SOILGUARD

Integrating soil biodiversity into global conservation frameworks to safeguard soil health and ecosystem services


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Soil biodiversity should be incorporated into global conservation frameworks to safeguard soil health and sustain essential ecosystem services.

There is considerable variation in the abundance, composition and complexity of soil biodiversity around the world, and these are strongly influenced by regional characteristics and management approaches.

Alternative management approaches can promote soil multifunctionality, and should be more widely adopted.

Soil management must be tailored to regional and local contexts to effectively preserve soil biodiversity.

Background: Strengthening the Global Biodiversity Framework

The Kunming-Montreal Global Biodiversity Framework (GBF) provides a comprehensive framework for coordinating global efforts on biodiversity conservation, aiming to safeguard the planet's ecosystems while promoting sustainable development.

The conservation of soil biodiversity is an aspect of these efforts which demands more global attention than it has so far received – indeed, soil biodiversity is an irreplaceable resource that underpins ecosystem services essential for human well-being. Urgent action is needed to safeguard it for future generations.

SOILGUARD is an H2020 project which – in line with the aims of the GBF – aims to boost the sustainable use of soil biodiversity to protect soil multifunctionality from land degradation, unsustainable management and climate change, thus increasing economic, social and environmental well-being.

Soil biodiversity is closely linked to two GBF targets:

Target 8 – Minimizing the impacts of climate change on biodiversity and building resilience.

Target 10 – Enhancing biodiversity and sustainability in agriculture, aquaculture, fisheries and forestry.

SOILGUARD: How can alternative management approaches benefit soil biodiversity?

SOILGUARD is a research project aimed at understanding the impact of soil management on soil biodiversity and multifunctionality. It compared conventional soil management with alternative approaches in three biomes across ten biogeographical regions.

BIOME	CONVENTIONAL SOIL MANAGEMENT	ALTERNATIVE SOIL MANAGEMENT
Croplands	Conventional use of phytochemicals	Organically managed croplands free of phytochemicals, synthetic pesticides and fertilizers
Grasslands	Low-diversity (one or two species) and high-input grasslands	Multi-species (six species) and low-input grasslands
Forests	Clear-cut forestry	Continuous-cover forestry

The research was designed to test three core hypotheses:

i) Land degradation and conventional soil management increase biodiversity loss.

ii) Alternative soil management promotes soil biodiversity and soil multifunctionality.

iii) The impacts of land degradation and conventional soil management are region-specific.

SOILGUARD in the field

You can find details of the global site network and the sampling protocols in two project deliverables:

D 2.1 – Map of the cross-biome network of sites and land degradation gradients

D 2.2 – Report on the soil biodiversity status in European and international biogeographical regions

