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Annual GHG emissions from forest soil of peri-urban conifer forests under different canopy densities in Greece

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ABSTRACT

The implementation of different forest management practices, such as thinning, can affect the budget of GHG through the alteration of soil characteristics and biochemical procedures.
In this study, we examined the impacts of three different canopy densities as result of thinning treatments:
- *control-unthinned,*
- *traditional(-21% change of basal area) and*
- *selective (-39% change of basal area) on GHG emissions from forest soil in coniferous forests in Greece (Xanthi), one year after thinning implementation, investigating the seasonal and spatial GHG response and the effect size of soil environmental factors (i.e. soil temperature -Tsoil- and moisture -Msoil) on them.*

INTRODUCTION

Forest soil that is responsible for 70% of total GHG emissions (IPCC, 2014), acts as source of CO_2 and N_2O and as a sink for CH_4 in Mediterranean forest ecosystem (Shvaleva et al., 2011). Forest thinning effects on GHG emissions that are driven by alteration of plant processes and forest microclimate (Gathany and Burke, 2014) (Figure 1).

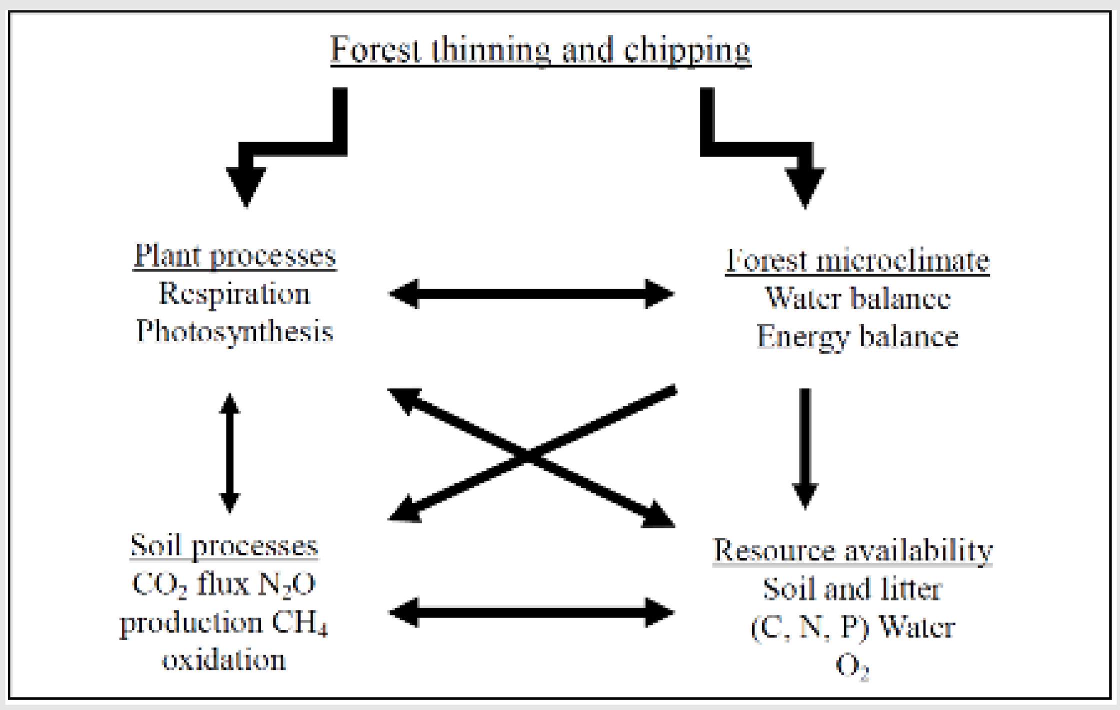


Figure 1. Forest thinning effects on soil processes related to GHG emissions (Gathany and Burke, 2014).

IMPLEMENTATION SITE-METHODOLOGY

In the peri-urban forest of Xanthi-Greece (41º 09΄ 27.33΄΄ N - 4º 54΄ 09.80΄΄ E) (Figure 2) CO_2, CH_4 and N_2O fluxes were measured with the static closed chamber method, for each treatment applied.

