

Effects of landscape configurational heterogeneity on farmland biodiversity supporting sustainable agriculture

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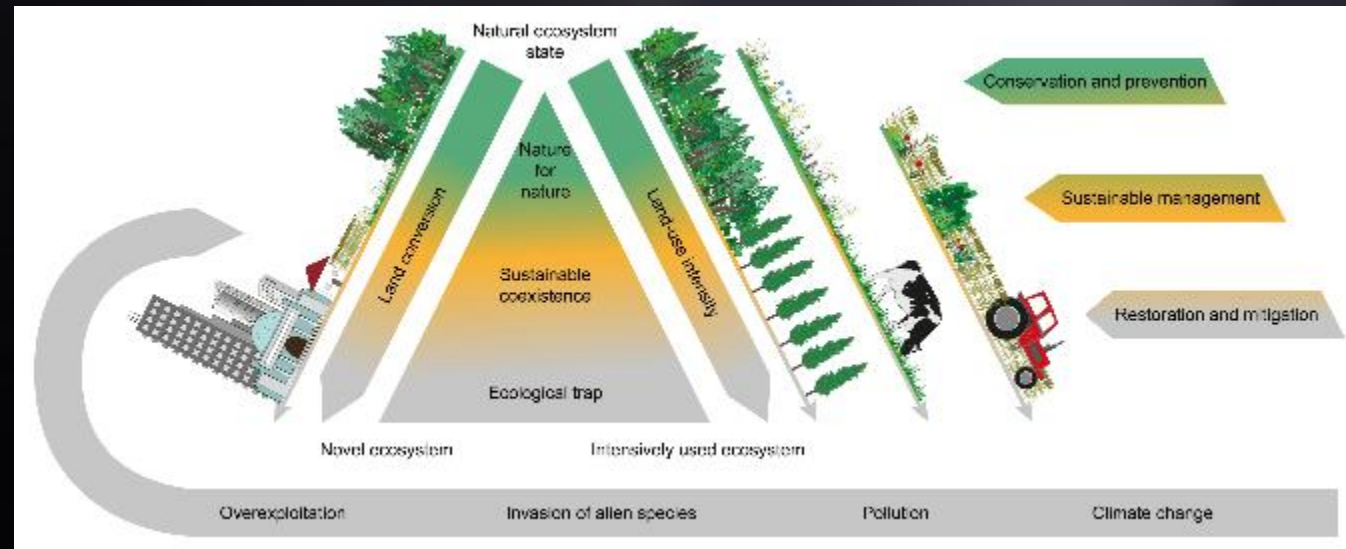
Planet under pressure – Land-use and land-cover change



50 % of Earth's terrestrial, habitable surface covered by agriculture.



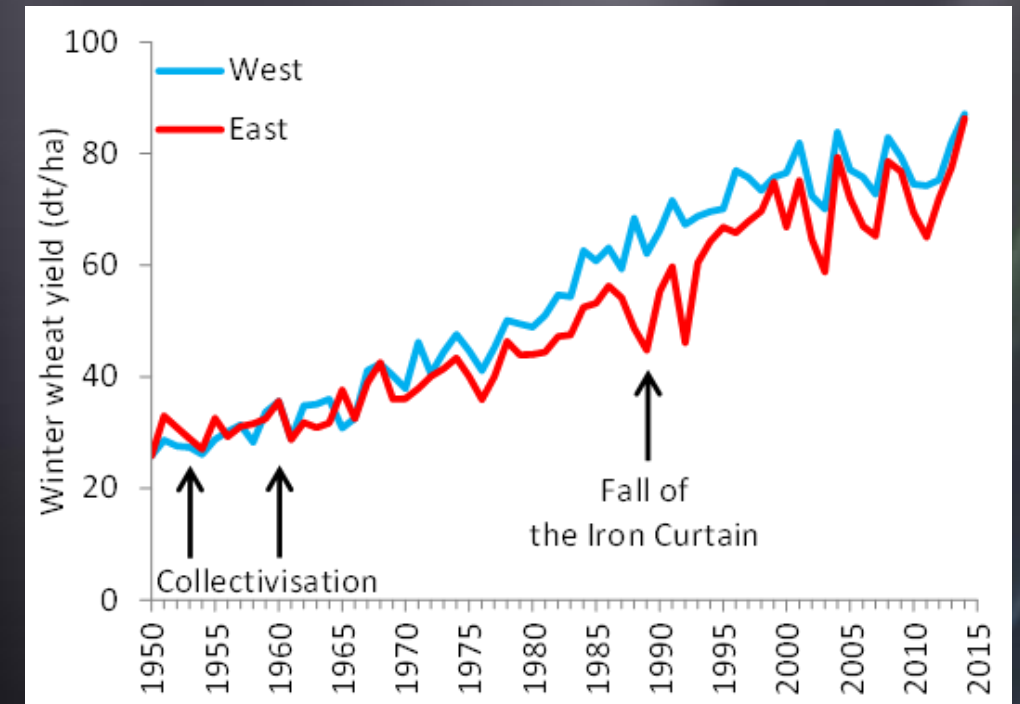
Dorota Kotowska
postdoc



Green revolution and yield increase



Norman Borlaug's Green revolution got Nobel Peace Prize (1970).



- Even if the 2nd Green Revolution (genetic engineering) came, and there are a lot of agroecological solutions, still 800m people malnourished or starving.
- Major problem is social inequity.



- Today's agriculture heavily based on conventional farming with high input of agrochemicals – still massive losses in staple crops too.
- However, it has severe externalities on environment and nature.
- SDG2: Zero hunger - End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
- EU's Green Deal targets a reduction of 50% of pesticides until 2030 along with 25% of agricultural land under organic farming (9% in 2020).



Trends in Ecology & Evolution



Opinion

Beyond organic farming – harnessing biodiversity-friendly landscapes

Teja Tscharntke,^{1,*} Ingo Grass,² Thomas C. Wanger,^{3,4,5,*} Catrin Westphal,⁶ and Péter Batáry⁷



Trends in Ecology & Evolution

Opinion

Mixing on- and off-field measures for biodiversity conservation

Teja Tscharntke ^{1,*}, Péter Batáry^{2,3}, and Ingo Grass^{4,5}

Landscape structure



Landscape composition refers to the variety and abundance of patch types without regard to their spatial character or arrangement.

Landscape configuration, in contrast, refers to the spatial character and arrangement, position, or orientation of landscape elements.

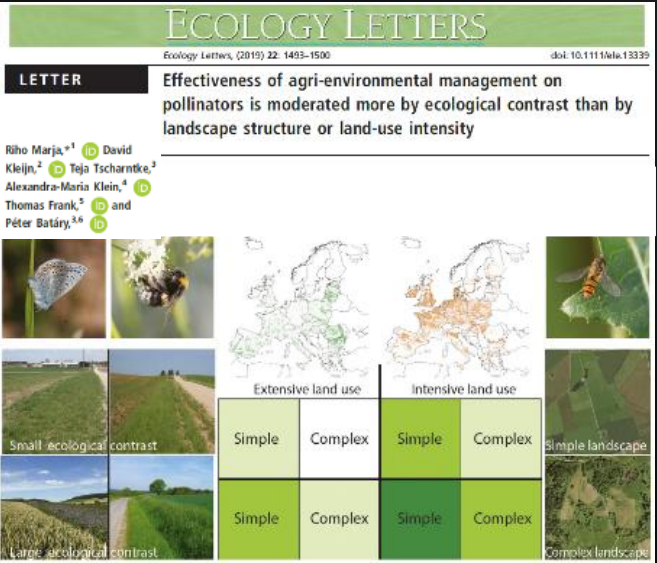
Bösztör puszta, Hungary



Hungarian Grey Cattle



Intensification vs. Fragmentation studies



Converted environment

Intensive farmland or urban areas

Local: management intensity

Landscape: composition (crop%, sealed area%, Shannon-diversity)

