



BAMBOO

TOWARDS CONSIDERING FUNCTIONAL DIVERSITY IN IMPACT ASSESSMENT

DF 87 - Biodiversity in LCA: how far have we come?

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03/09/2024



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Motivation

Need

- Going beyond species for a closer link to ecosystem functioning (Cadotte et al. 2011)
- Recommendation by UN Environment Life Cycle Initiative to include functional diversity as an additional indicator for a broader coverage of ecosystem attributes (Woods et al. 2018)

Limitation

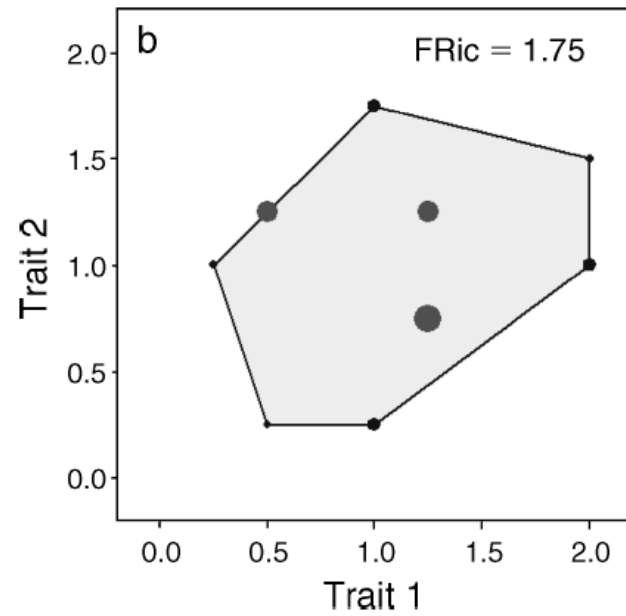
- No operational method yet
- Challenges to scale up initial attempts at a smaller scale
- Early steps for few impact categories

Opportunity

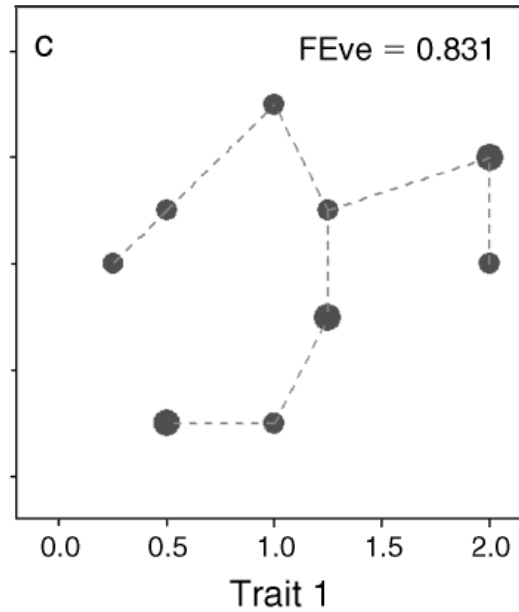
- Increasing availability of trait data



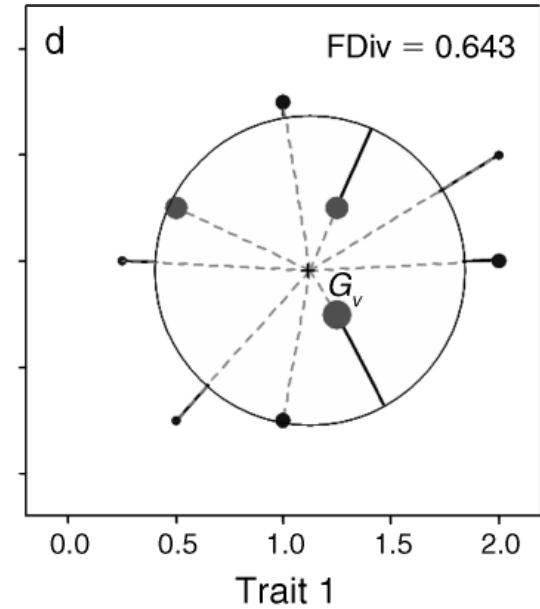
Functional diversity metrics



Functional richness



Functional evenness



Functional divergence

Source: Villéger et al. (2008)



Land use - Scope



Scherer et al. (2020)

→ Rosa et al. (2024)

