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HANS EM
FACULTY OF FOREST SCIENCES
LANDSCAPE ARCHITECTURE AND
ENVIRONMENTAL ENGINEERING



BOOK OF ABSTRACTS

INTERNATIONAL SCIENTIFIC CONFERENCE



*Better forestry,
for better forests,
for a better planet.*

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HANS EM FACULTY OF FOREST SCIENCES, LANDSCAPE ARCHITECTURE
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Ss. Cyril and Methodius University in Skopje
Hans Em Faculty of Forest Sciences, Landscape Architecture and
Environmental Engineering
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BOOK OF ABSTRACTS

15 - 16th June 2022
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Modelling of potential distribution of the atlas cedar (*Cedrus atlantica* Manetti) in Morocco

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Abstract:

The Atlas cedar (*Cedrus atlantica*) is an emblematic species of Morocco, classified by the International Union for the Conservation of Nature (IUCN) in the red list of endangered species. Determining its potential area under current climatic conditions is an essential step in planning and ensuring its conservation. In this paper, we applied the maximum-entropy algorithm (MaxEnt) to predict the current and potential distribution of the Atlas cedar in order to provide a basis for its conservation. The adjusted model had an excellent predictive quality (AUC = 0.967). The most significant variables influencing the distribution of Atlas cedar, under current climatic conditions, are the precipitation in the driest quarter, precipitation in the driest month, average annual temperature and relative humidity. The model developed made it possible to establish the first map of the suitable potential area of the Atlas cedar in Morocco. The results obtained will guide managers to identify favorable sites for the rehabilitation of the Atlas cedar threatened with extinction.

Keywords: *Cedrus atlantica*; potential area; MaxEnt; bioclimatic variables; maximum entropy; climate



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Mycodiversity in the coniferous communities of Shar Mountain - Literature review of macrofungi in coniferous forest on mountain Shar Planina in North Macedonia

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Abstract:

The coniferous forests on Shar Planina are distributed in the high mountain area and are represented by mixed or pure forest stands of *Abies alba* and *Picea abies*, and in a smaller surface area there is a community of *Pinus peuce*. This paper refers on literature review of available data on diversity of fungi in the coniferous associations, *Abieti-Piceetum scardicum*, *Piceetum excelsae-subalpinum*, as well as *Abieti-Fagetum*. Within the papers, most of the data presented is from a material that had been collected during the period 1995-1998 in the summer seasons, from three main localities: Jelak, Popova Shapka and Leshnica. A total number of 53 species of fungi are reported, out of which 28 species are from *Abieti-Fagetum*, 16 species are from *Piceetum excelsae-subalpinum* and nine species are from *Abieti-Piceetum scardicum* association. The highest number of species belongs to phylum *Basidiomycota* (50), and only three species are identified within *Ascomycota*. According to the substrate 30 species of fungi are terricolous while 23 are lignicolous. According to the available data, the mycodiversity in coniferous forests in Shar Planina is scarcely studied, especially the *Pinus peuce* forests for which there is no data concerning fungal diversity. Therefore, it is necessary to explore the diversity of fungi in the coniferous forest associations in Shar Planina and to provide a better mycological knowledge on these important forest ecosystems in order to gain more complete picture.

Keywords: Shar Planina; coniferous forests; mycodiversity; Ascomycota; Basidiomycota



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Morphological variability of bulbs, fruits, and seeds of the genus *Galanthus* L. (Amaryllidaceae) in Serbia

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Abstract:

To shed some light on the taxonomy of the genus *Galanthus* L. in Serbia, we analyzed variability of five rarely studied quantitative characters in 60 individuals from populations representing two autochthonous species (*G. nivalis* L., and *G. elwesii* Hook.f.). Morphometric measurements were conducted on living plant material, and the obtained data were processed employing descriptive, univariate, and multivariate statistical methods. The results show that the values of all analyzed characters were larger in (a) *G. elwesii* than in (b) *G. nivalis* (mean±standard deviation: bulb length a. 22.81±3.39 mm, b. 19.79±2.87 mm; bulb diameter a. 16.26±2.33 mm, b. 14.56±1.73 mm; bulb length to bulb diameter ratio a. 1.41±0.14, b. 1.37±0.20; fruit diameter a. 11.69±2.13 mm, b. 11.29±2.75 mm; seed diameter a. 3.77±0.47 mm, b. 3.74±0.58 mm). Almost all of the examined characters (except for fruit diameter in *G. nivalis*) exhibited moderate degrees of variability (coefficient of variation 10–20%), and the values of several characters (fruit and seed diameters in *G. nivalis*, and bulb length and fruit diameter in *G. elwesii*) exceeded the limits of variation stated in literature. The analysis of variance revealed statistically significant differences in bulb length ($P=0.0005$), and bulb diameter ($P=0.0022$). However, the canonical discriminant analysis did not provide differentiation between the two studied species, suggesting that for their taxonomic delimitation additional characters should be used. The results of the study contribute to the general knowledge of the variability of *Galanthus* species in Serbia, and could also be valuable for the management and protection of these species as they belong to the world's most traded bulb genus collected from forests. This study was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract No. 451-03-68/2022-14/200027).

Keywords: *Galanthus*; Serbia; morphological variability; numerical taxonomy; conservation



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First report of *Cryphonectria carpinicola* in the Balkans and *Cryphonectria radicalis* in Bulgaria

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Abstract:

The members of *Cryphonectria* are known to infect deciduous tree genera of forests, orchards and urban spaces. Its most infamous representative, *C. parasitica*, causes the blight disease in chestnut trees and is considered as the most aggressive *Cryphonectria* species in Europe. To study the invasion dynamics of *C. parasitica*, we have conducted sampling campaigns of symptomatic *Castanea sativa* in the Balkans since the mid 1990-ties. During isolation of fungi from the bark material, in some cases we encountered atypical mycelia, suggesting that different *Cryphonectria* species may be present in this region. The aim of this study was to identify the species of atypical cultures, excluding the well-studied *C. parasitica*. For this purpose, we combed through our isolate collection, preserved on dried glass filter, and recultivated up-to-25-year-old samples to obtain DNA from the cultures. If the dry samples were no longer alive, we applied forensic DNA extraction to recover DNA directly from the glass filter. We sequenced the ITS barcode of twelve atypical specimens preserved in our collection, and confirm here the presence of the recently described *Cryphonectria carpinicola* on a *Carpinus* tree from the Berkovska Stara Planina Mountain in Bulgaria, collected in 2007. Additionally, we also report the occurrence of *Cryphonectria radicalis* in the region of Blagoevgrad in Bulgaria isolated from *C. sativa* in 2005 and 2007. The oldest examined specimen dates from 1998 and is *Cryphonectria radicalis* from Belasitsa Mountain in North Macedonia, also previously reported. *Cryphonectria carpinicola* became noticeable only in the last two decades on declining hornbeam trees in urban areas of Central Europe. It shows only slight differences in morphology and anatomy to the two closely related species *C. radicalis* and *C. naterciae*, and differs from most other *Cryphonectria* species due to its preference for *Carpinus* trees as main hosts, while other *Cryphonectria* species are found on *Castanea* or *Quercus* trees.

Keywords: pathogen species diversity; ascomycete; barcoding; culture collection



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The role of Tharandt Botanic Garden in search for alternative tree species in climate change

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Abstract:

Climate change and with it more extreme weather events are causing physiological stress. In addition to new and developing pathogens spreading recently, a demand for alternative tree species in forestry as well as landscaping is rising. With the cultivation of well documented species of different provenances in nature and in numbers of at least 100 specimens per species in Tharandt Botanic Garden a contribution to testing alternative species is provided. While other institutions in Germany test species from South-eastern Europe and Caucasia in Tharandt a focus is set on North America, especially the Midwest and the Russian Far East, region Primorje. Both regions were chosen due to their climate conditions with cold winters and drought events in spring or summer. Growth, root development and competition in different mixed stands, reflecting different forest types, are evaluated and documented. First results after 20 years are presented and early suggestions for alternative species are made. This needs to be continued, but a broadening of cultivation trials in cooperation with the forestry administration for some species already seems promising.

Keywords: integration of alternative tree species; stand structure



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Correct planning and proper landscape design - key to quality urban life Case Study: Macedonia Park, Skopje, North Macedonia

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Abstract:

With the modernization of urban areas, green spaces are reduced, and the importance of the existing ones is rapidly increasing. The point is not just to have open green spaces in the cities but to have multifunctional and multipurpose parks. Whether a green place is successful depends on urban planning and landscape design. The correct planning and the proper landscape design of urban parks are key to quality urban life. The subject of analysis in this research is the planning and landscape design of the first part of Macedonia Park in Skopje, North Macedonia. The goal is to determine whether this area is functional and aesthetically beautiful at the same time. The analysis addresses several different aspects (its functionality, depending on the elements it contains; the safety of its visitors; plant species selection and the layout of the plants related to the functionality and the aesthetic appearance of the park). The results show that Macedonia Park (First part) is a multifunctional and multipurpose green area. Even though there are parts with different elements in the park which satisfy visitors with different interests of all ages, some mistakes or failures made in its planning and landscape designing are noticeable. Some of them refer to the safety of the visitors, some of the plant species selection and the others on the layout of the plants related to the functionality of the park. Also, there are errors in using some of the basic principles of landscape design, such as focalization, simplicity and rhythm and line. The aspects taken into consideration in the analysis in this paper include the potentialities and challenges of planning, designing and improving city parks in urban areas like Skopje.

Keywords: urban areas; green spaces; correct planning; landscape design; Macedonia Park



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Genetic differentiation of hungarian oak (*Quercus frainetto* Ten.) Populations in Serbia based on morphological characteristics of acorns and seedlings

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Abstract:

The research aim was to determine the level and pattern of phenotypic variability for morphological characteristics of acorns and seedlings, as well as the connection of phenotypic variability pattern with the genetic differentiation of Hungarian oak populations. The nursery test was set in the Scientific Research Station “Lipovica” near Belgrade. The seed for seedling production was collected in four natural populations. Morphological characteristics of acorns and growth elements of one-year-old (1 + 0) and two-year-old (1 + 1) seedlings were analyzed. The analysis of variance (ANOVA) and the multivariate analysis were both used to examine the variability between populations: analysis of main components (PCA) and cluster analysis. Pearson's correlation coefficient was used to assess a linear regression between analyzed characteristics as well as the link between characteristics and climate variables of the original habitats of the populations. The results of the ANOVA showed statistically significant differences ($p < 0.01$) between populations for all studied characteristics. Pierson's correlation analysis showed strong links between analyzed characteristics, as well as between analyzed characteristics and climate and geographical variables. The eco-clinal pattern of phenotypic differentiation of the populations was determined based on the elevation of the original habitats and associated environmental variables. The results of the PCA analysis showed the separation of the provenances along the first main component axis related to the elevation and associated climatic parameters. The identified differences in the phenotypic characteristics between populations indicate a high potential of the species to adapt to climate change. The obtained results indicate the genetic differentiation of the populations related to elevation. The significant genetic variability in the studied Hungarian oak populations points out their importance as potentially valuable sources of reproductive material.

Keywords: *Quercus frainetto* Ten.; phenotypic characteristics; variability; population.



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Prevention of Waste-Contaminated Forests by ICT, standards and legislation

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Abstract:

Protected natural areas of a city or outside of a city are important for maintaining biodiversity, together with the natural for habitats. The maximum benefit is achieved when natural areas are as large as possible and contiguous. 'Protected area' is a clearly defined geographical space, recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values. In these areas, the waste is completely unwanted. There is number of documents (including legislative documents, as well as standards) that deal with the topic of environmental engineering within EU and on the global level. Some of the European Union's policy fight illegal logging and associated trade (defined back in 2003 with the Forest Law Enforcement Governance and Trade (FLEGT) Action Plan). The FLEGT Action Plan covers both supply and demand side measures to address illegal logging (November 2003). Council Regulation (EC) No 2173/2005 of 20 December 2005 (the FLEGT Regulation) allows for the control of the entry of timber to the EU from countries entering bilateral FLEGT Voluntary Partnership Agreements (VPA) with the EU; Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 (the EU Timber Regulation) as an overarching measure to prohibit placing of illegal timber and timber products on the internal market.

