YOUNG RESEARCHERS MEETING

Conservation and Sustainable Use of Forest Systems

# XV Young Researchers Meeting on Conservation and Sustainable Use of Forest Systems

Palencia (Spain), 24-25 June 2021

Universidad de Valladolid

INIA Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

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# PREFACE

This year we celebrate the 15th edition of the meeting of Young Researchers in Sustainable Forest Management. After 10 editions in Valsaín (Segovia) the Young Researchers meeting is once again held in its initial place of celebration, the campus of Palencia, where the first three editions took place. In addition, the circumstances of the global pandemic in which we find ourselves this year have forced us to celebrate it later this year, more specifically at the beginning of the summer instead of at the beginning of the year.

This meeting is part of the training program of the University Institute for Research in Sustainable Forest Management (iuFOR) belonging to the University of Valladolid and INIA and the Erasmus Mundus (through the MEDFOR consortium). Students from different master programs (Master on Forestry Engineering, DATAFOREST, and MEDFOR) and from Conservation and Sustainable Use of Forest Systems PhD program exchange scientific ideas and results among themselves and with senior researchers and professors and with guests from other Universities and Research centers. Young Foresters meeting allows us to establish new synergies and network and advance in our scientific activities. In this edition a big number of students (more than 50) from several countries (as diverse as Ghana, Ethiopia, Syria, Pakistan, Turkey, Nigeria, Cameroon, Macedonia, Finland, France, Italy, or Spain among others) will participate. The wide geographic distribution of the participants along with the diverse ecosystems studied, allow us to cover main forestry topics and to and enrich the points of view in the discussions that are established.

I want to thank the organizers of the congress, both teachers and students, for the important work they have carried out and the effort they make so that year after year the conference is held with great success.

Prf. Dr. Mª Belén Turrión
Director
Sustainable Forest Management Research Institute
University of Valladolid-INIA

# PREFACE

One more time, on behalf of the Organization Committee, I am proud to present you the Abstracts Book of our Young Foresters Meeting 2021.

In this XVth edition we will listen to 41 short presentations, mainly by our masters and PhD students, all of them Young Researchers in Forest, as representative examples of the works currently developed in our Institute.

The aim of this meeting is not only to create a space in which our students can gain experience in scientific communication, through the presentation of their works in an international and high-level meeting both orally and using posters. Also, we give them the possibility of interacting and networking, not only among them, but also with professors, researchers, and professionals from different fields of the forest sector. In this scope, this year we wanted to present you the new chair on *Smart Global Ecosystems* recently established with the company SNGULAR, two of which researchers, Nerea Luis Mingueza and Cristina Palomo Garo, have been invited to give the Opening Conference of the congress. The training of Artificial Intelligence and Data Science and their application to natural ecosystems is being a more and more important clue for the future.

This year we have been forced to adapt our traditions to the pandemic global situation, as having our Winter School in June and our Valsaín Meeting at Palencia. But the most relevant identity traits of the Congress have been maintained, as they are considered very interesting issues of our students scientific training. Once again, our students are responsible for the whole organization, all aspects of logistic, scientific, and non-scientific program together with the responsibilities of being Chairpersons of the sessions. We are grateful to them all for their hard work, their effort, their time, and their availability.

Last, we also want to emphasize the active and enriching participation in the Meeting of the Professors and senior researchers of the different programs whose guidance and supervision of the presentations and abstracts and whose direct participation in the Meeting through questions and comments, are always very much appreciated.

We are sure that this edition will be again a real showcase of our activity at IuFOR and we wish you an enjoying Meeting. Nerea Luis Mingueza & Cristina Palomo Garo.

Prof. Dr. Elena Hidalgo
Coordinator of the Organization Committee XVth Young Forest Researchers Meeting


# XV Young Researchers Meeting on Conservation and Sustainable Use of Forest Systems

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## PROGRAMME

**THURSDAY 24th JUNE**

9:00-9:30 Registration

9:30-11:00 Welcome and Sesión I:
Chairpersons:
José Porto and Sara Uzquiano
Speakers:
- Cristina Zamora Ballesteros: *New insights into the pathogenesis of Fosarium circinatum through transcriptomics technologies*
- Šimon Hrbek: *Internations Forestry Students Association: space for your forestry realization and networking*
- David Fernando Pérez Abadía: *Variation in infiltration on the slopes of the Páramo de Palencia - Spain*
- Peter Agbor Ako: *Reconciling livelihoods enhancement protection. The case of Tali1 community, southwest region of*
- Mustafa Sert: *Evaluating productivity of mobile winch system used in logging operation on gentle ground slope*
- Alex Onatunji: *Choice of forestry programme by undergraduate students and willingness to pursue further studies in selected universities in Nigeria*

11:00-11:30 Coffee break

11:30-12:00 Opening Session
- Oscar Martínez, Research Vice Chancellor
- Paloma de Castro, Internationalization Vice Chancellor
- Amalia Rodríguez, Vice Chancellor Campus Palencia
- Belén Turrión, IuFor Director

12:00 -13:00 Opening conference
Chairperson:
Felipe Bravo Oviedo
Speakers:
- Nerea Luis Mingueza & Cristina Palomo Garo, *Sngular*: *Automation of forest classification tasks: an artificial intelligence approach*

13:00-14:00 Sesión II
Chairpersons:
Carolina de Castro and Cristina Zamora
Speakers:
- Marina Getino: *Soil carbon accumulation under mixed pine-beech forests*
- Eduardo Batista: *What do we know about Botryosphaeriaceae? An overview of worldwide current dataset*
- Huma Amin: *Mycroviruses: potential biocontrol agent for forest disease management*
- Tamara Sánchez Gómez: *Antagonist effect of nematophagous fungi against pine wood nematode (Bursaphelenchus xylophilus)*
- Esko Merontausta: *Review of the evolution on forest cover, green spaces and their continuity in Helsinki, Finland*

14:00-15:30 Lunch & Group Photo

15:30-16:30 Session III
Chairpersons:
Laura Martín and Marina Getino
Speakers:
- Xabier Amilibia Ochoa: *Marteloscope installation in mixed species forest for basic data collection*
- Elena Muñoz Cerro: *Effect of native shrubs and grazing on soil properties of reclaimed open-cast coal mines*
- Eric Cudjoe: *Differences in biomass models between monospecific and mixed species forests*

- Leandro Macedo Godoy: *Estimates of biomass production potential for Pinheiro bravo in northeast portuguese*
- Matthieu Desselas: *Zebro Valley restoration Assessing sustainability of invasive species control methods*

16:30-17:00 Coffee break

17:00-18:00 Session IV
Chairpersons:
Xabier Amilibia and Elena Muñoz
Speakers:
- YunFan Qian: *Applying satellite technology to forest fire management*
- Ali Askarieh: *Intra-annual radial growth variation in Mediterranean mixed pine forests*
- Michele Petrillo: *dendrochronology of the Azorean juniper, Juniperus brevifolia (SEUB.) Antoine*
- Tatek Dejene: *Survey of macrofungal diversity and analysis of edaphic factors influencing the fungal community of church forests in dry Afromontane areas of northern Ethiopia*
- Sergio Díez Hermano: *Machine learning presentation of loss of eye regularity in a drosophila neurodegenerative model*

18:10-19:30 Session V
Chairpersons:
YunFan Qian and Pilar Valbuena
Speakers:
- Aitor Vázquez Veloso: *Evaluation and validation of forest growth models iberopt and iberops*
- Jonatan Niño Sánchez: *Spray-induced gene silencing (SIGS) provides RNA interference effect against fungal infection on plant material*
- Irene Bocos Asenjo: *Seeking alternatives to forest disease management: RNA interference gene silencing*
- Juliette D'Amelio: *Impacts and Drivers of Signal Crayfish (Pacifistacus leniusculus) populations in UK river systems*
- Eduardo Velazquez: *Limited effect of forest expansion in abandoned agricultural lands to offset regional C emissions under Mediterranean-continental climate*
- Ignacio Sanz Benito: *Impact of silviculture practices in belowground fungal communities associated to Mediterranean Quercus pyrenaica Willd. forests in NW Spain*

19:30-20:30 Wine tasting by Oenology students

21:00 Community dinner

FRIDAY 25th JUNE

9:30-11:00 Session VI
Chairpersons:
Aitor Vázquez and Irene Bocos
Speakers:
- Andrés Armijos Montaño: *Wood anatomical evaluation of tree species from southern Ecuador, upcoming challenges and applications*
- Gianluca Segalina; *Bark thickness, stem straightness and life-history strategies in Pinus pinaster: is there any trade-off between them?*
- Emanda Kore: *Diversity and production of macrofungi associated with Pinus radiata (DON) plantations in Menagesha Suba state forest, central Ethiopia*
- Angelo Di Perna: *Land cover changes: an analysis for the case of Almaty, Kazakhstan*
- Sezin Kete: *Amenajman*
- Daphne López Marcos: *Soil niche complementarity as a responsible of small scale over-yielding in mixed pine forests*
- Alvaro Benito: *Life mycorestore: use of natural myco-control products and native fungal species for reduced pest/pathogen presence in forests*

