BOOK OF ABSTRACTS

WOOD – SCIENCE – ECONOMY
Sustainable forestry and forests – opportunities and constraints under climate change

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Influence of relative humidity upon surface roughness of flooring materials

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ABSTRACT

Flooring material maybe exposed to changes in weather conditions in its surroundings such as relative humidity and temperature. This change can affect the surface properties of the material in terms of smoothness, roughness, mechanical and thermal properties.

The aim of this work was to determine surface roughness of flooring material as a function of relative humidity.

Oak wood flooring materials were covered with the 4 different UV coating system ("brush", "matt", "standard" and "white") in the industrial conditions (a total of 40 samples).

The samples were subjected to 24 hours and 72 hours humidity test (modified test acc. to AMK-MB-005 procedure) with varying temperatures.

The surface roughness was estimated using portable stylus type profilometer (Mitutoyo SJ-210). Average roughness (Ra), mean peak-to-valley roughness (Rz) and maximum roughness depth (Rmax) were estimated. Six roughness measurement was carried out on each sample (along and across the fibers). The results were presented in numerical and visual diagram.

It was concluded that surface roughness parameters along fibers were higher in both Ra and Rz after humidity testing in two different conditions (24 hours and 48 hours). The surface roughness changes between twenty-four hours and forty-eight hours were not significant.
Similar trends were observed in all the tested systems.

Keywords: flooring material, oak wood, UV system, relative humidity test, roughness

Perceptions and expectations from a training program aimed at new forest workers in Greece

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ABSTRACT

Introduction: Forest workers' training is considered a precondition for modern forest management. This has led to various training systems initiatives internationally, whose aim, despite the different implementations and characteristics, is the same: Setting the basis for a solid professional life of new entrants in forest operations. The implementation of such a training program aiming at young forest workers has just started in Greece. The objective of the study is to examine the views, the expectations and educational needs from such a training program as expressed by active forest workers in the prefecture of Drama, a region with long tradition in forest operations and the highest production of wood products in Greece.

Materials and Methods: The research was carried out by means of a specially constructed questionnaire. After the necessary pilot study procedure, the questionnaire was used to conduct personal interviews with forest workers eligible to participate to the study. A total of two 210 questionnaires (150 male and 60 female) were collected. Statistical analysis was carried out with the statistical software IBM SPSS 23.

Results: The majority of the study participants (94.3%) was primarily employed as professional forest workers and lived in mountainous, in many cases remote, areas (72.4%). Most of them received no formal training rather on-the-job. Chainsaw, the main power tool used in the area, is considered as highly dangerous (74.7%) and they suggested that courses for active forest workers should also be provided. As a result of the training program, safety will be considerably promoted (56.7%), and a prior suitability test for the specific work would be helpful in this direction. The quality of forest operations is also expected to be upgraded (47.6%) but the social impact, especially in the form of keeping the younger people in the mountainous communities will be limited.

Conclusions: According to the study participants, the offered training program is expected to promote both safety in forest operations and the work quality. Interestingly, they tend to differentiate with some aspects of the existing program making suggestions for its improvement. A very important finding is their willingness to participate in courses (initial or refresher courses) that will be offered to active forest workers as well. In this context, the establishment of forest worker training schools deems necessary to organise and upgrade the professional capacity of the Greek forest workers, both existing and future ones.

Keywords: vocational training, motor-manual harvesting, perceptions, questionnaire

Unraveling the age structure of old-growth oak coppice woodlands in Eastern Mediterranean

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ABSTRACT

Introduction: In ancient times the Mediterranean island of Cyprus was largely covered with forests but today, after millenniums of felling, most of this woodland is long gone. Therefore, localities with coppice woodlands preserved up to these days are important culturally-historical traits and integral part of landscape, since they have been extensively shaped by human influence. Recent scientific reports with data from coppice woodlands provide an important basis for the evaluation and improvement of their ecological concepts. A dendroflora with such particular features in Cyprus is the island's National Tree, the endemic oak *Quercus alnifolia* Poech. This evergreen oak, occurs only on the ultra-basic rock formations of the Troodos Ophiolite Massif mainly from 450-1600 m and is the dominant species of dry habitats in pine and maquis woodlands.

Materials and Methods: The research took place in Paphos State Forest. Although nowadays contains the most productive and extensive coppice woodlands of the species, it suffered before from overexploitation and overgrazing. The objective in this study was to reveal the population age structure of the *Quercus alnifolia* stored coppices. For this purpose, we used tree-ring science as a proxy based on the limited existing knowledge in *Quercus alnifolia* wood anatomical structure. Until now, two unsuccessful attempts held 100 and 40 years ago respectively (Imperial Institute of the British Empire & Commonwealth Forestry Institute of the University of Oxford). In order to achieve the precise dating of the species, wood micro-sections were prepared from 162 samples which were collected from Paphos State Forest. Only the most dominant and undamaged stems were selected out of 100 different coppice stools in an area of 2.2 ha.

Results: The study showed that the samples had a maximum age of 150 years with an average of 108 years, thus having an average stem diameter and stem height of only 13 cm and 6 m respectively. In terms of age structure, 67% of the population was more than 100 years with an average stem diameter and stem height of 14.3 cm and 6,5 m respectively, while only the 11% of the population was less than 80 years with an average stem diameter and stem height of 10.6 cm and 5.7 m respectively.

Conclusions: These results are in identification with specific historical factors which outlined the critical characteristics in the determination of the present old growth coppice structure of this ecosystem: the establishment of the first provisions on Forest Management in 1881 and the final regulation of grazing in the 1940s by the British.

This study was supported by the Internal Grant Agency of Mendel University in Brno (Czech Republic), the Cyprus' Department of Forests (Republic of Cyprus), the Department of Forestry and Natural Environment of the Aristotle University of Thessaloniki (Hellenic Republic) and the Department of Forestry, Wood Science and Design of the University of Thessaly (Hellenic Republic).

Keywords: dendrochronology, tree-rings, wood micro-sections, Mediterranean oaks

Precision forest harvesting for monitoring timber extraction via forwarder

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ABSTRACT

Precision Forest Harvesting, consisting in the application of modern technologies to improve the overall sustainability of forest operations, has been proven to be an effective approach in the framework of sustainable forest management and on sustainable forest operations. In particular, timber extraction is a crucial operation along timber supply chain and improving its monitoring could lead to substantial benefits in terms of both research and management activities.
Taking the above into account, within the AGRIDIGIT project, the Centre for Engineering and Agro-food Processing of the Italian Council for Research in Agriculture (CREA-IT) has developed a monitoring system to track timber loads extracted via forwarder. This consists of a pilot system for monitoring the loads during timber extraction operations, providing loading and unloading positions and weight of the biomass handled. The system is managed through a specific App and consists of a GNSS receiver, a steel subframe for positioning the timber and a series of sensors for weight detection.

The GNSS receiver is a GNSS android 4G receiver Mobile Mapper 50, operating on GPS and GLONASS satellite constellations. The receiver is combined to a software (Mobile Mapper Office) for recorded data management. The weighing system of the wood loads is composed by a mobile iron frame and different sensors for data acquisition. For the management of the entire system, a specific App has been designed using the Android platform. In this way, the system can be managed through a simple Android smartphone, being therefore user-friendly and also applicable not only to a forwarder but to several different forest machines.

The system is therefore able to monitor the positions of the machine and the amount of loaded timber, being therefore useful also in the optic of time-motion research studies dealing with work productivity evaluation. The system has already passed a first stage evaluation phase and now our research group is going to test it in the operative framework in two different forest stands, namely an artificial coniferous plantation and a beech even-aged high forest. This second phase of pilot system evaluation will consist of both checking for the reliability of the data on timber weight provided by the weight sensors and of work productivity evaluation according to the harmonized protocol for forest work productivity evaluation developed within the COST Action FP-0902.

