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## 9TH INTERNATIONAL SYMPOSIUM FOREST AND SUSTAINABLE DEVELOPMENT

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# Book of abstracts

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# Plenary session

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# Using Genomics to Characterize Evolutionary Potential for Conservation and Use of Forest Tree Resources

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**Abstract:** *Preserving the evolutionary potential of wild populations is central to dynamic forest conservation and the management of tree genetic resources. However, in long-lived organisms such as trees it is difficult to assess adaptive potential in the wild. In this review we give an overview of how advances in genomics can help characterizing the capacity of species to evolve in response to changing environments and thereby best managing species persistence and maintenance of ecosystem services. We describe how the field of conservation is shifting from descriptive genetics towards integrating complementary approaches by linking genomes to phenotypes, fitness and ecology, with the objective of understanding adaptive processes. We also highlight the challenges in integrating genomics to inform conservation management decisions and to optimize the use of forest genetic resources in operative forestry.*

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# Management of Valuable Oaks

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**Abstract:** *Oaks are found in a wide range of forests worldwide. In Europe, the two most prominent oak species are pedunculate oak (Quercus robur L.) and sessile oak (Q. petraea (Matt.) Liebl.). They grow under a wide range of site conditions and are quite resilient to the detrimental effects of flooding, especially in the case of pedunculate oak, storm and drought and they are extremely long lived. They contribute to many ecosystem services and therefore are appreciated by forest owners and environmentalists alike. By appropriate management, oak dominated ecosystems meet ecological, economic and social needs at the same time. Large dimension branch free wood is highly valued, while small sized and low quality oak timber generate little income. This presentation describes how large dimensions of branch free wood can be produced by applying appropriate silvicultural measures. The results provide a quantitative basis for objective-oriented oak management.*

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# The Emerging Economic Role of Forest-Based Cultural Services

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**Abstract:** *Assuming the conventional CICES classification of ecosystem services (provisioning, regulating, and cultural services), it is possible to find evidence that in the European forestry sector the most dynamic demand and some of the most innovative supply responses are connected to the cultural services. Forest Europe includes in this category forest-based recreation, sports, and outdoor activities, educational activities, but also more recently forests used for nature art museum, concerts, theatre and historical artefacts and the initiatives related to social inclusion, wellness and health (forest therapy and forest bathing (known also as Shinrin-Yoku) as well as amenity services related to spiritual, cultural and historical functions, e.g. sacred spaces, religious or other forms of spiritual inspiration, sites of worship, landscapes that are "memories'' from past cultural ties, aesthetic enjoyment and inspiration. Burial or funeral forests are also a growing service in many European countries. These interesting developments are posing new questions related to forest management, also considering that many cultural services are not free of charge to the users, like most of the regulating services, and thus they can represent a new source of income for the service provider. At the same time, the activation of these services is frequently associated to some form of segregative use of the forest resources (this is, for example, the case of the adventure parks, the forest schools, the funeral forests) and to financial and technical inputs coming from outside the traditional forest arena. Forest landowners not always seem willing and open to support this development. Therefore, an emerging topic also for the development of market-based cultural services is social innovation, a driver identified in the 2020 Green Deal Strategy as one of the crucial, intangible factors required to promote smart, inclusive and sustainable growth.*

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# From Silviculture to Ecosystem Management – Challenges and Perspectives

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**Abstract:** *Silviculture has been the founding pillar for forest management since the early 1800s. Around the 1990s, the ecosystem management paradigm started to displace the silviculture paradigm, triggered by the book "creating a forestry for the 21st century – the science of ecosystem management". This paradigm shift raises the question of what the guiding principles of ecosystem management are and how they differ from silvicultural principles. The purpose of the presentation is threefold. First, it will develop a framework of ecosystem services that are relieving the "wood production – protection – welfare" triad of so-called forest functions. Second, it will explore how large-scale disturbance regimes, such as storms, wildfires, or calamities, could guide alternative regeneration regimes on the ground. Third, it will develop a concept for continual, adaptive management that could replace the mechanistic regulation schemes that have been guiding forest management for a long time. The presentation will focus on principles, taking into account that on the ground work has to consider local conditions and local demand for ecosystem services. Many achievements of traditional silviculture will still be valid, but the emerging field of ecosystem management will, for sure move the boundaries of understanding and managing our forest resources.*

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# Copernicus Assisted Services for Forest Management

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**Abstract:** *Copernicus offers a broad range of Earth Observation (EO) datasets in a repetitive way and with high quality, while guarantying long-term delivery. The forestry sector, among others, makes already use of such services and products, e.g. in support of the European Forest Fire Information System (EFFIS). The multitude of products and services, along with the advance of the research in terms of real physicochemical canopy values accuracy of approximation via remotely sensed proxies, offers new opportunities to derive information that is vital for natural resources management. Nextland H2020 project is mandated by the Executive Agency for Small and Medium-sized Enterprises (EASME) to face the challenge and move "from stand-alone observation data supply activities to more downstream integrated information services". In this context, services are being developed to assimilate EO data in an interoperable way with existing practices, requiring at the same time minimum human interference and competence in a systematized manner. Latest information technologies (IT) developments are supportive to this end. Selected workflows of information delivery are being discussed with forestry users, and will be transformed in IT cloud and Copernicus supported dedicated services. It is expected that decision enabling and supporting services will come up, which lead to informed and actual situation based forest management. Application domains concern forest classification, canopy height and change detection, tree health, density and statistics.*

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# Road Surfacing: Aggregate Shortages and the Effect on Roads and Logging

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**Abstract:** *In Oregon, most industrial roads used to access forests for timber are either constructed from the local soil or constructed from the local soil and surfaced with aggregate. Roads that are not surfaced with aggregate are subject to severe seasonal constraints, while surfacing roads with aggregate is a significant cost. This presentation will consider the current state of surfacing forest roads with aggregate in Oregon; supply, cost, and operational effects. Following the presentation of the current state I will explore alternatives such as geosynthetics, wood puncheon, and mulched wood.*

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# Variation of Radial Growth in Norway Spruce Provenance Trials

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**Abstract:** *Provenance trials are used for selecting the most valuable and most adapted provenances by testing them in homogenous site conditions. We have analyzed wood cores for 25 Norway spruce provenances, originating from seven European countries, in three provenance field trials established across Romanian Carphatians. Sampled trees were 48 years old.*

*Ring-width, latewood, earlywood and the proportion of latewood were analyzed for the period 1980-2019. Because the interaction Populations x localities was not significant for the analyzed provenances we used Type II Sums of Squares, which is statistically more powerful if no interaction exist.*

*Statistically significant differences were found for ring-width between sites and provenances. Differences were also significant for latewood and proportion of latewood.*

*For the analyzed provenances, the mean proportion of latewood was 24.11%, ranging from 20,3% - the Poland provenances, to 26,23% - the Norway provenances.*

*Our study provides new data for the improvement of Norway spruce in Romania.*

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# Leaves and Xylem Phenology, a Tool for Evaluating Forest Reproductive Material in the Context of Climate Change

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**Abstract:** *Our research aimed to show the influence of climate change on an oak community forest ecosystem consisting of thermophilic and xerophyte, or relatively thermophilic and mezoxerophyte taxa. Changes that can occur in the phenology of biological processes, considered as the most sensitive and prominent responses to global climate change were investigated. Three hundred trees belonging to five oak taxa Quercus pedunculiflora K. Koch, Q. robur L., Q. petraea (Matt.) Liebl., Q. pubescens Willd., Q. virgiliana Ten. and some trees considered presumptively of hybridogenic origin were evaluated in Fundeanu phytocoenosis, situated in Covurlui tableland (eastern Romania), at the contact with external forest steppe. Phenological observations were made in the entire crown at a two-four days interval; in addition, wood microcores were collected weekly from sixteen trees at breast height (1.3 m) to study xylogenesis phenology. The findings of the survey show that there is a significant correlation ($r=0.8$, $p < 0.05$) between leaves unfolding and environmental factors (average daily temperatures). A weakly positive correlation between the time of bud burst and cambium activity ($r=0.36$, $p=0.172$) was registered.*

*The presence of the representative taxa specimens in all three phenological categories: precocious, intermediate and tardy shows a high level of the variability and adaptability of the natural regenerated population. As expected, the tardy specimens, who have a share of 6% of all analyzed trees, can avoid the late frost (especially in the flowering period) and the early spring defoliators. The identified adapted genotypes are recommended as forest reproductive base material for the corresponding provenance region.*

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# Particularities of the Structure of Mixed Stands of Beech and Silver Fir Covered with Regeneration Cuttings

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**Abstract:** *Mixed stands of beech and Silver fir are encountered on the sub-zone of mixed forests of beech and resinous trees and in the sub-zone of beech in the entire Carpathian chain in Romania, at altitudes between 700 and 1250m. Knowing the structure of the stands as well as of ecological particularities of stands becomes more necessary the more considerably reduced the amount of Silver fir in mixtures at present is. For this reason, we chose mixed stands of beech and Silver fir in the Postavarul Massif. Through our research, we aimed at knowing the variability of the biometric characteristics of trees in such mixtures and highlighting the correlations among these characteristics. The stability of the stands is highlighted through values of the slenderness index between 70 and 110 and through proportions of the length of the tree crowns between 43 and 63%. At the level of the beech youth, planted as a result of silvicultural work, the slenderness indices present values between 110 and 250, these being especially sensitive to the action of destabilising factors. Our research has led to models that express the relationships between the biometric characteristics of trees and has highlighted, at the same time, the opportunity of interventions with a view to achieving silvicultural work aims and ensuring the stability of stands. The correlations expressed by models are explained by values of intensity between 0.86 and 0.99. These models lie at the basis of the methods of measuring the stands.*

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# Seasonal Heterogeneity of Soil Microclimates at Different Stand Ages in Beech Forest

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**Abstract:** *The heterogeneity of soil temperature (ST) and soil moisture (SM) are well- recognized influence on plant communities, thanks to variability of resource supply needed to vegetation. We tested for differences in the temporal heterogeneity of soil microclimate between natural beech forest with different ages of stand (10, 30, 80, 120 years old) in the Southern part of Romania, Arges county. Bimonthly measurements of SM and ST, over almost a year, we investigated the interaction between stand age and time (April to November). Temporal variability of soil environmental was defined as the coefficient of variation of relative soil microclimate (temperature and moisture). Coefficient of variation express variance as a proportion of the mean, allowing comparisons that are independent of scale. This statistical parameter was calculated for each site, both across the whole campaigns and across each season (Spring, Summer and Fall). ANOVA analysis was uses to test the differences between sites in the temporal variability of soil temperature and soil moisture. Temporal patterns of soil environmental differed significantly between stand age and temporal heterogeneity was significantly greater for SM (CV=47% in fall period, P120 plot) compared to ST (CV=37.4% in spring period, P30 plot). These results can conclude that, the ability of forest at small stand ages, will increase ST at highest values and will reduce SM at low levels consistent with intense below-ground competition between trees and grass.*

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# Quantitative Determining of Ecological Factors of Edaphic Nature Implied in Establishing the Productive Potential of Mixed Mountain Sites

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**Abstract:** *Because of natural conditions, the mixed zone of beech and resinous trees presents a fairly accentuated non-uniformity in the mountainous massifs in Romania. In Southern Carpathians, the lower limit descends to 800m, and the upper limit coincides with the lower limit of Norway spruce, reaching 1400m. Through this research, we aimed at knowing the relationship between a site and a stand on an altitude gradient between 750 and 1300m, in the Postavarul Massif in Romania. In order to assess the production potential of sites specific to mixtures, the combined method used in site mapping was applied. On the basis of laboratory analyses carried out on soil samples, the values of the main ecological edaphic factors were determined, used in determining trophicity and the capacity of water supply of soils. Determining the types of herbaceous blanket and of the main biometric characteristics of stands also offered indications regarding the productivity of sites. Laboratory analyses of soils and the information provided indirectly by the herbaceous flora and the tree zone have led to the identification of the types of soil – eutricambosoils with mull and districambosoils with a mull-moder. The values of correlation coefficients indicate very tight relationships among the main physical-chemical features of soils and the biometric characteristics of stands. These values prove the utility of the information provided by natural stands for assessing the productive potential of forest sites.*

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# Genetic Diversity in Norway Spruce Clonal Seed Orchards and Natural Populations

