Soil Functional variability of key C and N processes and related greenhouse gases across the BIOdiversity and ecosystem FUnction Network (BioFUNet)

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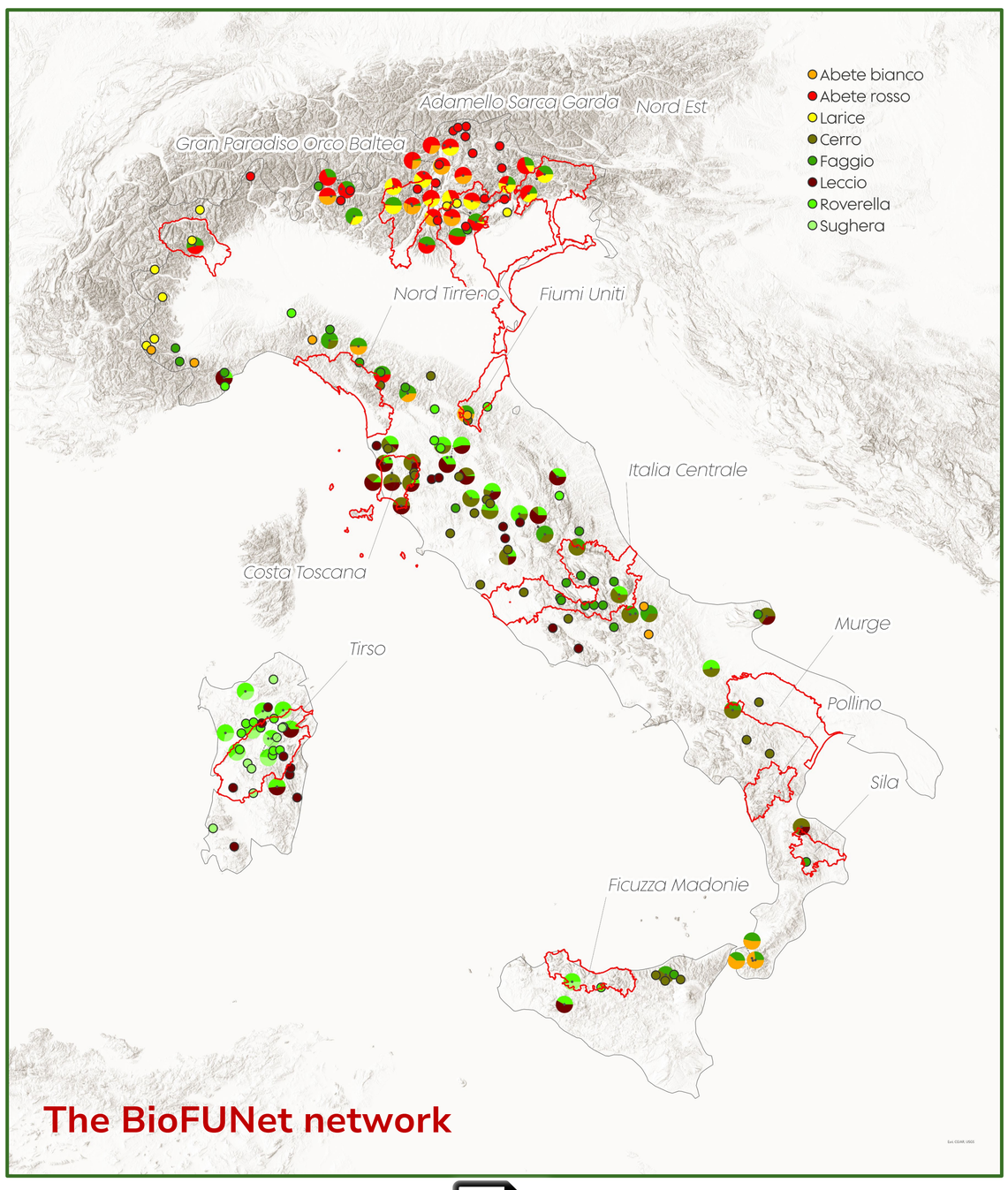
Objective

The **BioFUNet network** of Spoke 4 aims at exploring the relationship between biodiversity and ecosystem functions. *The overarching goal is to advance our understanding of the mechanisms linking specific and functional diversity and extract relevant information and indicators for improving the adaptive management, protection, and recovery of ecosystems.*

Thanks to the **"BIOSFeR3a" project** funded by NBFC spoke 4, **226 sites** of the BioFUNet were sampled, covering forest sites, Alpine and Apennines and Mediterranean pastures (right panel), with the **core objective** *to explore the variability of soil functions relevant to the biogeochemical cycles that contribute most to climate change, the C and N cycles, in relation to biodiversity.*

Biodiversity is strongly connected to efficiency of nutrient cycling and greenhouse gas fluxes but the extent and complexity of these relationships is still not fully explored.

