



BULGARIAN ACADEMY OF SCIENCES
FOREST RESEARCH INSTITUTE



International Scientific Conference
90 Years Forest Research Institute -
for the Society and Nature
24-26 October 2018, Sofia, Bulgaria

BOOK OF ABSTRACTS

Co – organizers:

Ministry of Agriculture, Food and Forestry of Republic of Bulgaria
Union of Scientists in Bulgaria



90
YEARS

Forest Research Institute - BAS



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FOREST RESEARCH INSTITUTE



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Book of Abstracts

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„90 Years Forest Research Institute - for the Society and Nature“
24-26 October 2018, Sofia, Bulgaria

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1. Introduction and aim of the Conference

The conference is aiming at bringing together leading scientists, international experts and government representatives to network and share the latest research, programs and policies in the field of forestry, ecology and environmental studies.

The objective of the event is to link traditions and innovations in international and local experience with forest ecosystems, their resources, services, functioning and management for social well-being.

General topics:

- Forestry and Ecosystem Management
- Forests, Soil and Water Interactions
- Forests and Climate Change
- Silviculture and Forest Genetic Resources Management
- Forest Health
- Biodiversity, Ecosystem Services and Biological Invasions
- Forest Engineering
- Natural Resource Policy
- Forests and Interdisciplinary Research

Our honored plenary speakers:

Acad. Alexander Alexandrov, Director of FRI-BAS (1989-1993 and 2003-2011), IUFRO representative (Bulgaria) – „History of the Forest Research Institute – Bulgarian Academy of Sciences with a view to the 100th anniversary“.

Prof. John Innes, Faculty of Forestry, University of British Columbia (Canada) – „Forests and climate: How do we plan for what we do not know?“

Prof. Alain Roques, Institut national de la recherche agronomique, Orléans (France) – „Past insect invasions in Europe and future trends in relation with global change“.

Prof. Paolo Cherubini, WSL Swiss Federal Research Institute, Birmensdorf (Switzerland) – „Dendroecology: The use of tree rings in forest ecology to provide solutions to forest management“.

Prof. Gavriil Xanthopoulos, Institute of Mediterranean Forest Ecosystems (Greece) – „Preparing for forest fires in Mediterranean countries under Global Change scenarios“.

2. Conference program

24 October 2018

08.30 - 09.30 *Registration – Metropolitan Hotel, Sofia, Bulgaria*

24 October 2018 – Sofia Hall

09.30 - 10.00 *Opening and Welcome address*

Plenary session

- 10.00 - 10.25** ALEXANDER ALEXANDROV *“History of the Forest Research Institute - Bulgarian Academy of Sciences with a view to the 100th anniversary”*
- 10.25 - 10.50** JOHN INNES *“Forests and climate: How do we plan for what we do not know?”*
- 10.50 - 11.20** Coffee break
- 11.20 - 11.45** ALAIN ROQUES *“Past insect invasions in Europe and future trends in relation with global change”*
- 11.45 - 12.10** GAVRIIL XANTHOPOULOS *“Preparing for forest fires in Mediterranean countries under Global Change scenarios”*
- 12.10 - 12.35** PAOLO CHERUBINI *“Dendroecology: The use of tree rings in forest ecology to provide solutions to forest management”*
- 12.35 - 14.00** Lunch break

Parallel sessions

T1. Forestry Engineering, Ecosystem Management and Natural Resources Policy

24 October 2018 - Sofia Hall

Session 1. Forestry Engineering, Ecosystem Management and Natural Resources Policy

Chairs: Yonko Dodev, Mira Georgieva

- 14.00 - 14.15** W.S. SHIN
Paradigm shift on forest utilization in Korea
- 14.15 - 14.30** A. ALEKSEEV, K. GADOW
Long rotation forestry: extent for Boreal zone and special conditions for planning and design
- 14.30 - 14.45** Y. DODEV, G. POPOV, I. MARKOFF, P. GLOGOV, S. MADZHOV
*Silvicultural conception for sustainable management of forests of Oriental hornbeam (*Carpinus orientalis* Mill.)*
- 14.45 - 15.00** M. GEORGIEV
*Forestry analysis of the conditions of the environment of the Scots pine crops (*Pinus sylvestris* L.) in Kraishtensko - Ihtiman forest-growing sub-area*
- 15.00 - 15.15** M. ÖZDEMİR, H. BÜYÜK
Silvicultural strategies for emerging problems and conversion of oak forests in Turkey
- 15.15 - 15.30** A. HAMIDIAN
Forest and rangeland management using indigenous ecological knowledge, a case study of Barzok district
- 15.30 - 15.45** M. STOYANOVA
Essential oils from coniferous species in Bulgaria
- 15.45 - 16.00** R. PETRIN
General regularities in the height structures of hungarian-oak, durmast and cerris-oak dendrocoenoses
- 16.00 - 16.30** Coffee break

Session 2. Forestry Engineering, Ecosystem Management and Natural Resources Policy

Chairs: *Sotir Glushkov, Svetozar Madzhov*

- 16.30 - 16.45** S. GLUSHKOV, I. MARKOFF, S. STOYANOV
Mechanized timber harvest in declined pine plantations
- 16.45 - 17.00** K. STEFANOV, K. MARINOV, D. PEEV, D. GEORGIEV
Exploitation research of machine for loading of wood
- 17.00 - 17.15** S. MADZHOV, Y. DODEV, G. POPOV, P. GLOGOV
Requirements for diagnostic parameters for the technical condition of machinery
- 17.15 - 17.30** K. MARINOV, K. STEFANOV
Operation performance of forestry milling brush cutters for poplar clearings cleaning
- 17.30 - 17.45** D. PEEV
*Particle size and quality of wood chips from Scots pine (*Pinus sylvestris* L.) wood, yielded with mobile chippers*
- 17.45 - 18.00** S. GLUSHKOV, E. VELIZAROVA, S. STOYANOV, V. CHAKUROV, I. MARKOFF, V. TRINGOVSKA
Chipping of biomass from urban areas with small wood chippers
- 19.00 - 21.30** Reception cocktail & Dinner

25 October 2018 – Sofia Hall

Session 3. Forestry engineering, Ecosystem Management and Natural Resources Policy

Chairs: *Hristo Tsakov, Angel Ferezliev*

- 09.00 - 09.15** H. TSAKOV, A. FEREZLIEV, A. DELKOV, H. HRISTOVA
*Thickness structure of Macedonian pine (*Pinus peuce* Gris.) plantations growing in the Vitosha mountain*
- 09.15 - 09.30** A. FEREZLIEV, K. KAROV, N. ZAFIROV, Y. DODEV
*Comparative study of the height and volume structure of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) forest plantations in State Forestry Alabak, Velingrad*
- 09.30 - 09.45** I. MARKOFF, T. TONCHEV, G. POPOV, Y. DODEV
A casting for growth tables for Bulgarian tree species based on inventory data

- 09.45 - 10.00** T. TONCHEV, I. DOBRICHOV, Y. IVANOV,
Y. PORYAZOV
Structure and stocking control of uneven-aged coniferous stands in Bulgaria
- 10.00 - 10.15** A. FERENZLIEV, H. TSAKOV, H. HRISTOVA
Horizontal structure and peculiarities in diameter structure of Fagus moesiaca (Maly) Czecz. Plantations in Shumensko plateau
- 10.15 - 10.30** N. ALEXANDROV, T. TONCHEV, E. MOLLE
Optimal rotation ages of coppice oak stands in Bulgaria
- 10.30 - 11.00** Coffee break

Session 4. Forestry engineering, Ecosystem Management and Natural Resources Policy

Chairs: *Grud Popov, Yonko Dodev*

- 11.00 - 11.15** I. MARKOFF, G. POPOV, Y. DODEV, P. GLOGOV
Climate change and its impact on the oak coppices in North Central Bulgaria
- 11.15 - 11.30** K. KARAMFILOV, I. MARKOFF
The use of sampling techniques to improve traditional inventories in Bulgaria, first steps and prospects
- 11.30 - 11.45** A. HAMIDIAN
Toward sustainable management of Miankaleh Biosphere Reserve
- 11.45 - 12.00** V. YAROTSKYI, V. PASTERNAK, V. NAZARENKO
Phitomass and mortmass assessment in pine forests of left bank forest steppe of Ukraine
- 12.00 - 12.15** A. TODOROV, G. ZHELEZOV
Productivity of the landscape in the region of Kraiste between rivers Bistritsa and Konska
- 12.15 - 12.30** Y. DODEV, G. POPOV, I. MARKOFF, A. FERENZLIEV
European experience in managing of coppice with standards and its prospects in Bulgaria
- 12.30 - 12.45** R. PETRIN
Thickness structure of seed-tree hungarian-oak, durmast and cerris oak dendrocoenoses

12.45 – 13.00 D. N. DIMITROV, V. ILINKIN, M. GEORGIEVA,
G. HINKOV
*Damages to beech forests caused by timber harvesting on
the territory of Berkovitsa state forestry*

13.00 - 14.00 Lunch break

T2. Forests, Soil and Water Interactions

24 October 2018 - Rome Hall

Session 5. Forests, Soil and Water Interactions

Chairs: *Milena Kercheva, Rositsa Yaneva*

14.00 - 14.15 M. KERCHEVA, E. DIMITROV, K. DONEVA,
E. VELIZAROVA, M. GLUSHKOVA, I. MOLLA,
T. SHISHKOV
*Soil water retention properties of forest soils under different
land use*

14.15 - 14.30 M. BAZGIR, M. CARNOL
C and N cycling in the forest floor under 7 tree species

14.30 – 14.45 M. ZHIYANSKI
*Carbon storage in soils from Pleven district regarding the
level of anthropogenic pressure*

14.45 – 15.00 D. SARI, S. İNCECIK, N. ÖZKUT
*Assessing the high ozone levels over the forest area of Biga
Peninsula in Turkey*

15.00 - 15.15 G. FROLOVA, P. FROLOV, N. IVANOVA, V. SHANIN
*Analysis of competitive interactions between undergrowth
and ground layer vegetation in pine forests of the European
part of Russia*

15.15 - 15.30 M. NIKOLOVA, S. NEDKOV
*Urban green infrastructure for climate change adaptation:
an integrated assessment of the regulating ecosystem services
in Karlovo, Bulgaria*

15.30 - 15.45 R. YANEVA, M. ZHIYANSKI, Y. DODEV
*Integrated approach for mapping the capacity of ecosystems
to mediate toxic elements in forests*

16.00 - 16.30 Coffee break

Session 6. Forests, Soil and Water Interactions

Chairs: *Vanya Kachova, Rositsa Yaneva*

- 16.30 - 16.45** A. SINGH
Functional attributes of planted woody species on coal mine spoil for ecological restoration in a dry tropical environment, India: an implication for C management in a changing environment
- 16.45 - 17.00** V. KACHOVA, E. POPOV, G. HINKOV
*Agroforestry riparian plantations with *Populus*. sp. and soil quality improvement*
- 17.00 - 17.15** E. DIMITROV, M. KERCHEVA, K. DONEVA, E. VELIZAROVA, M. GLUSHKOVA, I. MOLLA, T. SHISHKOV
Saturated hydraulic conductivity of forest soils under different land use
- 17.15 - 17.30** M. ZHIYANSKI, M. SOKOLOVSKA, M. GLUSHKOVA
Chemical characterization of Cambisols under different land-uses in highland region of Rila Mountain, Bulgaria
- 17.30 - 17.45** E. VANGUELOVA, R. PITMAN, S. BENHAM
Long term trends and effects of nitrogen inputs on forests and soils in the UK
- 17.45 - 18.00** E. VANGUELOVA
What is the capacity and potential for carbon sequestration in forest soils in the UK?
- 19.00 -21.30** Reception cocktail & Dinner

T3. Forests, Climate Change and Risk Processes

24 October 2018 - Brussels Hall

Session 7. Forests, Climate change and Risk Processes

Chairs: *Tsvetan Zlatanov, Dimitar Dimitrov*

- 14.00 - 14.15** W. BECK, T. ZLATANOV
*How does altitude modify climate-growth-relationships in common beech (*Fagus sylvatica*) forests on the Western Balkan Range and Belasitsa Mountain?*

- 14.15 - 14.30** G. KOSTOV, N. ALEXANDROV, K. KOLEV
Regional silvicultural systems for management of oak coppice forests in West Bulgaria
- 14.30 - 14.45** M. PANAYOTOV, N. TSVETANOV, E. TSAVKOV, G. GOGUSHEV
Historical data on disturbances in mountain coniferous forests in Bulgaria and implications for the risk for forest damages
- 14.45 - 15.00** D. DIMITROV, N. ZAFIROV, T. POPOVA, H. POPOV, S. MIRTCHEV, S. TORBATOV, V. KATSAROVA, I. BORISOVA-KATSAROVA, L. VAGALINSKI
Taxonomical status and tree-ring chronology building of timber excavated from different archaeological locations in Bulgaria
- 15.00 - 15.15** N. ZAFIROV, G. KOSTOV
Main stress factors in coppice oak forests in Western Bulgaria
- 15.15 - 15.30** M. PANAYOTOV, E. TSAVKOV, N. TSVETANOV, S. TOSHEV, S. YURUKOV
Dendrological and tree-ring analysis of 100 years of growth of local and introduced coniferous tree species in Kniazevska kultura forest near Sofia
- 15.30 - 15.45** D. DIMITROV, N. ZAFIROV, A. DELKOV, S. MIRCHEV, E. PAVLOVA-TRAYKOVA
*Dendrochronology of 358-year-old beech stand (*Fagus sylvatica* L.) from tree-line zone, Balkan Range Mt., Bulgaria*
- 16.00 - 16.30** Coffee break

Session 8: Forests, Climate change and Risk Processes

Chairs: *Ivan Marinov, Eli Pavlova-Traykova*

- 16.30 - 16.45** I. MARINOV, E. PAVLOVA-TRAYKOVA
Flooding risk assessment in connection with ecosystem services in Smolyan region, Bulgaria
- 16.45 - 17.00** I. BLINKOV, A. TRENDAFILOV, I. MINCHEV
Erosion Hot-Spots in the Skopje Region
- 17.00 - 17.15** E. PAVLOVA-TRAYKOVA
Evaluation of water erosion risk in Bistritsa River watershed, Southwest Bulgaria

- 17.15 - 17.30** I. FERNANDEZ, A. CABANEIRO
Temperature-induced changes in humus quality and $\delta^{13}\text{C}$ signatures as a proxy indicator of soil burn intensities after forest wildfires
- 17.30 - 17.45** I. BUKSHA, T. PYVOVAR, M. BUKSHA, V. PASTERNAK
Impact of drought on the forest vegetation in Eastern Ukraine: the long-term prognoses and adaptation measures
- 19.00 - 21.30** Reception cocktail & Dinner

25 October 2018 - Brussels Hall

Session 9: Forests, Climate Change and Risk Processes

Chairs: *Emiliya Velizarova, Lora Stoeva*

- 09.00 - 09.15** I. MARINOV
Soil erosion in Bulgarian mountain regions: stationary studies and risk assessment
- 09.15 - 09.30** E. PAVLOVA-TRAYKOVA, I. MARINOV
Evaluation of water erosion risk in Dzhubrena River watershed
- 09.30 - 09.45** L. KIROVA, M. ZHIYANSKI
Comparative analyses on some soil characteristics in different land uses from Central Balkan Mountains
- 09.45 - 10.00** L. STOEVA, I. MARKOFF
Establishing Forest Reference Level of Bulgaria for the period 2021-2025 – approaches used, interpretations, definitions and challenges
- 10.00 - 10.15** E. VELIZAROVA, P. ZHELEV, I. MOLLA
Vegetation restoration in fire-affected forests
- 10.15 - 10.30** L. MALINOVA, K. PETROVA, P. KARMAZOVA
Results of soil monitoring in the Western Balkan Mountain
- 10.30 - 11.00** Coffee break

T4. Silviculture and Forest Genetic Resources Management

25.10.2018 - Madrid Hall

Session 10: Silviculture and Forest Genetic Resources Management

Chairs: *Emil Popov, Tatiana Stankova*

09.00 - 09.15 A. LATINI, D. LACHANCE, M-J MORENCY,
G. PELLETIER, D. STEWART, P. LABRIE, P. TANGUEY,
S. REGAN, A. SÉGUIN

*Activation tagging in poplar: identification of new
phenotypes from a field trial in Québec*

09.15 - 09.30 V. GYULEVA, T. STANKOVA, M. ZHIYANSKI,
E. ANDONOVA

Five years growth of Paulownia on two sites in Bulgaria

09.30 - 09.45 E. POPOV, G. HINKOV, I. VELICHKOV, T. ZLATANOV,
P. STEFANOVA

*Productivity of experimental and industrial Douglas-fir
(Pseudotsuga menziesii (Mirb. Franco) plantations in Bulgaria*

09.45 - 10.00 A. KHOLODNA

*Cultivation of willow on degraded soils of the Left Bank
Forest-Steppe of Ukraine as a factor of improving of their
ecological properties*

10.00 - 10.15 N. SOLOMAKHA, T. KOROTKOVA

*Experience of reforestation of artificial oak forests in
the southeast of Ukraine*

10.15 - 10.30 G. P. GEORGIEV

*Ecological requirements of rare forest tree species in the
region of Eastern Balkan range*

10.30 - 11.00 Coffee break

Session 11: Silviculture and Forest Genetic Resources Management

Chairs: *Veselka Gyuleva, Maria Glushkova*

11.00 - 11.15 V. GYULEVA, M. ZHIYANSKI, T. STANKOVA,
M. GLUSHKOVA, E. ANDONOVA

Clone differences in the root biometry of hybrid black poplar

- 11.15 - 11.30** G. FROLOVA, P. FROLOV, I. PRIPUTINA
Growth of young artificial stands Scots pine (Pinus sylvestris L.) in the south Moscow Region
- 11.30 - 11.45** G. SPYROGLOU, D. ZIANIS, K. RADOGLLOU
Leaf area and foliar weight to sapwood cross sectional area models for Quercus frainetto (Ten.) in Greece
- 11.45 - 12.00** G. GEORGIEVA, N. CHIPEV
Regenerative and adaptive potential of Oriental beech (Fagus orientalis Lipsky) forests in Strandzha Mountain
- 12.00 - 12.15** M. TANDOĞAN, V. ASLAN, M. ÖZDEMİR
The effects of different humic acid applications on the germination of the Pin oak (Quercus palustris)
- 12.15 - 12.30** M. IOTTI, M. LEONARDI, F. ORI, A. ZAMBONELLI, G. PACIONI
Edible ectomycorrhizal mushrooms: a promising resource for agroforestry
- 12.30 - 12.45** P. DIMITROVA, K. KALMUKOV
Dynamics of growth parameters of plantations from half-sibs progenies of selected Robinia pseudoacacia L. clones in young age
- 12.45 - 13.00** P. PANAYOTOV, K. KALMUKOV, M. PANAYOTOV
Quality of Locust tree wood (Robinia pseudoacacia L. var. rectissima Raber.)
- 13.00 - 14.00** Lunch break

T5. Biodiversity, Forest Health and Biological Invasions

24 October 2018 - Madrid Hall

Session 12: Biodiversity, Forest Health and Biological Invasions

Chairs: Daniela Pilarska, Plamen Glogov

- 14.00 - 14.15** P. GLOGOV, D. PAVLOVA, M. GEORGIEVA, Y. DODEV
Invasive alien species in the flora of the Lozenska Mountain
- 14.15 - 14.30** A. SINGH
Biodiversity development under selected native woody plantations on coalmine spoil in a dry tropical region of India: A case study

- 14.30 - 14.45** S. KAVILEVEETIL
European plants invasive in the Asia-Pacific region: an appraisal
- 14.45 - 15.00** D. ZLATANOVA, I. STEPANOV, E. POPOVA, A. AHMED, R. ANDREEV, I. TODEV, P. GENOV
Preliminary data from red deer (Cervus elaphus L.) GPS/GSM telemetry in Bulgaria
- 15.00 - 15.15** I. PETROV
90 years Forest Research Institute - BAS, 70 years research in Hunting Economy
- 15.15 - 15.30** D. PILARSKA, G. GEORGIEV, M. DOBREVA, D. TAKOV, P. MIRCHEV, D. DOYCHEV, M. GEORGIEVA, R. NACHEV, P. DERMENDZHIEV, S. DRAGANOVA, A.E. HAJEK
Pathogens and parasitoids of forest pest insects in the region of Forest protection station Plovdiv (Bulgaria) during 1995 – 2017
- 15.30 - 15.45** K. SOTIROVSKI, K. SREBROVA, M. RISTESKI
Are hardly visible stromata (“micro-stromata”) in callused cankers additional means of persistence and dissemination of hypovirulence within populations of the chestnut blight fungus Cryphonectria parasitica?
- 15.45 - 16.00** E. FILIPOVA, M. GEORGIEVA
Distribution and impact of Cryphonectria parasitica (Murr.) Barr: causing chestnut blight disease on Castanea sativa Mill. in Bulgaria
- 16.00 - 16.30** Coffee break

Session 13: Biodiversity, Forest Health and Biological Invasions

Chairs: Plamen Mirchev, Margarita Georgieva

- 16.30 - 16.45** D. DAMIANOV, V. GEORGIEV
Age changes in the growth of lower canine teeth of wild boar (Sus scrofa) males
- 16.45 - 17.00** P. MIRCHEV, G. GEORGIEV, G. ZAEMDZHIKOVA, M. GEORGIEVA, M. MATOVA
Impact of parasitoids on egg mortality of pine processionary moth in new habitats

- 17.00 - 17.15** G. ZAEMDZHIKOVA, I. MARKOFF, P. MIRCHEV,
G. GEORGIEV, M. GEORGIEVA, R. NACHEV,
M. ZAIKOVA, M. DOBREVA
The expansion of pine processionary moth (Thaumetopoea pityocampa) in Bulgaria – zone and rate
- 17.15 - 17.30** G. GEORGIEV, D. DOYCHEV, P. TOPALOV,
G. ZAEMDZHIKOVA, V. SAKALIAN
New hosts of xylophagous longhorn beetles (Coleoptera: Cerambycidae) in Bulgaria
- 17.30 - 17.45** P. TOPALOV
A check list and arealography of longhorn beetles (Coleoptera: Cerambycidae) in Vitosha Mountain
- 17.45 - 18.00** M. GEORGIEVA, S. HLEBARSKA, M. DOBREVA,
R. NACHEV, P. DERMENDZHIEV, P. TERZIEV,
S. STAMENOVA, I. IVANOVA
New invasive needle blight pathogens on Pinus spp. in Bulgaria
- 19.00 - 21.30** Reception cocktail & Dinner

25.10.2018 - Brussels Hall

Session 14: Biodiversity, Forest Health and Biological Invasions

Chairs: Georgi Georgiev, Gergana Zaemdzhikova

- 11.00 - 11.15** S. RUSEVA, A. PENCHEVA
A survey of scale insects (Hemiptera: Coccoidea), infecting Cupressaceae family in Bulgaria
- 11.15 - 11.30** G. ZAEMDZHIKOVA, P. MIRCHEV, G. GEORGIEV
Economically important insect pests in Bulgarian forestry during the period 2003 - 2017
- 11.30 - 11.45** P. MIRCHEV, G. GEORGIEV, M. GEORGIEVA,
G. TSANKOV, G. ZAEMDZHIKOVA, M. MATOVA
Assessing pine processionary moth (Thaumetopoea pityocampa) unfertilized eggs in different localities in Bulgaria
- 11.45 - 12.00** S. RUSEVA, A. PENCHEVA
Pest status of Ovalisia (Palmar) festiva (Linnaeus, 1767) (Coleoptera: Buprestidae) in Bulgaria

12.00 - 12.15 S. BELILOV
Xylophagous insects in pine (Pinus spp.) plantations in the Ihtimanska Sredna Gora Mountain

12.30 - 13.30 Lunch break

T6. Ecosystem Services, Monitoring and Interdisciplinary Research

25 October 2018 – Rome Hall

Session 15: Ecosystem Services, Monitoring and Interdisciplinary Research

Chairs: *Svetla Bratanova-Doncheva, Nikolina Gribacheva*

09.00 - 09.15 W.S. SHIN, S.H. PARK
Measuring users' health benefits from three healing forests in Korea

09.15 - 09.30 N. GRIBACHEVA, G. GECHEVA, R. YANEVA
Moss monitoring of atmospheric deposition in Western Rhodopes, Bulgaria

09.30 - 09.45 S. PETEVA, M. LYUBENOVA
Urban tree management and ecosystem services in the town of Sevlievo

09.45 - 10.00 O. TRAPEZNIKOVA
Transformations of forest and field land use within the East European plain during the last 230 years

10.00 - 10.15 P. FROLOV, G. FROLOVA, V. SHANIN, E. ZUBKOVA
*Analysis of reaction of the *Vaccinium myrtillus* populations to the external influences by methods of simulation modeling*

10.15 - 10.30 S. BRATANOVA-DONCHEVA
The MAES Process in Bulgaria – next steps and new challenges

10.30 - 11.00 Coffee break

Session 16: Ecosystem Services, Monitoring and Interdisciplinary Research

Chairs: *Stoyan Nedkov, Bilyana Borissova*

11.00 - 11.15 E. IVANOVA
Potentiality of the remote sensing technics for quantifying carbon stock of forest ecosystems in Bulgaria

- 11.15 - 11.30** M. ASENOVA, Y. IVANOV, V. KARAKIYA
GIS-based approach to updating the database of old growth trees in Sofia
- 11.30 - 11.45** S. NEDKOV
Mapping and assessment of ecosystem services in Bulgaria at multiple scales
- 11.45 - 12.00** A. GIKOV
Mapping forest dynamics in key area "Bogdaia" (Northwestern Rila Mountain) during 50 years period
- 12.00 - 12.15** A. ASSENOV, B. BORISSOVA, K. VASSILEV,
B. GRIGOROV
The protective forest belts in Dobrudzha and their role in nectar corridors
- 12.15 - 12.30** M. PANAYOTOV, M. ASENOVA, N. TSVETANOV
Parameters of old-growth beech and fir-spruce-beech forests inferred from orthoimages, satellite data, and terrain analysis
- 12.30 - 12.45** L. TRICHKOV, K. TASHEV
Mapping and assessment of forest ecosystem types, their condition and the ecosystem provided by forest territories outside Natura 2000
- 12.45 - 13.00** I. MARKOFF, K. KARAMFILOV, G. POPOV
Clustering of sample plots - a case study in conifer forests in Bulgaria relevant to the design of a national inventory of forests
- 13.00 - 14.00** Lunch break

Poster session

25 October 2018 – Sofia Hall

14.00 – 15.30 – Poster session

15.30 – 16.00 – Coffee break

16.00 – 17.00 – Round Table – discussions

17.00 – 17.30 – Adjourning

26 October 2018

08.00 – 18.00 Excursions

Option 1: ***Sofia – Plovdiv – Karlovo – Sofia***

(Lecturer: *Assoc. Prof. Dr. Stoyan Nedkov*)

Option 2: ***Sofia – Rila Monastery – Sofia***

(Lecturer: *Assoc. Prof. Dr. Alexander Delkov*)

3. Plenary session abstracts

History of the Forest Research Institute – Bulgarian Academy of Sciences with a view to the 100th anniversary

Alexander H. Alexandrov

*Department of Agricultural and Forestry Sciences
at the Bulgarian Academy of Sciences, Bulgaria*

The Forest Research Institute (FRI-BAS) was established in 1928 as specific Service for Forest Experimental Activity, differentiated during the years as departmental or academic unit. The mission of FRI-BAS, the main objectives and tasks as well as its development are specified during certain periods. The chronology of the management structure, the number of scientific and supporting staff, and the number of employee with different academic positions and scientific degree has been performed. The data about the administrative, scientific, organizational, teaching and public activities of its employees are summarized.

Keywords: *FRI-BAS, objectives, scientific tasks, periods, structural units*

Forests and climate: How do we plan for what we do not know?

John Innes

Faculty of Forestry, University of British Columbia, Canada

In recent years, the possibilities of using forests to mitigate climate change has been frequently discussed. Many countries have incorporated forests into their Nationally Determined Contributions (NDCs) under the Paris Agreement and in some countries, major afforestation efforts are being made with a view to increasing forest-based carbon sinks and stores. However, climate change is already happening, and the trees being planted today will grow up in a rapidly changing climate. Unless the forests of the world can adapt to this changing climate, they will be unable to fulfil their mitigation role and could actually shift from being a sink to a source of carbon dioxide and other greenhouse gases. Many statements about forest adaptation are made without adequately considering the reality of the uncertainties surrounding future forests. A number of different scenarios, or Representative Concentration Pathways, have been suggested that enable us to estimate what might happen to the global climate given a set of assumptions, but these do not tell us what will actually happen. Even if we could predict the future path of the Earth's climate, there would still be major uncertainties over what would happen in particular areas. While broad trends in temperature are reasonably well understood, changes in moisture regimes have very high levels of uncertainty, yet this will be critical to forests in many years.

These uncertainties present major difficulties for anyone actually planting a forest. Statements are frequently made about increasing the resilience of future forests, and a number of suggested pathways to doing so have been proposed. However, most of these are very speculative and involve spreading the risk (e.g., planting multiple species rather than just one or two). This is not always feasible, as legislation over forest practices has lagged behind advances in our understanding of what steps we need to take. Consequently, a more holistic approach is needed: with those working with forest practices working more closely with those recommending forest policies related to climate change mitigation.

Past insect invasions in Europe and future trends in relation with global change

Alain Roques

INRA Zoologie Forestière, France

Globalization is resulting in an exponential increase in the establishment of non-native insects in Europe, with several species having substantial ecological and economic impacts. No saturation in the arrival of such species is observed, and a significant part of the new arrivals correspond to species that have never been introduced before outside their native range. Phytophagous species, especially those related to woody plants, largely dominate the recent introductions. Moreover, once established the recently-arrived non-native species appear to spread faster than those having arrived during the last centuries. The total area invaded by 1171 insect species for which the date of first record in Europe is known, was used to estimate their current range radius. The initial rate of radial spread was compared among different groups of insects for all years (1800–2014) and for a subset of more recent decades (1950–2014). Decreasing spread rates over residence time were observed in phytophagous species associated with herbaceous plants and crops but much less in those related to woody plants. Initial spread rate was significantly greater for species detected after 1990, roughly 3–4 times higher than for species that arrived earlier. It is hypothesized that the political changes in Europe following the collapse of the Iron Curtain in 1989, and the further dismantling of Customs checkpoints within an enlarged European Union (EU) have facilitated the faster spread of alien insect species. Also, the number of species first recorded in the Eastern Bloc of the politically-divided Europe before 1989 was lower than for the rest of Europe. A detailed analysis of several recent invaders associated to woody plants indicated a dominant role of long-distance translocations across Europe related to human activities, especially with the plant trade, in determining rates of spread. The additional role of global warming in favouring expansion will be discussed.