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**Abstract:** *Norway spruce is the most important coniferous species in Romania and is also the most planted tree species in the Carpathian region. Here we compare the genetic diversity in four clonal seed orchards and two natural populations of Norway spruce, located in the Eastern Carpathians. A set of highly polymorphic nuclear microsatellite markers was used. The analysis of genotypic identity of ramets for each Norway spruce clone in all seed orchards indicated that the majority (>95%) of sampled ramets were genetically identical. The genetic diversity in seed orchards (He=0.722) was very similar to that of natural populations (He=0.723). However, allelic richness was higher in natural populations (11.044), compared to clonal seed orchards (8.941). The Bayesian analysis indicated a genetic structure with two clusters, one corresponding to the clonal seed orchards and a second one consisting of natural populations of Norway spruce. Our results may contribute to the sustainable management and conservation of Norway spruce genetic resources in Romania.*

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# Assessing and Forecasting the Soil Protection Ecosystem Service of Forests in Different Management and Climate Change Scenarios - A Case Study in Romanian Mountains

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**Abstract:** *The demand for ecosystem services from a single parcel of mountain forest is manifold which includes protection from natural hazards, timber production, and landscape aesthetics. The provisioning of these services will be affected by climate change. Soil protection ecosystem services are assessed through different indicators and indexes. The existing indexes of assessing protective value of forest depend only on biometrical descriptors and neglect the topographical complex environment.*

*In this context, we developed a new indicator which includes both biological and non-biological descriptors of forest compartments, easily to be implemented by using data from the Romanian forest management plans (FMPs), and simply to be forecasted by operating indicators resulted from LandClim simulation. Additionally, we conducted simulation experiments with 2 management scenarios (BAUC – low intensity cuttings and BAUR – regular cuttings) and 3 climate scenarios.*

*We address three research questions: (i) Which are the key components of an indicator that assesses the soil protective value of forest? (ii) How can be predicted soil protective value of forest using LandClim simulation results, proxy indicators and forest management plan data? (iii) What is the influence of climate scenarios and management strategies on protective value of forest in forest stands planned for soil protection?*

*The results show that in the management strategies simulated, the protective value of forest is different in the mild and medium climate scenarios and similar in extreme climate scenario. The analysis on elevation classes shows a significant difference between management strategies and climate scenarios regarding the protective value of forest.*

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# The Effect of Thinning on the Stands Structure

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**Abstract:** *The effect of silvotechnical interventions should be monitored by regular evaluations in order to establish the best possible, long-term variants on the growth and production of stands. In this matter we have considered 13 experimental plots located in European beech and Norway spruce stands in which thinning will be performed. We tracked the variation of the main biometric parameters of the stands before and after the interventions. Among these are to be mentioned: the number of trees by diameter categories, the basal area, the volume and quality of the trees, the slenderness index and as well the characteristics of the mean tree of the stands, respectively the average diameter and the average height. We have adopted low intensities, moderate and strong, with harvest indices, for each intervention variant, with values between 5 and 25%. When determining the volumes of extract we aimed to guide the actual structure of the stands towards the future structures expressed by models characterized by normal distribution. A number of intermediate models characteristic of the development phases of the stands have been developed before their completion. The application of the interventions has led to significant fluctuations in biometric parameters, with favourable implications for the stability of the stands. Of the variants adopted, the combined thinning has led to the proximity of the real structures to those expressed by the models. It is only by monitoring the stands that the long-term effect of the intensities adopted on the production of the stands can be known.*

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# Forest Ecosystem Services for Sustainable Development in a Protected Area

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**Abstract:** *Forest ecosystems are increasingly being influenced by human activity, including rapid expansion of urban land cover, which may alter forest processes, functions, and the ecosystem services that can be provided by a forest.*

*In recent years there have been several attempts to record all the ecosystem services that can be provided by a forest. While there are several classification schemes for ecosystem services with more representative ones MA (The Millennium Ecosystem Assessment), TEEB (The Economics of Ecosystems and Biodiversity) and CICES (The Common International Classification of Ecosystem Services). The concept of ecosystem services is linked with the contribution of the structures and functions of ecosystems to the maintenance and improvement of the quality of human life. Understanding this link is critical for a wide range of decision-making frameworks. National parks are protected areas by law and no intervention is allowed in their core. The Dadia - Lefkimi - Soufli National Forest Park is one of the most important protected areas at national, European and international level. Opinions are expressed for the sustainable development of the wider area of the National Park. Ensuring equal living conditions and productive employment opportunities for citizens in this semi-mountainous region of the country, depending on their balanced population structure and demographic renewal. Upgrading the quality of life of citizens and improving infrastructure, especially where there are problems of lagging development and environmental degradation. The preservation, enhancement and promotion of residential and productive diversity, as well as natural diversity, with an emphasis on alternative crops. The systematic protection, restoration, conservation and promotion of areas, settlements, landscapes, featuring natural elements, cultural and architectural heritage. Systematic information, effective dialogue and the promotion of strategic alliances between all political, productive and social factors that influence, directly or indirectly, the formulation of spatial development options.*

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# Green for Care - Stakeholder Analysis in Romania

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**Abstract:** *The objectives of the study were to conduct a Stakeholder Analysis to identify, analyse and create an initial database of stakeholders relevant for Green4C project and to identify beneficiary training needs in social innovation and entrepreneurship for four specific Thematic sectors: Forest-based care, Social agriculture, Urban green care and Green care tourism.*

*The contents of the study thus focus mainly on two types of assessment: stakeholder analysis and beneficiary training needs assessment. The stakeholder analysis was carried out to identify all possible key actors that could be interested and targeted within the project, from and what sectors they operate in. These include targeted MSc and PhD courses, Green Care (and associated topics) research groups, business sectors and networks, alliances, initiatives.*

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# Spring and Autumn Phenology in Sessile Oak (*Quercus petraea*) near the Eastern Limit of Its Distribution Range

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**Abstract:** *Due to the visible and inevitable effects of climate change on species spatial distributions, the importance of populations situated in peripheral areas has become a subject of research. These populations are likely to display unique adaptations as a consequence of the stressful climatic environments in which they survive.*

*The aim of this study was to assess the spring (leaf development, flowering) and autumn phenology (leaf senescence) of sessile oak (Quercus petraea) a species with a large distribution across European forests in close proximity to the eastern limit of its general range.*

*The phenological research was conducted from the spring of 2017 to spring 2020 and included a transect with three low-altitude populations, a reference population from the inner part of the species' range and a sessile oak comparative trial, all situated in Romania. For each site was recorded also the climatic data in order to relate them with the dynamics of all phenophases.*

*The phenological data showed small variations between the reference population and the peripheral sites. In most cases, no significant correlation was found between the bud burst and leaf senescence, indicating the lack of influence of bud opening on the onset of senescence. Moreover, the timing of bud burst and the senescence in the sessile oak provenances have a more obvious longitudinal/altitudinal tendency.*

*The data obtained can serve in establishing strategies for the use and conservation of sessile oak genetic resources and for anticipating future phenological changes under the threat of environmental changes.*

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# Changes in Community Composition of Tropical Evergreen Forests during Succession in Ta Dung National Park, Central Highlands of Vietnam

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**Abstract:** *Fragmentation of tropical forests is a major driver of global extinction crisis. A key question is understanding the role of evolution history during forest succession in the context of forest restoration for maintaining ecosystem function and stability. This study was conducted in a fragmented forest landscape in central highlands of Vietnam. We sampled living trees with diameter at breast height ≥ 2.0 cm in nineteen 0.25 ha plots to evaluate forest community structure changing over three successional stages (< 10 yrs, 10-20 yrs old and old-growth). We used both statistically metric and non-metric analyses to examine correlation of community composition during successional stages and along elevational gradient. We found that (i) Significant differences were found in the structural compositions between early successional forests and old-growth forest (F= 2.4651; R2= 0.23555, p=0.0011), but did not differ within early successional forests. (ii) Phylogenetic structure shifted from overdispersion to clustering with increasing successional ages. (iii) Above ground biomass (AGB), presenting for ecosystem functioning, significantly increased from early to late successional stages but did not correlate with phylogenetic diversity and elevation. Our results revealed that forest community structure was strongly affected by fragmentation, particularly AGB and phylogenetic structure. Within 20 yrs of forest succession, community structure did not significant difference in early successional stages. Moreover, community functioning (AGB accumulation) did not correlate with phylogenetic diversity and elevation. This finding has clear implications for sustaining biodiversity persistence and ecosystem functioning in human-modified landscapes at study region.*

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# The Influence of Forest Ecosystems on Precipitation Based on Geomatic Technologies

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**Abstract:** *The use of remote sensing images and Geographic Information Systems in the analysis and management of large areas is an increasingly common practice and very useful. In this study, a predominantly mountainous area was analyzed, from Hunedoara county near the town of Hateg and the Retezat Mountains. In the analysis was used a satellite scene from 24.08.2019 from the Rapid Eye system. Rainfall interception is a process by which part of the atmospheric precipitation is captured and retained by vegetation, after which it evaporates. Rainfall interception is one of the important components of the hydrological cycle of water, it also influences the spatial distribution of water infiltration, and through vegetation canopies, has an important role in the hydrological process of ecosystems.*

*The evaluation of these time and space variable hydrological parameters are the key elements for the sustainable development of water resources.*

*For the study area, the database that we have is not sufficient, therefore the quantification of these hydrological parameters by traditional methods provides limited information. Therefore, satellite images were used to estimate the interception of spatio - temporal precipitation in a forest area. It is known that remote sensing has proved its usefulness in monitoring hydrological parameters (precipitation, interception, evapotranspiration, soil moisture, etc.).*

*To characterize the vegetation in the studio area, the NDVI index (Normalized Difference Vegetation Index) was determined based on the spectral bands and for rainfall interception, the LAI index (Leaf Area Index) was determined. LAI is an important biophysical parameter of vegetation and represents a ratio between the surface of the leaves and the unit of soil surface. In the long run, monitoring the LAI parameter can be useful in understanding the dynamic changes of climate impact on forest ecosystems.*

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# Current Responses to Severe Drought Events of Silver Fir, Black Pine, and Scots Pine Species from the Romanian Carpathians Are Determined by Legacies of Past Forest Management

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**Abstract:** *The future of many forests and the ecosystem services they provide might be destabilized by drought-associated tree mortality events. Along with climate, legacies of past forest management are key to understand current responses of different tree species to climate change. We studied one native (silver fir) and two introduced (black pine and Scots pine) conifer species from the Romanian Carpathians, affected by tree mortality events that peaked in 2012. The three species were compared in terms of mortality events, growth trends, growth resilience to severe drought events, climate-growth relationships, and regeneration patterns. Their mortality was found to be associated with severe drought events. Nevertheless, the native silver fir undergoes a self-thinning process, while the future of the remaining living black pine and Scots pine trees is uncertain as they show significant negative growth trends. The native silver fir also shows a higher resilience to severe drought events than the two introduced pine species. Furthermore, and unlike silver fir, black pine and Scots pine do not successfully regenerate. A high diversity of native broadleaves sprouts and develops instead under them suggesting a process of ecological succession, with broadleaves recovering their habitats. As native species seem to perform better in terms of resilience and regeneration than introduced ones, the overall effect of the black pine and Scots pine mortality might be compensated. Legacies of past forest management should be taken into account in order to better understand current responses of different tree species to ongoing climate change.*

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# Runoff from Small Forested Catchment Areas on Drained Peat Soils

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**Abstract:** *Various forestry activities may affect water ecosystems, posing a risk of erosion and increased runoff of suspended solids and nutrients, for example, from clearfelling areas, road reconstruction and drainage system maintenance sites. Considering that more than half of the land area in Latvia is covered with forest, the impact of forest management may be considerable. Drainage systems, acting as water transportation channels, may facilitate leaching of suspended solids and nutrients, therefore, to ensure sustainable interaction between forestry and water management scientifically sound information is required.*

*To calculate export of suspended solids and nutrients from forested catchments (forest cover exceeds 90%) on drained peat soils, runoff data and measurements of physical and chemical parameters from five relatively small catchments (area of individual catchments varies from ~30 to ~130 ha) were used. The study area is located in the central part of Latvia, Veseta river watershed in experimental forests of Forest Research Station Kalsnava where discharge is measured on main ditches of the drainage system with V-notch weirs since 1968. First time drainage in the area was carried out during the 1960s.*