Keywords: GNSS, forwarding, smartphone, work productivity, timber

Wood anatomy of forest species and it's role in understanding forests in a changing climate

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ABSTRACT

Wood anatomy is providing more and more critical knowledge in understanding the structural support of plant life, and new tools are available to extract information from the microscopic structure of the wood in trees. Exploring the anatomical plant response in tree rings allows us to infer forest species' behaviour in the changing climate. Building big datasets in wood anatomical traits spanning centuries and millennia is now possible thanks to new hardware and dedicated software. This talk will address up-to-date knowledge and solutions to methodological issues and will provide some examples from recent studies.

Keywords: wood anatomy, tree-rings, vessels, tracheids, wood, plant stem.

Energy ratio of a supply chain of pruning residues from pear orchards

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ABSTRACT

Introduction: Biomass has been identified as one of the main sources of energy and its importance is expected to increase in the coming years. All possible sources of biomass are under examination in Greece to identify their potential in satisfying the increasing pressure for energy safety. The Region of Thessaly, located in Central Greece is a predominantly agricultural region, where large amounts of biomass can be collected and further processed for energy production. The aim of this study was to examine the energy ratio of woody biomass originating from pruning of orchards in the Region of Thessaly and suggest further steps for optimization.

Materials and Methods: Harvesting and pruning works were carried out in a pear orchard by professional loggers, members of Forest Cooperatives. It was private land and tree removal took place due to a change in the cultivation type. The trees were about 8 years old and reached a height of 2-2.5 m. The equipment used consisted of a crane, a Liebherr 914 Litronic excavator with an attached grab, a DAF tri-axle truck, Husqvarna Model 365 chainsaws and five workers from the nearby area. At the energy plant site, a loader was used to feed a primary crusher (Model AMB 633). Time studies were carried out at all stages of production and transportation and data were collected on the number of employees, fuel consumption, use and availability of machinery and equipment as well as the quantities of biomass collected and processed. The scenario examined was based on a transportation distance of 35 Km, which can be considered as typical by Greek standards. The functional unit in our research was the kWh of energy produced.

Results: The study lasted for a total of 20 days. The first 10 days of were used for data collection regarding the pruning operations and biomass transportation and the remaining 10 days for material storage and comminution at the energy plant. The energy balance (energy input: energy output) was found to be 1:23.86. A total of 18.75MWh was consumed to produce 447.2 MWh, resulting in a carbon footprint of 0.28 kg CO_{2eq} / kWh. The carbon footprint was also calculated per solid wood volume unit over bark (m^3 s.o.b.) and amounted to 26.3 kg CO_{2eq} / m^3 s.o.b.

Conclusions: The high rental and operational costs of the excavator hardly justify its use under similar conditions. Due to the uprooting involved, the transported biomass was contaminated with soil and stony material, which created additional problems both in combustion and in the subsequent management of the ash residues. Furthermore, the lower density of the pruning residues resulted in lower transportation efficiency compared to other biomass sources in the area such as wood harvesting residues.

Keywords: biomass, energy production, motor-manual harvesting, time studies, fuel consumption, carbon footprint

Finishing of wood after thermal modification

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ABSTRACT

Thermally modified wood is typically used in external building elements and saunas. It is exposed to high and various temperatures and humidity. Therefore, it is necessary to apply appropriate finishing system related both to the selection of a suitable lacquer product or activating the surface of thermally modified wood before finishing.

The aim of this study was to present methods of thermal modification of wood, surface activation and lacquer products recommended for finishing of thermo-wood in Estonia and Poland. The results of investigations on the adhesion strength of waterborne and alkyd-urethane coatings to the substrate were presented.

The possibilities of using cold barrier discharge plasma treatment to activate the surface of thermo-wood prior to finishing were discussed.

Keywords: wood modification, plasma treatment, lacquer products, adhesion strength

Changes taking place in spruce wood used in construction

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ABSTRACT

Spruce wood, after pine wood, is the main building material used in Europe. Many wooden buildings from past eras were protected with simple means based on wood tar, vegetable oils and lime. In the Beskydy Mountains, in the works securing wooden objects, vegetable oil definitely prevailed, and later overworked engine oil prevailed. Due to the carcinogenic compounds contained in the burnt engine oil, wood obtained during renovation works or demolition of facilities goes to disposal. The share of post-consumer wood impregnated in Poland is about 3.1 million Mg per year, half of which comes from construction. The research covered about a hundred years old maintenance waste from utility facilities located in the Żywiec Poviat. Due to the fact of protection with burnt oil, this waste belongs to the group of hazardous waste. The research was carried out in order to determine the possibility of safe use of the discussed post-consumer wood waste. The work was carried out tests of the bending and compressive strength of wood using the Shimadzu model AG-XV testing machine and chemical properties through elementary tests performed with the LECO CHN628 + S analyzer and thermogravimetric on the TGA/DSC3 apparatus from Mettler Toledo. The tested waste is characterized by a calorific value Q net dry 18.8 MJ / kg the average lignin content of the tested material is 32.8%, cellulose 53.5%, hemicellulose 7.6% and the ash content does not exceed 1%. The density of the tested raw material in the dry state ranges from 372 to 421 kg / m3. The tested wood showed an average bending strength of 49.8 MPA and 39.5 MPA for compression along the wood fibre The tested wood meet the standards of structural wood ISO PN-EN 338:2016-06 class C27.

Keywords: spruce wood, constitant wood

Comparative study of natural or self-disinfection methods of different types of wood surfaces after contact with fresh meat or inoculation with pathogenic bacteria

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ABSTRACT

Introduction: Wood infection and disinfection is a significant challenge that relates to public health as well as food safety, since wood surfaces are often used as cutting boards or benches (e.g. at home or in butcher shops). The porous and nutritive nature of wood is ideal for the accumulation of microorganisms that can contaminate food, while the use of strong chemicals like chlorine, condensed acids or alkali is not appropriate for such surfaces, as they can harm wood or transfer toxic substances to food. Thus, more natural methods of disinfection of wood are necessary. Also, the type of wood and the cutting method may also affect the porosity of wood and the effectiveness of decontamination methods.

Materials and Methods: Three types of wood (chestnut, beech and fir tree) and two types of wood cutting method (tangential and axial cutting) were used as meat cutting boards and compared regarding their resistance to contamination and the efficiency of disinfection. Also, six different methods of wood disinfection were applied separately (control without disinfection, addition of salt, baking soda, vinegar, steam and pretreatment of wood with Zn0 for self-disinfection) and their decontamination efficiency was comparatively studied against meat spoilage bacteria naturally present in fresh minced meat (Total Plate Count, *Enterobacteriaceae*), or pathogenic bacteria (*Campylobacter*, *Salmonella*, *Escherichia coli*, *Staphylococcus aureus*, *Clostridium perfringens*) that were inoculated in minced meat before coming to contact with the wood surface.

Results and Conclusions: The results indicated that chestnut was the type of wood that was most resistant to contamination after contact with fresh meat, probably due to the presence of antimicrobial tannins that it contains and its less porous surface, compared to other types of wood, followed by fir. Beech, which is apparently the most common tree used for this type of application industrially and in butcher shops (as meat cutting boards) was in fact the least resistant to bacterial contaminations and in this sense, the least suitable for this use. The tangential cutting was generally preferable to axial cutting, probably due to the leaner and less porous surface that it produces, which is easier to clean, wash and disinfect. Addition of vinegar was the optimal method for wood surface disinfection (after contact with meat), regardless of the type of wood or the cutting method. ZnO was also quite effective against most of the tested bacteria. The efficacy of ZnO (which was embedded into wood) was better with the axial cutting method, which results in a more porous and absorbent surface, that can better absorb the ZnO solution. We can conclude that the use of vinegar can effectively decontaminate wooden surfaces, while if self-disinfection is desirable, the application of ZnO can be the method of choice.