Keywords: *insects, invasion, trade, global warming, woody plants*

Preparing for forest fires in Mediterranean countries under Global Change scenarios

Gavriil Xanthopoulos

*Hellenic Agricultural Organization „Demeter“,
Institute of Mediterranean Forest Ecosystems, Greece*

Wildland fires are a natural phenomenon but they are also a significant natural hazard for modern societies. Their management is a very complex issue as it has many environmental, technical, social, financial, and political aspects, and involves three different but interlinked phases: prevention, suppression and post-fire rehabilitation. This complexity is even higher nowadays because the dynamics of fires are evolving as a result of climatological, social and political changes, financial and legal constraints, etc., all of them being part of what is referred to as „global change“. More specifically, meteorological changes, such as more and longer duration heat waves, intense droughts and changed global atmospheric circulation patterns, are likely to increase the number of days of extremely high fire danger and may even increase the maxima of observed fire danger indices. This is going to affect greatly the probability of fire starts and the aggressiveness of fire spread making firefighting extremely challenging and dangerous. Changes in fuels, due to inadequate forest management and abandoned rural territories, also contribute to more intense fires that are hard to stop because of increased fuel continuity. Development of wildland-urban interface areas, political instability, illegal immigration flows, and other current changes, also increase the potential for increasing fire starts, further compounding the problem of excessive fuel load to the fire suppression mechanisms.

Most Mediterranean countries already face such challenges and they must be prepared to react to save their forests and to ensure citizen safety. In order to achieve this, they need first of all to recognize the problem, and to understand the factors that affect it. Then they have to plan for a long, challenging future that cannot only depend on costly increases of firefighting resources. Integrated forest fire management, based on state-of-the-art knowledge from all fields of forest fire science, will be needed. Forestry, firefighting and civil protection agencies, as well as the general public, will need to receive training that will

make them able to participate effectively and efficiently in the new scheme that will put emphasis on prevention, improved policies, rational organizational schemes, and clever adoption of new knowledge and technologies.

Keywords: *forest fires, forest fire management, fire prevention, global change, climate change*

Dendroecology: The use of tree rings in forest ecology to provide solutions to forest management

Paolo Cherubini

WSL Swiss Federal Research Institute, Birmensdorf, Switzerland

Tree rings have a tremendous power for reconstructing environmental conditions. In temperate climates, cambial activity of trees stops during the cold season and annual tree rings are formed. Tree rings have been widely used for reconstructing past climate, and can be used as indicators of the environmental (not only climatic) conditions in which trees have been growing, because their characteristics depend on the environmental conditions in which they grew. In forest ecology, tree rings have been used to infer information about tree growth, and the impact of environmental factors on it at a given site. However, tree-ring width is influenced by many environmental factors, and its analysis and interpretation needs appropriate, scientifically sound, sampling strategies, currently, unfortunately, not yet well developed.

Within a forest stand, tree rings can provide information that may help forest management in taking decisions, such as when, and to what extent, do thinnings, i.e., remove trees to improve the growth rates and vigour of the remaining trees. In dense stands, trees are under competitive stress from their neighbors, and thinning may increase the resistance and resilience of the stand to disturbances such as insect infestation, fungal disease, wildfire, snow avalanche, windstorm or drought and frost. Reading tree rings in a proper way, tree and stand age can be determined with annual resolution. Past tree-growth trends, and abrupt decreases or releases after suppression can be identified, and information on the spatiotemporal occurrence of past disturbances (natu-

ral and anthropogenic, such as thinnings and other forest management treatments), and their impact on tree growth, can be inferred for periods of time for which there are no historical records.

It is more difficult to use tree rings to assess forest stand biomass. Some attempts have been made, but almost all the studies have been subject to some form of sampling bias, e.g., usually dominant trees rather than suppressed ones are selected. Using tree rings as indicators of tree biomass accumulation through time is possible but a sampling design that deals with all these issues adequately has yet to be developed, and represents a major challenge for dendroecology.

4. Parallel sessions abstracts

4.1. (T1) Forestry Engineering, Ecosystem Management and Natural Resources Policy

Paradigm shift on forest utilization in Korea

Won Sop Shin

Chungbuk National University, Republic of South Korea

Use pattern of forest resources for people has changed from outdoor recreation to human health promotion; about 12.8 million people now visit recreation forests every year and about 61% of the total populations are aware of the effectiveness of forest healing. Background to forest healing was the strengthening scientific evidences of the effectiveness of forest healing through investment in research and development and conducting the national plans, the revision of laws in relation to forest healing policy. Forest healing policy has diverse meanings to forest owners, local residents, the public, and the government. Forest healing policy has certain limitations; healing forest construct for urban areas, more scientific evidences for forest healing effectiveness, business model for private healing forest.

Keywords: *Republic of Korea, new forest policy, forest therapy, paradigm change*

Long rotation forestry: extent for Boreal zone and special conditions for planning and design

Alexander Alekseev, Klaus v. Gadov

Saint-Petersburg State Forest Technical University, Russia

This paper describes some conditions and constraints which are characteristic for the Boreal forest ecosystems in Russia and their sustainable use. Considering possible social, economic and technological changes in any country during the past century, key economic parameters, such as timber price, cost

structure and rate of interest have become completely unpredictable. Details are presented which support the notion that net present value is not a suitable decision aid for comparing alternative long-term investments in Boreal forest ecosystems. Discounting makes it unreasonable to invest for long periods of time and may facilitate the overexploitation of a natural resource. Perhaps the only reasonable way to manage forests under such great uncertainty is to apply the sustainability principles as a basic premise. Two principles of sustainable forest design are dominant, first, the principle of inexhaustibility which ensures that it is possible to use the current forest resources in the future and, second, the principle of continuous use. For the practical implementation of the above principles a specific optimization model may be used. Forest rent, is extra income which arises due to differences in natural site conditions and transportation costs. A model is introduced which maximizes total income for a forest area subject to restrictions. Geographic information systems provide the required data for rent calculations. They contain information about the productivity of stands scheduled for harvesting, and their location relative to the transportation network. A spatial optimization of forest use offers the potential to estimate both types of forest rent, using the cost of the primal constraints in the dual formulation. An example involving Lisino training and experimental forest of Saint-Petersburg State Forest Technical University is presented to demonstrate the approach. The main focus of the paper concentrates around problems of long rotation forestry system and its characteristics; unpredictability and variability of main economic parameters for long periods of time; principles of forest resources use for long rotation forestry; models for optimization of forest resources use; forest rent as extra income arising due to differences in natural site conditions and transportation costs; GIS technology and special model for forest rent calculations.

Keywords: *long rotation forestry, forest rent, sustainable forest use, uncertainty, models of forest resources use, GIS technology*

Silvicultural conception for sustainable management of forests of Oriental hornbeam (*Carpinus orientalis* Mill.)

Yonko Dodev, Grud Popov, Ivailo Markoff, Plamen Glogov, Svetozar Madzhov

Forest Research Institute, Bulgarian Academy of Sciences, Bulgaria

The area of Oriental hornbeam forests in Bulgaria is about 200 000 ha, which is roughly 5% of the country's forest area. There is a lack of knowledge and understanding about their phytosociological characteristics and criteria for their management are greatly understated. Ecological and silvicultural characteristics of the forests of Oriental hornbeam on the territory of the South-West State Enterprise have been established. The Oriental hornbeam forests have been grouped into different types depending on their ecosystem fitting. The growth potential of Oriental hornbeam has been studied and compared with that of the edificatory tree species. Forest regeneration and natural succession processes in the separate forest types have been investigated. Based on that, a comprehensive silvicultural conception has been proposed for sustainable management of the Oriental hornbeam forests, depending on their sustainability and productivity. Specific harvesting and thinning techniques have been developed and economic evaluation has been made.

Keywords: *oriental hornbeam, ecological and silvicultural characteristics, ecosystem fitting, silvicultural systems, sustainable management*

Forestry analysis of the conditions of the environment of the Scots pine crops (*Pinus sylvestris* L.) in Kraishtensko - Ihtiman forest-growing sub-area.

Martin Georgiev

University of Forestry, Sofia, Bulgaria

The aim of the study is to clarify the natural conditions of the habitats on which the Scots pine crops in the Kraishhensko-Ihtiman sub-area have been created, with a view to properly identifying the future forestry activities for management.

Tasks: 1. Detection of spreading of Scots pine plantations in area of the study - their vertical and horizontal distribution, as well as their distribution by age.

2. Influence of habitat on growth, development and condition of crops. 3. Determination of stressful (limiting) factors for the development and existence of Scots pine crops. 4. Determination of the potential local forest-tree vegetation. In the context of the natural development of forest crops, a preliminary scheme of their development dynamics has been drawn up.

Data on statistical processing of the forestry projects of the farms situated on the territory of Kraishtensko - Ihtiman forest-growing sub-area are presented. It was found that the vast majority of crops (97%) fall in the quadrant II, zones 1, 2 and 3 and quadrant III, zones 2 and 3 according to their ecosystem compliance level. Transforming them according to their condition and productivity will vary in the different quadrants and according to the frequency of farming and other factors - altitude, exposure, gradient, natural regeneration, function.

Silvicultural strategies for emerging problems and conversion of oak forests in Turkey

Mehmet Özdemir, Hasan Büyük

Marmara Forestry Research Institute, Turkey

Oak (*Quercus* sp.) is among the most widely distributed species in Turkey. Most of these forests originate from shoots and were managed as coppice until 2006. Process of conversion to high-stem forest for these areas was launched especially in the west of the country. Now, thinning is only carried out in these areas. But, various problems have been encountered, such as reduction in fungi and pasturage, sudden peak dryness, deaths. This situation creates concern on villagers for the future of forests. The forest administration started to search for solutions to these problems. For these aims, it was decided to monitor these forests to develop strategies for the future. Firstly, some specific research areas were selected considering area and stand characteristics in the region of Thrace. Some data has begun to be obtained up to now. The causes of emerging problems will be searched and solution ways will be developed. Variables like seed resources for early natural regeneration, time of drying and competition of trees will be examined. Achieved results and carried out experiments will be contribute to the management of oak areas.

Keywords: *oak, conversion, problems, Turkey*

Forest and rangeland management using indigenous ecological knowledge, a case study of Barzok district, Iran

Ali Hamidian

University of Tehran, Iran

Rural sustainable development depends on two concepts: natural resources management and rural community or human-nature interactions. These social interactions not only indicate indigenous ecological knowledge but also demonstrate cooperative methods and participation in rural community. The role of traditional knowledge and cooperation is well-known to anyone involved so that more cooperative communities have more chance to achieve sustainable development. In this study we have used direct observation method with qualitative and face to face interview with target groups include farmers, pastoralists, and shepherds of Barzok district of Iran. The results showed that, in this village like other Iranian villages, there are several customary mechanisms in natural resources management. The customary laws are reflected from rural ecological knowledge and have demonstrated their usefulness during thousands of years. As this knowledge has been examined during several decades of rural life, it's the most sustainable method to utilize natural resources also as the cultures developed, rural communities have established social networks because of their common needs. Unfortunately this traditional culture had forgotten because of changes in natural resources ownership. This is remarkable that although this mechanism no longer exists but it can be used as a cultural and social potential in natural resources sustainable planning and policy.

Keywords: *indigenous ecological knowledge, sustainable development, cooperative management, socio-economic needs, rural community*

Essential oils from coniferous species in Bulgaria

Maria Stoyanova

Forest Research Institute, Bulgarian Academy of Sciences, Bulgaria

The complex and rational utilization of forest resources includes also the use of wood after felling as well as green parts of the trees (branches with leaves – twigs) for producing essential oils, vitamins etc. Essential oils with their bactericidal action and their role to purify the air from pathogenic microorganisms are used in perfumery, pharmacy and other productions.

Seasonal dynamics of the content of essential oil from twigs of Scots pine (*Pinus sylvestris* L.), Austrian black pine (*Pinus nigra* Arn.), Norway spruce (*Picea abies* (L.) Karst.), silver fir (*Abies alba* Mill.), common juniper (*Juniperus communis* L.) is studied in this work. It was established that the oils from the species of genus *Pinus* are with maximum in autumn-winter, while the oil from juniper twigs has maximum at the end of summer and in autumn. Juniper berries (cones, fruits) have highest content at the end of autumn and early winter. This is the most suitable time for collecting them as raw material for medicinal and other purposes.

The main components in the oil content are the turpentine hydrocarbonates – mainly α - and β - pinene, Camfene etc. High content of α -pinene is determined in oils of Black pine (69.55%), Scots pine (42.20%), Silver fir (20.06%). With relatively lower content of α -pinene is the oil obtained from Norway spruce – 6.98%. In the oil of Silver fir the highest content of β -pinene was established – 27.46%. From the studied species from genus *Pinus* the lowest content of β -pinene is determined in spruce oil – 3.52%.

The dominating group in oils from Common juniper are monoturpentine α -pinene and β -pinene. The content of α -pinene in the oil from juniper berries is 60.82%, while in the oil from twigs it is 25.12%. The β -pinene is 13.57% in juniper berries and 27.46% in the twigs, respectively. The content of bornilacetate is highest in the twigs of spruce – 22.27%, and with similar parameters are the oils of the Silver fir and Black pine (5.31% for the Black pine and 6.30% for the Silver fir). With low content of bornilacetate are the oils obtained from raw materials of juniper. From the performed characteristics of oils obtained from some of the coniferous species it could be concluded that

they are valuable material and their utilization could increase the effectiveness of forestry activity, especially in mountain regions through providing additional jobs for local population.

Keywords: *twigs, essential oils, coniferous species*

General regularities in the height structure of Hungarian-oak, durmast and cerris oak dendrocoenoses

Rumen Petrin

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The height structures of natural relatively even-aged Hungarian-oak, durmast and cerris oak dendrocoenoses of the regions of Staro Oryahovo, Serba, Tso-nevo and Aytos State Forest Enterprises have been studied and presented in this paper. A total of 90 sample plots have been laid-out, 40 of these being in Hungarian-oak dendrocoenoses, 48 – in Durmast ones, and 2 – in cerris oak ones. The ages of all the dendrocoenoses are within the range from 12 to 155 years. Their heights vary from 6 to 28 meters, and their spacing indices are mainly within the range from 70% to 90%.

The purpose of the investigation was to analyze the height structures of the natural dendrocoenoses of the three tree species in terms of finding out general regularities. For investigating the performance of the curves and, in particular, their steepness to the abscissa, Douhovnikov's method of natural indicators, developed in the Bulgarian Forest Mensuration, was applied. The availability of three groups of curves according to steepness levels has been found for the investigated tree species, namely: inclined curves, characteristic of dendrocoenoses of zero natural indicator (ZNI) $SH_{o,n} \geq 1.1$; semi-steep curves, of ZNI within the range of $0.86 \leq SH_{o,n} \leq 1.09$; and steep curves of ZNI $SH_{o,n} \leq 0.85$. Hungarian oak's and Durmast's distributions according to steepness types have been investigated in two scenarios – separately and together, while using a separate and a common curve of normal numbers, respectively, through the natural indicators method. While investigating the distributions of the studied curves, a general tendency was found out as to steepness types in both scenarios. This gives a certain reason for investigating together the height structures of the dendrocoenoses of Hungarian oak and Durmast, regardless of the

tree species. And this inference was confirmed while comparing the curves of the normal numbers for Hungarian oak, durmast and cerris oak with Tyurin's uniform average curve of relative heights, by means of the Willcoxon test. A statistically significant great proximity in their forms was found. As the uniform average curve of relative heights has been established for all tree species, this proximity shows a possibility of creating general average curves of orders for the heights of seed-tree Hungarian oak, durmast and cerris oak.

Keywords: *Hungarian-oak, Durmast and cerris oak dendrocoenoses, height structure, natural indicators, steepness of curves*

Mechanized timber harvest in declined pine plantations

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¹Forest Research Institute, Bulgarian Academy of Sciences, Bulgaria

²„MINA“ Ltd., Bulgaria

The technology of harvesting in declined pine plantations with 3 different harvesters has been studied. The productivity of the wheeled harvesters Valmet 911 and HSM 208F and the track excavator Caterpillar with a harvester head Woody 50 were compared to the productivity of motor-manual timber harvest with a chain saw Stihl 180. Timber has been extracted with the Valmet 1110 forwarder. Operation level time studies have been made. The system Valmet 911 harvester with a Valmet 1110 forwarder has achieved a daily production of 72 m³ 2 m-logs or 100 m³ 4m-logs. The chain-saw operator has achieved 9.8 to 12.4 m³ per day. An analysis of the working conditions of the machines has been carried out and recommendations have been formulated to the logging companies regarding the purchase of logging equipment.

Keywords: *harvester, harwarder, track excavator, productivity*

Exploitation research of machine for loading of wood

Kiril Stefanov, Konstantin Marinov, Dimitar Peev, Dimitar Georgiev

University of Forestry, Sofia, Bulgaria

The machinery and technologies, applied in the timber industry are analyzed. The used machines for loading of temporary forest warehouses are studied. Results obtained from the survey show the possibilities of the machine when working on the transverse and longitudinal slope. From the survey results were obtained for the possibilities of the machine when working on the transverse and longitudinal slope. Actual performance of telescopic handler is obtained by timing of individual technological operations.

Keywords: *telescopic loader, forest warehouse, productivity*

Requirements for diagnostic parameters for determining the technical condition of machinery

Svetozar Madzhov, Yonko Dodev, Grud Popov, Plamen Glogov

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To increase the efficiency of the use of the technique in forestry and wood-producing companies, individual information on their technical condition is needed before and after servicing, repairing and during operation. A means of obtaining such information is the technical diagnostics of the machines. Diagnostic parameters should be sensitive, unambiguous, stable and informative.

Keywords: *technical diagnostics, diagnostic parameters*

Operational performance of forestry milling brush cutters for poplar clearings cleaning

Konstantin Marinov, Kiril Stefanov

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The forestry milling brush-cutters are being used more and more for the clearing of forest clearings in a number of European countries. This process has already been in place in our country over the last 5 years. The implementation of this type of machinery leads to a more complete and environmentally friendly use of biological resources and areas for afforestation. It also leads to limiting the risk of forest fires and improving of the sanitary conditions of the forest plantations. There are several forestry mulchers and two multifunctional forestry milling machines in operation in our country currently for the purpose of preparing the forest areas for poplar and other intensive plantations establishment. Results from the survey of the operation of a multifunctional forestry tiller (mulcher) PT-400 for cleaning of poplar slashes from standing and lying wood biomass for poplar plantations establishment are presented in this study. The study was conducted in poplar clearings along the Danube river, habitat type D_{2,3}. The operating and shift performance of the forestry aggregate under various modes and operating conditions have been defined. There have been established functional dependencies and models for determining the operating productivity of the bush-cutter, based on the working conditions and the speed modes.

Keywords: *poplar plantations, forest clearings, multifunctional forestry tiller*

Particle size and quality of wood chips from Scots pine (*Pinus sylvestris* L.) wood, yielded with mobile chippers

Dimitar Peev

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In this article, was made an analysis on particle size of wood chips, to check how the different power of the cutting machine engine affects the quality of the chips for the individual industries. Were taken samples obtained by mobile chippers from different locations in the country. Were used machines with

different engine power in the range of 20 to 60 kW, equipped with disc or drum chippers driven by both the own engine and the PTO on a tractor. The wood that was used for chipping, had the same size in all the experiments. It was divided into lengths and diameters of individual groups of materials. The experiments were conducted with fresh, lightweight small-scale wood, grouped into nine groups of materials. The samples taken from each group of materials were based on two standards: BSS 8586:1989 – Wood chips for pulp production and 8587:1976 – Wood chips for particleboard and fiberboard. After the laboratory testing of the samples, their particle size was determined as a percentage distribution and established the intended use of the particular machine.

Keywords: *wood chips, particle size, chippers*

Chipping of biomass from urban areas with small wood chippers

Sotir Glushkov¹, Emilia Velizarova², Stefan Stoyanov³, Vassil Chakarov¹,
Ivailo Markoff¹, Vanya Tringovska⁴

¹*Forest Research Institute, Bulgarian Academy of Sciences, Bulgaria*

²*Executive Environment Agency, Sofia, Bulgaria*

³*„MINA“ Ltd., Bulgaria*

⁴*Maritsa Vegetable Crops Research Institute, Plovdiv, Bulgaria*

Much of the small wood chippers available on the Bulgarian market produce biofuel from woodworking or logging waste that meets the requirements of the European CEN/TS 335 standard. For the present study, four wood chippers most commonly used in Bulgaria for small amounts of energy chips have been selected. The fractional composition of the wood particles and the moisture content of the chips have been investigated. Methods consistent with the relevant European methodology have been used. The chippers performance and the conformity of the produced chips to the European standards have been determined. The operator safety conditions have been assessed, taking into account noise and ergonomics. The factors determining productivity of chipping and quality of the chips have been determined – the diameter and the density of the materials.

Keywords: *urban parks, biomass, choppers, chips, standard*

Thickness structure of Macedonian pine (*Pinus peuce* Gris.) plantations growing in the Vitosha Mountain

Hristo Tsakov, Angel Ferezliev, Alexander Delkov, Hristina Hristova

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The basic material for the study has been collected in the region of the mountain hut Aleko in the area Brezovitsa in the Vitosha mountain in a part of the Macedonian pine plantations out of the species natural habitat established in 1934 on a north-eastern slope at an altitude 1650 m a.s.l. The thickness structure of the studied Macedonian pine plantations differs from this one of the pure natural stands established by Tyurin in 1931. For the Macedonian pine plantations the variation curve is with a wider interval with 0.2 points (from 0.3 to 1.7) and with more clearly expressed maximum at the average diameter (15.8%) compensated with higher representation of the thin trees to natural levels of thickness 0.7 and in the range of the thicker ones from 1.1 to 1.7.

The χ^2 method is suitable for the following of the differences between the compared levels of the variation curves of the Macedonian pine stands. The table values of χ^2 , relating to a level of significance $P=5.0\%$ are several times bigger which shows insignificant differences between the studied rows and the variation curves can be successfully compared. At the studied Macedonian pine plantations the rule of Weisse (1880) is not valid. It is recommended to be used the established percentage 51.3 or its round value 50% from the thin trees and not its 57.8% value.

Keywords: *thickness structure, Macedonian pine plantations, variation curve, rule of Weisse*

Comparative study of the height and volume structure of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) forest plantations in State Forestry Alabak, Velingrad

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Comparative study on the variation curves of height and volume distribution in mid-aged Douglas-fir plantations, established after mid-20th century in State Forestry Alabak - Velingrad was carried out. The plantations are located at different altitudes and various forestry activities were conducted in them. Their mean height curves and the common height curve of Tyurin are compared. They, in the tended sample plots, are close to each other and, although varying in wide interval, they are closer to the common variation curve than to the variation in the untended plot. Curves and straight lines of the masses are built and they are recommended for use during cubic measurement of middle-aged plantations dominated by Douglas-fir and other similar tree stands, at higher altitudes.

Keywords: *variation curves for height and volume distribution, height and volume structure, forest plantations, Douglas-fir*

Growth tables of oak in Bulgaria

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The oak growth tables known in Bulgaria were compared to the actual distribution of the area of oak stands by age and tree height, as determined by the data bank of the forest stands. It was found that the foreign tables of Wimmenauer (for high forests of oak) and of Schustov (for oak coppices) were inadequate. On the contrary, the local tables of Nedyalkov and Sirakov are in good agreement with the actual distribution of the area by age and height and should be recommended for use.

The Shustov table is characterized by incorrect curve behavior and can be considered a misconception. The Wimmenauer table is a more interesting case. It is quite old, but it is in good agreement with the modern German table of Jüttner, at least in terms of height growth and is certainly adequate for Germany. For Bulgaria, it is not adequate for ages higher than 60, because in this range its curves do not pass where our empirical points are. On the contrary, the local table of Nedyalkov is in good agreement with the local data. Moreover, the Nedyalkov table is in good agreement with the Armaşescu oak table of Romania. This relationships suggest local peculiarities in oak growth as explanation: on the Balkan Peninsula, oak growth in height is inhibited early, while in Central Europe the growth in height continues to a high age.

Keywords: *growing stock, yield and growth*

Structure and stocking control of uneven-aged coniferous stands in Bulgaria

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This paper presents stand structure and some stocking control approaches of uneven-aged coniferous stands. In Bulgarian forestry even-aged forest management prevails on silvicultural practices. Uneven-aged silviculture started in early 1930's when the Biolley control method was applied in forest management plan of „Chamkoria“ state forest. There is a relatively little knowledge of uneven-aged compared to large amount of forest research related to even-aged forest management.

The horizontal stand structure of uneven-aged stands traditionally is described by diameter distribution. Data is obtained from natural stands and plantations located in Rila and West Rhodopes mountains. Reverse sigmoid, Weibull, reverse-J probability density functions are tested for fit. Two stocking control methods are applied for optimization of uneven-aged regulation and several silvicultural guidelines are proposed for conversion from even-aged to uneven-aged management.

Keywords: *Norway spruce, Silver fir, diameter distribution, forest management*

Horizontal structure and peculiarities in diameter structure of *Fagus moesiaca* (Maly) Czecz. plantations in Shumensko plateau

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The horizontal structure of two *Fagus moesica* (Maly) Czecz. plantations growing within the borders of High Shumensko plateau was investigated using the software Stand Visualization System (SVS) presenting graphically the stands according previously made model in Microsoft Excel. Comparative studies on variations curves of stem diameters according natural thickness levels were carried out. Peculiarities found in the diameter structure have their own characteristics and contribute to the investigation of sortiment structure of the stands studied. The place (rank) of the mean diameter tree was established and this is in the base of the practical instructions related with the usage of widely applied in the practice Waise rule and investigation of the rank effects caused by thinnings.

Keywords: *horizontal structure, diameter structure, variations curves of diameter distribution, Fagus moesiaca (Maly) Czecz. stands*

Optimal rotation ages of coppice oak stands in Bulgaria

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In last two decades a problem for determination of optimal rotation ages when considering not only wood production but carbon uptake has had big importance. The coppice stands in Bulgaria occupy approximately 47% of the forest area. The biggest part of it consists of species of genus *Quercus* which are managed by two silvicultural systems: traditional coppicing and conversion from coppice to high forest. The aim of this paper is to propose optimal rotation ages based on biological and technical maturity for two types of coppice oak stands: for compulsory conversion to high forest and for mixed coppice-seed management. Based on data obtained from forest management plans and temporary sample plots we propose different rotation ages from official regu-

lations for main oak species and recommend some guidelines for forest management of coppice oak stands.

Keywords: *biological maturity, conversion, silvicultural systems, coppice, high forest*

Climate change and its impact on the oak coppices in North Central Bulgaria

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Raev et al. (2011) predict the emergence and expansion of a new climatic zone in the plains of Bulgaria – the steppe, with de Martonne's index below 20. It will be characterized by a persistent deficiency in humidity, leading the forests to decaying and transition into grass-shrub communities. On the territory of the North Central State Enterprise, 57% of the oak coppices fall within this zone. Furthermore, our studies on their root system have found that they have lost their central root. This makes them particularly vulnerable to the climate change. This study is aimed at seeking silvicultural systems to create stable dendrocenoses and to preserve the endangered forests.

Keywords: *oak coppices, climate change, de Martonne's aridity index, stability*

The use of sampling techniques to improve traditional inventories in Bulgaria, first steps and prospects

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In the 50s, all Bulgarian forests were inventoried and covered by management plans. One of the consequences of this was the abandon of sampling methods which were considered dubious and less informative. However, later on it was recognized that traditional inventory data are biased. By the end of the 80s, GDR introduced again some sampling methods in order to eliminate the systematical errors in its data bank of the forest stands.

The present paper reports the results of an experiment sample plot measurement in the State Forest District Borovo in the Western Rhodopes aiming to determine and to eliminate the systematic error of growing stock.

Keywords: *systematic error; bias elimination*

Toward sustainable management of Miankaleh Biosphere Reserve

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In recent decade, human activities had endangered the environment and natural resources. It caused to irreparable effects on the planet. Therefore many concepts are presented, once is Cooperation. Social cooperation especially in recent decades has become an intellectual and ethical indispensability and also one of the most important variables of sustainable development. But unfortunately in Iran, this concept is neglected in development programs, whereas Iranian has a really rich cooperative potential. Ignorance of this concept had led to several social, economical and also environmental crises. This study illustrates how social conflicts affect on environmental problems in Miankaleh biosphere reserve. Miankaleh region is located in Māzandarān Province in the north of Iran. Overgrazing, illegal uses, land use changes, soil and water erosion and land cover destruction are reported as ecological and environmental problems in the study area. According to the results human activities are the main factors triggering environmental crises in this vulnerable area. These activities are many and vary by land use strategy and technologies applied. This research concluded lack of cooperation and also social conflicts had been resulted in environmental challenges. The results also demonstrated that the impact of human society does not depend solely on its density. In the study area, there were many traditional methods for pasture management; this indigenous ecological knowledge is forgotten. Also the results showed that, ignorance of cooperative opportunities and local organization had led to decreasing of local participation in wildlife preservation and conservation plans. Therefore this is necessary to reconsider in social and cooperative networks and also indigenous ecological knowledge of local people in Miankaleh biosphere reserve to prevent mentioned environmental crises.

Keywords: *environmental crisis, biosphere reserve, sustainable development, social problems*

Phytomass and mortmass assessment in pine forests of left bank forest steppe of Ukraine

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In the context of global climate change, the sustainable use of forest resources becomes of particular relevance, which is possible only with a comprehensive assessment of all components of forest ecosystems. At present, complex research on phytomass and mortmass of pine forests in Ukraine has been carried out in a limited extent. Hence, it is important to assess the quantitative and qualitative indices of phytomass and mortmass of forest stands. The Scots pine forests of the Left Bank Forest Steppe occupy an area of over 190 thousand hectares and perform important ecological functions. For the study, observations on 40 monitoring and inventory plots were used. On the plots, indicators of the main components of forest ecosystems were determined. The threshold of live trees minimal diameter is 8 cm, coarse woody debris is 7 cm. The density of wood was determined by the decomposition stages. The plots represented the main types of forest site conditions, productivity of Ia-II classes, age 40 to 120 years. The data was analyzed by productivity classes and types of forest vegetation conditions. The phytomass stock varies from 60 to 360 tons per hectare; maximum of the mortmass of dead trees is 13, and the coarse woody debris – 17 tons per hectare. The diversity of dead wood by species composition is very low, it is represented predominantly by Scots pine (*Pinus silvestris* L.), which is related to forest stands composition. The diversity of the coarse woody debris by the decomposition stages was rather high, both by the representation of different stages of decomposition and amount by stages. The average share of the stock of dead trees and coarse woody debris from the growing stock in bark is 8.8% and 9.4% respectively. The average stage of decomposition is 2.6. About 1.2 and 1.5 tonnes of carbon per hectare are stored in dead trees and coarse woody debris of pine forests, which amounts about 2.4% of the carbon stock in the pine forest biomass reservoir. The obtained results testify to the comparatively insignificant role of deadwood in carbon deposition of pine forests of the Left-Bank Forest-Steppe of Ukraine.

Keywords: coarse woody debris, dead trees, pine forest

Productivity of the Forest Landscapes in the Region of Kraiste between Rivers Bistritsa and Konska

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Productivity of the landscapes is one of the basic parameter of the landscapes. It is representative for the parameters of the landscapes and gives opportunity for evaluation of the potential of the landscapes. The region of Kraiste is situated in western Bulgaria and it is one of the poorest regions in Bulgaria. The investigation of the landscape diversity and present potential of the landscapes is key element in the process of sustainable development of the region and changing of the economical situation. The research includes two general levels. The first level is related with determination of the general landscape units. The second part consists estimation of the productivity of the landscape based of plant productivity in different landscape units.