Keywords: protected areas; waste; environmental engineering, legislation



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Accuracy assesment of supervised classification employing the MLC and RF algorithms on Sentinel2 image for the preparation of a vegetation map in the eastern part of the Republic of North Macedonia

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Abstract:

Vegetation mapping by employing supervised classification has been an essential remote sensing technique since the technology became widely available. Improving the accuracy of a classification method is the challenge and this is usually controlled via on-field visits of a study area. Not in this case-study though, the study area (55.700ha), in the eastern part of RN Macedonia, was thoroughly mapped via field mapping and the aim was to try and achieve as higher accuracy with remote sensing techniques by employing the Maximum Likelihood Classification (MLC) and Random Forest (RF) algorithms within the SNAP software package and its toolboxes. The image obtained for interpretation was a L2A Sentinel2 image from 26th of October 2019 since it provided zero cloud coverage and showed the seasonal changes in the vegetative period. The areas of interest were chosen based on the field mapping coordinates and the occupying vegetation type. Thirty-five different communities were registered via the field mapping. Carrying out a supervised classification based on all plant communities and trying to achieve a higher level of accuracy was not possible, due to the higher number of plant communities with very small habitat areas of less than a hectare to a few hundred. To this end, eleven of the communities with an area of more than 1000 hectares were selected for further processing. The obtained results were very satisfactory, with higher than 80% accuracy achieved and more in favor of the RF algorithm rather than MLC. Although in some areas the vegetation community size differs in relation to the field mapping, the spatial distribution of the classification follows that of the field mapping.

Keywords: supervised classification; vegetation mapping; remote sensing; Sentinel2; accuracy assesment



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Data on Distribution and Habitat Preferences of Edible Truffles in the Republic of North Macedonia

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Abstract:

The diversity of truffles in the Republic of North Macedonia is expected to be high owing to the diverse vegetation communities, the suitable geological substrate and favourable climatic conditions. During 2019-2021, a revision of deposited materials at the Macedonian Collection of Fungi along with field research confirmed presence of six edible truffle species (336 collections) within the genus *Tuber*, which are highly demanded on the market. The distribution of the taxa was analysed in terms of the biogeographical regions of RN Macedonia and the habitat preferences on oak, beech, coniferous, riparian forests, anthropogenic forests and parks. *T. aestivum*, the most foraged black truffle in RN Macedonia, is also the most common and broadly distributed in 26 regions, 60-1,600 m.a.s.l., in all habitat types, albeit it favors oak and beech forests. *T. mesentericum* is found in 13 regions, 300-1,600 m.a.s.l., also in a variety of habitats though it primarily occurs in beech forests. It is often misidentified as *T. aestivum* by truffle hunters; however, it is not as much valued due to the sharp acetate odor. *T. brumale* was recorded from 18 regions, 220-1,600 m.a.s.l., it mostly occurs in beech forest, but it is also largely reported from oak and riparian forests. *T. macrosporum* is an extremely rare species, discovered in only two regions, in riparian forests of *Populus* spp. at 400 m.a.s.l. Despite the fact that it is highly valued in Europe, it is not so well-known and used by truffle hunters in RN Macedonia. Two species of the white commercial truffles are present; namely, *T. borchii*, which is valued attributable to the pleasant aroma, and the most prized - *T. magnatum*. *T. borchii* is recorded from 19 regions, 100-1000 m.a.s.l. mostly in oak forests and mixed oak-pine forest; it could be confused with *T. dryophilum* or *T. puberulum* which possess no culinary value. *T. magnatum* is exceptionally rare, found in only two regions, in riparian forests of *Populus alba*, *Quercus* spp. and *Corylus avellana*, at 400 m.a.s.l. Further research on distribution, along with ecological analysis of the sites and molecular analyses are required to identify cryptic species.

Keywords: *Tuber*; biogeographical regions; oak forests; beech forests; riparian forests



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Urban forestry and disaster relief: The importance of urban forestry and greenery in the 1963 post-earthquake reconstruction of Skopje

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Abstract:

The goal of a green, walkable city was partially achieved in the post-earthquake reconstruction of Skopje in 1963-1965, through collaborative and international planning, architecture, and engineering efforts. The result of this endeavour was the Skopje Urban Plan Project (UPP), that created a framework of urban development focused on the promotion and protection of greenery and urban forests, sustainability, walkability, and humane urbanism while integrating the new construction into the existing natural terrain and architectural traditions. This paper will explain the unique disaster relief case of Skopje 1963 and the sustainable lessons that came out from the work, while arguing that the project provides a successful precedent for the future of the built environment facing the climate crisis.

Keywords: urban planning; humane urbanism; disaster relief; Skopje earthquake



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The role of urban trees in reducing land surface temperature

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Abstract:

Increasing urbanization in the world in recent years has resulted in the replacement of areas covered with plants by buildings. Because of this change, urban areas are warmer than rural areas (urban heat island). In this investigation, the urban heat island (UHI) effect, the methods of combating this effect and notably the role of urban trees are exhaustively elaborated by considering the relevant literature. In addition, suggestions were made on which species should be selected and how tree species should be positioned to reduce UHI effect. There are solid evidences that trees, urban green spaces and wider green infrastructure can bring significant reductions in urban temperatures. Urban planners and decision makers can help combat UHI and increase urban resilience to the effects of climate change, primarily by planting the urban environment with extensive shade-providing species and harnessing the most of the opportunities afforded by restoration activities. Trees and other vegetation can cool the surrounding air by evapotranspiration thanks to both transpiration from plant leaves and evaporation of water from irrigated soil. The tree canopy can considerably improve outdoor thermal comfort by preventing a pedestrian from being exposed to solar radiation, and also by protecting floors and building coverings from UHI effect. Furthermore, if a roadside afforestation is to be established to combat UHI effect, a proper plan based on the character of the road will be beneficial in terms of achieving the determined goals. Eventually, the adaptation to UHI should be achieved to plan short-, medium- and long-term changes.

Keywords: urban trees; urban heat island; cooling; woody species selection



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Conservation strategy targeting priority species of the Balkans: the example of the INTERREG programme CONSE-PP

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Abstract:

The CONSE-PP project aimed at the protection of biodiversity in the cross-border area of Greece and the Republic of North Macedonia. Selected taxa were prioritized as follows: priority A taxa (122 threatened and near threatened plants); B (372 local Balkan endemic plants) and C (237 rare plants). The project's scope was three-fold: (a) To document in situ the species-specific risks-threats, (b) To offer ex situ conservation for them as a back-up solution for future re-introductions, and (c) To introduce specific actions raising public awareness and alertness about the importance of local biodiversity. In the framework of the project, 20 independent botanical expeditions were carried out in 75 selected cross-border areas to collect samples and prioritized propagation material. During expeditions, 150 plant species and subspecies were targeted, 300 seed lots, 64 soil samples and 200 dried herbarium specimens were collected regarding the prioritized groups A, B and C. Additionally, all types of threats and risks were in-situ identified for 130 priority plants. The 150 priority taxa collected (530 accession numbers) were fully documented and are maintained under ex-situ conservation after many propagation trials (sexual, asexual); the latter resulted in the development of numerous species-specific propagation protocols. Consequently, new plant stocks were raised ex-situ and were established for in two awareness raising sites: (a) 1,000 plants of 70 taxa in the newly designed Kardia Botanical Park in Thermi (Greece), (b) 850 plants of 104 taxa in the thematic section in the phytodiversity awareness spot in the Balkan Botanic Garden of Kroussia, and (c) 42 plants of 14 taxa in the botanic garden of Ss. Cyril and Methodius University in Skopje.

In parallel, suitable infrastructure for the ex situ conservation of selected priority plants at low-altitude and special GIS applications were developed, one for species-specific



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ecological requirements and another one improving the awareness about the prioritized species and raising citizens' alertness. Finally, targeted awareness-raising and training activities for specific target-groups were carried out.

Keywords: priority plants; ex situ; conservation

Acknowledgements: The activities were co-funded by the European Union and National Funds of the participating countries in the framework of the INTERREG IPA CBC Program "Greece - Republic of Northern Macedonia 2014-2020" project entitled "Improving the conservation of the priority plants in the cross border area" (acronym Conse-pp)



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Collection of experiences from 25 years work on seed propagation of allochthonous dendroflora at the Hans Em Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering in Skopje and the surroundings

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Abstract:

Various efforts in the past decades have contributed for a large variety of allochthonous tree species to become a part of the urban and suburban landscape in Skopje. Of more than 200 registered allochthonous species in the urban and suburban green areas of the city of Skopje, we propagated from seed 65 species, of which 19 coniferous and 46 broadleaved, and subsequently analysed the attributes of their generative propagation potential. This paper summarizes 25 years' experience in generative propagation of allochthonous species at the „Hans Em“ Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering (HEF) in Skopje, R. of North Macedonia. The collected cones, fruits or seeds were processed to obtain sawing reproductive material. According to the quantity of the collected material and seeds/fruits characteristics, the quality features of the seeds were examined (seed germination rate or viability, seed purity). Prior sawing, according to species dormancy characteristics, different pre-sowing treatments were performed, e.g., pre-soaking in cold water; hydro-thermal procedure; pre-soaking in warm water; maceration in hydrogen chloride; and seed cold stratification. The seeds were sown in the nurseries of the HEF and in some nurseries of the PE National forests, in containers or in soil. Selection of the nurseries for the seedling production was made in terms with the ecological conditions, favourable for the certain species. One-year old seedling were measured for the shoot height (SH) and root collar diameter (RCD). Seeds germination/viability rate varies in wide range. Seedlings features also vary, depending mostly on nursery technology (bare root and container seedlings) and skills of the nursery staff. Largest differences in seedlings SH and RDC were recorded within the broadleaved bare root seedlings (e.g. in black locust up to 1000%), while in coniferous species the differences were not of such high significance. Generally, one-year old coniferous seedlings achieved better results in containers, while seedlings of broadleaved species in soil. These results, achieved during two-and-half decades, demonstrate that urban and suburban green areas in



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the city of Skopje can provide reproductive material for nursery production of species both for ornamental and reforestation purpose. Thus, further optimization as well as research regarding most suitable techniques for generative propagation is needed.

Keywords: allochthonous species; generative propagation; reproductive material quality; seedlings quality



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Analysis of the influence of CoVid-19 pandemic on residents' perception on the importance of the urban greenery on quality of life

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Abstract:

The overarching goal of this article is to understand the influence of the CoVid-19 pandemic on the residents' perception and visits of the urban greenery (e.g. Skopje City Park). Therefore, a combination of both quantitative and qualitative data were used. The questionnaire was consisted of 21 questions and was developed in an open online platform, distributed via the Internet (the social media) to the broader public. The total sample size was 100 responses, which were considered as relevant for generalizing the residents' perception. The data were collected during April 2022. The results show that 57% of the respondents were female; the youngest has 19 and oldest respondent has 77 years; 40% are working in the private sector and 31 in public/state administration; almost all (96%) have habit of visiting green areas, and 56% of them more than twice a week. 2/3 are visiting the green areas with at least one accompanying person, emphasising the social function of the green areas. More than 50% indicate that they find recreation and relaxation services in the green areas in the city of Skopje. There is a positive correlation between the place of living and the distance to the nearest green area, i.e. for 70% this distance is important or very important. There is an increasing trend on the frequency of the visit of the green areas (before, during and after CoVid-19 phase). Some of the findings stated that the access to green areas is linked for better or improved psychological relaxation and stress alleviation, as well as creating and improving social cohesion and encouraging physical activity of the respondents based on the negative influence of CoVid-19 pandemic and the restrictive measures, depicted through certain activities that were carried out on a regular basis during lockdown (CoVid-19), and continue in post CoVid-19 phase.

Keywords: urban greenery; green areas; residents' perception; CoVid-19



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Mapping and evaluation of cultural ecosystem services in City Park Skopje

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Abstract:

This paper discusses nature photographers as a part of a broader concept of cultural ecosystem services provided by the urban green area of the City Park Skopje. The scholars recognized that high-quality planning, design, management, and multifunctional capacities of urban green areas are essential for the improvement of human health and wellbeing. However, to maintain and enhance the quality of urban green areas there is a need for more in-depth knowledge of functions that green areas provide (ecosystem services). Based on the literature review for mapping and assessment of ecosystem services (cultural) the nature photographers were used as an example. The paper aims to explore how urban dwellers perceive and value the City Park Skopje. Therefore, the photographs of City Park Skopje placed on the google platform (Google Earth and Google Earth Pro) were taken for analysis. The total number of photographs was 268 posted by 61 authors. The photographs were analyzed in QGIS software. For the purposes of the research, a map of the park with hotspots was created depending on the number of images in certain parts of the City Park Skopje. The findings highlight certain hotspots based on the photographs indicating the importance of the cultural ecosystem services provided by City Park Skopje and its role in a better quality of life and human health in Skopje. The paper's findings need to be considered in future research about the role of ecosystem services (cultural) in raising environmental awareness and social cohesion and interaction between Skopje urban dwellers and City Park Skopje. In the end, the paper also provides suggestions for a research framework and conceptual models that need to be further developed to be applied in future selection and assessment of cultural ecosystem services.