*Yearly export of nutrients and suspended solids was calculated for different time periods (1997-2001, 2015-2016 and 2019) depending on availability of water chemical and runoff data. Yearly runoff of N-NH4+ varied 0.032-14.130 kg·yr/ha; N-NO3- – 0.004-5.495 kg·yr/ha; P-PO43- – 0.004-0.614 kg·yr/ha; DOC – 0.410-10.663 kg·yr/ha. These results were also compared to the present export trends from first half of 2020. The impact of drainage system maintenance, volume of precipitation and runoff was observed.*

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# The Mid-Term Impact of Stump Removal on Some Aspects of Nutrient Cycling and Tree Growth in Meso-Eutrophic Forests in Latvia

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**Abstract:** *Intensification of forest management due to increased demand for renewable energy resources calls for science-based knowledge on the environmental effects of the extraction of logging residues and stump biomass. Several studies on this topic in Baltic and Nordic countries have presented ambiguous results indicating that effects of logging residue removal are site- and region-specific.*

*To evaluate the impact of stump removal on site productivity, dynamics of nutrient cycling and growth of the young stand in regional conditions five study sites were established in typical meso-eutrophic forest site types in Latvia – Hylocomiosa and Oxalidosa. In each site two harvesting techniques were used – whole tree harvesting (WTH) and whole tree harvesting combined with stump biomass removal (WTH+SB); the areas were regenerated by planting Norway spruce and black alder afterwards.*

*Most explicit impact of the harvesting technique was observed on the productivity of the young stands. In spruce and black alder stands significantly higher productivity was observed in WTH plots than in WTH+SB plots, while in mixed stands (spruce+black alder) no statistical differences were observed during seven years after planting. Dynamics of nutrients in the soil water reflected site specific conditions and varied between sites showing significant differences between the harvesting techniques only randomly in some years. Peaks of several parameter concentrations were observed during first years after the logging and four-five years after logging – when remaining logging residues decomposed more intensively. Soil chemistry parameters showed no acidification and displayed similar trends of change in the plots of different harvesting techniques.*

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# Spatial Planning Indicators for the Sustainable Development of Mountainous Areas

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**Abstract:** *The development of mountainous areas is linked with human interventions on them, since any kind of economic development is usually characterized by unfavorable environmental impacts.*

*However, there is an inherent paradox, namely this human intervention degrades the natural and built-up environment, which at the same time constitutes the raw material for his development.*

*The objective of this paper is the specification of measurable criteria-indicators for an integrated strategic of sustainable development of mountainous regions. As a basic and necessary prior condition for achieving this objective is the rational development in all three sectors of the mountain economy, which are forest - agriculture, livestock and tourism, that can evolve dynamically and plan various activities and functions. This requires a regional approach to nature conservation, spatial planning and water management leading to certified objective decisions in order to draw out proposals regarding specialized production activities, according to a proper typology that characterizes the differentiation of regional problems, needs and perspectives.*

*The concentration of private and public investments in these areas targets to environmental protection and the economic revitalization of forestry, agriculture, tourism, cultural heritage and the existing network of villages, as well as to a total environmental upgrading.*

*Strengthening of the transportation system in mountainous areas and improving the access to the basic infrastructure system, as well as new information technology systems in order to address isolation problems.*

*Protection and upgrading of the natural ecosystems, forest aesthetics, and the natural and cultural resources of mountainous areas.*

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# Combining of Leaf Transcriptome Analysis and Growth Measurements to Monitor the Development of Poplar in Pure and Mixed with Black Locust Stands

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**Abstract:** *Poplar (Populus) hybrids are widely used for bioenergy production in monoculture systems due to their rapid growth. Robinia pseudoacacia L. (Black Locust) is a less known species for bioenergy production, but has the ability to fix nitrogen. We tested the hypothesis that mixing an economic important tree species with a nitrogen fixing tree species may improve ecological functions and enhance crop system productivity and stability. Experimental plots were established at two ecologically different sites (marginal and fertile soil conditions) to observe the influence of environmental conditions in mixed and pure stands on poplar and black locust tree growth and development. RNA-sequencing in leaves was used together with growth measurements to monitor effects of the two propagation types on gene expression and growth of poplar trees.*

*The data for three years of observation (2016, 2017, and 2018) indicated a strong influence of local environmental conditions, genotypes of clones, and competition with black locust on the performance of poplar trees during stand development. Unfavorable climate conditions during planting and 2017-2018 years induced interspecific competition between black locust and poplar trees in favor of black locust. At the study site with marginal soil conditions, poplar growth in mixture was thirteen times weaker as in the mixture growing under favorable soil conditions. Results of leaf transcriptome analyses were in agreement with the field observations. Influence of study site conditions and effects from the black locust competition pressure were clearly observed in gene expression levels. Additional studies to optimize the planting design are necessary.*

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**Detecting Genomic Signatures of Ecological Speciation and Parallel Evolution in Oaks**

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**Abstract:** *Oaks are considered at the same time as "worst case scenario for the biological species concept" and as "an evolutionary success story" which makes them interesting for studying species coherence in the face of gene flow at the genome level. Because of the wide distribution of oaks and overlapping ranges of differently adapted species, oaks are subject of many studies, focusing on the genes that play a potential role in adaptive isolation as well as species maintenance despite high interspecific gene flow.*

*In our study we will generate new whole genome sequence data for species pairs of the white oak (Q. petraea, Q. robur) and the red oak group (Q. rubra, Q. elipsoidalis) in order to analyze the genomic architecture of reproductive isolation and adaptive divergence across taxonomic sections. We sampled 8 population pairs of white oaks in Germany and genotyped them with 21 nSSR markers in order to identify species in neighboring populations and to select individuals for whole genome resequencing (individuals of 2 population pairs of red oaks from USA have been already sent for whole genome resequencing). Using this generated data, we will be able to study the genomic distribution of loci that differentiate these species in face of introgression. Specifically, we will perform outlier screens in white oaks and red oaks to test for parallel species divergence by natural selection.*

*This study will give us a better insight into the genetic basis for the maintenance of species integrity in oaks in the face of interspecific gene flow, and the role of genes that distinguish the species today in initial lineage divergence*

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# The Impact of Forest and Climate Change on Seasonal Dynamics of Hydrological Processes in Upper Tarlung Watershed

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**Abstract:** *This study aims to assess the possible impacts of climate change and forested areas reduction on seasonal dynamics of surface runoff, discharges, and sediment transport from Upper Tarlung watershed. In this respect, the Soil and Water Assessment Tool was personalized and exploited for the 2020-2100 interval divided on the short-term, medium-term, and long term. The simulations were performed in three hydrological scenarios resulted after coupling four local climate change models (REMO4.5, REMO8.5, CLM4.5, and CLM8.5) with three land-use change scenarios (maintaining the current land-use, 25% forested areas reduction and 50% forested areas reduction). The results highlighted that, compared with the baseline, in the spring months the discharges are foreseen to increase in all intervals, while surface runoff and sediment transport will record both increment and decrease. In the summer, a decreased tendency is projected for surface runoff and discharges, while sediment transport will show an alternative variation. In autumn, although surface runoff is expected to intensify, while discharges and sediment transport will record an increment tendency in the short-term and a decreases trend in the long-term. In winter, all three hydrological parameters will follow only an increment tendency in all three time horizons. This study provides valuable information for water and forest owners to avoid the negative effects of land-use reduction under climate change context.*

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# Growth and Adaptive Capacity of Douglas Fir Genetic Resources in Western Romania

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**Abstract:** *Douglas fir (Pseudotsuga menziesii) is one of the most valuable and productive timber species in North America. In Romania, the first Douglas fir plantations were established at the end of 19th century in western (Banat region) and eastern (Moldavia) parts of the country. The aim of this study was to evaluate the growth and adaptive capacity in Douglas fir genetic resources in Romania. Two of the most representative genetic resources located in Banat region were selected. Douglas fir occurs in 100-125 years old mixed stands with Norway spruce and broadleaved species. The growth and wood traits of Douglas fir and Norway spruce trees have been analyzed and compared. The climate-growth relationship was determined using growth response functions over a period of 100 years. To simulate the potential impact of climate change on Douglas fir in the study region, the RCP4.5 scenario was used over two periods: 2021–2050 and 2071–2100. Our results indicate that Douglas fir has an exceptional growth capacity, overcoming the Norway spruce ever since the early age both in high productivity and low productivity sites. The use of proper provenances of Douglas fir in mixed stands with native broadleaved species may be an option for climatically exposed sites, thus increasing the value of these stands and their capacity to adapt to climate change. Therefore, conservation of the most valuable resources of Douglas fir should have priority, as these stands can be potential seed sources for ecosystem restoration.*

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# Assessment of the Physical Status of the Torrent Control Structures in Romania

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**Abstract:** *The evaluation of torrent control structures must be an integrated part of watershed management. Moreover, these transversal torrential structures consist of complex structures that reduce runoff, reduction of the water velocity that implies the decrease of soil erosion. These works are requested in various ways, of different intensities, the essential factor is characterized by their stability and resistance over time. The vulnerability of structures is influenced by various factors, which high influences degradation over time. The aim of this researches has been to evaluate the evolution of damages and dysfunctionalities for 192 transversal hydrotechnical structures (repeated inventories at 5-10 years). The outcomes showed that the evolution of the physical status of structures is influenced by various factors on the one hand dependent factors (e.g. materials, dimensional elements of structures, and type of construction) and on the other hand independent factors (e.g. rainfall, structure age). The research relieved that the quality of the materials, but also, the age of structures were the most important factors with negative repercussions on the evolution of the physical condition of the structures. In order to know the evolution of the physical condition of those structures, both from the point of view of their resistance and of their functioning, a periodic evaluation of these is necessary.*

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# A Large Translocation Experiment Revealed Low Population Differentiation but High Phenotypic Plasticity of European Beech in Germany

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**Abstract:** *The vitality of European beech (Fagus sylvatica L.) is increasingly impaired by drought in several regions of its distribution range. Also, other adaptive traits such as plant phenology and frost tolerance are becoming more important in times of climate change. Local adaptation and phenotypic plasticity in European beech seem to be complex, as contrasting results regarding the relative effect of phenotypic plasticity and genetic variation in trait variation have been reported. Here, we used a large translocation experiment comprising more than 15,500 seedlings in three regions to investigate local adaptation and phenotypic plasticity in beech. We found low differentiation of the populations regarding plant survival, plant height, and plant height increment, but high phenotypic plasticity for these traits. Survival showed positive correlation with a climatic principle component strongly associated with temperature variables and less pronounced and negatively correlated with precipitation. This suggests a predominant effect of temperature and growing degree days on the survival of beech seedlings under moderate drought stress. The high phenotypic plasticity may help beech to cope with changing environmental conditions, albeit increasing drought stress may make adaptive changes necessary in the long term.*

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# Mapping Stakeholder's Perceptions on Power and Interest in Managing Protected Forest Habitats in Romania

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**Abstract:** *Management planning for protected areas has been an intense activity in Romania in the last decade, but there are few studies on the effectiveness of the process. Although, by law, every protected site should have a management plan and its elaboration should include extensive stakeholders' consultation process, there are no dedicated studies aimed at describing possible pitfalls in stakeholders' communication. Present paper aims to address this issue by evaluating perceptions on stakeholders' power and interest regarding protected sites management planning and management. Firstly, a preliminary list of stakeholders was established following a mixed selection method: by lists available on ministry sites and keywords web search. It resulted in a list of approx. 300 stakeholders, belonging to thirteen categories. Thirty interviews have been conducted afterwards with experts identified using the snowball sampling technique, in order to assess their perception regarding the power and interest of each stakeholder category over forest habitats within protected areas. The interviews comprised of nine questions using a Likert scale. Results suggest that NGOs and research and consultancy companies occupy a unique position, in that they have strong interest over the habitats, as well as a strong capacity to impose measures. Experts considered NGOs as having a stronger impact then necessary and, in the same time, they have scored landowners and communities with a smaller decision-making power.*

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# Measurring the Effect of Forest Land the Consolidation in State Owned Forest Enterprise in Bulgaria

