Modelling Soil Biodiversity, Niche Dynamics, and Climate Responses: Insights from the BiOservicES Project

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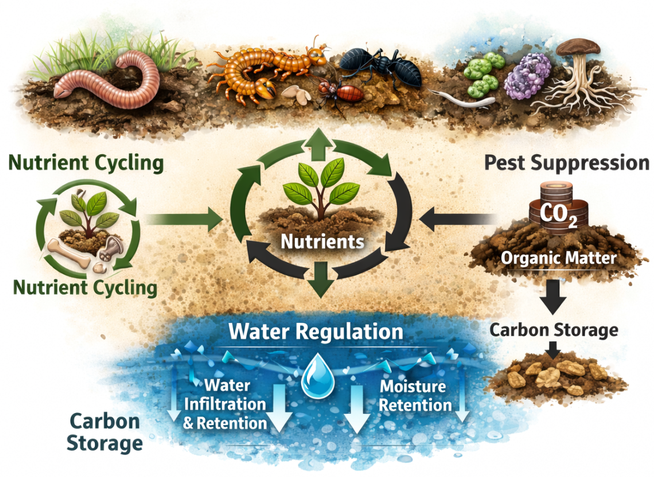
The Context



- **Soil organisms** regulate essential ecosystem processes (nutrient cycling, carbon storage, pest suppression and water regulation).
- Soil degradation causes **£4.8-8.0 trillion** in global economic losses each year, driven by land use and climate change.
- Understanding how soil biota respond to land use and climate change is crucial for **long-term sustainability**.

The Problem

- Soil organisms are essential and commonly observed, but their ecological niches, climate sensitivity and relationships with ecosystem functions and services (EFS) are **poorly understood**.
- This limits soil sustainability assessments, EFS valuation, and **policy support**.
- **BIOservicES** addresses this challenge by providing the missing link between soil biodiversity and EFS.

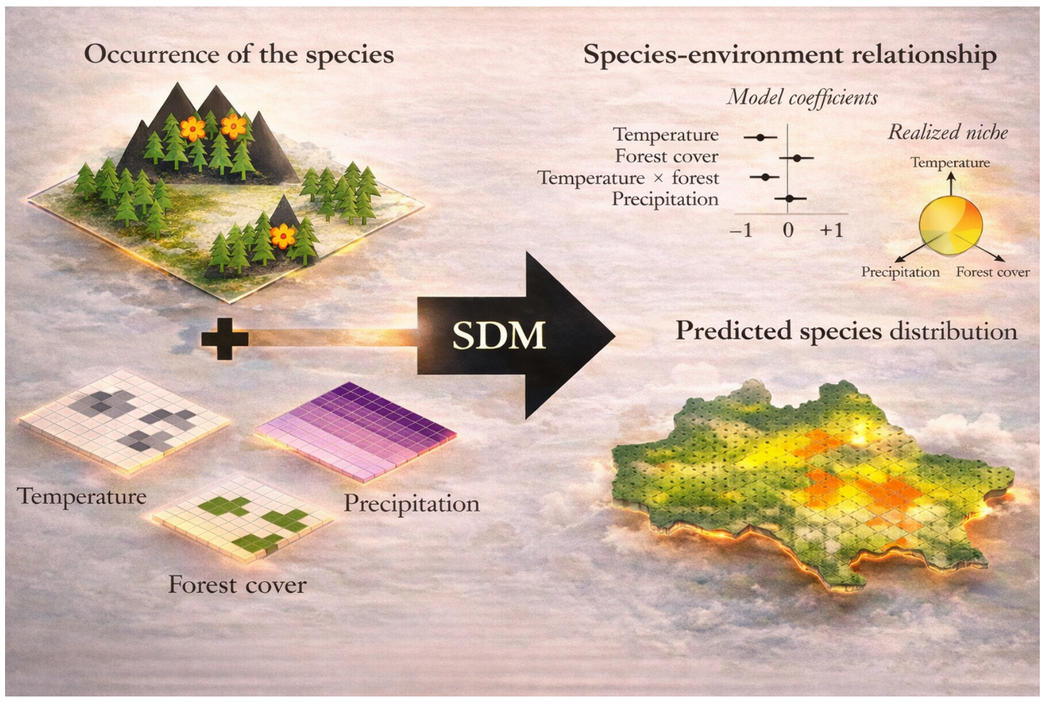
Our Approach

Inputs

- Soil biodiversity observations from 25 experimental sites
- Five biogeographic regions
- Eight land-use types
- Climate, land use and soil properties across environmental gradients

Ecological niche analysis

We characterise species' environmental preferences and tolerance to identify **ecological niches** across regions and land-use systems.