Keywords: ecosystem services; cultural ecosystem services; green areas; mapping; evaluation of ecosystem services



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Protected areas: History of their evolution and management practices

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Abstract:

This human impact on earth goes back for millennia; humans have transformed the world's landscape with the expansion of agricultural land, and more recently, the expansion of urban infrastructure. Half of the world's habitable (ice- and desert-free land) is now used for agriculture. In the process, we've lost one-third of the planet's forests and large areas of wild grasslands, peatlands and other environments. Thus, the main goal of this paper is to explore and learn about the history of the protected areas. How, when and where they began to be established? Why they were established and how they began to spread around the world? Therefore, the aim is not only dig into the beginnings, but to see how they evolved and how they developed through the years until now. Accordingly, the findings of this paper indicate that conservation, the original concept of a protected area, has strongly influenced the development of the subsequent protected-area models. In this sense, our response to the decline of biodiversity and ecosystem services has been to increase the supply side of conservation in terms of the number and size of protected areas, instead of managing the drivers of change and the demand for specific ecosystem services (which ultimately threatens biodiversity and ecosystem services).

Keywords: protected area; conservation; forests; biodiversity



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Policy support measures in forestry and nature conservation for climate change governance

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Abstract:

The negative impact and effects of climate change are, at the moment, one of the most significant problems in forestry and nature conservation in Serbia. Their complexity and possibility of occurrence, indicate the need to include all these issues in the policy-making of these sectors, for effective climate change governance. For successful implementation of those policies, regulatory, economic, and information support measures are needed, with the participation and cooperation of stakeholders from various sectors at different governance levels. This paper aims to determine the attitudes of respondents towards the availability, implementation, and success of the achievement of support measures for climate change governance in forestry and nature conservation in Serbia. Primary data were collected through interviews (103 in total), in the period from March 2017 to July 2019, in selected forest areas in Serbia. The interviews were conducted with representatives of organizations from the public (public enterprises - PE and local self-government - LS) and civil (NGO) sectors dealing with forestry, nature conservation, and climate change. Judgmental sampling was used for the selection of interviewees. The questionnaire that was used consisted of five groups of questions. For this paper, we analysed only those related to support measures for climate change governance. Respondents believe that informational (80.9%) and economic support measures (75.7%) are the most common, as opposed to regulatory support measures (24.5%). Most respondents from the LS group believe that regulatory support measures for climate change governance are available, while this is not the case with respondents from the PE and NGO groups. However, most respondents from all three groups believe that economic and informational support measures for climate change governance are available. Competent ministries dealing with environmental protection and forestry provide most of the available support measures for the public and civil sectors. International foundations and agencies (to a lesser extent) provide support measures for climate change governance to civil sector organizations. A large number of respondents from the PE group believe that the implementation of regulatory support measures is unsatisfactory, unlike respondents from the LS and NGO groups. Regarding the success of the implementation of informational and economic support measures for climate change



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governance, a large number of respondents from all three groups have positive attitudes. Respondents believe that there is a need to improve the success of the implementation of regulatory and economic support measures for climate change governance.

Keywords: support measures; forestry; nature conservation; climate change governance



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Importance of NWFPs for good forest governance

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Abstract:

On the global level, the forests provide a large variety of non-wood forest products (NWFPs) as a resource base for regional and local development in rural landscapes. The multifunctional ecosystem approach is transforming our understanding of forests. The recent economic relevance of NWFP for trading and food requires their integration into forest management. The integration of NWFP will make the shift from the traditional timber-oriented management paradigm toward an ecosystem forest management approach. The role of NWFPs differs and often is linked to the socio-economic context and the perspective of seeing NWFPs as forest ecosystem services. The impact of NWFP resources on livelihoods provides multiple benefits to rural populations. The research has identified a few constraints related to a) social issues concerning the interaction between different levels of governance and the stakeholders, and to what extent are the perceptions about the important role that NWFP has for sustainable rural development; b) the economic constraints were identified with the use of natural resources (e.g. the conflict between nature conservation and the economic interests); c) the official reporting on production volumes of NWFP is rare, weak or inaccurate as results of the complex system with inadequately understood value chains; d) the policy constraints were identified in the sharing of knowledge and information as well as in the integration and coordination of policies between environmental and forestry sectors which needs to operate as much as can as harmonized frameworks with compatible goals. The findings emphasize the growing interest in the importance of NWFP and their potential in the new bio-economy (on the national level) which is in balance with nature for which additional and more comprehensive research is needed. This additional research needs to focus on providing long-term forest security and stability (forests that are resilient and adaptive to climate changes) and developing a conceptual framework for transition designed in a close-to-nature way.

Keywords: NWFPs, forest governance, forest policy



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Intrapreneurship as a way for employee innovation behaviour in state-owned forest enterprises

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Abstract:

Intrapreneurial concept was based on Pinchot's perspective of "conservation ethics" which is the art of producing from the forest whatever it can yield for the service of man. The phenomenon of intrapreneurship implies that every employee has a certain creativity, which needs to be encouraged in order for the company to benefit from new business activities. This paper aims to identify enabling and constraining elements of intrapreneurial climate that affect employees' innovative behaviour. Specific focus was directed to big enterprises especially state-owned forest enterprises. In this paper we used systematic literature review to determine the elements of organizational climate which influence on employees' innovative behavior. Results indicate that initial intrapreneurial perspective known as "conservation ethics" was based on commitment to public goods, nature and the environment and disagreement with the concentration of wealth and power. This perspective is still applicable when conceptualizing intrapreneurship in the state-owned forest enterprises. It was found at least eight elements that influence employees' innovative behaviour. These elements are working time availability, reward system, work autonomy, managerial support, entrepreneurial attitudes and motives, flow of information, business environment, professional training. Positive entrepreneurial attitudes and motives and business environment have the greatest impact on employee innovativeness among all other elements of organizational climate. An organizational climate favorably for innovative behaviour is characterized by mutual positive and negative correlations, where managerial support, reward system and working autonomy are crucial for such climate. In practical sense such conclusion can be significant for the management of forest enterprises, i.e. it is necessary for the management to encourage the expression of entrepreneurial ideas of employees.

Keywords: entrepreneurship; organizational development; risk



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Identifying runoff sensitivity in forests and seminatural areas; Case study: Skopska Crna Gora

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Abstract:

Watersheds are dynamic systems constituted by a complex arrangement of interactions between the land and water environment. There are essentially three interconnected fluxes, not only of water but also of sediments/nutrients and pollutants. Surface runoff carries sediments, nutrients, and pollutants from the land through the drainage networks. It is important to note that those fluxes are varying over time and space. Runoff, in hydrology is the quantity of water discharged in surface streams. Runoff includes not only the waters that travel over the land surface and through channels to reach a stream but also interflow, the water that infiltrates the soil surface and travels by means of gravity toward a stream channel (always above the main groundwater level) and eventually empties into the channel. Runoff also includes groundwater that is discharged into a stream. Determining the type of runoff is very important for further assessing the sensitivity of the system to flood risk and it is mainly determined by several natural factors: land cover/use, soil type, geology type and slope of the terrain. The vegetative cover is one of the most important factors for diminishing the impact of the water. But the vegetation has a certain capacity of storing the water and postponing the effect of water concentration. The methodology used for this research is based only on the last three factors: soil, geology and slope. Since the vegetation is not a factor, the stress of the model is given to determining hot spots for runoff sensitivity. The method is developed by Gebhard Schüler (2006) and it is tested on a case study on Skopska Crna Gora. The study was developed in GIS environment with simple boolean dendrogram for polygon and linear (roads) features. The final products were two maps with determined runoff types, hot spots connected with soil erosion risk on a catchment level and on linear – forest road level. These maps were later used as recommendation on planned forest operation activities.

Keywords: runoff; soil erosion; Skopska Crna Gora; road runoff; GIS



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Development of soil erosion and desertification maps of Republic of North Macedonia

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Abstract:

Land is an essential building block of civilization. While land degradation is a global problem, desertification is land degradation in dryland areas. The United Nations Convention to Combat Desertification (UNCCD) recognized soil erosion by water and wind as the major cause for land degradation globally. An existed Erosion Map of the country was developed using EPM through direct on field mapping based on expert judgment 30 years ago. Erosion map using RUSLE has never been produced. Drought and Aridity maps are necessary for delineation of the region vulnerable to desertification. with wider environmental scope. Geographical scope of the project is the territory of the whole country. The major outcomes are: a) erosion maps using EPM and RUSLE methodology and corresponding data arising from spatial analysis; b) aridity and drought vulnerability map; c) map of region vulnerable to desertification. Erosion modelling was launched using 2 methods – EPM (Erosion Potential Method) and RUSLE (Revised Universal Soil Loss Equation). Model developed using EPM is on the whole country while would model developed using RUSLE is valid for agricultural land. For the erosion modelling using EPM, workflow consists of: desk-top analyses and field work. During the field work were directly mapped some necessary parameter later used for modelling as well as for validation of the final output of modelling. During this work, were made slight changes in original auxiliary tables for defining parameters Y and X_a . According to Erosion Map using EPM, mean erosion coefficient on country level is $Z = 0,31$. Based on this map (preliminary and validated only for central part), total annual production of erosive material (sediment) is $W = 12.900.832 \text{ m}^3$, or mean annual specific production $W_{sp} = 519 \text{ m}^3/\text{km}^2$. These values are lower than those acquired in the previous map prepared 30-40 years ago using direct on-field mapping using expert judgment method. About 33,6% of the



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country is affected by unacceptable intensity of erosion processes (I, II and III category), while 11,3% of the country is affected by high and very high erosion processes. From erosion point of view, situation is improved today because of several factors especially in the hilly and hilly-mountain region as follow: erosion control works, decrease of rural population, overgrowth of abandoned agricultural land with woody vegetation, improvement of agricultural practices, decrease of livestock. The erosion model using RUSLE methodology was done only with desk-top work. The working team followed the methodology modified by Panagos P. et al during preparation of erosion map of EU (2014, 2015). The only difference was in defining R – parameter, taking in consideration the absence of relevant data and because of that was used alternative approach based on annual sum of precipitations i.e. formulas by various authors. According to Erosion Map using RUSLE, mean annual soil losses on agricultural land is $E = 4,1 \text{ t/h}$. Total annual soil losses on agricultural land is calculated as 3,7 million tonnes. It means that erosion control works should be carried out immediately with high priority on the terrain where soil losses are over 10 t/ha that cover 88.094 ha, but also on terrains where soil losses are between $3\text{-}10 \text{ t/ha}$ that cover 340.394 ha with medium priority. For presentation of aridity model on the country were developed maps of Aridity index by UNEP and Bagnouls-Gausson aridity index (BGI). For further analysis, the aridity index (following UNEP adoption in 1992 where for interpolation on a national level were used two methods) was accepted: linear regression and kriging method. The semi-arid climate is represented with 8% along Vardar River and south east part of the country. Dry sub-humid climate conditions with 20% is distributed mainly in the central and northern part of the country. Near to moderate humid climate conditions are 18,4% distributed mainly in Pelagonija region and less than moderate climate conditions are distributed mainly in hilly-mountainous region with 53,6%. Region vulnerable to desertification ($A_i < 0,65$) according to the preliminary modelling based on FAO-UNEP approach cover 28% of the country. This area is generally located up to 600 masl in several valleys and surrounding lower hilly region in: Skopje Valley, Kumanovo Valley, Veles valley, Ovche Pole, Shtip-Kocani Valley, Radovish-Strumica Valley, Tikvesh Valley, Valndovo – Gevegeliija Valley. Additionally, 18% of the country where $A_i < 0,75$ are taken in consideration for future monitoring and analysis because of uncertainty of current modelling as well as future forecast climate changes.