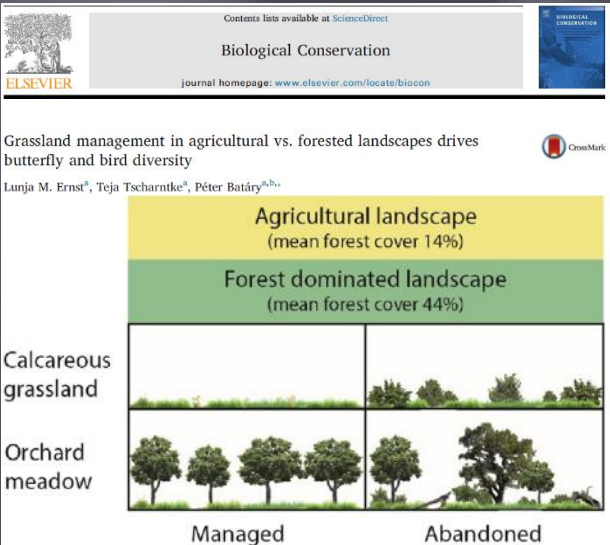
Habitat fragments

Remaining (semi)-natural fragments

Local: habitat quality, fragment size

Landscape: configuration (isolation/connectivity)

Interaction of effects between and within scales on biodiversity and ecosystem services



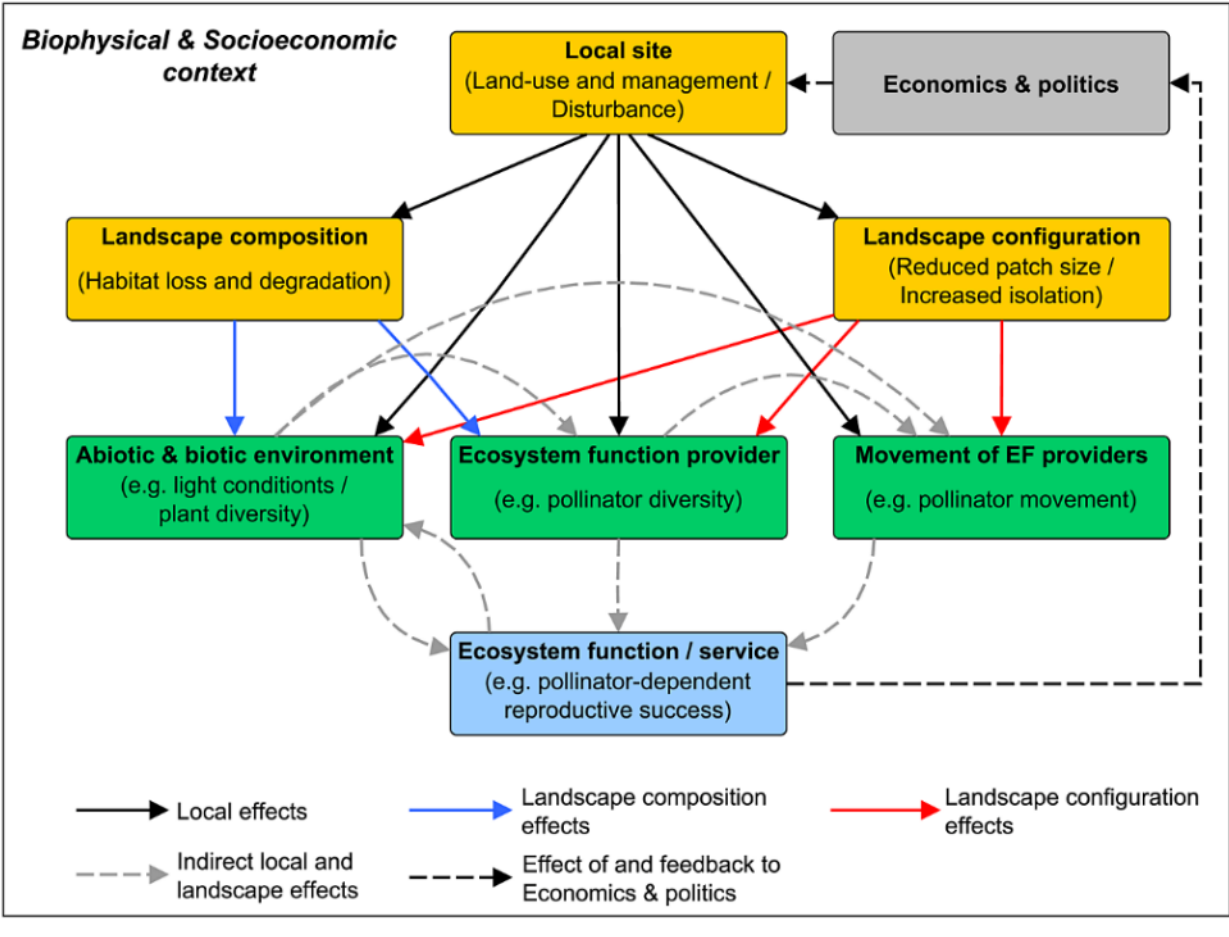


REVIEW



Biologia Futura: landscape perspectives on farmland biodiversity conservation

Péter Batáry¹ · András Báldi^{2,3} · Johan Ekroos⁴ · Róbert Gallé¹ · Ingo Grass⁵ · Teja Tscharntke⁶