11:00-11:30 Coffee break

11:30-13:00 Session VII
Chairpersons:
Andrés Armijos and Gianluca Segalina
Speakers:
- José Carlos Porto Rodríguez*: Vegetation map of the province of Pontevedra 2019 using Sentinel-2 imagery*
- Sara Uzquiano Pérez*: Understanding crown morphology in mixed pine and oak stands*
- Frederico Simões: *Assessing the impacts caused by drought in a eucalyptus plantation in Mato Grosso - Brazil..*
- Bojan Mihajlovski: *Use of modern geomatic techniques for creating and ipdating a green cadastre of urban trees and shrubs: a case study of Kumanovo city river bank*
- Ana Martínez: *Increment diameter data analysis as time series classification*

13:00-13:30: Closing session
- Carmen Camarero, Director EsDUVa
- Joaquín Navarro, Director ETSIIAA
- Belén Turrión, Director IuFOR
- Elena Hidalgo, Organization Committee

# WELCOME CONFERENCE

## AUTOMATION OF FOREST CLASSIFICATION TASKS: AN ARTIFICIAL INTELLIGENCE APPROACH

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*Keywords: machine learning, computer vision, auto machine learning, neural networks, supervised learning*

Computer Vision enables computers to understand the content of images and videos. Driven by the latest advances in Deep Learning, it is key both in the process of acquiring and improving the quality of images and in the detection of objects in real time. Computer Vision solutions are present in many day by day routines, like detecting people or animals, recognizing objects or specimens in spaces such as cities, forests, or even the sea, in an automated way. Thanks to this automatization, we can carry out safer inspection and maintenance tasks “at a distance”, by using cameras, robots and drones. Also, prediction or classification tasks by analyzing for instance satellite images. Here, topics such as Artificial Intelligence, Computer Vision and supervised learning techniques will be introduced. We will talk about algorithms of advanced analytics, neural networks and cloud computing. First approach shows how we could face real data forest research and how to build up a model for detecting pathologies in apple trees. A second approach will be carried out to show alternatives when image data is not available but tabular data exists, instead. It is mainly focused on Auto Machine Learning techniques.

# SESSION I

# NEW INSIGHTS INTO THE PATHOGENESIS OF *Fusarium circinatum* THROUGH TRANSCRIPTOMICS TECHNOLOGIES

Zamora-Ballesteros, C.[1,2*], Pinto, G.[3], Amaral, J.[3], Valledor, L.[4], Alves, A.[3], Diez, J.J.[1,2] and Martín-García, J.[1,2]

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*Keywords: Pine Pitch Canker, dual RNA-Seq, Pinus radiata, Pinus pinea, susceptibility*

*Fusarium circinatum* causes one of the most devastating diseases of conifers, the pine pitch canker (PPC). The pathogen has been recorded in countries of North and South Hemisphere, causing serious problems in nurseries, pine plantations and natural forests in many of these countries. Despite its importance, no effective field intervention measures aiming to control or eradicate PPC are available. *F. circinatum* can infect at least 60 species of *Pinus* along with *Pseudotsuga menziesii*, however, the range of susceptibility varies significantly between species and even intraspecific genotypes. The development of resistant varieties then offers an excellent opportunity for disease management. This study aimed to identify differences in the molecular responses of the highly susceptible *Pinus radiata* and the highly resistant *Pinus pinea* to *F. circinatum* at an early stage of infection. The use of a dual RNA-Seq approach also allowed to evaluate pathogen behavior when infecting each pine species. Genome-wide expression profiles showed dramatic transcriptional reprogramming mainly in the resistant species. The transcriptome profiling of *P. pinea* revealed an early perception of the pathogen infection together with a strong and coordinated defense activation through the reinforcement and lignification of the cell wall, the antioxidant activity, the induction of PR genes, and the biosynthesis of defense hormones. The susceptible species, in contrast, showed a weaker response, possibly explained by the impaired perception of the fungal infection that could have led to a reduced downstream defense signaling. *F. circinatum* showed a different transcriptomic profile depending on the pine species being infected. While in *P. pinea*, the pathogen focused on the degradation of plant cell walls, active uptake of the plant nutrients was showed in *P. radiata*. These insights improve our understanding of the pine-*F. circinatum* interaction as well as conifer defense responses to biotic stress, and can promote the development of better approaches for breeding disease-resistant programs.

# INTERNATIONAL FORESTRY STUDENTS' ASSOCIATION: SPACE FOR YOUR FORESTRY REALIZATION AND NETWORKING

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*Keywords: education, communication, bonding, opportunities, cooperation*

The International Forestry Students' Association (IFSA) is the largest organization connecting students of forestry and related fields worldwide. Being established in 1990, it has grown and spread to all the continents and currently counts to 131 local committees from 60 countries. IFSA provides its members with a broad scale of professional opportunities while cooperating with the main forestry-focused professional organizations and experts, and makes the youth voice heard by securing delegation spots in important political dialogues. It serves as a platform for exchanging knowledge and different points of view from the forestry and cultural perspectives among its members, as well as international friendships that last for life. Palencia Forestry Students Association (PFSA) is the newest local committee of IFSA, being established in November 2020 and officially accepted to IFSA in June 2021. Its aim is to connect forestry (and related) students especially from the University of Valladolid to organize local activities and to integrate into the international network.

# VARIATION IN INFILTRATION ON THE SLOPES OF THE PÁRAMO DE PALENCIA – SPAIN

Perez-Abadia, D.F[1]*, Navarro-Hevia, J.[1] , Córdoba-Córdoba, E.[2] , Mongil-Manso, J.[3]

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*Keywords: Forest hydrology, desertification, hydrological restoration, reforestation pine forests, holm oak*

Surrounding area Palencia city is formed by a geomorphology landscape of moors and valleys, with small and medium elevations. Loam-chalky slopes connect the moorland with the valley, and support agricultural and livestock practices for thousands of years. These activities have overexploited natural forests, and originated intense degradation of hillslopes, leading into desertification of the territory. Currently, crops, sheep herds, reforestation pine forests, and some relict holm oaks, share the landscape. In this study we assess the variability of soil infiltration among the reforestation pine forest, the crops, fallows, and the holm oak forest. Four sampling points were established, with three replications for each system. Soil infiltration was measured by mean of a single ring infiltrometer. The results show that the original soil of the relict holm oak forest presents the best soil hydrological condition, followed by the reforested pines; which show an important recovery compared to crops and fallows. The study shows that the pine forest has considerably improved the soil infiltration capacity of degraded soils, bringing them closer to the values of natural forests, reducing erosion and the risk of desertification.

# RECONCILING LIVELIHOODS ENHANCEMENT WITH ENVIRONMENTAL PROTECTION. THE CASE OF TALI1 COMMUNTY, SOUTHWEST REGION OF CAMEROON.

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*Key words: Deforestation, Agroforestry, Cocoa, mono crops, cooperatives.*

The second largest driver of deforestation in Cameroon is Cocoa production. Cameroon is ranked the fifth highest cocoa producer globally. The Southwest Region of the country is the highest producer of cocoa in the country. Like other mono crops, cocoa production requires that a forest be cut down before planting is done. Tali community located in the Southwest Region of Cameroon is highly involved in cocoa farming. An average cocoa farm in this community is between 3-5 hectares. Sometimes a farmer owns more than one farm, and due to high levels of unemployment, more youths are cutting down the forest for cocoa production, which has a high international demand. Though cocoa cultivation highly labour intensive with low returns and contributes to deforestation, water shortages, and food insecurity in this community, more and more people are opening new farms every day. Through focus group discussions, questionnaire administration and interviews, we sought to understand why these farmers continue to farm cocoa despite its associated economic and environmental problems. Over 250 farmers from 25 to 50 years were targeted. Each of the targeted farmer owns at least two cocoa farms. The results revealed that 70% of the farmers are quite aware of these economic and social problems but see cocoa production as the only means to generate “enough” income to cater for their family needs. This helps us understand why the keep opening new farms. 95% think to make more profit, they must own more than one farm and these farms must not have trees in them to ensure maximum sun rays getting into the farm. To reduce deforestation and enhance livelihoods in this area and Cameroon in general, agroforestry practice is highly recommended as well as grouping the farmers into cooperatives to give them a market power of their products.

