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science for global insight

Hotspots of future land use change impacts on terrestrial biodiversity under global mitigation scenarios

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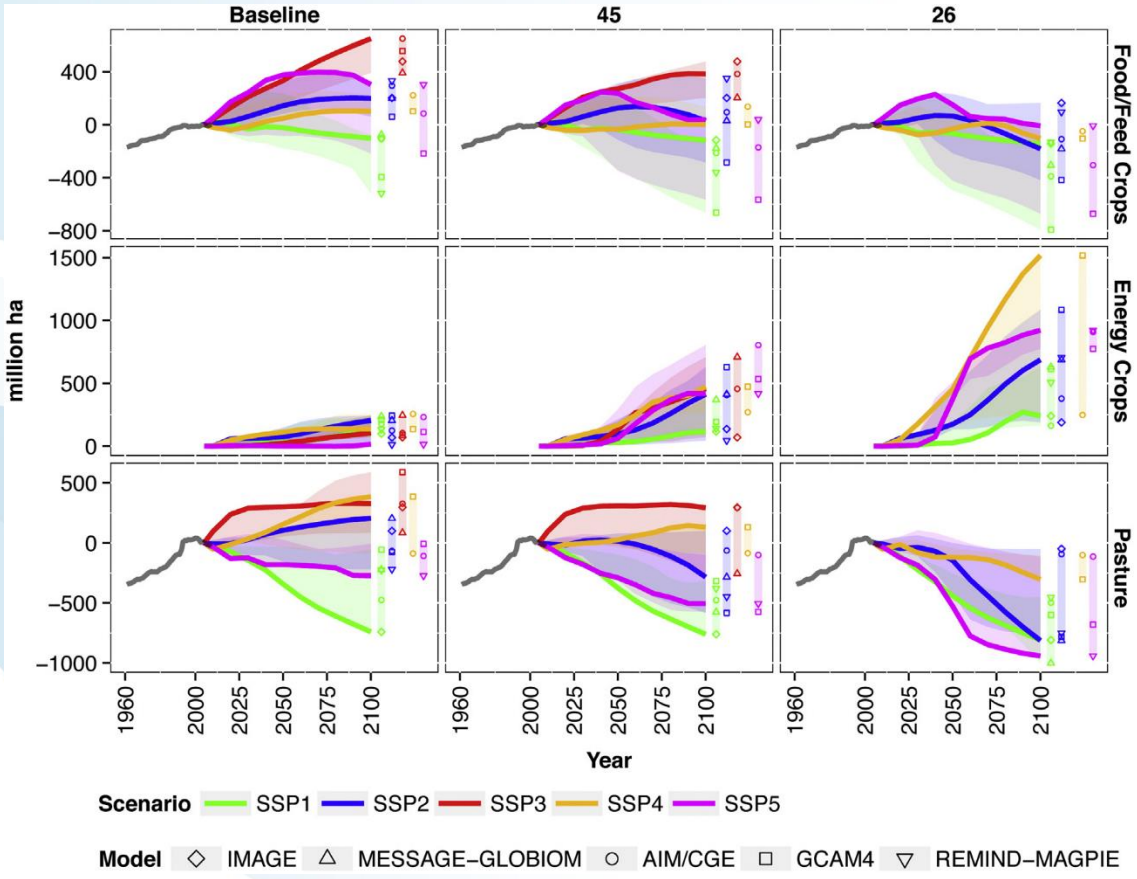
Introduction