Keywords: soil erosion; desertification; EPM; RUSLE; aridity index



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Natural revegetation and overgrowing on forest roads in beech stands and under mountainous conditions

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Abstract:

The first part of the study deals with the necessary width of forest road formation. Beside positive effects forest roads bring also negative effects. One of them is loss of forest area due to its construction. The overgrowing process of the clearance of a forest road cross-section in beech stands was studied. At age 25-35 years, forest roads undergo the most intensive differentiation in the filling in process of the clearance. The distance between tree crowns is 6 m in the case of a 15-year old forest road, 0.74 m in a 35-year old road, and 0.24 m in a 50-year old road, respectively. Therefore, we may expect the distance reduced to an average width of roadway (3,63 m) in 18 years, and in the next 10 years to 50 % of the roadway width. We conclude that knowledge of the filling in process of the clearance a forest road cross-section assists us in the planning of forest road maintenance. The second part of the study was focused to the forest road side slope revegetation on solid grounds in mountainous conditions. Side slopes with no vegetation are threat to the traffic safety, they spoil aesthetic image of countryside and are potential erosion focal point. Influence on the side slope revegetation has inclination of the side slope, width of a clearing among tree crowns and nevertheless, the ground. Fill slopes revegetate better than cut slopes, because they have on average lower inclination and are built in the way that ensures faster revegetation. Side slopes on warm sites (S, W) revegetate better than side slopes on cold sites (N, E), at the same time side slopes which get enough sunlight revegetate more successfully. We conclude that main factors for the successful revegetation of forest side slopes are exposition (azimuth) of the side slope, daylight exposure, roadside slope inclination with connection to the presence of organic substance in the side slope.

Keywords: forest road; overgrowing; revegetation; mountainous conditions; beech stand

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Contribution of forest certification to sustainable development goals

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Abstract:

Over the past few decades forest certification has evolved from a theoretical model to a concept that has gained acceptance in forestry practice worldwide. As market-driven approach, drawing on end-user concern about global environmental issues, forest certification solidified the position of specific forest policy instrument, responding to the dynamic changes in societal demands on forest ecosystems, the emergence of new stakeholders, and the complexity of global international processes. Sustainable forest management, as the ultimate goal of forest certification, contains the essence of the paradigm of sustainable development - meeting our current needs without compromising the needs of future generations. The methodological approach in this paper is based on analysis on how implementation of FSC Principles (Forest Stewardship Council) contributes to the Sustainable Development Goals from the 2030 Agenda. As FSC certification has been widely adopted in most of the Western Balkan countries, the analysis particularly addresses forestry realities in this region. The results show that FSC certification contributes to various SDGs through conservation and restoration of forest ecosystems, biodiversity protection, maintenance high conservation value forests and forest ecosystem services, securing freshwater supplies, improving relations with local communities and other stakeholders, better worker's rights and safety, economic growth and job security in rural areas as well as socially responsible production and consumption. While forest certification is a significant tool for achieving the SDGs, sustainable forest management, grounded on understanding of diversity of forest ecosystem services and dynamics in society's requirements towards forests, can be an important factor in the future of sustainable development.

Keywords: Forest certification; sustainable development; forest policy



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Real growth rate and age structure of Brown hare (*Lepus Europaeus P.*) at the Serbian hunting grounds

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Abstract:

Lepus europaeus P. is indigenous and from the economic point of view, one of the most important species of small game in Serbia. This paper includes an analysis of the real growth and age structure of culled hares. This analysis covers the period from 2018 to 2021, where 999 hare samples were collected from the hunting grounds, they were culled in the accordance with the Law on Game and Hunting (2010). In order to determine the age structure of the hare population, we used eye lens measuring method. This method is based on the fact that the eye lens grows during life. The real hare growth depending on the year varied from 47% to 54.44%, on average 51.28%. However, depending on the hunting ground, the real growth rate varied from 30.74% (very low growth rate) to 64.10% (very good growth rate). The participation of hares aged three months in the age structure of shot individuals was determined only during 2018 and it was 1%. Since the hare was hunted during the last week of October and in November, participation of offspring from the July-August litter was not present. The share of hares aged 3-6 months in the total culling was 16.11%, which indicates that the May-July litter in 2021 did not have a big impact on the size of the population. The share of brown hares aged 6 months to 1 year was 34.92%. This implies that in the observed period first brown hare litters have a significant share in the autumn population. The share of hares aged 1-2 years in this study was 5.35%. However, the share of hares aged 2-3 years was 21.36%, while over three years 22.01%. At the hunting grounds that were researched, during the four years, number of autumn hare population was mostly influenced by hare litters born before May. The variability of the age group participation is influenced by a large number of exogenous factors, especially climatic factors, the presence of vegetation at the hunting ground, as well as the presence of predators on the hunting ground.

Keywords: *Lepus europaeus* P.; growth rate; age structure



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The tradition of sustainable management in lowland forests of Croatia

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Abstract:

Forests are the most valuable renewable natural resource in Croatia and represent a common good of great interest. Forests and forest land are managed by Hrvatske šume doo, Zagreb on an area of 2,024,460 ha (73%), 72,857 ha (3%) used by other legal entities, which makes a total of 2,097,317 ha (76%) of state forests, while 661,720 ha (24%) of forest-owned (private) forests. The wood stock of state forests amounts to 418.6 million m³, of which 315.8 million m³ is in state forests managed by Croatian Forests and 19.1 million m³ in state forests used by other legal entities, while 83.7 million m³ is in the forests of private forest owners. The annual increase in wood stock in the Republic of Croatia is approximately 11 million m³, approximately 8 million m³ in state forests, and approximately 3 million m³ in private forests. Annual increment about 8.4 million m³. In view of imminent global changes taking place in forest ecosystems, and in comparison with others, Croatia currently represents an "island" of preserved natural forests of high biological diversity. This is the result of the rich tradition of Croatian forestry (over 257 years long). The main bearer of commercial and non-wood functions in lowland forests of Croatia is pedunculate oak (*Quercus robur* L.). With 210,000 ha it is the second management class after the common beech in terms of size, but in terms of economic importance it firmly takes the first place with 44% share of income from all sold logs. The largest forest complex is situated in the Slavonian area of Spacva, and represents one of the most coherent forests of pedunculate oak in Europe. With an area of 40,000 ha it accounts for 1/5 of all pedunculate oak forests in Croatia and achieves an annual volume increment of 280,000 m³. Forests of pedunculate oak are regenerated naturally under the crown shelter of old trees over large areas in three gradual cuts: preparatory, seeding and final cut. In addition to having high economic importance, pedunculate forests in the above areas also represent a climatozonal community in Croatia and are part of the network of special protection and conservation sites (NATURA 2000). This is the reason that these forests have great nature-protection importance. Their structure and functions must be preserved in a balanced state, especially via the adjusted, close-to-nature management method. Only in this way can we preserve the basic forestry credo in the sense of permanent self-renewal (sustainability, sustainable



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development), biological resistance, naturalness and preservation of multiple roles of non-wood forest functions.

Keywords: pedunculate oak; sustainability; natural regeneration; dieback; Croatia



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Spatial optimization for forest planning

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Abstract:

Forests are complex ecosystems performing multiple functions. Forest managers and planners must take into account several economic, environmental, and social criteria. Competing uses such as timber harvesting, recreation, water supply and biodiversity conservation make forest planning a difficult operation. The latter problems become more sophisticated considering the temporal and spatial dimensions of forest ecosystems. Meta-heuristics have been proved to be efficient methods for complicated spatial problems containing local and global, spatial and non-spatial objectives and constraints. Here, the integration of meta-heuristic algorithms with geographic information systems (GIS) supplies a decision support tool to forest managers. It can produce plan alternatives, showing trade-offs, along with spatial representation on a map.

Keywords: meta-heuristic algorithms; multi-objective optimization; spatial forest planning; timber harvest allocation



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Recent changes in the population structure of *Cryphonectria parasitica* in Turkey

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Abstract:

Vc types of the 1355 *Cryphonectria parasitica* isolates collected from 17 provinces were first phenotypically tested by using traditional co-culturing assay, then the results were confirmed by multilocus PCR assay with the specific primers to the biallelic six vic loci. To evaluate the current sexual reproduction status of *C. parasitica*, bark tissue of each isolate was examined for the presence of perithecia and PCR based mating type analysis was subjected to the 659 *C. parasitica* isolates. Vc type determination revealed that there were 25 vc types (EU-1, EU-2, EU-3, EU-4, EU-5, EU-7, EU-8, EU-10, EU-11, EU-12, EU-14, EU-17, EU-21, EU-22, EU-26, EU-28, EU-29, EU-30, EU-32, EU-33, EU-35, EU-44, EU-45, EU-51 and EU-60) in Turkey. EU-1 (75.2%) and EU-12 (17.7%) were the most dominant ones. Both mating types of *C. parasitica* were found in all provinces and the presence of perithecia were detected in 14 provinces, which evidenced that the sexual reproduction of *C. parasitica* is common in Turkey. In the PCR, all isolates produced amplicons for all the six vic loci. Co-culturing assay and PCR assay agreed with each other in 78 isolates but 29 isolates were vegetatively incompatible with their corresponding EU vc types testers. This study indicated that there was a great increase in vc type diversity of *C. parasitica* in Turkey.

Keywords: chestnut; chestnut blight; *Cryphonectria parasitica*; vegetatif compatibility types; diversity.



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Detected changes of population structure within a *Cryphonectria parasitica* population at the site Osoj, North Macedonia, during a time-span of over two decades

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Abstract:

Cryphonectria parasitica is historically considered as one of the most threatening plant diseases, and affects several species of *Castanea* worldwide. Applicability and success of control measures for the pathogenic fungus, consequently for control of its impact on European sweet chestnut *Castanea sativa* is highly dependent on presence of hypovirulence on populational levels, as well as on the population structure characteristics, most prominently vc-type diversity. In this study we compared the main characteristics of isolates of *C. parasitica* collected on 2 occasions with a time gap of 22 years (1998 and 2020) from the same site Osoj in the Kicevo region, in North Macedonia. We analyzed culture morphology, v-c type, and presence of hypovirulence of 72 isolates collected in 1998 and 39 isolates in 2020, by standard methods in vitro. In terms of the v-c type, from the total of 72 isolates collected in 1998, 49 (68%) were EU-12, 22 (30,55%) were EU-2 and 1 (1,38%) was EU-1. Of the 39 isolates collected in 2020, 32 (82%) were EU-12, 7 (18%) were EU-2, and no other vc types were detected, including EU-1. In 1998, 7 (13%) out of 54 assessed isolates were designated as hypovirulent, while in 2020 the proportion of hypovirulent isolates was much increased (33.33%), i.e. 13 of the total of 39. For the two-decade time frame, v-c type EU-12 remained dominant, with an additional increment of its prevalence on the populational level. From a practical point of view, it is more important that prevalence of hypovirulence was increased by over two-fold (x 2.57). This is likely the most important reason for difficulty during collection of viable samples, ultimately leading to a much lesser number of samples collected in 2020. As a conclusion, the *C. parasitica* population in Osoj has not only not diversified, but the most dominant vc type has become even more established with time. The relatively high proportion of hypovirulent isolates and the large increment detected in just over two decades timeframe, is interesting to further investigate in relation to overall health status of the chestnut population in Osoj.

Keywords: chestnut blight; v-c type; hypovirulence



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The effect of temperature on the growth of the phytopathogenic fungus *Ophiostoma novo-ulmi*

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Abstract:

Dutch elm disease (DED), which is caused by the aggressive ascomycete fungus *Ophiostoma novo-ulmi*, has led to the drying and decay of many elm trees (*Ulmus* spp.) across Europe, North America, and Central Asia. This phytopathogen is responsible for the second, current DED pandemic, while the less aggressive fungus *Ophiostoma ulmi* caused the first DED pandemic. The fungus *O. novo-ulmi* is divided into two subspecies: *O. novo-ulmi* ssp. *novo-ulmi* and *O. novo-ulmi* ssp. *americana* that can interbreed and form hybrids. To investigate the effect of temperature on the phytopathogenic fungus *O. novo-ulmi*, the growth rate of different *O. novo-ulmi* isolates was measured at temperatures ranging from 16 to 30 °C. Fungal isolates infecting elms in Croatian forests were determined according to the analysis of *cu* and *col1* genes as *O. novo-ulmi* ssp. *novo-ulmi*, *O. novo-ulmi* ssp. *americana* or hybrids. As expected, the growth rate was mostly highest at a temperature of 21 °C, while greater deviations from optimal growth temperature (at a temperature of 16 °C and ≥ 28 °C) led to significant slowdowns of growth for all tested isolates. However, differences between isolates were observed in the case of smaller deviations from the optimal growth temperature (at 18 and 25 °C) when some isolates had decreased growth rate due to increase and/or decrease in temperature, while for others there were no statistically significant differences compared to 21 °C. This points to the intraspecies variability in the tolerance and or/adaptability to a range of temperatures, but the growth pattern at different temperatures could not be correlated with the molecular identification of *O. novo-ulmi* isolates. To provide a better understanding of the ability of this phytopathogen to adapt to temperature changes, further research should include additional analysis of the response of *O. novo-ulmi* isolates to long-term as well as short-term exposure to different temperatures.