Keywords: *landscape, productivity*

European experience in managing of coppice with standards and its prospects in Bulgaria

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Experience of different European countries in application of coppice with standards has been studied – incl. essence of this silvicultural system, forestry aims, the most commonly used tree species, methods and stages for creation of coppice with standards forests, shape, structure and characteristics of stands, harvesting age, guidelines for management. Prospects for introducing of coppice with standards in Bulgaria are analyzed. The coppice with standards is recommended as a system for sustainable management of oak coppice forests, as well as an approach for their transformation into high forests. Estimate of incomes from coppice with oak standards in Bulgaria is made. In term of eco-

nomie efficiency, it occupies an intermediate position between simple coppice and high forests, striking a good balance between the ecological, social and economic forest functions.

Keywords: *coppice with standards, oak coppice, silvicultural systems, sustainable management, economic efficiency*

Thickness structure of seed-tree Hungarian-oak, durmast and cerris oak dendrocoenoses

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The thickness structures of natural, relatively even-aged Hungarian-oak, durmast and cerris oak dendrocoenoses of the regions of Staro Oryahovo, Serba, Tso-nevo and Aytos Forest Estates have been studied and presented in this paper. The investigation has been carried out on the basis of 105 sample plots, 59 of these being in Hungarian-oak dendrocoenoses, 43 – in durmast ones, and 3 – in cerris oak ones. The ages of all the dendrocoenoses are within the range from 12 to 155 years. Their heights vary from 6 to 28 metres, and their spacing indices are mainly within the range from 70% to 90%.

The purpose of the investigation was to study the curves of the distribution of the numbers of trees according to thickness levels, in terms of the curve's forms, as well as to look for general regularities. The thickness-level curves of the Hungarian-oak, durmast and cerris oak dendrocoenoses were investigated for finding their asymmetries in terms of the average diameter. As a result of the comparative studies of the obtained curves, as to how they correspond to the respective natural indicators, it has been confirmed what was found out during previous investigations, namely: curves of right-hand-side asymmetry and zero natural indicator $SNo \leq 0.85$; curves of left-hand-side asymmetry and $SNo \geq 1.16$; and curves of symmetric type - SNo within the range from 0.86 to 1.15. It has been found out that the distribution of the numbers of sample plots, respectively of the thickness-structure curves, according to their symmetry for the three groups investigated in two scenarios – separately and together – is similar. The stands of right-hand-side asymmetry dominate, next followed by the stands of left-hand-side asymmetry. The average curves of the normal numbers (qx_{av}) have been calculated through the natural indicators method, for the three investigated groups, and these curves

have been compared with Tyurin's uniform average curve of normal numbers (This curve pertains to all tree species.). The three average curves of normal numbers qxav – for seed-tree Hungarian-oak, durmast and cerris oak dendrocoenoses – are statistically close to Tyurin's curve, which proves the possibilities of studying together the thickness structures of the three tree species and of probable composing of general models of the volumes and the assortment structures.

Keywords: *Hungarian-oak, durmast and cerris oak dendrocoenoses, thickness structure, symmetry of curves according to thickness structure, average curves of normal numbers*

Damages to beech forests caused by timber harvesting on the territory of Berkovitsa State Forestry

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In Bulgaria, regeneration of beech forests is implemented through naturally growing seedlings. There is an increase in the damages done to the soil, remaining trees and seedlings after wood extraction and timber harvesting due to the increased implementation of mechanization processes. The mechanical injuries on the stems of young seedlings are entrance for pathogenic fungi attacks, timber decay or inferior quality that could compromise the whole process of regeneration. The mechanized extraction by forwarders resulted in damages to the soil as well as the root system of the remaining mature trees. In beech forests located in Berkovitsa State Forestry, nine round test stands (area of 3.14 m²), were situated in a grid, and seedlings were classified by measurement of height and quality characteristics before and after harvesting. After harvesting, the seedlings were classified according to the degree of damages and vitality. Wounded seedlings with symptoms of necrotic disease were collected and *Neonectria coccinea* was established as a pathogenic causer of necrotic disease. Certain physical and water-physical parameters were investigated. Deviations in the bulk density and total porosity of the soil were ascertained.

Keywords: *logging, beech forest, seedling, harvesting, pathogens*

4.2. (T2) Forests, Soil and Water Interactions

Soil water retention properties of forest soils under different land-use

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Soil water retention properties of Eutric Leptic Cambisols Ochric, Dystric Cambisols Ochric and Dystric Cambisols Humic (WRB 2015) under different landuse (herbaceous, deciduous and coniferous vegetation) were obtained by procedures similar to those described in ISO 11274:1998. The analyses were performed on undisturbed and disturbed soil samples taken from 12 surface (0-5 cm) and 10 subsurface (10-25 cm) soil layers from 12 soil profiles in the experimental stations of the Forest Research Institute in Gabra (4 sites), Govedartzi (3 sites) and Igralishte (5 sites). The soil water retention curves were plotted using 7 different suctions. A correction for the skeleton was applied for points at pF 4.2 (Wilting Point) and pF 5.6 (Hygroscopic water content) which were determined on fine earth samples. The values of soil water retention at suctions lower than pF 2.5 (Field Capacity) varied significantly among the studied sites. The water content retained at pF 2.5 varied from 6.9 to 60.6%. The influence of total soil organic carbon content (SOC) on water retention was quantified by regression equations. SOC varied from 0.32 to 6.79% depending on vegetation type, altitude and degree of soil erosion. The increase of clay in surface layer of strongly eroded soil (Eutric Leptic Cambisols Ochric) under grassland sites in Gabra station also increase the water retention capacity. The obtained information for water retention characteristics of the studied shallow soils can be applied in other studies dialing with soil water and heat balances.

C and N cycling in the forest floor under 7 tree species

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Plantation of coniferous stands with high production potentials has been a common European afforestation strategy. However, negative impacts leading to poor ecological soil conditions, a predisposition to insect attacks and storm events, as well as questions on their adaptability to climate change have led to serious concerns about the future of coniferous monocultures. An increasingly accepted management strategy is to restore broadleaved forests or to establish mixed stands. Such changes in forest management require specific information on the impact of tree species on nutrient cycling. In this study, we investigated the influence of common alder (*Alnus glutinosa* (L.) Gaertn.), European beech (*Fagus sylvatica* L.), pedunculate oak (*Quercus robur* L.), silver birch (*Betula pendula* Roth.), goat willow (*Salix caprea* L.), rowan (*Sorbus aucuparia* L.) and Norway spruce (*Picea abies* (L.) Karst.) on soil chemistry, soil microbial biomass and microbial activities related to C (basal respiration) and N cycling (N mineralization and potential nitrification), 11 years after conversion from a Norway spruce monoculture. The study was performed in the Haute Ardenne, south-eastern Belgium in 2009. Soil samples of the forest floor (Of and Oh layers) were taken under each broadleaved tree and each young spruce and open areas. Forest floor chemistry was improved under pioneer species such as rowan and birch through increasing soil pH and soil exchangeable cations. Net N mineralisation rates were not influenced by tree species. Nitrification was increased under the N₂ fixing alder. We found that C:N ratio to be a good indicator of potential nitrification rates, with a threshold of a C:N ratio of 10 above which soils did not nitrify or nitrification rate were extremely low. Our study demonstrate, through a change in tree species composition on poor, acid soils, relatively rapid positive changes may be obtained with regard to soil quality.

Keywords: broadleaved forests, forest soil, soil microbial activities, soil chemical properties, Haute Ardenne Belgium

Carbon storage in soils from Pleven district regarding the level of anthropogenic pressure

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Among the 28 soil groups defined by FAO (WRB, 2014), 20 are present in Bulgaria. The process of urbanization creates urban ecosystems and urbanized soils, which results in modified characteristics and properties of the most distributed soils - Chromic Luvisols, Chernosems, Haplic Luvisols, Distric Cambisols and Vertisols. The soils of green spaces in cities, towns and brownfields are referred to Anthrosols and Technosols in WRB. The carbon storage in superficial soil layers is one of the main indicators, which is quite informative and describes the overall condition in urban, peri-urban and natural ecosystems. The soils from Plevel region were studied regarding the level of anthropogenic impact and main soil characteristics related to the indicator „carbon storage“ of these soils were analysed. The values obtained were differentiated according to the 0-5 scoring scale. Based on the results an assessment was performed and maps in GIS were generated. The „carbon storage“ for the soils from Pleven region is predominantly referred to scores 3 and 4, which indicates a medium to good condition of this ecosystem component. The spatial variability in „carbon storage“ indicator of naturally distributed soils is mainly result of the special features of each soil type and its characteristics. Differences were indicated due to a higher anthropogenic pressure for the soils in the region of Cherven bryag and degradation processes were established for the Anthrosols in Park Skobelev in Pleven city. The „very good“ condition was defined for the alluvial soils in the region of Nikopol. For the urbanized green spaces in Pleven district it could be concluded, that anthropogenic pressure has resulted in formation of Haplic Anthrosols, which have characteristics of the initial taxonomic soil unit according to the basic classification of soils in Bulgaria (Penkov et al., 1992) with modifications of the combined effect of a partially destroyed soil profile and changed composition and properties of superficial layer of adjacent naturally distributed soils.

Keywords: *soil carbon storage, condition assessment, regional scale, mapping*

Assessing the high ozone levels over the forest area of Biga peninsula in Turkey

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Specifically, in rural areas surface ozone cause significant influences on forest and agricultural areas. Biga Peninsula located in the south part of the Marmara region of Turkey is one of the regions where high ozone levels are determined by the expansion of the air quality network in rural areas. The region consists of mountainous and rugged lands at the altitudes up to 725 meters and the dominant tree species in the region consists of red pine, *Pinus nigra* and olive.

The aim of the study is to describe the atmospheric conditions leading to the ozone episodes in the Peninsula. To identify and characterize the ozone episodes, O_3 and NO_2 concentrations measured by 10 passive samplers and two air quality stations between 2013 and 2015 are used. The results show that mountainous areas covering forests have higher cumulative exposure to ozone than the nearby locations. Moreover, AOT40 (Accumulated hourly O_3 concentrations Over a Threshold of 40 ppb) cumulative index was calculated using daytime hourly measurements. The AOT40 results indicate that the ozone values in the study area are much higher than the critical levels for local trees based on EU Directive 2008/50/EC. This may be attributed to the harmful effect of ozone exposure occurred on the local crops and forests in the Biga Peninsula. Additionally, the atmospheric trajectory model (HYSPLIT) is employed to examine the atmospheric transport patterns associated with elevated ozone levels in the study area. To identify the episodes, the HYSPLIT Model driven by the WRF mesoscale meteorological model output is used. This analysis was completed with 3-day backward air mass trajectories to assess the contribution of long-range transport resulting in the following main routes: İstanbul, Eastern Europe, and Western Russia. The most episodes were caused by local photochemical production and accumulation, and transport of pollutants from the highly polluted regions.

Keywords: Turkey, Biga Peninsula, HYSPLIT, WRF, O_3 , NO_2 , AOT40

Analysis of competitive interactions between undergrowth and ground layer vegetation in pine forests of the European part of Russia

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The importance of studying the functioning of forest ecosystems is determined by their global importance for the biosphere. The most important indicator of the sustainable development of forest ecosystems is the successful forest regeneration. This process is longstandin and depends on many factors, such as the quantity and quality of seeds and environmental conditions, e.g. light, moisture and temperature of soil and litter, soil fertility and aerationsoil, micro-relief, and others. The ground layer vegetationis one of the leading factors affecting the process of forest regeneration, seed germination, and development of seedlings under the canopy of the stand and on cutting areas. The purpose of our work is to collect data for the modeling and prognostic assessmentof seed regeneration of stands taking into account the competition with ground layer vegetation and heterogeneity of the habitat characteristics. We established 10 sampling plots in the pine forests of the Moscow Region. Each sampling plot was of 4x4 meters, with the presence of undergrowth in the center, and ground layer vegetation presented on the periphery. We conducted mapping of plants, and leveling microrelief, along with measurement of the moisture litter and mineral soil on 5 cm grid. The relative illumination and concentration of nitrogen and carbon in litter and mineral soil were measured on 50 cm grid. The measurement of carbon and nitrogen concentrations in litter and mineral soil was carried out on a CHN analyzer. On the basis of the data obtained, we will carry out the parametrization of the block of dynamics of nutrients of the CAMPUS model.

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Keywords: concurency, young trees, ground vegetation layer, ecological modeling

Urban green infrastructure for climate change adaptation: an integrated assessment of the regulating ecosystem services in Karlovo, Bulgaria

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The urban green infrastructure provides various valuable regulating ecosystem services in respect of bough global climate regulation by reduction of greenhouse gas concentrations (carbon storage and sequestration), which contribute for the climate change mitigation and services like regulation of air flows and atmospheric risks, water flow maintenance and flood protection, micro and regional climate regulation and improvement of air and water quality, which provide various options for adaptation of urban areas to the impact of climate change. Most of the adaptation measures in the cities depend mainly on the particular urban planning solutions and public regulations. The efficiency of those solutions, and of the urban adaptation policy as general, require much better understanding of the potential of green infrastructure to contribute to these processes. In this study we present an method for assessment of the synergies and trade-offs between the ecosystems services related to climate change adaptation using Integrated Ecosystem Assessment framework and analysis of broad range of published studies providing empirical evident for some of them. The results show that the multiple adaptation benefits of urban green infrastructure dominate over the trade-offs. It is matter of urban management and planning to use the full capacity of green infrastructure as a powerful measure for adaptation to climate change in urban areas.

Keywords: *Green Infrastructure (GI), Climate Change Adaptation, Integrated Ecosystem Services Assessment (IEA)*

Integrated approach for mapping the capacity of ecosystems to mediate toxic elements in forests

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A sound body of literature exists on the interactions in the soil-plant system that sets a basis for many practical and scientific questions regarding forest management and protection. It is generally accepted that forest vegetation improves the ecological quality and enhances the human well-being. To date, the knowledge about the transfer of toxic elements in that system has been derived from field surveys and laboratory analysis of soil samples. The ecological integrity of the forest ecosystems with focus on the relationship between the forest landscape components is critical for the regulating functions of forests to absorb pollutants and to reduce the impact of toxic elements.

This work is part of the research project InForEco (NSF DM16/5, 20.12.2017), funded by the National Science Fund – Ministry of Education and Science (Bulgaria). The purpose of this paper is to present a tentative methodological approach in generating maps of the capacity of forests from Central Stara Planina Mountain to provide certain ecosystem service (ES) by synthesizing a comprehensive database of soil analysis and topo-climatic properties while analysing the transfer of potentially toxic elements (PTEs) into the soil-plant system.

In our study, we integrated the ES concept into the analysis of the capacity of forest ecosystems to reduce the impact of PTEs. Firstly, we have identified the major forest types by applying GIS analysis. To investigate the soil properties and transfer of PTEs, different sites from the representing region of Beklemeto were sampled and analysed per components. Later, information and data about the forest ecosystems state, and land cover was compiled into an inclusive geo-spatial database. After performing soil sampling and integrated analysis within the ES concept, the level of PTEs concentration allows to present the potential of each forest type to reduce the impact of PTEs and to provide related ecosystem service.

Keywords: *forests, PTEs, ecosystem services, geo-spatial analysis, mapping*

Functional attributes of planted woody species on coal mine spoil for ecological restoration in a dry tropical environment, India: An implication for C management in a changing environment

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Due to mining operation significant areas of land are degraded and existing ecosystems replaced by undesirable waste materials in the form of dumps or mine spoil with low concentration of C, N and P nutrients. Therefore, the primary aim was to rehabilitate the soil component by planting certain desirable plant species as well as counteracting emission of CO₂ to the atmosphere. Thus, present study was conducted on young plantations of four native species (*Albizia lebbeck*, *Albizia procera*, *Tectona grandis* and *Dendrocalamus strictus*) raised on mine spoil.

We examined both component of the ecosystem (plant and soil); from soil part, total SOC (soil organic carbon) and their accumulation rates in deferent soil depth, bulk density, WHC, and microbial biomass C were analyzed. Whereas from plants; total plant biomass production and standing state of C nutrient stock in different plant components were estimated at ages 3, 4, 5 and 6 years respectively.

The soil bulk density, SOC and accumulation rates at 0-10 and 10-20 cm soil depth were significantly varied among plantations, therefore, nutrient stock C (kg ha⁻¹) was also varied in the corresponding way but values were substantially low in the plantation of *T. grandis* followed by *A. lebbeck*, *D. strictus* and *A. procera*. Total tree layer C stock (t ha⁻¹) significantly increased in all plantations as they aged from 3-yr to 6-yr. Plantations of *A. lebbeck* and *D. strictus* supported much more biomass than that of *A. procera* and *T. grandis* which indicates different species have different sequestering pattern. Biomass allocation in different components (leaf, stem and root) was widely different in both species. However, larger partitioning of leaf biomass contributed high amount of C input to the soil surface indicated high quality of C deposition in the soil layer that could be formed as organic layer of the soil in long term. Therefore, rapid biomass accumulation efficiency and faster growth rates in the plant species evidently indicates rapid deposition of C. Furthermore, it might be more beneficial step if we consider as in the way of ecological eco-

nomics of managing C as well as restoring degraded ecosystems in top priority approach in the current scenario.

Keywords: coal mine spoil, *Albizia lebbbeck*, *Tectona grandis*, accretions, *Tectona grandis*, *Dendrocalamus strictus*

Agroforestry riparian plantations with *Populus* sp. and soil quality improvement

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Agroforestry systems in which at a same plot is combined for a long-term trees with crops and/or grazing livestock can be a good method and opportunity to improve soil quality where it is practiced. Agroforestry plantations as a good land use practice can be used for preserving and enhancing soil fertility. The intensive poplar plantations established alongside the Danube for rapid production of wood can be well combined with the application of agroforestry practices at the early stage of saplings growth. The aim of the study is to compare plantations, in which were applied different agroforestry practices in relation with their main soil characteristics – content of total carbon and nitrogen. Comparative approach and standard methods were used. Also, we used the method of Kononova/Belchikova to define humus composition and stabilizing of organic matter in these alluvial soils. Analyzes were carried out in *Populus* sp. plantations along the Danube near Oryahovo and Kozloduy. The results obtained show better indicators for C% ($1.92 \div 0.96$) and N% ($0.07 \div 0.05$) in agroforestry systems compared to control (C% 0.48 and N% 0.01). The fractional composition of humus shows a higher content of humic acids than the fulvics in agroforestry systems ($Ch/Cf = 0.27 \div 0.67$) with respect to those systems where these practices are not applied ($Ch/Cf = 0.17$). This shows better opportunities for agroforestry as a method of land use capable of preserving and improving soil fertility in riparian forests. This way is created vibrant, productive, sustainable and adaptive ecosystem.

Keywords: agroforestry systems, soil organic carbon, humic and fulvic acids

Saturated hydraulic conductivity of forest soils under different land use

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Three experimental stations of the Forest Research Institute in Rila Mountain, Lozen Mountain and Maleshevska Mountain were chosen for investigation the impact of vegetation types, geology and soil properties on saturated hydraulic conductivity of Eutric Leptic Cambisols Ochric, Dystric Cambisols Ochric and Dystric Cambisols Humic (WRB 2015). The analyses were performed on undisturbed soil samples (100 and 200 cm³ soil rings) taken from 9 surface (0-5 cm) soil horizons under coniferous, deciduous and herbaceous vegetation. The saturated hydraulic conductivity (Ksat), bulk density, particle density, total porosity and drainage aeration pores were analyzed. The skeleton and root biomass contents in each soil core were determined. The values of Ksat varied from 14 to 156 cm.h⁻¹ and were classified as high to very high according to USDA classification. The values of soil bulk density varied from 0.7 to 1.3 g.cm⁻³ in dependence of soil texture, amount of gravel and organic carbon. The obtained data can be used as indicators of soil structure and for evaluation of water transmission processes of studied soils.

Chemical characterization of Cambisols under different land-uses in highland region of Rila Mountain, Bulgaria

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Soil chemical properties of Dystric/Eutric Cambisols under two mountain land-uses (three forest lands formed by *Picea abies* Karst., *Pinus mugo* Turra., *Pinus sylvestris* L. respectively, and one mountain grassland) in the Rila Mountains, Bulgaria, were studied to assess the role of vegetation on soil acidification. Soil organic matter content (SOM), pH, cation-exchange ca-

capacity (CEC), exchangeable cations with strongly acidic functions (CEC_{SA}), the type of ions exchange over the plant roots and the ion exchange capacity of SOM were evaluated. The studied forest soils characterized with medium to high SOM content, medium to low colloidal functions and low to medium level of bases saturation. Soils under coniferous trees and grassland vegetation differed in their level of acidification, characterized by strong total acidity of soils under forest. Over 70% of CEC of forest soils characterized by abundance of exchangeable aluminum, which may facilitate the transfer of amphoteric metals in toxic quantities. Under grass vegetation bases were between 44 and 91% of the soil sorption capacity, and exchangeable aluminum was present in minimum quantities, which indicated the lack of destructive processes. It could be concluded that grassland vegetation has the potential to reduce rates of soil acidification in studied mountain land-uses.

Keywords: soil CEC, exchangeable ions with strongly acidic functions, mountain-related land-uses

Long term trends and effects of nitrogen inputs on forests and soils in the UK

Elena I. Vanguelova, Rona Pitman, Sue Benham

Forest Research, Alice Holt Lodge, Farnham, UK

Critical nitrogen load maps currently indicate that the majority of both broad-leaf and conifer woodland in the UK exceeds the limits for nutrient nitrogen, although widespread effects of this excess deposition have not been evident, except at woodland edges.

Experimental research, long term intensive forest monitoring and spatial soil surveys undertaken by Forest Research during the last 20 years will be presented, summarising the current understanding of the effects of nitrogen deposition on broadleaved and coniferous forests and forest soil biogeochemistry across the UK.

Long term trends in nitrogen deposition and soil, soil solution and forest biological responses to deposition changes will be reviewed. The role of forest canopy in nitrogen transformations will be demonstrated through stable isotopes study and the role of tree species and soil type from the spatial forest

soil survey BioSoil. The impact of nitrogen inputs on forest growth, water use efficiency, nutrient and carbon cycling will be discussed by presenting results from detailed gradient studies from point sources of nitrogen pollution and regional studies comparisons between forest areas with low and high nitrogen deposition. The likely contribution role and links of nitrogen deposition to tree health and nutritional cycling will also be discussed by presenting examples of current research on the links of current spread of acute oak decline in the UK to deposition chemistry.

Keywords: *nitrogen deposition, forest and soil biogeochemistry, tree health, nitrogen and carbon cycling*

What is the capacity and potential for carbon sequestration in forest soils in the UK?

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Growing trees can help to mitigate climate change by sequestering carbon (C), making a significant contribution to meeting the UK Government's Greenhouse Gas (GHG) emission reduction targets, as well as offering an alternative fuel source to fossil fuels. On average, up to 75% of the overall forest C could be stored in the soil to 1 m depth. Different tree species have profound effect on soil functions and potential for carbon storage. Different soil types have different levels of C and capacity for long term C sequestration, and respond differently to forest establishment. For example, organic soils, which tend to be upland, peaty soils, store twice the C of mineral soils, yet need more intensive preparation for afforestation. Forests planted on mineral soils are generally accepted to result in increased soil C content. However, in some circumstances afforestation on organo-mineral or organic soils may result in substantial loss of soil C due to soil disturbance during forest planting. Forest management practices can change these forest soil carbon storage and dynamics. As a result, it is beneficial to know where best to focus efforts on future afforestation for GHG balance purposes. This can then be reflected in policies to support woodland creation targets and land use change to forestry. Quantification of forest soil C storage, fate and change is vital for underpin-

ning planning and sustainable management to aid forest C sequestration in the future.

This overview presentation will cover past and present forest soil C research studies and surveys carried out in the UK. Current forest stocks and stability under main tree species and forest soil types will be summarised. Changes of soil C during forest lifecycle assessed from repeated soil surveys, long term monitoring networks and forest chronosequences will also be discussed.

Keywords: forest soils, carbon sequestration, soil types, afforestation, forest management

4.3. (T3) Forests, Climate Change and Risk Processes

How does altitude modify climate-growth-relationships in common beech (*Fagus sylvatica*) forests on the Western Balkan Range and Belasitsa Mountain?

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Recently, climate change has modified the growth conditions of forests. Shade tolerant tree species such as Common beech (*Fagus sylvatica*) with high demands to moisture supply are assumed to be more vulnerable to increasing heat and drought. Current study assess the change of the climate – growth relationships for Common beech along an altitudinal gradient on the northern slopes of the Western Balkan range (WBR) in Bulgaria. The increment cores were taken at three elevations – 500, 1000 and 1500 m a.s.l. Tree ring width series were measured and transformed into basal area increment series (BAI) to evaluate growth patterns and into tree ring index series (TRI), which contain the climate signal. Climate-growth relationships were identified by use of the statistical analysis tool CLIMTREG (Climatic Impact on Tree Growth). Within the last 15 years growth rates are highest at 500 m a.s.l. and lowest at 1500 m a.s.l. Year-by-year fluctuations of BAI during the last 15 years are highest at 500 m a.s.l. and lowest at 1500 m a.s.l. This pattern corresponds to

the frequency of occurrence of heat and drought at the different elevations. The sensitivity of the year-by-year changes of growth rates rises between 1985 and 2000. All calculated PCR-models across the interval from 1951 to 2017 resulted in highly significant coefficients of determinations (R^2). As an exception, R^2 is below 0.7 at 28% of all cases between 1972 and 1989, which must be evaluated as a transition period towards the current, warmer and dryer climate. Within the annual range between 1951 and 2017, three striking time spans were selected. These are the spans from 1964 to 1984 and 1988 to 2008 with highest values of R^2 above 0.9 and, in between, from 1976 to 1996 with low R^2 (0.67), representing the climatic transition period. During the period from 1988 to 2008 all temperature variables loose completely their positive effects on growth rates. Beginning with the period from 1976 to 1996, all temperature variables affect negatively on growth rates at all altitudes. This fact means, that the optimal temperature range for beeches growth was overstepped recently at the WBR.

Regional silvicultural systems for management of oak coppice forests in West Bulgaria

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In the last 50 years, the total area of the oak coppice forests in Bulgaria has been steadily increasing. The traditional organizational approaches and silvicultural systems used to manage the oak coppice forests for conversion into high forests through ageing, have led to simplification of the structure and the species composition of the stands. Their average age is growing and about 70% of the stands are already mature. The stands are characterized by high density, poorly developed crowns, with low current increment and poor assortment structure. The incapability of doing all the needed activities in short terms leads to constant postponing of the conversion problems, increasing in the rotation period, loss of increment and puts the protective and special functions of these forests at risk. Even if the common long-term aim for conversion of the coppice forest into high forests is kept, it is necessary to reformulate the past silvicultural systems and the activities should be transformed from common to individual, taking regional features and micro-conditions

into account. Results of attempts and suggestions for specific regional systems for the management of the coppice oak forests on the territory of two state forest enterprises, are presented based mainly on the natural regeneration peculiarities.

Keywords: *coppice oak forests, silvicultural systems, natural regeneration*

Historical data on disturbances in mountain coniferous forests in Bulgaria and implications for the risk for forest damages

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Disturbances are among the most important processes that shape forest dynamics. However their historical occurrence in many coniferous forests in Europe and specifically in the mountains on the Balkan Peninsula are not well understood. We present an overview of available data on disturbance events in coniferous forests in the high mountains in southwestern Bulgaria. We documented at least 188 abiotic disturbance events including fires (39%), windthrows (31%) and avalanches (20%) and fewer disturbances caused by snow and ice. Fires primarily affected Pine-dominated ecosystems, especially pure *Pinus sylvestris* and mixed *Pinus sylvestris*-*Pinus nigra*. Our tree-ring analysis also provided evidence for repeated fires in subalpine *Pinus heldreichii* and *Pinus peuce* forests during the last 500 years. We also found data on several large fires in Spruce forests. Most of the fires were less than 100 ha, but some were larger, the biggest of which was the Batalach fire (1890, approximately 9000 ha) in the Rhodopes. The highest frequency of fires was in 1880-1910, 1940-1950 and 2000-2010. Windthrows were the second most important disturbances with at least 59 windthrows greater than 1 ha, mainly in pure *Picea abies* and mixed *Picea abies*-*Pinus sylvestris* forests. There was high variability in their size, ranging from small-scale to large blowdowns affecting more than 300 ha. The largest was the Beglika windthrow (1961, 3000 ha). Snow-related damage was important mostly for young pine forests in which several events affected high stock of wood in the 1930s, 1987, 1988 and 2015.

Our data demonstrate that natural disturbances of various types and sizes are

part of the natural dynamics of coniferous forests in Bulgaria. High proportion of the coniferous forests in the Bulgarian mountains are at risk of being affected by large disturbances. This is especially true for hardly controllable inter-connected disturbances such as windthrows or snowbreakages and the frequently following bark beetle outbreaks. Fires are also frequent despite all activities on fire suppression. Given the high availability of burning material and expected prolonged summer droughts in future, fires are expected to increase their importance.

Keywords: *disturbances, coniferous forests, Bulgaria, mountains*

Taxonomical status and tree-ring chronology building of timber excavated from different archaeological locations in Bulgaria

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The wood material findings from many archaeological locations in Bulgaria offer excellent opportunities for wood anatomical and dendrochronological studies. In this paper we focused on ancient wooden fragments from different constructions discovered in settlements from the Roman Empire period from 1st to 4th centuries AD. One beam from a bridge construction over a ditch, in front of the fortress walls, excavated from the Western gate of Serdica (present city of Sofia), five beams from a building structure from the centre of ancient Serdica and eight wooden samples from the ancient port Anhialo (present town of Pomorie), west Black Sea coast region, have been studied. By using anatomical identification methods, the taxonomical status of all collected timber materials has been defined. It was found that the systematic spectrum of the wooden materials is narrow and contains only species of genus *Quercus* (oaks), subgenera *Cerris* and *Quercus*. By using dendrochronological method, floating chronologies were built based on tree-rings widths of the oak samples.

Both graphical comparison via scatter plots and statistical correlation analysis have been used to test temporal placements and cross-matches of tree rings among samples. The constructed oak floating chronologies will be utilised and incorporated as essential structural components in on-going building of a millennial long master tree-ring chronology for the Eastern Balkan region.

Main stress factors in coppice oak forests in Western Bulgaria

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Climate anomalies, air pollution and biotic stress factors have caused several periods of decline (dieback) of different forest types in Bulgaria and in Europe as a whole during the last decades. In order to obtain up-to-date information on the development of this process, the aim of this study is to analyze the dynamics of the health status of coppice oak forests in Western Bulgaria and to identify the main stress factors in them. The research is carried out in oak forest stands (*Quercus petraea*, *Q. frainetto*, *Q. cerris* and *Q. pubescens*) located in several State Forestries in the Bulgarian Southwestern and Northwestern State Enterprises. Dendrochronological analysis is used predominantly, which is combined with defoliation assessment, macroscopic and microscopic phytopathological analyzes. Representative radial increment chronologies for the main oak species in the studied area are developed, which reflect the dynamics of their health status. It is deteriorated in some of the studied forest stands in the end of the analyzed period. All of the oak forests in this area have gone through stress periods in the mid-20th century and after the early 1980s. The obtained coefficients of determination by multifactor regression analysis for the influence of temperature and precipitation regimes on it are high ($R^2 > 50\%$). The results are related also to the management history of the forest stands.

