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SUSCEPTIBILITY OF BROADLEAVED AND CONIFER SPECIES TO *FUSARIUM CIRCINATUM* AND APPLICATION OF ENDOPHYTES, CHITOSAN AND PROPOLIS TO REDUCE THE SEVERITY OF THE PITCH CANKER DISEASE

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Abstract

The pine pitch canker (PPC) pathogen *Fusarium circinatum* is an important disease affecting and causing the death of *Pinus* spp. and *Pseudotsuga menziesii* worldwide. It has been present in Europe since at list 2004 when it was first found in nurseries and pine plantations in northern Spain. The spread of this pathogen to nurseries and plantations constitute a risk to forest production. Most of the pine species have been found to be susceptible to the pathogen under nursery conditions. Although Monterey pine (*Pinus radiata*) is the most frequently infected host, there is no information about how the fungus affects the broadleaved species. On the other hand, the current restriction on the use of chemicals with strict quarantine measures, alternative approaches for disease control are necessary. Biological control using endophytes is considered an alternative and eco-friendly method to deal with plant diseases. Therefore, the aim of the present study was to evaluate the susceptibility of broadleaved species to PPC, to know the effectiveness of two fungal endophytes against *F. circinatum* and to know the efficiency of chitosan and propolis to control PPC disease. Two different experiments, in laboratory conditions, were carried out. In general, conifer species were affected by the pathogen but no clear symptoms were recorded in the case of the broadleaved species. At the same time, the fungal endophytes *Chaetomium aureum* and the unidentified endophyte named 20.1, were evaluated against an isolate of *F. circinatum*. At the end of the experiment, seedlings were cut and the necrosis length of each plant measured. The endophytes *Chaetomium aureum* and 20.1 together with the chitosan and propolis reduced the area under disease progress curve (AUDPC) for *P. radiata* seedlings, indicating that they may, therefore, be suitable for use as biological control agents (BCAs) of the PPC disease.

Keywords: *Fusarium circinatum*, pathogenicity, biological control

ASSESSING BIODIVERSITY RELATED VARIABLES BY UNMANNED AERIAL VEHICLE (UAV) REMOTE SENSING

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Abstract

The continuous collection of forest data is crucial for a sustainable forest management. However, forest inventory data collection is time consuming and expensive. Remotely sensed data appear as an alternative to the field inventory. Despite the general knowledge of advantages satellite and airborne remote sensed data present, they possess a limitation in the application of forest management inventories and small scale forest monitoring where a number of forest stand structural (e.g. tree density, basal area, stand height, volume), compositional (e.g. dominant species, species proportions) variables must be assessed at extremely fine spatial scales. The unmanned aerial vehicles (UAV) imagery could be used to overcome the limitation the satellite/airborne remote sensing presents.

This research explores the capability of an UAV, known as eBee drone, imagery to map forest canopy gaps and derive some forest parameters such as, biodiversity indices, habitat trees, basal area, canopy height, deadwood, etc. using handy techniques in a test area of 240 ha of natural reserve of Lago di Vico in Central Italy. We used correlation and linear regression techniques to explore relationships between gaps patch metrics on one side and forest features on the other.

The mapping revealed that forest shaded canopy gaps can be faithfully extracted from UAV true color images. Estimation of forest features using canopy gaps as a proxy led to disparate results. Best results were obtained for understorey data with R^2 going up to 0.87 and intermediate results were observed in living trees data with R^2 of over 0.74. The approach failed to estimate the deadwood. Additionally, from the three forest types available in the study area, best results were observed in mixed forest while *Fagus* forest had the poorest ones and *Quercus* forest displayed intermediate results. UAV true color remote sensing presents high potential for forest inventory and forest monitoring.

Keywords: Drones, Forest, USA

META-ANALYSIS ON THE DRIVERS OF NOCTURNAL STOMATAL CONDUCTANCE IN PLANTS

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Abstract

It is currently thought that nocturnal water losses are negligible but recent research indicates that incomplete stomatal closure during night could cause more than 25% of transpirational water losses at leaf and plant levels. However, only day time transpiration is accounted for in evapotranspiration studies. Under the global warming scenario this significant amount of water losses during the night, when photosynthetic carbon gain is absent, could potentially have much more adverse impact on both global water cycle and plant productivity. However there are important uncertainties on the drivers and magnitude of nocturnal water fluxes that prevent generalizations.