Multiple demands from future land use

Scenarios of future land use: **agricultural land**



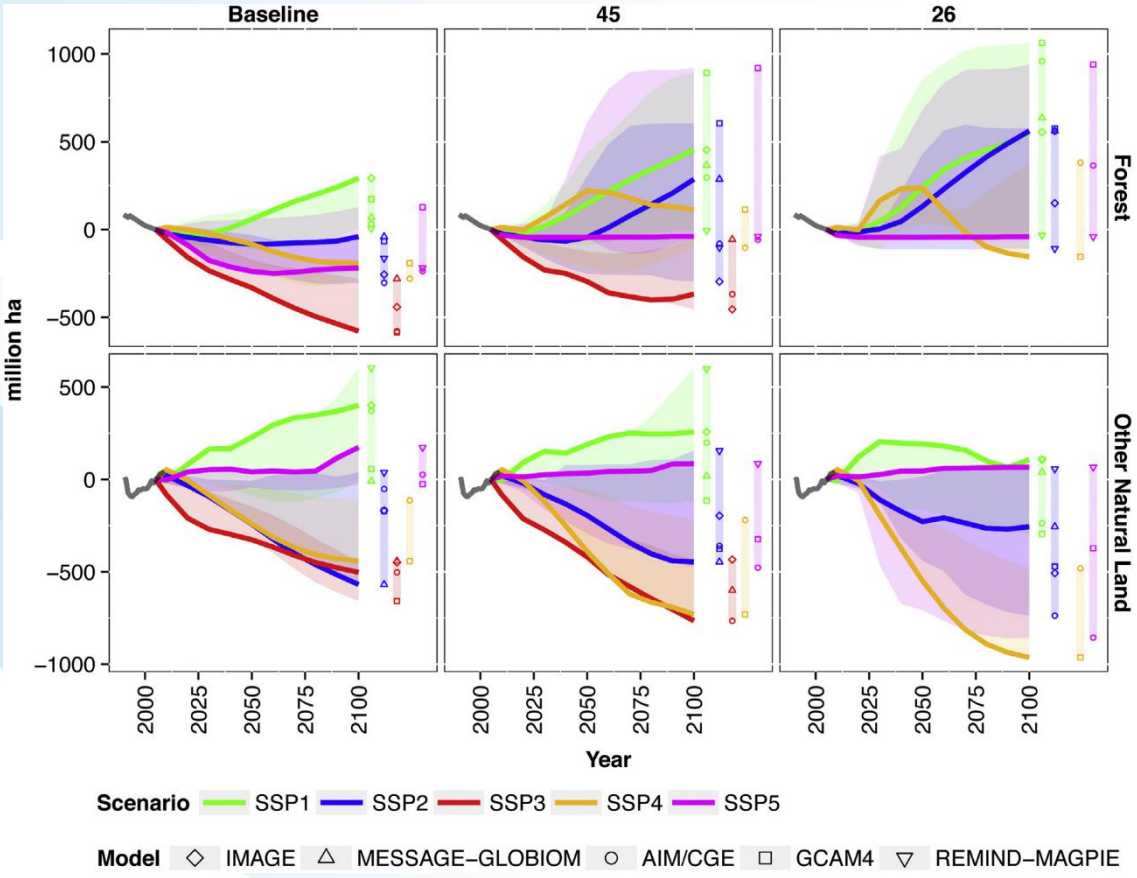
Popp et al. (2017)

SDG 2:
[…] achieve food security […]

SDG 13:
[…] combat climate change […]

Multiple demands from future land use

Scenarios of future land use: **non-agricultural land**



Popp et al. (2017)

SDG 2:

