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Soil respiration variability across three Pinus forests of different stand structure in Northern Greece.

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Abstract

Soil respiration (SR) is the second largest carbon flux between the atmosphere and terrestrial ecosystems, contributing 30–80% of total respiratory CO_2 efflux in most ecosystems. Even minor shifts in SR can significantly alter the global C balance. Forest management practices influence microclimate, canopy density, soil temperature, and moisture, that are key drivers of SR variability. Accurate assessment of SR is therefore critical, especially in Mediterranean pine ecosystems increasingly affected by xerothermic conditions. This study, conducted within the framework of the PineOptim project, aimed to evaluate the impact of different stand structure regimes on C dynamics across three pine forests in Greece: a *Pinus halepensis* (Mill.) forest in Sani (Chalkidiki) subjected to understory vegetation manipulation, and two *Pinus brutia* (Ten.) forests in Xanthi and Lesvos, characterised by different thinning intensities and post-fire age, respectively. Measurements of SR were carried out seasonally between June 2024 and July 2025 using a LI-8100A automated chamber system. Results showed significantly higher SR in *P. halepensis* plots (2.47 ± 0.13 μmol m^{-2} s^{-1}) compared to *P. brutia* sites in Xanthi (1.85 ± 0.14) and Lesvos (2.19 ± 0.23). In Sani, total removal of understory vegetation reduced SR significantly compared to plots with high and low understory density. In Xanthi, intense thinning resulted in higher SR (2.34 ± 0.2) than moderate (1.82 ± 0.12) or unthinned stands (1.39 ± 0.08). In Lesvos, the SR was significantly lower in the stand with 46 years post-fire age (1.65 ± 0.24). Seasonal variation was consistently significant across all sites, highlighting the strong influence of climate on SR dynamics. Stand structure, as resulted by different management régimes, influences SR in Mediterranean pine forests, highlighting that adaptive forest management is a powerful tool to enhance C sequestration and ecosystem resilience under climate change.

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