Quantification of the drivers of nocturnal water loss by plant at ecosystem level is challenging because of limitations in current techniques. However there are some fragmented data sets on nocturnal stomatal conductance (g_n) in the scientific literature. This study is focused to combine these studies to find out the major drivers of g_n and whether this process is beneficial in plants through a meta-analysis.

In total 62 research articles with 79 unique studies were scanned to find out the data on g_n, and 1,097, 589 and 998 data points on early night, late night and daytime stomatal conductance (g_d) respectively were digitize from those articles. 135 unique C3 or C4 plant species were identified from 11 plant functional types and 5 biomes around the world. In the preliminary result of this meta-analysis, it is evident that crop species have the lowest g_n/g_d (20.45%) ratio whereas tropical trees show the highest (49.42%). In case of biomes, tropical trees have dominated with highest g_n/g_d (46.74 %) and Mediterranean ecosystems have the lowest (19.31 %). Interestingly, desert species have the second highest g_n/g_d (37.60 %) among the catalogued biomes, in stark contrast with the much lower g_n/g_d in sclerophyllous Mediterranean vegetation, and probably driven by differences in leaf structural properties.

This study corroborates how significant g_n is widespread amongst biomes and plant functional types.

Keywords: Nocturnal stomatal conductance, transpiration

FORESTS FOR PEOPLE, PEOPLE FOR FORESTS:

STUDYING THE IMPORTANCE OF JORDAN'S PUBLIC FORESTS FOR CITIZENS' WELLBEING AND THE POTENTIAL OF ENGAGING SYRIAN REFUGEES IN FORESTRY PROJECTS

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Abstract

Forests and other green spaces have been proven to play a major role in citizens' wellbeing and public health. They provide important spaces for leisure, exercise, social interaction, as well as mental and psychological rehabilitation. While many studies about this topic have been carried out in different parts of the world, there seems to be a gap in which less developed countries are not taken into consideration. Jordan is an example of those countries, despite the fact that it is a significant country where this issue needs to be highlighted; Jordan's forest area covers only 1% of the country's total area, those forests are usually mismanaged and abused, there are not enough green spaces that are open to the public, and there has been a sudden high rate of population growth due to receiving large numbers of refugees fleeing war from neighboring countries.

Looking into the relationships between those aspects of Jordan, it is important to mention that although refugees form a significant part of the total population, they are not a significant user group of public forests in Jordanian cities, and in most cases, they are not included in public events and activities that are related to forests. Taking Syrian refugees as a focus group, a large percentage of them live in marginalized neighborhoods in Jordanian cities, while the rest live in refugee camps, where they face many environmental, economical, and social problems, suffer from war trauma and psychological issues, do not have access to green spaces in the country, and worst, are not allowed to plant trees in camps.

This project aims at studying the importance of public forests for citizens' wellbeing in Jordan, while highlighting the need of Syrian refugees to have access to these spaces. It also looks into the potential of engaging refugees in forestry projects and using refugees' skills to create common green areas that would provide spaces for community engagement, help connecting local communities to refugees, and promote refugees' psychological rehabilitation. By this study, I aim at forming the first milestone on which future projects can be built, with the hope to influence decision makers to consider a reform in related policies.