Linking radial increment data to climate and management history of the stands provides an opportunity to elucidate the main stress factors in them, through which their growth can be regulated. The most unfavorable climatic conditions for the coppice oak forests are associated with low precipitation combined with high air temperatures during the growing season. They coincide with the determined stress periods, which shows that unfavorable temperature-precipitation regime is the main predisposing stress factor in these stands. The health

status of the studied coppice oak forests requires active and differentiated by micro-conditions forestry activities.

Keywords: dendrochronology, oak decline, coppice forests, *Quercus petraea* (Matt.) Liebl., *Quercus frainetto* Ten.

Dendrological and tree-ring analysis of 100 years of growth of local and introduced coniferous tree species in Kniazevska kultura forest near Sofia

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The Kniazevska kultura is among the oldest large-scale plantations (1893) in Bulgaria. It provides the opportunity to analyze the long-term growth of local and introduced coniferous tree species and use the conclusions to select optimal species for future plantings.

Our results show consistent good growth of *Pseudotsuga menziesii*. The trees were strongly affected by droughts but recovered fast. *Pinus jeffrey* also produced wide tree rings and reached high diameters. Yet, the number of planted and analyzed trees was rather small and conclusions should be taken with care. *Pinus strobus* trees grew well and produced wide tree rings, but after the first 50 years they decreased sharply their tree-ring width and did not recover. At present much of the trees of this species are with decreased health status, have stem and root rot and the number of dead trees increases rapidly. *Larix decidua* trees had frequent suppressions and low overall growth. Much of the trees have suffered crown damages probably due to wet snow. *Pinus nigra* and *Pinus sylvestris*, which are local for Bulgaria, but not present naturally in the region of plantings, were strongly affected by known droughts. Yet, they maintained radial growth and good health status, especially *Pinus nigra*. However, a recent wave of mortality in *Pinus sylvestris* due to bark beetle infestations, lead to strong decrease in the number of surviving Scots pine trees. Our results demonstrate the high potential for ornamental and wood production plantings at similar conditions of *Pseudotsuga menziesii* and *Pinus nigra*. *Pinus jeffrey* deserves special attention as potentially very productive and ornamentally attractive species.

Keywords: tree-ring studies, introduced species, Bulgaria

Dendrochronology of 358-year-old beech stand (*Fagus sylvatica* L.) from tree-line zone, Balkan Range Mt., Bulgaria

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Through application of the dendrochronological method, the impact of changing climatic conditions on monodominant tree-line beech forests in Balkan Range Mt., Bulgaria was studied. Nineteen European beech (*Fagus sylvatica* L.) cross-section stem discs from elevation of 1550 m a.s.l. in the region of Etropole were dated and measured. It was established that the age of the sampled beech trees varies from 177 to 358 years. Increment series were calibrated to mean monthly temperatures and monthly precipitations, using climatic data from hydrometeorological station Petrohan, situated at approximately the same elevation in the mountain as the sample plot. The applied multifactor regression analysis showed that the influence of temperatures in the terminal zone of vertical distribution of the European beech in Balkan Range Mt. has dominant significance for the formation of the tree rings widths ($R^2 = 0.56$), compared to precipitations ($R^2 = 0.36$). Application of response function analysis indicates that the high temperatures in the summer months June and July have negative influence on annual radial increment, and in opposite, high temperatures in May and August have positive effect on tree-ring formation.

Flooding risk assessment in connection with ecosystem services in Smolyan region, Bulgaria

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Changes in annual and seasonal precipitations, which are more often increasingly intensive, land-use changes and small rates of erosion control activities are main cause of increased flooding risk in many regions of Bulgaria. The Smolyan region is one of the most affected of floods and erosion processes. In the recent years houses and infrastructure have been flooded, people have

been evacuated and there are significant material damages. In only one of the floods in 2016 the material damage amounted about 15 million levs. All this shows the necessity of applying effective approaches to assess and analyze the existing flooding risk in order to make the right decisions for activities to limited damages in case of future floods.

In this study is applied method used to assess the flooding risk and its relationship to ecosystem services developed under the TUNESinURB project and the method is conducted only at urban territories. Flooding risk assessment has been made for settlements with more than 2000 inhabitants in Smolyan region and data for distribution of area at flooding risk is presented. The territories at risk are 17% of total area and from them 11.02% are in category „very bad“.

Keywords: *soil erosion, flooding risk, ecosystem services, urban territories.*

Erosion Hot-Spots in the Skopje Region

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Erosion hazard is accepted as severity of the likelihood expressed in physical units while Erosion risk is defined as product of the likelihood or chance of erosion (erosion hazard) and the adverse consequences or impacts of erosion (on-site and off-site erosion damages) where negative consequences cover social, economic, environmental and other impacts. Skopje region has been facing with extremely negative consequences of erosion and torrents for years. Sediment produced on the mountains burden the stream fluid, usually close the culverts and bridges and cause overflowing in the surrounding area. In August 2016, torrents from the Skopska Crna Gora Mountain destroyed the suburban part of Skopje causing huge damages in the settlements and on infrastructure, sedimentation of the agriculture land and 23 victims.

The Skopje region consists of the city of Skopje and the surrounding municipality. Some torrents origin from other municipality but consequences felt in the city of Skopje. The whole area of the region is 181 800 ha. Activities in this study were separated in the following phases: 1) preparatory desktop analyses, 2) on-filed mapping of erosion parameters and inventory of high erosion processes including landslides, 3) Erosion factor analyses, 4) modeling ero-

sion Intensity (hazard), 5) delineation erosion hot-spot areas. Basic model for modeling erosion intensity (hazard) was Erosion Potential Method by Gavrilovic. Within the region are delineated 12 571 ha in the I and II category of erosion intensity (hazard). These areas were accepted for further delineation of erosion hot-spots following the criteria: I category hot spot - areas that are harmful to settlements; II category hot-spot - areas that are harmful for infrastructure; III category of hot spot - areas that are harmful for agricultural land; IV category hot-spot - areas that produce significant quantity of sediment that reach the river bed. After preliminary delineation, due to the fragmentation of the individual polygons and generalization is made into a logical unit. Finally, 5874 ha of erosion hot-spot areas are delineated in the Skopje region and assigned as priority for erosion control activities.

Keywords: *erosion*

Evaluation of water erosion risk in Bistritsa river watershed, Southwest Bulgaria

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Soil erosion is an ecological problem that influenced most of the world population. Soil losses and reduced soil productivity are also well known negative impacts caused by erosion processes in Bulgaria. For that reason a significant amount of erosion control activities have been performed in the last century. Regardless of this, there are still recognized active erosion processes which mainly occurs on areas with erodible soils and sloping terrain. Limited vegetation cover and heavy rainfalls are also factors for presence of active erosion processes.

The investigation has been carried out at Bistritsa river watershed which is left tributary of Dzherman river, part of Struma river watershed. The total area of Bistritsa river watershed is 56.9 km² and from them about 24 km² is forest fund. It is applied a methodical approach for determine and mapping the territories of erosion risk by using GIS. The methodology is prepared only for forest territories and it is giving actual state of the problem. The total assessment for forest territories in Bistrisa river watershed is „moderate“ potential soil erosion risk and „very low to low“ actual soil erosion risk. At about 20%

of the forest territories are with „moderate“ and „moderate to strong“ actual risk. This data shows high potential abilities for high amount runoff and sediments formation in this territories and necessity of future planning of erosion control activities.

Keywords: *soil erosion, risk assessment, Bistritsa river*

Temperature-induced changes in humus quality and $\delta^{13}\text{C}$ signatures as a proxy indicator of soil burn intensities after forest wildfires

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Due to the increasing number and virulence of forest wildfires recently observed around the world, the establishment of a simple, accurate and reliable index that would correctly evaluate the fire effects on soil quality as a support for a suitable forest recovery management is becoming progressively more necessary. This objective is addressed here by using both $\delta^{13}\text{C}$ isotope ratio mass spectrometry and traditional solvent fractionation methods (widely used to assess soil biogenic components or humus fractions) to quantify the temperature-induced changes in soil chemical and isotopic composition. Soil samples from the upper 5 cm layer of two Cambisols developed over granite under pine forest in the NW of Spain were heated in an oven under controlled conditions to attain moderate or intense soil burn severity levels by using two different temperatures (220 °C or 350 °C). Biochemical changes induced by the heating process appreciably differed according to the intensity of the temperature applied. Multilinear regression modelling not only showed a significant relationship between soil C isotopic signature shifts (Δ soil $\delta^{13}\text{C}$) with temperature increases but also revealed other key outcomes: i.e. > 96 or > 81% of its total variance can be predicted by changes in lignin or non-humified organic matter, respectively. Indeed, Δ soil $\delta^{13}\text{C}$ explained by itself $\approx 60\%$ of thermal variance, pointing to the potentiality of soil $\delta^{13}\text{C}$ shifts as an accurate soil burn severity index for the next future.

Keywords: *controlled heating, soil thermal alteration, soil burn severity, fire effects, soil organic matter, stable C isotopes*

Impact of drought on the forest vegetation in Eastern Ukraine: the long-term prognoses and adaptation measures

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The study was carried out for eastern Ukraine (Sumy, Kharkiv and Luhansk regions) in the frame of the Integrated drought management programme in Central and Eastern Europe supported by Global Water Partnership.

On the base of climatic models from the IPCC fifth Assessment Report the vulnerability of forests to climate change was assessed at the region. According to prognosis the main climate change driver for this territory will be intensification and duration of droughts.

The dynamics of ecological conditions and their suitability for forest vegetation under climatic scenarios were studied for the region. The spatial distribution of climate zones by de Martonne index were built using GIS and distribution of forest vegetation areas by climate zones for present climate and for scenarios RCP 2.5; 4.5; 6.0; 8.5 in 2050 and 2070 was estimated. Adaptation measures for forests and forest management for forecasted changes were proposed.

Present climate at eastern Ukraine varies from moderately arid (B) to moderately humid (D) by de Martonne index. At the second half of XXI century significant climate warming and aridization is expected (average year temperature will increase by 3–6°C). Zone of semiarid climate (A) will occur, which is unfavorable for forest vegetation. *Quercus robur* L. and *Pinus sylvestris* L. are dominating forest tree species in the region as well as in Ukraine. Now pine forests are represented at all climatic zones and take 41% from the forest area of the region. 30% of them are at favorable climate conditions (zone D) at the southern boundary of their natural area. 69% of oak forests grow at suitable climate conditions (D zone – 22.2%; C – 46.6%). It is expected that by 2050 all forests of the region will grow under unfavorable climate conditions (high vulnerability zones A and B). It should be expected fragmentation of natural areas of Scots pine and English oak, and it's shifting to the north, zonal vegetation of flat interfluvies may change significantly. Proposed adaptation measures included: formation stands with appropriate species composition, fire protective and silviculture measures, preservation of gene fund, monitoring of biotic and abiotic damage, support of natural regeneration etc.

Keywords: *climate change, forests, vulnerability, adaptation, de Martonne Index*

Soil erosion in Bulgarian mountain regions: stationary studies and risk assessment

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This paper aims at presentation of the main results from long term field researches on erosion processes, and results of risk assessment and erosion mapping in some mountain watershed basins of Bulgaria. Long terms and systematic researches on erosion processes in mountainous regions have been carried out in experimental stations Gabra and Igralishte, situated at 850-900 m a.s.l. The research in Gabra (Sredna Gora mountain) aims to determine the dynamics of rainfalls, surface water runoff and soil losses for plantations of Scots and Austrian black pine, and for grass and fallow lands. The experimental station Igralishte is established in Maleshevska mountain. Data from four small watershed basins (7.5 to 64.8 ha) was obtained on the basis of researches on rainfall, water runoff and eroded soil. Watersheds are with different characteristics - oak forest managed through branch-cutting and grassland free for grazing, Scots pine plantations, oak and beech forest managed through branch-cutting and grassland free for grazing.

The used in our country methods for erosion risk assessment in mountain watersheds are presented as well as the results from mapping the territories according to risk level. Data on distribution of territories with erosion risk for Struma, Eleshnitsa, Rakovitsa, etc. river watersheds are given.

Keywords: *erosion research, experimental station, risk assessment, mapping, Bulgaria.*

Evaluation of water erosion risk in Dzhubrena river watershed

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Soil erosion is a global environmental problem that affects a large part of world soil. In Bulgaria the annual soil losses are significant and it is assumed that almost 10% of the forest fund is affected by soil erosion in different degrees. In recent years the lack of erosion control activities and changes in pre-

precipitation trends and intensity are also reason of degraded soil conditions. All these factors increased the risk of floods, especially in the case of watercourses with torrent activities in the past.

The purpose of the investigation is to analyse the main erosion factors and to assess the potential and actual soil erosion risk in the watershed of Dzhubrena by applying a methodical approach for determining and mapping the territories of erosion risk by using GIS. The assessments were made according to accepted for implementation „Methodology for preparing the national long term programme for soil erosion and floods preventing“. The total assessment of Dzhubrena watershed is „low to medium“ risk of potential soil erosion and a „low“ risk of actual soil erosion.

Keywords: *soil erosion, risk assessment, Dzhubrena river*

Comparative analyses on some soil characteristics in different land uses from Central Balkan Mountains

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The aim of this work was to explore dependence of some soil characteristics from land use type and management focusing on whether and how the carbon (C) accumulation in the mineral soil layers. The following effects were investigated: a. the management effect of thinning activities in beech forests, b. harvesting in meadows, c. grazing in pastures, d. the land use change effect of pasture converted to spruce plantation, and e. the change of the vegetation type. In addition it was explored how these changes affected some of the general soil characteristics – nitrogen (N) content, pH and C:N ratio. The carbon content was found to be higher in the top soil layers and smoothly decreasing in depth. The content of total nitrogen follows the variation of the carbon – higher in the top soil horizon and decreasing in depth. The acid reaction was found to be strong acid (4.02 - 5.20), which supposes that the studied soils have very low base saturation. The tendency in depth was increasing of pH. In studied soils many of the nutrients are under soluble form which suppose their leaching in depth. Afforestation led to increasing of the carbon content in the soil, changes in the carbon stock, nitrogen content and pH observed in

the whole soil profile. The performed forests management activities and the change of vegetation type from beech to spruce didn't affect significantly the studied soil characteristics. The lack of management in the studied grasslands resulted in decreased soil organic carbon and nitrogen content.

Keywords: *carbon stock, mountain soils, conversion, grassland, forestry*

Establishing Forest Reference Level of Bulgaria for the period 2021-2025 – approaches used, interpretations, definitions and challenges

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In May 2018, EU adopted the Regulation on Land use, land use change and forestry in 2030 climate and energy framework (LULUCF Regulation), which puts in place an accounting framework for the compliance period (2021-2030). According to the Regulation, in terms of Forest Land, the GHG emissions and removals will be accounted based on the concept of „Forest Reference Level“ (FRL) - a country-specific projected baseline of future forest emissions and removals, against which the actual reported emissions and removals in the compliance period will be compared for accounting purposes. The key concept, when constructing the FRL, is the principle of „continuation of forest management practices and intensity“ as documented in a historical reference period (years 2000-2009). In this way the regulation aims to promote an active and sustainable forest management and to reflect in the accounting all the changes in management practices since the reference period, due to mitigation efforts or market demand, in a transparent and credible way. This paper aims to present how the forest reference level of Bulgaria has been established in accordance with the requirements listed in the LULUCF Regulation. More specific, the paper gives information on approaches used and explains the main challenges in predicting the GHG emissions and removals from Bulgarian forests in line with the Regulation. In more details the report describes the country-specific forest characteristics and forest area stratification associated with management practices representative for the reference period. The interpretation and definition of „historical documented forest management prac-

tices“ and defined operational criteria, which are specific for Bulgaria, are also explained. The projection of evolution of forest land area, carbon pools and future harvest, associated with the continuation of forest management practice and intensity as documented in a historical reference period are described.

Keywords: *LULUCF, Forest Reference Level, Bulgarian forests*

Vegetation restoration in fire-affected forests

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Studies focused on vegetation restoration (regeneration) in forests affected by fires are of increasing interest, because of the necessity of elucidating the evolving species dynamics and developing / applying appropriate strategies for an adequate restoration policy. Thus, the present investigation was focused on the evolving vegetation peculiarities during a relatively short-term (up to 5 years after the fire event) regeneration on distinct fire-affected forests, located in the areas of Dolna Banya (the northern slopes of Rila Mt.) (Object 1) and in Osogovska Mt. (Objects 2 and 3) with pre-fire dominant tree species of Scots pine (*Pinus sylvestris* L.). The results show clear differences depending on the after-fire time period. The highest post-fire species variability was found in Object 1 after a 4-year restoration period.

Keywords: *post-fire regeneration, Scots pine, forest fire*

Results of soil monitoring in the Western Balkan Mountain

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The chemical composition and cation exchange properties of soils in the western Balkan Mountain region have been monitored since 1986 in 10 sample plots. The analysis of the results was carried out in two periods 1997 - 2007 and

2008 - 2017. Their assessment shows stability of the soil acidity, and maintained exchange of basic cations, as a key to neutralizing acidic products, entering the soil. For the analysed 30-year period, the study shows that the heavy metal content is relatively constant. Increased heavy metal content is found in the forest litter and the surface soil layer, including above the toxic level, a more detailed study is required to prove their natural or anthropogenic origin.

Keywords: *monitoring, heavy metals, soil, pollution, acidity*

4.4. (T4) Silviculture and Forest Genetic Resources Management

Activation tagging in poplar: identification of new phenotypes from a field trial in Québec

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T-DNA activation tagging is a method to generate dominant mutations in plants by random insertion of a T-DNA carrying constitutive enhancer elements, which can cause transcriptional activation of flanking plant genes (Mamelink 2003). It has been already showed that activation tagging can be used successfully as an effective forward gene discovery tool in poplar (Busov et al. 2010). About 1000 hybrid *Populus* trees (*P. tremula* x *P. alba*) were established at the Valcartier experimental forest, close to Québec City (QC, Canada) from a larger population of T-DNA lines (Harrison et al. 2007).

This population was phenotypically analyzed and various traits have been considered. A first screening revealed visible traits such as change in tree or leaf architecture. Also the developmental stage of the trees was compared among each other to identify mutants showing early or late bud break, dwarfism and winter spoiled foliage. From the initial group of about 100 phenotypic mutants

several were lost during the second growing season because of lack of vitality, leaving about 30 mutants for further analyses.

Furthermore, most selected mutant lines were regenerated in the greenhouse using rooted cutting, and some phenotypes (e.g. leaf shape) were clearly confirmed. We also took the opportunity of using this small population for testing susceptibility to *Melampsora* infestation. We used a simple spraying inoculation of leave disks with a solution of rust spores to revealed possible rust tolerant/susceptible phenotypes.

The insertion copy number has been evaluated by Southern blot for about 15 lines and the insertion region has been identified by TAIL-PCR. Here we report some more detailed results about the molecular characterization of the mutant lines.

Acknowledgements: This work is supported by the Genomics R&D Initiative of Canada and the Arborea project (www.arborea.ca funded by Genome Canada and Genome Quebec).

Keywords: *T-DNA activation tagging, poplar, functional genomics, development, leaf and tree architecture*

Five years growth of Paulownia on two sites in Bulgaria

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Growth potential of *Paulownia tomentosa* and *Paulownia elongata* x *fortunei* was investigated in two contrasting environments - in Zlatna Panega on Haplic Kastanozem (agricultural land) under continental temperate climate and in „Mikrevo“ nursery on Fluvisols under transitional Mediterranean climate, using conventional field and laboratory methods. Data on the survival percentage, base diameter, diameter at breast height, height of the plant and aboveground biomass during the last five years were obtained and analyzed. Insignificant differences in growth and productivity of the tested clones of *Paulownia tomentosa* and *Paulownia elongata* x *fortunei* were found. The site conditions impeded the aboveground biomass growth of *Paulownia elongata* x *fortunei*.

Keywords: *Paulownia tomentosa, Paulownia elongata* x *fortunei*, biomass

Productivity of experimental and industrial Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) plantations in Bulgaria

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The high productivity, adaptive potential and valuable wood of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) are some of the reasons Douglas fir forests to be considered a valuable biological resource. Douglas fir timber is well known and accepted in world wood markets. In Bulgaria the species occupies an area of 9078 ha. For decades, it has been both used to create highly productive plantations and protective forests. The aim of this study is to provide new information and elaborate the existing data on the productivity and state of experimental and productive Douglas fir plantations established in contrasting geographical regions and altitudinal belts. Studied stands are located on the territory of Smilyan, Zlatograd, Koprivshtitsa, Rila Monastery, Kostenets, Gorna Oryahovitsa and Kazanlak, at altitudes from 350 m a.s.l. to 1400 m a.s.l. Climate analogues based on climatograms were used to compare climatic conditions. To determine the state of Douglas fir plantations, the methods of dendrobiometry and comparative analysis were used. Mean values for heights and diameters, basal area and growing stock volume per hectare, mean volume increment and canopy closure of plantations were determined. The mean annual volume increment of the fifteen best provenances in the 20-year old provenance experimental plantation at State Forestry Enterprise Kostenets (800 m a.s. l.) varies from 17.9 m³ha⁻¹ to 13.0 m³ha⁻¹ per year, and for the plantations in the Smilyan region – from 17.0 m³ha⁻¹ to 11.0 m³ha⁻¹ per year. These numbers increase significantly when taking into account the volumes previously harvested during commercial thinnings. A good general status of plantations was observed in all studied areas. Considering the good status of the studied plantations as well as their high productivity in contrasting regions we can recommend increasing the share of the afforestations with Douglas fir. Using appropriate habitats and provenances, relevant establishment and breeding technology, good results can be achieved in terms of productivity, sustainability and protection of vulnerable territories. Douglas fir

plantations, methodology for their establishment and subsequent care should be perceived as a powerful biotechnological tool for timber production, landscape protection and carbon sequestration.

Keywords: *Pseudotsuga menziesii*, growing stock volume, mean annual increment, carbon sequestration

Cultivation of willow on degraded soils of the Left Bank Forest-Steppe of Ukraine as a factor of improving of their ecological properties

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In the Left Bank Forest-Steppe, Kharkiv Region, the most fertile soils of the chernozem type are widely distributed. Last are used exclusively for the cultivation of traditional crops. However, about 90 000 hectares of them are degraded floodplain soils, which are rich in shrub vegetation, the so-called „urban soils“ – soils that have suffered significant damage due to anthropogenic activity. These areas can be classified as marginal due to their soil properties. The suitability of marginal lands for the cultivation of energy crops is studied. The cultivated plant is willow. Seven types of soils of varying degrees of degradation were selected. The selected types give a rather representative picture of the marginality of the soil cover of the Kharkiv Region. Among the selected, soils of the floodplain of Vilhovatka river present special value for the forestry.

The dynamics of changes in the ecological components of soil has been studied by determining the number of microarthropods and enzyme activity (protease) on the experimental plots laid in the fall of 2015. Microarthropods are among the few organisms that, despite significant quantitative changes in comparison with natural conditions, retain high levels in soils that are in agricultural use. Therefore, research into changes in their population dynamics in marginal lands, where energy crops are growing, proves the positive role that energy crops can play as biological soil reclamators.

Proteases play a significant role in the life of the soil, as they are associated with changes in the composition of organic components and the dynamics

of nitrogen-digested for plants. At the same time, the cellulolytic activity of the soil characterizes its general microbiological activity, which in turn determines the ecological state of the soil. Samples were taken at the beginning and end of the growing season in 2017. We have found that the activity of the protease and the number of invertebrates under the willow increased comparing to control. In addition, the concentration of heavy metals under plants and in intermediate rows slightly decreased. All this together with agrochemical indicators shows a positive dynamics in the change of the ecological and biological component of degraded drained floodplains.

Keywords: *marginal lands, energy crops, microarthropods, proteases, floodplain soils*

Experience of reforestation of artificial oak forests in the southeast of Ukraine

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Forest stands in the steppe zone carry out important functions on nature protection, scientific, educational, recreational and are the basis of the ecological network of the region.

Forest of the State Enterprise „Mariupol Forest Research Station“ of the Ukrainian Research Institute of Forestry and Forest Melioration Agroforestry named after G.N. Vysotsky (State Enterprise „Mariupol FRS“) is an unique example of the success of artificial forest growing in the severe climatic conditions of the dry open steppe of the southeast of Ukraine (Donetsk region). In this category of forests, the processes of weakening and mortality of different level and rate occur in result of forest age structure peculiarities, high frequency of climatic anomalies (particularly prolonged droughts), increased recreational load and spread of injurious insects and pathogens. Since biological stability, productivity and ecological effectiveness of forests decrease, it is very important to develop the methods and technology of reforestation.

Since 2008, the State Enterprise „Mariupol FRS“ has laid down a series of experiments to replace degraded forest stands by creating oak plantations in the clear-cuts after clear sanitary felling without rooting out.

The aim of research was to evaluate the effectiveness of different mechanized

methods of tillage, revealing of optimal row spacing, expediency of using fertilizers and herbicides, testing of complex systems of plantations care and silvicultural operations for growing and forming a mixed and multilevel oak stand.

When carrying out clear sanitary felling of 90 to 120-year-old oak artificial stands, a width of felling areas was 20 to 50 m (small-size felling area). Forest plantations creation by acorn planting, by planting material with closed (potted) and open root system were tested. The possibilities of additional use of natural seed and vegetative renewal of oak were studied.

The generalization of the experience of degraded artificial oak stands reforestation in SE „Mariupol FRS“ indicates its success. The growth and condition of oak stands in the clear-cuts after clear sanitary felling without rooting out is significantly affected by unfavorable factors of the natural environment. In conditions of arid steppe climate, the optimal method of artificial restoration of oak stands is the autumn planting of acorns with an optimal row spacing of 4 m. The natural seed renewal of oak becomes an additional component of forest plantations only under the condition of abundant fruiting in the years before the cutting. Implementation of the system of plantations care and silvicultural operations during forest growing cycle contributes to formation of optimal species composition and spatial structure of artificial stands.

Keywords: *steppe oak stands, reforestation, oak plantations.*

Ecological requirements of rare forest tree species in the region of Eastern Balkan Range

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The object of the study are the distribution and ecological characteristic of forest tree species *Sorbus torminalis* L. Crantz., *Sorbus domestica* L., *Prunus avium* L. and *Corylus colurna* L. The distribution of the forest tree species is determined in the territory of the Eastern Balkan Range, as well as their variability and the availability of valuable forms.

The forest genetic resources of these species evaluated according stem form and crown, height and diameter of trees.

Keywords: *ecological requirements, rare forest trees, Eastern Balkan Range*

Clone differences in the root biometry of hybrid black poplar

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The five-year-old root systems of the *Populus x euramericana* clones of ‘Agathe F’, ‘Guardi’, ‘BL’, ‘NNDV’ and ‘I-45/51’, grown in two contrasting environments – in „Mikrevo“ nursery on Fluvisols under transitional Mediterranean climate and in „Galovo“ nursery on Haplic Kastanozem under continental temperate climate, were investigated. The parameters number of adventitious roots, length of the longest root, root biomass, carbon and nitrogen content were analyzed, depending on the growth spacing. Root system allocation below ground was identified for each poplar clone. The clones with the largest root systems showed the highest amount of aboveground biomass. The growth environment and the cultivation mode affected significantly root allocation of the tested clones.

Keywords: *Populus euramericana*, root, biomass, spacing, carbon accumulation

Growth of young artificial stands Scots pine (*Pinus sylvestris* L.) in the south Moscow Region

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In the Moscow region, the forest is an important supplier of environmental services, so there is an active reforestation. For effective management of forestry, it is necessary to plan and prognosis reforestation and various activities in the forest. The prognosis is possible through the individual-based stand-level model EFIMOD. The model EFIMOD was developed for the description of stand growth and biological turnover of elements in natural forest ecosystems. We plan to parameterize the EFIMOD model, which will be used to predict the growth of artificial forest plantations. The purpose of this study is to collect data for the parameterization of the EFIMOD model. We established 4 sampling plots in young pine artificial stands (planted in 2014–2017)

in the south Moscow regions. We measured the height of trees, the root collar diameters and took soil samples. Also, we took 15 trees from each sampling plots. We measured the weights of organs of these trees (needles, branches, trunk and roots) and determined the concentrations of nitrogen and carbon in the organs. Dependence of the height on the root collar diameter was linear for all sampling plots. We observed an increase in the heterogeneity of trees as the age of the artificial stands increased. Leading trees appear already in the early stages of development of the artificial stand. This fact indicates intense competition in young artificial stands. We studied the rank distribution of the biomass of organs of young trees. The needles had the largest biomass and nitrogen concentration. This fact indicates active photosynthesis occurring in young trees on artificial stands, since the illumination of this area is great. The rank distribution of the biomass of organs of young trees growing under the canopy of the forest may be different. The results of this study will be used to parameterize the model EFIMOD.

Acknowledgements: The work was supported by the Russian Foundation for Basic Research (project no. 17-45-500038 p_a) and the Russian Science Foundation (project no. 18-14-00362).

Keywords: scots pine, management of forestry, young trees, ecological modeling

Leaf area and foliar weight to sapwood cross sectional area models for *Quercus frainetto* (Ten) in Greece

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The relationships between leaf area and foliar weight with four stem dimensions (sapwood area, total stem cross-sectional area, current sapwood area, and dbh) were studied in five different stem sections such as stump height (0.3 m), breast height (1.3 m), mid stem, base of live crown and mid crown in the most important oak species in Greece, Hungarian oak (*Quercus frainetto* Ten.). 23 trees were destructively sampled in the university forest Taxiarchis,

Chalkidiki. Linear and nonlinear regression techniques were used for model development. In all tested models total stem cross-sectional area was consistently the most accurate estimator for leaf area and foliar weight exhibiting $R^2 = 0.859$ and $R^2 = 0.879$ respectively. Current sapwood area, defined as the area of the early wood of the current growing season plus the entire growth ring of the previous season, was the next more accurate estimator ($R^2 = 0.726$ and $R^2 = 0.762$) followed by sapwood area ($R^2 = 0.767$ and $R^2 = 0.843$). The addition of more variables such as crown length, tree age and crown ratio improved slightly the accuracy in the multiple linear models. Both leaf area and foliar weight were best described as a linear function of current sapwood area and tree age $R^2 = 0.861$ and 0.846 respectively followed by sapwood area and crown length ($R^2 = 0.808$ and 0.829). These relationships were getting weaker as we move from stump height to upper stem sections. Specific leaf area was significantly the highest in the lower part of the crown, moreover the difference of specific leaf area between the lower and middle part of the crown was smaller than of that of the upper part. The results show that the whole sapwood area than the most recent two growth rings may be active in water conduction for Hungarian oak in the Mediterranean.

Keywords: leaf area, pipe model theory, foliar weight, sapwood area, *Quercus frainetto*

Regenerative and adaptive potential of Oriental beech (*Fagus orientalis* Lipsky) forests in Strandzha Mountain

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The Oriental beech forests are an important element of the vegetation in Strandzha Mt. They form the main types of ecosystems defining the characteristic appearance of the area and its conservation importance. The sustainable persistence of these forests is a priority in the conservation efforts of the „Strandzha“ NP.

The aim of the present study was to assess the adaptive and regenerative potential of the different oriental beech forests ecosystems.