Calcareous grassland fragments
Germany

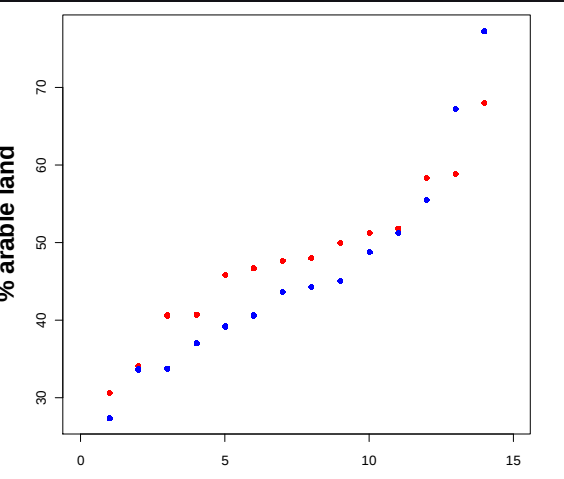


Forest-steppe fragments
Hungary

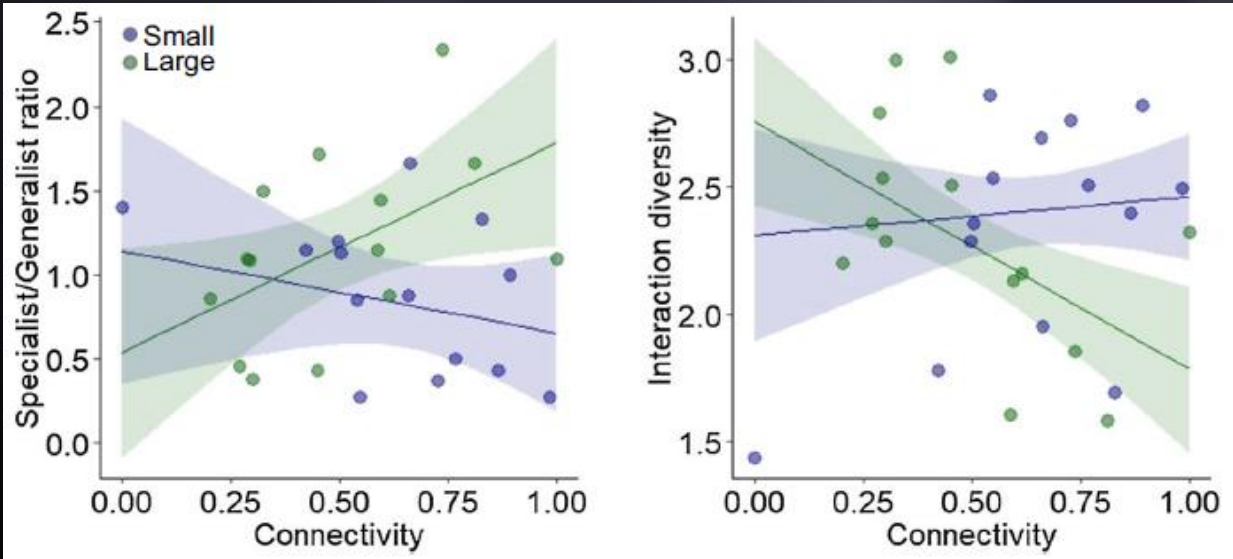
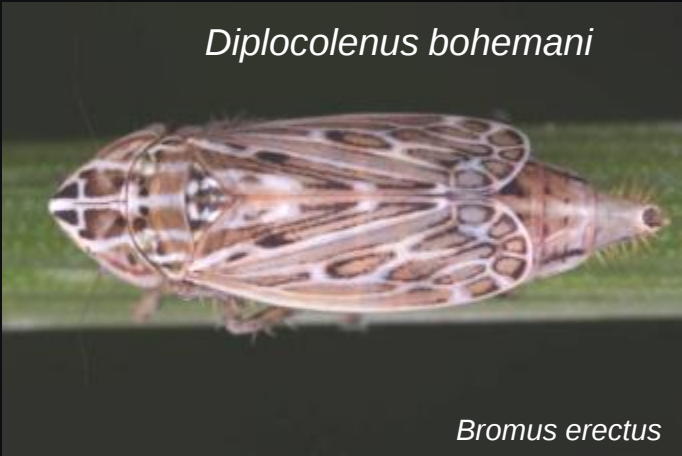
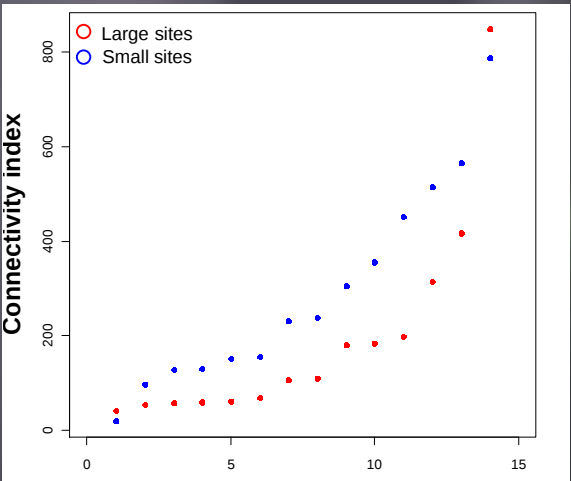
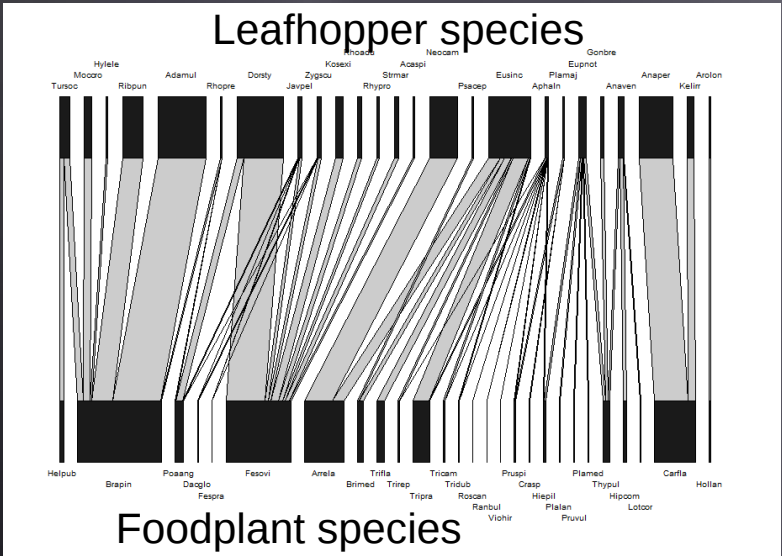


Kurgans
(ancient burial mounds)
Hungary

Habitat fragmentation studies



Verena Rösch
PhD student



Increasing connectivity enhances habitat specialists but simplifies plant–insect food webs

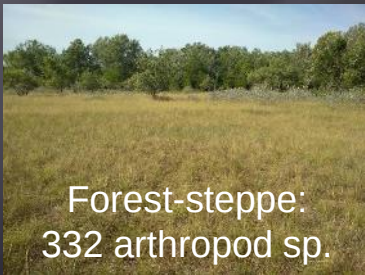
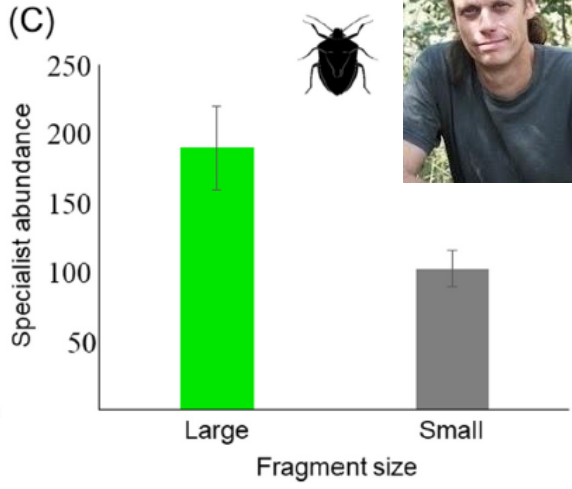
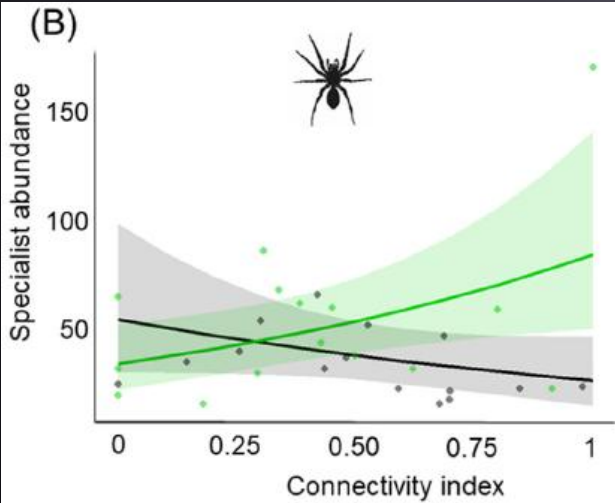
Habitat fragmentation studies + Invasion ecology