Keywords: Forests, Refugees, Engagement, Psychological health

ROLE OF MEDITERRANEAN FORESTS IN SECTORS OF GREEN ECONOMY

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Abstract:

Green economy as defined by **UNEP** is the one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. Green economy is further divided into six sectors Building, transportation, Energy, Agro forestry, water and Tourism. In its simplest expression, it is an economy that is low carbon, efficient and clean in production and also inclusive in consumption and outcomes, based on sharing, circularity, collaboration, solidarity, resilience, opportunity, and interdependence. The growing interest in green economies provides opportunities to demonstrate how forests and rangelands can provide more of these benefits and increase the visibility of the forest and rangelands sectors in public policies. Therefore it is important to explore what different aspects of the green economy do Mediterranean countries see as most important and where forests, rangelands and related activities could make the greatest contribution to the green economy. The research Objective is to improve the understanding that how can Mediterranean forests better contribute to low carbon economy, sustainable development, economic activity and job creation and How far can they contribute to different sectors of Green economy. Mediterranean forest represents approximately 25 percent of world forest area and an estimated forest area in Mediterranean countries is over 85 million hectares. Sustainably managed forests play an essential role in the carbon cycle, releasing oxygen, while locking up carbon dioxide in the trees and soil. The wood and forestry sectors in Mediterranean can make a significant contribution towards meeting green economy objectives, linked to climate change policies, mainly through the abatement of greenhouse gas emissions and expansion of renewable energy and efficient building objectives. Apart from Timber and firewood there are arrays of public goods and externalities provided by Mediterranean forests including Watershed protection, landscape quality, soil conservation, carbon sequestration and recreation resources but they are seldom recognized and therefore are difficult to evaluate and price. The research concludes that Rovaniemi Action Plan for Forest sector in Green economy is ambiguous for Mediterranean Forest keeping in view the limited forest resources in Mediterranean. In order to take the maximum contribution of Mediterranean Forest towards Green economy objectives, a smart approach is required in region, i.e, expanding the forest area in the region but at the sametime improving the value chain of NWFP products and utilize the services provided by forests.

INTEGRATION OF WATER ECOSYSTEM SERVICES PROVISION OBJECTIVES IN FOREST MANAGEMENT PLANNING MODELS

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Abstract

In recent years, the integration of water production values for forest ecosystems into forest management models has become increasingly important in sustainable forest management. The reason is that both for surface and groundwater resources quantity and quality – forests play a vital role. The main objective of this work is to produce an analysis of computer-based tools that have been used the most frequently for assessing the optimal integrated forest and water management for forested catchments.

This research is the part of ALTERFOR project being developed to assess the computed-based tools that support the sustainable forest management by means of including a variety of ecosystem services: such as provisioning, regulating, cultural and supporting services. For that purpose, we use a taxonomy of ecosystem services based on the three main international classification schemes, the Common International Classification of Ecosystem Services, the Millenium Ecosystem Assessment and the Economics of Ecosystems and Biodiversity. The taxonomy is used to develop a query of relevant references from 2754 journals, encompassing 46 scientific categories, stored in the ISI Web of Science database over the last 30 years. Query results are analysed and going to be discussed. Decision-making methods are going to be classified and assessed according to their supporting role to forest managers in addressing specific ecosystem services. As forest managers are often confronted with conflicting preferences by owners and stakeholders regarding ecosystem services target levels, the query will further address the potential of decision-making methods to facilitate negotiation and consensus building.

Keywords: Ecosystem services, forest management, operations research, multi criteria decision making

VALIDATION OF THE METHOD USED BY THE SUBER MODEL FOR THE ESTIMATION OF EXTRACTED CORK DRY WEIGHT WITH MORE AND LESS THAN 9 YEARS OF GROWTH

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Abstract

Extraction of cork from *montados* or cork oak forests is one of the main activities in Portugal. 23% of Portuguese forests are from *Quercus suber* and Portugal is the main producer of cork in the world. Commonly, every 9 years, but also 10 or more, the cork of the stem and branches with perimeter at breast height greater than 70 cm is removed. Possibly this intervals are not the optimum for the production of cork. Most of the models that exist only predict cork weight for 9 or 10 years of cork age. But a new model developed by Paulo and Tomé (2010) allows the prediction of mature cork biomass with t years of growth, based in one measurement taken at any other age. The model is based on two sub-models; the first one predicts cork biomass with 9 years of age using four alternative models with different variables as inputs; and a second one that estimates cork back weight proportion at 9 years of age. The method has already been validated for 9, 10 and 11 years of cork age, and the objective of this work was doing the validation of the model for that ages and also adding new data of 8 and 13 years of cork age. The evaluation was done by comparing the observed and the estimated values of cork biomass from corks with 8, 9, 10, 11 and 13 years of age. According to previous validation, it was confirmed that the model work better as more input variables are added in the model and it was also found that as the ages of cork biomass move away from 9 years, as well as the extremes of cork thickness classes, the worst is the performance of the model