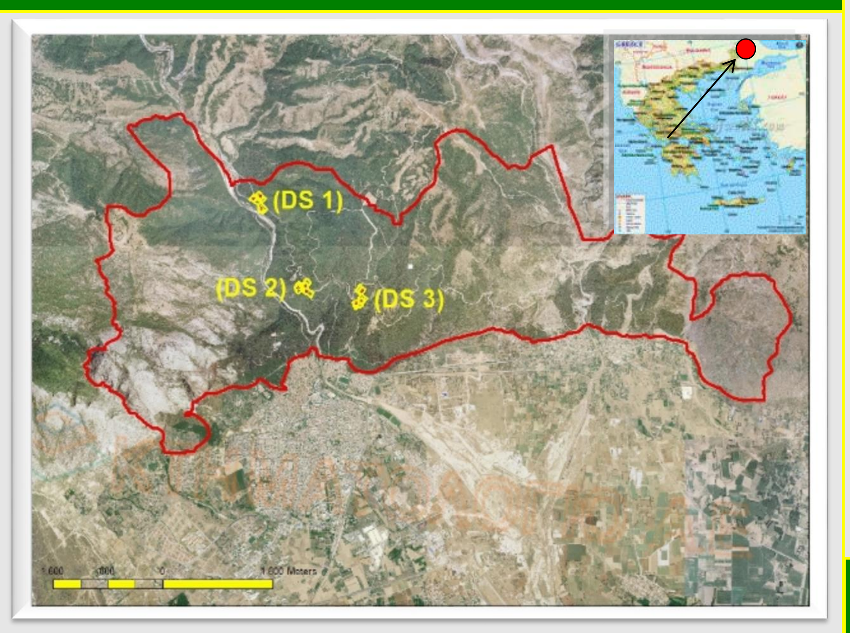


Figure 2. Study area -Periurban Xanthi Forest

Methodology:
Closed static chamber method

Time:
Twice per month

Localization:
Eighteen collars in subplots
(6 for each thinning treatment)

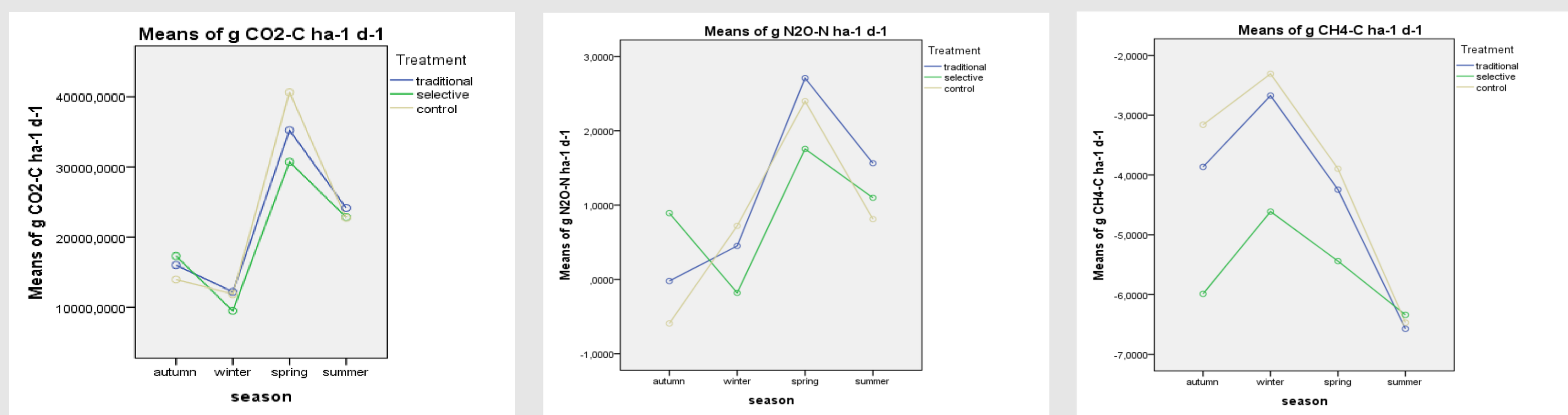
GHG effluxes were measured twice per month intervals using the closed static chamber method for one year. Tsoil and Msoil were monitored also along with the CO_2, CH_4 and N_2O of GHG emissions in each thinning treatment. Estimation also of Global Warming Potential (GWP) of GHG emissions for each treatment was assessed, thus giving an initial picture of mitigation potential of thinning practices against global climate change.