# EVALUATING PRODUCTIVITY OF MOBILE WINCH SYSTEM USED IN LOGGING OPERATION ON GENTLE GROUND SLOPE

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*Keywords: Log production, Logging operation, Portable winch system, Productivity*

This study was carried out using a portable winch system in a gentle slope logging area. In this context, extraction from the stand with a portable winch system was evaluated in terms of efficiency in the thinning operations implemented in the red pine stand within the borders of Çınarpınar Forest Enterprise Chief of Kahramanmaraş Forest Management Directorate. During the field study, the portable winch system was examined in two different applications. In the first application, wood materials were transported from the cutting area to the ramp using the portable winch, a synthetic rope and a chain choker. In the second application, the portable winch was used in combination with a skidding cone and thus the effect of the skidding cone on the extraction from the stand was investigated. In both applications, the slope of the land was between 11-20% and the measurements were taken at three different skidding distances (20 m, 40 m and 60 m). The productivity was determined using the time study method and then factors affecting the productivity were evaluated. The results showed that the skidding distance and log volume are the main factors affecting productivity. It was found that the productivity increased from low volume logs to high volume logs in both applications. In addition, it was found that the risk of the log products getting hanged in the remaining trees, stumps, and other obstacles is decreased when the skidding cone was used, which has positive results on skidding time and productivity.

# CHOICE OF FORESTRY PROGRAMME BY UNDERGRADUATE STUDENTS AND WILLINGNESS TO PURSUE FURTHER STUDIES IN SELECTED UNIVERSITIES IN NIGERIA

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*Keywords: Forest Education, Career Motivation, Graduate studies in Forestry, Student Perception*

In recent time, very few students chose forestry during the university entrance examination in Nigeria. Therefore, it is pertinent to study factors affecting the choice of forestry programme and as a career for appropriate decisions on curricula and proper development. This study assessed the factors influencing the choice of forestry programme by undergraduate students in two selected Nigeria Universities. The Federal University of Technology, Akure (FUTA) and University of Ilorin (UNILORIN) were purposively selected for the study. Students from 300, 400 and 500 level were randomly sampled because of their appreciable knowledge of the programme. A total of 178 students were surveyed (77 in FUTA and 101 in UNILORIN). Data was collected with the aid of a structured open and close-ended digital questionnaire. The mean age of the sampled students was 21 years which means a youthful generation of future professional. Over 90% of the students did not directly apply to study forestry. More male students willingly chose to study forestry than females, and total enrollment is increasing yearly in both Universities. The students indicated a high level of willingness to pursue further studies and work in the forestry field, with personal interest being the major factor. Universities in other continents were the most desired place to undertake postgraduate study by most students. Students should be adequately prepared for further studies and professional forestry opportunities by incorporating career counselling/guidance into future curriculum design of undergraduate forestry programme in Nigeria.

# SESSION II

# SOIL CARBON ACCUMULATION UNDER MIXED PINE-BEECH FORESTS

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*Keywords: C Stock, SOM, Mixed forest, Pinus sylvestris, Fagus sylvatica*

There's no need to say that Global warming is probably the biggest environmental threat that current and future generations have to cope with. It's known that soil has a great potential for C sequestration, but it is also important to point out the contribution of forest ecosystems to the mitigation of global warming. When talking about forests, in the last decades Mixed stands has aroused great interest among the scientific community. But it is still necessary to intensify the studies about its soils and the capacity for C storage. In this study we assess soil C sequestration potential in soil and litter in mixed stands versus pure stands of Scots pine and beech (*Pinus sylvestris-Fagus sylvatica*). To this end, a total of 9 plots were studied (3 per stand type; pine, beech, mixed), two located in Niepołomice (Poland) and one in Schobenhausen (Germany). 36 circular plots of 5m radius were selected within the triplets, covering the whole range of species mixture. Mineral soil horizons were sampled up to 40 cm of depth. Lately, data were converted into four different depths (0-10, 10-20, 20-30, 30-40 cm). Litterfall was collected at each point, and then separated into three fractions: fresh fraction (FsL), fragmented fraction (FgL) and humified fraction (HmL). Mineral soil and litter were analysed for total C and N content by dry combustion in a LECO CNS928 autoanalyzer. C-to-N ratio and C stocks were calculated. Data shows that as Pine proportion increases, C-to-N ratio in FgL increases sharply. No differences were found in HmL or mineral soil. Regarding total C stock (soil + litter), pure beech stands seems to accumulate more C than Pine ones, and similar, but slightly higher, to mixed. Despite, total C stock in Pine stands were the lowest, almost half of this C (43%) is located in deeper layers of soil (10-40cm). The deeper the C is located, the more protected it will be, and therefore more stable, making it less likely to return to the atmosphere, a fact of great relevance in the fight against climate change.

# WHAT DO WE KNOW ABOUT BOTRYOSPHAERIACEAE? AN OVERVIEW OF A WORLDWIDE CURED DATASET

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*Keywords: Botryosphaeriaceae; fungal diversity; host jumps; pathogenicity; ecological niches; quarantine measures*

Botryosphaeriaceae-related diseases occur worldwide in a wide variety of plant hosts. The number of studies targeting the distribution, diversity, ecology, and pathogenicity of Botryosphaeriaceae species are consistently increasing. However, with the lack of consistency in species delimitation, the name of hosts, and the locations of studies, it is almost impossible to quantify the presence of these species worldwide, or the number of different host–fungus interactions that occur. In this review, we collected and organized Botryosphaeriaceae occurrences in a single cured dataset, allowing us to obtain for the first time a complete perspective on species' global diversity, dispersion, host association, ecological niches, pathogenicity, communication efficiency of new occurrences, and new host–fungus associations. This dataset is freely available through an interactive and online application. The current release (version 1.0) contains 14,405 cured isolates and 2989 literature references of 12,121 different host–fungus interactions with 1692 different plant species from 149 countries.

# THE POTENTIAL OF THE FLORA FROM DIFFERENT REGIONS OF PAKISTAN IN PHYTOREMEDIATION

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*Keywords: phytoremediation, soil contaminants, tree, heavy metals, uptake*

The soil and water quality is greatly affected by the environmental pollution due to increasing trend of urbanization and industrialization. In many developing countries, including Pakistan, the situation is more alarming as no preventive measures are still taken to tackle this environmental pollution. Although in developed countries, many techniques are used to remediate the environment including phytoremediation. Phytoremediation, the use of plants to decontaminate soil and water by taking up heavy metals, shows considerable promise as an eco-friendly, low-cost technique and has received much attention in recent years. However, the application of this technique is limited due to low biomass of hyper-accumulators and plants with long growing seasons required. Therefore, to maximize phytoextraction efficiency, it is important to select a fast-growing and high-biomass plant with high uptake of heavy metals Pakistan has a great diversity of plants that could be used for the remediation of environmental pollutants. We studied the use of flora for phytoremediation and about 30 plant species were studied for this purpose. The purpose of this study was to investigate the potential of different plant species for phytoremediation and their comparison to other countries to relate future perspectives.

# ANTAGONIST EFFECT OF NEMATOPHAGOUS FUNGI AGAINST PINE WOOD NEMATODE (*Bursaphelenchus xylophilus*)

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*Keywords: Pine Wilt Disease, Beauveria spp., integrated management strategy, reproduction rate, biological control*

Conifers worldwide are nowadays under a severe threat by *Bursaphelenchus xylophilus*. This pathogen, commonly known as Pine Wood Nematode (PWN), causes sudden decay and death of affected trees leading to the so-called Pine Wilt Disease (PWD). So far, disease control has been focused on insect vectors (*Monochamus* spp.). Specifically, the Forest Entomology team of the UVa patented the insect attractant (Galloprotect 2D) and developed an attract&infect method based on the use of *Beauveria spp.* (an entomopathogenic fungus) to reduce the vector populations. However, an effective integrated management of the disease will require the control of the pathogen as well. For this purpose, the potential nematophagous effect of 8 fungal species was tested, among them two *Beauveria* species. The assay consisted of testing if reproduction rate of nematode decreased under the presence of these fungi. This *in vitro* experiment has achieved encouraging results, since several species showed a strong antagonist effect on the nematode reproduction. In fact, *Beauveria* species and *Trichoderma citrinoviridae,* not only resulted in a null reproduction rate, but also a nematicidal effect. Therefore, a truly effective method of biological control based on *Beauveria* species might become implemented for a simultaneous management of the nematode and its vector.

# REVIEW OF THE EVOLUTION ON FOREST COVER, GREEN SPACES AND THEIR CONTINUITY IN HELSINKI, FINLAND

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*Keywords: urbanization, urban forest, park, forest continuity, city planning*

Helsinki, the capitol city of Finland, has had nearly continuous population growth during more than a century, following the global trend of urbanization, and the growth has been estimated to continue for the upcoming decades. The urbanization has had an impact on the forest cover and other green spaces in the city. This work attempts to review the evolution of the forests and green spaces in the city since 1940's. The work was carried out with ArcGIS program with satellite images provided by the City of Helsinki. Comparable study between the images from 1940's and 2020 was done in 55 neighbourhoods. It was seen in this study that most of the neighbourhoods had lost green spaces due to the urbanization. However, in some of the neighbourhoods further from the historical city centre, green areas have increased due to the fact that before urbanization, they used to be cultivated areas with little green spaces. Regardless the increase in green space in these neighbourhoods, the impacts of the urbanization are still noticeable. Urban forests and green spaces offer many valuable benefits for the citizens as they reduce stress and mental disorders and increase physical activity and self-reported general health. Green spaces also provide services such as flood control, thus being an important part of the city structure. Besides the evaluation of the current impacts urbanization has caused for green spaces in Helsinki, the study aims to offer information to the city planners, and can be used as a planning tool by the city policy makers.