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**Abstract:** *Land consolidation in forest areas is a problem that has been sought in Bulgaria in recent years. This is a problem in all forests where ownership is distributed between the state, municipalities and private owners. Timber harvesting and exportation is much easier and cheaper when access is easier. This article summarizes the main results of forest land consolidation, highlighting the leading effects of the land consolidation campaign in Bulgarian Forestry. The purpose of the study is to calculate some basic outcomes of consolidation that allow to determine the economic effectiveness of it. Current paper is the first step of developing an optimization model in purpose of supporting the forestry units in Bulgaria and in other countries which have undertaken such an uneasy task.*

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# Economic Valuation of Carbon Sequestration in Retezat National Park

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**Abstract:** *Carbon storage and sequestration is one of the most important ecosystem services provided by the ecosystems, one of the most powerful tools on climate change mitigation and adaptation. Its value is not captured and appreciated at the real level, people taking for granted this benefit provided by the ecosystems. The paper calculates the amount of the carbon stored, sequestered carbon and the economic value of the carbon sequestered by the ecosystems within a specific area - Retezat National Park in a specific time-frame, using mainly the data from the approved forest management plans. Before using these data, a data validation process was conducted in the field, using a mobile scanning with 3D mapping technology named GeoSlam Zeb Revo. Processing these data revealed comparable volumes with the ones inscribed in the approved forest management plans, enabling us to us these plans as an accurate source of information. Further, using current and future Land Use/Land Cover maps and the amount of stored carbon, we have calculated the changes in the carbon storage over 10 years (sequestration and loss). Based on the carbon market price, we came up with the monetary value of the sequestered carbon. We underlined that the financial effort for the management of the ecosystems which provides these services can be sustained by implementing financial mechanisms aiming to direct ecosystem services values into the management of these ecosystems.*

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# A Fractal Analysis of the Phenological Green Wave in South Eastern Transylvania

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**Abstract:** *The paper presents a fractal analysis of the springtime spatial evolution of the broadleaved forest vegetation, in south-eastern Transylvania, for the period 2017-2020.*

*Phenological observations provide useful information for inferring local climate characteristics, for identifying trends induced by possible climate changes etc.*

*The classical approach in phenology is labour intensive, requiring numerous observation plots, which have to be carefully monitored by field research staff (sometimes supported by volunteers and recently aided by video recording devices), for an accurate determination of the phenological phases moments.*

*The remote sensing approach offers a convenient overlook of spring phenology over large regions and a suggestive visualisation of the phenological green wave, but it requires further development and refinements in order to improve the utility of the outcoming data.*

*As presented in the paper, the fractal analysis could bring significant improvement of the information derived from satellite images, enabling enhanced outcomes in comparing areas (green wave segments) or phenological seasons. This fractal approach could be also helpful in designing or optimising the existing and future ground observation networks, consequently reducing the costs, and increasing the quality of the resulting data.*

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# The Impacts of Silvicultural Interventions on Nature-Based Recreational Activities: The Visitors' Perspective

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**Abstract:** *The nature-based recreational activities are one of the most important cultural ecosystem services offered by forests, providing benefits to local economy, human health and well-being, reducing depression and mental illnesses risk and increasing social interactions. The aim of this research is to assess visitors' perception on the effects of silvicultural interventions (i.e. selective thinning and thinning from below) on cultural ecosystem services and to evaluate the socio-economic importance of forest-based recreational activities. The study was implemented in a Calabrian (Pinus brutia) and Austrian black (Pinus nigra) pine forest in Central Italy (Pratomagno forest) characterized by a high multifunctionality and diversified recreational attendance. The study on forest-based recreational activities was organized in four steps: development and pre-testing of a questionnaire; identification of the sample of visitors; administration of the questionnaire to 200 visitors; data processing.*

*The results show that visitors prefer a forest managed through a selective thinning compared to other two forest management scenarios: business-as-usual scenario (unmanaged forest) and forest managed through a thinning from below. The results highlight that the most important forest-based recreational activity carried out by visitors is relaxing into the nature, followed by hiking and picnicking. The occasional visitors prefer passive recreational activities (relaxing into the nature and picnicking), while regular and loyal visitors prefer active recreational activities (hiking, mountain biking, picking non-wood forest products). A consumer surplus – estimated using the Travel Cost Method – is between 39 and 44 € per visit based on the Poisson and Negative binomial model, corresponding to 60.5-68.3 € per hectare.*

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# Genetic Diagnostics of Invasive Alien Phytopatogens of the Forest Forming Species in Belarus

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**Abstract:** *Due to the introduction of new plant species, different alien pathogens are recorded in Belarus regularly. Favorable conditions for their invasion and distribution (suitable climate, lack of the antagonists and enemies, etc.) can advantage to their mass reproduction, that together with impact of the native-born pathogens lead to significant damage of both introduced and aboriginal plant species.*

*To date in Belarus, more than 10 alien phytopathogenic fungi of forest forming species have been identified and genetically (species-specific PCR and DNA barcoding) verified:*

*Dothistroma septosporum (Dorog.) Morelet (NCBI ID – MK622273) – causative agent of the red band needle blight of pine. It was diagnosed in Pinus mugo Turra (Minsk region);*

*Lecanosticta acicola (Thüm.) Syd. (NCBI ID – MK621329) – causative agent of the brown spot needle blight of pine. It was diagnosed in Pinus mugo Turra (Minsk region);*

*Neocatenulostroma germanicum (Crous & Braun) Quaedvl. & Crous (NCBI ID – MK622897) – causative agent of the Neocatenulostroma needle blight of pine. It was diagnosed in Pinus nigra Arnold (Minsk region);*

*Gremmeniella abietina (Lagerberg) Morelet (NCBI ID – MK622845) – causative agent of the Scleroderris canker (Brunchorstia disease). It was diagnosed in Pinus rigida Mill. (Minsk and Grodno regions);*

*Cyclaneusma minus (NCBI ID – MK622796) – causative agent of the Cyclaneusma needle cast. It was diagnosed in P. mugo and P. sylvestris (Minsk region);*

*Nothophaeocryptopus gaeumannii (T. Rohde) Videira et al. (NCBI ID – MT154259) – causative agent of the Swiss needle cast. It was diagnosed in Picea pungens Engelm. (Minsk region);*

*Allantophomopsis lycopodina (Höhn.) Carris (NCBI ID – MT154252) – causative agent of the shoot and needle blight of pine. It was diagnosed in P. rigida (Minsk region);*

*Hymenoscyphus fraxineus Baral et al. (NCBI ID – JF342718, MK621286) – causative agent of the ash dieback disease. It was diagnosed in F. excelsior Baral et al. u F. pennsylvanica Marsh. (Gomel, Brest, Mogilev, Minsk, Grodno and Vitebsk regions);*

*Phytophthora alni – causative agent of the root and collar rot of alders. It was diagnosed in Alnus glutinosa (L.) Gaertn. (Gomel region);*

*Melampsoridium hiratsukanum (NCBI ID – KY652673, KY652674) – causative agent of the rust disease of alders. It was diagnosed in A. glutinosa (Vitebsk and Minsk regions);*

*Ramularia vizellae (NCBI ID – KY652671) – associated with the alder dieback. It was diagnosed in A. glutinosa (Mogilev region);*

*Diaporthe oncostoma (NCBI ID – MK637449) – causative agent of the shoot and stem canker of Robinia pseudoacacia L. (Gomel region). Cryptogenic species (unknown origin).*

*The obtained data will be used to design algorithm of effective protection events, including updating the list of pathogens and diseases, monitoring of the pathogen populations state, development science-based measures for the maintenance and protection of plants.*

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# Monitoring of Phoma Blight in Forest Nurseries of Belarus

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**Abstract:** *Phoma blight of coniferous planting material is a new, but already widespread disease that occurs in every second forest nursery in the Republic of Belarus. The prevalence of the disease in some areas of the nursery can reach 40% or more. The symptoms of the disease are quite diverse, often depending on the type, age of the planting material, and also the growing conditions.*

*The study of the symptoms of Phoma blight, as well as the prevalence, degree of development of the disease and the biological characteristics of its pathogens was carried out in 2011–2018. The survey covered more than 40 permanent forest nurseries located in all six production forestry associations of Belarus. Diagnostics was carried out by visual methods with ob-ligatory confirmation of the phytopathogen type by laboratory studies of the affected plant tissues.*

*Depending on the nature of the location of the affected plants, the degree of development of the disease and some features, we identified the following types of Phoma blight prevalence over the area: single, diffuse, clump-group and local foci.*

*Due to the lack of criteria for assessing the infection of plants with Phoma blight in the regu-latory documents of Belarus in force in forestry, we have developed a 5-point scale based on a visual assessment of the degree of development of the disease (% damage to the vegetative part of the plant) and additional criteria, such as the degree of reduction the growth of the af-fected plant in comparison with the healthy one, the localization of the main areas of the le-sion, the color of the needles.*

*For the timely detection of Phoma blight of planting material, it is recommended to carry out reconnaissance examinations of coniferous plants at least once a month with the establishment of the prevalence of the disease and the area and nature of the lesion (visually).*

*Detailed examinations of nurseries should be carried out when areas of Phoma blight lesion with a disease prevalence of more than 10% are identified. In this case, it is necessary to lay registration areas with a total area of at least 0.1% of the surveyed, on which the condition of the seedlings should be assessed according to the scale of the degree of disease development recommended by us (in points). The calculation of the weighted average score of plant dam-age in the surveyed area will allow to objectively assess the degree of plant damage and adjust protective measures.*

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# Analysis of Public Forestry Institutions in the Republic of Moldova using a Causative Model

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**Abstract:** *The forestry sector institutional reform process in the Republic of Moldova, together with the evolution of public forest governance towards greater transparency, social integration and market economy, triggered the need for assessing the outcomes of the new policy implementation in terms of institutional orientation from both economic and sustainable management perspectives. This paper describes the institutional framework and forest policies and analyses the Moldovan public forest institutional performance in terms of fulfilling the forest policy tasks and objectives. It also identifies the development needs of forest institutions and policies. The research method consists in measuring the perception of public forest institutions employees, using two questionnaires developed based on four principles of 3L Benchmarking model. The model is assessing the following areas: forest goods and services, market orientation of public services/products, strengthening economic performance in forestry and intra/inter-sectorial coordination and cooperation. The questionnaires were developed for institutions performing different roles of the state: forest management on one hand and legislation and forestry policy making on the other. The results show that implementation of Moldovan forest policy differs on the paper and in the reality, especially concerning economic profit orientation. Useful recommendations for public forestry institutions are outlined, especially concerning the balance between sustainable management and profit seeking.*

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# Identification of Autochthonous Norway Spruce Gene Pools for Conservations in the Romanian Carpathians

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**Abstract:** *Norway spruce (Picea abies (L.) Karst) is one of the most important forest tree species in Romania. A detailed knowledge of genetic diversity and spatial genetic structure is essential for gene conservation and selection of well-adapted forest reproductive materials in the context of significant change of Norway spruce distribution range, caused by forest management in Europe during the last centuries. In this study we analysed patterns of genetic variation at chloroplast and mitochondrial level to characterise the phylogeography of Norway spruce in the Romanian Carpathians. A total of 1152 individual trees from 72 populations, were characterised by means of three chloroplast microsatellites (cpSSRs) and a mitochondrial marker (second intron of the nad1 gene). The 746bp mitochondrial DNA haplotype was the most common in the Romanian Carpathians, yet a relative frequency of over 80% was found only in the South-Eastern corner of the Romanian Carpathians and in several populations located close to the timber line. Two main groups of populations were distinguished based on both marker types. We found evidence of long distance transfer of forest reproductive materials. Our results highlight the possibility to distinguish autochthonous from allochthonous populations and thus to contribute to the identification of valuable gene pools in the Romanian Carpathians.*

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# Assessing the Characteristics of Trees and Stands using UAV Photogrammetric Data