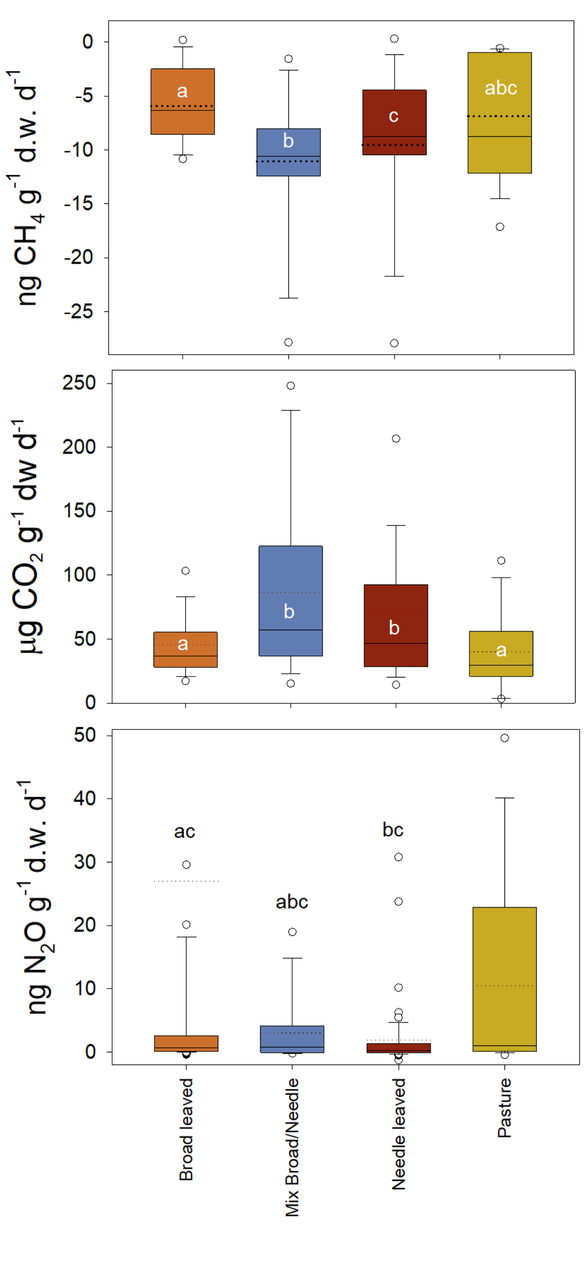


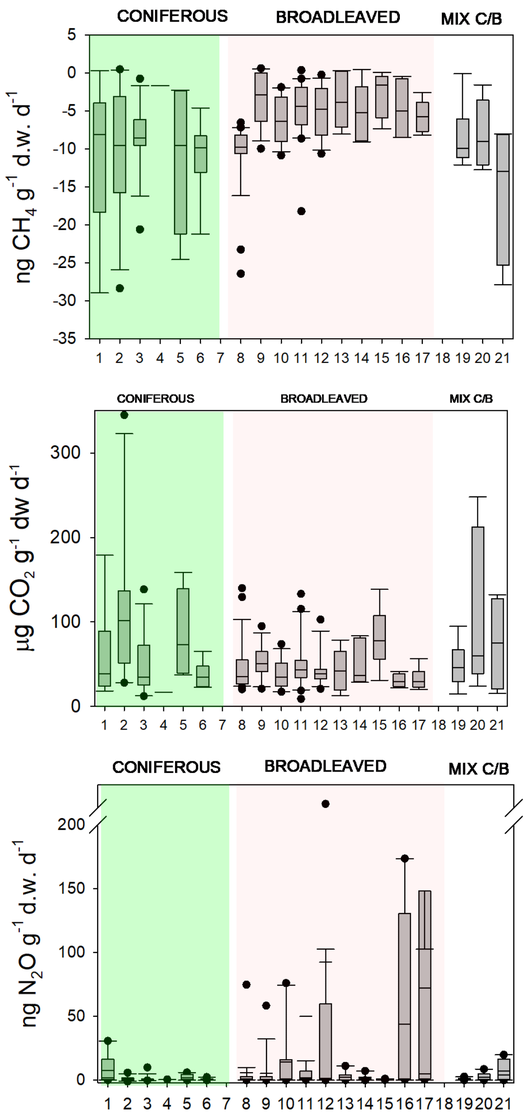
The BioFUNet network

The soil database

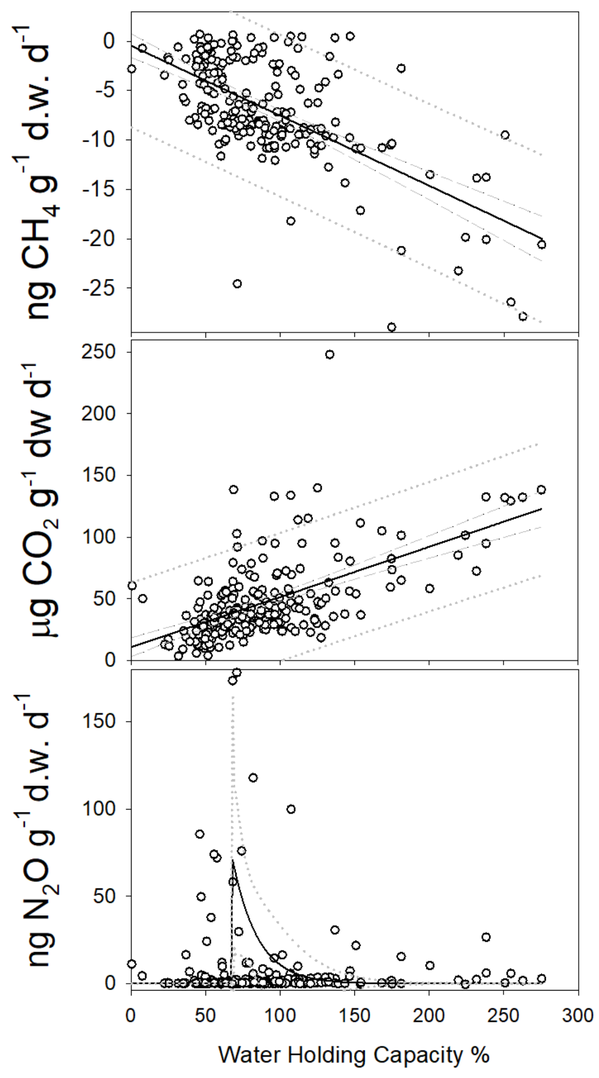
Soil samples were collected in 226 site of the Italian BioFUNet sites during a vast campaign run in spring-summer 2025. Soil for each site represent a composite sample of 5 cores taken at **0-20 cm depth,** coherently with LUCAS soil sampling procedure.

As the key focus of data analysis is the relationship between plant community diversity, site key environmental characteristic and soil C and N pools and related processes, a basic characterization was done for each soil including **soil pH, cation exchange capacity, water holding capacity, soil organic C and total nitrogen, mineral nitrogen pools, SOM ^{15}N, SOM phenolic and tannin content**. Biological activities include **soil respiration, net N mineralization, net nitrification, 5 enzymatic activities.** In addition to **CO_2 emissions, fluxes of CH_4 and N_2O** were also measured by gas chromatography in incubation experiments at optimal conditions (25°C and at 2 optimal water contents, ideal for aerobic activities and N_2O emissions). Parallel studies, not reported here, investigated on the same sites **eDNA, plant community and functional traits** to be related to soil variables.