Keywords: Dutch elm disease; elms; growth rate



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Pedunculate oak (*Quercus robur* L.) phenological varieties exhibited a different response and recovery potential to extreme drought in Serbia

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Abstract:

Across South-Eastern pedunculate oak (*Quercus robur* L.) marginal populations three phenological oaks were determined: (i) early QURO variety (*Q. robur* var. 'praecox'; E-QURO); (ii) typical QURO variety (*Q. robur* var. 'typica'; T-QURO); and (iii) late QURO variety (*Q. robur* var. 'tardiflora'; L-QURO). In our study, we have analyzed pedunculate oak from a common garden experiments in Panonian plain near Sremska Mitrovica (45.00529936; 19.61420536) during two extreme drought periods in 2012. and 2017. We have focused on the radial growth and their plasticity for the above-mentioned extreme drought events to define their resilience, resistance, and recovery potential. Based on the early- and late-wood radial growth chronologies, we have concluded that E-QURO has a better drought resistance, while T-QURO and L-QURO exhibit a greater recovery potential after the extreme droughts. If analyzed phenologically, varieties had a significant variation in vegetation period (up to 28 days) while differences between early and latewood were not observed, and their ratio cannot be a reliable indicator of the analyzed variability. In conclusion, based on the observed findings, typical and late pedunculate oak varieties are better prepared to withstand climate change and should be favored in the upcoming periods which will be more unfavorable to pedunculate oak and for what the different and 'climate-smart' forest management should be implemented.

Keywords: Tree ring; Dendrochronology; Common garden experiment; Climate change adaptation.

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Forest resource dynamic in Republic of North Macedonia in the period from 1961 to 2016

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Abstract:

Unlike classical forestry which has been oriented towards the demands of sustainable wood supply, modern multifunctional forestry is oriented to fulfilment social, economic, ecological, cultural and spiritual human needs of present and future generations. The Forest Principles arisen from the conclusions of the Earth Summit as well as MCPFE resolutions provide tools used to define, guide, monitor and assess progress towards sustainable forest management (SFM). The main source of current and long term forests resources information provides National Forest Inventories. At the state level, in the Republic of North Macedonia (RNM) three mass statistical operations (census) have been performed so far to assess the forest resource, 1949/50, 1961 and 1979, but all three rely on management inventories made with temporary simple plots, estimation using growth tables related to other environmental conditions or expert opinion. In this paper an attempt is made to perceive the dynamics of the forest resource in the RNM through information from the years 1961 and 1979 forest censuses, report of State Statistical Office (SSO) about 2016 as well as analyzing all forest management plans, state on 31.12.1989 and 31.12.2016. According to the two last censuses as well as the information from the SSO, the total forest cover area is estimated at 887517ha, 905653ha, 1001665ha, respectively. Area of forest for which forest management plans have been developed, managed forests (MF), in 1979 is 744981ha, in 1989 is 817891ha and in 2016 is 888649ha. Average growing stock (AGS) in 1961 is 70.8m³/ha and in 1979 is 82.1m³/ha or 0.63 m³/ha/ year. Related to MF, AGS in 1979 is 87.9m³, in 1989 is 97.2m³/ha and in 2016 is 104.7m³/ha. Average growing stock in MF in the period 1979-1989 is increased for 9.3m³/ha or 0.93 m³/ha/year and for the period 1989-2016 is increased for 7.5m³/ha or 0.28 m³/ha/ year. Annual volume increment in MF estimated 1979, 1989 and 2016 is 2.1, 2.2 and 2.0m³/ha, respectively. Presented data show that the total forest cover area in the analyzed period has increased by 114148ha or by 12,9%. One of the main reason to the expansion of the forest area, mainly driven by large-scale afforestation program running from 1971 to 1990 and spontaneous regeneration on abandoned agricultural land caused by the accelerated rural exodus



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in the second half of the 20th century. There is also an increase in the growing stock but the intensity of increase in the period 1989-2016 is significantly reduced which is observed in the annual volume increment

Keywords: forest resource; dynamic; growing stock



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Urban hedges – an important green element in the system of landscape design

Case study: Settlement of Taftalidze 1 and residential complex 'Sveti Jovan',
Skopje, North Macedonia

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Abstract:

Urban hedges as a green element of landscape design are very important due to their aesthetic and functional value. As dense greenery in a small space together with vertical gardens and green roofs, hedges can play a significant role in providing urban areas with efficient green infrastructure.

This research aims to inventory and analyse hedges in terms of species composition, types of hedges according to shaping (formed: low or symbolic, medium-high, high and free-growing) and their condition in terms of decoration and functionality. Their condition is defined in 4 categories: excellent, good, bad and very bad. Two different locations are a part of this research: the settlement of Taftalidze 1 and the residential complex 'Sveti Jovan' in Zlokukjani, both located in the municipality of Karpos, in the city of Skopje, North Macedonia. While the entire territory of the second location is a part of this research, only private houses at the first location are involved.

The presence of hedges around private houses in Taftalidze 1 is 72,9 %. Of a total of 443 private yards, 323 are with hedges. Their species composition is quite rich and it consists of 25 different taxa. Most of them, 285 are formed medium-high. Only low or symbolic formed hedges are not present at all. The most common species is *Ligustrum vulgare* L. 30 % of all are in very bad condition, 28,2 % in bad, 37,2 % in good and only 4,6 % are in excellent condition.

In the residential complex, 'Sveti Jovan' 21 different taxa are used for creating hedges. The most common species are *Hedera helix* L. and *Pyracantha* 'Orange Glow'. There are hedges of all types. Almost all are in excellent condition.

The results show that hedges in the urban landscape design are a commonly used green element. Their type, function and condition depend on many different factors (location, the purpose they are planted for, species composition). All results are a



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great base for additional analyses related to the opportunity and impact of hedges in providing certain benefits in support of ecosystem services provision. From the aspect of landscape design, this research can help combine the ecological and social dimensions of urban hedges for analytical and planning purposes.

Keywords: urban hedges; green element; landscape design; private houses; Taftalidze; 'Sveti Jovan'



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Criteria for Evaluation of Urban Green Spaces: A Case of Macedonian Cities

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Abstract:

The constant growth of cities, their densification, the increase in the number of inhabitants, the problems with pollution of all kinds and the conditions caused by climate change, increase the pressure on the quality of life in urban areas. The commitment to achieving sustainable urban development is a globally accepted concept, but its implementation, in many respects, is a major challenge. Most often, the quality of life in cities is measured or evaluated through developed sets of criteria and indicators, the establishment of which is expected to be easier assessment and comparability at local and global level. Macedonia has long been in the "race" for sustainable and green cities, but in determining the policies for providing, planning, financing, construction and maintenance of urban green spaces, there is a lack of applicable set of criteria and indicators for their evaluation. Hence, this paper aims to examine the conditions for establishing operational criteria for the assessment of public urban green spaces in our country, regarding to economic, social and environmental issues. The research was conducted through review and analysis of: theoretical basis, legislation, experiences from other cities and local characteristics. The results of the paper would provide guidance for establishing a set of criteria and indicators that would help all stakeholders involved in the process of creating sustainable cities and specifically urban green spaces, to improve the quality of life in Macedonian cities.

Keywords: quality of life; urban life; urban green spaces; sustainable cities; criteria; indicators



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Legal solutions regarding the management of game and hunting grounds in R. North Macedonia, R. Serbia, R. Croatia, R. Slovenia and R. Bulgaria

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Abstract:

The current legislation governing the hunting laws in different countries in the region haven't been analyzed yet. The practices in the hunting and management of the hunting grounds between the countries can be analyzed in several terms. In this study we conducted a comparative and content analysis between North Macedonia's hunting law and the hunting laws of the Republic of Serbia, Republic of Croatia, Republic of Slovenia, and Republic of Bulgaria. We presented the game and hunting grounds management practices, comparing the hunting laws implemented in the above listed countries in the region. We analyzed the legal solutions between each of the hunting laws, in terms of the management of the game and hunting grounds. In the analysis we determined the different practices between each of the selected countries, as well as the uncommon acts in the laws governing the hunting grounds and the game management. The analysis revealed strengths and weaknesses in the legislation and practices in the management of the game and hunting grounds. In the results we pointed out parallels in the law concepts, but still odds in the practically implemented hunting law, for each of the addressed countries; the common practices between hunting legislation in the Republic of Serbia, Republic of Croatia, Republic of Slovenia, and Republic of Bulgaria, excluding North Macedonia; the abundance of the shortcomings, inconsistencies and unenforceable provisions leading to major negative impacts in the managing with the game and hunting grounds in the actual hunting law of the North Macedonia.

Keywords: hunting law; hunting grounds; content analysis



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Soil erosion and Torrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

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Abstract:

The floods that have occurred in the last decades on the territory of Bosnia and Herzegovina and Serbia were of catastrophic proportions with great material damage and loss of human lives. For these reasons, there is a need for a more detailed study of the problems of erosion and torrential floods and a unified problem-solving approach applied in the wider region. To provide necessary knowledge regarding soil protection and flood prevention to graduate students from universities in Serbia and Bosnia and Herzegovina, it was necessary to modernize existing study programs, as well as to develop a new master's program. It was done through the Erasmus + K2 project under the acronym SETOF which involves universities from Serbia (UB-Faculty of Forestry, UNI-Faculty of Occupational Safety, and UNS-Faculty of Agriculture) and Bosnia and Herzegovina (UBL-Faculty of Forestry and UNSA-Faculty of Forestry) as the members of the partner countries. Participants in the project are also universities from programme countries, i.e., Austria, Italy, North Macedonia, and Bulgaria. The specific objectives of the project are improving soil protection from degradation and improving flood prevention, developing new and modernizing existing curricula following the Bologna Declaration and EU good practices, and implementing improved knowledge in practice by educating employed engineers and local governments to take torrential flood prevention measures. The project, within the first work package, studied the state of soil degradation and torrential floods in all countries participating in the project, which formed the basis for the modernization of existing and development of a new curriculum. At all faculties of Serbia and B&H, 11 study programs have been modernized (27 advanced syllabi and 12 new courses). The master's program is accredited as a joint study program of three universities in Serbia with the participation of professors and students from universities from B&H. Within the project, more than 120 employed engineers were



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trained. Also, training in flood protection is conducted in 15 local communities of Serbia and B&H.

Keywords: degradation; soil erosion; torrent; flood; study program; Western Balkan region



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Dendroecology analysis of Macedonian pine (*Pinus peuce Gris.*) radial growth and climate relationships at National Park Pelister in North Macedonia

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Abstract:

The climate-growth relationship in tree development is evident and the development of trees directly depends on climate. Numerous dendroecology analyses have been developed for Europe, but there are still regions with limited data of this kind. In order to assess the impact of climate variations on Macedonian pine stands in National Park Pelister (NPP), the radial growth of Macedonian pine trees and their dependence on temperature and precipitation were studied using dendroclimatological and dendroecological methods. In that context, at NPP 35 core samples were taken from dominant trees. The stands are located on the northern slope in pure even-aged Macedonian pine forests with the same structural characteristics. Core samples were firstly air dried, sanded, scanned with height resolution and then measured and visually cross-dated using Coorecorder and CDendro software. To standardize and evaluate the measurement of tree ring width was used dplR library package. Also were calculated some dendrochronological data as Mean sensitivity (MS), running rbar, Expressed population signal (EPS) and autoregression coefficient (AR). The climate-growth relationship was determined by Treeclim package in R. This dendroclimatic study was prepared using correlation and response function analysis. The Pearson correlation coefficients between the chronology indices and 18 precipitation and temperature data were calculated for the period from 1951 to 2015. The applied response function analysis included 18 precipitation and temperature variables from May of the prior year to October of the current year. Dendrochronology statistics show MS of 0.21, rbar value of 0.211, EPS of 0.831 and autoregression coefficient of 0.846. The results of the correlation analysis pointed out that there was a strong tendency towards a positive response to the summer and late summer/early autumn precipitation and a weak significant negative response to the summer temperatures. Climate-growth relationships were further studied using the response functions for individual months from previous May to current October. In that way, higher precipitation in August of the previous year as in May and June of the current year has a positive response to tree ring width (TRW). Otherwise, the high temperature in July of the current year has a negative impact on TRW. These results show the relationship between climate and growth, but as a result



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of the small number of sample cores with a relatively small number of rings, these stands need to be further explored to define the climate-growth relationship.