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**Abstract:** *Digital elevation models (DEMs), obtained through processing the UAV aerial images, represent a rich source of information for characterising the structure of stands, particularly useful in forest management planning. Using DEM to assess the characteristics of trees and stands was the main objective pursued through this reasearch. We chose a mixed forest of sessile oak, common beech, and common hornbeam found in the proximity of Brasov city in Romania, with varied stands in terms of structure, sizes of trees, and density. The findings were only for sessile oak. The characteristics of trees were determined also through ground measurements regarding the coordinates (for 202 trees) and the diameter, height, volume, and crown diameter (515 trees). The values of the characteristics determined on DEM are similar to those obtained through ground measurements, RMSE% being: 15.70 – 24.13 for crown diameter; 0.83 – 1.07 for trees diameter; 10.40 – 11.70 for trees height and 8.75 – 9.62 for trees volume. The relationships between the diameter of the prevailing tree crowns, determined on DEM and the other biometric characteristics of the trees, with ground measurements, have led to regression models. Finally, a simplified method was developed for determining the tree and stand volume depending on the variables of the trees measured on DEM, which led to errors compared to ground measurements of ±6%. The models obtained can be applied for stands of sessile oak with structural conditions similar to the stands under study. The research has to be continued for drawing up regression models by types of structures.*

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# Assessing the Hydrological Impact of Land and Forest Management Change under Climate Projections in the Tarlung River Basin (Upstream Sacele Reservoir)

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**Abstract:** *Decision-makers need personalized information regarding future climate, land and forest management scenarios for sustainable watershed management. To support them in the decision-making process, we applied Soil and Water Assessment Tool for modelling the hydrological processes within Tarlung River Basin. We applied four local climate change scenarios developed from RCP4.5 and 8.5 coupled with land and forest management scenarios (the combination of three forest and three lands management scenarios). Moreover, all of these scenarios have been designed together with local decision-makers to accomplish their needs. After calibrate and validate SWAT model we obtain a satisfactory model performance in simulating the hydrological processes. The simulation period for appraising the dynamics of water and sediment flow was 2020–2099. The results indicated that climate change is the main factor that influences the water flow, while sediment flow is mainly influenced by land-use scenarios. For water flow, we foresaw a decreased tendency until 2099. Nevertheless, the sediment flow is projected to increase until 2060 particularly in the scenarios developed from RCP8.5 and decrease afterwards. Assessing short, medium and long term of various climate and land-use management scenarios is mandatory to support local decision-making to achieve sustainable watershed management. Therefore, SWAT model is considered a useful tool to provide tailored data for integrated management of watersheds.*

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# The Spatial Heterogeneity and Recent Evolution of the Gaps in the Largest Beech Virgin Forest of South-Eastern Europe – The Nera Forest Reserve

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**Abstract:** *The very numerous studies on gaps structure, evolution and role in the forest dynamics have revealed interesting conclusions and models for forestry practice, but the variety of natural conditions and the existing small area of virgin forest in Europe are a challenge in implementing various research results in practice. The role of forest gaps in the virgin beech forest dynamics is largely recognized but the gap distribution, size, complex structure, longtime spatial evolution on very large natural forest areas are not very much studied although they could provide valuable information for establishing models to be applied in the future adaptive strategies to sustainable forestry management. The study area is very significant and important for forest science: the largest virgin beech forest in the EU, recently included in the UNESCO list. The scope of the present paper is to contribute to the description of the recent forest gaps evolution and their potential relation with natural regeneration and general stand development in the beech natural forests, using satellite imagery. The forest gap characteristics in 10 circular representative plots of 1 ha each in the period 1968 – 2018 and their spatial distribution and structure were analyzed using satellite imagery and recent direct measurements in the field. The broad structural variety and complex dynamics of Izvoarele Nerei virgin beech forest show the extent of diversity a monospecific but natural forest could reach.*

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# Specimens of Sequoia gigantea from Romania

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**Abstract:** *Sequoia gigantea or Sequoiadendron giganteum (Lindley) Buchholz is a giant tree spread in the most northern areas of a band nearly 400km long distributed along the western slope of California's Sierra Nevada mountains.*

*In Europe, they are some of the largest trees, but the species is little used for wood products, it is widely planted as ornamentals. In Romania trees of this species are cultivate only for decorative purposes.*

*The researches took place in the west and northwest part of the country, since, after the public consultations and bibliographic investigations, only in that part of the country were identified some specimens of Sequoia giganteum.*

*In Romania only a few specimens of Giant Sequoia were introduced for the first time in 1845 in Măderat, village from Arad county. Another 5 specimens of Giant Sequoia were identified in Caraș Severin county (in the cities of Băile Herculane and Reșița), in Bihor county 2 specimens in Oradea city and in Cluj county one specimen in Secuieu. All of these specimens of Sequoia from Romania, proved that this species could adapt to very different conditions, compared to the conditions in which it usually grows. And even if these conditions are very different, the specimens have significant increases in diameter and height. All the six specimens are in a good and very good health status. The specimens which have been brought from California from the altitude of over 2000 meters, only for ornamental purposes, not only did they survive but they also had significant increases.*

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# Forest engineering

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# Moisture Content Management, Fuel Reduction Technologies, and Optimization-Based Planning Techniques for More Sustainable Transport Operations

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**Abstract:** *Transport accounts for up to 50% of the costs of supplying roundwood and biomass from the forests to consumption centres, which means several millions of dollars annually for the forest industry worldwide. Also, transport of timber and biomass constitutes a major contributor to CO2 emissions as indicated by previous Life cycle analysis (LCA) studies. The high level of expenditure and emissions involved makes it essential to apply optimization tools to plan and implement timber and biomass transport operations efficiently. In this study, we designed and implemented a transport optimization tools called MCPLAN which implements a linear programming model, allowing optimal monthly harvest scheduling, transport flows from the forest to consumption centres, and drying time of logs and biomass in the forest. We used MCPLAN to test the impact of moisture management control and fuel reduction hybrid technologies on the economics and emissions generated from transport operations. Our transport optimization approach was tested in a case study in Asturias, Spain under three scenarios, which included a) the drying of logs and biomass before transport to the consumption centre, b) transport without drying, and c) drying with volumetric (logs) and content of organic matter (biomass) losses. Our analyses indicate that moisture content management, use of hybrid technologies, and implementation of optimization-based planning techniques, can result in a substantial reduction in fleet size, $CO_2$ emissions, and transport costs.*

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# Examining Effects of Forest Roads Pavement Types on Carbon Footprint

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**Abstract:** *Nowadays, carbon footprint calculations are very important, which are the measurement of the amount of greenhouse gas released by the human activities on the world in terms of CO2. Studies are carried out to show that road pavement, especially on highways, have an effect on the fuel consumption of vehicles and heavy vehicles. It has been indicated in previous studies that the sustainable road pavement plays an important role in the reduction of road construction works and consequently traffic disruptions, fuel consumption and exhaust gas emissions. In forestry, functional planning may be possible to reduce greenhouse gas emissions that cause global warming and to achieve success in combating climate change. For this purpose, the effect of sustainable forest road pavement on the carbon footprint was examined in this study. It is thought that the use of environmentally friendly and more efficient construction equipment, minimizing moving distances has a significant impact on reducing carbon dioxide emission during transportation.*

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# Following the Time Behavior of Forest Roads

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**Abstract:** *The national legislation regarding the quality in constructions gives a special importance to the follow-up in operation of the existing constructions, so this activity is considered as part of the quality system in constructions.*

*Of all the components of the quality system in constructions, the pursuit in operation of constructions has the greatest extent in time (decades) and has as finality the preservation of the technical parameters and the initial destination for all constructions.*

*The current monitoring of the behaviour of forest roads over time consists in visual observation and finding phenomena, aspects, and parameters that may signal changes in the initial technical characteristics of the objective and may affect its functionality and the applicable fundamental requirements (mechanical strength and stability, safety and accessibility in operation, sustainability, etc.).*

*The aim of the research was to establish current methods for current monitoring of the behaviour of forest roads over time both by direct visual examination and by temporary or permanent measurement of some edifying parameters that may lead to conclusions about the behaviour of the forest roads.*

*The research was carried out on forest roads from the network managed by the Bacau Forest Directorate.*

*As a result of monitoring the technical parameters, an accentuated degradation of the projected parameters was observed under the impact of traffic but also of other external factors (degree of sunshine / shading of the road platform, excess water in the road bed, contamination of alluvial road superstructure, etc.).*

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# Effects of Sampling Strategy on the Accuracy of Postural Classification: An Example from Motor-Manual Timber Felling and Processing

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**Abstract:** *The OWAS method for postural assessment has gained a lot of interest in forestry. While it relies on data sampled and processed as shares per categories, its use can be resource-challenging and the trade-off between accuracy, sample size and sampling strategy is important. A dataset of 6608 observations was used as population for sampling which was implemented both randomly and systematically. Random sampling was done incrementally at 0.25, 0.5 and from 1 to 99% of the population size, using a step of 1%. Systematic sampling was adapted to get the finest rates up to an interval of 150Hz, followed by an incremental dilution up to an interval of 1500Hz. For each sample, shares on action categories and tasks were extracted and compared against the population, then the margin of errors and absolute differences were computed. For a targeted margin of error of 5%, a sample size of ca. 5% seemed to be sufficient to get accurate results irrespective of the sampling approach since the absolute experimental differences were of up to ±1.2 and ±2.1% for the shares on action categories and tasks, respectively. For higher sample sizes the differences were lower and more consistent for systematic sampling while the results of comparison tests revealed significant differences only for very low sample sizes (very high absolute differences). Therefore, a sufficient sample could be of 5 to 10% of the population size and the systematic sampling should be used whether possible. As a strategy, nonparametric comparison should be used with caution.*

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# Performance of Forwarding Operations in Biomass Recovery from Dismantled Apple Orchards

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**Abstract:** *Fruit orchards cover large areas and during their management, they require annual pruning which leaves abundant residues on the ground; when fruit production declines, the plants are dismantled to make place for new ones. In Europe, apple orchards are common, covering 35% of the area cultivated with fruit trees. Frequent renewal of this crop type requires a reduction of termination costs, which can be achieved by the utilization of biomass. This study evaluated the performance of biomass recovery from dismantled apple orchards by the means of an HSM 208F forwarder and a Jenz BA 725 chipper. Time studies were conducted to estimate the productivity and fuel consumption of forwarding operations. Data was collected by the means of a GPS unit, a video camera and an electric fuel pump, and 30 work cycles divided into elemental tasks were monitored. Models for time consumption and productivity as a function of extraction distance were developed by the means of least-square simple regression techniques, at different scales needed to characterize the forwarding operations. The average forwarding distance was of ca. 830 m and the net and gross forwarding production rates were 21.79 and 15.35 loose m3 h-1. Operational speed was the highest in the empty turn and varied between 4 and 11 km h-1, averaging ca. 7.4 km h-1, while the hourly fuel consumption was 11.82 l. The study provides reference data for forwarding operations deployed in apple orchards and demonstrates the successful use of forestry machines in the agricultural sector.*

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# Does Diameter at Breast Height Affect the Mechanical Characteristics of Fine Roots?

