Scientific papers in International SCI Journals

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CLIMARK
Forest management promotion for climate change mitigation through the design of a local market of climatic credits

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CLIMARK LIST OF SCIENTIFIC PAPERS PUBLISHED IN SCI JOURNALS

Several publications have been produced as a result of the development of the Actions C1-C5 in the project. This document lists the papers published, with the full reference and DOI, and the corresponding abstract.

Alcasena F, Rodrigues M, Gelabert P, Ager A, Salis M, Ameztegui A, Cervera T, Vega-García C. (2021) Fostering Carbon Credits to Finance Wildfire Risk Reduction Forest Management in Mediterranean Landscapes. *Land* 2021, 10*,* 1104.

https://doi.org/10.3390/land10101104

Abstract:

Despite the need for preserving the carbon pools in fire-prone southern European landscapes, emission reductions from wildfire risk mitigation are still poorly understood. In this study, we estimated expected carbon emissions and carbon credits from fuel management projects ongoing in Catalonia (Spain). The planning areas encompass about 1000 km^2 and represent diverse fire regimes and Mediterranean forest ecosystems. We first modeled the burn probability assuming extreme weather conditions and historical fire ignition patterns. Stand-level wildfire exposure was then coupled with fuel consumption estimates to assess expected carbon emissions. Finally, we estimated treatment cost-efficiency and carbon credits for each fuel management plan. Landscape-scale average emissions ranged between 0.003 and 0.070 T CO_2 $year^{-1}$ ha^{-1}. Fuel treatments in high emission hotspots attained reductions beyond 0.06 T CO_2 $year^{-1}$ per treated ha. Thus, implementing carbon credits could potentially finance up to 14% of the treatment implementation costs in high emission areas. We discuss how stand conditions, fire regimes, and treatment costs determine the treatment cost-efficiency and long-term carbon-sink capacity. Our work may serve as a preliminary step for developing a carbon-credit market and subsidizing wildfire risk management programs in low-revenue Mediterranean forest systems prone to extreme wildfires

Ameztegui A, Rodrigues M, Granda V. (2022) Uncertainty of biomass stocks in Spanish forests: a comprehensive comparison of allometric equations. *European Journal of Forest Research* 141:395-407.

https://doi.org/10.1007/s10342-022-01444-w

Abstract:

Biomass and carbon content are essential indicators for monitoring forest ecosystems and their role in climate action, but their estimation is not straightforward. A typical approach to solve these limitations has been the estimation of tree or stand biomass based on forest inventory data, using either allometric equations or biomass expansion factors. Many allometric equations exist, but very few studies have assessed how the calculation methods used may impact outcomes and how this impact depends on genera, functional group, climate or forest structural attributes. In this study we evaluate the differences in biomass estimates yielded by the most widely used biomass equations in Spain. We first quantify the

discrepancies at tree level and among the main forest tree species. We observed that the divergences in carbon estimations between different equations increased with tree size, especially in the case of hardwoods and for diameters beyond the range used to calibrate the equations. At the plot level, we found considerable differences between the biomass values predicted using different methods (above 25% in one out of three plots), which constitutes a warning against the uncritical choice of equations to determine biomass or carbon values. The spatial representation of the differences revealed geographical patterns related to the dominance of fast-growing species such as *Eucalyptus* or *Pinus pinaster*, with a minor effect of forest structure, and almost no effect of climate. Finally, we observed that differences were mostly due to the data source rather than the modelling approach or equation used. Based on our results, BEF equations seem a valid and unbiased option to provide nation-level estimations of carbon balance, although local equations should preferably be used if they are available for the target area.

de Wergifosse L, André F, Goosse H, Boczon A, Cecchini S, Ciceu A, Collalti A, Cools N, D'Andrea E, De Vos B, Hamdi R, Ingerslev M, Knudsen MA, Kowalska A, Leca S, Matteucci G, Nord-Larsen T, Sanders TGM, Schmitz A, Termonia P, Vanguelova E, Van Schaeybroeck B, Verstraeten A, Vesterdal L, Jonard M. (2022). Simulating tree growth response to climate change in structurally diverse oak and beech forests. *Science of The Total Environment*, Vol.806, Part 2, 2022, 150422.

https://doi.org/10.1016/j.scitotenv.2021.150422

Abstract:

This study aimed to simulate oak and beech forest growth under various scenarios of climate change and to evaluate how the forest response depends on site properties and particularly on stand characteristics using the individual process-based model HETEROFOR. First, this model was evaluated on a wide range of site conditions. We used data from 36 long-term forest monitoring plots to initialize, calibrate, and evaluate HETEROFOR. This evaluation showed that HETEROFOR predicts individual tree radial growth and height increment reasonably well under different growing conditions when evaluated on independent sites.