# SESSION III

# MARTELOSCOPE INSTALLATION IN MIXED SPECIES FOREST FOR BASIC DATA COLLECTION

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*Keywords: marteloscope, mixed species forest, data, analysis*

A marteloscope is a permanent plot within the forest where all trees are located and measured with the aim of creating a didactic tool for forestry training. Through the use of software tools allows tests to be carried out that help subsequent decision-making. The marteloscope was created in Jarandilla de la Vera (Extremadura), with the need to take basic plot data and analyze the state of the area. Data were taken on trunk diameter, height, bark thickness, plot position and tree state. This will be interesting in order to be able to carry out social experiments and to be the starting point of other studies such as biodiversity, future and previous growth of forest mass, total age of mass or knowledge of soil properties. The project was carried out on one hectare comprising three different forest stands: *Pinus pinaster* pine forest, *Quercus pyrenaica* oak groves and *Alnus glutinosa* riverside forest. The work was undertaken within the framework of the COMFOR-SUDOE project which aims to enhance complex forests to combat climate change and promote biodiversity.

# EFFECT OF NATIVE SHRUBS AND GRAZING ON SOIL PROPERTIES OF RECLAIMED OPEN-CAST COAL MINES

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*Keywords: shrub cover, herbivory pressure, Sub-Mediterranean climate, soil improvement, coal wastes.*

Many studies have shown that native shrubs have a nurse effect on oak seedlings' establishment in stressful and degraded environments such as open-cast coal mines in Northern Spain. To assess how nurse shrubs can promote soil fertility (direct facilitation) and reduce herbivory pressure (indirect facilitation) facilitating oak seedlings' establishment in coal-mine substrates, we tested the combined effect of native shrubs and grazing on soil properties. The pH was higher out of shrubs and excluding grazing independently, whereas electrical conductivity, cation exchange capacity, $K^{+}$, and C/N were higher under shrubs independently of grazing exclusion. A shrub x fence interaction effect was found on the remainder chemical soil parameters: whilst base saturation was significantly higher out of shrubs in the fenced plots, total nitrogen and carbon, available phosphorous, and organic matter were significantly higher under shrubs in the no-fenced plots. Among physical properties, grazing exclusion affected negatively bulk density and positively porosity; these results imply more soil compaction at grazing areas. Furthermore, sand, clay, water holding capacity, and available water responded to a significant shrub x fence interaction. The sand was higher and the clay lower under shrubs in the no-fenced plots suggesting that cattle trampling could favour erosive processes of fine particles (silt, clay), and shrubs could be capable to retain sand windborne particles. Water holding capacity and available water were the highest out of shrubs in the fenced plots. In summary, our results showed a clear influence of native shrubs on soil chemical properties, whereas grazing exclusion further affected the physical properties. These findings suggested that guidelines concerning grazing exclusion and shrub cover will need to follow in the reclaimed coal mines to facilitate seedling establishment by improving soil properties.

# TREE BIOMASS ALLOCATION IN TEMPERATE MIXED FORESTS

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*Keywords: Scots pine, Sessile oak, allometry, aboveground biomass, biomass allocation*

Mixed forest is one of the best ways of managing the forest to face the recent environmental issues such as climate change. Some of the essential reasons behind mixed forests are provision of higher productivity, higher temporal stability, lower risk of biotic and abiotic disturbances and a more diverse portfolio of ecosystem services from forests. Therefore, one of the key landmarks in sustainable resource management is the estimations of forest carbon stocks. This presents a hefty challenge to do in mixed forests as it has been showed that stand productivity can be benefited by mixtures. The research work was mainly focused on identifying how the stand mixture affects allometric relationships and tree biomass allocation. Triplet approach of monospecific and mixed stands of *Pinus sylvestris* L. and *Quercus petraea* (Matts.) Lieb. in Northern Spain was adapted. We fitted 4 different height-diameter models for monospecific and mixed forests for Scots pine and Sessile oak species. The Korf curve for height-diameter models performed better than Power equation, Meyer equation and Naslunds equation, as the lowest AIC and highest $R^2$ obtained suggested. In addition, there was no variation of height-diameter relationships for oak trees in monospecific or mixed stands. However, an extensive difference in the monospecific and mixed stands for Scots pine was found. Dirichlet regression was used to fit biomass models using diameter at breast height (dbh) and total height (ht) as independent predictors for both species. Moreover, the total aboveground biomass of trees growing in mixtures was not significantly different from trees growing in monospecific stands. Also, the biomass proportion of different tree components in mixed stands was like that of monospecific stands. The results illustrate clearly that there was no difference in both monospecific and mixed stands for both species studied. Therefore, the biomass allometric models developed from monospecific stands can be used to predict tree biomass in mixed stands of the study mixture without any significant bias.

# ESTIMATES OF BIOMASS PRODUCTION POTENTIAL FOR PINHEIRO BRAVO IN NORTHEAST PORTUGUESE

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*Keywords: modelling, simulation*, *behaviour, Terras de Trás-os-Montes, energy*

To verify the behaviour of biomass, this work in progress aims to use statistical modeling based on data from the 5th National Forest Inventory and the Land Use and Land Cover (COS2018) to simulate the growth and production of biomass from maritime pine in the Terras de Trás-os-Montes sub-region considering different management and productivity scenarios. The scenarios will be defined according to the Regional Forest Planning Program of Trás-os-Montes and Alto Douro, and these will be incorporated into the Stochastic Forest Simulator software, having the AppTitude® software as base code, both developed in C# language. The biomass equations for a species will also be incorporated into the program, to calculate the available residual biomass considering a percentage of 25% of waste generation for the species according to information from the bibliography. The verification carried out by selection allows verifying the potential of existing vegetable fuel, its potential for energy use and as a tool for preventing fires with a reduction in vegetable fuel.

# ZEBRO VALLEY RESTORATION; ASSESSING SUSTAINABILITY OF INVASIVE SPECIES CONTROL METHODS

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*Keywords: Invasive species control, Acacia, Zebro Valley, debarking*

The Zebro Valley in Portugal is a marshland area with high biodiversity value that is prone to a strong invasion of various species of acacia trees. The “Life Biodiscoveries Project” seeks an alternative to the traditional costly models of invasive species control by implementing a management model based on public participation. The objectives of this model were to achieve a better cost-benefit ratio, in terms of both resources’ allocation and environmental impact. The objective of this research was thus (1) to assess whether the control methods used were effective in reducing the invasive species population, (2) to compare the effectiveness of the two control methods used: debarking and cutting, and (3) to explore which control method is more sustainable when integrating the socio-economical dimension. The methodology used to answer those questions was to conduct a floristic inventory in the field of four sample plots: 1- reference site of natural forest, 2- Invaded riparian stand, 3- Restored riparian stand by debarking, 4- Restored riparian stand by tree cutting. An ordinal analysis of the floristic inventory using “R” software was conducted to characterise the study area. Then statistical analysis of both control methods allowed to compare their effectiveness applied to different factors. The results of the analysis found that both the debarking and cutting techniques were effective in controlling the invasive species, with the cutting technique showing stronger results. However, the significant results obtained in the sampled sites were not replicated in the rest of the valley due to a lack of manpower. The voluntary labor the management model was rallying on did not meet the project’s expectations. The study recommends to strengthen the sustainability of the project by developing its social engagement. Alternative uses of the acacia trees are proposed to generate revenues and secure further public participation.

# SESSION IV

# APPLYING SATELLITE TECHNOLOGY TO FOREST FIRE MANAGEMENT

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*Keywords: forest fire, satellite, NDVI, idrisi Kilimanjaro*

Forest fires are a major natural disaster that occurs frequently worldwide. With the rapid development of space technology, satellite remote sensing technology, especially infrared satellite remote sensing, has become an effective means of forest fire monitoring. Numerous environmental detection satellites have been launched worldwide, including the Sentinel series, the Landsat series and many others. They carry infrared multispectral cameras, which are uniquely suited for forest fire monitoring and can play an important role in early fire detection, mid-disaster tracking and later disaster damage assessment. This presentation focuses on the advantages of environmental mitigation satellites for forest fire monitoring and provides a brief example of how the satellite image analysis software idrisi Kilimanjaro can be used.