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**Abstract:** *Shallow landslides and slope failures are major problems which cause environmental and economic damages. Stabilization of slopes by bioengineering using vegetation combines the knowledge of ecology and engineering and plays a critical role against the triggering forces of landslides, erosion and debris flows. Among the various components of the plants, root system contributes to an increased slope stability by reinforcing the soil. Nevertheless, the knowledge of biomechanical characteristics and root reinforcement of trees from different diameter classes, environmental, and regional conditions is lacking. This study was carried out in the Kheyroud forest (Caspian Ecoregion, Northern Iran) and it aimed to investigate the biomechanical characteristics of Carpinus betulus roots. Fine roots (0.02 to 7.99 mm) were collected from 15 trees across three DBH classes (small = 7.5-32.5 cm, medium = 32.6-57.5 cm, and large = 57.6-82.5 cm). In the laboratory, maximum tensile force required to break the roots was determined using the SANTAM (STM5) standard. ANCOVA was used to check the effect of DBH on root tensile force. To obtain the power-law regression coefficients, a nonlinear least square equation was used. We found that root tensile force strongly depends on the root size, and the roots of larger trees were the most resistant in tension. Overall, our findings raise the awareness about the role of trees in preventing shallow landslides and evaluate their contribution in reinforcing soil and slope stability.*

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# Development of a Web-GIS Geoportal to Support Forest Road Inventory and Management for the National Forest Administration - RNP Romsilva

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**Abstract:** *The need to assess and monitor in real time the state of the forest road network managed by the National Forest Administration has been one of the priority challenges of the central state forest administration and of the Faculty of Silviculture and Forest Engineering from Brasov. Starting with some elemental road features such as the road length, road width and the spatial occurrence of bridges, culverts and retaining walls, an integrated database was developed to enable a real-time monitoring of the forest road network managed by the National Forest Administration. Among other built-in features, the geo-portal allows for a quick identification on an integrated map of the forest roads, based on their name and inventory number.*

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# Environmental Impact Assessment of Forest Road Networks

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**Abstract:** *Road network development and upgrading is a lever to the effectivity and efficiency of forest operations and transportation. Those positive effects are linked with adverse effects on the biophysical and social environment, which have been targets of criticism and public debate and resistance against the development of other road networks. The trend of entering development projects into the public arena calls for a systematic approach to anticipate, avoid and mitigate adverse effects comprehensively. Impact assessment developed into an own discipline that is providing a comprehensive assessment framework, which can be adapted and used for forest road network project, too. The purpose of the presentation is to provide a framework on how to organize impact assessment activities and how to identify relevant environmental and social aspects that might be affected. The purpose of the contribution is threefold. First, it proposes a framework on how impact assessment activities fit into the project-development life-cycle. Second, it presents a comprehensive scheme of biophysical and social assets that support the screening and scoping of adverse effects. Third, it illustrates selected techniques to investigate specific effects. Although environmental impact assessment was formalized in the 1980s in the European Union, it is not mandatory for forest road network projects. But the forestry sector can improve its public acceptance by adapting the EIA procedures voluntarily.*

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# Content of Trace Element in Needles and Leaves as an Indicator of Forest Soil Fertilization with Wood Ash

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**Abstract:** *Forest soil improvement with wood ash, likewise drainage and thinning may enhance forest growth conditions. In this study, we analyzed the results of 21 forest soil fertilization experiment in order to estimate the possible input of trace elements (Cd, Mn, Zn, Ni, Cr, Fe and Cu) in the forest ecosystem. Experiment was conducted in 21 objects in Norway spruce, Scots pine and Birch stands, in Latvia. The forest stands are located on dry mineral soil, drained mineral soil and drained organic soil, thus including various growth conditions. We found both – elevated and decreased concentrations of the elements in the samples from the fertilized plots. A part of the differences were statistically significant ($p<0.05$). We detected a tendency of a comparatively high concentrations in the samples of leaves. The mobility of trace elements is soil's pH dependent. The data of soil's pH were available for a part of the plots; nonetheless, we detected negative correlations between the soil's pH and content of Cd, Mn, Fe, Zn and Ni in the samples of the collected needles and leaves. The significant ($p<0.05$) negative correlations were found for control and treated plots, mostly for Cd. It could be explained with considerable amounts of Cd that wood ash contains.*

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# Postural Risk in Manual Planting Operations of Poplar: Two Options Compared

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**Abstract:** *Poplar forests are cultivated worldwide on extended areas, contributing to the provision of wood for industries. Their management is intensive, especially in planting operations which are done, in many parts of the world, by the use of manual labor. This situation raises the question on their sustainability from an ergonomics point of view. Particularly, the postural risk is in question, as uncomfortable work postures may cause musculo-skeletal disorders. Two types of planting operations (large cutting - CP and bare – root seedling - SP) were selected as representatives for the evaluation of postural risks which was carried out for 14 subjects. Based on the analysis of approximately 14,500 images (approximately 67 h of field study), the postural risk indexes were estimated at 259 and 250 for the CP and SP, respectively. No significant differences were found between the operations, but the high share of effective planting tasks and their associated postural risk indexes generated these concerning results. The main conclusion is that these kinds of planting operations need postural improvement and ways for doing so should be researched in the future.*

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# Improving Environmental Efficiency and Energy Efficiency in Wood Transportation for a Carbon-Neutral Forest Industry

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**Abstract:** *Wood transportation is an important source of greenhouse gas emissions, which should be considered when carbon neutrality of forest industry is of concern. The EU is dedicated to improving technology for a carbon-neutral development. This study investigates the carbon neutrality by analyzing road freight transportation fleets consisting of various vehicle size combinations. The environmental emission and energy efficiency of transportation fleet was analyzed in the wood procurement regions of Stora Enso corporation (Finland). Based on the Enterprise Resource Planning (ERP) data (2018-2020), the environmental emission efficiency, measured in relation to the trip, increased by 11%. The maximum reduction in fuel consumption was 26% for 92t vehicles, though this was achieved when forest operations were fully adjusted to the maximum weight limit. The wood-based energy efficiency measure (wood energy/transport energy) was an accurate development indicator. It revealed that the currently adapted fleets of the transportation companies support a positive development in the carbon-neutral forestry. The use of 76t vehicles increased energy efficiency most effectively, by 50% compared to 64t vehicles. Currently, transportation service providers and their clients are using ERP information to tailor their energy efficiency measurements and to implement them locally in the transportation monitoring systems. A six-year sensitivity analysis demonstrates that the technological development to improve transportation efficiency is essential for larger and heavier vehicle utilization. In the future, other functions of wood-procurement logistics from forests to mills will also be optimized with respect to energy efficiency criterion to ensure a low-carbon forest industry.*

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# Particularities Regarding Wood Volume with Stem Decay in Norway Spruce Stands from Eastern Carpathians

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**Abstract:** *The stem decay has a large impact on wood quality in the Norway spruce stads. Because it is located at the base of the trunk, the part with the most valuable wood, the quantitative and qualitative losses are significant. This research was conducted Eastern Carpathians, in six experimental plots, Norway spruce stands, with different frequencies of trees with stem decay, occurred as a result of damages caused by the red deer. The aim was to quantify the influence of the presence of trees with stem decay on the quality, assortments and the value of the resulting volume using two different calculation methods, which take into account different elements (quality clases, correlative relationship between wound age and decay height). Regarding the volume of wood with stem decay calculated by the two methods, there are differences that increase with increasing frequency of affected trees. At a frequency of affected trees of 30%, the difference between the volume of wood with decay calculated by the two methods is 40,8%. At a frequency of 90% the difference increase at 78,6%. The value decrease of the standing wood it is insignificant at a low frequency of affected trees (a decrease of 1,5% at a frequency of 13%) and increases at high frequency (a decrease of 35,3% at a frequency of 90%). Stem decay significantly affects the volume of resulting assortments and the value of standing wood, in case of these artificial Norway spruce stand damaged by red deer. In these cases, it is recommended to use and other evaluation methods besides the ones used in forestry practice.*

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# Root Rot Detection in Norway Spruce Standing Trees Using Rotfinder® Device

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**Abstract:** *Root rot causes sever economic damage in Norway spruce stand. The most important is wood deterioration, followed by growth reduction, higher risks of windthrow and stem breakage. The evaluation of presence and extent of root rot in living Norway spruce trees is not sufficiently possible by visual methods. Rotfinder® is a fast and non-invasive device, based on electrical conductivity, that offers the possibility to evaluate the presence and extend of root rot using a scale from 0 to 10 which indicates an increasing degree of probability of decay. Were analyzed 398 healthy standing trees (according with visual inspection) in six Norway spruce plots. More than 16 % from the analyzed trees was affected by root rot. The relationship between the value indicated by the Rotfinder® device and the proportion occupied by the root rot in the cross-section of the Norway spruce trees is given by a logarithmic equation. The correlation is very strong and very significant (r = 0.960***). This is a considerable practical importance because it is possible to estimate the proportion of root rot in the cross-sectional area for different forest areas.*

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# Analytic Hierarchy Process and Benefit Cost Analysis for the Selection of Suitable Eucalypt Re-Establishment Methods: A Case Study un Kwazulu-Natal, South Africa

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**Abstract:** *Since 2010, various semi- and fully-mechanised silviculture technologies have been introduced into South Africa, mainly due to labour related issues such as the increasing labour costs and the need to improve ergonomics. In plantation forestry, re-establishment includes practices such as residue management, site preparation, planting, fertilisation, and weed control. Deciding which re-establishment methods to apply has become increasingly complex due to the expanding range of options and the numerous criteria (costs/social/environmental) that need to be fulfilled to support any chosen options. The objective of this study was to develop a decision tool for the selection of the best method to perform different re-establishment activities, based on stakeholder preferences. The preference for each re-establishment method was rated according to the following broad criteria: compliance with health and safety standards, machine/man productivity, tree planting quality, social development and upliftment, and environmental sustainability. The Analytical Hierarchy Process (AHP), which is a multi-criteria decision analysis (MCDA) tool, was used in conjunction with Benefit Cost analysis to facilitate the process of selecting the best re-establishment method.*

*Results from the case study carried out in Kwazulu-Natal on eucalypt re-establishment showed that the mechanised and semi-mechanised re-establishment alternatives were best for all criteria assessed, except for cost efficiency, where manual methods offered improved financial returns. The results of this study show that decision makers can use AHP as a decision support tool in selecting the most appropriate re-establishment method(s).*

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# Performance of Wood Transport Combining Crane-Truck and Semi-Trailer Truck – A Simulation Study

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**Abstract:** *Due to the increasing impacts of extreme events like storms or massive bark beetle infestation high amounts of salvage wood have to be harvested and transported quickly in order to prevent further damage and wood value loss. Therefore, forestry needs innovative logistics strategies redesigning the roundwood supply chain. Additionally, forest based industry is confronted with an increasing lack of skilled crane-truck drivers.*

*Multi-echelon unimodal transport combining short-distance crane-truck transportation with long-distance semi-trailer truck transport by transhipping logs at a specific terminal potentially provides means to overcome transport capacity bottlenecks after severe damage events. As this logistic concept is very rarely applied under mountainous conditions its potential performance had to be investigated by a discrete event simulation model. Simulation results show the optimal fleet configuration with respect to specific performance indices like cost or transport capacity. In addition, the redesigned supply chain has advantages compared to single-echelon transport lowering driving time and costs. Furthermore, the multi-echelon unimodal supply chain can be seen as a promising strategy to overcome the lack of crane-truck drivers, since less crane-trucks are needed to transport the same amount of roundwood per time unit.*

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# Estimation of the Efficiency Machine for Timber Primary Transportation Taking its Influence on Forest Environment into Consideration

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**Abstract:** *Improving the efficiency of using forwarders by increasing productivity and minimizing the cost of resources is closely linked to the negative impact of the machine on the forest environment.*

*The results show that the forwarder causes the most damage to the soil surface during the first 5-7 runs. With the same number of passes on the sandy soils, the forwarder MTZ-892 + RDM-12 4WD creates a greater (up to 51%) depth of the track compared to AMKODOR 2662-01. The use of bogy tracks significantly reduces the depth of the rut: for AMKODOR 2662-01 up to 26%, and for MTZ-892 + RDM-12 4WD up to 56%.*

*As a result of the timekeeping observations, specific time expenditures on the major technological operations implementation in the process of timber primary transportation have been determined. Moreover, the operational efficiency of the AMKODOR 2662-01 forwarder, which varies within the range of 5.1-6.4 m3 per hour from the transport distance of 500-1000 m., has been defined. Timekeeping observations have also shown the dependence of operation productivity on the length of service of the operator.*

*According to the results of the study, practical recommendations for choosing the type and technical and operational parameters of the machines for the timber primary transport taking the impact on the forest environment into account have been developed.*

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# Multicriteria Decision Making Techniques for Improvement Sustainability of Forest Road Engineering

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**Abstract:** *Forest roads are widely recognized as the major source of disturbance in any forest development. Most of the forest roads in Greece are in the mountain region, characterized by steep terrain, with a dense river network, creeks, glens and springs. Thus, a large volume of works, consisting mainly in the construction of retaining walls, ford and culverts, is required for the protection and stabilization of roadbeds. Impact is defined as any change, positive or negative, caused by the characteristics of the environment, due to a project or activity. Impact assessment is the description and evaluation of potential significant effects on the various natural and socio-economic features of the environment.The lack of specifications for an objective environmental impact assessment and then for the construction of technical projects within the forest areas, with immediately measurable criteria, led us to assess the forest road with technical (quantitative) criteria, which are also qualitative indicators of impact on the environment. Aim of this paper is the study of forest road in terms of how it is designed, constructed and maintained, as well as whether it contributes to the sustainable development of the wider area.Multi-criteria evaluation (MCE) analysis (the implementation of decision-making rules to identify and enable the combination of many criteria, in the form of GIS layers, into a single map) and Geographic Information Systems (GIS) are two examples of tools that aid in the development of geographic data and maps for different purposes, such as conserving land for forestry uses and the quantitative and qualitative evaluation of the impact of the forest road on the environment.*

