Not applicable	Power producers
h) Revenues from mining industry	Partly		Mining companies
i) Voluntary contributions by energy companies	No	Not applicable	Energy companies
6. For-profit investments			
a) For profit investment	No	Not applicable	Private investors
b) Biodiversity prospecting	No	Not applicable	Pharmaceutical companies

Tourism revenues: One of the important aspects of every national park is tourism development and nature based tourism. In order to develop this branch of the economy it is necessary to integrate tourists with the area they want to visit. PS and MESP stress that NPFG has a huge potential to use this resource since they have comparative advantage in there position toward the urban areas. Tourism can become one of the major financial mechanisms if all preconditions could be accomplished. Preconditions are in particular good road communication, infrastructural facilities and marked attractions within the NP and foremost well established services for its utilization. Examples of the possible financial mechanisms are protection area entry fee, recreational fee, airport passenger fee and voluntary contribution by tourists and tourism operators. In this moment NP collects only some type of recreational fee, while huge potential lays in protection area entry fee in the opinion of the managers in the NPFG. Hotels don't participate in any tax collection for protection purpose but there is a tourism tax that goes to development of local communities. Also tourism operators are in obligation to pay toll for using the area of NP but they don't behave according to law.

Real estate tax surcharges and development rights: This group of mechanisms refers to possible use of economic instruments as real estate taxes, conservation concession and conservation easement. Conservation easement can be used for protection of public and private land such as purchase or donation of land. It is a mechanism for conserving biodiversity on private land. In this case the owner can give or sell easement on his property to a government agency or to some trust fund. First group is mainly oriented toward development rights while purchase or donation of land can be used for unsolved ownerships legitimacy. In the opinion of the managers in the NPFG conservation easement could be a good instrument that would directly influence the problem with the monastery communities and the land that they owned. It needs the help of the government or some international or domestic donor agency. In the case of the NPFG only conservation concessions are present. After the process of reorganization, some of the activities were privatized or given in form of concessions. They have revenues from yearly leasehold which goes directly to their budget. Special tax for real estates in the vicinity of NP do not exists

Resource use fees: In order to better understand this field one has to distinguish park products and revenues made from energy, mining and transport versus park products related to different wood products, non wood products and processes of eco labeling or certification. Wood products are the main resource for financing the NPFG. The national park is also involved in collecting non-wood products on the basis of licenses for utilization. There are four types of licenses depending of there lasting and type of product. At the moment the NP does not have any type of certificate for use of eco labeling. Beside this NP management can collect hunting and fishing fee. The second type of fee is in the field of energy, mining and transport, including right of way fees for transport, telecommunication and electric power revenues and voluntary contribution by energy companies. Right of way fees, telecommunication and electric power revenues are interconnected. For both of them there is a special payment depending on the activity made in NP (fee for use of road, cable-car, electric and telecommunication cables). Collection of these revenues is based on act standard approved by government. For the mining industry it is interesting that the local industry can extract different materials. The good side of there utilization is that they make, after some period, re-cultivation of already used mining sites. The last component is contribution for energy sector but in our situation this does not exist. Resource use fees are the main component of NP funding. In this category services that NP provides are already now quite diversified, both with regard to wood production and non-wood forest products.

For profit investment: We can distinguish two types of investments, first dealing with private sector investments and second biodiversity prospecting. Private sector investments focus on the prevention of land-based pollution. In our case this refers to reclamation of queries by different industry

facilities. One of the biggest industries operating in the area is Lafarge located in Beočin. The agreement for extraction of material from queries is made with relevant ministries and the companies pays only road fee for using parts of the area of the NP. Concerning biodiversity prospecting, there are no arrangements with none of the pharmaceutical companies.

4. DISCUSSION

The objectives of NP management can be grouped in two parts. The first one is dealing with nature protection and preservation including scientific and educational purposes. The second one includes parameters emphasizing production and utilization of different park products and services. To consider these objectives in a perspective of financial matter is important, since besides protection and preservation, economic instruments for obtaining are essential.