Sustainable forestry and climate change – uncertainties from tree mortality following extreme events

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ABSTRACT

Forest ecosystems are facing unprecedented changes in climate conditions. Rapid increases in temperature, along with increasingly frequent occurrences of climate extremes like drought and heat, are posing a severe threat to forest survival and to the persistence of forests in their current form. Large forest damages following the extreme summers 2018-19 have also highlighted that established forestry approaches may not be sustainable for future forest management.

In this presentation I will show the current extent of unusual tree mortality globally and I will give an overview on physiological mechanisms related to climate change-induced tree mortality. I will document how difficult it is to predict future forest condition and, finally, I will underscore that forest management will have to account for further severe changes in climate during the next decades by rethinking established paradigms.

Cold liquids resistance of UV lacquer coating systems prepared under industrial conditions

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ABSTRACT

The aim of the investigations was determination of the influence of application and hardening parameters of the UV lacquer products on the HDF boards surface (amount of basecoat and topcoat, the number of layers and the different lamp powers) upon resistance of coatings to cold liquids action. Samples for experiments in industrial conditions were prepared.

For the investigations 10 liquids (acetone, beetroot juice, coffee, ethanol, milk, blackberry juice, paraffine, tea, water and wine) were used. Resistance of coatings acc. to the PN-EN 12720 standard was carried out.

For deeper analysis color changes of coatings after liquid action were estimated. According to the study's findings, the hardening parameters of UV lacquer systems have an effect on their resistance to cold liquids action.

Keywords: HDF, UV lacquer system, lamp power, hardening, cold liquid, color

Valorisation of lignocellulosic biomass towards adhesive and wood composite materials development

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ABSTRACT

The valorization of lignocellulosic biomass for the manufacturing of value-added materials is a fundamental pillar of sustainable development and circular economy, providing an alternative to petroleum-based refineries and contributing to green transition in production. Lignocellulosic biomass is a valuable source of components and can be utilized to produce biopolymers via chemical, physical, microbiological, or enzymatic routes. Fractions obtained from the lignocellulosic biomass can be used in suitable and specific applications.

Currently and primarily, wood is the raw source of nanocellulose production. In the interest of the diminishing wood resources in the world, the nanocellulose can be extracted from the lignocellulosic biomass, including waste biomass. In turn, liquefaction can be employed as one of the effective methods of lignocellulosic waste management.

The presented study focused on the different aspects of synthesis, modification, and applications of biopolymers obtained from lignocellulosic biomass, such as nanocrystalline cellulose (CNC), nanofibrillated cellulose (CNF), and liquefied wood. The research aimed to valorize the lignocellulosic biomass for the production of biopolymers intended to use in adhesives and wood composite materials. Firstly, the potential of lignocellulosic biomass towards the formation of biopolymers was discussed. Further, different methods for biomass pretreatment were explained. The need for nanocellulose modification was highlighted to improve the functionality of the materials. Finally, the application of both kinds of nanocellulose and liquefied wood were explored in the field of the wood-based panel sector.

Nanocellulose was effectively recovered, and liquefied wood was successfully obtained from lignocellulosic biomass, which was confirmed by microscopic examination. Nanocellulose acted as modifying and reinforcing agent of amine resins improving mechanical performance and reducing formaldehyde emission. On the other hand, replacing 40% of the standard amino resin with liquefied wood caused that the minimum requirements for particleboards of type P2 according to PN-EN 312 has been met.

The research was partially carried out within project no. LIDER/14/0174/L-7/15/NCBR/2016: New bio-polymer adhesives modified with silanes and ionic liquids for application in wood-based materials technology (BioAdSIL), funded by the National Centre for Research and Development in Poland under the LIDER VII Programme.

Keywords: adhesive, biopolymer, lignocellulosic biomass, liquefied wood, nanocellulose, wood composite

Carbon pricing schemes in the forest sector: an overview of modelling efforts

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ABSTRACT

Forest-related climate mitigation options become increasingly acknowledged to meet the target of the Paris Agreement. To increase carbon sequestration in forests and forest products, carbon pricing schemes are seen as a promising approach. The implementation of these economic incentives is likely to impact wood products markets, potentially affecting the demand and supply side. To shape efficient climate mitigation measures, forest sector models are widely used instruments to assess such impacts of carbon pricing schemes. However, characteristics of implemented carbon pricing schemes can differ among conducted modelling analyses, possibly influencing the assessment results in return.

We conducted a scoping review on the implementation of carbon pricing schemes in forest sector models, reviewing systematically studies published between 1990 and 2021. Drawing on 48 modelling studies, we provide an overview of technical characteristics of implemented carbon pricing schemes, underlying assumptions and scopes of analysis.

Among reviewed articles, we identified profound differences regarding the type and the system boundaries of carbon pricing schemes implemented, as well as carbon price-related characteristics. In most cases, these differences can be related to the modelling framework and in particular the formulation of the optimization problem. Depending on the specific system boundaries, two main categories of carbon pricing schemes were identified: symmetric schemes, which account for both carbon sinks and sources, and asymmetric schemes considering only one of both sides. The number of sinks and sources valued in the studies varies in accordance with their research objectives and model boundaries. Besides modelling analysis on a global level (44%), studies have focused on European countries (25%) and on the US (23%), both corresponding to the key regions for the development of forest sector models. Furthermore, commonly addressed issues regarding permanency, additionality and leakage of forest-related climate mitigation options are treated differently across the reviewed studies. While most studies do not explicitly consider these issues, more recent studies integrate them through adaptations of the optimization framework.

Carbon pricing schemes have been extensively analyzed in forest modelling literature. Nevertheless, the broad range of characteristics of implemented carbon pricing schemes, their differing system boundaries and scopes make a comparison between the results of these modelling studies challenging. Therefore, a critical appraisal of the results regarding the underlying modelling assumptions is essential to inform the policymaking process. This scoping review offers an overview of the state-of-the-art methods to represent carbon pricing schemes in forest sector models, discusses technical aspects and identifies research gaps to highlight possible future research trends.

Keywords: Carbon pricing schemes, Forest sector modelling, Forest economics, Carbon markets, Scoping review

Dynamic land use land cover change in the Barekesse-Owabi catchment and Kumasi metropolitan area in Ghana

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ABSTRACT

Ghana like all countries in Sub Saharan countries has long been undergoing intense land-use landcover changes (LULCC) which have given rise to in extensive forest loss (deforestation and degradation) and arable land loss and land degradation which have affected other essential ecosystem service. The need for LULC information for improved land-use planning and sustainable management of land-resources cannot be overstated. This study assessed the past LULCC in the Atwima Nwabiagya which contains the Barekesse and Owabi Headworks) and the Kumasi Local Assemblies' Areas in Ghana and projected the scenario in 2040 for business-as-usual (BAU). The synergies of satellite imagery of 1990, 2000, 2010 and 2020 were classified with an overall accuracy of 90%. Markov Cellular-Automata method was used to forecast the future LULC pattern after detecting main driving forces of LULCC. The findings showed an extensive increase in built up areas from 11% in 1990 to 39% in 2020 owing largely to 23% decrease in forest cover and 6% decrease in agricultural lands within the past 30 years (1990 – 2020). The projected LULC under the BAU scenario for 2040 showed built-up surge from 39% to 45% indicating additional forest loss from 43% in 2020 to 40% and decreasing agricultural land from 17% to 14%. The main driver for the LULCC is clearly anthropogenic driven as the human population in the study area keeps rising every censual year. This study exemplifies the fast-tracked forest loss, loss of arable land and the challenges on ecosystem sustainability of the Barekesse-Owabi-Kumasi landscape, necessitating the apt implementation of suitable interventions such as reforestation, protection measures and policy decision in deliberate land-use planning to mitigate further loss of forest cover and safeguard the Barekesse and Owabi headworks.