Keywords: dendroecology; climate; tree ring width; *Pinus peuce* Gris.



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Influence of elevation on some structural elements of Macedonian pine (*Pinus peuce* Gris.) stands in National Park Pelister in North Macedonia

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Abstract:

The influence of elevation on the forest development and also on more structural elements are evident. This paper research the influence of elevation on the relationship between diameter at breast height (DBH), tree height (H), crown length (L) and steam volume (V). In the area of National Park Pelister in North Macedonia, we established 6 circle experimental plots (EP) at 1150 m a.s.l., 7 at 1350 m a.s.l. and 9 at 1550 m a.s.l. total 22 EP with an area of 500 m² each of them in the even-age *Pinus peuce* Gris. stands with an average age of 90 years. It was measured DBH, tree height, and crown length at 481 trees in all EP. We determined the connection between DBH and H thought height model from Prodan. It was prepared nonlinear (polynomial) regression for the relation between DBH and L and nonlinear (Power) regression for the relation between DBH and V. Also, were calculated quadratic mean of DBH, average Loray height, average crown ratio, and the density of the stands. The steam volume was calculated with a formula from the volume table from Parishko for *Pinus peuce* Gris. The relationship between DBH and H, L, V was tested with Pearson correlation and root mean square deviation (RMSE). The differences between data of H, L, V from the EP were tested with analysis of variance (ANOVA) with a single factor. All statistical analyses were done with Excel, Statsoft Statistica, R (CranRstudio) software. The density of stands is 490, 429 and 409 trees per ha on 1150 m, 1350 m and 1550 m a.s.l. respectively. The average DBH is 39.8 cm, 46.5 cm and 45.5 cm and Loray height is 23.9 m, 24.1 m and 22.6 m at 1150 m, 1350 m and 1550 m a.s.l. respectively. Crown ratio points out different results on the different elevation, thus average value of 40.5 %, 43.7 %, 39.3 % at 1150 m a.s.l., 1350 m a.s.l. and at 1550 m a.s.l. respectively. The differences between data are significantly $p < 0.05$ and F of 3.4, at data of H, with $p < 0.05$ and F 3.2 for data of L and $p < 0.05$ with F of 9.7 for data of V. In that way, H has a bigger regression model at a lower elevation, the tree has a longer crown length at lower elevation and also has more biomass at lower elevation. The regression model of Prodan for H has a significance correlation index of 0.85, 0.80, 0.79 and RMSE of 6.55, 8.04, 6.18 for 1150 m, 1350 m and 1550 m respectively. The polynomial regression model for the connection between DBH and L has a correlation of 0.80, 0.81, 0.69 and RMSE of



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8.31, 10.40 and 10.77 for 1150 m, 1350 m, 1550 m respectively. The power regression model for DBH and V has a correlation of 0.99, for all elevations and RMSE of 1.08, 1.48, 0.75 for 1150, 1350, 1550 m respectively. From the results can be concluded that the elevation has an influence on DBH, H, L and V as structural elements and also has an influence on the whole development of stands. It can be said that at higher elevation trees has a smaller height, DBH, volume and have longer crown length than trees at lower elevation.

Keywords: structural elements; elevation; *Pinus peuce* Gris.; diameter at breast height; height of trees; crown length.



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Human dimension of large carnivores' management and conservation in Serbia

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Abstract:

Serbian hunting legislation recognizes five autochthonous large carnivores, which have a different legal status and population size. Species like wolf, jackal and fox are well abundant and as such under hunting management. In contrary brown bear and lynx are endangered and strictly protected. Since the implementation of both game and wildlife management goals depends on human dimension, the aim of this research was to identify hunters' and hunting professionals' attitudes toward these species. For that purpose, wildlife managers and gamekeepers from 80 hunting grounds, which manage or protect these species, were interviewed. They received the questionnaires by mail, which was distributed by the Hunting Chamber of Serbia. Study involved survey of 335 hunters in hunting 2018/19 season, which represent the simple random sample for Serbia. The obtained results show that attitudes of respondents are linked with the species abundance. In that sense, the endangered species are the most likable, in contrary to the jackal which is stigmatized. Despite high abundance, the wolf gathered favorable attitudes. These findings confirmed the special status which the wolf has in the Serbian culture.

Keywords: large carnivores; Serbia; attitudes; hunters; gamekeepers; wildlife managers



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Spatial structural characteristic of Macedonian pine (*Pinus peuce Gris.*) forest in National Park Pelister in North Macedonia

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Abstract:

Forest spatial structure strictly defines ecosystem resilience, the success of its functioning, and development. The spatial structure of forest compartments provides additional information on the forest stand heterogeneity. The aim of this study is to examine structural patterns (both spatial and nonspatial ones) in Macedonian pine (*Pinus peuce Gris.*) forests located at National Park Pelister, North Macedonia. We analyzed middle-aged (~ 90 years) Macedonian pine stands in terms of structural metrics collecting data from geo-referenced trees on the established 14 circle sample plots (SP). The area of each SP was 500 m². In SP for the nonspatial characteristic (NC) were collected data for tree diameter at breast height (DBH), tree height (H), azimuth, the distance of trees from the center of SP and data for stand characteristic. For spatial characteristic (SC) were calculated the index aggregation of Clark and Evans, mean distance, uniform angle index (W), mean directional index, DBH, H differentiation and domination. For testing the spatial structure of stands, we were used L and pair correlation functions. Were used Excel, Crancod and StatSoft Statistica software for NC and SC analysis. The average age of SP ranges from 88 to 99 years. The average value of DBH, H, basal area and volume of trees per hectare are 33.9 cm, 20.1 m, 55,8 m² and 502 m³/ha respectively. According to the aggregation index, trees in SP are randomly deployed with coefficients from 0.73 to 1.34 with an average value of 1.07. Distances between the reference tree and 1st neighbourhood are in the range from 1.27 to 3.36 with an average value of 2.18. The position of the four trees around the reference tree is random and uniform because the range value of the W index is from 0.49 to 0.67 with an average value of 0.56. The mean directional index points out that trees are grouped around referent trees with an average value of 2.05. In the stand of Macedonian pine, trees have low differentiation of DBH and H with average values of 0.19 and 0.09 respectively. Regarding domination of DBH and H, it can be said that trees around the reference tree have some bigger diameter with the coefficient of 0.54, while regarding height



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they have an equal domination index with a value of 0.5. L correlation function points out that trees are grouped and, in some cases, they are randomly positioned. The same result has a pair correlation function where trees are grouped and relatively randomly positioned. It can be concluded that trees in the Macedonian pine stand have a rather random and uniform arrangement, with little differentiation and a small dominance in the DBH and the H.

Keywords: spatial structure; index of aggregation; uniform angle index; mean directional index; differentiation and domination index; *Pinus peuce Gris*.



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Analysis of Croatian *Ophiostoma novo-ulmi* populations – insight into changes occurring over time

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Abstract:

Ophiostoma novo-ulmi is a phytopathogenic ascomycete fungus that causes Dutch elm disease (DED) – a highly destructive disease responsible for killing numerous North American and European elms (*Ulmus* spp.). DED spreading began in the early 20th century and it was originally caused by *Ophiostoma ulmi*, while *O. novo-ulmi* emerged in the mid-20th century, initiated an even more destructive DED pandemic, and eventually became the main DED pathogen. Two *O. novo-ulmi* subspecies (*O. novo-ulmi* ssp. *novo-ulmi* and ssp. *americana*) are widespread throughout Europe and their hybrids are frequently found in areas of overlapping distribution. Following the DED survey across Croatia conducted in 2012, elms were resampled in selected Croatian forests (sites Nova Kapela and Jastrebarsko) in 2021. An increase in disease incidence at site Nova Kapela was observed in 2021 compared to 2012, while at site Jastrebarsko a decrease in disease incidence was detected. Molecular characterization of *O. novo-ulmi* isolates based on analysis of the *col1* and *cu* gene sequences indicated that in 2021, similar to 2012, the *O. novo-ulmi* ssp. *novo-ulmi* is more frequent compared to *O. novo-ulmi* ssp. *americana* which was only detected at site Nova Kapela in 2021. *O. novo-ulmi* ssp. *novo-ulmi* x ssp. *americana* hybrids were found at both sites in both years of investigation. Obtained results point out that variations in disease incidence do occur over time, but the dominance of *O. novo-ulmi* ssp. *novo-ulmi* and hybrids over *O. novo-ulmi* ssp. *americana* is retained in investigated sites.

Keywords: Dutch elm disease; elms; temporal variability



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The valorization and valuation of historical park - Topcider in Belgrade

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Abstract:

Topcider Park stands out as a special spatial natural and cultural whole of Belgrade. It is one of the oldest locations in the park area of the City of Belgrade and as such has always been a significant part of the green infrastructure of the city. By declaring a "monument of nature", Topcider Park is placed under the protection from the Decision of the Belgrade City Assembly in 2015 year. Valorization and evaluation of wooden flora, given its age and diversity, are of great importance for taking measures to protect the biodiversity of this park area. This paper shows the results of the Bioecological basis document which contains the description and condition of each individual tree on the surface of Topcider Park. Each tree is rated attributes according to the internationally recognized VTA (Visual tree assessment) methodology, which has been modified and adapted to the conditions of this park space. Based on the results of measurement and evaluation, guidelines have been proposed for improving the condition and protecting the biodiversity of this space.



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Current status of forest soil mapping in Serbia

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Abstract:

Spatial analysis of soil types distribution in management units in Serbia shows the soil productivity potential for forest growing. This is the reason for the research of spatial distribution of soil production potential in management units (Galić et al. 2014; Galić et al., 2015, Galić et al., 2017, Galić et al., 2018, Galić et al., 2019). Paper is an analysis of previous research of soil mapping in following management unit: Muzljanski rit; Ristovaca; Branjevina; Doroslovacke sume and Kolut Kozara. All mentioned studies confirm the significant deviation of soil distribution in the management units compared to previously available soil data cover (Nejgebauer et al., 1971). Mapping the soil potential is an opportunity to improve forest management through the definition of site production, and it should be considered during the management planning process in the management units. The aim of this paper is to show current status of spatial soil type distribution and forest soil mapping in Serbia.

Keywords: spatial analysis; forest soil mapping; forest management

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Nationwide fuel models structure analysis using discrete ALS data in Portugal

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Abstract:

Annually, wildfires burn millions of hectares of forest and the trend will continue to grow under the current climate scenarios. As a result, definite knowledge of fuel conditions and fuel characteristics plays an increasingly important role for predicting fire hazard and fire behaviour. Accurate fuel type mapping is crucial for simulating fire behaviour across the landscape. In this study, 499 plots within 6 different study areas were used to assess a nationwide fuel-type classification in Portugal by means of discrete ALS (Airborne Laser Scanning). More specific goals were: (1) develop simple tree cart and random forest models to classify the main fuel type groups in terms of horizontal and vertical structure based on field data (cover and height of each fuel layer: shrubs, litter and grass along transects) using only ALS metrics; (2) investigate the performance of the models to classify the fuel types using different point density (5 and 10 point m²); and (3) mapping more complex classification of fuel models, which includes the forest tree species, combining ALS data and Multispectral Satellite Imagery (Sentinel 1, Sentinel 2) and PALSAR-2 radar (ALOS-2 Satellite).