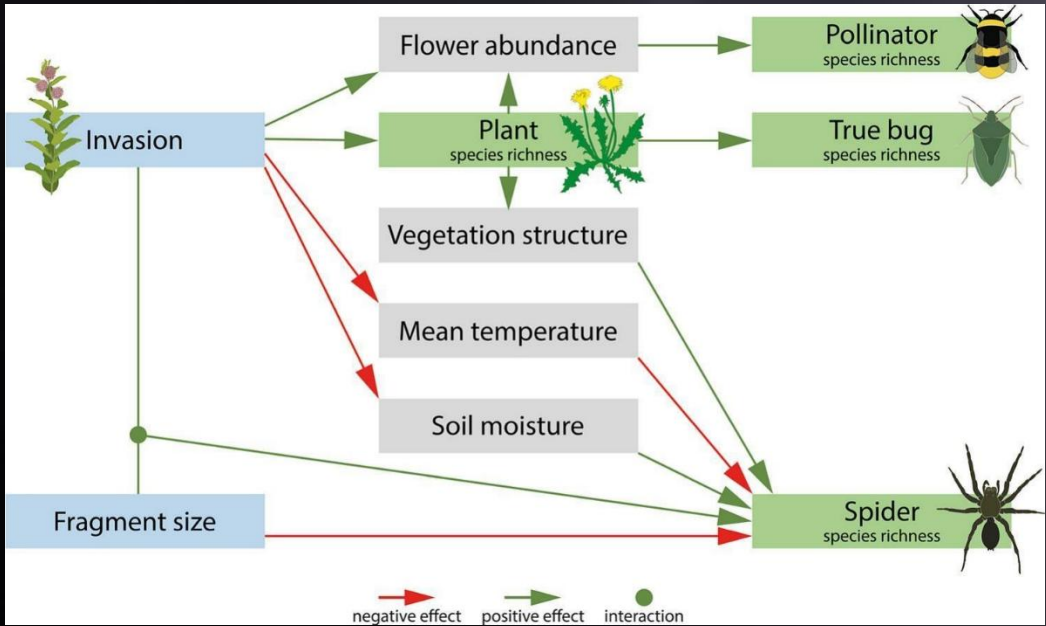
Róbert Gallé, senior researcher



Kurgan:
448 arthropod sp.

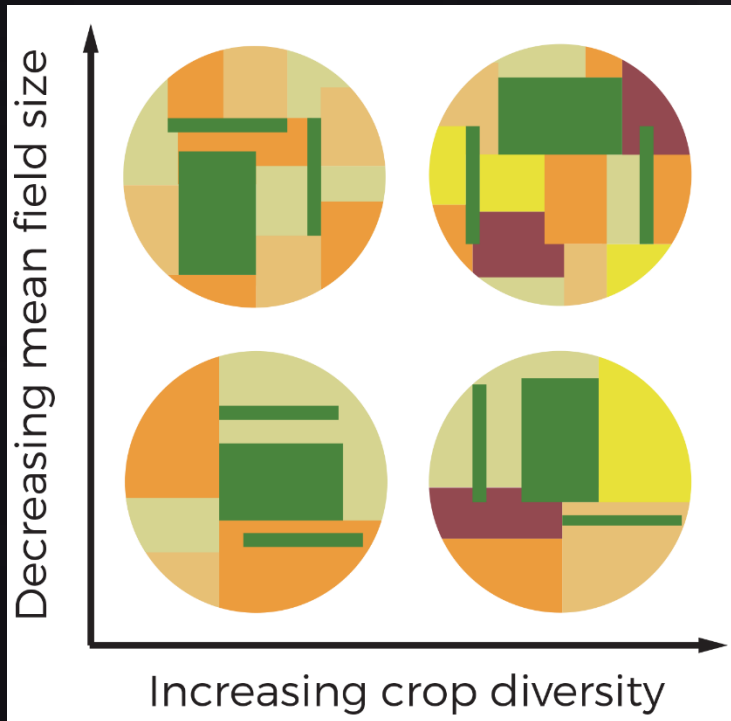


Forest-steppe:
332 arthropod sp.



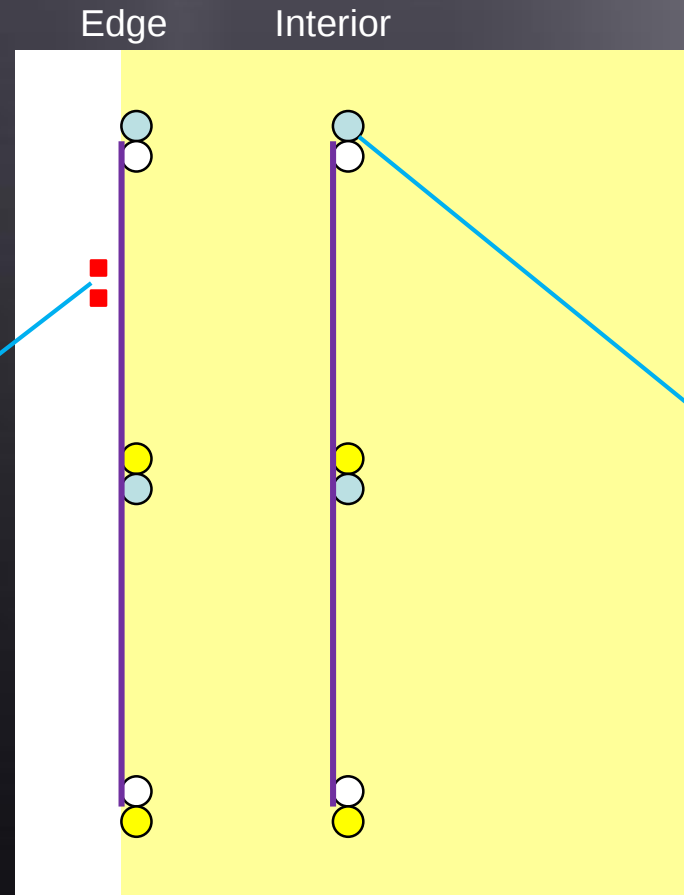


Increasing crop heterogeneity



- Root crop
- Cereals
- Maize
- Oil seed rape
- Legumes
- Semi-natural forest or grassland

