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The influence of thinning on soil CO_2, N_2O and CH_4 fluxes in a degraded peri-urban forest

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Aim of the research

This study is based on LIFE FoResMit project mitigation options that include reducing emissions from forest degradation, enhancing the sequestration rate in restored stands in peri-urban pine forests. The objective of this study was to investigate how soil temperature, soil moisture, C and N pools in forest floor influence the green-house gases (GHGs) fluxes under different thinning treatments.

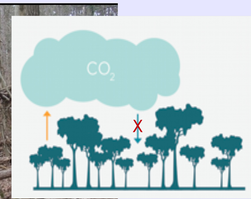
Forest degradation: implying a decrease in canopy cover, growth rate and regeneration, contributes to atmospheric GHG emissions through decomposition of remaining plant materials and soil C. These larger emissions are no more balanced by the C storage capacity in woody biomass and soil.

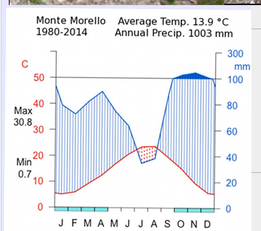
Research context

- CH_4 and N_2O atmospheric concentrations have increased significantly in the last century, currently being around 1774 and 319 ppb respectively. Although the absolute quantities of CH_4 and N_2O emitted are small compared with that of CO_2, their importance rely on their larger global warming potential (GWP) that is respectively 34 and 298 times greater than CO_2 over a 100 yr period.
Since appropriate forest management can reduce emissions from forest degradation contributing to climate change mitigation, it is important to estimate the magnitude of this service to include them into climate policy.
- Most studies assessing the impact of environmental variables and disturbances on pools and GHG fluxes from forest soil have been conducted in boreal or temperate forests and have mainly focused on CO_2, so few data are available for CH_4 and N_2O.
- In Mediterranean ecosystems an urgent need for in situ trace gas exchange data is emerging to enhance the adaptation and mitigation strategies under forest degradation.

Methods

Study site: Monte Morello (Italy)

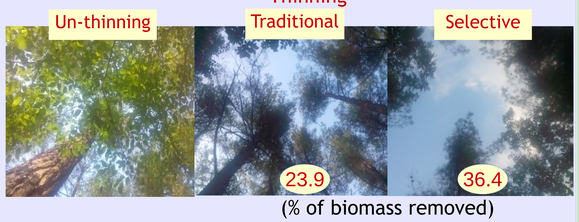




Mediterranean climate

Site characteristics	
Vegetation Type	EEA-EFTs code: 6.14.1 Plantations of site-native species
Mean tree density (tree ha^{-1})	980
Basal area (m^2 ha^{-1})	62.9
Mean height (m)	17.1
Soil type	Calcaric Cambisols and Cambic Calcisols
Sand – Clay (%)	38.4 – 27.1

Thinning



(% of biomass removed)

CO_2, CH_4 and N_2O emissions have been monitored together with C and N pools in forest floor before and after the thinning intervention. Fluxes of GHGs were measured using the static chambers method and gas chromatographic techniques. In addition CO_2 emissions were monitored also with portable instruments (PP system) for evaluating the litter contribution to total soil respiration. C and N pools have been measured in three horizons of forest floor according to litter degradation process.

Sampling:
once or twice per month – 9 plots, each divided in 2 subplots.

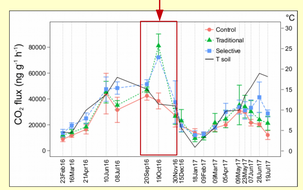
a) Closed static chambers (18 collars, 30 cm diameter): CO_2, N_2O and CH_4 fluxes.

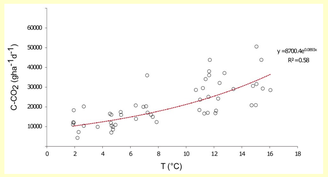
b) In addition small gas chambers (36 collars, 15 cm diameter) for CO_2 (PP-system) with and without litter.

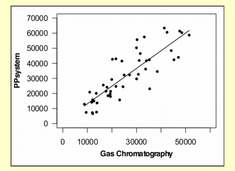
Forest floor horizons

L: fresh or slightly discoluored material, undecomposed and recognizable;
F: medium to strongly fragmented material;
H: humified amorphous material, highly decomposed –unrecognizable.

Short-term results

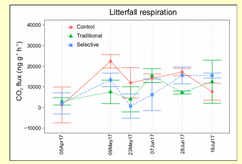


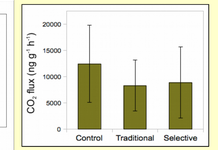




F(1,45)=115.1, R^2=0.72 p<0.001

During thinning operations significant peaks (P<0.05) under both traditional and selective treatments



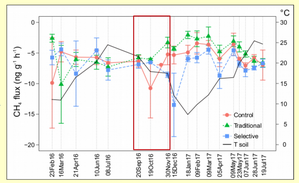


Higher litter respiration rates in the Control

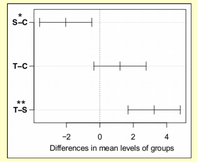
CO_2

Soil temperature resulted the main driving variables for CO_2 efflux and CH_4 uptake

CH_4

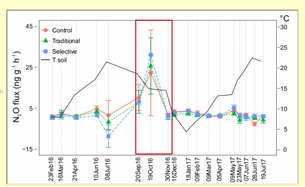


- The pine forest studied appears as a CH_4 sink
- CH_4 uptake increases after selective thinning



CH_4 uptake showed a weak linear correlation with soil moisture (r=-0.34, P<0.05)

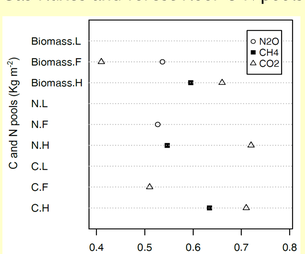
N_2O



N_2O emission peaks during thinning operations

N_2O fluxes showed a weak linear correlation with soil moisture (r=0.39, P<0.05)

Gas fluxes and forest floor C-N pools



Conclusions

Our findings suggest that C and N pools should be considered, together with environmental variables as soil temperature and moisture, for accounting GHG fluxes in degraded forests.

Evaluating the coupled effect of short and long-term impact of management practices on GHG balance may be useful to calibrate specific and appropriate management options of forest ecosystem growing in climate sensitive regions and under degradation processes.