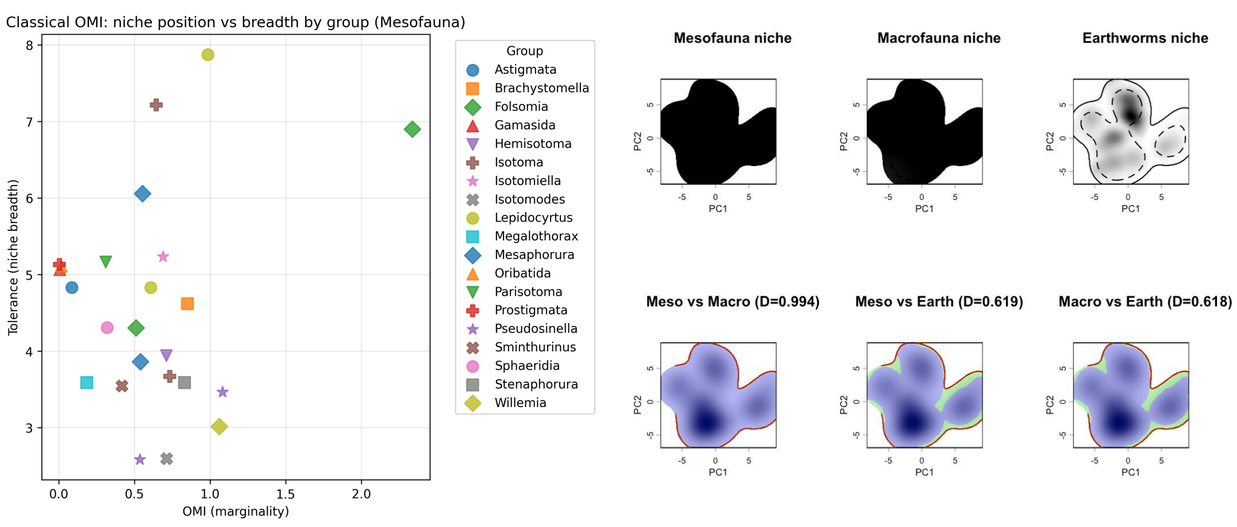
Understanding niche similarity improves species distribution modelling and strengthens predictions under future climate and land-use change

Species distribution modelling (MaxEnt): Habitat suitability is estimated using a MaxEnt framework that incorporates rapid environmental change:

$$\max_P H(P) = -\sum_x P(x) \log P(x)$$

Subject to environmental constraints derived from species-environment relationships.

Results: Niche Overlap, Position and Breadth

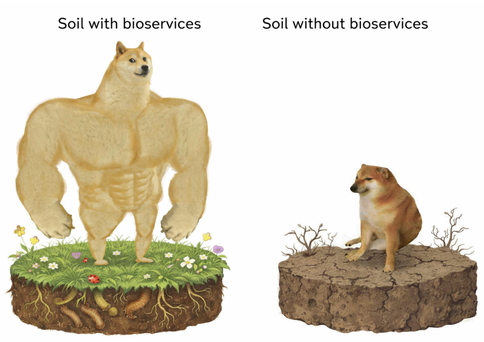


- We identify varying degrees of niche overlap among soil fauna groups
- Some groups share highly similar environmental preferences, while others occupy distinct niches
- Niche position and breadth distinguish generalist (Low OMI + high tolerance) and specialist (High OMI + low tolerance) strategies, revealing their resilience and responses to climate change

Towards Precision Ecology

Modelling niche dynamics across diverse environments and climate scenarios will:

- Enable prediction of soil biodiversity under future scenarios
- Deliver decision-support tools through BIOservicES partners
- Inform soil management and climate adaptation policy



Explore the BIOservicES Project

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