Raphanus sativus
- Seeds per pod



Pan traps for bees and syrphids

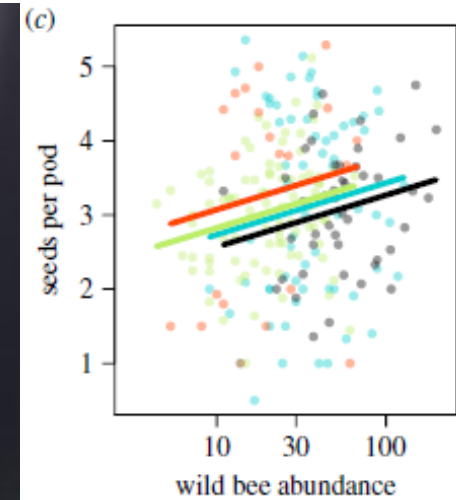
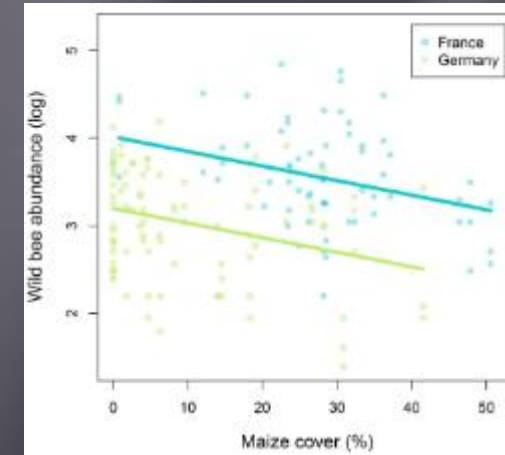
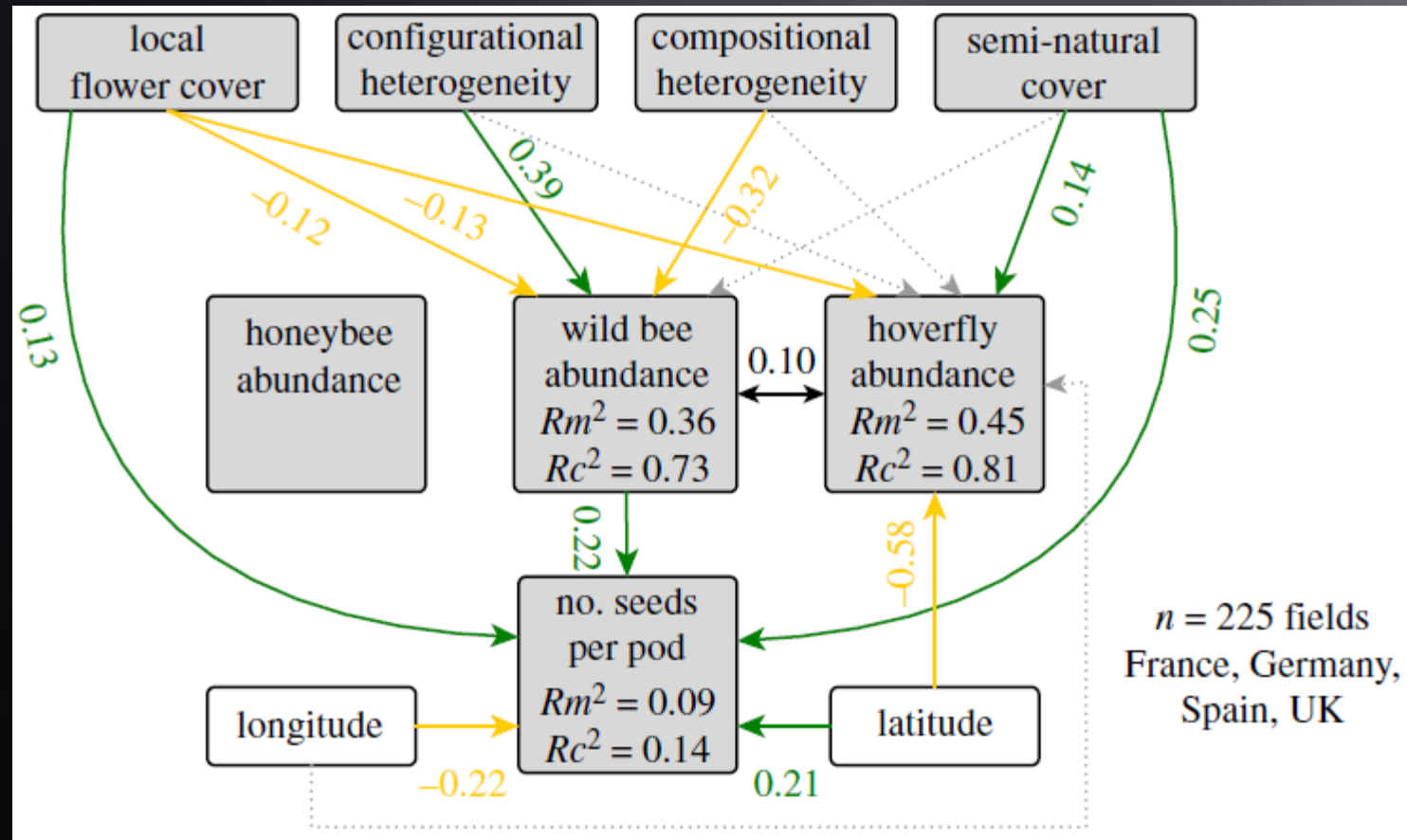
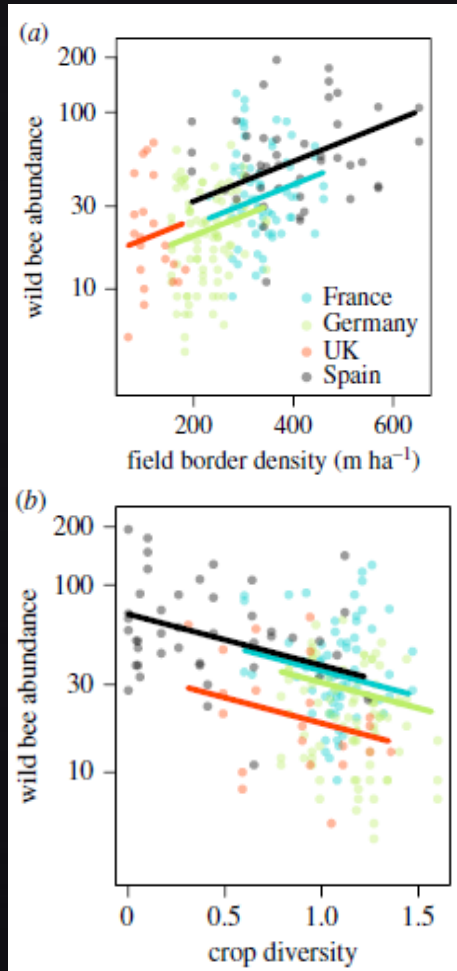
- 3 colours
- 12 traps
- 4 days
- 2 visits



Annika Hass and Aliette Baillo
PhD students



Increasing crop heterogeneity



Landscape configurational heterogeneity by small-scale agriculture, not crop diversity, maintains pollinators and plant reproduction in western Europe



Small vs. large-scale agriculture



Division of Germany to East and West (1945-90)



After >35 years of German reunification (1990), still lot of differences (economy, social aspect, culture...)

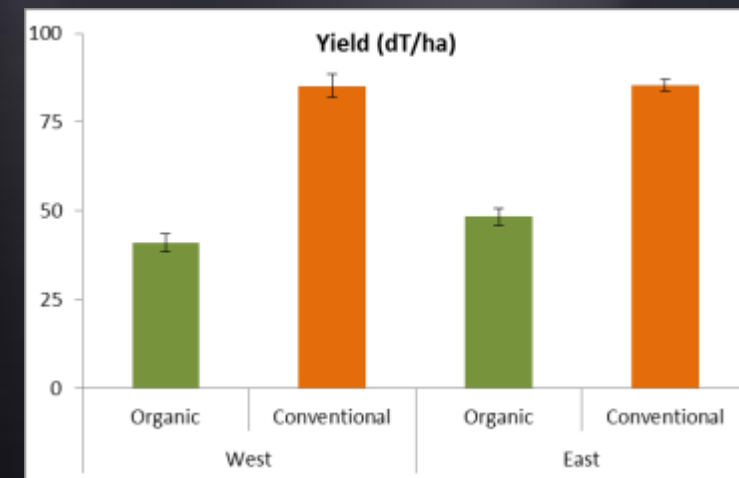
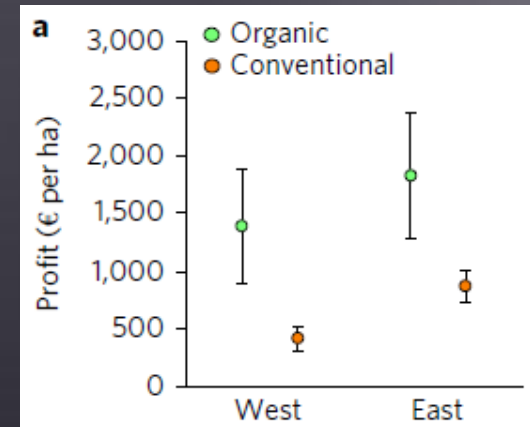
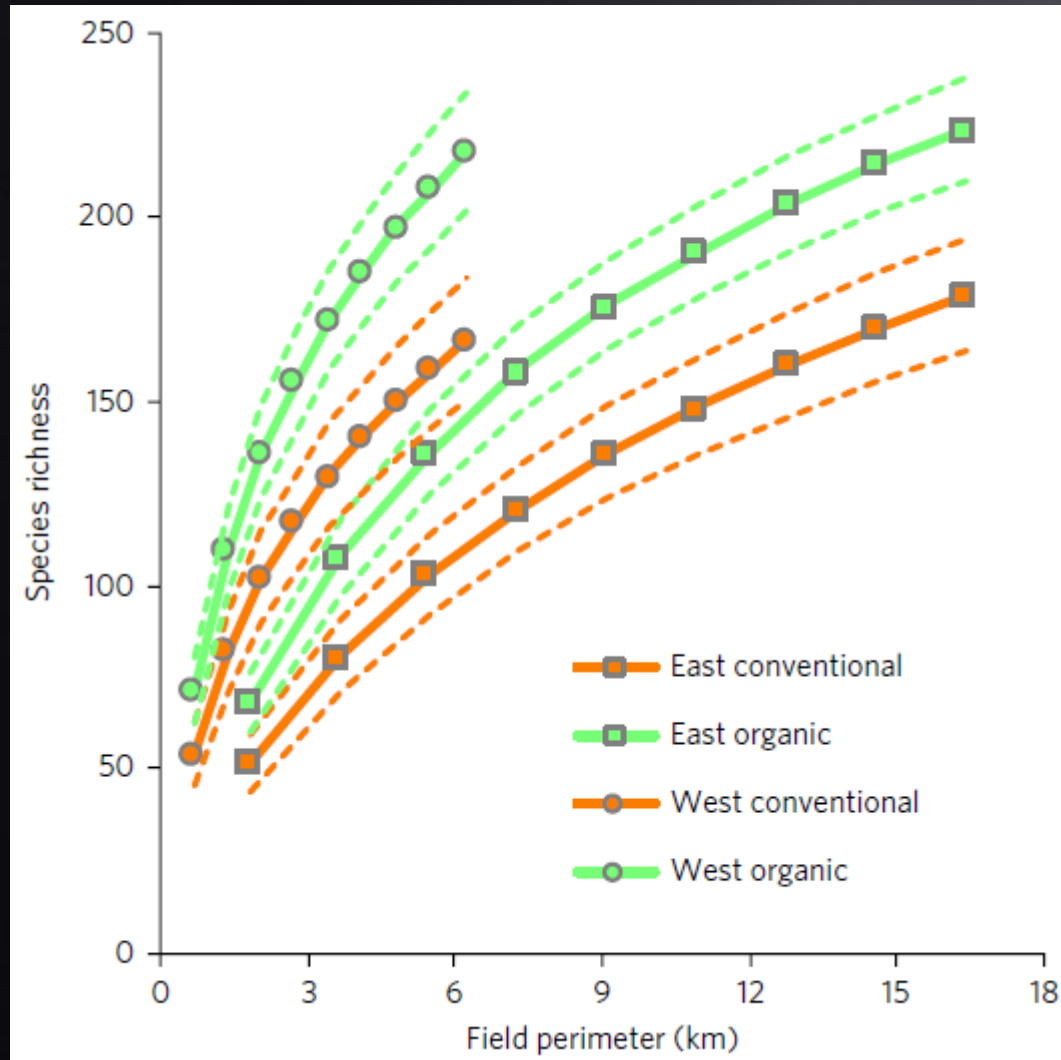
9 pairs of organic and conventional wheat fields in both regions = 36 wheat fields.