- 2,197 → 73,074 vegetation plots
- 860 → 7,185 species
- 4 → 30 traits



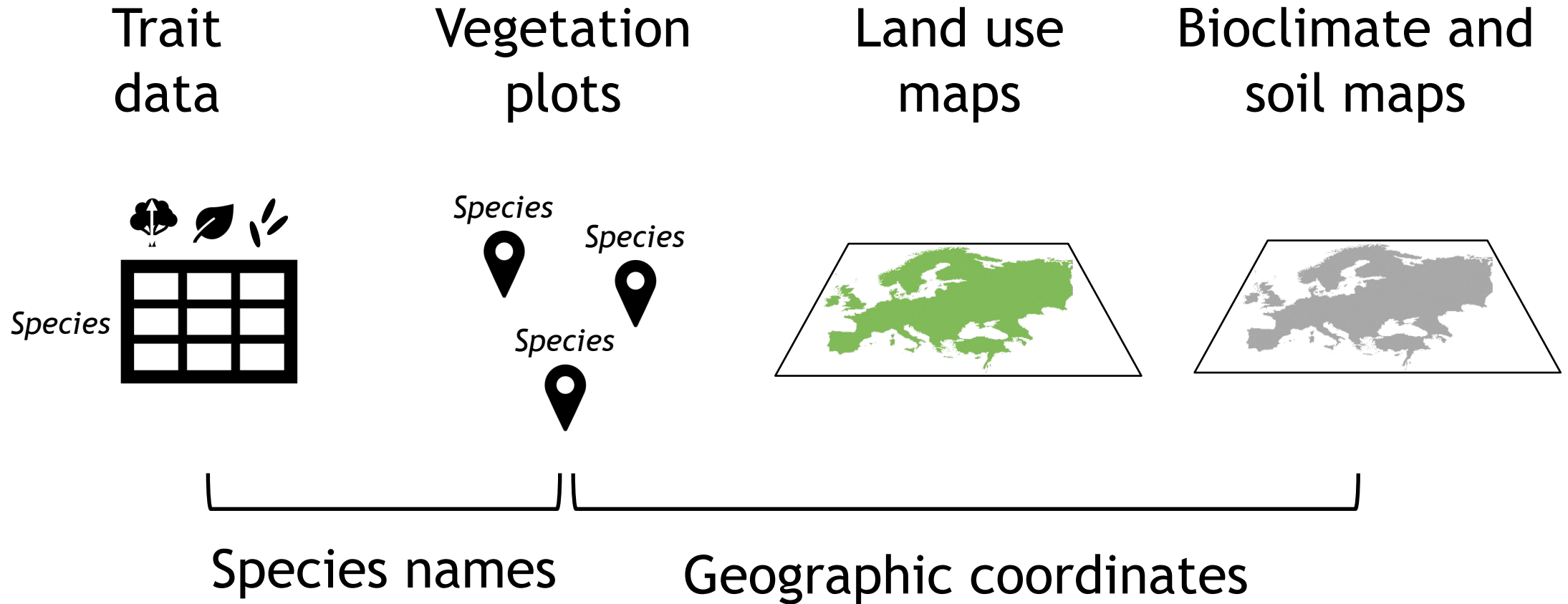
Scherer et al. (2020)

- Germany

Rosa et al. (2024)