Keywords: Forest loss; urbanization; Markov-cellular automata; anthropogenic factors; satellite imagery

Assessment of forest loss in the agro-ecological zones in Ghana

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ABSTRACT

Tropical forests are fraught with a range of pressures driven by different scales of anthropogenic perturbations. Large expanses of diverse tropical forests are lost or degraded annually with drastic outcomes for biodiversity, climate change, forest resources and critical forest ecosystem services. Deforestation and forest degradation occurring in tropical countries are driven primarily by socio-economic largely and environmental factors. These have resulted in land use land cover changes (LULCC) that threaten biodiversity, water, and energy resources, and contribute to trace-gas emissions. This study analyzed forest loss (deforestation and degradation) and LULCC at three different ecological zones (Savannah, Transitional and Deciduous) in Ghana via a combination method in Remote Sensing (RS), Geographic Information System (GIS) field survey and community interactions. The study reveals a very significant problem of forest loss (deforestation and degradation) at varying scales underpinned by similar causes. In the Savannah zone which covers the Community Resource Management Areas (CREMA) of the Mole National Park in Ghana, reveals that the area is well endowed with diverse composition and structure of woodland including dense, open and riverine stretches. The results reveal that there had been an annual deforestation rate of 0.11%. In the Transitional zones, the major findings of the assessment include substantial land use/land cover conversion agricultural expansion, urbanization, charcoal production and wood fuel harvesting; dense woodland and riverine forest experienced a decline for the period whilst agriculture open woodland/grassland and settlement were appreciated; floral diversity was high in the dense woodlands with low regeneration potential because of persistent annual wildfires; significant socio-economic and environmental impacts resulting in the conversion of woodlands and removal of riverine vegetation leading to drying out of streams. In the Deciduous Forest zone which covers the Greater Kumasi area, revealed that both Open Forest and Agriculture class categories decreased from 51.98 to 38.82 and 27.48 to 20.11, respectively. Meanwhile, Built-up class increased from 4.8% to 24.8% (over 500% increment from 1990 to 2020). Rapid urbanization caused the depletion of forest cover and conversion of farmlands into human settlements. Overall, the study offers vital pieces of information which may be used to observe; advice and sway land use to a more beneficial and sustainable manner as the trend of forest loss is alarming in this part of the country.

Keywords: anthropogenic impacts; deforestation; degradation; remote sensing; land use land cover

Removal of copper, chromium, and arsenic from CCA-treated wood using deep eutectic solvents

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ABSTRACT

Many chemicals and methods have been extensively studied for removal of copper, chromium, and arsenic from wood treated with chromated copper arsenate (CCA). However, in these studies, it is seen that deep eutectic solvents (DES) are not used in the removal of copper, chromium and arsenic. In this study, the effect of DES on the removal of copper, chromium, and arsenic from CCA-impregnated wood and the changes caused by DES solutions in wood samples were investigated. The DES solutions were prepared by mixing lactic acid (LA) and urea (Ur) as the hydrogen bond donor (HBD) and choline chloride and betaine (BT) as the hydrogen bond acceptor (HBA) in different molar ratios. According to the results obtained, it was observed that the LA solution prepared with LA:CL was more effective in the remediation process and removed 62.5% Cu, 95.19% Cr and 98.12% As. It was obtained in FTIR analysis and lignin determination that the lignin ratio of the wood samples decreased after the remediation process. It seems that the crystallinity ratio of wood samples treated with LA:BT decreased significantly.

Keywords: deep eutectic solvents, chromated copper arsenate (CCA), remidiation, chemical characterization

Models of predicting strength and durability of thermoplastic adhesive joints of wood

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ABSTRACT

Predicting the strength and durability of adhesive joints of wood is a complex and relevant problem. The difficulty lies in prolonged and cumbersome research and the lack of modern techniques which could be based on a mathematical description of the physical and mechanical processes during operation of adhesive joints of wood.

An analysis of adhesives for gluing wood was carried out, a several of experimental studies were conducted in natural and laboratory conditions. The research results are analyzed on the basis of which mathematical models for predicting the strength and durability of thermoplastic adhesive joints of oak wood have been developed and proposed.

It is found that the strength of thermoplastic adhesive joints of oak wood will depend on the change in the elastic-deformation state of the adhesive joints during operation. The change in the elastic-deformation state is influenced by the air humidity and ambient temperature.

Mathematical models for predicting the strength and durability of thermoplastic adhesive joints of oak wood depending on changes in the air humidity and ambient temperature have been constructed. The elastic-deformation state of the adhesive joints of wood depending on changes in the air humidity and temperature is mathematically described. Constructed are graphical dependences of the distribution of moisture in the material for initial and changing conditions. Stress modeling in thermoplastic adhesive joints of wood was carried out. The distribution of normal σ_x and σ_y stresses and tangential τ_x and τ_y stresses is obtained.

Keywords: strength, durability, models, PVAC adhesive, glue line, prediction

Transformational needs of wood construction sector on the example of the West Pomeranian Region in Poland

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ABSTRACT

Building with wood is an emerging industry that can contribute to the reduction of greenhouse gas emissions and help to unlock the low-carbon, circular economy. By maximizing the use of wood in new buildings and renovation through optimal hybrid solutions with other materials, the built environment can be transformed into a large-scale carbon sink. However, unlocking the potential of wood as both a sustainable building material and climate solution (the 'forest carbon-pump') requires a stronger focus on the regional dimensions of wood construction chains and the whole innovation ecosystem. Regional characteristics are not yet sufficiently accounted for in the European and national policy initiatives and programmes. National and regional initiatives are focused on local context and are still rather disconnected from the European level. Hence, for example, European funding programmes are not well geared towards the needs of wood construction industries.

This paper, based on the results of the BASAJAUN Project entitled "Building a Sustainable Joint Between Rural and Urban Areas Through Circular and Innovative Wood Construction Value Chains", presents an assessment of the competitiveness of the pilot region of West Pomeranian in Poland. The paper summarizes available information about the regional context, the forest resources and management, its wood construction value chain, market trends and policy programmes. In addition, a value chain stakeholder map and a SWOT analysis were prepared for the pilot region, pointing to challenges and possibilities for regional transformation towards increasing the role of wood construction (including, inter alia, in the West Pomeranian Voivodeship).

In the summary, the circumstances / conditions, that should be met for the development of wood construction in the West Pomeranian Voivodeship and in Poland, were described. Determinants of development may be external (exogenous - resulting from the external environment of the wood construction sector) and internal (endogenous, originating in the sector itself) and have a diverse nature, e.g. legal, organizational, economic or technological. However, they are to a large extent a derivative of barriers slowing down the currently possible / potential dynamics of the sector's development (and result from the need to overcome / eliminate these barriers).

Keywords: sustainable wood construction, forest-based bioeconomy, engineered wood products, regional innovation systems, co-creation

Deadwood amount and quality in Central Italy beech high forests located in a natural reserve

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ABSTRACT

In the framework of sustainable forest management, deadwood plays an essential role within forest ecosystems. In recent years it has properly become a fundamental indicator of sustainability in the management of forest resources. In fact, deadwood plays many ecological and functional roles, for instance it provides habitat for many living organisms (contributing to the conservation of biodiversity), acts as a long-term carbon stock, increases and maintains the overall productivity of the forest, contributes to the development of soil and nutrients cycles. The pan-European criteria recognize the value of forest deadwood as an indicator of sustainable management and the standards for forest management certification give to the evaluation of deadwood a primary role in the assessment process. Although the importance of deadwood for the assessing the sustainability of forest management, information on this fundamental parameter of forest ecosystems is widely documented mainly for primary forests, while for managed forests it is much scarcer. Taking into account these considerations, this work aims to quantify and qualify the woody deadwood present within the managed beech forests of the Abruzzo, Lazio and Molise National Park. These beech forests have an important socio-economic function for local populations: they are actively managed, and residents are allowed to collect deadwood according to specific rules established by the Park Authority. Forest parcels of the local forest management plan were taken into consideration, within which sample areas were created to collect data concerning quantity and type of deadwood present in the stand. Samples were also collected to qualify the deadwood present according to widely recognized scientific protocols. It has been observed that silvicultural management and good accessibility to the forest affect the volume and type of deadwood present. It is therefore emphasized that even within a protected area there are zones in which the removal of timber on the ground affects the volumes of the deadwood due to the need to take into account the civic use rights of collecting downed logs or branches for domestic fuel by local populations. The results obtained made it possible to compare the volumes and types of deadwood both laying and standing present in these managed beech forests, with the data collected from other studies concerning managed and primary forests.