>70% longer field edges in the West than in the East.



Small vs. large-scale agriculture

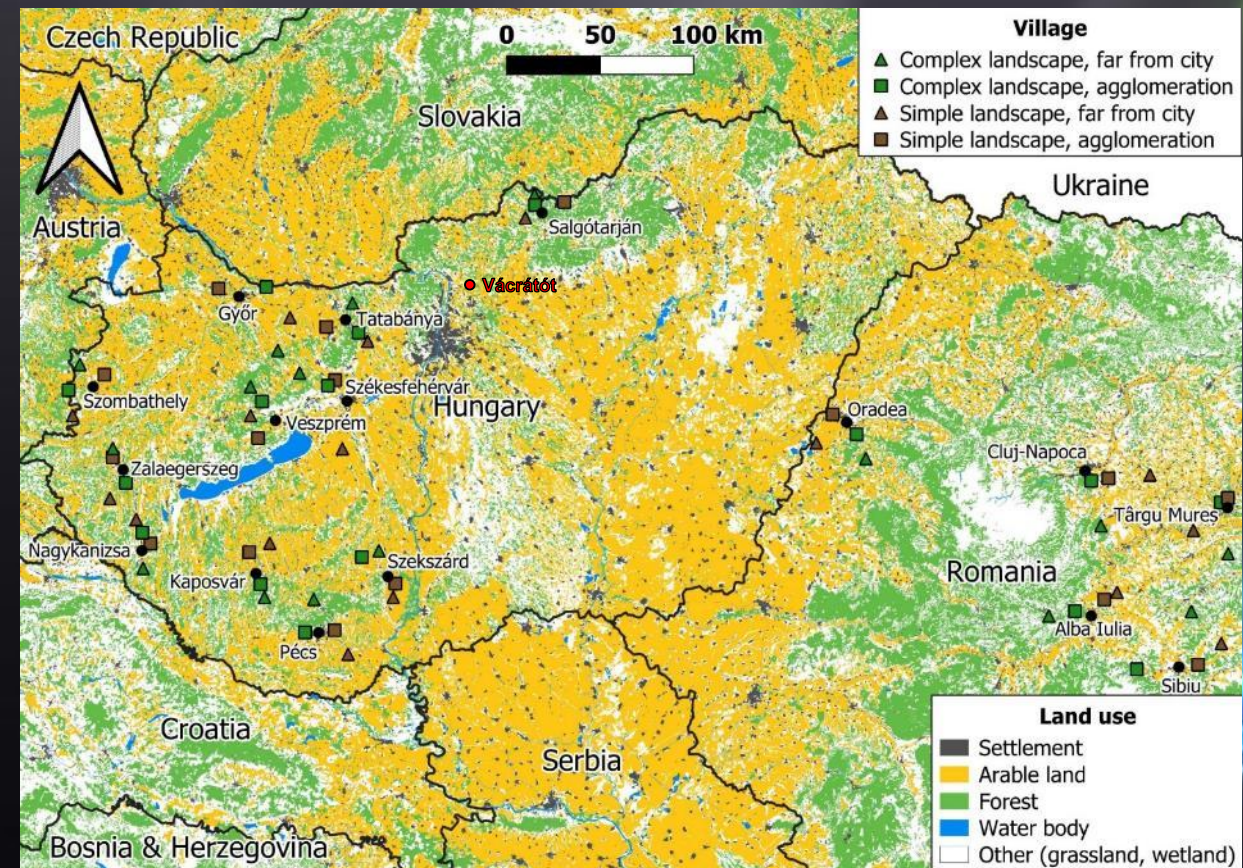


Contribution of small-scale agriculture to biodiversity was more important than organic management.



Villages – heaven or hell for biodiversity?