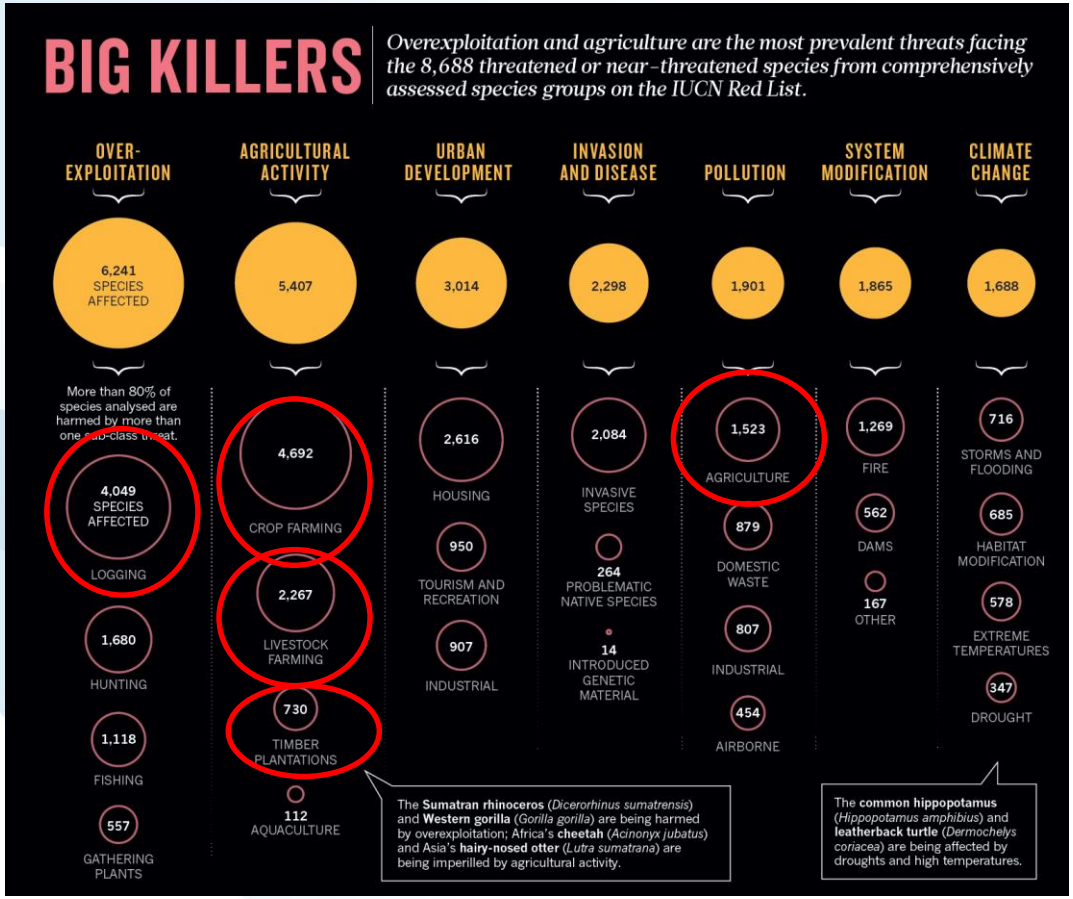
[…] achieve food security […]

SDG 13:

[…] combat climate change […]

Multiple demands from future land use

Scenarios of future land use: **what about biodiversity?**



Maxwell et al. (2016)

SDG 2:

[…] achieve food security […]

SDG 13:

[…] combat climate change […]

??

SDG 15:

[…] halt biodiversity loss […]