The survey was carried out during the period 2013-2014 in the area of Malko Tarnovo and the village of Kosti. A total of 27 research plots (RP) were set up

in oriental beech forests with different composition of the understory floor: understory of Strandzha periwinkle, weed cover of *Daphne pontica* L., herbs as lower layer and cover of dead litter. On every RP basic dendrometric indicators, crown condition indicators and characteristics of the habitats were determined. The number of seedlings and samplings on each RP were counted. Based on the studied indicators the stress response and degree of forest decline were determined. The regenerative and the adaptive potential of the stands were assessed using stress response and forest decline indicators.

The degree of defoliation during the study period was low, with some improvement in the second year. All studied oriental beech trees were damaged and slightly transformed and belonged to the third category of stress. Depending on the degree of forest decline, the surveyed individuals were considered to be resistant or slightly deteriorated. The obtained results indicated significant variation in the amount of the undergrowth in the different types of studied forests, depending on the composition of the understory. In the RP with cover of Strandzha periwinkle the amount of undergrowth was little or absent at all. The most active regeneration process was present in the stands with herbal floor and with no cover (only litter). On the basis of these results, the regeneration potential of the studied stands was determined. Over the two years of the study period, approximately 65% of stands had relatively good regeneration potential (category R2) and 35% had lowered regeneration potential (category R6).

Keywords: *Strandzha, forests, regeneration, adaptation, beech*

The effects of different humic acid applications on the germination of the Pin oak (*Quercus palustris*)

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This study was conducted to determine the effects of 4 different concentrations of humic acid + fulvic acid (10 mg, 20 mg, 30 mg /1 kg seed) on germination of Pin oak seeds. The study was carried out under the conditions of 20°C temperature, 16 hours darkness and 8 hours light and 80% humidity conditions in the climatic conditions collected from the seed collected from Fatih Forest Campus at the end of 2017. In appropriate laboratory conditions, it was carried out using four replicates and 25 seeds per replicate. The ratio of

humic acid was found to be effective on germination of *Quercus palustris*. It is thought that the results can be used in landscape and nursery studies.

Keywords: *Quercus palustris*, humic acid, germination

Edible ectomycorrhizal mushrooms: a promising resource for agroforestry

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Mycorrhizas are mutualistic symbiosis between soil fungi and the roots of vascular plants. Mycorrhizal fungi are fundamental for plants survival, growth and reproduction as well as for the mitigation of environmental stresses and protection against soil pathogens. Almost all terrestrial plants form mycorrhizas, among which ectomycorrhizas (ECM) and arbuscular mycorrhizas are the most common types. Many species in the Ascomycota, Basidiomycota and some in Zygomycota (Endogonales) form ECMs with the most widespread forest tree species in the boreal and temperate regions. It was estimated that at least 6000 plant species and 20000 fungal species are involved in this type of symbiosis. More than 1000 species of ECM fungi produce above- or below-ground fruiting bodies that are used by humans for consumption. In contrast to saprobic mushrooms, edible ECM fungi need a host plant to complete their life cycle and can be grown in specialized plantation obtained by using seedlings mycorrhized in greenhouses. Currently, only few species of epigeous ECM species in the genera *Lactarius*, *Suillus* and *Rhizopogon* can be cultivated reliably by using mycelium-inoculated seedlings. Many of the most valuable ECM mushrooms (e.g. *Boletus edulis*, *Tricholoma matsutake*) are only found in the wild and the fruiting body production relies on the conservation and management of natural populations. So far, the best results in the cultivation of edible ECM fungi have been with hypogeous fungi of the genus *Tuber*. With the exception of the Italian white truffle (*T. magnatum*), the cultivation of *T. melanosporum* (Périgord black truffle), *T. aestivum* (Burgundy truffle) and *T. borchii* (bianchetto truffle) has been successful in many countries around

the world. The forest management for mushroom production (mycosilviculture), has long been poorly considered foresters who are naturally focused on tree growth and wood production. However, the concept of the forest as a potential source of food as well as a simple source of wood is becoming increasingly important in Europe, particularly for the low-input agroforestry systems. Cultivation of edible ECM fungi offers new sustainable opportunities for marginal lands but more studies are needed to find the appropriate practices for managing the dual mushroom and timber system.

Keywords: *mycosilviculture, symbiosis, truffles*

Dynamics of growth parameters of plantations from half-sibs progenies of selected *Robinia pseudoacacia* L. clones in young age

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The aim of this study is to make a comparative analysis of the dynamics of growth parameters and productivity in young age of plantations from half-sibs progenies of three black locust clones growing on the territory of State Forest Enterprise Svishtov on Haplic Chernozems, planted at scheme 3.0 x 1.5 m. Assessment is made of basic parameters of growth and productivity in sample plots with half-sibs progenies of three black locust clones (Roszin Varga, Tsarevets and Karaisen). Results show differentiation in growth and productivity both between local and introduced selected black locust clones and between individuals in social categories after investigated parameter in each sample plot. In spite of different dynamics of growth parameters of the three sample plots, basic inventory characteristics of the trees in SP3 confirm the better qualities of the progeny from Karaisen clone and should be taken into account in the selection of material for establishment of industrial plantations and plantations for biomass on similar sites, as well as for carrying out and selection of thinning activities.

Keywords: *black locust, clone, half-sibs progeny, growth, productivity*

Quality of Locust tree wood (*Robinia pseudoacacia* L. var. *rectissima* Raber.)

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White acacia (Locust tree, *Robinia pseudoacacia* L.) is fast growing tree species, which can produce high quality wood within 15-20 years and is therefore economically very important. The structure and wood properties of 7 locust clones (*Robinia pseudoacacia* L. var. *rectissima* Raber) at ages between 7 and 35 years were investigated. They were cultivated in four schemes of plantation densities on carbonate chernozems (CH), alluvial (FL) and alluvial-meadow (Fle) soils in North Bulgaria. The obtained results show that there is good correlation between wood density and mechanical properties. We suggest that such differences are due to site influence, plantation densities and tree age.

Keywords: *locust tree, locust clones, wood properties, wood quality*

4.5. (T5) Biodiversity, Forest Health and Biological Invasion

Invasive alien species in the flora of the Lozenska Mountain

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The study is new for the territory of the Lozenska Mt. and is part of investigation of its floristic composition conducted in the period 2016-2018. The aims of this study are to (i) describe the taxonomical and ecological structure of the invasive alien flora in the Lozenska Mt., and (ii) provide information on the distribution of the globally most widespread invasive species. Thirteen alien invasive species are identified, 4 of which (*Ailanthus altissima* (Mill.) Swingle, *Acer negundo* L., *Robinia pseudoacacia* L. and *Opuntia humifusa* (Raf.)

Raf.) are included in the list of the 10 species with most significant negative impact in the world. A map with the localities of the alien invasive plant species found on the territory of the mountain is prepared. The analysis of the distribution of the invasive alien species shows their predominant presence in areas around rivers with permanent water regime such as Iskar, Rakita and Gabra, and near urbanized terrains adjacent to settlements, along roads and abandoned mines. The populations of the species *Robinia pseudoaccacia* and *Opuntia humifusa* are predominant in communities in some parts of the mountain. The vast majority of the other invasive alien species have so far formed small populations that enter as assectators in the natural plant communities.

Keywords: AIS, ecological strategy, plant distribution, anthropophytes, decorative species

Biodiversity development under selected native woody plantations on coalmine spoil in a dry tropical region of India: A case study

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Present study was conducted in a dry tropical region of India where mining is one of the serious problem degrading precious forests with unprecedented rates. Hence, ecological restoration is a really challenging ecological problem; moreover, their recovery by natural succession is very slow. To understand ecology of soil carbon sequestration and restoration potential, a number of parameters like soil organic carbon, accretion, accumulation, soil microbial biomass, soil respiration etc. were monitored from soil component and biomass, growth performance (culm/clump recruitment) standing stock of carbon, cycling of carbon (plant-soil), mineralization (CO_2), turnover (carbon accretion rate, sequestration rate) and several others were monitored from vegetational component. The objective of this study was to quantify biodiversity recruitment, and to estimate biomass, net primary production (NPP), carbon cycling and standing stock under planted plots of selected woody species: *Albizia lebbeck*, *A. procera*, *Tectona grandis* and *Dendrocalamus strictus*. Results indicated that influence of all these plantations on soil carbon sequestration and redevelopment was more pronounced with increasing age of planta-

tion. However, recruitment of biodiversity development was not so effective due to age because canopy cover provides more shade and cool region under plantation surface which maintain significant level of soil moisture in the rhizosperic zone that provides feasible condition to the microbial flora and fauna. Moreover, contribution of fine and coarse roots biomass provided substantial amount of soil organic matter, after mineralization, contributing more carbon accretion in soil with increasing age significantly showing impact of plantations on soil redevelopment. Moreover, accretion of soil organic carbon (SOC) in redveloping soil was significantly related with soil carbon sequestration with plantation age confirming positive way of soil redevelopment.

Keywords: *soil carbon sequestration, coal mine spoil, restoration, soil-revelopment, biomass*

European plants invasive in the Asia-Pacific region: an appraisal

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Invasive alien plants are a great threat to the economy and ecology of most countries in the Asia-Pacific region. Managing the spread and damage caused by these plants has not been particularly successful except in a few cases and in a few countries where biocontrol has been relied upon. Lack of awareness, poor policy framework and a host of other reasons frustrate management options in several countries.

Curiously, majority of the invasive plants in the region originates from tropical America for obvious reasons. However, there are several European plants also which include *Ulex europaeus*, *Cytisus scoparius*, *Sonchus arvensis*, *Clematis vitalba*, *Heliotropium europaeum*, *Carduus tenuiflorus* and *Marrubium vulgare* which are highly invasive in the Asia-Pacific region. This paper will present an overview of these invaders, their distribution within the region and examine ways and means for prevention of new incursions and managing the spread of established invaders.

Keywords: *invasive plants, European origin, Asia-Pacific region, management*

Preliminary data from red deer (*Cervus elaphus* L.) GPS/GSM telemetry in Bulgaria

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Telemetry is a widely utilized method to track animal movements and analyze behavior. So far, there have been no published studies on telemetry of red deer in Bulgaria. Here we present preliminary results from a pilot study from GPS/GSM telemetry. 10 red deer individuals (7 males, 5 of which subadults (approx. 1.5-year-old) and 3 adult females) were collared and tracked on the territories of several State Hunting Enterprises on the Northern slopes of the Central Balkan Mountains, Bulgaria. The total tracking period was 2032 days, accumulating 6035 GPS fixes. Minimum convex polygon (MCP) was used to estimate home range sizes. The subadult males' home range sizes varied between 1.3 and 11.2 km², while adult males exhibited much larger home ranges – between 75.1 and 79.8 km². The females' home ranges varied between 2.5 and 5.8 km². Interesting patterns were observed in the overlapping of the territories between two subadult males and between a subadult male and a female. Some of the observed individuals demonstrated high mobility during the study period. These results might have implications for red deer management, and also enhance our understanding of the species' mobility, behavior and dispersal patterns.

Keywords: *red deer, home range, MCP, mobility*

90 years Forest Research Institute - BAS, 70 years research in Hunting Economy

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The scientific department „Hunting Economy“ in the Forest Research Institute was established in 1948, later renamed „Ecology and reproduction of hunting fauna“. It has been an independent scientific unit in the structure of the Institute and is the only one in the BAS system where scientific and applied studies of hunting fauna are made. Research work in the field of hunting is aimed at broadening knowledge of biology and ecology of game, relationships and interactions between species and methods of population management. Due to the reduction of the staff, in 1988 it was transformed into a laboratory „Ecology of the hunting fauna“. In 2009, there remain only one researcher, and during the reorganization of the Institute, the unit was deleted and this specialty went to section „Forest entomology, phytopathology and hunting fauna“. The priority directions of research are:

- studies on the biology, ecology and ethology of major game species in order to manage them on a scientific basis;
- studies on game damage and the possibilities for limiting them;
- organization and management of the hunting economy;
- heavy metal pollution of biotopes and its impact on game populations;
- increasing the culture of hunting sport;
- popularizing scientific results.

Keywords: *Forest Research Institute, hunting economy, game fauna*

Pathogens and parasitoids of forest pest insects in the region of Forest Protection Station Plovdiv (Bulgaria) during the period 1990 - 2017

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During the period 1990-2017, a survey of entomopathogens and parasitoids of several pest insects, including the lepidopterans *Lymantria dispar*, *Euproctis chrysorrhoea*, *Leucoma salicis*, *Malacosoma neustria*, *Orthosia cerasi*, *Aporia crataegi*, *Operophtera brumata*, *Eilema complana*, *Tortix viridana*, *Archips xylosteana*, *Paranthrene tabaniformis*, *Gypsonoma aceriana*, *Thaumetopoea pityocampa*, *T. solitaria*, *Phyllocnistis unipunctella*, the coleopterans *Saperda populnea*, *Ips typographus*, *I. acuminatus*, *I. sexdentatus*, *Pityogenes chalcographus*, *Dryocoetes autographus*, *Hylurgops palliatus*, *Phyllobius* sp. and the hymenopteran *Diprion pini*, *Neodiprion sertifer*, *Gilpinia* sp. and *Tremex fuscicornis* has been conducted. As a result of these studies 5 viruses, 1 protozoan species, 7 microsporidian species, 5 species of entomopathogenic fungi and 46 parasitoid species have been documented in 27 pests collected in the region of the Forest Protection Station - Plovdiv. The first successful introduction in Bulgaria of the entomopathogenic fungus *Entomophaga maimaiga* into populations of *L. dispar* was conducted in 1999 in the region of the Forest Protection Station at Plovdiv (in the village of Gorni Domlyan, Karlovo Forestry) and 7 subsequent introductions were later performed in the region of the station. As a result, the *L. dispar* density has been maintained at low levels in that area and only 60 hectares were sprayed with insecticides for *L. dispar* control in the last 18 years. Another success was the first field release in Europe and Bulgaria of the entomopathogenic fungus *Entomophaga aulicae* in a healthy population

of the brown tail moth *Euproctis chrysorrhoea* in 2016 in the village of Zhenda (Kardzhali Forestry). Investigations in 2017 showed that 19% of *E. chrysorrhoea* larvae sampled from release sites died due to infections caused by *E. aulicae*.

Keywords: Forest Protection Station - Plovdiv, insect pests, pathogens, parasitoids, *Entomophaga maimaiga*, biological control

Are hardly visible stromata („micro-stromata“) in callused cankers additional means of persistence and dissemination of hypovirulence within populations of the chestnut blight fungus *Cryphonectria parasitica*?

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The phenomenon hypovirulence present in isolates of the chestnut blight fungus *Cryphonectria parasitica* is caused by dsRNA viruses named CHV. Hypovirulence is naturally spread within populations of the blight fungus, thus allowing for recovery of affected trees. Various aspects of the modes and vectors of its dissemination and spread have been thoroughly investigated in the past. Still, many questions remain unanswered regarding the seemingly disproportionately successful spread compared to the restricted production of stromata and pycnidia in healing cankers of the chestnut blight.

We assessed for presence of stromata of *C. parasitica* in callused cankers which appear to be stromata-free to the naked eye. We used magnifying lenses to thoroughly inspect callused cankers in situ at 7 chestnut subpopulations throughout the territory of the Republic of Macedonia. From these cankers, 104 bark samples were collected, containing one or more bodies resembling stromata of *C. parasitica*. All collected stromata were with unusually small dimensions (compared to stromata easily visible to the naked eye) and we dub them „micro-stromata“. All samples were dissected and assessed for presence of pycnidia by using a compound microscope, and for isolation purposes. Isolation was attempted from all micro-stromata, and all isolates were cultured for assessment of hypovirulence.

Of the total of 104 samples, we isolated 43 hypovirulent and 30 virulent cultures, while we failed to isolate *C. parasitica* from 31 samples (due to contamination or failure of growth). Presence/percentage of hypovirulence in microstromata var-

ied depending on sites, from only 16% in Vratnica, up to 85% in Raven. However, we stress that the number of samples per site is insufficient for a statistically valid conclusion regarding this aspect. We observed only 1 pycnidium in all assessed micro-stromata, and the culture isolated from it was hypovirulent.

Although we present preliminary data, we can conclude that micro-stromata present on callused cankers of chestnut blight, normally invisible to the naked eye, bare hypovirulence to a certain extent, and are likely one mode of persistence and dissemination of hypovirulence in *C. parasitica*. Additional research is needed in order to assess if these structures have any role in dissemination of hypovirulent isolates, or they are remnants of underdeveloped stromata without the possibility to eventually form pycnidia.

Distribution and impact of *Cryphonectria parasitica* (Murr.) Barr. causing chestnut blight disease on *Castanea sativa* Mill. in Bulgaria

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The invasive pathogen *Cryphonectria parasitica* causes one of the most destructive diseases on *Castanea sativa* stands. In Bulgaria, the disease was observed for first time at the end of 1980s in pure and mixed chestnut stands in the Belasitsa Mt. and the Eastern Rhodopes. Over the last decades, the disease has a negative effect on the vitality of *C. sativa* populations throughout the country, leading to the loss of an important chestnut stands production and the progressive death of the trees. In 2018, the incidence of the pathogen, its distribution and strain diversity were surveyed in a network of permanent sample plots established on the northern slopes of Belasitsa Mt., Southwest Bulgaria and the Eastern Rhodopes. For each tree, stems and crowns were visually assessed for signs of the pathogen and symptoms of the disease. The severity of chestnut blight disease was evaluated according to the number of cankers on stems and degree of defoliation compared on different plots and regions. New records for *C. parasitica* spreading on a chestnut mature plantation planted in the region of Makaza and Krumovgrad, the Eastern Rhodopes, were established. Current knowledge of the incidence and severity of the disease is important for implementation of timely and effective management control strategies.

Keywords: *Cryphonectria parasitica*, *Castanea sativa*, distribution, severity, Bulgaria

Age changes in the growth of lower canine teeth of wild boar (*Sus scrofa*) males

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As a secondary sexual trait, the male wild boars develop canine teeth (tusks) that begin to grow at the end of the first and the beginning of the second year of their life. According to their purpose, the lower tusks are real weapons of struggle. The tooth enamel of the upper tusks has a porcelain-like consistency and is produced throughout their growth period as opposed to the crowns of the remaining teeth that are formed only once. Because of the hard surface, the wear of the upper tusks is far less than the lower ones, which consist only of dentin. That is why their growth in length is only a quarter of that of the lower tusks. In the first year of male age, the lower tusks have no eroded parts. The process of erosion begins when the animal is 15 months old, and the tooth reaches 20-25 mm. The eroded part of the tooth increases with increasing age of individuals: up to 1 year is 2.5 mm, up to 2 years - 19.1 mm; up to 3 years - 31.9 mm; up to 4 years - 39.7 mm; up to 5 years - 48.2 mm; up to 6 years - 54.7 mm; up to 7 years - 62.8 mm; older than 7 years - 71.5 mm. The size of the eroded part of the lower tusks is used to determine the age of wild boar males.

Keywords: *Sus scrofa*, males, tusks, age changes

Impact of parasitoids on egg mortality of pine processionary moth in new habitats

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In 2010, in the land belonging to the village of Vetren (Nevestino Forest Service), South-West Bulgaria, in *Pinus sylvestris* stands, appearance of pine processionary moth was detected. The study began three years later. Egg batches were collected from 2013, 2014 and 2016 generations. Parasitoids on its eggs

were established: *Ooencyrtus pityocampae*, *Baryscapus servadeii*, *Anastatus bifasciatus*, *Trichogramma* sp. and the hyperparasitoid *B. transversalis*. The most numerous was *O. pityocampae*, its relative share gradually decreasing. A significant regulating role of the parasitoids on the number of pine processionary moth has been reported: 17.3-23.0%. For the parasitization of the eggs in individual batches a wide range of combinations between the parasitoids was established and observed. After sample collection, in laboratory conditions, all emerged individuals of *O. pityocampae* and *B. servadeii* were female, *A. bifasciatus* – male, and of *B. transversalis* – from both sexes, at a ratio of female:male – 2:1. In laboratory, the longest emergence period was for *O. pityocampae*, reaching up to 178 days, ending in July-August.

Keywords: *Thaumetopoea pityocampa*, egg parasitoids, new habitats, Bulgaria

The expansion of pine processionary moth (*Thaumetopoea pityocampa*) in Bulgaria – zone and rate

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Data records of the Forest Protection Station in Plovdiv were used to study zone and rate of spread of pine processionary moth (*Thaumetopoea pityocampa* (Den. & Schiff.)) in plantations of *Pinus sylvestris* L. and *Pinus nigra* J.F. Arnold on the territory of Regional Forest Directorate Stara Zagora. During the observation period (1995-2017), some fluctuations of the dynamic of attacks were observed, with two peaks within 10 years, the first at the beginning of the past decade and the second - at the beginning of the current one. Initially, the processionary moth attacks spread gradually in the territory of the State Forest Enterprises Chirpan and Pavel Banya and the State Hunting Enterprise Mazalat. Later on, the pest started spreading eastward and, in the recent years, it affected small areas in the State Forest Enterprises Stara Zagora, Kazanlak and Maglizh. There is a clear spatial dependence of newly infested areas on the already infested ones. Our conclusion is that in order to prevent *T. pityocampa* to affect the whole territory of the eastward neighboring forest

enterprises, as it as it has done it in Pavel Banya, it is necessary to control effectively its initial outbreaks.

Keywords: *Thaumetopoea pityocampa*, expansion, rate of spread, pine plantations, Bulgaria

New hosts of xylophagous longhorn beetles (Coleoptera: Cerambycidae) in Bulgaria

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In 2017 and 2018, 42 trophical connections between 28 cerambycid taxa and 16 trees and shrub species were established in Bulgaria. Longhorn beetles belong to five subfamilies as follows: Prioninae (1 species); Lepturinae (6); Spondylidinae (3); Cerambycinae (9); Lamiinae (9). Thirty-three relationships are new records for Bulgaria: *Prionus coriarius* – *Quercus rubra* and *Prunus avium*; *Anastrangalia dubia dubia* – *Abies alba*; *Pachytodes erraticus* – *Q. rubra*; *Rhagium bifasciatum* – *A. alba*; *Rhagium inquisitor inquisitor* – *A. alba*; *Rhagium mordax* – *Alnus glutinosa*; *Rutpela maculata maculata* – *Betula pendula* and *P. avium*; *Alocerus moesiacus* – *Quercus suber*; *Saphanus piceus ganglbaueri* – *P. avium*; *Anaglyptus mysticus* – *Fagus sylvatica* and *Crataegus monogina*; *Cerambyx cerdo cerdo* – *Q. suber*; *Cerambyx scopolii scopolii* – *Quercus rubra* and *Quercus cerris*; *Phymatodes testaceus* – *Q. rubra*; *Purpuricenrus budensis* – *Paliurus spina-christi*; *Pyrrhodium sanguineum* – *Quercus dalechampii*; *Ropalopus femoratus* – *Q. rubra*; *Callimoxys gracilis* – *P. spina-christi*; *Trichoferus pallidus* – *Quercus dalechampii*; *Acanthocinus griseus* – *Abies alba*; *Aegomorphus krueperi* – *Q. suber*; *Leiopus linnei* – *Juglans regia* and *Q. dalechampii*; *Leiopus nebulosus nebulosus* – *Q. rubra*; *Mesosa curculionoides* – *Q. rubra* and *P. avium*; *Mesosa nebulosa* – *Quercus cerris* and *Q. dalechampii*; *Morimus asper funereus* – *Q. dalechampii* and *Salix caprea*. *Trichoferus pallidus* is a new species for Vitosha Mt, and *Juglans*

regia is a new host of *Leiopus linnei*. The new records enlarge knowledge of longhorn beetles host ranges and distribution of the species in the country.

Keywords: *Cerambycidae, xylophages, host plants, Bulgaria*

A check list and arealography of longhorn beetles (Coleoptera: Cerambycidae) in Vitosha Mountain

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The analysis of literature data and studies of original biological materials showed that the complex of longhorn beetles in Vitosha Mt. includes 116 taxa from six subfamilies: Prioninae (2 species), Lepturinae (36 species and subspecies), Necydalinae (2 species), Spondylidinae (7 species and subspecies), Cerambycinae (32 species and subspecies) and Lamiinae (37 species and subspecies). The established taxa belong to 20 zoogeographical categories and 7 complexes. The European complex occupies dominant position (36.2%), followed by the Palaearctic complex (21.6%). The Mediterranean and Euro-siberian taxa are almost equally presented in the total complex – 12.9% and 12.1%, respectively. However, the cerambycid endemics in Vitosha Mt. (1.7%) have smaller share compared to endemics for the country (6.8%).

Keywords: *Cerambycidae, chorotypes, Vitosha Mt., Bulgaria*

New invasive needle blight pathogens on *Pinus* spp. in Bulgaria

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In recent years, occurrence of *Dothistroma* needle blight (DNB) caused by fungal pathogen *Dothistroma septosporum* and brown spot needle blight (BSNB) infection, caused by *Lecanosticta acicola*, was established for first

time in Bulgaria. *D. septosporum* was confirmed in 2017 as the causal agent of DNB on *Pinus sylvestris* and *P. nigra* trees planted in the region of Panichkovo, Kardzhali district. *L. acicola* was detected on *P. sylvestris* and *P. nigra* needles in a seed orchard of *P. sylvestris* and on pine stands near the orchard in the region of Ardino, the Eastern Rhodopes. The new pathogens showed high aggressiveness, rapidly infected hosts and produced large quantities of inoculum. They are included in the EPPO quarantine lists (EPPO 2008 and EPPO 2005, respectively), and are considered as invasive highly adaptable to new susceptible hosts and favourable environmental conditions pathogens. The noticed symptoms and pathogenicity of DNB and BSNB diseases strongly suggest that the new emerging pathogens in Bulgaria have the potential to cause severe damages and to threaten *Pinus* spp. in the country.

Keywords: *Dothistroma septosporum*, *Lecanosticta acicola*, *Pinus* spp. needle blight disease

A survey of scale insects (Hemiptera: Coccoidea), infecting Cupressaceae family in Bulgaria

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Over the last twenty years the representatives of Cupressaceae family are massively cultivated and have become very popular in urban and garden design. Most of the members of this family have alien origin and only some junipers grow in natural habitats in Bulgaria. Among the different pests attacking cypress plants, coccids play a major role in hampering their development and significantly reduce their aesthetic and market value. In this paper the annotated list of country's detected scale insects which includes data on their organotrophic specialization, established localities, review of spreading pattern and current population status is presented.

The most important pests among the scale insects are *Planococcus vovae* and two species from genus *Carulaspis*. Detailed data on their biology, phenology and ecology, determined by a study conducted in the period 2016-2018 is discussed.

Keywords: *Cupressaceae* family, scale insects, *Planococcus vovae*, *Carulaspis juniperi*, *Carulaspis minima*

Economically important insect pests in Bulgarian forestry during the period 2003-2017

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During the period 2003-2018, damages of economically important insect pests in Bulgarian forests were investigated according to data of Executive Forest Agency information system. Attacks of multiple insects belonging to 26 families and 6 orders have been recorded. The total attacked area is 224 828.8 ha, which makes 15 000 ha per year. The share of deciduous forests in the heavily attacked area (60%) is less than their share in the total forested area (72%), which indicates that they are attacked less often than conifers. In the coniferous forests, almost 100% of the attacks are caused by pine processionary moth (*Thaumetopoea pityocampa*), bark beetles (Coleoptera: Curculionidae, Scolytinae) and conifer sawflies (Diprionidae and Pamphilidae). In the deciduous forests, nearly 93% of the attacks are caused by gypsy moth (*Lymantria dispar*) and the group of leafrollers (Tortricidae) and geometer moths (Geometridae). Compared to a previous survey period (1990-2002), two significant differences are highlighted: increasing of economic damages caused by bark beetles in coniferous plantations; reduction of *L. dispar* attacks after the successful introduction of *Entomophaga maimaiga* in 1999.

Keywords: forestry, insect pests, damages, Bulgaria

Assessing pine processionary moth (*Thaumetopoea pityocampa*) unfertilized eggs in different localities in Bulgaria

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During the period 1991-2016, the main characteristics of *Thaumetopoea pityocampa* in egg stage were studied in different parts of the species range in Bulgaria. As a result, 52 samples containing 1238 egg batches and 293189 eggs were collected in 33 localities. Successful hatching of caterpillars was

observed in 66.1% of the eggs, and the amount of sterile eggs was 3.7%. The relative share of sterile eggs in different samples varied within a wide range - 0.2-29.1%. The majority (77.0%) of egg batches contained sterile eggs between 1% and 10%. Sterile eggs below 1% and above 10% were counted in 15.4 and 7.6% of the samples, respectively. The highest percentage of non-fertilized eggs of *T. pityocampa* was recorded in the samples from the southern part of the country: Marikostinovo vill., an average of 29.1% and a maximum value of 100% in a single egg batch; Garmen vill. (15.9% and 92.0%, respectively); Dicchan vill. (10.3% and 79.1%), and Ploski vill. (7.4 and 22.5%). In the area of the northern range of the species, these values are considerably lower: Bania vill. (5% and 17.9%), and Kurtovo vill. (1.7 and 6.4%). Hypotheses about the reasons for the extremely high proportion of non-fertilized eggs are suggested.

Keywords: *Thaumetopoea pityocampa*, unfertilized eggs, Bulgaria

Pest status of *Ovalisia (Palmar) festiva* (Linnaeus, 1767) (Coleoptera: Buprestidae) in Bulgaria

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The subject of our study, conducted between 2016 and 2018, was the associated with representatives of Cupressaceae family pests. In this paper the pest status of this previously considered as quite a rare species in Bulgaria *Ovalisia festiva* is reported. This species is reported for the first time in 1931 and over the last seven years has considerably extended its distribution area, causing significant damage to the Cupressaceans in nurseries, gardens and parks in Bulgaria. Detailed morphological and bio-ecological features are presented together with the potential host plants, present distribution and established locations in Bulgaria.

The damage caused by *Ovalisia festiva* is compared to that caused by the species of the genus *Phloeosinus* which until recently were one of the most important pests on *Thuja* sp. Although it is too early to estimate the impact of *Ovalisia festiva* we claim that this beetle has become a real threat for the cultivars in a lot of regions in Bulgaria and should be strictly monitored.

Keywords: *Cupressaceae* family, *Ovalisia festiva*, jewel beetle, distribution, *Thuja*

Xylophagous insects in pine (*Pinus* spp.) plantations in the Ihtimanska Sredna Gora Mountain

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During the period 2017-2018, xylophagous insects on *Pinus* spp. were studied in Ichtimanska Sredna Gora Mountain in Bulgaria. Drying of pine plantations located at low altitudes (up to 700-900 m a.s.l.) has been established in the region. The bark beetles (Coleoptera: Curculionidae, Scolytinae) were observed as the most dangerous insect pests. In *Pinus sylvestris* plantations, the first attacks were caused by *Ips acuminatus* Gyll., followed by infestations and development of *Ips sexdentatus* Börn., *Orthotomicus laricis* (F.), *O. erosus* (Woll.), *Tomicus minor* Hart., *T. pinipera* L., etc. Representatives of other taxonomic groups – the steel-blue jewel beetle *Phaenops cyanea* F. (Coleoptera: Buprestidae) and pine weevils of *Pissodes* genus (*P. pini*, *P. piniphilus*, *P. castaneus*) are also important pests, attacking healthy pine trees.