ANALYSIS

There was a significantly difference among seasons regarding CO_2 emissions (F(3,6)=48,378, p=.000 with effect size 42,70%), one year after thinning implementation. Particularly, CO_2 emissions are significantly higher in spring season compared to the other seasons in all treatments (P<0,05).

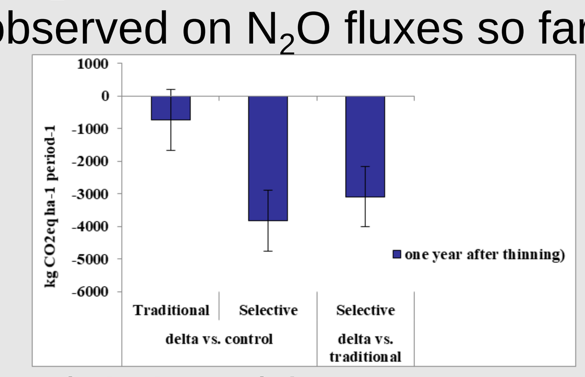
It has been observed also a significantly difference among seasons regarding N_2O emissions F(3,6)=5,328, although the effect size was small (P=.002, effect size=8%). N_2O emissions are significantly higher in spring season compared to autumn and winter (P=.000 and P=.004, respectively), but there was no significantly difference between spring and summer (P=.059).

Regarding CH_4 there was both significantly spatial (F(2,6)=5,643, P=.004, effect size=5,7%) and seasonal (F(3,6)=10,181, P=.000, effect size=14%) difference. The largest amount of CH_4 uptake has been observed, owing to season variation, during summer (-6,461±398min) that it was significantly higher compared to the other seasons (P<0,05) and owing to treatments in selective thinning (-5,59±0.357min) compared to control (-3,958±.368, P=.02) and to traditional (-4.339±,365min, P=.015) (graph 1).



Graph 1. Seasonal and spatial comparison of mean GHG emissions during the first year after thinning implementations.

Tsoil affects significantly CH_4 uptake (R^2=11,3%, P=.000<0,05) whereas both Tsoil and Msoil (R^2=15,3%, P=.001<0,05) affects significantly the variability of CO_2 emissions. No significant effect of these environmental factors has been observed on N_2O fluxes so far.



Regarding GWP, selective thinning saved 3833 kg CO_{2eq} ha^{-1} compared to unthinned and 3091 kg CO_{2eq} ha^{-1} with respect to traditional thinning (Graph 2). Traditional thinning has been saved 742 kg CO_{2eq} ha^{-1} compared to control.

Graph 2. GWP delta among treatments one year after thinning. Error bars indicate the standard error.

CONCLUSIONS

It has been assessed that both spatial -owing to thinning implementations- and seasonal variation affect significantly GHG one year after thinning. The differences of CO_2 and N_2O fluxes among treatments depend on season variation, in a higher level for CO_2 and in a lower for N_2O, mainly due to the temperature alteration among seasons. Both season and thinning significantly increase CH_4 uptake, with the largest amount being observed in selective thinning during summer. Environmental abiotic factors affect also GHG. Tsoil was the most important driving factor for CH_4, whereas both Tsoil and Msoil were significant correlate with CO_2 fluxes. There is no evidence, so far, of environmental factors effect on N_2O emissions.

Finally, regarding GWP, selective thinning appeared to have the best performance in terms of GHG emissions, saving a significant amount of kg CO_{2eq} ha^{-1} compared to unthinned and traditional thinning, contributing largely to climate change mitigation. Additional future research, based on more years of measurements, is essential before extracting definite conclusions.

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