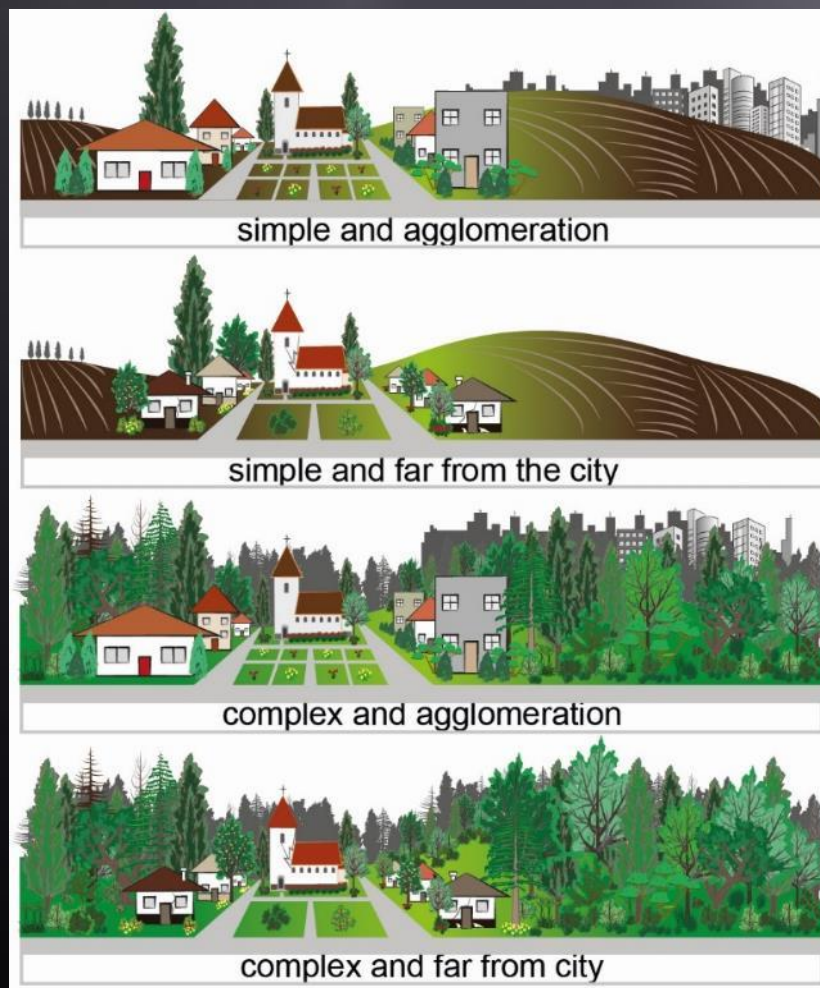
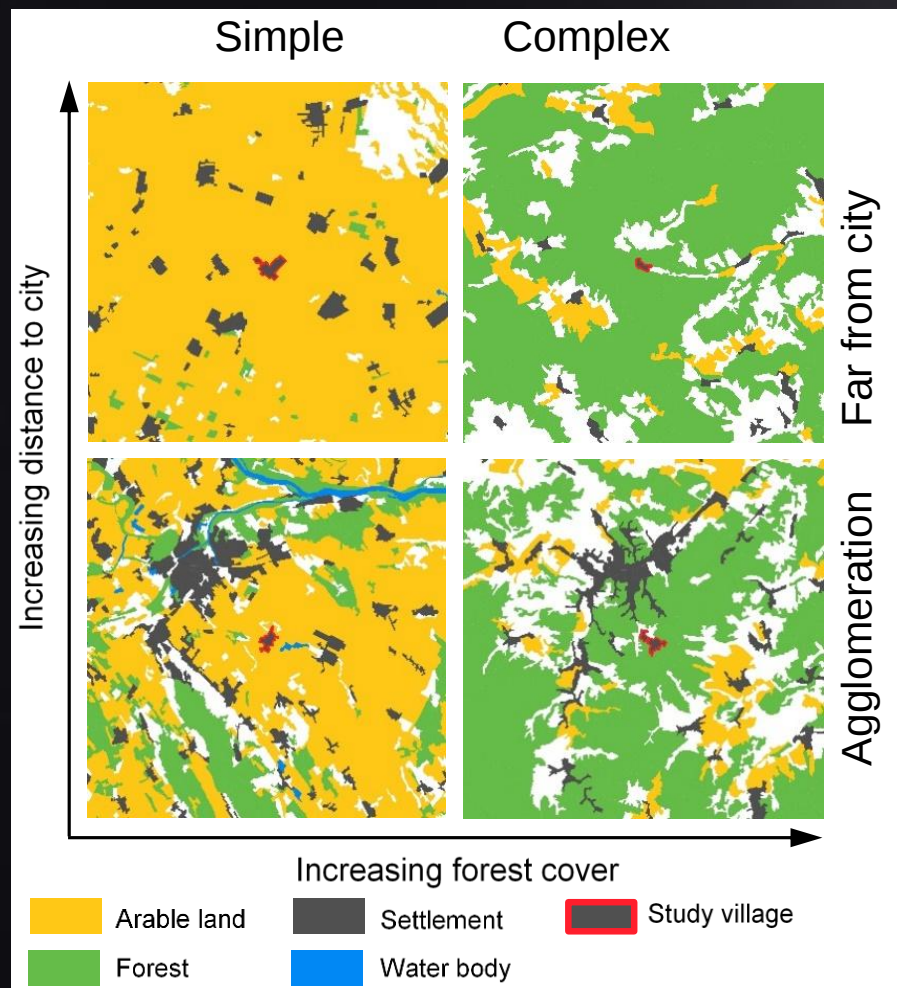
- Village: a group of households with a public building(s) and about 200 to 2,000 residents, and well separated from town or city.
- Only ~0.1% of urban ecological studies focus on villages.
- 64 villages around 16 focal mid-sized cities in HU and RO (6 research groups).
- 4 villages/city:
 - 2 agglomeration vs. 2 far from city
 - 2 simple vs. 2 complex landscape.
- Agglomeration: Comprises a city or town proper and the suburban fringe or thickly settled territory lying outside, but adjacent to, its boundaries.



Villages – study design



Disentangling the effects of landscape composition and configuration.

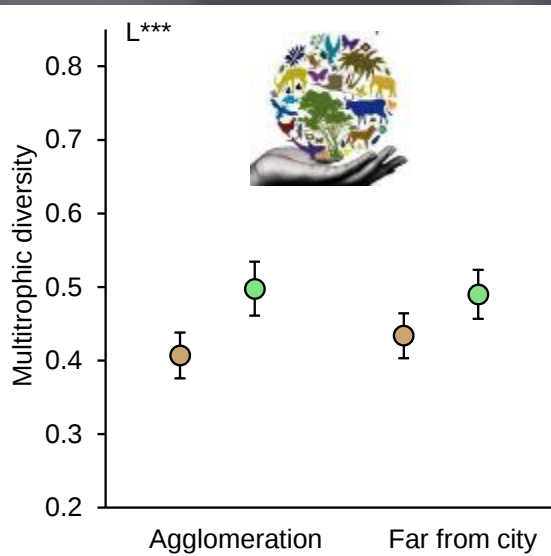
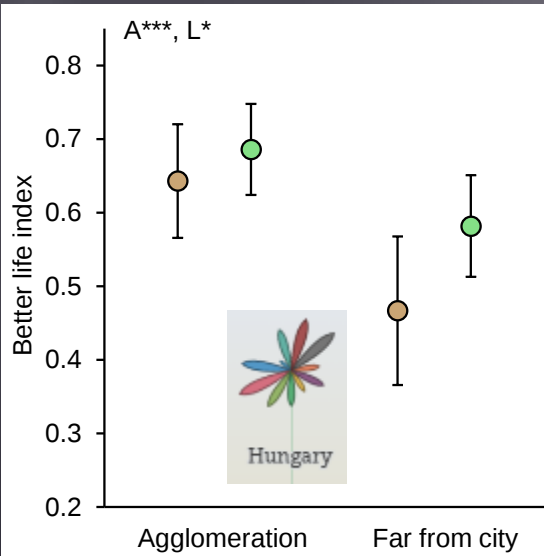
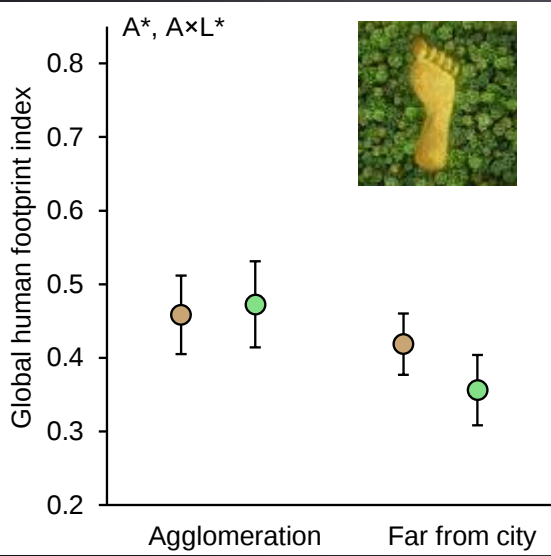