Keywords: *Pinus*, drying, xylophages, Ichtimanska Sredna Gora

4.6. (T6) Ecosystem Services, Monitoring and Interdisciplinary Research

Measuring users' health benefits from three healing forests in Korea

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Using forest is considered one approach to promoting health in the modern urbanite's life. Previous studies and empirical data suggest that contacting with forest provide various health benefits to users. Engaging with forest can even cultivate ecological sensibilities that motivate us to protect the health of our planet. This study was conducted to identify visitors' health outcomes from three national forest uses, and to examine whether or not the visitors' health

outcomes were related to some characteristics of forests. Structured surveys were conducted with 600 forest visitors in three national forests across South Korea. Examination of forest health outcomes revealed that there were multiple factors of outcomes including psychological, physical and social. The results also indicated that there were highly correlated between level of outcomes and socio-economic characteristics of visitors such as gender and education. From the results of this study provided valuable management implications on managing forest and related facilities for human health.

Keywords: *health benefits, South Korea, human health*

Moss monitoring of atmospheric deposition in Western Rhodopes, Bulgaria

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Moss biomonitoring technique was used for the first time in Western Rhodopes for studying the air pollution in 2014/15 in the framework of International Co-operative Programme on Effects of Air Pollution on Natural Vegetation and crops under the auspices of the United Nations Economic commission for Europe (UNECE-ICP Vegetation). The survey was repeated in 2018 when the moss samples were collected during vegetation season from 5 sites over the territory of Western Rhodopes.

Concentration of Al, As, Cd, Cr, Cu, Fe, Ni, Pb, V and Zn were determined by ICP-AES and ICP-MS. Principal component analysis (PCA) was used to study relationships between the different elements in each site. The element values were divided by their standard deviation and PCA was species-centered. The spatial trends were assessed and evaluated. The maps were produced using ArcMAP, part of ArcGIS, an integrated geographical information system (GIS).

Data obtained from these two surveys were compared, and additional comparison was done with data obtained from similar studies in Bulgaria and Europe as well.

Keywords: *Hypnum cupressiforme, moss survey, atmospheric deposition*

Urban tree management and ecosystem services in the town of Sevlievo

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A total of 2555 trees in the green infrastructure of the town of Sevlievo were established. There are a few researches about the value of trees ecosystem services on the air quality and human health. Urban trees provide an ecosystem service for purification the air in the city through absorption of gaseous pollutants. (Sz-kop, 2016; Daniels et al., 2017; Doick et al., 2017). This is important issue because Sevlievo is an economic center and the production of different industries in the area is much bigger than in the other cities. According to the collected data the average daily concentration of the particulate matter is 250 mg; the average 24 - hour concentration of SO₂ is 125 micrograms; the average 24 - hour concentration of NO₂ is 200 micrograms. 100 leaf samples of two tree species (*Juglans regia* L. and *Paulownia tomentosa* L.) were tested. It was found that the most accumulated element is Fe – 123 mg for *Juglans regia* L. and 156 mg for *Paulownia tomentosa* L. The total quantities of pollutants accumulation by dendroflora of Sevlievo was calculated. The role of trees for the regulation and support services in urban environment of Sevlievo, as well as the space distribution of these services were presented.

Keywords: *air pollution, urban green infrastructure, dendroflora, ecosystem services, management*

Transformations of forest and field land use within the East European plain during the last 230 years

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Our research deals with analysis of forest change at the East European Plain for the last 250 years. The analysis of historical maps shows that at different periods forest areas changed differently from region to region. For example south taiga forest area decreased during the whole 19th century and especially in the end of the 19th century- first part of the 20th century because of arable area growth

whilst some parts of the mixed forest zone, such as the river Ugra basin, demonstrate constant increase of the forest area up to the 6 times during the whole period. The current change of the forest area was studied with the help of remote sensing data. We have found two opposite trends. From one side arable land area has been dramatically declined and changed by growing forests since the non-market economy failed in the nineties of the 20th century. From the other hand, at that period uncontrolled mature wood felling increased all over the area.

So we study up-to-date forests both with field trips and remote sensing imagery particularly Landsat. Winter Landsat imagery is used to separate coniferous woods, deciduous woods, and non-wooden vegetation. We use a special filter showing brightness variations around each pixel of the image in order to exclude anthropogenic wooden vegetation such as gardens, forest shelter belts, and parks. The algorithm of image processing for deciduous forest division by species composition is suggested taking into account the time shift in the onset of the same phenological phases for different tree species. We used radar survey (SRTM) for a landscape map, which includes land units such as flood plains, river terraces, ravine-beam networks, slopes and plains. Comparison of forest cover map with landscape map shows that interfluvial forests disappear now only in the south of the studied area.

Keywords: *Forest area, uncontrolled wood felling, decrease of arable land, remote sensing data, image processing*

Analysis of reaction of the *Vaccinium myrtillus* populations to the external influences by methods of simulation modelling

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Dwarf shrubs are widespread in boreal forests, influencing the regeneration of trees, competing with them for resources, and being involved into the biogeochemical cycles, play a significant role in the restoration of forests after disturbances. A field experiment was conducted to identify the reaction of bilberry clones to various disturbing effects (shoots', rhizomes' damage, removal of litter) in the pine forest (Moscow region). After severing the rhizomes, the ramets which completely lost contact with other parts of the clone, were virtually eliminated (survival rate

was 3%). Survival rate of ramets that retained the link with at least one ramet exceeded 40%. After cutting of rhizomes or shoots, the evocation of 1–3 dormant buds was occurred. After removal of the litter, the rhizomes that appeared on the soil surface took an orthotropic position, and the shoots located on them combined into a single system. A module simulating the reaction of the dwarf shrubs to the disturbances was developed for the CAMPUS model. Module consists of unit for simulating disturbances and unit for setting the parameters of reaction to influences. It allows specifying certain types of damage and their combinations, thus simulating real scenarios of disturbances (fires, cuttings). The restoration of clones begins at the next step of the model in case of damage occurred during the vegetation period, and in the first month of the next growing season when damage occurred during the winter. The scheme of location of invoking dormant buds on the rhizome is modified. The number of new shoots that are formed after the damage of part of the clone depends on the number of dead ones and the type of damage. As a result of the simulation experiments it was shown that not only the intensity and type but also the frequency of the disturbances, influences the restoration of the bilberry populations. With single exposures, bilberry populations are able to recover after the damage of 95% of the territory, while with annually repeated disturbance, populations die if 10% of the territory is damaged

Acknowledgements: The work was supported by the RFBR (18-34-00556) and the RSF (18-14-00362).

Keywords: *Vaccinium myrtillus*, modelling, disturbing effects

The MAES process in Bulgaria – next steps and new challenges

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The MAES process in Bulgaria has completed its first stage with very good results, highly appreciated by the MAES Workgroup at the European Commission. However, some important issues await their development - the relationship between the assessed ecosystem capacity to deliver ecosystem services and their use by the public supply/demand, how to make an integrated ecosystem assessment, how to use regulating ecosystem services to adapt to

climate change, how to strengthen resilience and the health of ecosystems in the changing world, how to involve the stakeholders to ensure the protection of ecosystem services. A process of their valuation is forthcoming. We also face new challenges - the problem of the lack of quality data at the ecosystem level - the creation of a concept for ecosystem monitoring, new policies in the field of agriculture, cities (green infrastructure), etc. Problems are not only administrative issues related to the implementation of new policies, but they are based on very important scientific issues that need to be addressed both globally and at national level.

Potentialities of the Remote Sensing technics for quantifying carbon stock of forest ecosystems in Bulgaria

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Global climate is being affected by human activities that result from the emission of certain greenhouse gases (GHG) into the atmosphere. Types of vegetation cover, especially forests, are considered to be a major components affecting biosphere-atmosphere interactions and play an important role in combating excessive GHG emissions by converting carbon dioxide into biomass-carbon. Therefore, biomass measurements per unit area and productivity have been set as one of the objectives of the International Geosphere and Biosphere Program (IGBP).

However, the conventional ground-based assessment of biomass is a laborious process and has been found insufficient to present spatial extent of the biomass. Therefore, combining terrestrial biomass estimation and Remote sensing technics is an increasingly used approach in many countries as a good opportunity for quantifying carbon stock. This study presents the possibilities of applying this multidisciplinary approach to the territory of Bulgaria in order to instigate its widespread use in different fields of forest ecology and ecosystem research.

Keywords: *remote sensing, carbon sequestration, forest ecosystems*

GIS-based approach to updating the database of old growth trees in Sofia

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The article discusses issues related to the maintenance and updating of old growth trees data in the capital Sofia. The data was collected in an electronic register of old growth trees protected under the Biological Diversity Act. The Regional Inspectorate of Environment and Water (RIEW) in Sofia examines the ecological status of the old trees every year and registers the changes. The care for trees on the territory of Sofia municipality is in fact Sofia municipality's responsibility. Many governmental and non-governmental organizations are involved in the protection and popularization of old growth trees. Moreover, citizens take part in the process of updating and refining information on existing old growth trees in the capital. The purpose of this study is to integrate existing databases and to add location (coordinates and address) of each old growth tree as a mandatory element. The old growth tree „passport“ was created to contain the necessary information about a tree's biometric characteristics and status assessment. The results of the tree study and data updates have been integrated in a GIS database. They are visualized via freely available web GIS platforms where the old growth tree map of Sofia can be supplemented.

Keywords: *database, GIS, interactive map, old growth trees, tree passport*

Mapping and assessment of ecosystem services in Bulgaria at multiple scales

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The EU Biodiversity strategy to 2020 aims to halt the loss of biodiversity and ecosystem services in the EU and helps to stop global biodiversity loss. The action 5 of the strategy calls member states to map and assess the condition of ecosystems and their services in their national territory. Urban landscapes

are the environment where most of the population live and perform their usual everyday activities. They also provide a number of benefits for the human society through their ecosystem services. Mapping of ecosystem services has broad application potential since it is an extremely valuable method for visual representation of qualitative and quantitative spatial data.

Following MAES framework, a methodology for mapping and assessment of nine ecosystem types was developed. It consists of three main parts: mapping of ecosystem types; assessment of ecosystems condition; and assessment of ecosystem services. The later addresses assessment of ecosystem services defined after CICES classification and adapted for the specifics of ecosystems in Bulgaria. The maps of ecosystem services were produced for two different scales: national and local. The national scale maps are produces using municipalities as spatial unit. The local scale maps are produced using the ecosystem polygon data. The potential impacts of these maps to stakeholder needs at national, regional and local level are discussed.

Keywords: *ecosystem services, MAES, spatial unit, CICES*

Mapping forest dynamics in key area „Bogdaia“ (Northwestern Rila Mountain) during 50 years period

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Archival aerophotographs and recent satellite VHR images are used as a source of spatial information for forest areas mapping during the long period. All images are processed for precise orthorectification. It is necessary to be certain that recognized changes are due to real forest dynamics instead errors processing. A sustained trend of forest restoration during the half-century period is observed.

Keywords: *multiannual landscape dynamics, change detection, Rila mountain*

The protective forest belts in Dobrudzha and their role as nectar corridors

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The current study is dealing with the role of the protective forest belts, as nectar corridors, in the functional categorization of the forests in the territory of Silistra Municipality. The species composition and structural configuration of these linear elements are investigated in the context of the overall landscape structure of the area, dominated by agro landscape systems. Their importance, as providers of the ecosystem service of pollination, and the indivisibly connected diversity of species, habitats and the ecological connections among them are analyzed. The analysis is bound with the functioning of the newly announced „Srebarna Biosphere Park“, territorially coincidental with Silistra Municipality, which depends on the presence of ecosystem services and the functional landscape zoning for the improvement of the local economic development, the diversity of land use and the improvement of the welfare of the local people.

Keywords: *nectar corridors, species, habitats, Srebarna Biosphere Park*

Parameters of old-growth beech and fir-spruce-beech forests inferred from orthoimages, satellite data, and terrain data analysis

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In our study we used photogrammetric and remote sensing methods, analysis of orthoimages and satellite images, and terrain field work to collect data on Old-growth forests. We studied beech-dominated forests in the Steneto reserve in Central Balkan National Park (Stara Planina Mountain, Bulgaria) and mixed fir-beech-spruce forests in the Parangalitsa reserve in Rila National

park (Rila Mountain, Bulgaria). For those sites we found forest parameters typical for Old-growth forests – high number of trees with big DBH (78 n/ha in Parangalitsa; 34 n/ha, max 73 n/ha, in Steneto), high volume of deadwood ($>200 \text{ m}^3/\text{ha}$ in Parangalitsa and $>150 \text{ m}^3/\text{ha}$ in Steneto), DBH distribution close to the Negative Exponential curve and lack of traces of large-scale logging. Ages, which we determined by the use of tree-ring analysis, were above 250-300 years for the oldest trees. They were higher in the beech forests in the Steneto reserve.

The computer-assisted processing of orthoimages and high-resolution satellite images helped us to determine the crown area, gaps, number of trees, density and other parameters. The average area of crowns in the Parangalitsa reserve was 34 m^2 , while in Steneto it was 39 m^2 . Gaps were in average 28 n/ha with size of 69 m^2 in Parangalitsa and 12 n/ha in Steneto. Our approach shows the practical value of computer-aided mapping with the use of orthoimages and satellite images for the extraction of precise and up-to-date data on Old-growth forests, which are needed for the proper management and protection of these forests. These methods can be used as a valuable supplement to the traditional methods for evaluation of forests.

Keywords: *remote sensing, forest interpretation, GIS, criteria for Old-growth forests.*

Mapping and assessment of the forest ecosystems, their status and ecosystem services provided from the forest territories outside NATURA 2000

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In the implementation of the project „Forests and woodlands - mapping and assessment of ecosystem services outside NATURA 2000 - FOR OUR FUTURE“ types of forest ecosystems have been mapped and their status and ecosystem services provided by them are assessed and mapped. The surveys and activities were carried out on an area of 1 803 862 ha of forest areas. The project was implemented in the period from 09.2015 to 04.2017 by the Executive forestry agency under the BG03 Program „Biological Diversity and Ecosystems“. Within the project, all representative forest ecosystems have been iden-

tified, described, assessed and mapped to a subsection level falling into forest areas outside NATURA 2000. A NATURA 2000 forest layer was created and a centralized database of information containing topologically processed spatial data for sites, an assessment of the state of ecosystems and an assessment of the ESS that they provide to society. The forest ecosystems types at EUNIS (EU Nature information system) level were determined at the planting level and an algorithm for the determination of the habitats under the EUNIS was created on the basis of charging descriptions from the forest databases. The typological scheme of the habitats is updated and supplemented, including four basic sub-types of forests on level 2 - high-stemmed broad-leave, coppicing, coniferous and mixed coniferous and broad-leaved coniferous forests is updated and supplemented. At level 3, the typology includes four major groups of habitats, respectively, G1- broad-leaved deciduous, G1- coppicing, G3-coniferous and G4-mixed coniferous and broad-leaved coniferous forests. At level 4, 26 subtypes of ecosystems, including 3 new ones, have been identified. Data identification algorithms have been developed with a list of indicators for assessing the status of forest ecosystems, each individual type of ESSs for each stand and systems for assessing the state of forest ecosystems and the ESSs provided by them at sub-section level. Digital maps of forest ecosystems, their condition and the ESSs provided by them are prepared.

Keywords: *ecosystem services, mapping, ecosystem assessment, state of forest ecosystems, types of forest ecosystems*

Clustering of sample plots – a case study in conifer forests in Bulgaria relevant to the design of a national inventory of forests

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The projects of a national inventory of forests have revived the discussion about the advantages and disadvantages of clustering of the sample plots. An existing net of sample plots in the State Forest District of Yundola has been used in order to determine the effect of some strategies of clustering.

Keywords: *sampling design, variance, growing stock*

5. Poster sessions abstracts

Age of reaching different height of Norway spruce (*Picea abies* (L.) Karst.)

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The natural forests of Norway spruce (*Picea abies* (L.) Karst.) are among the widely distributed forest stands in our country. This implies a deep understanding of their specific dynamics based on the accurate determination of their age. Often the stand age is determined on the field based on the approximately relation to the diameter, which is related with high uncertainty. Much precisely method for age determine is increment borer used to extract cores from trees, but sometimes the time necessary for the tree to grow up to the required technological height is underestimated. For individuals with diameter at a breast height less than 4 cm, the age is calculated by determination of numbers of stem ramifications or data about the relation of age with the height. Due to these reasons the collection and analyses of data for age necessary to reach the defined height for trees in Bulgaria as a part of Southeastern Europe is urgently needed in order to better understand the dynamics of Norway spruce forests. More than 400 wood discs were collected from Norway spruce trees with diameter at a breast height up to 4 cm from technologically different wood at the territory of biosphere reserve „Parangalitsa“ (NP Rila) and „Bistrishko braniste“ (NP Vitosha). Twelve models for precisely determination of age were tested, as 70% from the discs were used for elaboration of the models and 30% for the verification. The data showed that the trees of Norway spruce in open-air conditions (single trees) reach a height of 0.3 m for 7 (± 4) years; 0.5 m – for 11(± 4) years; 1.0 m – for 16 (± 5) years and 1.3 m – for 18 (± 5) years. Statistical error at the age determination is up to 6 years. In stand conditions the trees of Norway spruce reach a height of 0.3 m for 9 (± 4) years; 0.5 m - for 15 (± 6) years; 1.0 m - for 20 (± 5) years, and 1.3 m - for 27 (± 12) years. The age variation in different height groups was up to 15 years, with exception of the group up to 1.3 m where the variation was over 20 years. For all height groups (excl. the group 0.0-1.3 m) the variation is within one age class in terms of forest dynamics and the application of height corrections is possible.

Keywords: Norway spruce, age determination, Parangalitsa, Bistrishko braniste

A contribution to the species diversity of hypogeous fungi of Bulgaria

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The aim of this work is to enrich the data, concerning the species diversity of less studied group of hypogeous fungi in Bulgaria. Thirteen species are reported for the first time from the country: six species from genus *Elaphomyces* (*E. asperulus*, *E. aculeatus*, *E. maculatus*; *E. papillatus*; *E. septatus*, *E. virgatosporus*), *Chamonixia caespitosa*, *Hymenogaster griseus*, *Hysterangium crassum*, *Jimgerdemannia flammicorona*, *Leucogaster nudus*, *Sclerogaster candidus* and *Trappea darkeri*. Three genera: *Chamonixia*, *Leucogaster* and *Trappea* (Basidiomycota) are first reported from Bulgaria. The fungal materials were collected by the authors during the last two years (2017-2018) in different regions in Bulgaria. The results of the studies confirm, that the representatives of genus *Elaphomyces* are very important ectomycorrhizal fungi for the forest ecosystems, especially for those spread on slightly acid or acid soils.

Keywords: *hypogeous fungi; truffle; truffle-like fungi, Balkan mycota; Elaphomyces*

Growth and survivorship in young beech forests under different silvicultural history

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Silvicultural practices in beech forests influence important ecological characteristics and services, which are reflected in natural regeneration. Different forest regime of silvicultural interventions has created prerequisites for homogenizing the beech stands by composition, age, and structure. The aim of our research was to determine the impact of the regeneration history in beech

forests on the growth and survivorship of beech saplings. In a system of experimental sites, we were used biometric and inventory measurements to assess the progress of tree growth, and tree health. The experimental sites were located at different altitudes, with varying inventory indicators and microclimatic conditions. The assessment of the health status was done on a three-step scale. The beech saplings from thinning stands have a significantly higher growth rate than these from stands, where was not taken a thinning. Saplings in both cases reach their maximum height growth at 1000 m a.s.l. which altitude is most favorable for the growth of beech there. Most of the saplings in all examined altitudes are in a good condition followed by these in a satisfactory condition and the smallest part is taken by a poor condition.

Keywords: *growth, survivorship, regeneration, beech saplings, silvicultural practices*

Assessment and mapping the dynamics of soil properties in selected forest ecosystems from the region of Central Balkan National Park

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Forests set natural conditions and embody a repository of biological diversity that represents a myriad ecosystem services for the human well-being. The spatial patterns and the forest ecosystems' dynamics over time make the forests of particular environmental significance for the provision of ecosystem services. The terrestrial biodiversity and the sustainable management strategies demand for mapping and assessment of the dynamics in the condition of forest ecosystems by drawing the attention on the soil properties. In order to take on that task the data series obtained by the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) for the period 1986–2016 were found as appropriate quantitative indicators that convey information about the ecosystem's capacity to provide certain regulating ecosystem services. The ICP Forests Level I sites located in the Central Balkan region provide consistent information, collected on regular basis about observed forests.

The primary focus of the present research is to conduct biophysical assessment of the forest ecosystems and to define their overall condition regarding two time series – the periods 1987-1993/5 and 2014-2015. This study attempts to introduce an innovative approach and aims at linking the existing ICP Forests network dataset with the ecosystem services concept and the identified spatial units from the CORINE Land Cover (CLC) polygons for the territory of Central Balkan National Park. On this basis and through the implementation of GIS techniques, the dynamics of soil properties in forest ecosystems were analysed and their capacity to supply relevant ecosystem services was assessed and mapped. The biophysical data provides robust information on the ecosystem services and the results show the dynamics of the capacity of different sub-types of forest ecosystems to provide ecosystem services within a well-defined land cover unit. Additionally, the research work intended to review the generated outcomes - with reference to the DPSIR method by giving feedback on the changes in the terrestrial ecosystems in the last 25-30 years. Further application of the mapping approach in assisting the communication and in the process of decision making in the relevant policy measures is also discussed.

Keywords: *mapping, dynamics, ecosystem services, forests ecosystems, ICP Level I data*

Heavy metal contents in the soils from gold-containing ore „Milin Kamak“ deposit region

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Gold-containing ore deposit „Milin Kamak“ is situated in the land of Breznik city in the Breznik district. Its exploitation, which pursuits extraction of gold, is pending. The expected concessional area is 2198 dka. It includes agricultural and forest lands. The agricultural area is 1903 dka, 693.8 dka (31.6%) of which is arable land. The total area of the forest territory inside the concessional outline is 295 dka. The aim of this study is to grade the heavy metal content in soils taken from different types of land use. The actual contents of

Pb, Cu, Zn, Mn, Cd is determined, which can help for the tracing of changes under the influence of the forthcoming ore deposit extraction. Soil samples were taken for analysis from soils in pastures and arable lands close to the deposit and Viskyar village. Soil samples were taken from the soil in the forest territory from the plantation of black pine which is in close proximity to the Viskyar mountain. Database for heavy metal contents in soils of different types of land use is created, which allows a long-term observation of the soil chemical contents and of its reaction.

Keywords: *gold-containing ore, heavy metals, contamination, soil*

Investigation of heavy metal content in soils in the area of Petrohan Pass

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The content of Mn, Zn, Pb, Cu and Cd was investigated in the area of Petrohan Pass. It is known from the literature that heavy metal content in the soil near the main road, as well as in water bodies is increased, assuming the source of pollution is the road transport. In the present study their natural enrichment is also assumed. The investigated soils are distant from the main road – Dystric Cambisols and Modic Umbrisols. Under conditions of very high acidity, the results show the predominance of the cumulative processes over the migration only in relation to Pb. The profile distribution of the remaining metals indicates the dominance of migration processes and their quantities in the litter prove an increased presence of mobile forms that can easily pass into other natural components.

Keywords: *heavy metals, soil, pollution, acidity*

Climate, deposition and soil type are strong predisposition factors to acute oak decline in England and Wales

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Acute Oak Decline (AOD) affects both native oak species (*Quercus robur* and *Q. petraea*) in England and Wales and is of great concern as Oaks represent the largest component of native broadleaf woodland in the United Kingdom. Affected trees have characteristic stem symptoms, dark coloured liquid runs out from cracks between the bark plates and necrotic lesions are present in the phloem tissue. The symptoms are found in conjunction with galleries of the two-spotted oak bupresid (*Agrilus biguttatus*) and specific necrogenic bacterial species isolated from lesion areas. Similar symptoms have been described across Europe and form part of a wider oak decline complex which can establish following exposure to environmental predisposition factors, such as drought.

In order to understand the occurrence of oak decline it is necessary to not only investigate the impact of biotic agents and their interactions, but rather consider the whole system beginning with the links to environmental factors. A survey with more than 500 locations has been used to map AOD occurrence with soil type, climatic factors and deposition (nitrogen, sulphur and base cations) using GAM models. The presence of AOD in England and Wales is significantly influenced by rainfall, air temperature, and elevation, as well as nitrogen, sulphur and base cation deposition. Preliminary analysis highlighted differences between soil types and soil moisture, however these now need to be investigated at smaller scales, e.g. at site and tree level. This knowledge underpins risk mapping and will help develop best practice management advice.

This spatial study reemphasises the importance of predisposition factors in the Oak decline syndrome. Such spatial mapping and modelling could be applied to ICP forest survey data to derive information on predisposition factors across tree species at both national and European scales.

Biochar addition to a soil with low metal contamination and its effects on microbial community structure and plant growth

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Biochar induces changes in soil properties and crop biomass (Claudia et al., 2015; Kolton et al., 2017). Nevertheless, the mechanisms associated with improved plant biomass and soil microbial community structure in low metal contaminated agricultural soils are not well understood (Seneviratne et al., 2017). Here, we conducted a greenhouse experiment using two kinds of biochar from different feedstocks [wood chips (B1, from Carbon Terra, Germany) and wheat straw pellets (B2, from UK Biochar Research Center, Edinburgh University)]. Two Italian durum wheat (*Triticum durum*) varieties, Duilio and Marco Aurelio, that we had previously phenotypically selected for their contrasting growth performance in presence of biochar, were considered. Pots were filled with a gleyic fluvisol coming from the alluvium of the Litavka river (Láz close to Příbram City, Czech Republic), containing a negligible amount of nutrients (9% SOM) and a very little amount of Pb and Zn (total content of both metals up to 100 ppm). Four different treatments were performed for the two wheat varieties: only soil control (C), soil amended with 3% (w/w) woody biochar equilibrated with nutrient solution (B1+) and non-activated (B1-), and soil amended with 3% (w/w) wheat straw biochar non-activated (B2-).

The overall main objectives of this study, still in progress, are to evaluate the effect of the two biochars on plant growth and on the root-associated bacterial community, as well as to identify the relationship among them and soil structure (Genevieve et al. 2016) and nutrient composition. Seven weeks after seed germination, fresh (FW) and dry weight (DW) of aboveground plant tissues and roots were evaluated. Bulk soil and rhizosphere samples were collected and DNA was extracted twice for subsequent metagenomics 16S rRNA analysis on illumine MiSeq platform. Soil, biochars and mixtures are being

assessed through the main soil chemical-physical analysis. Here, we report our preliminary results that can answer the question if biochar exhibits a significant effect on soil traits, and/or wheat growth.

Acknowledgment: This experiment has been planned and performed thanks to the granting of a COST FP1305 BIOLINK STSM to Arianna Latini.

Keywords: *Biochar, low metal contaminated soil, durum wheat, soil microorganism community structure, metagenomics 16S rRNA analysis*

Net ecosystem exchange of boreal forest

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Forest ecosystems are representing components of the global carbon cycle. Each component affects global climate change through forest stand respiration and photosynthesis. For a better understanding of future carbon (C) cycle in forest ecosystem must be comprehension of its various components. Forests are playing key role in carbon balance. Global change, temperature rise and disturbances (e.g., fire, clear-cutting, storm, insects) has a great effect on C flux levels of forest ecosystems. It is important to focus on C net ecosystem exchange (NEE) to monitor forest ecosystems and its functioning. Eddy covariance (EC) method provides opportunity to understand C dynamics, measure NEE and climatic variables, such as wind speed and direction, water vapor, temperature etc. EC is a micrometeorological technique by measuring carbon dioxide (CO₂) exchange between atmosphere and canopy including all vegetation. This technique has emerged as one of the most reliable and provide relevant results of C fluxes at the forest stand level. As a output of EC measured data allows us define forest ecosystem functioning as a C-sink or C-source, even specify C neutral situation. It is very important to understand how long it takes to recover from stand-replacing disturbances. Attention should be paid on forest ecosystem C balance and forest stand acting as a C-sink or C-source. This review of published literature studies was taking account different disturbances at boreal forest sites. Generally forest is a C-source after disturbance and it takes several years to recover and be able to absorb C and become a

C-sink. Immediately after stand-replacing disturbances forests were C-sources. Recovery required approximately 5 years after storm or insects outbreak, however because of the missing data we can not predict future. Clear-cut areas required up to 20 years to become a C-sink again. Recovery after wildfire disturbance was much longer, more than 50 years.

Keywords: *Forest ecosystem recovery, carbon balance, carbon dioxide (CO₂), disturbances, eddy covariance*

Base cations budgets of forest ecosystems in the UK

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There is growing concern that available base cation pools in soil are declining due to the combined effects of acid deposition and harvesting. To assess these concerns in the UK, elemental mass balances for calcium (Ca), magnesium (Mg), potassium (K), were calculated from more than 10-years monitoring data from the UK's ICP Forest Intensive Monitoring (Level II) plots.

On averaged Ca loss through leaching was 42% of total inputs (deposition + soil weathering) varying between 7 and 86 % depending on sites geology, soil type, tree species and sensitivity to acidification. High Ca removal from sites by tree biomass was measured averaging 68% of the total inputs, varying from 5% to over 100% depending on site. Out of the nine sites investigated negative Ca balances were observed in three sites with the most acid geology and nutrient poor soils, also being heavily acidified in the past. At present, there is sufficient Ca in the soil exchangeable pool to sustain forest growth at most sites, however, continued losses of Ca due to leaching and harvesting at the present rate may ultimately threaten the health and productivity of the forest within just a few decades.

Mass balance calculations generally indicated positive Mg and K balance, with the exception of one site with negative Mg balance. Site Ca, Mg and K budgets were significantly ($p < 0.01$) positively related to soil exchangeable cations and soil base saturation status. Current soil resampling of the UK Level II sites will provide repeated field measurements of soil exchangeable cations over the last 20 years enabling us to determine if soil cations have been changed at any of the Level II sites.

Production possibilities of alluvial semiglay in the alluvium of the Sava river in Serbia

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Alluvial semiglay occurs in conditions of meadow type of pedogenetic processes on alluvial deposits in the central part of the field. This research presents investigation of pedological profiles of this soil in the floodplain of the the Sava River in Serbia. The humus horizon of these soils ranged up to 15 cm of width, with texture classes from clay to clay loam, with a humus content of over 4%. The deeper layers of this soil are of different texture composition with texture classes range from sandy clay, clay, silty clay loam to clay, while the humus content decreases with depth and ranges from 1.97 to 0.80%. The soils in investigated area were well supplied with water through periodical flooding and certain times of ground water which is at a depth of 100 to 180 cm on average, depending on the period of the year. Due to the different texture classes, which mainly dominate clay, the explored soils have favorable water-air properties. Based on good water supply and favorable water-air properties, these soils have good production potential for poplar cultivation where they achieve the maximum wood volume, and also these soils show good production possibilities for growing hardwoods, primarily oak and ash.

Keywords: *alluvial semiglay, fertility, alluvium, the Sava River*

Genomic and metagenomic analysis of soil ammonifiers involved in nitrogen cycle

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The nitrogen cycle is sequence of chemical and biochemical transformations, where atmospheric nitrogen is turned into accessible for plants forms, which is essential for both grass and forest ecosystems. One of the key players in ammonification process is soil bacteria from genus *Bacillus* and *Clostridium*.