Keywords: *Fagus sylvatica*, protected areas, sustainable forest management, standing and laying deadwood

Performance of heat-treated Ayous wood after one years of outdoor exposure

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ABSTRACT

Wood is an interesting material used outdoors where it is exposed to weathering and degradation. The heat treatment of wood has proved to be an ecological modification system for outdoor use which is particularly useful for less durable wood, a non-biocidal alternative to the classical techniques of extending the natural durability of wood. The heat treatment causes a decrease in hygroscopicity which guarantees a lower sensitivity of the wood material towards environmental variations both of moisture and temperature. In this context, it is essential to check the behavior of heat-treated wood over time. The aim of this work was to verify the effects of the natural aging process on some physical properties of heat-treated Ayous (*Triplochiton scleroxylon* K. Schum) wood. The wood of this species is increasingly attractive on the international market due to the rapid growth of the trees and the easy processing of the wood. The material used comes from forests certified for the sustainability of management that grow in Cameroon. The Ayous planks were donated by Vasto Legno, which also provided for their heat treatment in an industrial plant. The heat treatment was carried out at 215 °C for three hours with a slight initial vacuum. Planks, treated and untreated, were exposed outdoors for one year. Statistical analysis showed that the density of heat-treated aged wood remains significantly lower than untreated aged wood. Compared to environmental humidity, heat-treated wood reaches a consistently lower moisture content than untreated wood that indicates an appreciable dimensional stability of the material. Even after 12 months a lower ability to absorb moisture than untreated wood was retained. The anti-shrinkage efficiency (ASE) value supports this improvement. However, the ASE value was found to be below the 75% threshold, indicated as the minimum effective threshold. Colour affects the aesthetic of wooden products. The heat treatment induced darkening, measured by the chromatic coordinates' values and clearly visible even to the naked eye, on the natural light yellow colour of ayous. The colour variation indicates chemical modifications, and lignin degradation contributes to the darkening of wood. The natural aging process causes a color variation, both in the untreated wood and in the treated one. In the natural wood there was a darkening of the surface, and the plank surface acquired a color tending to gray. The heat-treated wood, darkened by the treatment, instead highlighted a lightening. Natural aging of wooden surfaces leads to a slow deterioration of wooden surfaces, which cause unwanted changes. However, it is worth checking after longer exposure times.

Keywords: natural aging; density; Anti-Shrinkage Efficiency (ASE); colour

Changes occurring in oak wood as a result of long-term stay in the aquatic environment

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ABSTRACT

Oak wood is characterized by high durability and resistance to changing weather conditions, it is a heavy, hard material (Brinell hardness class II), easily splitting, elastic. As a material, oak wood is easy to mechanically process. Due to the above, oak wood is a valuable raw material with a wide range of applications in construction, including water construction. The research material was an oak obtained from the lock of the Czaniec Dam. The dam was built in 1958, this year also the studied oak elements of the dam lock were built. The tested material was used in extremely variable environmental conditions until 2020 (temporarily completely submerged with water and outside the aquatic environment). The work was carried out tests of the bending and compressive strength of wood using the Shimadzu model AG-XV testing machine and chemical properties through elementary tests performed with the LECO CHN628 + S analyzer and thermogravimetric on the TGA/DSC3 apparatus from Mettler Toledo.

The average density of the tested raw material in the absolutely dry state was 639 kg /m^3, calorific value 18.39 MJ/Kg, cellulose content 43% hemicellulose 21%, lignin content 29% H2O 6% resins and ash 1%. The tested wood showed a bending resistance of 76 MPA and a compressive strength of 60.77 MPA along the fibers. The wood meets the required standards for structural wood ISO PN-EN 338:2016-06 class D40. Despite the difficult conditions and the long period in which the tested raw material has been kept, it has properties similar to those of medium fresh oak wood.

Keywords: oak wood, dam, wood properties

The use of industrial hemp residues as an alternative lignocellulosic raw material for wood composites manufacture

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ABSTRACT

The objective of this study was to investigate the technical feasibility of manufacturing new composite products (particleboards) from agricultural residues (non-useful parts of industrial cannabis stalks). The use of such a material may benefit both the socioeconomic and environment development since these are settled on the field and decay and therefore they are generally considered as waste material of no industrial value.

After the receivement of the hemp residue material, where the outer part of the stem of the cannabis plant was separated from the inner part by a special defibrillating machine, followed up the evaluation of the physical and chemical properties of the material (percentage of moisture, density, extracts, pH, determination of the percentage of pith, woody part and fibers, percentage of moisture absorption, shrinkage, swelling). The internal woody part was cut down appropriately for use in the manufacture of wood based panels, followed by the fractional analysis to control the shape and dimensions of the wood chips. From the evaluation of these results, the most suitable way of crushing was chosen, with the ultimate goal of using the appropriate fractions for the manufacture of particleboards. Eight types of particleboards were made, with different parameters, in which the wood chips of the hemp stems (hemp fibers and woody part of hemp) participated in various mixing ratios with the industrially produced wood chips (wood to hemp percentages of 75:25, 50:50, 25:75 and 0:100). Phenol-formaldehyde and urea-formaldehyde resins were used as the reference adhesives. Mechanical properties (internal bond strength, modulus of rupture and modulus of elasticity) and physical properties (thickness swelling, water absorption) were also determined.

The production of particleboards seems to be the most ideal way of utilizing hemp residues since the product is widely consumed worldwide, it is cheap and the raw material requires little energy expenditure to reach the final production form. The main advantage of these new products is the lower cost and weight. Overall, an economy in the use of new raw materials is achieved and agricultural waste finds use in value added applications.

Keywords: industrial hemp, agricultural residues, wood composite panels, lignocellulosic materials

Development of Vietnamese forest and wood sector

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ABSTRACT

Vietnam, which has a forest area of almost 15 million hectares, has a favourable climate and fertile soils for forest growth. Only plantation forests (4.4 mill. ha, mostly acacia and rubber wood) are used for timber production and logging is prohibited in natural forests. There are two million forest owners, and the mean area of privately owned forest stands is less than two hectares. Almost half of the plantation forests, too, are owned by private people or communities. Therefore, conflicts over forest land tenure are common in many regions. Plantation forests are managed by regimes aiming at pulpwood production but logging and timber transportation have a low level of mechanization. Sawmills suffer from sawlog quality variations and inappropriate log dimensions, which results in poor sawn timber yield and challenges in productivity and profitability, as well as drying and further processing of lumber. This setup restricts the willingness to invest in modern saw milling capacity, while the forest resources and lumber demand of the furniture producers suggest doing so. Consequently, most of the harvested roundwood (>30 mill. m^3/a) is chipped and exported to Chinese pulp mills, while the extensive furniture sector relies on imported wood. Sawn timber made of Vietnamese roundwood ends up in relatively low value applications such as pallets. The country aims at developing local use of domestic timber. This article maps the pathways to develop Vietnamese forest and woodworking sectors towards a higher degree of self-sufficiency. The approach is based on SWOT analysis, *i.e.*, systematic mapping of strengths, weaknesses, opportunities, and threats in the respective sectors, followed by analytical conclusions. The results show that the opportunities in the forest-based livelihoods and industrial value chains should be more clearly highlighted and communicated to citizens and decision makers. The plantation forest resources, yet located far from current industrial production sites, allow much greater sawlog production than now. There are also risks, such as a higher probability of windfalls, associated with prolonging the rotation times of plantation forests to increase the saw log yield. Vietnamese woodworking industries, as well as public sector, are highly committed to develop the forest management and industrial, value adding processing of domestic wood towards an agile, modern, and low-risk market player and investment environment. The production philosophy should be shifted from production push to market pull, which requires better management and networking of the numerous micro scale producers, as well as integration of the large industrial producers more tightly in the forestry-wood product value chain development.