Keywords: Cork biomass, *Quercus suber* L., validation

THE RELATIONSHIP BETWEEN CLIMATE AND TREE GROWTH RATE ON VARIOUS TREE SPECIES ACROSS CANADA AND USA WITH FOCUS ON DIVERGENCE DECADAL CLIMATE OSCILLATIONS

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Abstract

The forests and tree species across the Canada and USA are very sensitive to climatic fluctuations. Also, different climate trends have been observed over different regions of Canada and USA connected to decadal climate oscillations, therefore climate in that regions characterized by high spatial and temporal variability. The climate over there is influenced by large-scale atmospheric and oceanic oscillations such as El Nino-Southern Oscillations, the Pacific Decadal Oscillations, North Atlantic Oscillations, and these factors influence temperature and precipitation. These climate patterns have enormous impacts on tree growth over these regions, ultimately causing substantial changes in tree's radial growth. Assessing a tree's growth response to climate change is complex and challenging. A review of the divergence problem has shown that the loss in sensitivity is circumpolar in the northern latitudes, and may be due to a number of biological and ecological factors. Further, the loss of sensitivity is not limited to temperature, but also precipitation, and the divergence problem has been observed in some areas of Canadian tree rings. Most studies of the tree radial growth response to climate focus on a single tree species or in a specific region on the species' range. This study addressed the tree radial growth response to climatic factors of two coniferous tree species (*Picea glauca* and *Picea engelmannii*) across Canada and USA. Analysis and results of this study revealed the temporal and spatial relationship between radial growth and climate variables (temperature and precipitation) for each species across its range. The tree-ring chronologies and indices were developed by ARSTAN program, DendroClim2000 used to correlate climatic variables with annual tree-ring width and the outcomes from correlations were mapped and analyzed for spatial patterns using Arc Map program. From the 49 tree ring sites of *Picea glauca*, 148 significant correlations were found between tree-ring width and monthly climate variables (average temperature and precipitation), with 64 (43.2%) significant correlations for the 26 western sites, 50 (33.8%) significant correlations for the 17 central sites, and 34 (22.0%) significant correlations for the six eastern sites of *Picea glauca*'s range. From 28 tree ring sites of *Picea engelmannii*, 129 significant correlations were found between tree-ring width and monthly climate variables (average temperature and precipitation), with 101 (78.3%) significant correlations for the eight northern sites and 28 (21.7%) significant correlations for the 20 southern sites of *Picea engelmannii*'s range.

Keywords: Tree-rings, Growth-climate relationship, Large-scale climate oscillations

CLIMATE IMPACT ON EARLY GROWTH OF PINUS PINUSTER AIT.

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Abstract

Maritime pine (Pinus pinaster Ait.) is a great economic, ecological and aesthetic importance of Mediterranean species. Survival probability, biomass fraction and basal diameter growth of the Mediterranean conifer sapling of P. pinaster Ait. was studied. To generate the experiment material, seedling were grown in different conditions in nursery, and planted in a natural forest stand in central Spain. Eleven years after saplings were harvested.

The main objectives were to know: to identify the most important factors affecting sapling survival; to analyse the effect of climate factors on biomass partitioning and estimate sapling biomass; to analyse the effect of climate factors on annual basal diameter growth of sapling operating at natural stand of P. pinaster Ait.

The result revealed that water is associated with light good predictive for survival. Moreover, biomass allocation has a strongly influenced with completely sun exposition. The SUR method was superior to Dirichlet methods due to unbiased and produced very small RMSE values for biomass estimation of sapling. Moreover, annual basal diameter growth has a strongly influenced with summer water availability and completely sun exposition. The overall study indicated ontogenetic drift (slope≠1) in growth rates and biomass allocation depended upon which resources was more limiting, according to optimal partitioning theory.

