

Ecosystem condition of temperate and boreal forests: integrating soil eDNA and remote sensing data for protection and restoration



ABOUT

This pilot investigates the ecosystem condition of temperate and boreal forests across Europe by integrating soil environmental DNA (eDNA) with remote sensing observations. The main aim is to monitor biodiversity patterns and detect the effects of forest disturbances and environmental stressors on ecosystem functioning by linking soil microbial diversity indicators with satellite-based information.

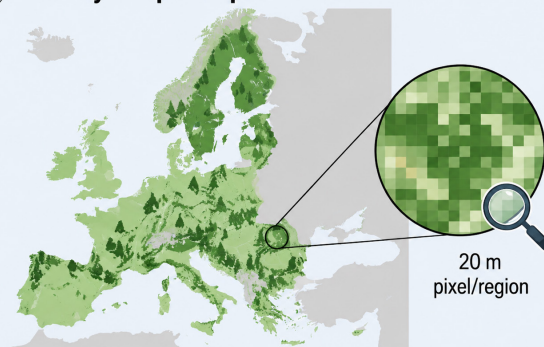
CURRENT PROGRESS

To date, we have completed the processing of the soil eDNA data and generated a set of soil eDNA metrics, including alpha- and beta-diversity indicators, as well as metrics related to nitrogen cycling and nitrogen deposition. Preliminary outputs include 1 km resolution maps of soil alpha-diversity, beta-diversity, and the relative abundance of selected groups of taxa across temperate and boreal forests in Europe. At the current stage, we are further analysing hotspot areas to explore how nitrogen deposition affects soil eDNA patterns and microbial biodiversity across European forests.

SCOPE & BACKGROUND

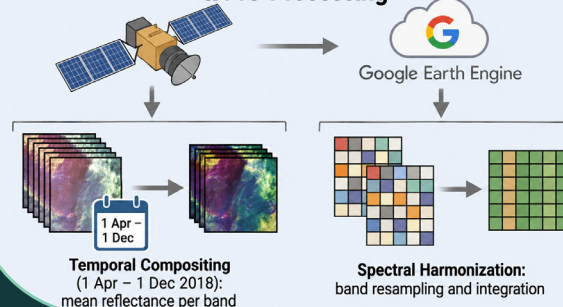
Soil biodiversity plays a fundamental role in ecosystem functioning, nutrient cycling, and forest resilience, yet it remains difficult to monitor consistently across large spatial scales. Soil eDNA provides a powerful means

1 Study Scope & Spatial Domain



Pan-European forested regions delineated. Analyses predominantly at 1 km resolution, with site-level 20 m zoom-in.

2 Sentinel-2 Reflectance Data Acquisition & Pre-Processing



Co-funded by
the European Union



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



OBSGSESSION receives co-funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101134954. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor REA can be held responsible for them.

to characterise microbial community composition and diversity, but translating these local observations into spatially continuous biodiversity indicators requires integration with Earth Observation data and environmental variables. This pilot addresses that gap by combining soil eDNA with remote sensing to generate scalable indicators of ecosystem condition across European temperate and boreal forests.

OBSGESSION'S CONTRIBUTION

Within OBSGESSION, this pilot integrates processed soil eDNA data from the LUCAS soil biodiversity dataset with Sentinel-2 observations and additional environmental variables. It develops a scalable framework to estimate soil biodiversity metrics from satellite and environmental predictors, with a particular focus on understanding how forest disturbance, environmental stress, and nitrogen deposition influence microbial biodiversity and ecosystem condition across Europe.

EXPECTED RESULTS

The pilot will deliver spatially explicit maps of soil biodiversity metrics across temperate and boreal forests in Europe and identify patterns of biodiversity variation linked to ecosystem condition and environmental pressures. It is expected to provide new scalable indicators for biodiversity monitoring, improve the integration of eDNA and remote sensing approaches, and support the assessment of forest condition, disturbance impacts, and restoration priorities..

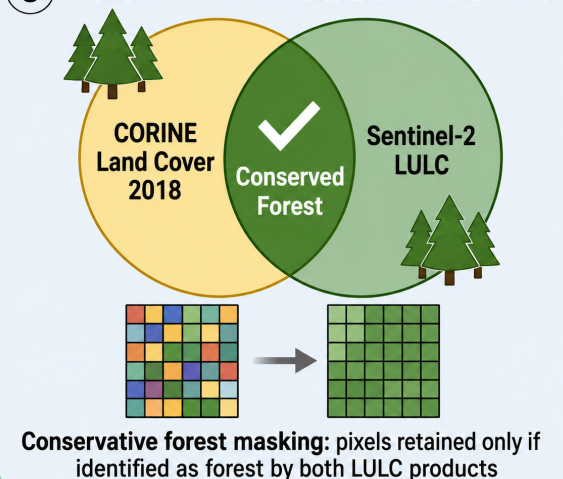
STAKEHOLDERS

The results are relevant to forest conservation and restoration authorities, biodiversity monitoring networks, environmental agencies, and policymakers implementing European biodiversity and forest strategies. The pilot is also relevant to researchers working on soil biodiversity, microbial ecology, ecosystem functioning, forest disturbance, and Earth Observation-based ecological monitoring.

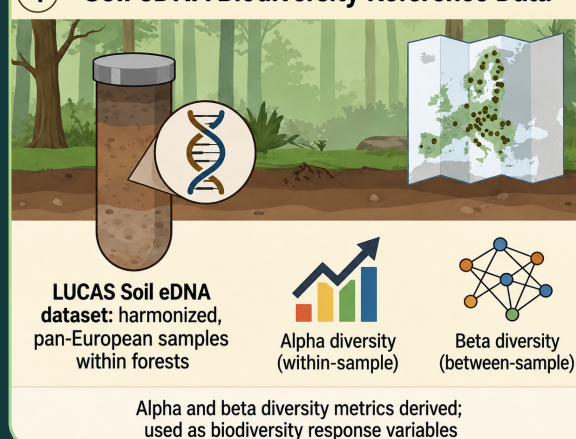


Follow
OBSGESSION

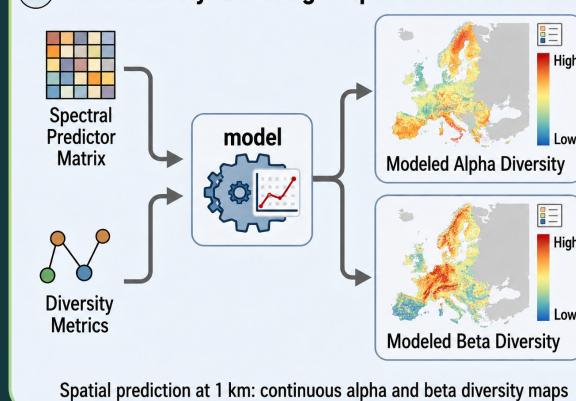
3 Robust Forest Mask Generation



4 Soil eDNA Biodiversity Reference Data



5 Biodiversity Modeling & Spatial Prediction



6 Ecological Pattern Analysis & Environmental Correlates