- 12 of 16 European bioregions

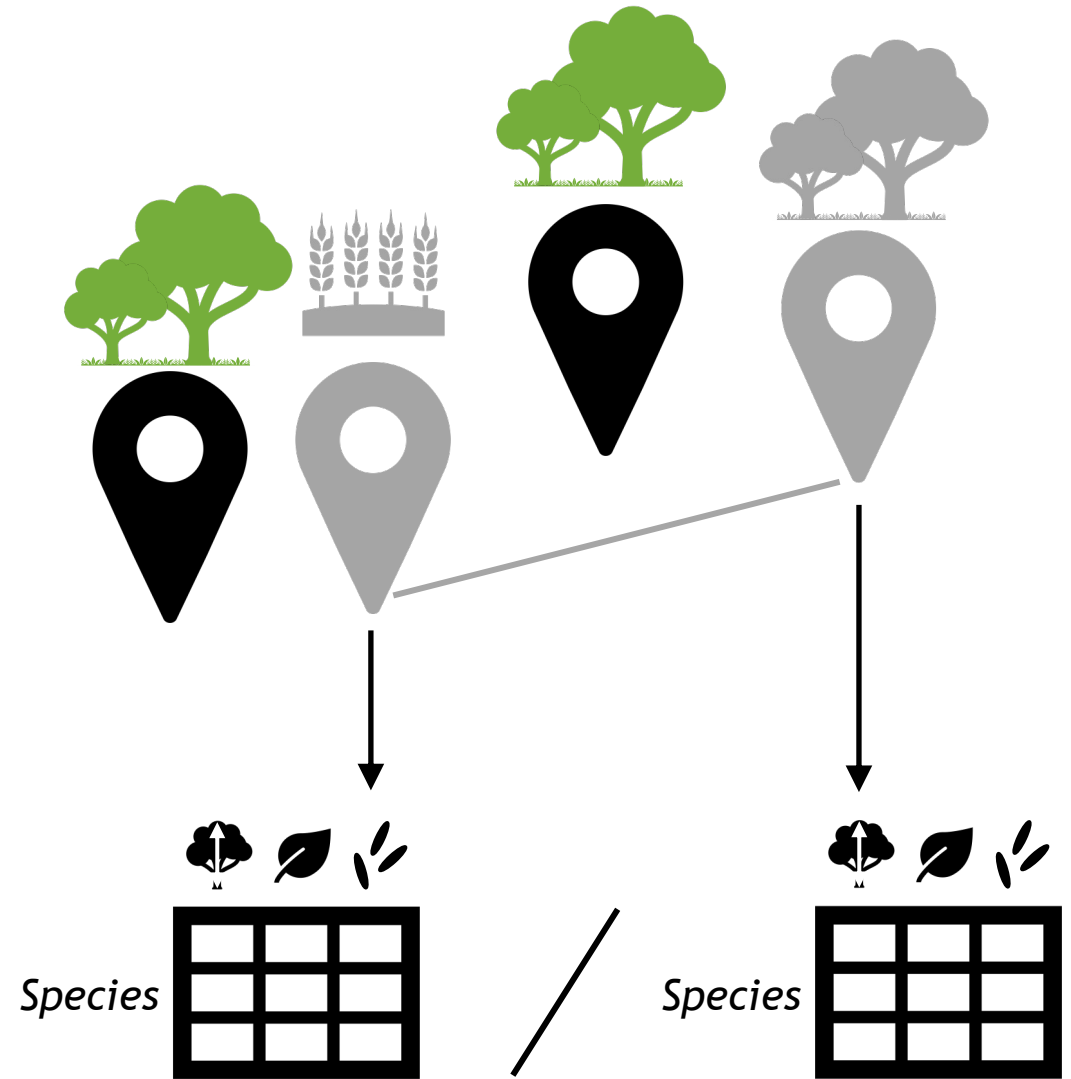
Land use - Concept



Land use - Concept

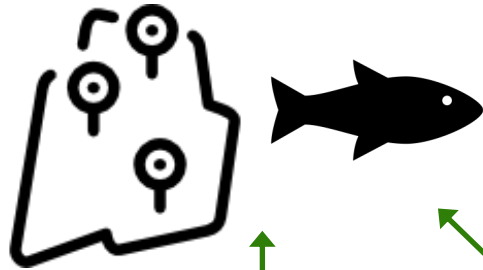
Matching of land use pairs
based on environmental
covariates

Ratio of functional
diversity metrics

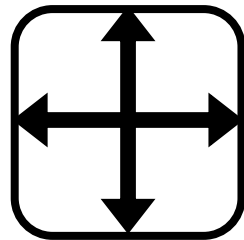
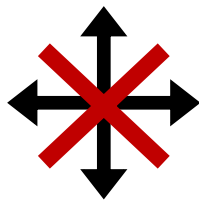


Climate change (freshw.) - Projections

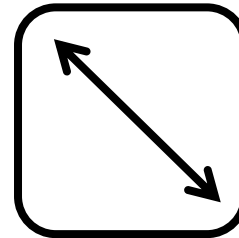
Geographical ranges of 11,425 riverine fish species



Dispersal



Climate niche limits



... and their exceedance

Water temperature and streamflow extremes



Warming

1.5 2.0 3.2 4.5 °C



Icons partly made by Freepik from Flaticon



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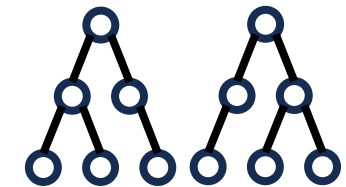
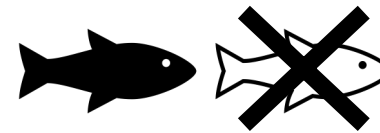
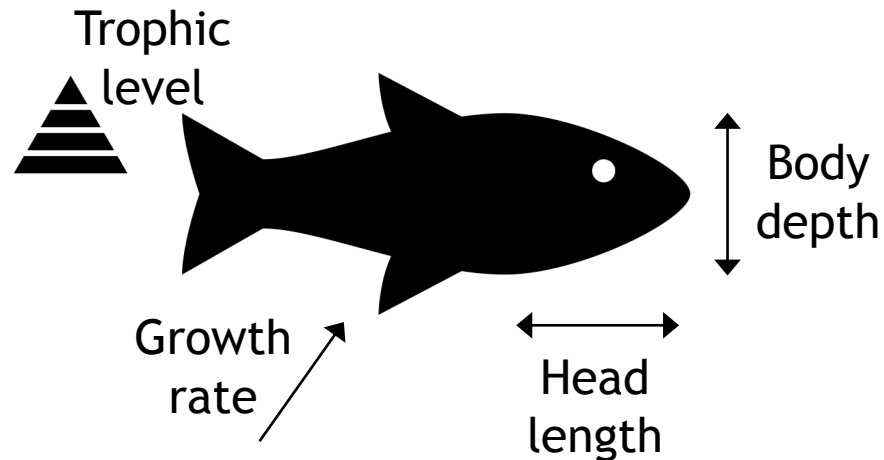


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Climate change (freshw.) - Functional diversity

