Changes in SOC stocks and fractions after natural afforestation of alpine grasslands

Claudia Guidi[1,2], Mirco Rodeghiero[1], Lars Vesterdal[2], Damiano Gianelle[1]

Background

Due to socio-economical reasons, the dominant form of land use change in the European Alps is represented by the **abandonment of mountain grasslands** and their consequent **invasion by tree species**. The impact of these changes on soil organic carbon (SOC) is still unclear and the processes which lead to changes in SOC need to be

AIM: *study the effect of abandonment and natural afforestation of alpine grasslands on soil organic carbon, considering*

✓Changes in mineral SOC concentrations and stocks

✓Changes in carbon allocation to physical SOM fractions

Site description

The study area, located in a **pre-Alpine area** (Lavarone, Trento 45.9458 N, 11.2515 E), represents a typical situation of afforestation in Trentino region:

✓ elevation 1150 m, south aspect, gentle slope (4-15°)
✓ mixed forest, dominated by Norway spruce (*Picea abies*) and beech (*Fagus sylvatica*)

Four contrasting land uses are compared, along a management gradient:

Managed Grassland
Mown twice a year and manured

Transitional Phase
Abandoned grassland

Natural afforestation
Abandonment after 1973

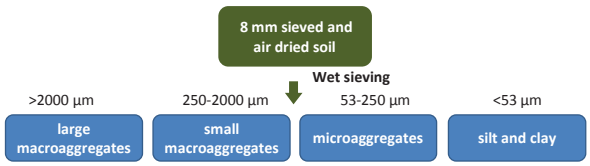
Reference Forest
Already present in 1861 land register

Methods

For each land use type three sites were sampled. In each site, 8 soil cores were collected to 30 cm depth and divided in 4 depth increments.

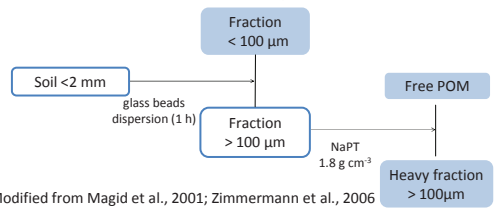
To assess changes in SOC stocks, bulk density, stoniness, root biomass and organic carbon content were determined. Mineral SOC stocks were calculated with both an **equivalent depth** and **equivalent mass** approaches.

Aggregate size fractionation



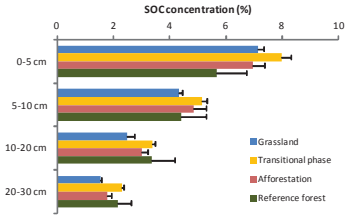
From Cambardella and Elliott, 1993

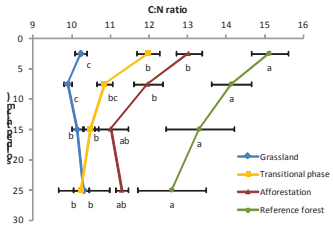
Size/density fractionation



Modified from Magid et al., 2001; Zimmermann et al., 2006

Results

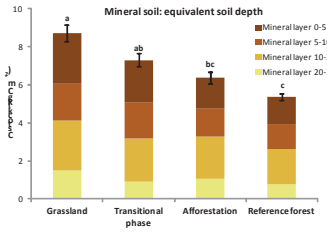


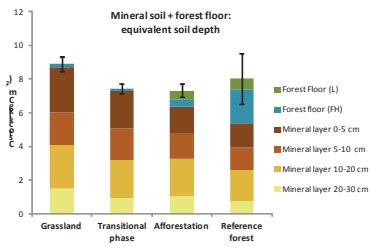


Considering the SOC concentration across land uses and depth, no significant difference was found.
The variability was high especially in forest sites.

The C:N ratio is a good indicator of land use change. It is significantly affected by land use in all soil depth increment, with more pronounced differences in the upper layers.

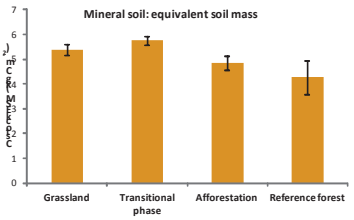
SOC STOCKS: EQUIVALENT SOIL DEPTH

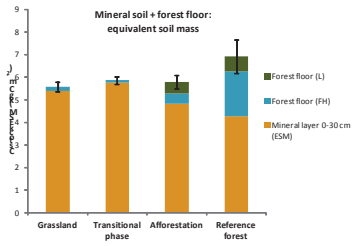




Mineral C stocks are lower in forest sites compared to grassland, due to lower **bulk density** and higher **stoniness**. If C stocks in litter and forest floor are accounted for, no significant differences are evident between land uses

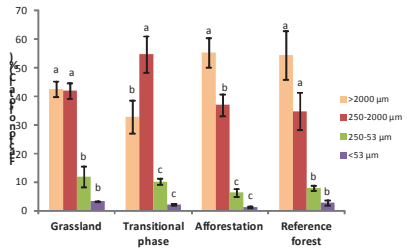
SOC STOCKS: EQUIVALENT SOIL MASS

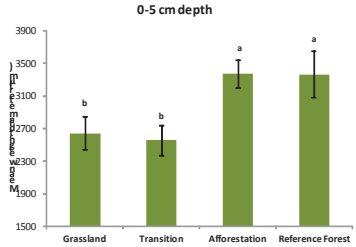




If C stocks are computed using an **equivalent soil mass** approach, no significant differences are detectable in the mineral soil of different land uses. Adding litter and forest floor, the reference forest shows higher but still not significantly different total C stock.

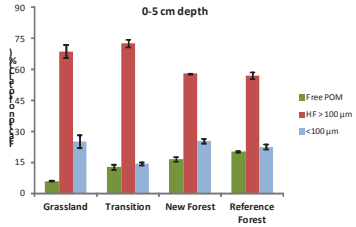
AGGREGATE SIZE FRACTIONATION





- C is stored mainly in **large macroaggregates** following afforestation: different rooting system between grassland and forest;
- The mean dimension of aggregates is higher in forest sites for the 0-5 cm depth

SIZE/DENSITY FRACTIONATION



- Increase in C stored (more than 3 times) in **free POM** from grassland to forest;
- Decreasing trend of **HF > 100 µm**
- With grassland afforestation: shift from stable to more labile SOC pools

References

- Cambardella, C.A., Elliott, E.T., 1993. Carbon and nitrogen distribution in aggregates from cultivated and native grassland soils. Soil Sci. Soc. Am. J. 57, 1071-1076.
- Magid, J., Kjærgaard, C., 2001. Recovering decomposing plant residues from the particulate soil organic matter fraction: size versus density separation. Biol Fertil Soils 33, 252–257.
- Zimmermann, M., Leifeld, J., Schmidt, M.W.I., Smith, P., Fuhrer, J., 2006. Measured soil organic matter fractions can be related to pools in the RothC model. European Journal of Soil Science, 1-10.

[1] Sustainable Agro-ecosystems and Bioresources Department, IASMA Research and Innovation Centre, Fondazione Edmund Mach, San Michele all'Adige, Italy;
[2] Dept. Geosciences and Natural Resource Management, University of Copenhagen, Frederiksberg C, Denmark

Contact: claudia.guidi@fmach.it