Keywords: wildfires; remote sensing; lidar; fuel-type mapping



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***Corythucha arcuata* (Say) predilection research results in 70 pedunculate oak clones (*Quercus robur* L.)**

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Abstract:

In 2013 the first record of the oak lace bug (*Corythucha arcuata* Say) was in Serbia was registered. Since then, it has evolved into a significant oak pest with damaging consequences in both adult and nymph stages of the bug, which feeds by sucking sap from the lower abaxial leaf side. Aside from chemical management, we tried to take a more natural approach by assessing *Corythucha arcuata* propensity to different pedunculate oak clones and kinds to see if we could control it. The study took place at the clonal seed plantation in Banov Brod, Višnjićevo, which has 70 different pedunculate oak clones. This is the first study of its kind that has included such a huge number of oak clones. The findings point to the possibility of solving the oak lace bug problem by planting certain pedunculate oak clones or their progenies that have lower predilection of *Corythucha arcuata*. There were 70 clones evaluated for the existence of considerable leaf damage caused by *Corythucha arcuata*. The stand was 50 years old, established by planting material, where clones were propagated by grafting. Four of examined clones suffered no severe damage caused by the pest, in seven clones 1 to 25% of plants were found with considerably damaged leaves, and in four clones 26 to 50% of plants were found with considerably damaged leaves. The broad-sense heritability was moderate ($H^2=0.514$), suggesting that there is a considerable genetic basis for tolerance to *Corythucha arcuata* in examined group of genotypes of *Quercus robur*. This research should be continued along with the improvement of technological measures in order to cope with the severe infestation of this pest.

Keywords: *Corythucha arcuate*; *Quercus robur*; clones; predilection



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Growth of scots pine (*Pinus Sylvestris* L.) in international provenance tests in Žepče, Bosnia and Herzegovina

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Abstract:

Scots pine (*Pinus sylvestris* L.) is one of the most important tree species in European forests and one of the most investigated forest tree species in Europe. This study research variability in morphological traits of height and diameter at breast height of Scots pine in the international provenance test in Žepče, Bosnia and Herzegovina. The results will help choose the most productive provenance for afforestation of suitable areas with this tree species.

For this research, in 2020. we measured the height and diameter at breast height of the plants of Scots pine in the provenance test in Žepče, Bosnia and Herzegovina. The test was established in 2012. It contains 14 provenances (three from Austria, one from Bosnia and Herzegovina, three from Italy, one from Germany, one from Poland, one from Romania, one from Slovakia, one from Norway, one from Scotland, and one from Ukraine). The data were processed using SPSS 26.0.

Variance analysis showed statistically significant differences among provenances for both traits. Provenance Hochwolkersdorf Stift Reicheresberg from Austria showed the highest average value of height, and provenance Raciane – Nida from Poland had the highest value of average breast height diameter. The lowest values of both traits had provenance Piani – Valda from Italy. It is necessary to continue with the research of Scots pine in the international provenance test, to confirm these results in older age plants.

Keywords: Scots pine; provenance tests; height; diameter at breast height



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The role of site ecology into planning and designing of the conifers seed orchards in Serbia

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Abstract:

The diversity of site ecological characteristics of potential localities for establishing of conifer seed orchards in Serbia involves the changes into planning and designing of spatial structure of these plantations. The localities for establishing of seed orchard have been selected based on the results of multiannual analyses of the climatic parameters such as decade's temperature of air, annual extreme temperature and monthly precipitation and chemical and physical characteristics of soils. By multiannual analyses of the sample of 200 trees, flowering phenophases, sexual functionality of trees, abundance of seed crop, as well as tree growth and development were monitored. The researches have been based on a detailed study of influences of the analyzed ecological parameters to the variability of nine morphological parameters of seedlings - seedling height, annual height increment, diameter of root collar, diameter of crown horizontal projection, number of branches in the last three whorls and the share of photosynthetically active pigments - chlorophyll A and B and carotenoid. The results show a great variability even in slight site changes, as well as a high adaptability of the nursery stock. Correlation analyses confirm significant positive interdependence of almost all growth elements. Based on its structure, it is possible to realize the effect of genetic development mechanisms and regulation mechanisms and also, to realize the effect of ecological mechanisms which will be favorable for the successful conservation of the species gene pool.

Keywords: site ecology; seed orchards; conifers.



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Diversity of pedunculate oak (*Quercus robur* L.) in Serbia based on phenotypic traits

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Abstract:

The study of leaf morphology from the aspect of genetic differentiation provides useful information on population variability and can be the basis for the ex situ and in situ conservation of genetic resources. This paper presents the results of a study dealing with leaf morphological variability of *Quercus robur* L. sampled from 7 populations across Serbia. Interpopulation variability was confirmed by the results of the analysis of variance (ANOVA). A statistically significant ($p < 0.05$) effect of population was obtained for most of the studied morphological characters. By applying the canonical discriminant analysis (CDA), the first discriminant function accounted for 34,2% of the variability between populations and the second accounted for 29,5% of the population variability. The number of veins petiole length and lobe width had the greatest effect on population differentiation based on CDA. According to the principal component analysis (PCA), it was determined that the first ten main components show variability. These components explained 72.33% of the total variance. The lamina length, maximum leaf width, maximum leaf width height, leaf area, mass and total lamina length had the greatest effect on population differentiation based on PCA. According to CDA and PCA, it could be possible to single out three populations for conservation. It is assumed that different environmental conditions and genetic constitution affect population differentiation.

Keywords: interpopulation; variability; conservation; morphology; leaf

Acknowledgements: This research was supported by the Science Fund of the Republic of Serbia, PROMIS, #6066697, TreeVita.



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Possibilities of hybrid drives of forest vehicles

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Abstarct:

Forest vehicles offer big possibilities for the use of hybrids. Common drivers of the development of hybrid drive solutions in forest machinery are: low emissions and noise, high performance, fuel efficiency, regulation (emission standards for non-road diesel engines: EU and US EPA with continuous restriction), and public image. The current technical and technological development of hybrid drive systems, as well as their components, has led to significant improvements in drive performance and thus better performance of the new generation of forest machines. Improved energy efficiency through the use of hybrid propulsion systems in forest machines would result in a significant reduction in greenhouse gas emissions and possibly lower maintenance costs. Variable fuel prices, stricter exhaust emission regulations, and lower prices of electrical components will accelerate the development and application and share of different types of hybrid drives in forest machines. The development of methods for the determination of the energy consumption of different types of forest vehicles performing different work tasks under different terrain conditions is a very important topic of scientific research in the field of forestry engineering. These data could be used as a basis for the development of hybrid and electric forest vehicles. The paper describes the measurement method of energy consumption of skidder during timber skidding and represents possibilities of hybrid drives of skidder.

Keywords: forest vehicle; skidder; hybrid drive; energy consumption



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Cooperation and networking of non-wood forest products-based enterprises in the Topličko and Moravsko forest region

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Abstract:

Mutual cooperation and networking are crucial for small and medium enterprises (SMEs) to achieve a competitive advantage in each economic sector. Cooperation is a particularly important for small and medium enterprises involved in non-wood forest products (NWFPs) business, due to its specifics (e.g. dependence on natural resources and weather conditions; perishable products, etc.). This research aims to investigate the respondents' attitudes towards the cooperation with NWFPs pickers, other enterprises and institutions, business networking, and benefits expected from membership in business associations. A study was conducted in the Topličko and Moravsko forest regions (both located in the region of Southern and Eastern Serbia). Data collection was conducted using face to face survey with representatives of 28 NWFPs-based enterprises in March 2022. The research results indicate that almost all enterprises (96.3%) have cooperation with the local community. Respondents are mostly satisfied with the cooperation with NWFPs pickers (92.8%) and local community (92.3%). All SMEs cooperate with other enterprises. The most common forms of cooperation with other enterprises are buying raw materials (57.1%) and selling products (92.9%). The majority of respondents (85.7%) stated that they cooperate with public institutions in charge of NWFPs in Serbia, mostly regarding permits for NWFPs collection and export. Around ½ of them (56.5%) rate this cooperation as "good" and "very good". Only 32.1% of analysed enterprises are a member of a business association. Still, 77.8% of those who are not a member, are interested in joining an association. Almost all respondents (96.4%) see the association as one of the opportunities to improve their business. They expect several benefits from membership in a business association and the most common benefits they expect are: "joint selling on domestic market", "joint export" and "NWFPs market information". All respondents believe that networking with other enterprises can bring financial benefits to their business.

Keywords: small and medium enterprises; non-wood forest products; cooperation; business networking



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Forests in women's hands: Activities on the development of the National action plan for Serbia

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Abstract:

The Interreg Danube project „Forests in women's hands” (Fem4Forest) aims to strengthen the capacity of the forestry sector at the local, regional and interregional levels, through increased participation of women, improving their skills and promoting their equal representation and competencies in the Danube region. One of the most important activities within the project is the development of a National action plan for each of the 10 participating countries, which will enable a more active role of women in the forestry sector. The project team from the University of Belgrade - Faculty of Forestry, has developed a proposal for a National action plan for Serbia (NAP), which contains 4 chapters. In the introductory chapter, the purpose and goals of its development are stated. The NAP is a strategic planning instrument that defines a way to improve the representation of women at all levels of the labor market in the forestry sector, and to reduce vertical segregation. The NAP should create favorable political conditions to support greater involvement of women in the forestry sector and aims to improve the ability of private forest owners to innovate their forest management and to encourage the competitiveness of women employed in the forestry sector in the labor market. The second chapter „Frameworks of the National action plan” presents definitions of the most important terms, which refer to the gender equality issue, and considers the strategic and legislative frameworks dealing with gender equality in Serbia. The third chapter of the NAP „Gender equality in the forestry sector in Serbia” presents the results of research conducted within the project „Forests in women's hands” in Serbia. The primary and secondary data were collected and analyzed. The primary data were collected by conducting online surveys with female forest professionals and private forest owners, as well as undergraduate and master's students in the Department of forestry and nature conservation, University of Belgrade - Faculty of Forestry. Quantitative data were collected in the period March-May 2021 with 64 female forest professionals and private forest owners and 32 female forestry students. The secondary data referred to the total number of employees, and the participation of women in institutions and organizations in the forestry sector (Directorate of forests and Public enterprises in forestry and nature conservation). The fourth chapter of the NAP is the „Action plan” which presents the objectives and measures for their implementation, grouped into 4



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key areas: education, mentoring, networking and promotion. The objectives and measures were defined based on the conclusions from two round tables with key stakeholders (organized online in May and November 2021) and the results of the respondents' attitudes. During the development of the NAP proposal, in-depth interviews were conducted with experts from the forestry sector, who were selected by judgmental sampling. Interviews were conducted with 6 experts from various institutions and organizations (1 representative of public administration, 3 representatives of public enterprises for state forest management and 2 representatives of educational and scientific-research organizations). In the final phase of the development the NAP proposal, interviews were conducted with representatives of decision-makers from the forestry sector, who gave a significant contribution to the improvement of the proposed draft document. The Faculty of Forestry and members of the national project team are responsible for the implementation of most of the defined objectives and measures, and the period for its realization is from 2022 to the end of 2024.

Keywords: strategic document; women in forestry; gender equality



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In situ conservation of rare and endangered forest tree species at the locality „Jelovarnik” - National Park „Kopaonik” in Serbia

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Abstract:

National Park „Kopaonik” is one of five national parks in Serbia, with a total area of 11,969.04 ha. There are 13 localities with the protection regime of the first degree in National Park „Kopaonik”, one of them is „Jelovarnik”, which was the subject of this research. This research aimed to identify rare, endangered, and forest tree species „at-risk” at the locality „Jelovarnik”, and to propose a program for conservation and monitoring of the available gene pool. The locality „Jelovarnik” is located at an altitude of between 1150 and 1780 m and covers an area of 66.69 ha. The main value of this locality is the waterfall „Jelovarnik”, with cascades, surrounded by natural beech forests, forests of beech, spruce and fir, as well as spruce forests. By terrain reconnaissance, a total of 15 forest tree species were recorded at this locality, which indicates a significant diversity of this area. A total of 9 forest tree species belong to the categories of rare (*Sorbus aucuparia* and *Ulmus glabra*), rare-endangered (*Acer platanoides*, *Betula pendula*, *Malus sylvestris*), and species „at-risk” (*Populus tremula*, *Prunus avium*, *Pyrus pyrastrer* and *Sorbus aria*) in Serbia. In addition, 3 shrub species that rarely occur in the study area have also been recorded: *Euonymus verrucosus*, *Euonymus europaeus*, and *Cotoneaster vulgaris*. Conservation of forest genetic resources in protected areas, such as national parks, presents an important aspect of in situ conservation in Serbia. Based on the results of research at the locality „Jelovarnik”, measures of conservation and monitoring of individual genotypes or groups of trees have been defined. The in situ conservation area will include sites where 9 rare, endangered and forest tree species „at-risk” were selected and georeferenced. The basic function of this in situ conservation area is educational, but it will also represent a well-planned basis for the long-term preservation and improvement of the available gene pool, as well as improvement of the degree of its variability and vitality of forest ecosystems.