The main conclusion of this study is that summer water availability shows a higher impact in respect to survival, biomass allocation and basal diameter growth in the early stages of Mediterranean Maritime pine.

Keywords: Biomass, Survival, Cox hazards model, Dirichlet regression, Dendroecology, Spain Northern Plateau

EXPLORING THE SPATIOTEMPORAL DYNAMICS OF GOLCUK PLANNING UNIT OVER 43 YEARS AND ITS IMPLICATION TO ECOSYSTEM MANAGEMENT PLANNING AND THE INTERNATIONAL CONVENTİONS

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Abstract:

For sustainable forest planning, spatial temporal forest dynamics study is indispensable. The overall objectives of this study are to measure LULCC & species mix chages by studying the spatial-temporal dynamics over 43 years using GIS. To analyse socio-cultural, economic, environmental causes and consequences of the change particularly deforestation. Evaluate the current allocation and may propose a potential classification of areas into land-based values on the principles of ecosystem-based multiple use forest management, and critical analysis of forest management dynamics in relation to Turkey's commitments on forestry related international agreements. The study area covers the spatiotemporal dynamics of Golcuk Forest management planning (133998 ha) unit using the spatial database from 1972-2015. For this purposes, a spatial database was created based on the forest management plans of 1972, 2004 and 2015. In 1972 the research area covered by 4097 ha of forest, 3812 ha of agricultural area, 915 ha of degraded forest, 727 ha of residential area, and open land included 33 ha. In 2004, forest area was 4886 ha and in 2015, and 5491 ha of forest area was calculated. During 1972-2015 the forest area increased. (Note: Results are still being produced) During this period __% of agriculture area has been replaced by forest area mainly because of forest recovery and management practices by forest sector. The forest recovery and conservation practices succesfully improved the forest condition and increased the coverage of forest. The shift of energy source from fuel wood to fossil fuel also contributed to replace the degraded coppice forest into even age pure stands. LULCC map and forest cover map which included canopy cover, development stage and species mixes were produced using ArcGIS. After 2004, as Turkey signed UNCCD, UNCBD and UNFCCC forestry related agreement so the management plans were prepared accoring to ecosystem-based multiple use such as ecologic, biodiversity, recreational, economic and socio-cultural functions. There has been a significant improvement in the forest area as a result of these agreements which binds Turkish forest management to follow the sustainable management of forested landscapes.

Key words: Spatiotemporal, LULCC, Species Mix.

ESTIMATING SUSTAINABLE FOREST MANAGEMENT (SFM) INDICATORS AT OPERATIONAL SCALE IN CENTRAL ITALY

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Abstract

How to manage and maintain forest resources according to sustainable development principles have caused numerous attention since forest ecosystem plays a key role in the global ecosystem. Criteria and indicators have become powerful tools to achieve and evaluate SFM. Criteria demonstrate the conditions of the process applied for SFM assessment, whereas indicators permit measurement of given criteria. Stand structure can be considered from two aspects, structural attributes and stand structural complexity. Expected benefits for the biodiversity of forest ecosystem and recreational values of forest landscape are content during the management for sustainability. Tree species diversity and tree size diversity are vital to forestry. Dead wood acts in the literature as a structural attribute comparable in importance with the overstorey trees. Besides, the ecological roles of standing dead trees or snags and logs in the functioning and productivity of the forest also must be realized if we would like to do land stewardship a better job. Since high variability in microhabitats affect biodiversity positively, microhabitats is also a reliable monitoring tool for evaluating and demonstrating biodiversity of forests that naturally have a high structural heterogeneity and show instances for adopting microhabitats for forest inventory and monitoring as a measure of nature conservation.

The general aim of this thesis is to give an overall suggestion on choosing SFM indicators at operational scale based on the data from central Italy.

The sub-objectives are: to find the roles-- stand structure, biodiversity (whole stand and understorey), microhabitats -- play during the sustainable forest management by analysing the data collected from central Italy; to generalize the indicators those could be used for SFM at operational scale; to select a better sampling method for estimating.

Keywords: Stand structure; biodiversity, microhabitats