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# Wildlife management

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# Airport Fauna Study from Timișoara Airport Area

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**Abstract:** *Considering that sustainability and biodiversity play significant roles around the world and, in addition, human safety is involved as well, the study aims to identify and mitigate the bird and wildlife strikes from Timișoara Traian Vuia International Airport area based on some key factors, risk indicators and previous events. Moreover, preventing measures specific to fauna dwellers of the fenced airport and within a radius of 13 km around it are required, according to ICAO. Constant monitoring of wildlife behaviour from the location of the study is essential. Corvus sp. have the highest density in the studied area, from which the rook (Corvus frugilegus) and the western jackdaw (Corvus monedula) are the best represented. Pheasants' and partridges' nests can be found all over the airport surface and in the vicinity cultivated lands. Besides, individuals of common kestrel species hunt in the grassy area adjacent to the runways and paths. The existing attractants, such as garbage or tall vegetation, lure many mammals: European hare, roe deer, wild boar, and small mammals like rodents, respectively. The latter is considered bait for predators as red fox and feral cat, while the others are preyed by feral dog and golden jackal. Both fauna and habitat management are demanded in order to comply with the required safety standards and to keep a high as possible biodiversity of the airport area. The presented study may contribute to the improvement of safety conditions of the aircraft while the negative impact on fauna and its habitat will remain minimal.*

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# Assessing the Regional Landscape Connectivity for Multispecies to Coordinate On-The-Ground Needs for Mitigating Linear Infrastructure Impact in Brasov – Prahova Region

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**Abstract:** *While many initiatives, studies and projects are focusing only on modelling wildlife connectivity movement, coordinated efforts should help to deliver adaptative solutions for the on-the-ground needs, while helping the planners and involving communities in the landscape protection. Multispecies spatial models and maps allow the generalisation of findings across more significant regions and provide insights to maintain, improve or restore landscape connectivity, while individual species could contribute in establishing regions of focus in conservation efforts. Giving the challenge of multispecies connectivity we chose to build model connectivity for brown bear, wolf, red deer, wild boar and roe deer then we combined in a regional spatial map, on which we identified areas of high importance for connectivity conservation. Results were similar with those resulted from brown bear landscape genetics modelling and eastern slope facing aspect was a clear preference of multispecies, we trust this is due abundant vegetation, food resources, and lack of fragmentation of forest regions. However, a vital area called Cold River was validated both functional (brown bear) and structural (for carnivores and prey species) by this study and the results from previous research. While gene flow maintenance should become a priority for all species conservation, management and planning, we advocate that the remaining conservation potential of the Cold River area should be maintained whenever possible. Conservation easements could provide protections against development considered together with coordinated efforts for "smart development", and maintenance of existing forest and wildlife management and land uses preservation.*

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# Wolf Diet Adaptability to Pray Availability

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**Abstract:** *Research on wolf diet was done in many parts of the world. The results show a great variability of species in the diet and different proportion of domestic and wild animals. They also show that the main prey was different from one area to another. Also, the size and the structure of the pack was in correlation with the size of the main prey. But usually the research on diet was not taken in to consideration the dynamic in time of diet and main prey in the same region. This research compares the diet of the wolves in half a century of evolution of wolf population interacting with human pressure, wildlife dynamic and domestic animals. Results obtain in fore periods were compared in order to see the adaptability of the wolf population to various pray density under different human management measures.*

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# The Estimation of Mammals Population using Photo Trap Cameras

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**Abstract:**

*Introduction: The density and distribution of species and also population attributes are critical data for biodiversity conservation. Two of the most commonly applied methods to survey large- and medium-sized mammals are the track plot recording and camera trapping, both non-invasive methods which permit the estimation of species presence and/or abundance (Wemmer et al. 1996; Cutler and Swann 1999). As an important tool for obtaining such data, photo trap camera have become increasingly common into wildlife research. It is known that the photo trap camera method has some limitations due to imperfect species detectability and the use of capture rates as surrogates for abundance (Varman and Sukumar, 1995). In order to reduce these limitations and increase the accuracy of density estimation we used the snow-track counting for calibration.*

*Aims: The researches carried out in the Teleajen basin aimed at estimating the mammals population from the hunting unit managed by Brasov Forestry University. The work has primarily sought to identify the main game species and the specific habitats along the study area.*

*Materials and Methods: In order to achieve the objectives set and to obtain the expected results and taking into account the specificity of the research area, a data collection device comprising 13 transects was used. These transects (primary sampling units) are located along the entire hunting area unit, have an average length of about 6.1 km and a total length around 79,4 km and within them were placed relatively randomly 3 plots (secondary sampling units) with a size of 0.1x0.1km. Within each plot, all relatively randomized, 1 photo trap station was established. The field data collection was done using non-invasive methods, the snow tracking method and the photo trap method.*

*Results: The main result obtained was the estimation of mammals population from the study area using both methods by comparation. GIS maps with the density and distribution of main game species have also been the results of the project.*

*Conclusion: The results of the project have demonstrated the important role of photo trap cameras in estimation of the mammal species as a important tool with more credibility, transparency and relatively lower costs.*

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# The Size of Beaver (Castor Fiber) Territories, in Different Habitat Conditions of Southeastern Transylvania, Romania

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**Abstract:** *The management of the Eurasian beaver has become a priority as the population has grown significantly and conflicts with locals have become more frequent.*

*In this context, determining the size of the territory is important to identify the areas where the support capacity of the habitat has been reached.*

*The study was conducted over 2 years, in southeastern Transylvania, on a total of 14 juvenile and adult beavers naturally established in two very different areas in terms of habitat conditions.*

*There was a total of 87 days of capturing beavers, the result being the capture of 16 specimens of different ages. 2 devices were used to monitor the beavers: R1000 (portable) and TR500 (fixed station). The monitoring was done with the help of radio telemetry, after capturing the beavers, a Telonics radio transmitter being attached to their tail.*

*The 14 specimens are divided into two groups according to the river they populate: 5 beavers on the Pănicel stream and 9 beavers on the Bârsa river.*

*The size of the territories was determined by the method of the maximum convex polygon and was between the values of 2.41-6.36 ha on the Panicel stream and 0.48-21.32 ha on the Bârsa river.*

*It is important to mention that out of the 9 individuals on the Barsa River, 4 beavers migrated to look for other territories, without completely interrupting the connection with the parental family, which is the reason why the size of the territory is very large.*

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# Fallow Deer in the Western Plain of Romania

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**Abstract:** *The fallow deer (Dama dama L.) occupies an extremely favorable area in the Western Plain of Romania, both in terms of frequented habitats and environmental conditions encountered in this area. Representative in this sense is the fact that approximately 85% of the deer population of Romania is found in the Western Plain. Located at the interference between the western chain of the Western Carpathians and the eastern Pannonian Basin, the Western Plain offers favorable and varied habitat conditions for the fallow deer. Forest bodies, with associations of quercinea and deciduous species, with a specific flora such as Poa pratensis, Rubus-Aegopodium, Carex-Iris (for areas with additional groundwater intake), with grouped subshrub composed of species such as Sambucus nigra, Prunus spinosa, Crataegus monogyna or Ligustrum vulgare, provides both shelter and important sources of food for deer populations in the Western Plains of Romania during a year. Large-scale agricultural crops adjacent to the forest vegetation bring an important nutritional, protein and mineral intake during the period of calving, breeding and lactation of fallow deer chicks, as well as significant biological resources necessary for the winter season. The interaction between agricultural crops and the fallow deer population in the Western Plain of Romania has always generated numerous conflicts between farmers and hunting guards. These habitats have always been areas suitable for frequenting, growing and developing important populations of fallow deer. A proof in this sense is the fact that for more than 100 years the fallow deer from the Western Plain of Romania has highlighted the richness and resources of the habitats in this area, producing the most vigorous and valuable hunting trophies in Romania, being used as source population for numerous repopulation actions in other areas of Romania.*

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# Antler Size and Form of Red Deer (Cervus Elaphus L.) in Relation with Elements of Cranial Architecture, Applied to a Segment of the Population in the Curvature Carpathians

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**Abstract:** *The study has been conducted on a number of sixty-six specimens of adult deer, the skulls belonging to specimens harvested in the hunting season 2017-2018, as well as from trophy collections, their origin belonging to the group of Curvature Carpathians.*

*Eight trophy variables were selected for analysis, whereas cranial variables belonging to the four cranial areas, respectively six on the dorsal face, two on the lateral face, two on the ventral face and three on the occipital face. The sample analyzed after determining the age have been divided into three classes, respectively 4-6 years, 7-9 years and over 10 years.*

*For the investigations has been used a method of descriptive and multivariate statistical analysis to highlight the existing a correlative aspects.*

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# Research Methods on Factors that Can Have an Influence in Small Game Population Dynamics in Romania

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**Abstract:** *Over the last decades the declining populatios of small game throughout Europe, such as from wild stocks pheasants (Phasianus colchicus) and the brown hare (Lepus europaeus), lead to new strategies in small game management. In the context of intense processes of urbanisation and agricultural intensification that resulted in increased mechanization and use of chemical compounds, fragmentation of agricultural and forest landscape became a major threat. In addition, other factors such as predation and climatic influences of temperature and precipitations are commonly associated with the small game population yearly abundance. Different methods have been tested worldwide in order to identiffy the direct factors that influence the population dynamics. This paper aims to process and differentiate these methods in order to determine the most appropriate measures that can increase the efficiency of the management of small game populations and their economic effects. Though data on hunting bags offer precise population characteristics, comparing different populations distribution and abundance define other essential criteria on specific high influential factors. Climatic factors, predation and different changes in agricultural management that produce a loss of habitat density and diversity, are positively associated with hare and pheasant abundance.*

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# Geomatics

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# The Effect of LiDAR Data Density on DTM Accuracy for Areas with Heavy Forest Cover

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**Abstract:** *Laser scanning via LiDAR is a powerful technique for collecting data necessary for DTM (Digital Terrain Model) generation, even in densely forested areas. LiDAR data consists of discrete observations positioned in a 3D system, a data structure commonly called point cloud. This cloud contains bare-earth observations (ground points) and observations corresponding to obstacles intersected by the laser beam on its trajectory towards the ground (non-ground points). Meanwhile, a DTM is a continous surface representing the bare earth. Therefore, obtaining a DTM from a LiDAR point cloud is a two-step process: (1) the data is initially filtered (non-ground points are separated from the dataset) and (2) a continous surface is generated by interpolation from the filtered point cloud.*

*This paper proposes a quantitative analysis of the accuracy of DTMs obtained from LiDAR data, for a mountainous area characterised by steep slopes and dense forest cover. Three algorithms for interpolation, of varying degress of complexity, were tested (Inverse Distance Weighted, Natural Neighbour and Thin-Plate Spline). Research was mainly focused on the issue of point data density. To analyze its impact on the quality of ground surface modelling, the density of the filtered dataset was artificially lowered by randomly removing point observations in 10-percent increments. We find that, while lowering the density leads to a less accurate DTM in all cases, the exact impact varies by algorithm. Overall, the accuracy of the generated DTMs, even for significantly reduced densities, is relatively good (of course dependent on the intended purpose of the product).*

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# Using Remote Sensing and Satellite Technology to Identify Past Anthropogenic Activities in Białowieża Forest Deemed to Be Primeval

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**Abstract:** *In this research we examine various examples of using remote sensing and satellite technologies to identify different evidences of past forest utilization and management and other activities of anthropogenic derivations. The identified activities include systematic former harvesting, linear alignment of regularly spaced trees in similar age classes, suggesting planting origin of parts of the forest populations, and various examples of residues of past human activities in areas that are considered to be primeval forest. The main conclusion from considering the presented examples is that the Białowieża "primeval forest" is a man-made construct that has been managed and utilized as mixed-age mixed-species populations, utilized, and protected by those responsible for their management. The second conclusion is that everyone interested in this subject can verify some evidences, such as satellite imagery, which are publicly available and support presented here claims in readily available and comprehensive ways obtainable even by layman without related experience. Finally, an associated side reflection is that in the contemporary political environment even the most evident and apparent truths may be denied and contradicted by public individuals and institutions that are motivated to support such misleading claims despite apparent facts contradicting them.*