# INTRA-ANNUAL RADIAL GROWTH VARIATION IN MEDITERRANEAN MIXED PINE FORESTS

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*Keywords: Dendrometer band, Tree competition, Forest management, Climate change,* non-linear mixed model

Nowadays, there is a growing interest in mixed-species forests as an option of adaptive forest management, where they are considered a guarantor to safeguarding a wide variety of ecosystem services within the framework of sustainability. Stem radial growth analyses help us to better understand tree responses to weather and tree competition, hence evolving robust management programs, which in turn leads to enhancing the contribution to climate change mitigation and adaptation. There are some evidences of benefits of mixing Scots pine (*Pinus sylvestris* L.) and Maritime pine (*Pinus pinaster* Ait.) in terms of productivity and resistance and resilience in comparison to their corresponding monospecific stands. However, the underlying mechanisms which explain between species niche complementarity are not well understood. In this sense, exploring species-specific intra-annual growth patterns may help to identify temporal niche complementarity. Using data from band dendrometers established in monospecific and mixed Scots pine- Maritime pine stands in *Sierra de la Demanda* in Spain we analyse the intra-annual radial growth variation of the two species. The experiment includes three triplets, each triplet consisted of three circular plots (radius = 15 m), including one pure plot of *Pinus sylvestris*, one pure plot of *Pinus pinaster* and one mixed plot with both species established under same site conditions. In each plot 10 band dendrometers by species were installed covering the diameter distribution. In a first-step analysis, a non-linear mixed model based on 3-parameters Richards curve was fitted to show species differences in intra-annual cumulative radial increment patterns. We observed that for both species there are differences in the intra-annual growth pattern of trees growing in mixed and pure stands.

# DENDROCHRONOLOGY OF THE AZOREAN JUNIPER, JUNIPERUS BREVIFOLIA (SEUB.) ANTOINE

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*Keywords: Dendrochronology; Dendroclimatology; Growth rings; Wood anatomy; Juniperus brevifolia; Cross-dating; Azores*

Juniperus brevifolia is a vulnerable endemic species of the Azorean archipelago. To implement sustainable forest management basic information on tree age and growth rate are required, nevertheless, this information was still lacking. One of the aims of this research was understanding the relation between tree age and other dendrometric traits such as trunk diameter and tree height and finding a model for age estimation. Moreover, the wood anatomy of microcores was observed to aid the macroscopic analysis of increment cores and an attempt to build a master chronology was made by the process of cross-dating. A total of 112 individuals were cored in three different study areas in the North - West of São Miguel, nonetheless, only 15 samples were clear enough (all the annual rings were well defined) for analysis. J. brevifolia's wood anatomy confirmed the descriptions given by other authors for other Azorean islands. This species typically forms clearly distinguishable growth layers, nonetheless, often, samples presented doubtful tree rings where it was not possible to identify the layers as real annual rings, false rings, micro rings or density fluctuations. Due to these anomalies, the majority of the samples collected were discarded and it was not possible to build a reliable master chronology. Therefore, although J. brevifolia is potentially appropriate for climate reconstructions it is advised to investigate the potential of other species that present less difficulties during the analysis. A linear model relating tree age and trunk diameter at the base was found to be significant. By incorporating the tree height in the allometric equation, the best-fitted linear model was produced (adj. $R2 = 0.55$). It is advised to carry out further research to increase the depth and accuracy of the dataset to improve the age estimation model. The results obtained in this project can be used as a basis for future investigations and potentially support the sustainable management of J. brevifolia.

# SURVEY OF MACROFUNGAL DIVERSITY AND ANALYSIS OF EDAPHIC FACTORS INFLUENCING THE FUNGAL COMMUNITY OF CHURCH FORESTS IN DRY AFROMONTANE AREAS OF NORTHERN ETHIOPIA

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Keywords*: Conservation; Edaphic variables; Fragmented forests; Macrofungi; Church forests; Sporocarps*

The Dry Afromontane forests in Northern Ethiopia have been cleared for agriculture and reduced to small and isolated fragments. Most of these forests are located around church territories and are they called church forests. The church forests are known to be biodiversity islands and provide key ecosystem services to local communities. However, to date, the fungal resources of these forests have not been assessed and, therefore, the contribution of fungi to their conservation value is unknown. In 2019, we investigated the fungal diversity of three Dry Afromontane church forests. In each forest, we established nine permanent plots (2 m × 50 m), which were surveyed weekly during the rainy season to quantify the fungal diversity and sporocarp production levels. Explanatory variables were also analyzed to determine their relationship with macrofungal species composition. We collected 13,736 sporocarps corresponding to 188 taxa. Of these, 81% were saprotrophic and 14% were ectomycorrhizal. Sixty-eight species were edible, including economically valuable species such as *Tricholoma* and *Termitomyces*. This suggests that these fragmented forest systems could be managed to provide valuable non-timber forest products such as mushrooms and socioeconomic benefits for local communities. Although many species were present in all three forests, some were only found in one forest, highlighting the importance of conserving individual forests. The correlation of the Shannon diversity indices of the two communities showed a positive trend in spite of the lack of correlation between their richness. Macrofungal communities as a whole were influenced by edaphic, spatial and climate variables. This study indicates that church forests support a wide diversity of fungi, including potentially novel fungal species, and highlights the need for forest managers to consider the importance of fungi in forest ecosystem management and to provide habitats that will maintain fungal diversity and sporocarp production when planning conservation strategies.

# MACHINE LEARNING REPRESENTATION OF LOSS OF EYE REGULARITY IN A DROSOPHILA NEURODEGENERATIVE MODEL

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*Keywords: neurodegeneration, rough eye phenotype, spinocerebellar ataxia, classification, deep learning*

The fruit fly compound eye is a premier experimental system for modeling human neurodegenerative diseases. The disruption of the retinal geometry has been historically assessed using time-consuming and poorly reliable techniques such as histology or pseudopupil manual counting. Recent semiautomated quantification approaches rely either on manual region-of-interest delimitation or engineered features to estimate the extent of degeneration. This work presents a fully automated classification pipeline of bright-field images based on orientated gradient descriptors and machine learning techniques. An initial region-of-interest extraction is performed, applying morphological kernels and Euclidean distance-to-centroid thresholding. Image classification algorithms are trained on these regions (support vector machine, decision trees, random forest, and convolutional neural network), and their performance is evaluated on independent, unseen datasets. The combinations of oriented gradient + gaussian kernel Support Vector Machine [0.97 accuracy and 0.98 area under the curve (AUC)] and fine-tuned pre-trained convolutional neural network (0.98 accuracy and 0.99 AUC) yielded the best results overall. The proposed method provides a robust quantification framework that can be generalized to address the loss of regularity in biological patterns similar to the Drosophila eye surface and speeds up the processing of large sample batches.

# SESSION V

# EVALUATION AND VALIDATION OF FOREST GROWTH MODELS IBEROPT AND IBEROPS

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*Keywords: methodology development, mortality, ingrowth, SIMANFOR, modeling, silviculture*

Forest modeling is a tool that allows us to predict how forest stands evolve under different silviculture scenarios, helping the managers to take decisions. Equations to calculate different forestry variables were developed at the tree and stand levels, which accuracy on predictions was commonly evaluated individually. To use them, models that group equations and simulators that facilitate their use were also developed, centralizing the information and simplifying the use. However, although individual equations validation is a well-known field, model validation is very underexplored. This study is the first attempt to the development of a methodology that allows us to validate full models. To do it, we treat to validate IBEROPT and IBEROPS models, developed to *Pinus pinaster mesogeensis* and *Pinus sylvestris*, respectively, by using the data of the Spanish National Forest Inventory (SNFI, IFN on Spanish) and SIMANFOR platform to their performance. Our results demonstrate the adequation of the developed methodology in order to improve the accuracy of the growing equations, while it is not enough to validate mortality and ingrowth equations.

# SPRAY-INDUCED GENE SILENCING (SIGS) PROVIDES RNA INTERFERENCE EFFECT AGAINST FUNGAL INFECTION ON PLANT MATERIAL

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*Keywords: Cross-Kingdom RNAi; Environmental RNAi; RNA uptake; fungal pathogens; Botrytis cinerea*

Fungal pathogens are responsible for many plant diseases and cause severe crop losses worldwide, threatening global food security. It is known that *Botrytis cinerea,* the causal agent of grey mold disease on over 1000 plant species, can deliver small RNAs (sRNAs) to its host during the infection process to silence host defense genes, and the host plant is able to send sRNAs to the fungal pathogen to inhibit virulence genes. This mechanism, belonging to the plant-fungal pathogen interaction, has recently been described and called “cross-kingdom RNA interference”. The subsequent discovery that many pathogenic fungal species can efficiently take up environmental sRNAs that silence fungal genes with complementary sequences led to the development of an innovative and eco-friendly fungal disease management strategy: spray-induced gene silencing (SIGS), which is a really promising tool with plenty of avenues to be explored on forestry applications.