Keywords: forestry, SWOT, value chain development, Vietnam, wood products

Production of wood and polysterine alternative composites from fungal mycelium and cellulosic biomass and study of their functional properties

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ABSTRACT

Introduction: By-products of agriculture and forestry (such as straws, dried plant matter or sawdust) and spent mushroom substrate (SPS), a waste of mushroom cultivation (amounting to 3.65 million tons/year only in Europe), can be significant renewable sources of cellulosic biomaterials that can be reformed and reused in order to produce substitutes for wood or plastic, under the framework of a green and circular economy. In this concept, the polysaccharides of cellulolytic fungi that can grow on these substrates can form a well-bound network of so-called "mycowood", the properties of which can be enhanced after processing and formulation in order to produce durable alternatives to wood or plastics for different types of constructions.
Materials and Methods: In our study, SMS of *Pleurotus ostreatus* from mushroom farming were dried naturally at room temperature for 2-4 months. Then they were pressed under a STETON wood press (100 bar for 10 min), with or without use of heating (160ºC). The physical (density, moisture), mechanical (hardness, elasticity-expasion, resistance to break, resistance to penetration), insulating (thermo-insulation) and thermal (calorific content) properties of the processed biomaterial were tested. Also, wheat straws, bean stalks and mixed sawdust were used alone or in combinations (50/50) and inoculated with the fungi *Pleurotus ostreatus, Ganoderma lucidum* and *Aspergillus niger*. and after development of the mycelium they were processed and analyzed as described above.
Results and Conclusions: The mechanical properties of processed SPS was dependent on the moisture content/drying period, and use of heating (160 ºC) during pressing, which improved the hardness and consistency of "mycowood". Also, the central parts of "mycowood" were harder and more consistent compared to peripheral parts. In the inoculated substrates *A. niger* grew relatively easy in all tested substrates but did not result in high consistency of the pressed substrate, while *P. ostreatus*, which resulted in "mycowood" of good consistency and hardness, grew better in substrates containing bean stalks or straw or combinations thereof (without addition of sawdust), probably due to the presence of more fungal polysaccharides in *P. ostreatus* mycelium and the prevalence of heat-degradable polysaccharides (celluloses, pectins) in bean stalks and straw, instead of lignin (which is abundant in sawdust). *Ganoderma lucidum* was easily outgrown by other contaminating fungi. In comparison to polysterine-based insulation materials (EPS/XPS), the central parts of heat-pressed SPS showed higher hardness, expansion (elasticity) and resistance to penetration or fracture, while the thermo-insulating properties of "mycowood" from SPS were close to EPS/XPS and better than different types of wood. Heat-pressed SPS had a calorific content similar to industrial pellets fuels. Constructions (tables, baskets, etc) based on processed SPS or let us conclude that this "mycowood" can be a viable alternative to wood and plastic materials for different uses in furniture and constructions.

Keywords: mycowood, spent mushroom substrate, Pleurotus, polysterine, wood composite, mechanical properties, insulation

Influence of ultraviolet ageing on gloss and colour of high gloss finished wood composites

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ABSTRACT

Ultraviolet (UV) curable technology is one of the fastest growing markets in the paint and coating industry. In recent years high-gloss finishes are popular in the furniture industry. However, it sometimes happens that coatings change their high gloss during daily use..

The aim of the study was to establish the influence of ultraviolent aging on degree of gloss and colour of high gloss coated wood based composites before and after exposing to accelerated UV radiation and UV+IR radiation. The utilitarian aim was to examine its potential recommendation of utilization in Ghana which has an average UV index of 7. Samples in both versions “white” and “black” were prepared in the industrial conditions.

From the results of the study, it was stated that all tested finishings in both versions “white” and “black” were effective against UV radiation degradation after ageing. There was no negative effect of colour change after aging. They could be recommended for use in Ghana and Africa as a whole because from the results, UV radiations even improves its gloss so even at a place with extreme UV index, it will be durable.

Keywords: UV high gloss system, ageing, gloss degree, colour

Progress intumescent coating for wood protection and wooden product against fire

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ABSTRACT

Intumescent coatings covering wood, composites and steal swell under influence of heat and form porous, non-flammable charred layer. They cut oxygen supply and cut heat penetration from flammable surfaces e.g. wood and lignocellulosic composites. They are effective and create non expensive barriers which protect flammable materials. There are mainly two types of barriers. They confuse usually modified resins, carbonizing agents, foam forming agents, dehydrating agents and according to area of application - different modifiers. Another types of intumescent materials were developed on the base of alkali silicates, lithium, sodium and potassium, which also can be used as a coat on wood, composites and metals. They start swelling in 100 °C, or in contact with flame due to endothermic process and is associated with an emission of water vapor. The solid foam is rigid and consists of hydrated silica and some products of decomposed mineral endothermic fillers. The fire proofing efficiency of protected surface is determined by: heat release rate, the effectiveness of combustion heat, the mass loss rate and specific swelling ability of this coating. After some modifications of this type of barrier coating was also developed another type as sealant for fire barrier doors and for protective coat of chassis and rubber tires of military vehicles, resistant to napalm conditions. A new effective intumescent coating – EXPANDER FR, transparent system based on modified nano-scale silica is presented below.

Char forming materials swell and intumescence occur during heating of covered materials. There is strong correlation between char yield and fire resistancy because char is formed and are emitted combustible gases and water vapor. The presence of formed char inhibits spread of the flame, acting as a thermal barrier around the unburned material. This resulted in perfect insulation of covered flammable materials (wood, composites, flexible textile barriers) from the excessive rise of temperature and oxygen penetration. Intumescent coating protects flammable materials against thermal decomposition. It is observed a strong correlation between char yields and fire resistance. In case of polymers and polymer composites the temperature of burning surface of polymer is close to the temperature at which extensive thermal degradation occur (300-600 °C). The bottom layer of char, near the protected surface, has similar temperature below 300 °C whereas the upper surface is exposed to almost 1500 °C.

Fire protecting coatings with intumescent properties were used for about 50-60 years, whereas the process of incorporating intumescent additives intrisinctly in different polymer structures e.g. by using especially modified dendrimers is relatively new. Summing up family of expanders FR is effective thanks to proper selection of: carbonizing agents, foam forming agents, dehydrating agents and special modifiers agents including very effective high dispersion endothermic fillers. The intumescent coating – Expander® is produced on base of license at Innovative Company Delta in Poland.

Keywords: fire barriers, intumescent coatings, wood, composite, tire protection

Propolis extract and silicon compounds in pine wood protection

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ABSTRACT

The development of ecological alternatives for wood protection is of great interest in research worldwide and is essential for environmental protection. One of the bio-friendly methods of wood protection can be impregnation with natural substances or synthetic chemicals with a low environmental impact. In this research, a preparation based on natural substance – propolis, which exhibits multiple biological activity and silicon compounds with hydrophobic properties, was used as wood preservative.

The aim of the research was to determine the chemical and biological properties of Scots pine (*Pinus sylvestris* L.) wood treated with a preparation consisted of propolis extract and silicon compounds – tetraethyl orthosilicate (TEOS) and octyltriethoxysilane (OTEOS). The fungal resistance of treated wood was assessed against brown rot fungus – *Coniophora puteana* by gravimetric method, as well as by the analysis of ergosterol concentration in decayed wood. The chemical properties of wood were investigated using atomic absorption spectrometry (determination of silicon concentration), X-ray diffraction (degree of crystallinity), UV-VIS spectroscopy (concentration of phenolic compounds), high pressure liquid chromatography (ergosterol concentration) and attenuated total reflectance Fourier transform infrared spectroscopy (changes in wood structure). Moreover, part of the treated wood was subjected to the artificial ageing (leaching in water) to determine anti-leaching stability of the treatment preparation constituents from the treated wood.