Village edge



Village centre

Villages – results



nature sustainability

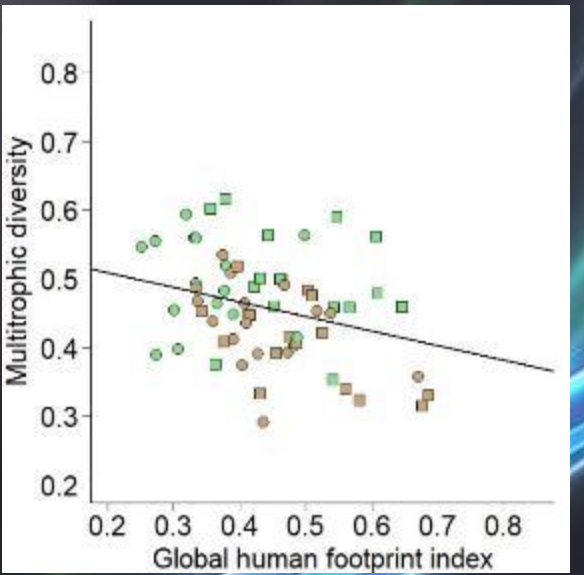
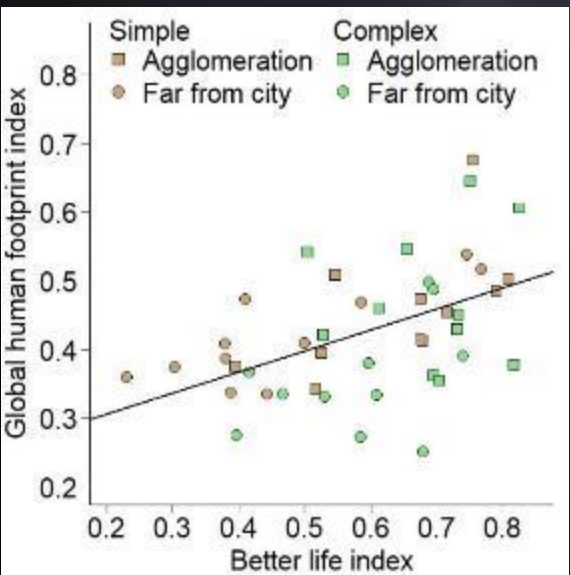
Article <https://doi.org/10.1038/s41893-025-01592-y>

Biodiversity and human well-being trade-offs and synergies in villages

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Check for updates

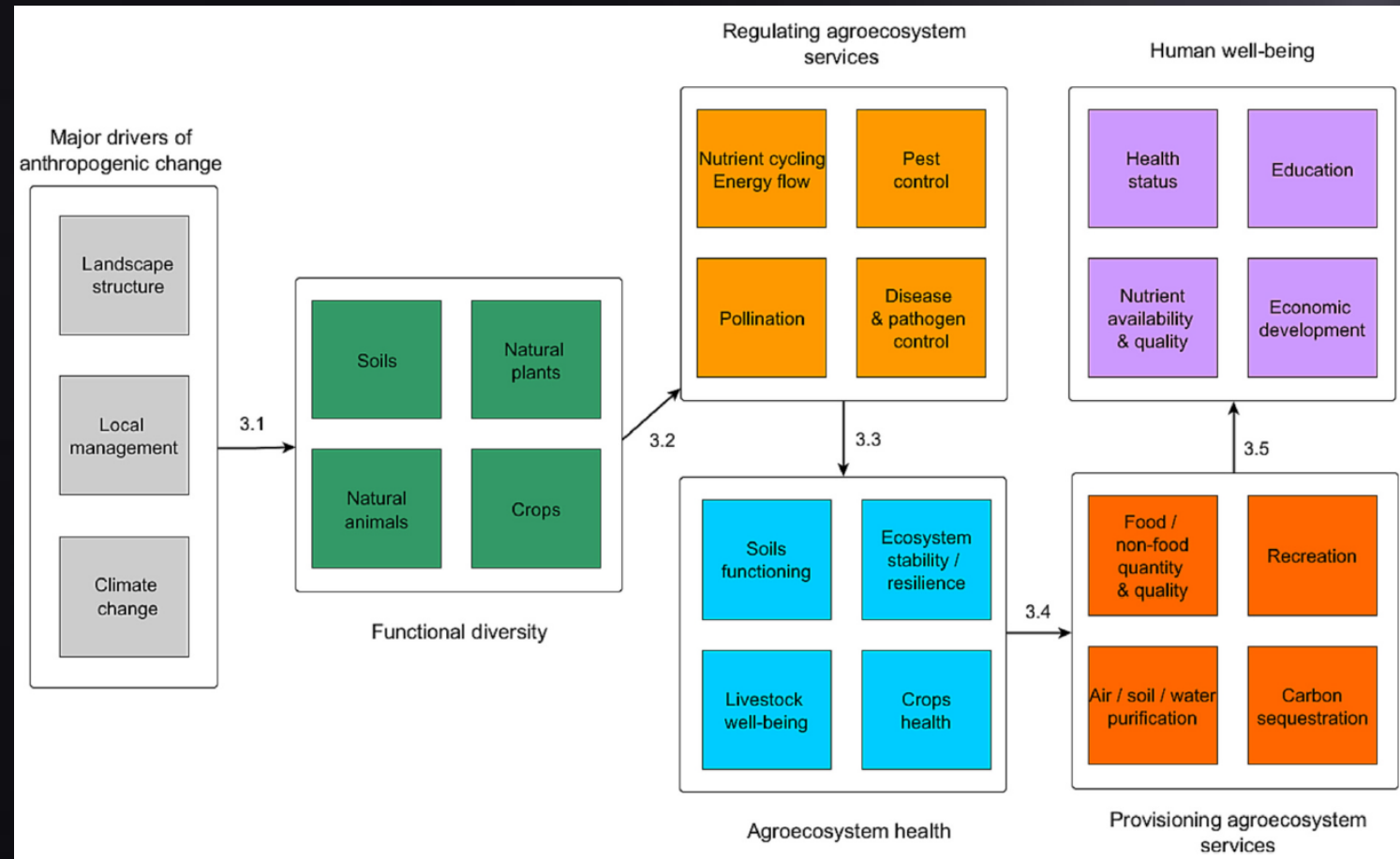
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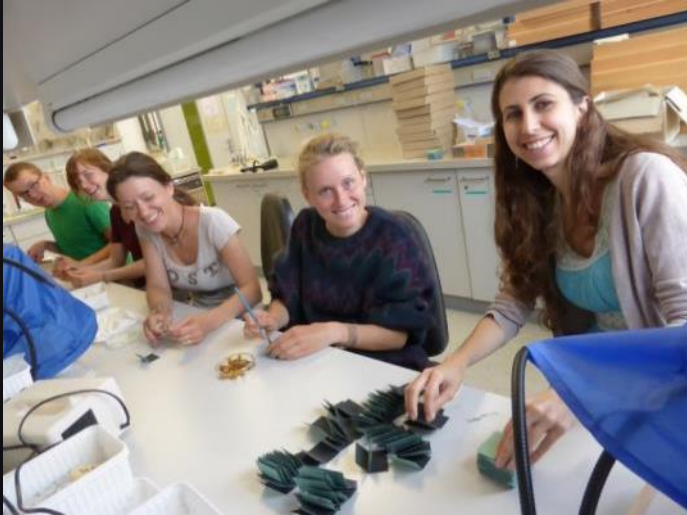
Summary

- Landscape structure (composition + configuration) drives biodiversity patterns.
- Biodiversity patterns determine ecosystem functions and services.
- Thereby ultimately also crop/livestock health and human well-being.



Relationships between functional diversity and food production and quality under ecological intensification

Thank you for your attention!



Students preparing aphid cards in Göttingen (2016)



Joint retreat of Agroecology and LACE group in Hungary (2019)



LACE group participating at the ECCB in Prague (2022)



LACE group retreat in Eger, Hungary (2025)