Multiple demands from future land use

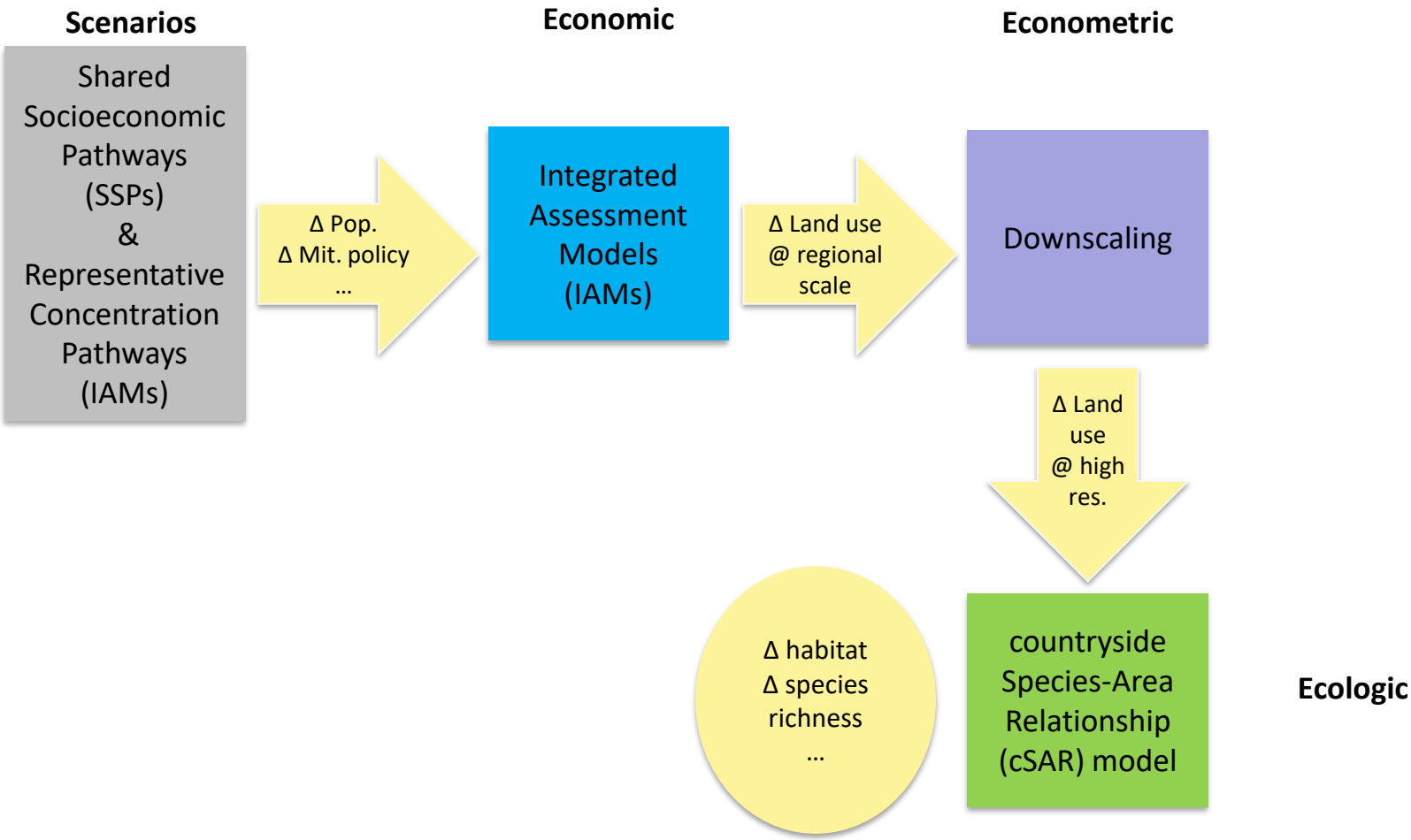
- Modeling approaches required to navigate through trade-offs
- Biodiversity impacts so far overlooked within IAM & AgMIP community

Goal:

Develop a methodology to assess impacts of SSP x RCP scenarios on terrestrial biodiversity through habitat loss & degradation