We explored available genomic data bases, which contained sequenced cDNA from those systematic groups (RefSoil, Blast, etc.) to identify potential candidate genes involved in the process of nitrogen oxidation. Further, we evaluated the metagenomic features of these genes by obtaining encoded by them amino acid sequences and protein secondary and tertiary structure. Thus, implications for protein metabolic activity of these enzymes are suggested.

Keywords: *genomics, nitrogen cycle, ammonification, soil microorganisms*

Features of the trace element composition of Bryophytes in coastal landscapes (Southern Curonian Spit, Russia)

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The Curonian Spit is curved sand-dune spit that separates the Curonian Lagoon from the Baltic Sea coast. It is a UNESCO World Heritage Site shared by the two countries: Russia and Lithuanian. The high level of biological diversity due to the combination of different landscapes - from the desert (dune) to the tundra (upland marsh) - gives an idea of important and long-term ecological and biological processes in the evolution and development of terrestrial, river, coastal and marine ecosystems and plant and animal communities. The location of the spit and its relief are unique. The forest is cover of 72% of Spit Territory. Two plots with different conditions were chosen to study the features of moss capacity to accumulate trace and other elements. The one plot is in the root of the spit, and the another - in 35 km from the first plot. The long of Russia part of Spit is 46 km There are three biotopes in each plot: The first plot: green-moss pine forest; alder forest; Swamp. The second plot – green-moss pine forest; alder forest; dune. Samples of mosses were collected from the soil, tree trunks, sand, rotten wood. There are 12 species of mosses in the first plot, and 15 in the second one. X-ray spectrometry was used to identified micro elemental composition of mosses. Eight elements – zinc, nickel, bromine, strontium, iron, calcium, rubidium and manganese were quantified. The descriptive statistics method and principle component analysis were applied to the elemental concentration data set to explain variations in the data and their origin. A significant positive correlation was established between Fe -Ni, Sr -Ca, Br - Sr, Ni-Sr, Fe-Ca; a high - between Br-Fe and Sr-Fe. And negative correlation between Mn-Br, Mn-Sr. It

may be associated with the effect of wind transfer and atmospheric deposition, marine aerosol, leaching processes from plant residues.

Principal component analysis showed three factors. The first factor with a weight of 38.6% is characterized by the addition of nickel and iron, it has to be associated with wind transfer and atmospheric deposition, which is reflected in its manifestation in the advance. The second factor (22.9%) is associated with accumulation of zinc, strontium and calcium, which may indicate the plant origin of these components - leaching from leaf litter, the second factor is characteristic of alders; the third factor (18.1%) influences the accumulation of bromine and rubidium and manganese removal, which is probably due to the influence of marine aerosol, high values of this factor appear in all biotopes.

Keywords: *mosses, coastal area, microelements composition*

Root biomass and root distribution in two different forest ecosystems in Bulgaria

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Root systems (fine and coarse roots) are major contributors to the total biomass pools of forest ecosystems and take up water and nutrients from the soil, they store C compounds, and provide physical stabilization (Brunner and Godbold, 2007). Fine roots (< 2 mm of diameter) represent a relatively small part of the total plant biomass, but they are the most dynamic component of the root system with annual net primary production approximately 30% in forest ecosystems and can contribute up to two-fold higher organic carbon to the soil than leaf litter (Assefa et al., 2017). Biomass studies are fundamental for understanding the dynamics of ecosystems.

The aim of this investigation is to give a data on fine and coarse root, compare the root stock, fine production and turnover in natural European Beech stand and non-native Douglas fir plantation in Bulgaria. Belowground coarse biomass was estimated up to 50 cm depth, five depths in the soil column: lit-

ter, 0–10 cm, 10–20 cm, 20–30 cm, 30–50 cm during 2015. Root biomass is presented on a sample of 4 model trees. Comparison of the results showed that the biomass of coarse roots at *Pseudotsuga menziesii* (Mirb.) Franco significantly exceeds the same at *Fagus sylvatica* L. It was estimated that the total belowground biomass in the ecosystem formed by *P. menziesii* was 177.12–245.78 t.ha⁻¹ while this content in the ecosystem formed by *F. sylvatica* was 91.00–125.91 t.ha⁻¹. Fine root dynamics were investigated using sequential coring. Sequential soil cores were used to obtain fine root data monthly from May to October in 2015 and April in 2016.

Keywords: root biomass; necromass; sequential coring; turnover rate; annual production; *Fagus sylvatica*; *Pseudotsuga menziesii*

Wildfires in Republic of Serbia in the period 2009 - 2017

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The forest ecosystem is one of the most complex ecosystems on the planet. The various influences cause the destabilization of it, and fire -uncontrolled wildfire is one of the main factors. It has been shown that in Serbia wildfires are among the most common natural disasters. The analysis of the initiators of the wildfires (human activity, natural disasters, global change of the climate conditions, such as melting and decrease of the average precipitation, particularly in the periods which are critical to the wildfire initiation) is necessary in order to determine the level of the danger of the re-occurrence of them. In the nine-year-period (2009-2017), 44.19% of the total number of wildfires in Serbia have been started by human activities, 1.72% have had a natural cause and 54.09% have been of unknown cause. The most critical years were 2012 and 2017 (fire-damaged area 48.44 : 15.58%). In regard to only type of the tree, forest ecosystems in Serbia were classified by the appropriate six levels of endangerment by the Wildfires, and in the observed period 49.09% of the fire-damaged area is of the IV level (stands and cultures of oak and hornbeam), 21.04% is of the I level (stands and cultures of pines and larch trees), 17.88% is of the V level (stands of beech and other deciduous trees). Analysis shown that the most danger forest damaged by wildfires were Cop-pice mixed Hungarian oak forests (12.96%) and Artificial Black Pine forests

(11.38%), but in Serbia broadleaved trees account for 90.7% of the growing stock, conifers for 6%, while mixed forests of broadleaved trees and conifers account for 3.3%. Wildfires in the conifer cultures and stands are by its character and harmful effects more significant than in the deciduous ones. The direct damage cause by wildfires was estimated to 3 453 238.7 Euro, and it were registered with the burnt area of 24 178.8 hectares. In the fire-damaged areas the great quantities of the dry and partially burnt wood, can serve as the perfect base for the development of the xylophagous insects which are also economically important.

Keywords: *Forest stands, cultures, wildfires analyses*

Modeling of forest ecosystem services by dendrochronological and dendrometric investigations

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Forest ecosystems with their great biological diversity, ecological footprint on the environment and economic footprint on the society are source of multiple ecosystem services of different groups: material, supporting, regulating and cultural. At the climate change conditions, modeling of forest ecosystem services is important tool for adaptive management and prevention of ecological risk for forest ecosystems, society and environment sustainability. There are no published studies about forest services modeling by the stem growth investigation. Dendrometers are precise sensors by which stem growth during the growing season can be analyzed to optimize forest growth. Dendrometric investigations on dynamics in radial growth of trees have not yet been conducted in Bulgaria. The indicator used as the radial growth, enables the forest state and productivity assessment that correlates with the services it provides.

The object of research is natural forests of *Quercus frainetto* Ten. in Maleshvska Mountain. The programs TsapWin, SPPAM 2.0 and the statistical package CANOCO 2000 have been used for modeling of radial growth and ecosystem services. The results of analyzes are functional characteristics of *Q. frainetto* ecosystem, forecast of its future state and modeling of ecosystem services provision dynamics.

Keywords: *dendrochronology, dendrometer, radial growth, ecosystem services, modeling*

Land use, litter quality and climate effect on early stage litter decomposition

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Litter decomposition represents one of the largest fluxes in the global terrestrial carbon cycle and a number of large-scale decomposition experiments have been conducted focusing on this fundamental soil process. The main factors affecting litter decomposition are the environmental conditions, litter quality and microbial community. In order to be able to quantify the relative importance of the different drivers over litter decomposition process we tested the effect of climate (temperature and moisture), litter type and land-use on early stage decomposition (3 months) across different ecosystems. The potential litter decomposition is investigated by using standardized substrates (Rooibos and Green tea) for comparison of litter mass loss at 6 experimental sites. Our results indicate that multiple drivers are affecting early stage litter mass loss, but the predominant controlling factor for this process was found to be litter quality. The effect of climate and land-use on early stage litter decomposition within studied ecosystems was not significant. Additional observations over time (medium to long-term data) are essential for improving the understanding of the long term decay process of plant litter.

Keywords: *decomposition, land-use, litter quality, climate*

Woody biomass estimation of coppiced plants from open pollinated progenies of two selected black locust clones

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The main objective of this study was to derive progeny-specific stump-level biomass models for coppiced plants from open pollinated progenies of the selected black locust clones ‘Tsarevets’ and ‘Srebarna’, grown in central northern Bulgaria. We used as principal predictor variables the measurements of

the main shoot on the stump - total height, basal and breast-height diameters and we applied the method of conditioning in order to expand the models with an additional (secondary) predictor. Spacing, root age, shoot age and number of shoots per stump were considered as additional independent variables. The allometric equation, applied to the basal diameter of the main shoot and the modified constant form-factor equation with the same predictor were adequate to describe the amount of the aboveground dendromass of both families. Exponential form of dependence of stump biomass on age and shoot number was established and power form relationship to spacing was found.

Six allometric models for the progeny of 'Srebarna' and 7 models for the coppiced plants of 'Tsarevets' were derived, which provide robust estimates of the aboveground dendromass from various sets of tree- and stand-level predictors. They can be applied to estimate the aboveground woody biomass of coppiced plants with the respective genetic constitution, which are grown under the temperate continental climate of northern Bulgaria and are harvested within five years of stump age.

Keywords: *allometric equation, Nelder wheel design, Robinia pseudocacia L., stump-level models, dendromass*

The relationship between stand spatial structure and crown shape of individual trees

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Since the most of ecosystem models do not take into account the asymmetry of crowns resulted from the competition between trees, the objective of current study was to estimate quantitatively the effect of competition on shape and size of tree crowns. The 1-ha permanent sampling plot was established in Prioksko-Terrasny State Natural Biosphere Reserve (Moscow region, Russian Federation) in 2016. All trees with DBH higher than 5 cm were mapped. Stem diameter, crown length and crown spread in four cardinal directions were measured for each tree. The relationship between crown size and tree stem size was analyzed, as well as spatial distribution of stem bases and centroids of

crown projections. We found that crown size and shape is strongly dependent on tree species, its location in stand, and stand density. Pioneer tree species (pine, birch and aspen) are characterized by relatively narrower crowns with high relative crown base height while the late-successional tree species (oak and lime) have relatively wider crowns. The asymmetry of crown projection was shown to be strongly influenced by tree's neighborhood. We also found that centroids of crown projections are distributed in space more regularly than stem bases. As a result, the species-specific features in crown development were shown. The analysis of results confirmed the previously described mechanism of adaptation to competition from neighboring trees through asymmetric crown expansion in different directions. The relationships derived can be used for development of improved algorithm of simulation of aboveground competition. New procedure will allow for accounting the influence of tree's neighbourhood on size and shape of its crown.

Acknowledgements: The work was supported by the Russian Foundation for Basic Research (project no. 18-04-00527) and the Russian Science Foundation (project no. 18-14-00362).

Keywords: *spatial structure, crown shape, centroids*

Conservation of European chestnut (*Castanea sativa* Mill.) genetic resources in Bulgaria

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The current study is related to assessment of the condition of *in situ* and *ex situ* conservation units and their role in conservation of chestnut genetic resources in Bulgaria. It was observed that „Kongura“ reserve provides good conditions for conservation of biodiversity and genetic variation of *Castanea sativa* Mill. The total area of seed production stands is sufficient for the inclusion of the large variety of chestnut. They are characterized by high richness of genotypes and allow unlimited and random crossing. Century-old trees are also rich and unique gene pool and are important for conservation of chestnut genetic resources. However, a large part of *in situ* conservation units are damaged and degraded to different extent and some of them do not meet the requirements

for future conservation. The potential for *ex situ* conservation of the species in the clonal archives is very limited due to the small number of clones and cultivars and poor health status.

Keywords: *Castanea sativa* Mill., genetic resources, *in situ* and *ex situ* conservation, genetic variation, genotypes

The effect of drought on physiological parameters of sessile oak (*Quercus petraea* L.) seedlings

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This research presents investigation of drought on physiological parameters of 1 year old seedlings of sessile oak (*Quercus petraea* L.). One year old seedling were planted in pots containing 1:1 mixture of peat and sand and grown in greenhouse vegetation period from April to September. During growth, half of the pots were subjected to 2 month drought treatment with soil moisture content of 12.4%, while control plants had moisture content of 41.6%vol. After 2 month period, physiological parameters related to photosynthesis (A, E, WUE), nitrogen assimilation (NRA) and free proline content was assessed. Obtained results showed almost no disturbance on photosynthetic processes of sessile oak seedlings together with no change in nitrogen assimilation expressed through enzymatic activity (NRA). These results can be explained by the biology of species Although not expressed through above mentioned parameters, the effect of drought was observed in the increase of free proline accumulation in oak leaves where drought treated plants had 50% higher amount of proline. Since the effect of drought on plants can increase proline content several times, this increase showed relative drought resistance of penduculate oak seedlings.

Keywords: *photosynthesis, transpiration, water use efficiency, NRA, proline*

A study of spatial autocorrelation in natural populations of *Platanus orientalis* L. in Bulgaria

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The present research of spatial autocorrelation of populations of *Platanus orientalis* L. is first of its kind for the territory of Bulgaria. The spatial autocorrelation between the individuals in populations of two geographically remotest from each other natural habitats of the species - in the area of the town of Sandanski and the village of Topolovo has been studied. For evaluation of spatial autocorrelation and spatial genetic structure of natural populations Moran's index and statistical methods was used. The results for the population of Sandanski show a statistically significant spatial correlation of the distances between the individuals in the range of 20 to 40 m and from 80 to 120 m. Statistical significance of spatial autocorrelation for Topolovo's population is founded only for a distance up to 30 m. In both populations the Moran's index values are higher than expected 5% error, indicating the existence of partially inhomogeneous, structured populations in them. The study shows that analysis of only top polymorphic loci can give an idea of spatial autocorrelation without including low-level polymorphism loci that carry significantly less information.

Keywords: *autocorrelation, Platanus, genetic diversity, genotypes*

Dynamics of the pine processionary moth (*Thaumetopoea pityocampa* Schiff.) populations in the Republic of Macedonia

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This paper presents results concerning the dynamics of the pine processionary moth populations and the impact of reduction factors in the period from 2007 to 2017. The abundance of its populations is determined by the number of caterpillar nests per tree and per hectare. Also, the impact of extremely

low winter temperatures on the mortality of caterpillars of pine processionary moth was monitored in the 2016/2017 generation. Population density of the pine processionary moth varies during this research period. The number of individuals in the populations from the generations from 2007 to 2010 is growing, and then rapidly decreasing. From 2011 progradation trend has been recorded as a result of the huge number of individuals from the previous years who were in the pupae stage during the winter diapause. Population density is increasing in the several subsequent years. The abundance of pine processionary moth populations because no corrective measures were taken continued to grow in 2016, and in the winter 2016/2017 there was a pronounced retrogradation. The density of the populations came to latency due to enormous number of dead larvae from the second and third larval stage from the extremely low temperatures that were present for a long period of in January 2017. This research has identified 100% mortality of caterpillars of pine processionary moth in the black pine cultures in the regions near Prilep, Sveti Nikole, Shtip, Kochani and Negotino.

Keywords: *Thaumetopoea pityocampa*, population, dynamics, black pine forests

Total chlorophyll content and normalized difference vegetation index of two *Populus × euramericana* clones („Agathe“ and „Guardi“)

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The aim of this study was to determine some physiological criteria for biomass accumulation ability of two poplar clones. The measurements were carried out in experimental 5-year-old poplar plantation, growing as Nelder's wheel in Mikrevo (Strumyani-region), Southwestern Bulgaria in June 2017. The experimental plantation consists of two poplar cultivars: *Populus × euramericana*, cv. Agathe F. and Guardi, each of them planting in three growing space – 1.63, 2.66, and 4.34 m². Total leaf chlorophyll content was measured nondestructively by using an AtLEAF+ device. Normalized difference vegetation index (NDVI) for leaves was determined by a Plant-Pen NDVI-300. Total chlorophyll content in the leaves of cv. Guardi was significantly greater

than in leaves of cv. Agathe at each variant of growing space. The results of this study indicate that the respective values of leaf NDVIs for separate cultivar and growing space are different. Leaves of cv. Guardi had also significantly higher NDVI, especially in the cases of a smaller growing space. At the conditions of the largest growing space, leaves of cv. Guardi tended to decrease this index. Such trend reflects a raised water demand of better-illuminated leaves. Higher total chlorophyll content and leaf NDV–indexes could be regarded as an evidence of greater growth potential and biomass accumulation capacity of cv. Guardi compared to cv. Agathe.

Acknowledgements: This research was supported by a grant DN 06/3 (2016-2019) from the Bulgarian National Science Fund.

Keywords: total chlorophyll content, NDVI, poplar cultivars

Distribution of the invasive pathogen *Diplodia sapinea* on *Pinus* spp. in Bulgaria

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One of most important invasive pathogen *Diplodia sapinea* was established as a pine shoot disease agent on *Pinus* spp. in Bulgaria. In the period 2016-2018, it was investigated that *D. sapinea* is a widely distributed conifer pathogen in the country. The reasons of this severe spread was the consequence of the climate change and physiological stressors like drought, nutrient deficiency and hail damage that are the main factors for successful infection by *D. sapinea*. In 2017-2018, the occurrence of the pathogen was investigated on 680 *Pinus nigra* and 120 *P. sylvestris* trees in 20 permanent sampling plots established in South Bulgaria. Assessment of crown condition – defoliation and discoloration on sample trees was done. The fungus was detected on all visually infected needles, cones, shoots, seeds, buds and stems. The main insect species that were established as vectors of the pathogen were the bark beetles, which help the fungus to spread over long distances. In addition to shoot and needle disease, the pathogen caused stem canker, collar rot and sap stain, cones and seeds.

Keywords: *Diplodia sapinea*, shoot blight disease, distribution, *Pinus* spp.

Early performance of willow (*Salix* spp.) saplings in response to wastewater sludge treatments

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Some early growth properties and photosynthetic characteristics in willow (*Salix* spp.) plants subjected to wastewater sludge treatments were studied. Two willow clones (*S. alba* L. and *S. viminalis* ‘rubra’) were included in both field (on Vertisols) and pot experiments (Alluvium soil substrate) with different doses of sludge from a wastewater treatment plant (WWTP). Within the field experiment positive effect of treatment on the photosynthetic rate was not detected. However, the biometric parameters appeared to be genotypically affected. The experimental results are commented in terms of possible application of wastewater sludge in short rotation energy plantations and their bioproductivity.

Keywords: *bioproductivity, energy plantations, Salix spp., wastewater sludge*

Acacia bark from eradication and control actions: a possible resource for forest nurseries

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Acacia melanoxylon is a fast-growing tree, native to Australia. In Southern Europe (France, Spain and Portugal), introduced *Acacia* stands, formerly for tannin extraction, degraded soil reclamation and ornamental purposes, have become a major environmental concern due to invasive expansion following land abandonment and/or wildfire occurrence. Eradication and control actions involve high costs and require sustained in-

vestment over long periods of time due to the need of several follow up control actions. Valorization of the residual biomass as a growing-media component for forest nurseries may be an alternative to mitigate those costs.

This work aims to use *Acacia melanoxylon* bark as raw-material for growing-media formulation. Two types of bark were used: fresh bark and aged bark (wetted and aged during 8 weeks). Bark phytotoxicity was evaluated according to the European Norm EN 16086-2. Fresh bark was phytotoxic for seeds causing root growth inhibition, presenting a root length index significantly lower than the peat-only control substrate. After 8 weeks of aging, phytotoxicity was removed, and aged bark showed seed performance equal to peat-only control substrate.

Barks were mixed with peat at the proportion of 50% by volume, and tested in a pot experiment, according to the European Norma EN 16086-1, using Chinese cabbage as test plant. 50% fresh bark substrate revealed plant growth inhibition, reinforcing the fresh bark phytotoxic. On the contrary, aged bark mixture recorded plant growth statistically equal to peat-only control substrate, suggesting the feasibility of using aged *Acacia melanoxylon* bark up to 50% in future growing-media formulation.

Keywords: *alien tree, debarking residues, phytotoxicity, growing-media*

Properties of *Cedrus atlantica* Man. wood

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Atlas cedar (*Cedrus atlantica* Man.) is a typical tree species for the region of North Africa. Trees reach a significant height of 35-65 m. The diameter of the trunk at the chest height ranging between 0.9-1.8 m that gives it a considerable economic interest. The wood core could be coloured from reddish brown to dark brown. The sapwood is with light brown to grey colour. The average density of wood is 550 kg/m³, ranging from 500 to 600 kg/m³. This tree species was introduced in Bulgaria at the beginning of the last century in parks and gardens. In the middle of the last century, forestlands were afforested in the regions of Haskovo and Kardzhali, so the quality of the wood should be known in view of its use. There is information that it is very suitable for mak-

ing furniture, windows, doors and musical instruments. The conducted studies show that, for our region, the mechanical indicators of cedar are with better properties than those of *Pinus sylvestris* L.

Keywords: *Cedrus atlantica*, wood properties

Distribution, syntaxonomy and ecology of chestnut forests in Bulgaria

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Castanea sativa (chestnut) woodlands are locally distributed in southwestern (Slavyanka, Belasitsa, Orazhden Mts.) and northeastern parts (Berkovska Mt.) of the country. Traditionally it is also planted from natural stands in same regions but also some plantations are found in the Eastern Rhodopes. It is distributed from 300 up to 1150 m a.s.l. (optimum 400-700 m. a.s.l.) on slope with different expositions and predominantly moderately steep slopes. Chestnut woodlands represent mesophyte and xeromesophyte deciduous forests, where species with higher cover and abundance are *Castanea sativa*, *Fagus sylvatica*, *Carpinus betulus* and *Quercus petraea*.

According to the dominance approach, widely used in the past, chestnut forests in Bulgaria have been classified to 5 associations: *Castanetum-Mixoherbosum*, *Castanetum-Coryloso-Mixoherbosum*, *Castanetum-Carpino-Mixoherbosum* and *Platano-Castanetum-Mixoherbosum*. The most widespread is *Castanetum-Mixoherbosum* association. Nowadays following to the Braun-Blanquet approach *Castanea sativa* communities are found in phytocoenosis of *Asperulo odoratae-Fagetum sylvaticae*, *Tilio tomentosae-Castanetum sativae*, *Armonio agrimonoidis-Fagetum sylvaticae* associations and *Ostrya carpinifolia* and *Quercus dalechampii* communities.

Keywords: *Castanea sativa*, distribution, syntaxonomy, Bulgaria

Native Bulgarian plants present in the Al. Beldie Herbarium from INCDS Bucharest

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Marin Drăcea National Institute for Research and Development in Forestry (INCDS) from Bucharest hosts a reference herbarium for specialists from Romania and abroad (including Bulgaria also). The herbarium contains no fewer than 60 000 plant species, arranged in 30 modules, with 20 drawers each. The herbarium is named after Alexandru Beldie, a botanist known for his work dedicated to the flora of Bucegi Mountains from Romania.

The first step was doing an inventory of the species and plates present in this herbarium. Amongst them, approximately 230 plates were cataloged as gathered from Bulgaria. From the 115 existent species, the following are worth mentioning: *Acer tataricum*, *Androsace maxima*, *Tilia tomentosa*, *Lappula echinata*, *Melica ciliata*, *Trifolium hybridum*, *Senecio vernalis*, *Quercus ceris*, *Quercus pubescens*, *Sorbus aucuparia*, *Trifolium arvense* etc.

The oldest plates were collected in 1871, while the most recent ones date to 1967. The most massive period of gathering is represented by the years 1933 and 1937. Most of the plants were gathered from areas that belonged to Romania between the two world wars (Durostor, Caliacra, Turtucaia), as well as from other Bulgarian regions, such as: Jambol, Vitosa, Kazanlak, Varna, Filipopel etc. The plants were gathered by renowned botanists from Romania (Al. Borza, Al. Beldie, Badea, Cretzoiu, C.C. Georgescu, S. Pascovchi) or Bulgaria (Janka, V. Stribrny, B. Stefanoff, T. Georgieff).

The native Bulgarian plants were obtained through a bilateral exchange with Flora Bulgarica Exiccata Herbarium. This collaboration can be reinstated and even extended between the two neighbor countries as they both have similar silvicultural and botanical traditions.

Keywords: *herbarium, species, trees, Romania*

A comparative study on *Dothistroma* needle blight disease on *Pinus* spp. in Bulgaria and Serbia

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Dothistroma needle blight (DNB) diseases caused significant damages on susceptible pine species in some localities in Bulgaria and Serbia where environmental conditions are suitable for its incidence. This study represents the first results of a joint work on the morphological diversity of *Dothistroma pini* isolates from three *Pinus nigra* localities in Serbia (Deliblato sands, Subotica sands and Kovil) and fifteen mountain and urban localities in Bulgaria including a range of five native *Pinus* spp. – *P. nigra*, *P. sylvestris*, *P. peuce*, *P. heldreichii* and *P. mugo*. The potential distribution and abundance of *Dothistroma* spp. were determined by collecting needles that had symptoms considered characteristic of the disease. The morphological peculiarities of isolated mycelium cultures were compared and the differences among them were defined. *Dothistroma* fruit structures were most frequently recovered from samples originating from all regions in Serbia, and least frequently from the Bulgarian localities. In Bulgaria, it was established on *P. nigra* plantations in four localities (St. Vlas vill., Vechtovo, Plachkovci and Kyustendil) and on *P. heldreichii* trees that is detected for the first time in the country as a new host of DNB. Compiling data for the distribution of susceptible hosts in areas predicted to be suitable for range expansion of *Dothistroma* spp. defining the current situation of DNB disease in both countries. Isolations made from symptomatic needles onto general fungal growth media had yielded a range of other fungi long recognised in Bulgaria as causers of *P. nigra* needle and shoot blight diseases – *Cyclaneusma niveum* and some saprophytes or secondary pathogens such as *Lophodermium* spp. and *Diplodia sapinea*. The pathogen *Cytospora pinastri* was found for the first time on *P. peuce* in Bulgaria.

Keywords: *Dothistroma* needle blight, *Pinus* spp., fungal pathogens, Bulgaria, Serbia

Characteristics of the locality of *Opuntia humifusa* (Cactaceae) on the territory of the Lozenska Mountain

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This study presents current data on the locality of the invasive alien species *Opuntia humifusa* (Raf.) Raf. on the territory of Lozenska Mt. The species population is more than 15 years old and has predominant coverage in the herb layer of a natural xerothermic shrub community formed by small populations of *Cotinus coggygia* Scop., *Fraxinus ornus* L., *Quercus pubescens* Willd. and *Pinus nigra* Arn. on eroded rocky terrain over Pancharevo Lake. The results of the bio-morphological and phytocoenological observations show high adaptability of the species to this type of habitat. With its strong propagation and distribution strategy *Opuntia humifusa* poses a threat to the remaining populations of indigenous species occupying similar ecological niches, including species with conservation status such as *Orchis purpurea* Huds. and *Stipa capillata* L., which have limited presence in the same locality.

Keywords: *invasive species, adaptation, ecological conditions, Opuntia humifusa, Bulgaria*

Mountainous territories of protection in Azerbaijan

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Dashkasan district is located 33-41 km south-west of Ganja city, 1600-1800 meters above sea level in the north-eastern part of the Lesser Caucasus. The Zivilen village, which is characteristic of tourism, has a very marvelous nature. The village has a very clean air, dense forest, rich flora and fauna. Zivilen village is located on the right bank of Goychay. The village covers an area of approximately 6 hectares. Bala Murov, Bavanovshly, Garagaya, Garashish, Kurdarkhachi, Saruschug, and Koshgar's puppets. Goychay, flowing through the village, owns its source from 2000 to 3500 meters above sea level. from

the hills of Murov and Koshgar. The water is quite clean because it has no residential and industrial facilities before the Zivilen village on the river. There are varieties of Mulberry and Garaxallus Farelas in the river. In recent times, these types of fish are rarely found in the river as a result of illegal fishing. This species of endangered species needs protection. The village territory is surrounded by dense forests. The village has significant healing medicines that are of particular importance to human health.

Keywords: *Zivilen, Goychay*

Small mammals species diversity and population structure driven by habitat heterogeneity in Rila Mountain, Bulgaria

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Small mammals were sampled along altitudinal gradients in Rila Mountain, South West Bulgaria. Species composition varied according to altitude and habitat with a total catch of four rodent and one shrew species. Population number, sex and age structure and some morphophysiological parameters of the yellow necked wood mouse (*Apodemus flavicollis*), bank vole (*Clethrionomys glareolus*), pine vole (*Pytimis subterraneus*) so as the common shrew (*Sorex araneus*) from forest and grassland habitats and snow vole (*Chionomys nivalis*), yellow necked wood mouse (*Apodemus flavicollis*) and pine vole (*Pytimis subterraneus*) from alpine zone was investigated. Correlations were found between abundance of rodent species and habitat variables, particularly vegetation structure, diet, cover of rock and microhabitat.

Keywords: *small mammals, habitats, vegetation structure*

**Study of insect pests, significant to forestry in
the Department of Forest entomology, phytopathology and game fauna
in the Forest Research Institute, Bulgarian Academy of Sciences**

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The Forest Research Institute was established in 1928. Specific forest entomology studies started after 1951 – initially on biology, ecology and measures of fighting *Lymantria dispar*, conducted by Marin Keremidchiev. Later the investigations were expanded to cover the entomopathogenic microorganisms regulating the numbers of this pest, *Stereonychus fraxini*, and others. Significant scientific achievement with great economic effect was the introduction of *Entomophaga maimaiga* to contain the gradations of gypsy moth.

With the recruitment of a second entomologist, Georgi Tsankov, the focus expanded with studies of *Ips acuminatus* and *Thaumetopoea pityocampa*. As a result of the conducted investigations, in the context of the conditions in this country, essential features were established in the development of both *Ips acuminatus* and *Ips typographus*, which should be born in mind when developing the relevant measures aimed to reducing their numbers and the harms they do. As to the pine processionary moth, it was the first report in the world of the pupa diapause established by G. Tsankov and of two phenological forms of this species in Bulgaria. Studies were conducted on the parasitoid complex of the species in its world range.

The investigations on the insect pests and the measures aimed to containing their numbers after the wind throws in the Rhodopes in 1961 and the Vitosha Mountain in 2001 made a great scientific and applied contribution. Other scientific contributions were made by the studies on the cerambycid and tortricid fauna. The phytophagae on poplars and the parasitoid complex on them were also investigated.