Traits
(Morphological & physiological)

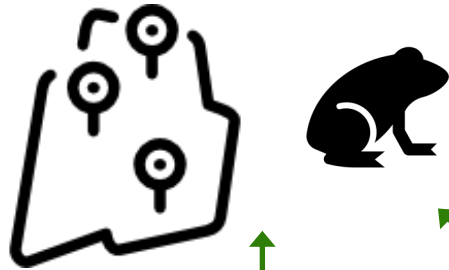
Missing values
Species removal vs. missForest



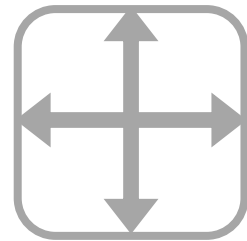
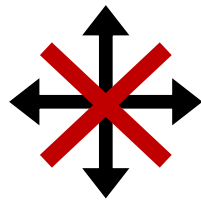
$$\text{Loss: } 1 - \text{FD}_{\text{warming}} / \text{FD}_{\text{historical}}$$

Climate change (terrestrial) - Projections

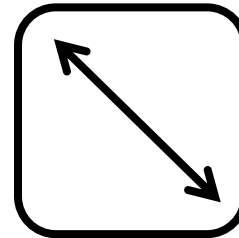
Geographical ranges of 7,727 amphibian species



Dispersal



Climate niche limits



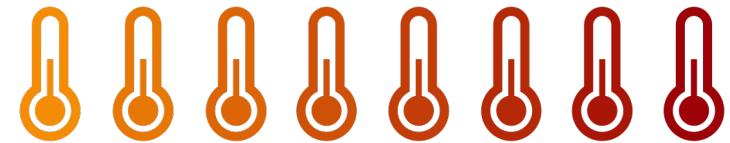
... and their exceedance

Surface temperature and precipitation



Warming

1.3 1.8 2.2 2.3 2.6 3.2 4.1 5.1 °C

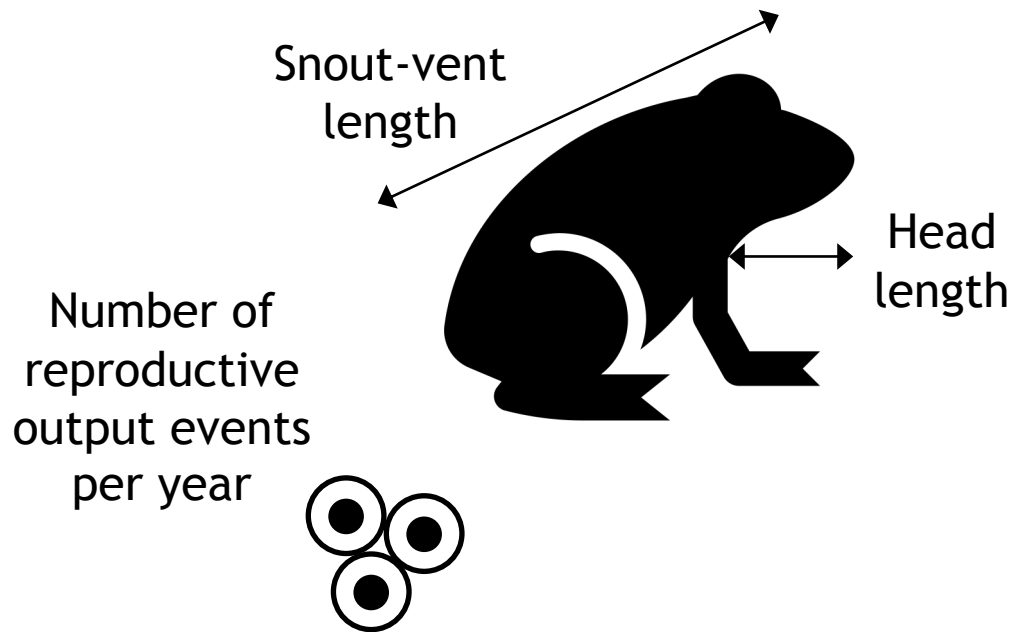


Icons partly made by Freepik from Flaticon

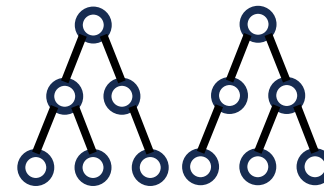


Climate change (terrestrial) - Functional diversity

Traits
(Morphol., physiol. & life history)