# SIGS IN PINE AND HOLM OAK AGAINST *Fusarium circinatum* AND *Phytophthora cinnamomi*

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*Keywords: double-stranded RNA, RNAi, sustainability, gene silencing, forest diseases*

The diseases affecting trees seriously compromise our life quality as well as the resources obtained from the forest. In our region two forest species are seriously threatened due to this: pine pitch canker is caused by *Fusarium circinatum* in *Pinus* sp. and holm oak decline is caused by *Phytophthora cinnamomi* in *Quercus* sp. These diseases have for a long time been treated with chemical products, which have a high ecological impact on nature. Moreover, these methods are not entirely effective in controlling the diseases. Thus, other sustainable alternatives are in the spotlight of forest plant pathology at the moment. One such alternative is spray-induced gene silencing (SIGS). SIGS is a plant protection method based on gene silencing using RNA interference (RNAi) technology. This strategy is environmentally friendly and could be a sustainable alternative to chemical disease control methods. We are studying the potential of SIGS in the treatment of *F. circinatum* and *P. cinnamomi*, trying to silence certain genes involved in cell vesicle trafficking (VPS51, DCTN1 and SAC1) that have already been tested in other pathogenic fungi. Silencing these genes would reduce growth and infectivity of the pathogens, offering a sustainable alternative for the treatment of these diseases. The results of this research will help to explore the use of this technology in forest pathogens where it is not widely developed.

# IMPACTS AND DRIVERS OF SIGNAL CRAYFISH (*Pacifistacus leniusculus*) POPULATIONS IN UK RIVER SYSTEMS

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*Keywords: Alien species, introduction, freshwater ecosystems, biota, Pacifistacus leniusculus*

Ever Since its first introduction in the late 1970s, the signal crayfish (*Pacifistacus leniusculus*) has been constantly dispersing across the rivers of the United Kingdom, and reducing their native freshwater biota. There is little knowledge on the species' impact on the freshwater ecosystems of East England. The aim of this study was to assess its presence and ecological impact in the county of Essex, East of England, UK. Three rivers were surveyed: Salary Brook, Layer Brook, and the Stour, in Autumn 2019. Baited Funnel traps (BFts) were placed to capture crayfish, to evaluate their presence, and to measure their carapace length (CL). Macroinvertebrate species were counted by collecting and storing them in surber samplers. Signal crayfish were found in all of the three surveyed rivers.Water samples were also collected to detect concentrations (mg/L) of nitrate ($NO^{-}3$) and phosphate ($PO4$) , in order to assess any correlation between water quality and the populations' size of the signal crayfish.The most crayfish were captured in the Stour, with 297 individuals, followed by Layer Brook, 39, and Salary Brook, 2. The highest number of macroinvertebrate species was also found in the Stour, six, followed by Salary Brook, with 5 different species, and finally Layer Brook, with four species. Several freshwater macroinvertebrate taxa were found, including crustaceans, snails, and insects. The results indicated a correlation between population size of the signal crayfish and the recorded taxa of macroinvertebrates only in Layer Brook (ANOVA, $F=9.941$, $P= 0.01056$). There was no difference between the total taxa count and the mean crayfish CL in all of the three rivers. There was evidence that the crayfish population size varied based on phosphate in the Stour (ANOVA, $F2= 1524$, $P= 0.0163$), but not in any other site, nor with nitrate.The results do not support all the hypothesis, but they display the current situation of the presence of signal crayfish in the rivers of East England. The study provides insights into the possible control strategies of the species, and it can be useful if repeated at different times throughout the year, on a seasonal basis.

# LIMITED EFFECT OF FOREST EXPANSION IN ABANDONED AGRICULTURAL LANDS TO OFFSET REGIONAL C EMISSIONS UNDER MEDITERRANEAN-CONTINENTAL CLIMATE

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*Keywords: carbon sequestration, above-ground biomass, below-ground biomass, allometric equations synthetic aperture radar.*

It is widely accepted that forest expansion in abandoned agricultural lands has largely contributing to the land C sink trend detected in the Northern Hemisphere. However, in areas of Mediterranean-continental climate, where this process has been particularly pervasive over the last decades, its implications in terms of atmospheric CO2 sequestration are still poorly understood. We assessed the area affected by forest expansion in abandoned agricultural lands, and estimated the mean above- and below-ground carbon (AGC and BGC) densities and total stocks generated by this process, over the period 1957-2017, in a vast area (9.4 million ha) of Mediterranean-continental environment. We achieved this objective through and approach combining AGC and BGC estimations based on direct field measurements taken in 30 plots (25 × 25 $m^2$), and plot-level Synthetic Aperture Radar (SAR) backscatter data from 2018. We found that 145,193 ha of forests, woodlands and other wooded lands (1.54 % of the study regions' total area) were developed through spontaneous revegetation in abandoned agricultural lands. We also detected relatively large mean AGC (18.04 Mg C·$ha^{-1}$) and BGC (6.78 Mg C·$ha^{-1}$) densities of 18.04 and 6.78, but the total AGC and BGC stocks (6.27 and 3.73 Tg C, respectively), were modest. Our findings indicate that the process of C accumulation as a result of forest expansion in abandoned agricultural lands in Mediterranean continental environments will barely contribute to offset a 1 % of the total regional $CO_2$ emissions, which points toward a much smaller sequestration potential that that detected under temperate-cold conditions. We strongly advocate for an appropriate quantification of these newly regenerated areas at continental scale, as well as for the application of active forest management measures on them in order to increase their $CO_2$ sequestration potential while minimizing the negative effects of upcoming climatic events.

# IMPACT OF SILVICULTURE PRACTICES IN BELOWGROUND FUNGAL COMMUNITIES ASSOCIATED TO MEDITERRANEAN *Quercus pyrenaica* Willd. FORESTS IN NW SPAIN

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*Keywords: Illumina sequencing, forest disturbance, fungal metabarcoding, fungal functional groups, fungal community ecology, Mediterranean ecosystem, Beta diversity, ITS rDNA sequencing.*

*Quercus pyrenaica* forests are widespread over the Iberian Peninsula. Firewood or livestock exploitation under silvopastoral systems are some of the historical uses of these forests. These activities summarized with the current social abandonment of the rural environment, has given rise to different aged and structured forests, with their associated problems. The amount of biomass accumulated in these *Quercus pyrenaica* forests are a potentially driver for a highly risk of wildfires and, in comparison, Dehesas presents a low tree density, highly aged, with serious regeneration problems and a very weak phytosanitary status. Facing this scenario, we inquire ourselves which associations in terms of fungal community are found within each stage structure of these stand types and their potential ecological roles in their conservation. In these regards, young, intermediate and mature structured stands were analysed to find out the sequences of fungi found and descript the edaphic variables associated with these systems. Carbon, the pH and the Carbon-Nitrogen ratio where measured to understand how them affect, together with the type of land use, to the fungal composition dynamics. Two distinguishable communities were observed. One was dominated by pathogens, parasites and endophytes appearing in old stands while saprotrophs and ECM dominated young stands. Intermediate stands presented mixed community. Age and structure of the stand also affected Ectomycorrhizal fungi and its exploration types. Higher richness in the intermediate stands were seen for the hole guild and for short exploration types. Finally, various edible genera such as *Boletus*, *Tuber*, *Terfezias* or *Cortinarius*, among others, were seen to be significantly influenced by the stand age and structure, as human action.

# SESSION VI

# WOOD ANATOMICAL EVALUATION OF TREE SPECIES FROM SOUTHERN ECUADOR, UPCOMING CHALLENGES AND APPLICATIONS.

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*Keywords: wood anatomy, classification, wood identification, forest, management,*

The identification of tropical woods through their anatomical characteristics has become more important in recent years, in which the Laboratorio de Anatomía de Maderas Tropicales of the Universidad Nacional de Loja has been developing several investigations in this area, through some methods of classification and analysis. The beginning was a classification of 50 anatomical characteristics in 50 forest species obtaining interesting results and anatomical records of several species for the first time based on IAWA standards, the results showed that the family and genus of the species does not directly influence the anatomical properties of the wood, noting large anatomical differences between species even within the same genus. However, by studying the relationships between anatomical characteristics and their physical and organoleptic properties, this type of analysis improves significantly, so that from these results it is expected to promote actions focused on the management of forest resources, reducing the pressure of exploitation of a certain group of species, which would allow the diversification of its use and the processes of identification of forest species through macroscopic and microscopic patterns.

# BARK THICKNESS, STEM STRAIGHTNESS AND LIFE-HISTORY STRATEGIES IN *PINUS PINASTER*: IS THERE ANY TRADE-OFF BETWEEN THEM?