The wood impregnated with propolis-silanes preparation was characterized by fungal resistance, also after accelerated aging, compared to unprotected wood samples. The mass loss of the treated wood before and after leaching procedure was 3.4%. The higher durability of treated wood against *C. puteana* compared to unprotected wood was also confirmed by the analysis of ergosterol concentration. The value of ergosterol reduction in the treated wood both before and after leaching procedure was over 94%. Moreover, chemical analysis indicated, that the components of preparation formed a permanent bond with the wood components. The analysis of phenolic compounds concentration in the treated wood showed that the propolis extract was leached from wood in a slight extent. In turn, the analysis of silicon concentration indicated that the degree of silicon compounds leaching from wood was also low. Moreover, the XRD analysis indicated that the wood treatment with propolis-silanes formulation did not affect the crystallinity degree. The obtained results show that the preparation consisted of propolis extract and silicon compounds may be promising ecological wood preservative, harmless for the natural environment.

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Keywords: propolis, silicon compounds, pine wood

Determining the utility of *Paulownia Clon in Vitro 112* as a wood raw material with respect to its fungal resistance

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ABSTRACT

The decomposition and depreciation of wood and lignocellulosic materials cause serious material losses in the economy, as well as a potential threat to the health of people staying in buildings and facilities infested with microorganisms. The recently observed significant increase in the prices of wood and wood-based panels on the European market, related to the reduced supply of this raw material for construction, furniture and energy, forces the search for alternative wood raw materials in the form of fast-growing plantation species. The environmental aspect related to climate warming prompts the search for new species of trees that could at least partially counteract the negative environmental trends that have been observed for a long time, especially in countries with relatively high carbon dioxide emissions to the atmosphere. Trees of the *Paulownia Clon in Vitro 112* species (the so-called oxytrees) are characterized by large increases in biomass, which allows them to be treated not only as a potentially readily available raw material in the wood industry, but also as a tree species that efficiently sequesters carbon dioxide, which is a greenhouse gas. For this reason, the cultivation of *Paulownia Clon in Vitro 112* has been carried out throughout Europe for several years now.

The aim of the study was to determine the fungal resistance of soild wood and wood-based panels made of Paulownia Clon in Vitro 112 and compare it to native tree species. As part of the research, the natural durability of wood obtained from the *Paulownia Clon in Vitro 112* tree was determined against wood-decomposing fungi, i.e. basidiomycetes (*Coniophora puteana, Trametes vercicolor*) and soft-rot fungi (*Chaetomium globusom, Humicola grisea, Petriella setifera, Lecythophora mutabilis, Trichurus spiralis*). The subject of the research was wood from a 7-year-old plantation in Spain, imported to the Institute in May 2021. Additionally, the evaluation of fungal resistance to decomposition caused by basidiomycetes was made for chipboards made of *Paulownia Clon in Vitro 112* wood.

The obtained results showed that the wood from the 7-year-old (Spanish) plantation of *Paulownia Clon in Vitro 112* should be classified, according to the EN113-2 standard, as a species not very durable against wood-decomposing basidiomycetes. However, the intensity of the decomposition of this species by basidiomycetes is lower compared to the native reference wood, *Fagus sylvatica* L. The wood of *Paulownia Clon in Vitro 112*, however, turned out to be more susceptible to soft-rot decomposition in relation to the reference wood of *Fagus sylvatica* L. Moreover, it was observed that wood-based panels made of the studied species exhibited lower degradation under the influence of *C. puteana*. compared to the reference panels made of *Pinus sylvestris* L.

Keywords: paulownia, oxytree, fungal resistance, wood-based panels, fast-growing species

Forest area development under socioeconomic parameters–a spotlight on Environmental Kuznets Curve and Forest Transition Hypothesis

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ABSTRACT

With its multiple functions, forests serve global needs of different ecosystem services, one of which is the provision of wood for material and energy use. Understanding the influencing factors of forest area development is crucial to shape future options for action. Global forest area dynamics are often represented as a function of socioeconomic variables. In this context, over the last 30 years, various economic concepts, mainly "Environmental Kuznets Curve (EKC)", "Forest Transition Theory (FTH)" and "Land-use Change Concept", were derived. Using these concepts, a huge number of publications estimate correlations between socioeconomic drivers and forest area developments.

We provide an evidence-based overview on the estimation of forest area development using the two most important economic concepts, EKC and FTH, through a systematic literature review, following the established method of RepOrting standards for Systematic Evidence Synthesis (ROSES). We specify the dependent and independent variables used, as well as the curve shapes and estimation methods. The evaluation of the data is carried out strictly under ROSES criteria and includes the search for articles, the screening process with inclusion and exclusion criteria, and the coding strategy.

The evidence base amounts to 46 articles and 141 studies and is more comprehensive for EKC than FTH. We identify eight dependent variables, where the "rate of deforestation" occurs most often. Additional other dependent variables repeatedly estimated are "forest cover", "annual rate of forest change", "forest area" and "arable land". As for the 135 independent variables, these were tested 748 times for all studies. Less than half of them have no significant effects. "Gross domestic product (GDP) per Capita" and "GDP per Capita squared" are the most common independent variables, especially for the EKC concept. Followed by "population annual growth rate", "population density", and "institutions", which both are tested for FTH and EKC as well. Of the 14 different estimation methods used in the studies, ordinary least squares and fixed effects are the most frequently applied estimation methods.

Our results show, that the concepts on EKC and FTH do not provide a unified picture. Differences between the EKC and FTH concepts occur not only in the numerical estimation of each concept, but also differ within each of them. Hence, the results show that estimations complement each other and can provide transferable insights for further advanced concepts for the estimation of forest area development. For the enhancement of these concepts, our results confirm the relevance of the choice of dependent variables, independent variables, and estimation methods.

Keywords: Environmental Kuznets Curve, Forest Transition Hypothesis, forest development concepts, evidence base, systematic review

Investigations of interlayer adhesion and adhesion strength in printing technologies with the use of energy-saving sources of energy

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ABSTRACT

In recent years finishing of the lignocellulosic materials with the use of UV lacquer systems is very popular. Producers of furniture elements try to use energy-saving sources of energy. In these technologies is very important to correlate the parameters relating to the amount of application, the radiators power and number of radiators and the speed of the production line. All these factors influence on the interlayer adhesion and quality of final coatings.

Finishing of HDF boards with the use of UV lacquer systems in the technological conditions with different parameters were performed.

Adherence of obtained coatings to the substrate acc. to the PN-EN 4624 standard was carried out. Moreover on the basis of the contact angle measurements surface free energy and work of adhesion were calculated.

It was stated very good adherence of coatings to the HDF boards. All coatings showed good work of adhesion too. The final coatings were characterized by lower surface free energy than the interlayer coatings.

The research was carried out under project No. POIR.01.01.01-00-1235/17, implemented within the scope of the Operational Programme Intelligent Development 2014-2020, co-financed by the European Union from the European Regional Development Fund.

Keywords: HDF, UV lacquer system, lamp power, adherence, interlayer adhesion, contact angle, work of adhesion

Effect of a drought year on wood formation of two age-classes European beech stands on the South-Moravian Region, Czech Republic

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ABSTRACT

Trees adaptation to the climate change impact and the increased frequency of stressful weather conditions on their secondary wood formation/growth (or else called xylogenesis), is site- and species-specific and still poorly comprehend. Thus, for a better understanding of how trees respond to climate warming, is critical to assess the tree-ring growth relationships with the local weather conditions. Monitoring seasonal cambial activity and intra-annual xylem phenology is an approach to illustrate the influence of tree growth response to climate.

European beech (*Fagus sylvatica*), one of the most dominant, widely distributed, and important timber species in Europe, is known to be sensitive to drought effects. The year 2018 in the Czech Republic was characterized by warm heat waves and drought periods during the trees' annual radial growth period.

