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Impact of thinning treatments on C sequestration and green-house gas fluxes in a degraded Pine forest

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Management of degraded forests aims at increasing soil stability, forest biodiversity and resilience, together with enhancing climate change mitigation potential. Traditional and selective thinning treatments have been applied in a peri-urban Pine forest of Mediterranean area and compared with untreated control. Thinning reduced standing biomass by 24 and 36% respectively for traditional and selective thinning. Trees growth increment of the degraded forest was close to zero in Control plots, mainly because the high density and the competition for light, water and nutrients. After two years from thinning, a significative increase of trees Net Primary Productivity was observed, particularly with selective thinning. Thinning operations determined in the short term an increase of organic matter inputs, up to 30%, to forest floor and soil until 30 cm depth, which was already observed in the first months after thinning. CO_2, CH_4 and N_2O exchanges between soil and atmosphere have been monitored for two years after thinning treatments, cumulated emissions expressed as CO_2 equivalents and global warming potential were also estimated. A short-term increase of CO_2 emissions has been observed during thinning, which declined to control values after few months and for the following two years. Selective thinning further increased CH_4 uptake in the forest soil, which acted as a CH_4 sink throughout the year. N_2O fluxes fluctuated around low values with seasonal peaks independent of treatments. Overall, global warming potential followed CO_2 trend, which was the main contributor, with a short-term increase and without significant differences due to thinning after two years. The effect of thinning treatments on green-house gas exchanges was mediated by abiotic (temperature and moisture) and biotic drivers, mainly C and N content of both forest floor and mineral soil. Overall, the loss of biomass consequent to thinning and the short-term increase of CO_2 emissions was more than offset by an increase of NPP, C sequestration in soil and CH_4 uptake, with a positive trend expected in the future. Selective thinning showed to be a proper management tool to restore degraded pine forests functionality and reach climate change mitigation objectives.