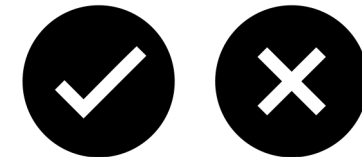


Missing values
missForest

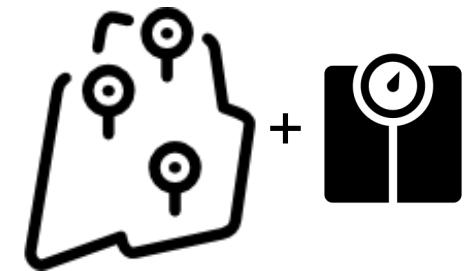


Species
occurrence

Presence / absence

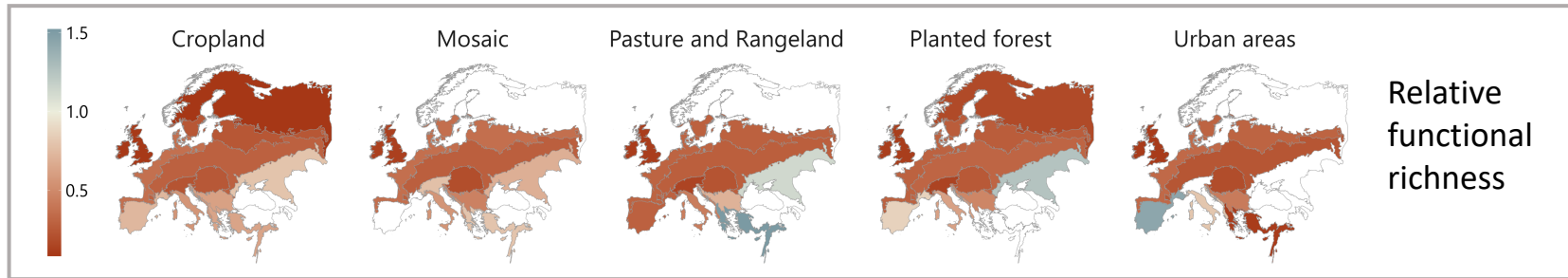


Abundance

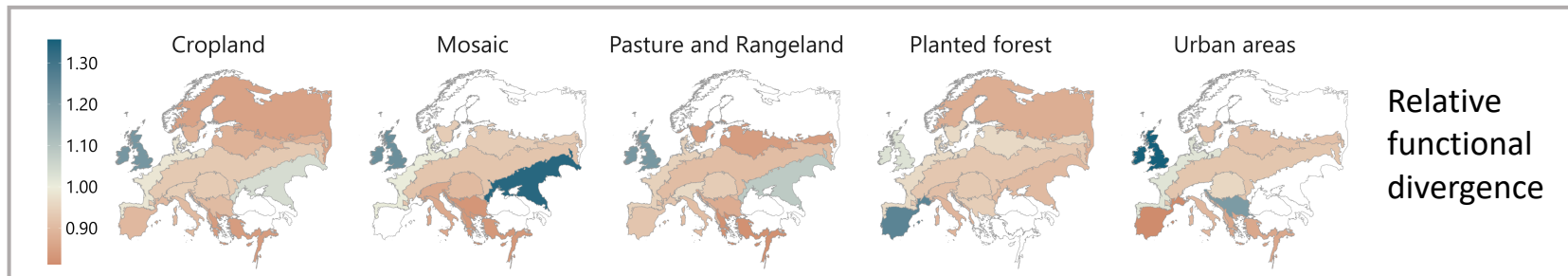


$$\text{Loss: } 1 - \text{FD}_{\text{warming}} / \text{FD}_{\text{historical}}$$

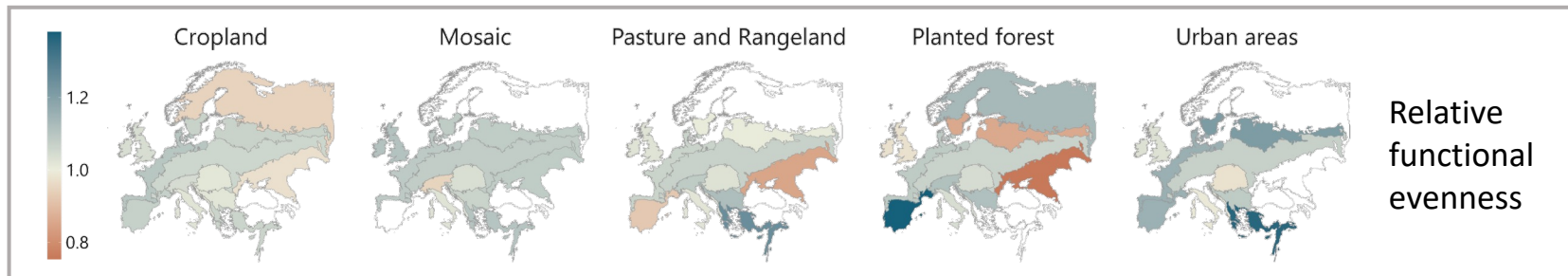
Land use - Results



Reduction of trait space



Less extreme traits

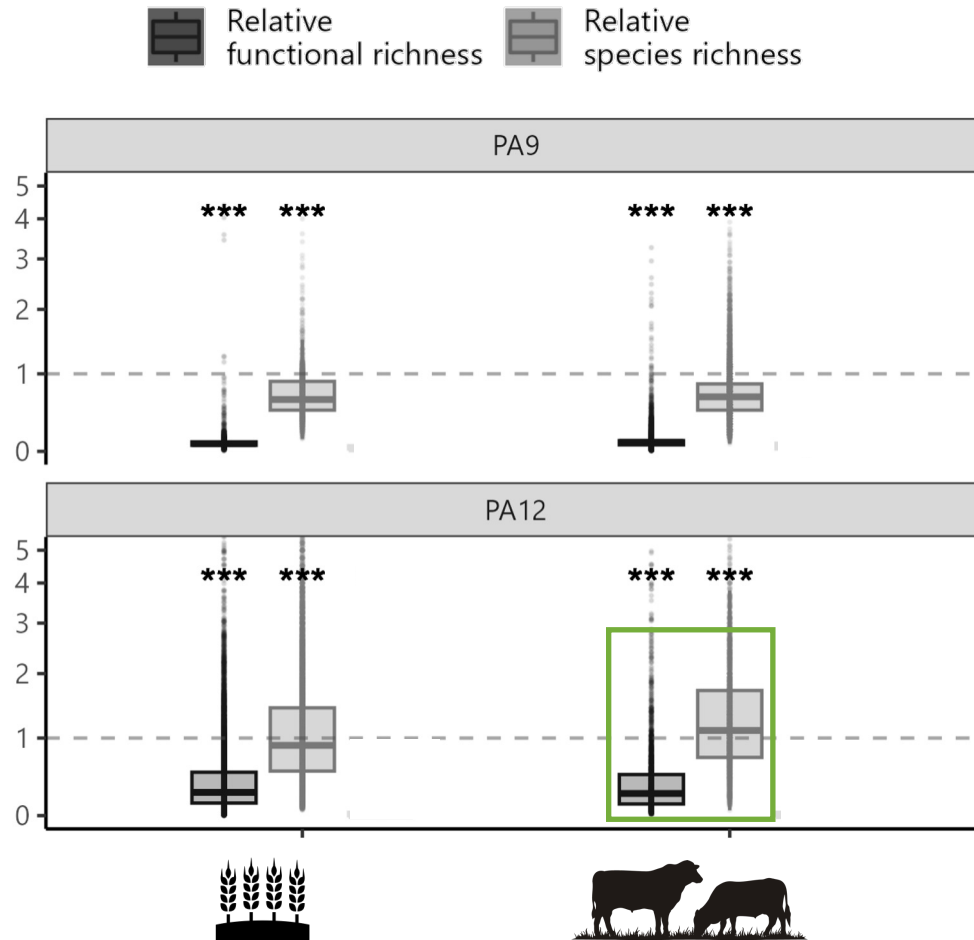