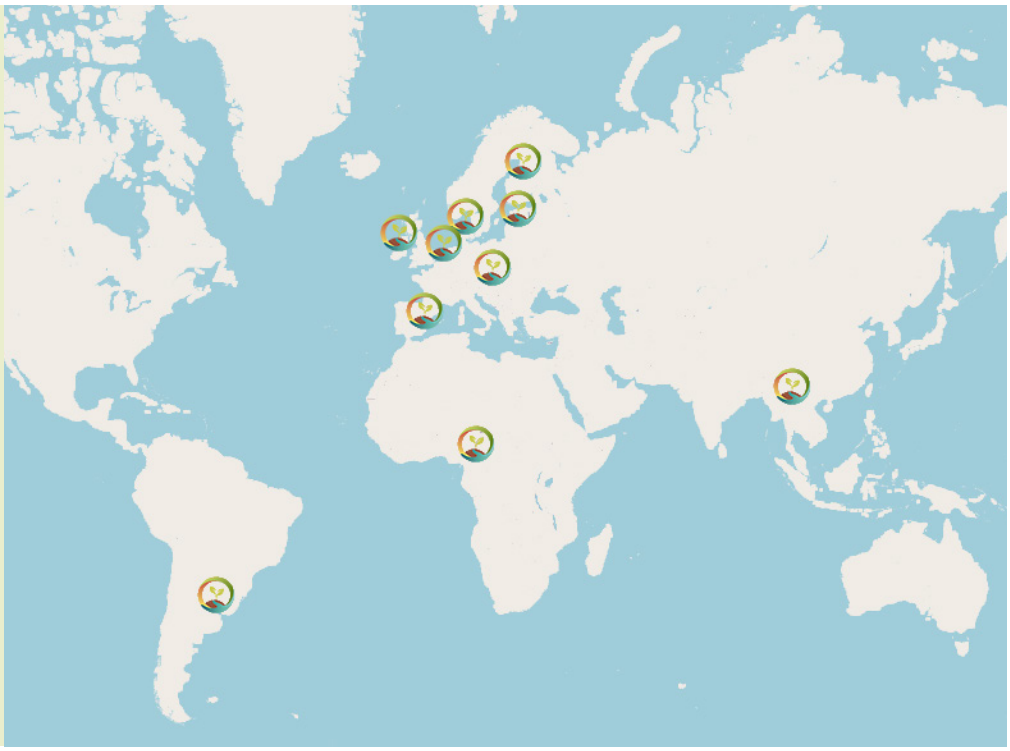
SOILGUARD in numbers

233
sites

8
biogeographical regions

4
continents

3
biomes (cropland, grassland, forest)



SOILGUARD: Key Findings

Regional variation

- There is considerable variation in the abundance, composition and complexity of soil biodiversity around the world. These features of soil biodiversity are strongly influenced by biogeographical, regional and local characteristics.
- Soil biodiversity is closely correlated with factors such as soil texture, acidity, organic matter content and quality, land use, climate, and their complex interactions.
- Biomes located further north, with higher carbon content, perennial crops and lower land-use intensity have higher microbial and faunal biomass and abundance than croplands with lower carbon content located further south.

Monitoring soil biodiversity

- Understanding spatial variations and distribution patterns in soil biodiversity is crucial for the sustainable use of the ecosystem services it underpins. Consistent monitoring and data-driven conservation are fundamentally important.
- Following extensive research, we propose four key indicators that together can account for more than 70% of observed variations in soil biodiversity:
  - Soil fungal biomass
  - Prokaryotes richness
  - Mites abundance / springtails abundance
  - Total microbial storage biomass / arbuscular mycorrhizal biomass
- These indicators should be measured in a standardized manner, while allowing flexibility to include other indicators depending on the regional context of each site.

Effective – and alternative – soil management

- Soil management must be tailored and contextualized to local conditions to effectively preserve soil biodiversity.

The effects of soil management on soil biodiversity vary across different types of organisms and across biomes:

- In **croplands**, alternative soil management benefited eukaryotes, particularly fungi, suggesting that organic farming has an overall positive effect on biodiversity.
- In **forest sites**, alternative soil management (continuous cover) was found to have positive effects on prokaryotes, eukaryotes and fungi, but not on mesofauna groups.
- In **grasslands**, we found mixed results depending on the soil organisms, with greater diversity under alternative soil management (multi-species grassland mixtures) for collembola and fungi, but lower for eukaryotes and nematodes.

- Alternative soil management can have neutral, positive or negative effects on soil biome complexity. Therefore, understanding the effects of soil management on soil biota under specific conditions is crucial for preserving soil biodiversity.
- Alternative soil management practices can have positive effects on key aspects of soil functioning. Targeting medium- and highly-degraded soils for conversion to organic agriculture would maximize benefits for soil biodiversity and functionality, while minimizing potential yield losses in croplands.

Soil biodiversity and soil multifunctionality

- Even accounting for numerous other drivers, our results show a positive correlation between soil biodiversity and soil multifunctionality: maintaining diverse biological communities in soil is crucial for sustaining ecosystem services.
- There are no inherent trade-offs between soil biodiversity, multifunctionality and yield in croplands: there is potential to achieve high levels of all three simultaneously under both organic and conventional management.

Climate and soil biodiversity

- SOILGUARD results show that agricultural soils under climates with higher temperatures in the warmest and driest seasons and higher aridity have lower soil biodiversity.
- Nevertheless, in croplands and grasslands the impact of moderate, short-term droughts on soil biodiversity were small. The ability of soil biodiversity to buffer such droughts is particularly relevant for sustaining ecosystem functioning under extreme weather conditions, and – with GBF Target 8 in mind – underscores the importance of prioritizing climate change adaptation of soils in regions with long-term aridity and higher temperatures.

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Summary

Soil biodiversity is a crucial aspect of soil multifunctionality, and its promotion should be incorporated into the global conservation agenda under the GBF and other frameworks.

Alternative soil management can achieve strong results in many circumstances, although wide regional variation in the abundance, composition and complexity of soil biodiversity means that locally tailored approaches are essential: management solutions must be adapted to specific contexts.

Soil biodiversity can also act as an effective buffer to climate change impacts, which further highlights its importance in the provision of ecosystem services.

For the conservation community, the time has come to actively integrate soil biodiversity into strategies, advocacy and actions to enhance soil health and ecosystem services – building on the scientific evidence provided by SOILGUARD to inform more effective and context-specific interventions.

For more information about the project, visit the SOILGUARD website.

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