Keywords: forest genetic resources; conservation measures; national parks; endangered species



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Influence of tree crown status on the growth of common beech (*Fagus sylvatica* L.) in Croatia

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Abstract:

There is an increasing concern in Europe over the sustainability of forest ecosystems under global change (FOREST EUROPE 2011). As the effects of climate change on forests in Southern Europe will potentially be stronger and more rapid than in the rest of Europe, this area represents an ideal model for studying the impact of changing climatic conditions. Common beech is a dominant broadleaved tree species both in European and in Croatian forests. The causes of decline in beech vitality are uncertain, but it is likely that drought years are important. In the future, Croatia is expected to be hotter and drier, with considerable impacts to be expected for the forest ecosystems. Tree vitality can be defined as the ability of a tree to assimilate, to survive stress, to react to changing conditions, and to reproduce. Tree vitality is best assessed by the use of various vitality indicators. Crown defoliation and radial growth are indicators of tree vitality that are most often used in forest monitoring, and both are related to climate parameters. Defoliation is a non-specific symptom of tree vitality widely used in forest practice. Typically, the defoliation of trees will change from year to year and will rise sharply under heavy stress (such as drought), often not in the same, but the following year. Trees are also known to be able to recover from leaf loss, the interval for the return to pre-stress values depending as much on the environmental conditions as on the tree species. Similar to other indicators of vitality such as defoliation or foliar composition, radial growth of trees is an integrative variable of tree response. Trees generally respond to environmental stresses by increment decrease as a consequence of a reduced photosynthetic activity and altered carbon allocation. We used the infrastructure of UNECE ICP Forests Level I plots (16x16 km grid) in Croatia for our field work. For this research, a set of 29 plots in which common beech is significantly represented in the mixture of tree species and where crown defoliation assessment has been carried out at least 90 % of the time period from 1996 to 2017 was used. On these plots, tree core sampling was additionally performed. Our primary interest was to establish the relationship between defoliation and radial growth of common beech, in view of the climate change acting as the dominant external pressure on beech vitality in Croatia. Conclusions derived from this research will expand knowledge on the defoliation/radial growth relationships on a broader scale.

Keywords: tree vitality; defoliation; radial growth; climate change



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Conservation of forest fruit trees gene pool in the protected area „Košutnjak forest” (Serbia)

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Abstract:

The natural monument (NM) „Košutnjak Forest” has been declared protected due to its significant spatial functions and bioecological values of the complex under forest vegetation. The management plan of the NM „Košutnjak Forest” envisages the protection of natural values, especially the gene pool of those woody species that belong to the group of “rare”, “endangered” and species “at-risk”. By terrain reconnaissance, in addition to the gene pool of indigenous oak species, important for this area, the gene pool of forest fruit trees was found. In Serbia, forest fruit trees are classified as species “at-risk”. Forest fruit trees that significantly contribute to the biodiversity of NM „Košutnjak Forest” are wild cherry (*Prunus avium* L.), wild pear (*Pyrus pyraster* (L.) Burgsd.), service tree (*Sorbus domestica* L.), and wild service tree (*Sorbus torminalis* (L.) Crantz.). The wild cherry gene pool is recorded in 18, out of a total of 24 compartments in NM „Košutnjak Forest”. It occurs individually or in small groups of mostly older trees with visible damage. The wild pear gene pool, represented by individual trees, is recorded in 10 compartments. Wild service tree was recorded in 9 compartments, while service tree was recorded in only 3 compartments. Natural regeneration of these species is limited, except for wild cherry which regenerates very well naturally. The recorded gene pool of studied species in NM „Košutnjak Forest” is included in the plan of genetic conservation to preserve and improve the ecological adaptability and evolutionary potential of these species. Ex-situ and in-situ gene pool conservation methods were applied. Ex-situ conservation was implemented by establishing 2 progeny tests in the nursery of the Faculty of Forestry (Belgrade): the wild cherry test, represented by 13 half-sib lines, and the wild pear test, represented by 25 half-sib lines. The NM „Košutnjak Forest” is considered one in-situ conservation area, where 5 in-situ conservation units were allocated, including the gene pool of all 4 studied forest fruit tree species. The application of conservation methods provided a starting point for long-term conservation, monitoring, and sustainable utilization of the available gene pool of forest fruit trees in NM „Košutnjak Forest”.

Keywords: forest fruit species; conservation of forest genetic resources; species at-risk



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Climate changes' impact on management and activities in protected areas: Managers' and Stakeholders' attitudes

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Abstract:

Protected areas management faces major risks and uncertainties in front of current and future climate changes. Implementing appropriate activities, improving the system of support and protected areas management are major challenges for managers and other institutions and organizations in the nature conservation sector. This paper aims to examine the respondents' attitudes towards climate changes' impact on protected areas, managers' and stakeholders' activities, as well as towards the need for improvements of the protected areas management system. Data collection was conducted in the period January-March 2021 in Serbia. A comparative method was used to examine the similarities and differences of the respondents' attitudes, while the obtained data were processed by content analysis. An in-depth, structured interview was used as a research technique. The sample consisted of 20 representatives of national and provincial public administrations and public services in the nature conservation sector, protected areas managers, educational, research and civil society organizations. The respondents were selected by judgmental sampling. Almost all respondents stated that the consequences of climate change are already present in protected areas (e.g. changes in ecosystems and natural processes), as well as that they will be more visible in the future. Most of the managers' representatives believe that the effects of climate change on their activities are also present (e.g. increased scope of activities on species and habitats' monitoring and implementation of active protection measures). Also, most respondents stated that their institutions and organizations conduct activities that (directly or indirectly) affect climate change mitigation and adaptation (e.g. initiating and funding of new researches, adjusting of educational activities). Respondents did not agree on possible changes or adjustments of some of the activities related to the management of protected areas in the future due to the negative effects of climate change. The need for improvement of regulatory framework and stakeholders' cooperation is clearly stated. Based on the research results, it can be stated that climate changes already have a significant impact on protected areas in Serbia. Thus, it can be expected that their management will face great challenges in the future which will primarily imply the change of protected areas management system.



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Keywords: climate changes; protected area management system; managers; stakeholders.



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The impact of pest insects and fungal diseases on the dieback of pine forests in the R. of N. Macedonia

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Abstract:

Since the 1950's on the territory of today's R. of N. Macedonia, vast areas of bare land and pastures have been afforested. As drought tolerant and adaptable, one of the most used tree species to this day is the Austrian pine (*Pinus nigra*). This trend has contributed to pines becoming important economic and ecological trees in the country. However, this is not without consequences. Many of these forests lack in their development and are with poor health. This research is one of several that focuses on determining the causes and finding a remedy for this situation. The observation period was from 2016-2021. The object of research was the natural and planted pine forests across the country. In total, we examined eleven sites in different regions. Out of these sites, nine are predominantly made up from *P. nigra*, one is mixed (*P. nigra* and *P. sylvestris*) and one is made up from *P. peuce*, a forest in the NP Pelister. During the research that focused on examining physiologically weakened trees, we found fourteen species of mainly secondary pests. Out of them, eleven species are bark beetles (Scolytinae; Curculionidae). Of the previously mentioned species, *Ips acuminatus*, *Ips sexdentatus* and *Tomicus minor* stand out from the rest concerning their harmful influence on the forest health. Mainly because these three species were in overpopulation. Consequently, in the absence of enough physiologically weakened trees, these pests started infesting healthy trees, thus becoming primary pests. The most commonly found fungal disease was *Cenangium ferruginosum*. It was predominantly present on physiologically weakened trees as well, on which has important role in causing their dieback. Since many of the newly established pine forests are on sites that are far from optimal, the trees suffer immense stress caused by abiotic factors. Hence, the presence of secondary pests and diseases is very common. To prevent the further spread of pests and diseases, sanitation felling is necessary.

Keywords: pests; fungal diseases; dieback; bark beetles



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Bioecological characteristics of two mass outbreaks of *Altica Quercetorum* foudr. in the R of N. Macedonia

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Abstract:

Oak forests in the R. of N. Macedonia are under the constant negative influence from different insect defoliator species. However, the species *Altica quercetorum* is not one of the species that are continuously present with a high population density. This research focused on forest health data from a period of 20 years (2001 – 2022). In that period, the populations of *A. quercetorum* reached critical levels only twice. The first time was in 2002 in the forest management unit (FMU) Plachkovica, near Radovish. The outbreak was on a forest area of 1200 ha. The second outbreak happened in 2018 in the FMU Anska Reka, near Valandovo. This time the spread of the overpopulation of this species was limited to an area of 100 ha. In both cases, the most common host species was *Quercus pubescens*, with *Q. frainetto* also being infested. The defoliation percentage was determined visually, while the abundance of *A. quercetorum* was calculated by the number of adults and the number of larval colonies on the test plots. The average defoliation percentage on the forest areas of each of the outbreaks was around 80%, with cases of total defoliation on certain sites. The local populations of *A. quercetorum* have a high reproduction potential with females being able to lay between 600 and 900 eggs. However, the environmental conditions influenced significantly the species population in the subsequent years. Most notable of these are the lack of food and the population increase of its natural enemies. As a result, both outbreaks ended abruptly in the following year. Since then, the species *A. quercetorum* is regularly present in the oak forests in the R. of N. Macedonia, but with a low population density.

Keywords: pests; oak forests; *Altica quercetorum*; defoliators



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Effect of Wildfire on Forest Soils in Maleshevo–Pijanec Region

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Abstract:

For the last three decades, wildfires have been a significant problem for forests and forestry, causing great economic and environmental damage. They are common in Malesh and Pijanec region, as well as throughout the country. In 2021, a total of 192 wildfires were recorded in North Macedonia. The big wildfire in Maleshevo–Pijanec region occurred in the period 2-11 August 2021, estimated at 6,378 hectares of burned oak and pine forests area. The burnt area is mostly represented by Complex of Mollic and Umbric Leptosol, Regosol and Leptosol with 30.8% of the territory, followed by Complex of Mollic and Umbric Leptosol with 17.4%, Complex of Albic Livisol and Regosol with 11.2% and Chromic Luvisol on Saprolite with 9.4%. In this research, the effects of fire on biological, chemical and physical properties of soils are analysed. The most affected areas after the fire show increased biological activity and an abundance of symbiosis between plants, fungi and bacteria as a result of increased pH and release of nutrients from the ash. The fire significantly affected the soil fauna due to the burning of the root system, so it is severely disturbed up to 2 cm of depth, moderately disturbed up to 8 cm, partially disturbed up to 15 cm and weakly disturbed in the deeper soil layers. Food sources for soil fauna are significantly reduced. Occurrence of certain types of fungi has been recorded in the burned area. The increased biological activity and the increased amount of nutrients have enabled the accelerated multiplication of bacteria. The fire has decreased the capacity for cation exchange (CCE). Sandy soils show lowest CCE after the fire, of 100 meq/100 g of soil in pine stands and 180 meq/100 g of soil in oak stands. Increased soil acidity and increased soil biological activity indicate improved nitrification, especially in burnt acid soils. The fire decreased organic carbon (C) content in soils and caused structural changes in aliphatic compounds, while humic acids remained unchanged. Carbonated plant debris in large quantities are accumulated on the soil surface (to a depth of 2 cm), where it makes up 30-40% of the soil. Burnt soils are black coloured as a result of the coal-fired organic waste and the black ash created by incomplete combustion. Surface accumulated ash (up to 1.5 cm of depth) contains Ca, Mg, K, Si and P. Soil water repellency is present in the burned soils, but it is not strongly expressed and is not a limiting factor for future revitalisation activities. The aggregate composition is significantly changed to a depth of up to 15 cm, mainly through changes in porosity and water retention capacity. It can be concluded that it will take relatively long time for the soils to return to their original condition.

Keywords: wildfire, burned forest soils, soils properties.



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