Traits distributed more regularly

Functional homogenization



Land use - Results



Stronger response in functional richness than species richness

Opposite trends in some cases

Wilcoxon test: ***: p-value < 0.001, **: 0.001 < p-value < 0.05, *: 0.05 < p-value < 0.1, no *: p-value > 0.1.



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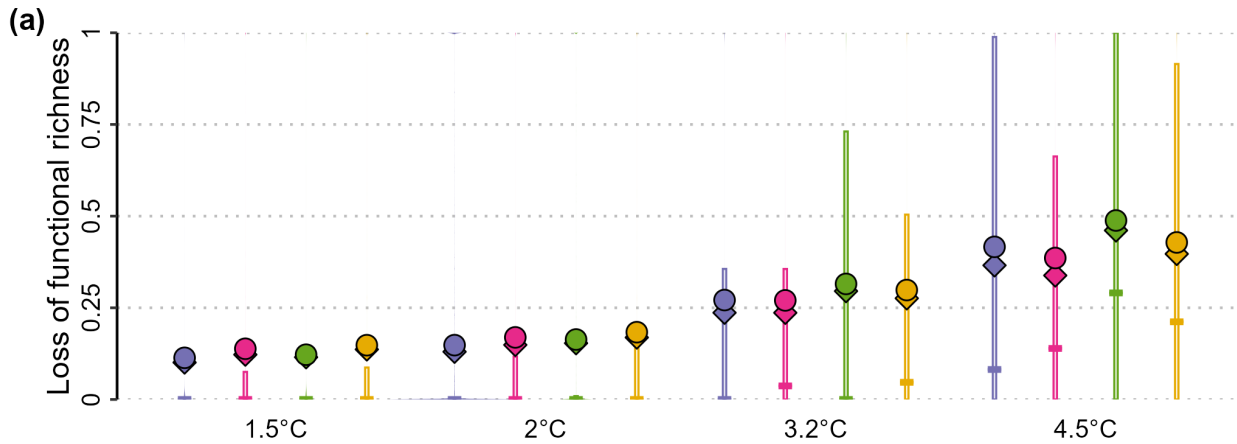
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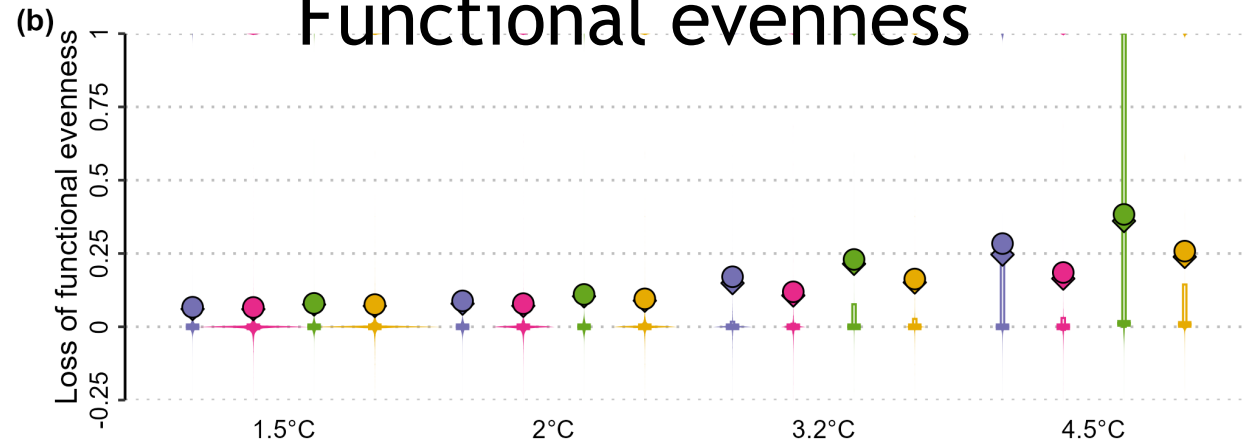