In addition, previous findings have shown that the timing and duration of xylogenesis, as well as tracheary elements morphology is also age-dependent. The aim of this research was whether and how age difference affects the sensitivity of European beech to drought. To determine potential differences during the 2018 growing season, the timings and duration of xylogenesis phenological phases of two age-different European beech trees were interpreted and compared.

In total, 12 healthy and dominant European beech trees (six from each stand) were selected in two nearby stands located in the research plot of Rájec-Němčice (49°26´N, 16°41´E) located in the Czech-Moravian (Drahanská) highlands, at an altitude of 610-625 m a.s.l. Microcores of 2 mm diameter, were collected at breast height (1.3 m), at weekly intervals between the middle of March till the beginning of November using a Trephor tool. Transverse sections of 8-12 μm thickness were cut with a Leica RM 2245 rotary microtome, and the sections were transferred to microscope slides and stained with a safranin-Astra blue solution. Histometrical analyses were performed by a Leica DMLS microscope connected to a Leica DFC 295 digital camera.

Preliminary results, support the hypothesis that wood formation phenology differed from European beech trees age. Timing of cell differentiation differed between young and old trees during the 2018 year, with premature cessation of cambial productivity in both ages as a result of precipitation shortage. In terms of vessel features, variations within the xylem growth were also observed.

This research was funded within the framework of the project entitled "Age-dependent plasticity variation of xylem formation in European beech (Fagus sylvatica) at South Moravia region", grant no. IGA-LDF-22-IP-034 (legislation No. 130/2002 Coll.) and supported by the project "Adaptation strategies in forestry under global climate change impact" (ASFORCLIC), grant agreement N°952314, a European Union's Horizon 2020 research and innovation programme.

Keywords: *Fagus sylvatica*, climate change, xylem phenology

Biochar and charcoal: possible uses and applications

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ABSTRACT

The low economical valorization of wood products from coppices and from high forest logging residues is a problem to solve. According to this, there is the need of products diversification to have more opportunities for the forest owners. To reach this goal, wood charcoal could be rediscovered in order to improve forest value chain. Charcoal production whit new models of mobile charcoal kiln were tested evaluating the characteristics of the process and the product. This process could be very advantageous for local community, differentiating economically marginal productions and qualifying new operators. The focus in this regard is also the need of performing production at landing sites, thus considerably reducing transport costs. The possibility of producing charcoal directly at landing sites could make the overall economic chain consistently more valuable.

Wood charcoal is an activated charcoal, due to the mode of production, which activation increases if crushed or pulverized. Due to the high specific area the activated carbon has high adsorbent capacities. The product charcoal, even if it is wrongly considered "poor", has remarkable qualities that make it interesting under different aspects. In fact the uses of charcoal are multiple and in different fields: over traditional use, this product is applied in industrial waste water treatment, water purification, air filtration; food industry for decolorization and deodorization of wine, vinegar, fruit juices and alimentary use; herbal, pharmaceutical and cosmetic industries; textile sector and in the agriculture as a soil improver called "Biochar". Biochar is a biomaterial which can be produced starting from several different feedstocks. Just for example, our research group, in the framework of different projects and international collaborations, has been producing biochar starting from beech firewood, pine wood chips, poplar wood chips, chestnut pruning as well as from the lignocellulosic residues of wood liquefaction process.

Given the increasing interest around this product, nowadays, several studies aimed at characterization are progressing, trying to identify the best woody residues from which to produce small-scale charcoal for different uses. Moreover, its properties seem to open new frontiers continuously. Charcoal produced in forest chains could also appeals to the certification of Chain of Custody of PEFC reaching a more qualified market, both for products and for process of sustainable productions. In this regard will be important to respect the basic principles of Circular Economy and Green Economy.

Keywords: wood charcoal, Biochar, mobile charcoal kiln, circular economy

Project entitled "An innovative product made of shrub willow for the wood industry" financed by ME&S under the "Science for Society" program

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ABSTRACT

In the era of a shortage of raw material, which is full-size wood and high prices of forest wood, it is necessary to search for previously unused sources of quickly renewable and valuable lignocellulosic raw materials. The current situation of wood industry in Poland and forecasts of price increases generate research trends that can be considered a priority for the growth of innovation and competitiveness of the wood industry in Poland.

At the Faculty of Forestry and Wood Technology of the University of Life Sciences in Poznań, research was undertaken on the development of a new product using easily available, quickly renewable wood material such as one-, two- and three-year-old *Salix viminalis* willow rods.

The Department of Chemical Wood Technology at the University of Life Sciences in Poznań, together with the Research and Development Center of the Wood-Based Panels Industry in Czarna Woda, are implementing a project entitled: "An innovative product made of shrub willow for the wood industry". The project is financed by the Ministry of Education and Science as part of the "Science for Society" program. The cost of the project is 1,142,620 PLN.

The aim of the project is to develop a technology for the production of an innovative product for the wood industry, from one-, two- and three-year-old rods of fast-growing bush willow species. The preliminary research results are very satisfactory. As a result of the production process of the new product, the density and bending strength increased compared to the starting material.

In the initial stage of research and development of the technology of its production, the bush willow product will be intended for indoor use. According to the authors of the project, the planned innovative product may compete with solid wood in terms of its environmental impact. It is an environmentally friendly alternative to wood-based materials and plastics, with a wide range of applications in wood industry. The use of fast-growing bush willows for the production of wood-based products indicates another economic aspect. It makes it possible to obtain regional raw material from areas close to production plants, which eliminates long-distance transport and there is no need to use heavy equipment to obtain the raw material.

Keywords: shrub willows, new product for the wood industry

Variability of selected macrostructure features and density of wood of dawn redwood trees (*Metasquoia glyptostroboides* Hu & W. C. Cheng), from the garden of the Cistercian Abbey in Kraków-Mogiła

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ABSTRACT

The dawn redwood (*Metasequoia glyptostroboides* Hu et Cheng) was considered an extinct tree, known only from fossils found in excavations. In the 1940's, living trees of this species were found in China. In the 1950s, dawn redwoods seeds were sown in the USA and Europe, including Poland. Despite several decades of cultivation of this species, there are still few data of wood of these trees, growing in European conditions. In the case of Poland, as far as the authors know, one paper with the results of study of properties of one tree wood has been published. The aim of this study was to analyse the variability of selected macrostructure features and wood density of dawn redwood, growing in the garden of the Cistercian Abbey in Kraków-Mogiła. The subject of the study were 8 trees, from each one, a single increment core was taken. After preparing increment cores, the width of sapwood was measured and the number of rings in the sapwood was counted. Then the increment cores were scanned, and on the electronic images, the width of rings and late wood zones was measured. Then, starting from the bark, the cores were divided into 5-rings sections. For each section the relative wood density was established. The density of the entire tree cross-section was calculated as the average weighted with the shares of individual sections in the cross-sectional area. Based on the measurements, the share of sapwood in the radius and in the cross-section of stem and the share of late wood in annual rings were calculated.

The average width of the sapwood was 6.5 cm, with values ranging from 4.1 to 8.4 cm in individual trees. The sapwood zone contained 11 to 17 annual rings, on average 14. The mean share of sapwood on the radius of stem cross-section was 30.8%, while on its surface - 51.1%. The average width of the annual rings was 6.0 mm (4.70 - 7.18 mm in individual trees). The mean share of latewood was of 8.7% (5.4% - 11.4% in individual trees). The widest annual rings with the lowest proportion of latewood were noted in the central part of the stem. Then the rings width decreased and the proportion of late wood increased towards the bark.

The average relative wood density was 0.267 g•cm^{-3} (0.255 - 0.287 g•cm^{-3} in individual trees). The highest wood density was found in the central part of the trunk, then up to about half of the radius, the feature decreased and in two peripheral sections it increased again.

The obtained means of the studied macrostructure features were similar to the data obtained from the analyses of wood of one dawn redwood tree from Poland. The wood density was comparable to the values given for trees grown in the Netherlands, but slightly lower compared to the data from Poland.

Keywords: dawn redwood, rings width, share of latewood