Keywords: *Forest Research Institute, Department of Forest entomology, phytopathology and game fauna*

Development and achievements of Forest Phytopathology at Forest Research Institute – Bulgarian Academy of Sciences

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In Forest Research Institute - BAS, established in 1928, the scientific study in the field of forest pathology began in 1949 when the first researcher working in this area was appointed. In general, the phytopathological scientific team, students and technical assistants have a great deal of experience on identification of fungal pathogens and the infections they cause, and achievements in investigating the interactions between the pathogenic organisms and other elements in forest ecosystems. The studies are mainly related to diseases causing damages tree species, identification of causative agents, their biological characteristics and environmental requirements as well as the necessary measures to control them. The distribution and dynamics of epiphytotic damages caused by *Heterobasidion annosum* in the coniferous forests in Bulgaria have been investigated. A program of measures for biological control based on the fungus-antagonist *Peniophora gigantea* have been developed and used for limiting the damages of *H. annosum*. A strong development and spread of fungal pathogens *Lophodermium* sp., *Sphaeropsis sapinea*, *Dothistroma pini*, *Gremmeniella abietina*, *Cryptosporiopsis grisea*, *Cytophoma purchella*, *Hypoxylon mediterraneum*, *Diplodia mitila*, *Cryphonectria parasitica* etc. causing economically significant diseases on main forest species were established in connection with the occurrence of climatic changes during last decade. Complex investigations and experiments have been carried out to determine the reasons for the large diebacks occurred in coniferous and oak forests. Damage reduction measures have been proposed with a view to appropriate resolving the pathological problems in the forests of Bulgaria. Phytopathological scientists have been involved in the development of ICP Forests long-term monitoring of forest ecosystems, the results of which have made it possible to make fundamental and practical conclusions about the impact of climate factors, environmental pollution and bio-factors on the health status of Bulgarian forests.

Keywords: *Forest Research Institute, phytopathology, achievements*

Eulophidae and Pteromalidae (Hymenoptera: Chalcidoidea) from the Rhodopes and Stara Planina Mountains, Bulgaria – recent knowledge, gaps and perspectives

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Parasitoid insects are widely distributed in various biogeographic regions and may play an important role in the ecosystems regulating the population density of many other insect groups. Despite their ecological importance and impact for the insect species complexes the information regarding their faunistic diversity as well as parasitoid-host relationships still remains scarce. Here, we review the recorded data concerning two chalcidoid families – Eulophidae and Pteromalidae from territories of two Bulgarian mountains - the Rhodopes and Stara Planina. The available data shows that only the eulophids of the Rhodopes were extensively studied so far. The subject of these studies was species diversity, but in many cases biological contributions were also presented. In the literature there is data from only few studies that include both morphological and molecular approaches for species identification. Only three species of the family Eulophidae were recorded in the Stara Planina ridge - *Entedon diotimus* Walker, *E. sylvestris* Szélnyi and *Elasmus platyedrae* Ferriere. Pteromalids from these mountains are also poorly known. *Roptrocercus xylophagorum* (Ratzeburg) was the only one species recorded from the Rhodopes, but pteromalid fauna of the Stara Planina still remains unstudied. However, data about 10 pteromalid species from the Podbalkan natural territory was found in the literature. Based on the available records a list on Eulophidae from the Rhodopes including data type and number of taxa is performed. Information concerning Pteromalidae is considered and evaluated in the light of the recent records of the Bulgarian fauna. We also discuss taxonomical studies, gaps in our knowledge and future perspectives for more extensive biological and faunistic investigations.

Keywords: *Eulophidae, Pteromalidae, diversity, the Rhodopes, Balkan Range*

Parasitoids and fungal pathogens of *Phyllonorycter issikii* (Kumata, 1963) (Lepidoptera: Gracillariidae) from Bulgaria

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The lime leaf miner, *Phyllonorycter issikii*, is a moth species native to East Asia which recently invaded considerable part of Europe. A study on the natural enemies of this invasive species was conducted in Bulgaria. *Tilia cordata* leaves infested with the lime leaf miner were collected in 2015 and 2016 in two public parks in Sofia - Borisova gradina and Vrana Park - Museum. A total of ten eulophid species (Hymenoptera: Eulophidae) belonging to three subfamilies – Ectedoninae, Eulophinae and Tetrastichinae, were recorded. *Minotetrastichus platanellus* was dominant species in our samples comprising more than 78.46% of the parasitoids reared from collected immature stages of *P. issikii*. It was followed by *Sympiesis gordius* (6.67%) and *S. sericeicornis* (6.15%). Also, three new host-parasitoid associations were established – *Phnigalio incompletus* (Eulophinae), *M. platanellus* and *Oomyzus sokolowskii* (Tetrastichinae) were found to attack *P. issikii* on *T. cordata*. The entomopathogenic fungi *Beuveria bassiana* and *Metarhizium anisopliae* (Hypocreales) were isolated for the first time from cadavers of *P. issikii* larvae and pupae.

Keywords: lime leaf-mining moth, Hymenoptera, Eulophidae, new associations, entomopathogenic fungi, Sofia

Monitoring on the wolf (*Canis lupus* L.) population in the northern part of Central Balkan Range using photo traps

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Since 2017, impact of wolf (*Canis lupus* L.) on wild ungulates have been studies on northern slopes of Central Balkan Range. A system of different terrain methods, wolf excrement analysis and monitoring of wolf and game populations by photo traps have been created in State Hunting Areas Rusalka and Rositsa. The populations of ungulates include red deer (*Cervus elaphus* L.), deer dama (*Dama dama* L.), roe deer (*Capreolus caperolus* L.), wild boar (*Sus scrofa* L.) and chamois (*Rupicapra rupicapra* L.) in the highest parts of the mountain. A total of 40 cameras have been set in a 1 x 1 km scheme. A specialized program CAMERA BASE was used to process image information.

Biodiversity of soil fungal communities in two forest ecosystems using metabarcoding

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In soils, the determinants of biodiversity change and community assembly are insufficiently studied. The lack of knowledge is mainly related to the small size of soil organisms, their hidden life mode, high cryptic diversity, as well as the great heterogeneity of soil habitats. However, the rapid advances in molecular techniques provides unprecedented opportunities for understanding soil biodiversity. During the last decades studies on belowground microbial communities and their diversity increased substantially and recent data revealed their important functional role. The combination of DNA-based identification methods and next-generation sequencing has proven to be a powerful tool to investigate and monitor biodiversity in environmental samples. The target-

gene amplicon sequencing is the most exploited high-throughput sequencing application in microbial ecology revealing high cryptic fungal diversity (Lindahl et al., 2013). In soil ecology, the internal transcribed spacer regions (ITS1 and ITS2) of rDNA array are usually used for fungal diversity assessment. In the present study soil fungal diversity of two forest ecosystems – Douglas fir plantations and European beech forest were compared using ITS1 and ITS2 metabarcoding. Soil samples were collected from four permanent sampling plots in two mountain regions (the Balkan and Rhodope Mountains) in Bulgaria. Both metabarcoding sets revealed similar results. The genetic richness (220-373 OTUs) and diversity (Shannon Index 3.3-4.7) were high. The most common and abundant genera are *Russula*, *Mortierella*, *Solicoccozyma*, *Inocybe*, *Xerocomellus*. Both PCAs show that soil fungal community composition from both regions differ significantly. Douglas fir fungal complexes have higher variation in genetic diversity and spatial structure. More detailed analyses on taxonomic structure and functional diversity are underway.

Acknowledgment: This study was supported by Bulgarian Academy of Sciences

Keywords: *ectomycorrhizal fungi, Fagus sylvatica, functional groups, NGS, Pseudotsuga menziesii*

Diagnosis of machines in the forestry systems

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This article discusses the possibilities of increasing the efficiency of technical maintenance (TP) and repair (R) of machines by means of technical diagnostics. Characteristics of the diagnostic signs and parameters are formulated. A classification of diagnostic parameters is proposed.

Keywords: *technical diagnostics, diagnostic features, diagnostic parameters*

Sustainable exploitation of biomass for bioenergy from forest marginal lands – the case of Greece and Bulgaria

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Mountainous forest land, especially in Balkan countries, has often lost some degree of its natural productivity due to human impact. Intensive or repeated disturbance, such as repeated fires or overgrazing have inhibited forest regrowth, leading to land degradation and low carbon stocks. This land can also be classified as marginal, due to the existence of limitations for a given use. Marginality may be a transitional state, depending on whether its assessment is based on economic indicators or physical parameters that can be improved with proper management.

In the past decades, the concept of marginal land has been broadly applied to support bioenergy production. Even though the definition and understanding of marginal lands are diverse and limited, there is general agreement on their suitability for bioenergy crops, in contrast to conventional crops. The use of marginal land for short rotation forestry or short rotation coppices may be an effective way to improve soil quality and foster natural regeneration on barren land, while producing revenue from biomass production for bioenergy purposes. The potential of forest marginal land, as well as the environmental, economic and social aspects of this practice is currently being assessed by the SEEMLA project funded by HORIZON 2020. SEEMLA incorporates the establishment and monitoring of pilot plots with forest species in 3 partner countries (Germany, Greece and Ukraine), the development of support tools for the identification of marginal lands and their exploitation, as well as the Life-Cycle Assessment and Life-Cycle Environmental Impact Assessment of the exploitation scenarios. Current land use and protection status have been applied as constraints for biomass production in order to avoid conflict with food or feed production and nature conservation. According to the preliminary results of the project, marginal land available for biomass production in Greece is approximately 1.9 Mha and 0.9 Mha in Bulgaria, with mountainous forest land accounting for a significant share of this area. Thus, the SEEMLA approach can provide an alternative exploitation strategy for marginal forest land to become productive, focusing on environmental benefits and promoting land reclamation.

Keywords: *marginal forest land, biomass, bioenergy*

Economic evaluation of the applied forestry systems in the coppice oak forests in Western Bulgaria

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In Bulgaria, oak forests occupy the largest area - 35% of the total afforested area and 47% of the deciduous forest area (around 1350 million ha). Among them, 87% are of coppice origin. The importance of coppice forests is not only due to their large share in forests in Bulgaria but also due to their very important environmental, forestry, social and economic functions.

The report presents the theoretical basis and the results from the economic assessment of applied forestry systems on coppice oak forests in two Bulgarian state-owned forest enterprises. The wood-producing function of these forests is analyzed depending on the age of logging, stock, costs, income and other characteristics of the forest.

Keywords: *economic assessment, forestry systems, coppice forests*

Performance of the mountain harvester MOUNTY 4000 in the wind throw near the city of Smolyan

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Hourly performance and quality of production of two mountain harvesters Mounty 4000 (mobile cable yarder and crane processor mounted on a truck chassis) have been studied. The time study has been performed on 4 routes with an average length of 595 m in a wind thrown spruce forest with an average tree diameter of 34 cm. An average daily productivity of 87 m³ has been observed. A comparison has been made with the productivity of another such machine, operating at the same time near the town of Laki, and Wanderfalco mountain harvesters, operating in similar conditions in Austria and Switzerland.

Keywords: *mountain harvester, cable yarder, crane-processor, productivity, quality*

Non-wood forest products in the Forest Research Institute

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Since ancient times the forests are source of materials which people use in their everyday life – wood and non-wood forest products as balsam resin, wood kindling, tanning substances, medicinal products, food products – forest fruits, mushrooms etc. In this work the development of the scientific domain „Non-Wood Forest Products (NWFP) (also known as Non-Timber Forest Products (NTFPs), minor forest produce, special, minor, alternative and secondary forest products) in the Forest Research Institute-BAS is presented. The beginning of scientific research oriented toward complex and rational utilization of forest materials is given by the works and publishing the manual „Lesopolzvanie“ („Forest utilization“) in 1932 by Corr. Member V. Stoyanov. In 1947 the scientific domain „Special utilizations“ is included in the department „Lesotechnika“ („Forest technics“) at the Technical Institute of BAS. From then to 1966 the department „Special utilization and wood knowledge“ is leaded by Corr. Member V. Stoyanov, then by Prof. Dinyu Koev, Prof. Krum Kaludin and Assoc. Prof. Hristo Stoykov. Till 1994 the section exists as a single department, but with the structure reform in the Forest Research Institute, this research domain is included in the department of „Forest biology“, now „Forestry and management of forest resources“.

The topic of the research studies of the non-wood (special) utilizations are wood and non-wood forest products and materials in forest ecosystems, their sustainable utilization and protection of biological diversity. During the years many studies are performed to establish the production of balsam resin from *Pinus peuce* Griseb. – researches on resin system, efficiency of different methods for collection of resin and dependencies of resin leakage (flow) from climate changes. There were studied different methods, technologies and organization for resin collection by chemical and bio stimulating substances, the physiology and vital condition of production stands and increasing their productivity, growth and qualities. It was studied the influence of resin collection on technical parameters of wood.

In the research domain „wood knowledge“ was worked in biological and ecological aspects, biomass and utilization of wood materials, standardization of round wood materials and other forest products, strength and endurance of wood, conservation of round wood materials from shivering and cracking.

Biochemical investigations on vitamin and micro elemental content of some forest trees, shrubs and grasses were done, related to their growth and opportunities for ecological and non-exhausting utilization and protection, incl. medicinal plants and fruiting species, determination of their stock, enriching of biological diversity and their cultivation.

It was established the content of essential oil from coniferous species and its dynamics. Studies in mountain meadows and pastures were realized, defining their species diversity, options for fertilization and their productivity. The opportunities for collection of materials for tanning substances production – oak and spruce bark, osier etc. were also studied.

The results of the scientific researches are published in many books, manuals, articles etc. and have found their application in forestry practice contributing the development of the forestry and biological science.

Keywords: *non-wood (special,) forest products utilizations*

National programme of forest ecosystems monitoring in the frame of ICP Forests

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Bulgaria has a long history and tradition of forest management, which includes large-scale monitoring. The Executive Environment Agency maintains a network of permanent sampling plots where data have been actively and manually collected over long periods. This network provides the long-term data needed for analyses, assessments and forecasts to support the preservation and protection of Bulgarian forests. The National Programme for Forest Ecosystems Monitoring is operationalized as part of the National System for Environmental Monitoring and implemented on two levels, namely, large-scale monitoring (Level I) and intensive monitoring (Level II). All activities of the Programme are carried out in accordance with the International Cooperative Programme (ICP) Forests Manual. Data collection is focused on determining stress factors and assessing the condition of forest ecosystems.

Keywords: *forest, ecosystem, monitoring*

Forest ecosystems monitoring programme in Bulgaria in the frame of ICP Forests

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The National Programme for Forest Ecosystems Monitoring is operationalized as part of the National System for Environmental Monitoring and implemented on two levels, namely, large-scale monitoring (Level I) and intensive monitoring (Level II). The National System is managed by the Executive Environment Agency and all activities of the Programme are carried out in accordance with the International Cooperative Programme (ICP) Forests Manual. Data collection is focused on determining stress factors and assessing the condition of forest ecosystems.

Keywords: *forest, ecosystem, monitoring*

Spatial distribution of high mountain ecosystems using Remote Sensing and GIS: A case study in South West Rila Mountain – Bulgaria

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Dynamics in spatial distribution of high mountain ecosystems, located in Bulgarian South West (SW) Rila Mountain, has been studied in current article for a period of around 40 years (1977 - 2018). Using satellite data in GIS environment we have been obtained results related to the dynamics of the spatial distribution of high mountain ecosystems in the study area. Normalized Difference Vegetation Index (NDVI) based on satellite data from Landsat and Sentinel 2 sensors has been used for a quantity assessment analysis of the ecological dynamics. The obtained results are presented as thematic maps providing quantity and quality assessment of the spatial distribution of high mountain ecosystems in SW Rila Mountain.

Keywords: *high mountain ecosystems, remote sensing, GIS, NDVI*

High mounting eco monitoring in Rila Mountain using EDXRF technique

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Environmental contamination caused by anthropogenic activities is a global problem and is observed not only in urban and industrial areas. The risk of pollution of the mountains with heavy metals and toxic elements is getting higher in many cases due to the trans-border transition of large mass of air and water. Monitoring over the years helps us to determine the concentration changes during the years.

The goal of this study is to determine the content of heavy metals, trace and toxic elements in environmental samples (soils, plants and small mammals - mice) from Musala peak in Rila - the highest mountain in Bulgaria. Samples from grass, moose, small mammals and other biological monitors were analyzed using Energy Dispersive X-Ray Fluorescence (EDXRF) method for more than 20 macro and micro elements. The monitoring of heavy metals and toxic elements concentrations gives us the opportunity to investigate the distribution and dynamics of chemical elements accumulation in flora and fauna and their passing over the trophic chains and also for evaluation of anthropogenic influence of toxic elements and technogenic transportation on the ecosystems. The 2018 results are compared to those from previous years to analyze whether pollution has increased in recent years.

Environmental monitoring at the Institute for Nuclear Research and Nuclear Energy experimental bases situated in Sofia and Rila Mountain

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An important objective of environmental monitoring is to provide data that permit the analysis and evaluation of environmental status and human exposure. A scientifically based environmental radiation monitoring is carried out

in accordance with the specially developed program based on the purpose of the study - to establish the current status of an environment or to establish trends in environmental parameters. In order to provide sufficient data for estimating any ecological problem, an environmental monitoring program was performed at the experimental bases of the Institute for Nuclear Research and Nuclear Energy (INRNE), Bulgarian Academy of Sciences (BAS). Investigations are based on determination of contaminant levels and concentration changes. Monitoring of environment is performed at a net of pre-selected observation posts in which the quantity and distribution of contaminants are determined. It is based on samples taken and determination of potentially toxic element and radionuclide contents in air (aerosols), water (groundwater and rainfall), soils and selected plants - proven bio-indicators.

This paper presents the results of the long-term environmental monitoring conducted by the experts of the Nuclear Scientific Experimental and Education Centre (NSEEC) with stopped of operation research reactor IRT and the Basic Environmental Observatory (BEO) Moussala.

All obtained data demonstrate a high level of environmental safety in accordance with the requirements of existing legislation. The results prove the absence of any anthropogenic impact in the observed sites boundaries.

Keywords: *Rila mountain, high mountain monitoring, BEO Moussala, toxic element, radionuclide*

Assessment of forest ecosystems, the condition and provided services outside NATURA 2000

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The assessment of forest ecosystems in Bulgaria (Forest territories outside NATURA 2000 Network) was done as one activity of the project „Forests and woodland - ecosystem services mapping and assessment in the Bulgarian forest territories outside NATURA 2000 network“ - FOR OUR FUTURE, funded by the EEA FM 2009-2014, under the Programme BG03 „Biodiversity and Ecosystems“.

The performed and analyzed data from the elaborated models (algorithms) for assessment of the condition of the forest ecosystems and the provided ecosystem services were compared to the existed data into the forest system but also collected on the field. The assessment of the two main models, resp. for defining the condition of the forest ecosystem and of the provided ecosystem services was done.

Though the significant scale of the studies performed, the elaborated models and the based on them analytical algorithms do have imperfections and gaps with insufficient information. The three types of woodland and forest ecosystem services were observed - provisioning, regulating and cultural. For the most of the cultural ecosystems either there is no or few and unclear data and information.

For any further assessment of the woodland and forest ecosystems' conditions and of the ecosystem services in Bulgaria, the methodology used in the project should be refined in order to make the used definitions of indicators clear and some parameters to be available.

Keywords: *forest ecosystem services projects*

PineManageTool – a software for estimation of growth, yield and tree size distribution, and for simulating thinning alternatives for Scots pine plantations in Bulgaria

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This work presents the simulator PineManageTool, which is adapted for estimation of growth, yield and tree size distribution, and for simulating thinning alternatives for Scots pine plantations in Bulgaria.

PineManageTool is a multi-modular program based in MS Excel and elaborated using Visual Basic for Applications. It combines two, alternative to each other, whole-stand sub-models (Module 1) and distribution sub-models (Modules 2 and 3), which are arranged in three, consecutively applied, modules. The first module provides prediction and projection in time of growth and yield variables at stand level and allows simulation of thinning alternatives

to suggest various options according to management objective. Module 1 can be implemented in two different ways: using a Stand Density Management Diagram (SDMD) (M1) or by a Dynamic growth model (M2). Module 2 recovers the diameter distribution of the trees in the stand using the stand-level information about density and quadratic mean diameter. Module 3 employs the output information of Modules 1 and 2 to differentiate the stand into size classes according to height and volume.

The whole package encloses four files, one of which is the simulator and the other three are chart-containing auxiliary files. The simulator is organized on eight sheets, six of which include the two alternative whole-stand models, their applications and parameters (Module 1), while the other two sheets contain each of Modules 2 and 3. At least MS Excel 2010 environment or higher is required and installation consists of simple download and permission to enable macros at file opening.

Keywords: *simulator, Visual Basic for Applications, Stand Density Management Diagram, Dynamic growth model, Pinus sylvestris*

Common cross-border policies for forestry protection (FORPRO)

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The FORPRO project to Cooperation Programme ‘INTERREG V-A Greece-Bulgaria 2014-2020’ was implemented in cross-border area of Regional Forestry Directorate Kardzhali (Bulgaria) and Dadia-Lefkimi-Soufli Forest National Park (Greece) which is one of the most ecologically sensitive in the Mediterranean, including important forest and coastal ecosystems of ecological value and biodiversity.

The project activities are focused on several relevant insect pests that pose major threats to the forest stands. The selected model species are: *Lymantria dispar* (L.), one of the most important forest insect pests in broadleaved forest stands; *Thaumetopoea pityocampa* (Den. & Schiff.), dangerous urticating insects and strong defoliator in Bulgarian and Greece pine forests; economi-

cally important insect pests from Geometridae family (*Operophtera brumata* L., *Erannis defoliaria* Cl., etc.); *Euproctis chrysorrhoea* (L.), strong allergen in urban areas; bark beetles (Coleoptera: Curculionidae, Scolytinae) causing drying of pine plantations.

The monitoring of forest ecosystems is based on remote sensing and in-situ observations. The forest protection pilot activities include: use of entomopathogenic fungus *Entomophaga maimaiga* as environmental safe biocontrol agent of *L. dispar*; determination of the regulatory capacities of egg parasitoids of *T. pityocampa*; use of trap trees to control bark beetles in pine plantations.

Keywords: Cross-border area, Bulgaria, Greece, forest protection, *Lymantria dispar*, *Thaumetopoea pityocampa*

Trees for the future - NFG in Bulgaria

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Since 2012 in my very first meeting with the members of Norwegian Forestry Group (NFG) it was clear that we will collaborate in the future, because of the principles and especially objectives of the NFG:

International consulting services, project development and project implementation based on sustainable forestry and appropriate natural resource management; Marketing of competence from seed to final wood products and from environmental protection to commercial utilization of forests in a long-term perspective; Tailoring of projects and expert groups according to the needs of public and commercial customers. So far the NFG has successfully completed 6 projects within the past Programming period and new born ideas and concepts arise for the present one in the fields of: Forests and poverty eradication; Forests are crucial for the natural environment; Forestry for economic development; Forest Research and Forest Education and Extension.

Keywords: Norwegian Forestry Group joint projects

Development of integrated strategies for the prevention of pine cancer

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Fusarium circinatum Nirenberg & O'Donell is a fungus that affects *Pinus* spp. and *Pseudotsuga menziesii* plants causing its death. *Pinus pinaster* and *Pinus pinea* have an important economic role in Portugal (*P. pinaster* represents 23% of forest area and 20% of forest exports; *P. pinea* fruit has an economic value of 50 to 70 M€/year). This fungus is a quarantine pest (Community Decision 2007/433/EC, of 18 June). It was first detected in Portugal in 2008, at a forest nursery, and until the end of 2017 it was detected in 16 forest nurseries and in 2 *Pinus radiata* stands.

The European Commission established protective measures against the introduction into and spread within the Community of this fungus, that involve the destruction of all plants or seeds of the infected lots and a quarantine period (2 years) of the remaining host species present in the same site.

The application of these measures have been creating difficulties for national forest nurseries (destruction of thousands of host seedlings) and for the supply of the national market with pine seedlings. Prevention is the most effective

way of reducing losses caused by *F. circinatum*: good management practices for forest stands and adequate nursery health procedures.

In order to minimize or eliminate the risk of pine pitch canker spread in Portugal, the Portuguese Forest Service (ICNF) implemented a project (GO +PrevCRP, 2017-2021), supported by the Rural Development Program 2020, to evaluate the effectiveness of different disinfection treatments for seeds, substrates, containers and irrigation water, on fungus survival and seedling quality. The most effective treatments will be applied to commercial forest nurseries and their applicability and impact on seed germination and seedling quality will be evaluated. After application of the treatments in the nursery, the performance of the plants in the field (first year of planting) will also be monitored.

The expected results are: contribute to fungus's control through a new process to be integrated into the current system of forest plants production through the application of preventive measures based on disinfection treatments applied to the different production factors in the nursery.

Keywords: *Fusarium circinatum*, forest nurseries, preventive measures, disinfection

6. Round table - discussion

The conference will be officially closed on 25th October with a plenary session and Round table. During the discussion, the moderators of each session will be able to report and to present a brief summary of the conference sessions. The objectives of the Round table will tend to highlight the main outcomes from the presented research works, as well as to focus on some take-away messages, comments, and questions raised during the presentations.

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8. Practical information

Transport to Metropolitan hotel

Aiport transfer

Metropolitan Hotel and Dream Hotel offer fast and comfortable airport transfer with modern vehicles. The address is: 64 “Tsarigradsko Shose” Blvd., Mladost 1, 1784 Sofia.

Please call Reception desk to arrange pick up / drop off service.

If not included in room rate: 5 EUR/person/direction.

Taxi services

There are a few well-known taxi companies in Sofia: “Yellow”, “OK Super-trans”, “Green Taxi”.

Standard rates are as follows:

- day: 0.79 BGN/km
- night: 0.90 BGN/km

From Metropolitan Hotel to Sofia Airport – around 2.55 EUR (5 BGN) in low traffic and around 3.60 EUR (7 BGN) in rush hour. From the hotel to the city centre – maximum of 6 EUR (12 BGN).

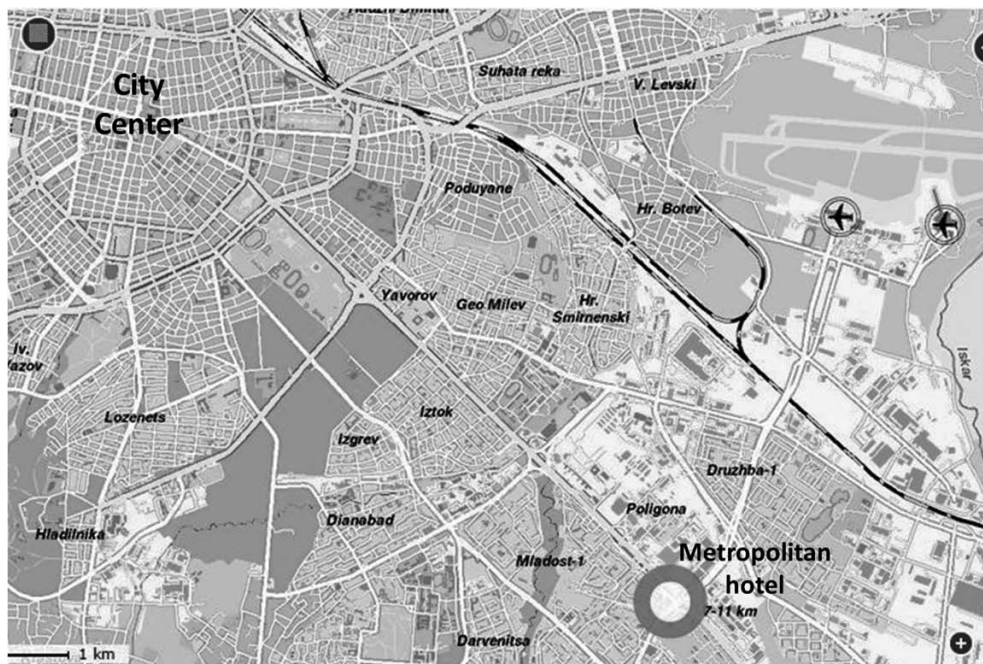
The taxi driver must have an ID and a vehicle license which must be on the dashboard. Do not hesitate to file a complaint if you are not satisfied with the service. In order to call a taxi, you need to dial a phone number or hail a taxi with a green light if you are on the street.

Always check the rates in order to avoid a deceit.

Public transport in Sofia:

<https://www.sofiatraffic.bg/en/common>

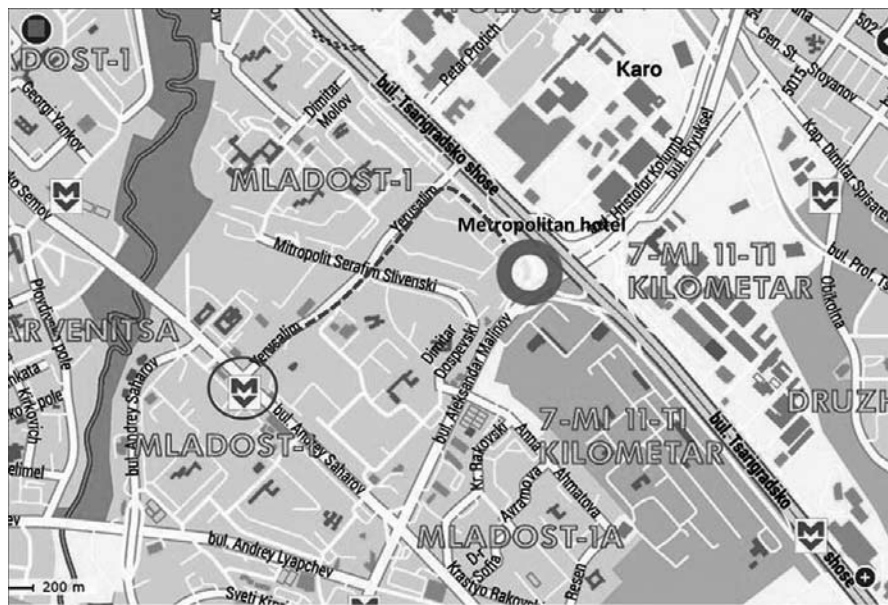
Hotel location



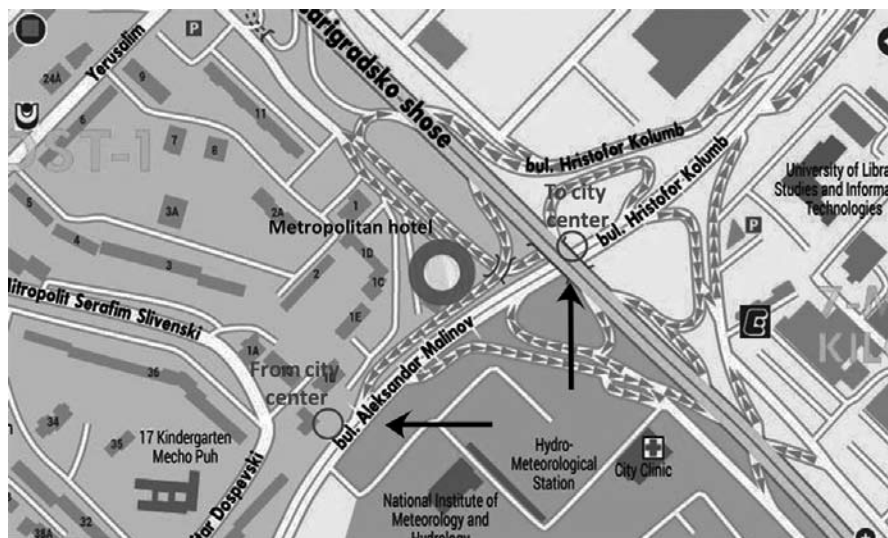
Public transport to the city center

- Buses – № 1, 3, 5, 76, 84, 88, 204, 213, 305, 604 – bus stop “HMS” or “Printing Works of the Bulgarian National Bank Corp.”
- Fixed route taxis – 3, 4, 9, 14, 16, 30, 35
- Trolleybus – 5, 8
- Subway: station Mladost 1, distance from the hotel – 1km.

Location of the closest Subway station – about 1km



Location of the closest bus stops



NOTES

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