Loss of functional diversity (freshwater)

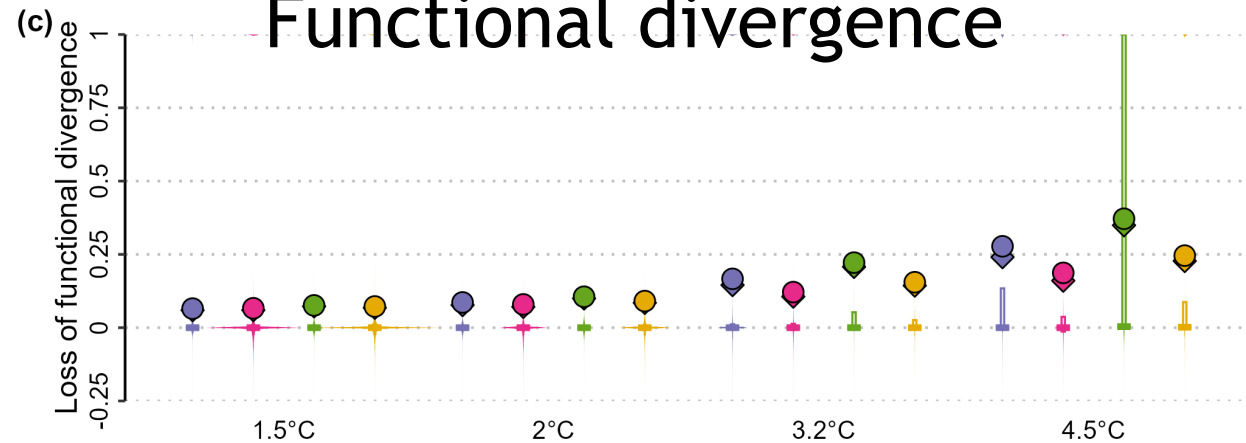
Functional richness



Functional evenness

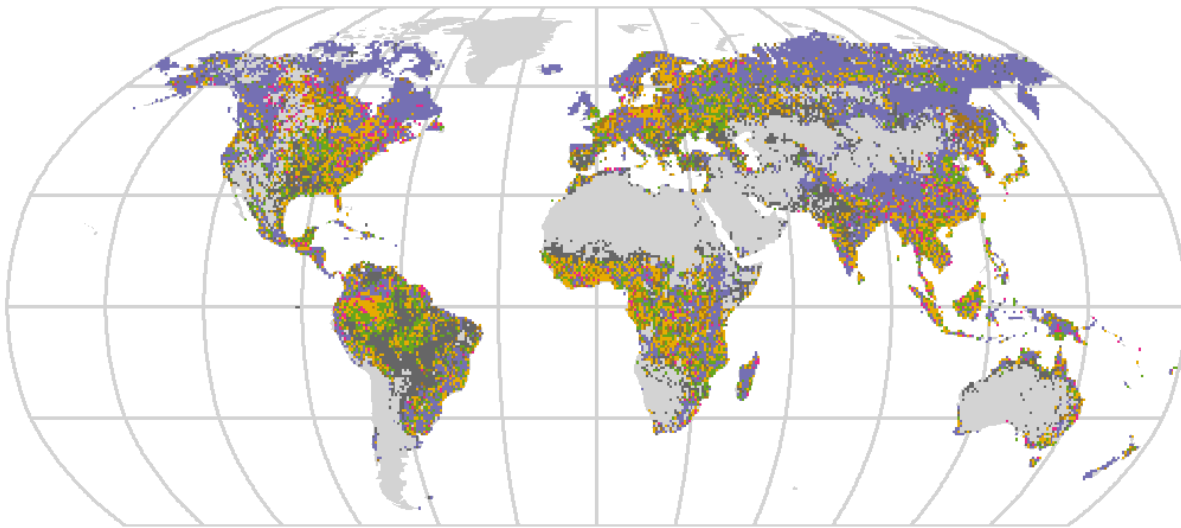


Functional divergence

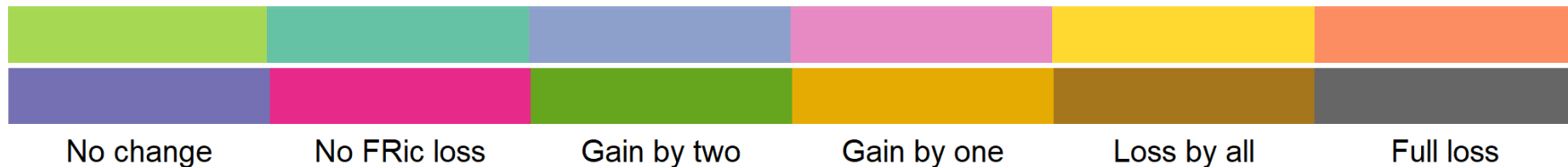
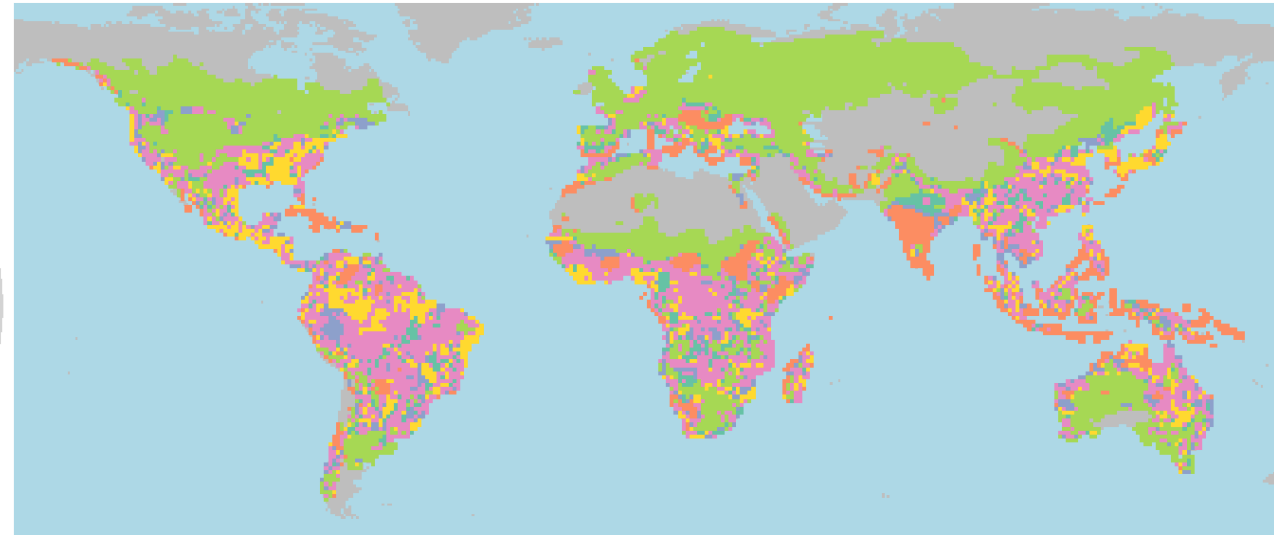


Functional diversity change categories (no dispersal, imputed traits, presence/absence, 3.2°C)

Freshwater



Terrestrial



Outlook

Ongoing and planned related work in BAMBOO project:

- Climate change impacts on marine ecosystems
- Eutrophication impacts on marine and freshwater ecosystems
- Development of impact assessment methods



Outlook - Ecotoxicity

Horizon Europe project TerraChem

From soils to apex species: chemical pathways, effects and impacts on terrestrial biodiversity and ecosystem services and applications for better chemicals management




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Key take-aways

- Remaining challenges but also progress across multiple impact categories
- Added value compared to species richness
- Complementarity among the three facets
- High potential losses
- Strong spatial variation



For more info

Land use - Proof of concept
Publication by Scherer et al. in
ES&T



Land use - European bioregions
Preprint by Rosa et al. on

bioRxiv



Climate change - Freshwater
Publication by Scherer et al. in
GCB





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Thank you!

Visit <https://www.bamboo-horizon.eu/>



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