1.Abies alba, 2.Picea abies, 3.Larix decidua, 4. Pinus pinea, 5. Abies alba + Picea abies, 6. Picea abies + Larix decidua, 7.Void, 8. Fagus sylvatica. 9.Quercus cerris, 10. Quercus pubescens, 11. Quercus ilex, 12. Quercus suber, 13. Quercus cerris + Quercus ilex, 14. Fagus sylvatica + Quercus cerris, 15. Quercus pubescens + Quercus cerris, 16. Quercus pubescens + Quercus ilex, 17. Quercus pubescens + Quercus suber, 18. Void, 19. Fagus sylvatica + Abies alba, 20.Fagus sylvatica + Picea abies, 21. Fagus sylvatica + Larix decidua



Some preliminary results

The soil analysis of the 226 sites is still ongoing for several parameters but the first available data already delineate some interesting aspects:

- All the analysed sites are **a significant CH_4 sink**, the highest values are measured in coniferous stands and the lowest in pastures and broadleaved sites
- The **fastest respiration rates are** measured in mix stands and in coniferous soils.
- Coniferous sites have the **lowest N_2O emissions**, pastures the highest
- The **variability of GHG fluxes** among stands of species belonging to the same broad groups (coniferous, broadleaved, mix) is smaller than among groups, suggesting group characteristics as relevant drivers of GHG fluxes
- **Separating the stands by species** and groups further evidences the lower fluxes of N_2O in coniferous stands compared to broadleaved
- The CH_4 sink and the soil C respiration tend to be higher in soils having higher **WHC**, which might in part be related to their higher porosity
- N_2O fluxes peak at intermediate **WHC**, as expected by this gas dynamics

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