Funding possibilities were explained in previous chapter where all financing mechanism were grouped in six parts. This categorization was made in order to better understand different types of services that could be provided within the NP. Government revenue allocation in many countries provides good mechanism for diversification of the existing ones. The main potential is presently the willingness of different state institutions for financing the work in the NP. Beside direct allocation from budget, mechanisms mentioned in this part can be used as innovative financing approach. Instruments as tax deduction schemes in some countries as Hungary have gathered specific funds for protection purpose (IUCN, 2000). This also includes premium vehicle plates and wildlife stamps. Naturally this needs changes in some regulation which is the task of different ministries and institutions. Their support can initiate these instruments and promote them as social responsible behaving of our citizens. A debt relief program is an instrument for decreasing of foreign debt in international organizations. It could be use if there is demand of our country and sympathy of these institutions.

Use of second instrument which refers to grants and donations appears to be rather limited. The main potential will be after accession into the EU with access to different specialized funds. One of these funds are the new Financial Instruments for the Environment (LIFE+) which already disposes of funding for next few years. This funds can be used both by non-governmental (conservation trust funds, foundations etc.) and governmental organization Cooperation between donors at regional and global level is needed as well as information sharing among NPs in the region.

Tourism revenues, as the third group of financial mechanisms are applied in different forms in PA. NP position is quite unique and can bring a lot of tourism development. One of the mostly used instruments is an entry free,

which could be obtained if some conditions are fulfilled. This could bring huge amount of revenues which further could be used for some other potential costs. The overall status of collection of these revenues is quite undervalued. This is connected with the actual organization and insufficient use of the tourism potentials from surrounding cities Second potential lies in collection of special hotel tax for conservation purpose. Beside residence tax one small tax of 1 percent can be also included for protection purpose. In next period cooperation with all relevant Ministries will be done in order to solve the problem of tourism operators who don't provide any type of fee for conducting there activity within the borders of NPFG. Efforts need to be undertaken in promoting national park activities through information centers. These centers should not only be established in the NP but rather in major cities nearby (Novi Sad and Belgrade).

Forth financial instrument, real estate tax surcharges and development rights, is partly used and has potential for generation of revenues from estates which are in their neighborhood through special tax while conservation easement can be a good mechanism if there is support from state institutions. The main potential lays in development of tourism and good cooperation with state institutions. Actions which are needed are for sure investment in tourism facilities and regulations for construction within the park borders.

In the fifth mechanism, resources use fees, we can find most of the incomes generated by the NP. This part represent the basis for there management and financial sustainability. This structure gives enough space for collection of funds and provides a certain amount of economic autonomy from state institutions (Djordjevic, 2009). The main potential lies in the fact that there is need for these products in nearby cities providing a huge market for this branch of the economy.

For-profit investments as the sixth group do not provide revenues for NP since their management does not have direct contacts and agreements are made on provincial and state level.

5. CONCLUSION

Better use of current financing mechanisms and applying of some new innovative one in NP can provide sustainable financing of there management. Besides state support strong efforts should be put on grants and donations due to openness of EU funds after accession. Tourism revenues represent one of the major potential in future management of this park. This mechanism could provide enough revenues if it would be followed with proper development of tourism facilities and improvement of tourism propositions. Some steps concerning this mechanism are already done but it will need more cooperation between different state institutions in order to become realistic.

All of the mentioned mechanisms should be optimized and improved to become applicable in the management of the National park "Fruska gora". Further analysis of these instruments, and there integration in to the financing sustainability patter, will be done, in order to see how they are going to change the current situation.