In our simulations under constant CO2 concentration ([CO2]cst) for the 2071-2100 period, climate change induced a moderate net primary production (NPP) gain in continental and mountainous zones and no change in the oceanic zone. The NPP changes were negatively affected by air temperature during the vegetation period and by the annual rainfall decrease. To a lower extent, they were influenced by soil extractable water reserve and stand characteristics. These NPP changes were positively affected by longer vegetation periods and negatively by drought for beech and larger autotrophic respiration costs for oak. For both species, the NPP gain was much larger with rising CO2 concentration ([CO2]var) mainly due to the CO2 fertilisation effect. Even if the species composition and structure had a limited influence on the forest response to climate change, they explained a large part of the NPP variability (44% and 34% for [CO2]cst and [CO2]var, respectively) compared to the climate change scenario (5% and 29%) and the inter-annual climate variability (20% and 16%). This gives the forester the possibility to act on the productivity of broadleaved forests and prepare them for possible adverse effects of climate change by reinforcing their resilience.

Garcia-Pausas J, Romanyà J, Casals P. (2022). Post-fire recovery of soil microbial functions is promoted by plant growth. *European Journal of Soil Science*, e13290.

https://doi.org/10.1111/ejss.13290

Abstract:

Forest fires can alter the biological properties of soils. There is increasing evidence that fires cause a shift in soil microbial communities, which play a central role in forest carbon and nutrient cycling. In this study, we evaluate the effect of soil heating on soil microbial functions. We hypothesised that fire reduces the catabolic functional diversity of soil, and that post-fire plant growth enhances its recovery. To test this, we experimentally heated a forest soil at 200°C (T200) or 450°C (T450). Heated and unheated soils were then incubated in tubs with or without live grass (*Lolium perenne* L.). We determined the functional profiles by measuring the substrate-induced respiration (SIR) using the Microresp™ technique and analysed nutrient availability at the end of the incubation. At both temperatures, soil heating altered the respiration responses to substrate additions and the catabolic functional diversity of soils. Functional diversity was initially reduced in T200 soils but recovered at the end of the incubation. In contrast, T450 soils initially maintained the catabolic functional diversity, but decreased at the end of the incubation. Heating-induced nutrient availability stimulated the growth of grass, which in turn increased the response to several substrates and increased the functional diversity to values similar to the unheated controls. Our results suggest that fire-driven alteration of soil microbial communities has consequences at a functional level, and that the recovery of plant communities enhances the recovery of soil microbial functions.

Ghadban S, Ameztegui A, Rodrigues M, Chocarro C, Alcasena F, Vega-Garcia C. (2021). Stand Structure and Local Landscape Variables Are the Dominant Factors Explaining Shrub and Tree Diversity in Mediterranean Forests. *Sustainability* 2021, 13*,* 11658.

https://doi.org/10.3390/su132111658

Abstract:

Plant diversity is a core value of forests and is rapidly becoming a primary management goal under the threat of global environmental changes. Changing conditions, including forestry interventions, or lack of them, may endanger its preservation. Abandonment of management in forests previously subjected to a multipurpose silviculture and secondary succession is hypothesized to have altered the biodiverse Mediterranean forests in recent years and affected plant diversity. We used data in national forest inventory plots and local landscape ecology metrics from forest cartography, combined with artificial neural networks, to predict richness and Shannon diversity indices for the tree and shrub layers of several Mediterranean forest types. We found that richness and diversity depend on forest structure and on local landscape patterns, and also, though to a lesser degree, on site conditions (mainly soil pH), but not on forest intervention. In order to benefit plant diversity in the forest landscapes analyzed, forest management practices need to promote diameter variety, the presence of large trees, tree cover, variation in the height of trees and shrubs, and a heterogeneous local landscape at the stand level. Aleppo pine forests and Scots pine forests showed more consistent results in their models than cork oak and black pine forests, both of which require further research.

Under 2nd Revision in Forest Ecology and Management:

Vilà-Vilardell, L., de Cáceres, M., Piqué, M., & Casals, P. Prescribed fire after thinning increased resistance of sub-Mediterranean pine forests to drought events and wildfires.

Manuscript Number: FORECO-D-22-01318R1.

Lleida, 30/06/2022