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*Keywords: bark, Pinus pinaster, straight, crooked, life-history*

Global change is modifying climate and perturbation regimes which, especially in the Mediterranean environment, means a change in the frequency and intensity of wildfires. That's the reason why adaptive traits must be considered within adaptive forest management. More in the specific, bark thickness is a key trait in fire prone ecosystems. Bark heat diffusivity is much lower than the air and its capacity of isolating the cambium cells from extreme temperatures increases exponentially with its thickness. *P. pinaster* is a Mediterranean species with adaptations to fire. In this species, a high genetic variability between provenances has been found in multiple traits, such as the bark thickness and the stem straightness. The thin bark has been found in populations with high levels of serotiny (a trait also related to the fire regime), while non-serotinous populations correspond to trees with thick bark. Stem straightness has been shown to be heritable and has been related to the ability to restore the stem's mechanical equilibrium position after deviations. This straightening process is related to the production of compression wood and other mechanisms that involve changes in the allocation of resources. Since both bark production and straightening processes require resources, our hypothesis is that there could be a trade-off between them. Our objective is to explore the relationships between bark thickness and stem straightness in two types of populations, typically straight-stemmed and typically crooked, taking into account the individual variation of bark thickness along the stem. We used a common garden of *P. pinaster* aged 9 years, including seven provenances chosen among those typically showing straight-stemmed and crooked-stemmed phenotypes. We established a manipulative experiment consisting in an artificial temporal bending to an inclination of 35º, in plants pertaining to both provenance groups. The bending was maintained for a month and then released. Control and bended plants were chosen considering a similar range of plant size. Eight months later, we harvested the plants to study the bark thickness along with its orientation and position regarding to the stem development. Data was taken in four stem cross sections for each tree: at the base, below the fourth whorl, below the first whorl and above the first whorl. The bending treatment had mostly affected the straight provenances but almost didn't affect the crooked ones. The way straight provenances were affected was a reduction of maximum bark thickness and of bark area at the fourth and first whorl levels, and an increase of the bark thickness on the top. Such increase occurred towards both north and south orientations.

# DIVERSITY AND PRODUCTION OF MACROFUNGI ASSOCIATED WITH *Pinus radiata* (Don) PLANTATIONS IN MENAGESHA SUBA STATE FOREST, CENTRAL ETHIOPIA.

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*Keywords: Edible fungi, edaphic variables, fungal community, stand age, succession.*

Edible mushroom production in artificial plantations is a resource that could provide significant benefits for local and poor communities in Ethiopia, both as an additional food resource and as a source of income. However, this resource has not previously been assessed in Ethiopian Pinus radiata plantations. Here, we report the first systematic mycological survey of these short-rotation plantations in Ethiopia. During the rainy season in 2020, sporocarps were sampled weekly in a set of permanent plots (100 m2) in young (5-year-old), medium-aged (14-year-old), and mature (28-year-old) P. radiata plantations. Fungal taxa richness, diversity, and sporocarp yields were estimated. Composite soil samples were also collected from each plot to determine explanatory edaphic variables driving fungal taxa composition. We detected the presence of appreciated edible genera such as Morchella, Suillus, and Tylopilus. Although these edible genera are not presently used by local populations in this region, they could represent significant food resources and provide economic benefits. Overall, we collected 92 fungal taxa, of which 8% were ectomycorrhizal (ECM). Taxa richness, the Shannon diversity index and ECM species richness were higher in mature stands than in other stands, suggesting that ECM species could compensate for the effects of nutrient stress, which is frequently observed in mature forests. Interestingly, about 26% of taxa were classified as edible and sporocarp yields showed significant increasing trends with increasing stand age. Edaphic variables such as organic matter and the C/N ratio significantly affected fungal community composition and sporocarp production. Clear cutting is the only type of management undertaken in Pinus plantations in Ethiopia, with no intermediate management undertaken before stands reach turnover. However, the deliberate retention of mature trees in Pinus stands could be useful to conserve and promote fungal diversity and production, including valuable taxa such as Suillus, which forms sporocarps in all stand age groups. Thus, this strategy could improve the economic outputs of Pinus plantations in this study area.

# LAND COVER CHANGES: AN ANALYSIS FOR THE CASE OF ALMATY, KAZAKHSTAN

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*Keywords: Landsat, ArcMap, land cover changing, Fragstats, fragmentation.*

Gaining, achieving and studying the ways of how land cover and its practices are developing is nowadays a central reason for the global change research community, furthermore in relation to negative impacts of climate change. Being able to predict future states of land cover is a requirement for making predictions regarding global changes. Owing to this purpose, the present work has had the aim to analyse and compare land cover data obtained from Landsat TM/ETM satellite data of 30m resolution. The main objective was to identify and examine land cover changes based on the land cover data between the years 2010 and 2018 and try to investigate land cover fragmentation and the reasons behind it occured in the area of Almaty, Kazakhstan. The cover of the land has been classified through the utilization of ArcMap and afterwards classified into six classes: water, urban area, forest, snow, crops and bare soil. Subsequently, the fragmentation of the landscape and classes have been examined using FRAGSTATS software, according to the landscape and class metrics. In both years, it has been included under examination the following classes: urban area, forest, crops and bare soil. The most dominant land cover in either case was bare soil (25.351 ha in 2010, 28.949 ha in 2018). The results showed a socioeconomic progress, which could be related to the dynamic land cover fragmentation that occurred over the temporal range in question. Finally, this study provides knowledge on spatiotemporal land cover fragmentation that are pursuant to anthropogenic disturbances in the studied areas.

# AMENAJMAN

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*Keywords: documentary, management, planning*

The forest engineering discipline, which has been developed for the engineering and management activities of forests, which are one of the terrestrial renewable ecosystems, is designed to ensure the sustainability of the resource, whose ecological, economic and social aspects differ at the country, regional and local level. With this documentary work, it is aimed to record the inventory studies of forest engineers in Turkey, especially in the field with terrestrial measurements, and the preparation of management plans, by referring to the difficulties they have, through interviews with the engineers who working in. Interviews and area shootings for the Amenajman Documentary were held between 01 September – 07 September 2020. The study was supported with photographs and videos collected from the study areas. The collected data was fictionalized between 10 September 2020 – 20 February 2021 and the documentary work was completed. Documentary pays attention to creating the ground that Will contribute to asking new questions about the future of the profession based on variables such as social pressure, gender equality and technological developments, which directly by conveying to the documentary audience. Documentary fiction is made by conveying the comments of forest engineers and additional information in binary differences such as experienced-young, woman-man. It was prepared in accordance with international screenings, with a length of 23 minutes, with Turkish voice over - English subtitles.

# SOIL NICHE COMPLEMENTARITY AS A RESPONSIBLE OF SMALL SCALE OVER-YIELDING IN MIXED PINE FORESTS

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*Keywords: Neighbourhood spatial scale, Soil niche complementarity, Mixed forest, Scots pine, Maritime pine*

Most reports of the positive effects of tree mixture on the biodiversity–productivity relationship focus on mixtures that combine tree species with contrasting traits. However, this effect is little known in mixed stands of species of the same genus as the mixed pine forests. Thus, we evaluated the effect of mixing on production in six triplets [6 triplets × 3 forest stands (2 monospecific stands + 1 mixed stand) = 18 plots) of Scots pine (*Pinus sylvestris* L.) and Maritime pine (*P. pinaster* Ait.) in north-central Spain and its relationship with the soil. In each plot, the basal area and density (ind/ha) were analysed at two spatial scales (stand: 1 plot of 15 m radius; and neighbourhood: 10 inventories of 4 m radius per plot), and the soil in a pit per plot where the hydric status (water retention capacity) and fertility (stock of sum of exchangeable bases) were analysed. A positive effect of the mixture on production was observed, on the smallest spatial scale. The greater space-use efficiency (higher tree density and basal area) of both *Pinus* species in the admixtures was related to soil water and fertility niche complementarity.

# LIFE MYCORESTORE: USE OF NATURAL MYCO-CONTROL PRODUCTS AND NATIVE FUNGAL SPECIES FOR REDUCED PEST/PATHOGEN PRESENCE IN FORESTS

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LIFE MycoRestore seeks to utilize diverse mycological resources and forest management practices to add value to and aid in the biological resilience of forests in Spain, Italy, and Portugal, generating new sources of income and ensuring the stability of forest ecosystem services while addressing the effects of Climate change. Plants are affected by biotic stressors, including a variety of pests and pathogens which weaken and kill forest flora. Weakened plants are susceptible to other biotic and abiotic stressors which ultimately places the health and existence of the whole forest ecosystem at risk. Within this scope of action, UVA is responsible for providing proof of concept on the use of natural myco-control products and native fungal species for reduced pest/pathogen presence in forests.Four sites were selected in different areas of the Salamanca region. In each selected site the predominant tree species were different, being Quercus Ilex, Quercus pyrenaica, Quercus suber and Castanea sativa. At these four different sites, wood, bark, branches and leaves were sampled from 5 healthy trees and 5 sick trees, in addition to recording the main characteristics of each one. With these samples a metabarkoding analysis was performed to characterize the fungal populations present in the area. In addition, these samples were cultured in petri dishes with PDA medium and Ampicillin and Streptomycin antibiotics in order to isolate as many native fungi as possible. An antagonist test against the pathogen *Cryphonectria parasitica* was performed with the isolated fungi in order to evaluate its potential use as a mycopesticide.This study is in progress, future work includes laboratory inoculation in young plants of these fungi tested in the in-vitro study, field inoculation, repeat sampling after inoculation to check the success or failure of the potential mycopesticidal fungi and testing of the isolated fungi as potential mycoinsecticides for pest control (Coraebus Undatus and Cerambyx Welensii).