Structure of the interview:
Date of the interview:
Name and surname of the interviewer:
Position of the interviewer:

1. What is the current level of government revenue allocation?
2. Do non-governmental organizations participate through project or donations in the work of NP?
3. Is there a possibility for establishing protected area fee or recreational fee?
4. Do hotels provide any kind of contribution to protection purpose?
5. Are there frees for provision of tourist services?
6. Since there is huge proportion of private land under the management of NP, what is your opinion on conservation easement?
7. Does real estate tax exist for private owned property?
8. Does the NP collect revenues from different services provided within the NP?
9. Is there possibility for collecting right of way fee and revenues from power industry?
10. Does the NP collect revenues from resource extraction?
11. Are there contacts with pharmaceutical companies for biodiversity prospecting and for-profit investments?

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REFLECTION OF DIFFERENT FINANCING MECHANISMS WITHIN THE NATIONAL PARK "FRUŠKA GORA"

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Summary

Law on nature protection recognizes the National Park "Fruska Gora" as one of five national parks in the territory of the Republic of Serbia. This law was adopted in 2009 and its provisions are defining the manner of management and financing of protected areas. National Park "Fruška Gora" was established in 1965 when its borders were set, while law on National from 1993 accurately define the boundaries of the park on the territory of 25 393 ha.

The paper analyzed the management of National Park, with its financial aspects and possibilities of additional funding in the near future. The method of research is descriptive and explorative, since it gives a descriptive picture of the current situation in National Park, while the explorative analyzes current trends related to the financing of protected areas. To collect data for this research was used qualitative methods in the form of in-depth interviews. Through interviews, current method of financing and use of financial mechanisms defined by (Koteen, 2004) was questioned. All the financing mechanisms are processed through the six groups: a) government revenue allocation; b) grants and donations, c) tourism revenues; d) real estate tax surcharges and development rights; e) resources use fees and f) profit investments.

This approach provided a deeper insight into the current financial sustainability of national park management as well as proposals for additional sources of income, which could cover potential costs in the future

RAZMATRANJE RAZLIČITIH MEHANIZAMA FINANSIRANJA U OKVIRU NACIONALNOG PARKA "FRUŠKA GORA"

Ilija ĐORĐEVIĆ Radovan NEVENIĆ, Zoran PODUŠKA

Rezime

Zakon o zaštiti prirode prepoznaje Nacionalni park „Fruška Gora" kao jedan od pet Nacionalnih parkova na teritoriji Republike Srbije. Ovaj zakon je usvojen 2009. godine i njegovim odredbama definiše se način upravljanja i finansiranja zaštićenih prirodnih dobara. Nacionalni Park „Fruška gora" je osnovan 1965. godine kada su i postavljene njegove granice, dok je zakon o Nacionalnim parkovima iz 1993. godine tačno definisao granice parka na teritoriji od 25 393 ha.

U ovom radu analizirano je upravljanje Nacionalnim parkom, sa aspekta njegovog finansiranja kao i mogućnostima dodatnih finansiranja u bliskoj budućnosti. Metod istraživanja je deskriptivan i istraživački, deskriptivni daje trenutnu sliku u Nacionalnom parku dok istraživački analizira trenutne trendove vezane za finansiranje zaštićenih prirodnih dobara. Kako bi se prikupili podaci za ovo istraživanje korišćena je kvalitativna metoda u obliku dubinskih intervjua. Kroz intervjue ispitani su trenutni načini finansiranja i primene finansijskih mehanizama definisanih od strane Koteen-a u 2004 godini. Svi mehanizmi finansiranja su obrađeni kroz šest grupa a) prihodi od strane države; b) donacije i pokloni; v) prihodi od strane turizma; g) prihodi od poreza na nekretnine i prava gradnje; d) prihodi od korišćenja prirodnog resursa i đ) profitne investicije.

Ovaj pristup omogućio je dublji uvid u trenutnu finansijsku održivost upravljanja Nacionalnim parkom kao i predloge za njegove dodatne izvore prihoda koji bi omogućili pokrivanje potencijalnih troškova u budućnosti.

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