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# GPS Precision in the Forest

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**Abstract:** *Topographic measurements performed with GPS technology have seen an explosive development in recent decades. However, this technology has its limitations when it comes to the obstacles between the receiver and the signal received from the satellite. The errors that different obstacles produce have different values, may or may not be known and corrected. A special case is that of the errors we encounter in the case of GPS measurements in the forest. The crown of trees is a living organism that looks different throughout the year depending on the season. At the same time the measurement accuracy may be different depending on the method used. The present paper aims to determine this accuracy under the crown of trees with and without leaves using different measurement methods.*

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# Morphological Analysis of a Lake Basin in the Context of Bathymetric Determinations

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**Abstract:** *In the current context of society development, the analysis of the lakes' morphology has gained a lot of interest for sciences such as the hydrology, geomorphology, geology and geography. Hence, the terrain morphology plays an important role in understanding, modelling and analyzing the Earth's surface geomorphological processes even though they may refer to those surfaces located underwaters. High resolution Digital Terrain Models (DTMs) are absolutely necessary to be able to carry on studies on terrestrial surface analysis, representing a key subject of the Earth-related sciences. Currently, the water stands for one of the most important natural resources being of a crucial importance in agriculture, industry and human health, a fact that requires its sustainable management. There are a lot of studies on water's quality, temperature, salinity as well as studies dealing with volume measurements of the lakes, measurements of the dredging depth and the development of bathymetric maps for hydrological features such as the rivers, lakes or channels.*

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# Testing AR (Augmented Reality) Point Cloud Reconstruction For 3D Position and DBH (Diameter at Breast Height) of Trees

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**Abstract:** *Today, the forest needs to be seen as a complex ecosystem and used in a sustainable way, however, as one of the few renewable resources on this planet, the need for wood is on high demand. Therefore, a good management system of this resource can actually increase its potential.*

*The availability of data on forest characteristics, as well as its quality in terms of precision and timeliness, can considerably improve forest management and of course, the wood resource.*

*Consequently, technology is being used more and more in forestry and, in silviculture as well, simplifying and reducing the fieldwork. Thus, drones, scanners, mobile devices, satellites, and many others are used frequently, due to the speed and ease of obtaining data.*

*The aim of this study is to test the differences between classical measurements and those made using AR technology, in order to assess the applicability in the current silvicultural system. As technology is advancing rapidly, its application in forestry is still taking off slowly.*

*In this process, 3D models of the environment, acquired through photogrammetry and laser scanning, are used to compare the results with classical methods.*

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# Research Regarding the Consolidation of Cadastral Parcel Plans of Forest Plots with Forest Management Plans

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**Abstract:** *This paper intends to highlight the problems faced by a topography specialist when creating a land parcel plan for forest plots in a mountainous region. It is a known fact that, in order to be approved by a cadastre and land registration office, such a plan must have the prior approval of the forestry agent that is managing the respective forest area. Most of the time (if indeed not always), the boundaries that are surveyed on site by the topography specialist do not coincide with the boundaries in the forestry databases. These latter ones have been obtained by vectorisation of cadaster plans containing forest boundaries, a process that introduces a series of errors. The variation of measured points against the forest management unit boundaries (which is as high as a few metres and as low as a few centimetres) and the manner in which this is reflected on the calculated forest areas are presented. It is noted that, although differences in precision are relatively high (commonly over 2-3 metres), differences in terms of area are relatively low (2-5 percent).*

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# Analyzing Tree Shape Variability in Similar Site Conditions for Quercus Frainetto, Quercus Petraea, Quercus Pubescens and Quercus Robur using LiDAR Technology

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**Abstract:** *The accuracy of the description regarding tree architecture is crucial for data processing. LiDAR technology is an efficient solution for capturing the attributes of trees, using FARO FocusS 70 - a high-speed 3D scanner. The aim of the present study was to analyze tree shape variability in similar site conditions for Quercus frainetto, Quercus petraea, Quercus pubescens and Quercus robur. Moreover, the hypothesis that among these species pollen donors have a larger size in terms of trunk and crown traits than non-donors was tested. The woody structure of a tree was defined by the quantitative structure model (QSM) providing information about topology (branching structure), geometry and volume.*

*The number of branches for pollen donors was 209% higher in comparison to non-donors category. The mean total area was 114% smaller for the non-donor category than pollen donors. Trees from the first category were bigger in terms of all traits analyzed except the mean DBH. The crown variables were strongly correlated to each other, the branch volume being influenced by branch length, maximum branch order and the number of branches but less influenced by*

*DBH, trunk length or tree height. In half of the cases, the category of trees influenced the volume, length, number and the maximum order of branches.*

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# Informatics, modelling and statistics

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# Advanced Site Model for Intensive Plantation Management Loblolly Pine Stands in Georgia, USA

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**Abstract:** *Described is an advanced polymorphic site model with variable asymptotes developed on intensive management plantations in Georgia. The mathematical formulation of the dynamic equation was derived using the Generalized Algebraic Differences Approach (Cieszewski and Bailey 2000) and the parameter estimation was conducted using the fixed effects approach estimating simultaneously all local parameters, one specific for each tree, and the global parameters common for all trees. The data came from permanent sample plots in long-term research trials of intensively managed loblolly pine plantations in Georgia, USA. The intensive plantation management included site preparation, vegetation control, and fertilization.*

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# Modelling Site Index Curves and Romanian Yield Tables Variables

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**Abstract:** *Dominant height is often used as a site index in many yield tables. Furthermore, dominant height curves are used as a reference curves within individual tree growth models to predict the potential height growth over time. Romanian yield tables provide dominant height site index curves for the 15 most important species with different curves for seedling and resprout. However, dominant height is calculated indirectly using mean height curves, raising computation requirements and making it (the dominant height prediction) susceptible to error propagation. The purpose of this work is to bypass the computation of site index curves based on dominant height and recalibrate site index curves using a multivariate model that can be integrated easily in future individual tree growth models. In order to do that, different functions were tested for their fit. The Korf growth function gave the best results for all species and the final multivariate models provided a residual standard error ranging between 0.028 and 0.282. The same methodology was applied for the remaining variables of the Romanian yield tables obtaining similar accuracy as the one obtained for the site index curves. The newly developed model can be used for forest management planning applications as it can predict yield values for any intermediate yield classes.*

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# Impact of Regulations on Sustainable Forest Management: A Rotation Perspective

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**Abstract:** *Active forest management should operate under the rules and regulations defined by sustainable development principles. To accommodate the variety of societal interests and forest realities, a regulatory framework should be flexible in implementation of the guiding principles of sustainable forest management (SFM). However, in many cases, the enactment of SFM could lead to solutions far from optimal especially when the modeling assumptions are not continuously revisited to accommodate forestry dynamic. In this study we assessed the mandated or generally accepted rotations across five areas defined by the rigidity of the SFM regulations: Romania, Czech Republic, Belgium, south-east USA, and the Pacific north-west USA. The regions were selected to cover a perceived gradient of SFM enforcement, from very strict (the case of Romania) to very flexible (the case of USA). We focused on two indications of sustainability: land expectation value (LEV), as representing the economic component of SFM, and structural diversity, measured by diameter distribution, as representing the ecological component of SFM. We found that strict enforcement of SFM rules can lead to a decrease in LEV of almost 50%, and a homogenization of the forest ecosystem by approximately one third – in the case of Romania. It seems that flexibility in policies and practices is crucial in ensuring SFM, as even in countries with high population density, such as Belgium or Czech Republic, the two indicators do not differ considerably from their optimum. As expected, the prescriptions in the USA, which is considered the country with one of the most flexible forest management strategies, regardless of the region, provides the largest LEV and structural diversity.*

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# Improving the Local Calibration of Allometric Biomass Models

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**Abstract:** *It is well established that allometric models are site-specific. Local calibration of allometric biomass models requires new measurements of biomass for a sample of trees from that specific site or location. However, measuring biomass is laborious, time-consuming and entailing extensive logistics especially for very large trees. In this paper we develop site-specific allometric biomass models for European beech and silver fir and, investigate approaches that can improve the prediction at site-level using a reduced sample of trees. Since measuring biomass is difficult, using a local sample of small trees to calibrate the models for the entire range of diameters may be a good compromise between prediction accuracy loss and the effort for measuring biomass, being known that small trees are highly cost-effective. We used a random intercept model and a Bayesian regression with strong informative priors to enhance the information of the local sample. Both the random intercept model and Bayesian regression with strong informative priors have proven efficient in local calibration of allometric models based on a few small sample trees. Although the random intercept requires access to raw data (observations from other locations) the Bayesian approach uses only the parameter estimates and their standard errors. Therefore, based on availability of raw data one of the two methods can be successfully used to improve biomass prediction at local level.*

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# Artificial Neural Network Application to Estimation of Productivity of Brazilian Plantation of Eucalyptus

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**Abstract:** *Artificial Neural Network (ANN), which can be used to model the complex nonlinear forest interrelations are challenged by the choice of the training algorithm and structure or size of the network. The objective of the present study is to find efficient ANN configurations to estimate the eucalyptus productivity from environmental and silvicultural data. We defined the efficiency of a Multilayer Perceptron ANN as the processing time to supply an accurate solution. We increase the efficiency of the ANN either outside the network, through Principal Component Analysis (PCA), or inside the network, through pruning. To test different network configurations (i.e., combination of number of neurons, training algorithm and pruning method), we used data from 507 Eucalyptus plantations. The most accurate result was supplied in 38.81 sec by an ANN using the data trimmed with PCA and pruned with the Magnitude Based method. The second most accurate result (i.e.,<1%) was obtained in 1.7 sec using the same ANN configuration, but no pruning. Our results indicate that an efficient prediction of Eucalyptus productivity with ANN does not use all the data or the most complex training algorithms. Furthermore, ANN can predict eucalyptus productivity from environmental variables close to models based on dimensional variables.*

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# Individual Tree Detection and Measurement from Terrestrial Point Cloud

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**Abstract:** *This research develops a novel method in tree stem identification and attribute computation. The method includes four procedures: data thinning, semantic segmentation with PointNet, density-based clustering and sector-based attribute measurement. To test the robustness, universality, and accuracy of the algorithm two dataset were used: the international benchmark TLS data and a McDonald-Dunn forest data. The methods applied to the dominant and codominant trees from the multiple scan international benchmark data achieved for the plot labeled "easy" 97.83% completeness and 100% correctness; whereas for the plot labeled "medium" 78.12% completeness and 100% correctness. Most missing trees are caused by edge effect and inconsistent point density, but they are still better than the state-of-the-art algorithms presented in the benchmark study. The bias in estimation of the diameter at breast height's (DBH) is 0.29 cm in the easy plot and 0.16 cm in the medium plot. For the two plots, the RMSE of DBH is 1.04 cm and 1.2 cm, respectively, which is superior to the current best result (i.e., 2 cm) in both plots. The proposed method supplies superior results than the existing algorithms even for single scan of the forest, with the RMSE of DBH at least 0.2 cm smaller than current methods. The application of the proposed method to the McDonald-Dunn forest, which is a data on which the trees are rendered with points not surrounding the stem, leads to a completeness of 94.25% and a correctness of 96.47%. The relatively bias of the diameters located at 1.5m and 2.5m is 1.3% and -0.42%, respectively, confirming the performances of the algorithm.*

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# Efficient Synthetic Generation of Ecological Data with Preset Spatial Association of Individuals

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**Abstract:** *Experiments are not feasible to be conducted as large factorials, therefore simulated data can be used to supplement the filed measurements. The main objective of the present research is to develop a methodology and a platform to synthetically generate forest ecosystem entities that can be represented by points with a predefined pattern. Using a method with a polynomial complexity we have empirically proven that large preset forest ecosystems can be generated in a short amount of time. The proposed method was tested on 1200 25 ha generated forests using 10 spatial indices: Clark-Evans aggregation index, Ripley's K, Besag's L, Morisita's dispersion index Grieg-Smith Index, the size dominance index of Hui, index of nonrandomness of Pielou, directional index and mean directional index of Corral-Rvias, and size differentiation index of Kint. To ensure generality replicability of the study we have provided a free fully functional software, with GUI and help, to execute the stated tasks.*