# SESSION VII

# VEGETATION MAP OF THE PROVINCE OF PONTEVEDRA 2019 USING SENTINEL-2 IMAGERY

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*Keywords: sentinel-2, remote sensing, random forest, vegetation map, forestry management*

The province of Pontevedra, located in the Autonomous Community of Galicia, in the northwest of the Iberian Peninsula, is characterised for being an area where the forestry sector is of great importance, because Galicia is responsible for half of the timber production in the whole of Spain, with productive species such as *Eucalyptus spp*. and *Pinus spp*. This high rate of exploitation, together with the high number of wildfires, the change in land use and rural abandonment mean that the forest area is changing at a very high rate. Simultaneously, an up-to-date and accurate forest inventory is essential to ensure good sustainable forest management. Thus, in Spain there are two quality official cartographic products which are the MFE25 and the IFN3. These were developed following traditional methods of field sampling and visual interpretation of PNOA orthophotos which are both slow and costly processes. Thus, for the province of Pontevedra, the MFE25 was carried out using PNOA orthophotos from 2004 and 2005, and the IFN3 was carried out using field sampling between 1997-2007. So, due to the time lapse and taking into account the high rate forest change of Pontevedra, these products are currently not so accurate. On the other hand, in recent years numerous satellite products have been published openly, such as Sentinel or Landsat imagery, which with resolutions of up to 10 metres per pixel and update rates of 3-5 days are very useful for cartography. Therefore, one of the best known examples is the Land Cover Map of Europe 2017, developed by the Space Research Centre of Polish Academy of Science using Sentinel-2 satellite imagery. Given the circumstances described above, this study developed a methodology for the classification of the different vegetation covers in the province of Pontevedra using Sentinel-2 satellite imagery. This methodology was based on a supervised classification using the Random Forest machine learning algorithm in Rstudio. Finally, a vegetation map was generated for the province of Pontevedra for the year 2019, with 8 different classes: Eucalyptus, Coniferous, Other broadleaves, Crops and Grassland, Scrubland, Bare Soil, Anthropic Use and Water. After a verification process, an overall accuracy of 91.12% was obtained. In this way, it is considered that the methodology developed could complement the official cartography since it generates an accurate vegetation map that can be updated annually using open-use satellite products.

# UNDERSTANDING CROWN MORPHOLOGY IN MIXED PINE AND OAK STANDS

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*Keywords: forest modeling, mixture, crown, TLS, triplets*

Mixed forests seem to be in certain conditions more productive and more resilient than pure forests to extreme weather events, which have become more frequent and severe due to climate change. However, how species interact with each other under these new ecological conditions is still poorly understood. In this regard, one of the most important components to study and understand is crown morphology since they define the structure of the stand and the competition between trees. At the same time, historically, crown morphology has been one of the hardest components to obtain. To overcome this, Terrestrial Laser Scanning (TLS) technology has recently been used due to its great accuracy. The objective of this study is to see whether the mixed pine-oak (*Pinus sylvestris* and *Quercus petraea)* affects their crown shape. We scanned with TLS two triplets (two pure pine stands, two pure oaks stand, and two pine-oak mixed stands) located in Northern Spain. Each plot is 25x25m. In total 190 pines and 250 oaks have been isolated from the 3D point cloud. For each tree, we extracted eleven variables: Total Height (TH), Diameter Breast Height (DBH), Crown Base Height (CBH), Maximum Crown Width Height (MCWH), Maximum crown area, Crown Volume (CV), Crown Surface Area (CSA), Crown Length (CL), crown asymmetry and, Sweep and Lean of the trunk. For each studied tree, we selected five different radii of influence (5m, 7.5m, 10m, 12.5 m, and 15m) to determine the competition influence of its neighborhood, whether or not they are of the same species. We fit crown models for MCWH, CBH, CV, and Crown Projection Area (CPA) with independent variables of size, density, competence, and mixture. Preliminary results show that, indeed, the mixture has in most cases a significant influence on the crown size of trees for both species.

# ASSESSING THE IMPACTS CAUSED BY DROUGHT IN A EUCALYPTUS PLANTATION IN MATO GROSSO - BRAZIL.

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*Keywords: Forest monitoring; Growth dynamics; Production forestry; Productivity*

Planted forests of fast-growing species play a crucial role in meeting demand for forest products and relieving the pressure on native forests. Grown in more than 90 countries, Eucalyptus spp. are fast-growing trees used in plantations that provide important inputs for pulp, wood, and thermal energy production. The viability of these important production systems is threatened by the increasing frequency, severity, and duration of drought. In Mato Grosso, Brazil, where water stress is the main limiting factor for eucalyptus, the second-largest drought episode in the entire historical series was recorded in 2019. Using forest inventory data from thousands of individual trees for the years 2019 and 2020, was applied mixed-effects models to identify the most significant factors influencing the mortality and growth dynamics of four different eucalyptus genotypes under drought stress, also was used valuation techniques to quantify the financial impacts of reduced production and increased mortality. Reduced increments were observed in stock under extreme water stress; mortality was directly associated with stand density, and inversely related to age. Stands of genotype E. urograndis (APS F2) with planting densities <250 trees ha-1 were more resistant to drought stress. On average, 2019 drought triggered an estimated $3.5k ha-1 losses due to increased mortality. The choice of genetic material and planting density can be used as silvicultural tools to sustainably manage fast-growing forest plantations in the face of current climate change and extreme episodes of water stress. Implications: This study illustrates how remote sensing technologies, genetic improvements, and applied operations research can be integrated to improve the efficiency and resilience of eucalyptus plantations and explore optimal productivity limits under global change.

# USE OF MODERN GEOMATIC TECHNIQUES FOR CREATING AND UPDATING A GREEN CADASTRE OF URBAN TREES AND SHRUBS: A CASE STUDY OF KUMANOVO CITY RIVER BANK

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*Keywords: GIS, GPS, UAV, urban dendroflora inventory, geomatic techniques, remote sensing*

The goal of this study is to implement modern, up-to-date, geomatics technique and technologies in the environment with the focus on urban green areas. The base is made in GIS software, a GPS (Global Positioning system) device is used to record detailed points on the field and for recording and preparing a new orthophoto was used sophisticated drone DJI Mavic Pro. QGIS (Quantum Geographic Information System) as a key software was used for computer data processing and recordings obtained from the field research, as well as other utility programs were used to perform the tasks. The subject of the research is the Kumanovo city promenade in North Macedonia, which is a convenient place to try and implement this data processing method. The results obtained give us a map of the entire urban dendroflora on the river bank in the city of Kumanovo. In fact, an inventory of all trees and shrubs was carried out, 4 projections were prepared with the help of modern applications, and finally as the ultimate goal a web digital map of the entire trees in a form of TREE ID was obtained. This method can be applied in forestry, agriculture, water management, geodesy, space planning, sustainable development and environmental protection.

# INCREMENT DIAMETER DATA ANALYSIS AS TIME SERIES CLASSIFICATION

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Keywords: increment diameter, dendrometer, machine learning, sustainable forest management, growth

The management of forest systems requires data, collected through inventories and sampling, and used to create predictive tools and growth models. They are used to simulate and predict the development of the forest system over time. This allows the manager to anticipate the effects of different treatments on the evolution of the stand. The treatment or management of the data collected can be carried out in different ways, one of which is using machine learning techniques. Machine learning is a methodology for analysing data, which allows analytical models to be built automatically. It is a branch of artificial intelligence based on the possibility that systems can learn from databases that identify patterns and make decisions with minimal human intervention. In the study of the dynamics of a forest stand, diameter growth is a very important variable. The aim of this work is to analyse the influence of different thinning intensities on the increase in diameter in stands of Pinus halepensis Mill. and Pinus pinea located in the centre of the province of Palencia. For this purpose, the diameter of the trees has been measured monthly with band dendrometers from 2011 to the present. The analysis of the data, using time series data, shows the effectiveness of the use of machine learning in the analysis of predictive variables widely used in forest management, facilitating the work of forest managers.