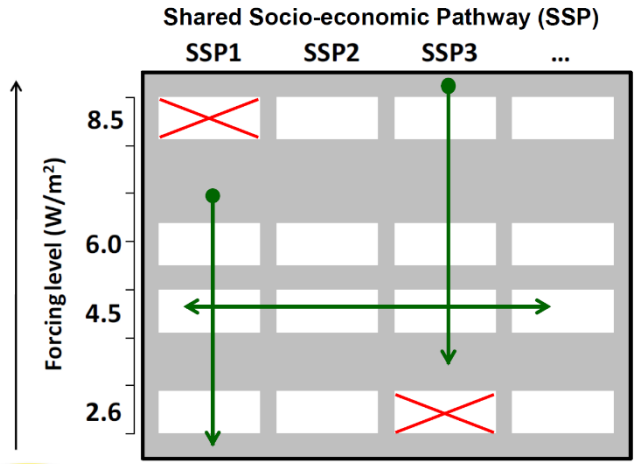
Methods

Methods in a nutshell



MESSAGE-GLOBIOM IAM & scenarios

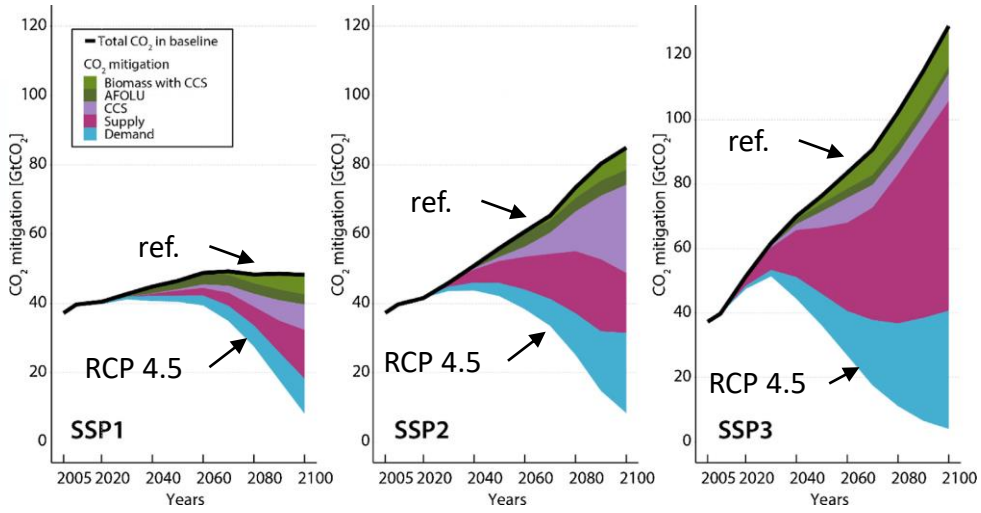
Fricko et al. (2016)



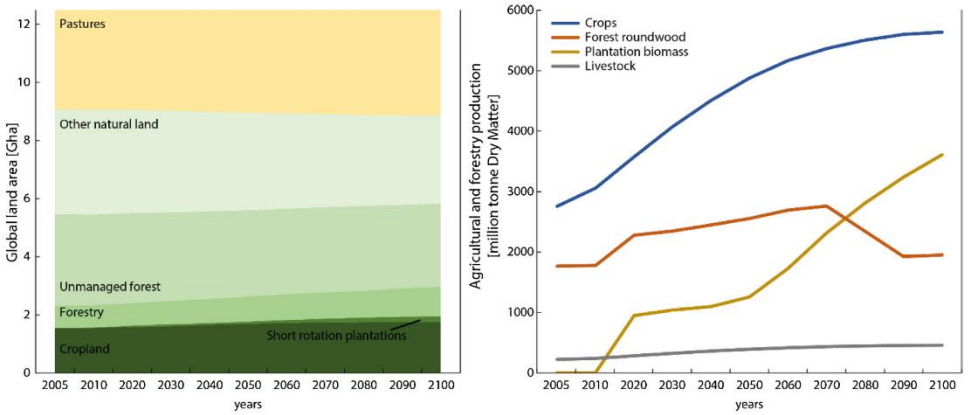
scenarios

MESSAGE-GLOBIOM Integrated Assessment model

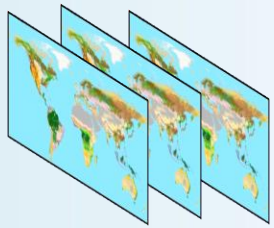
Δ land use (regional)



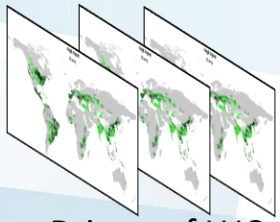
RCP 4.5 land use (global scale)



Downscaling econometric model



LUC Data 2000-2010



Drivers of LUC

Krisztin et al., in prep.

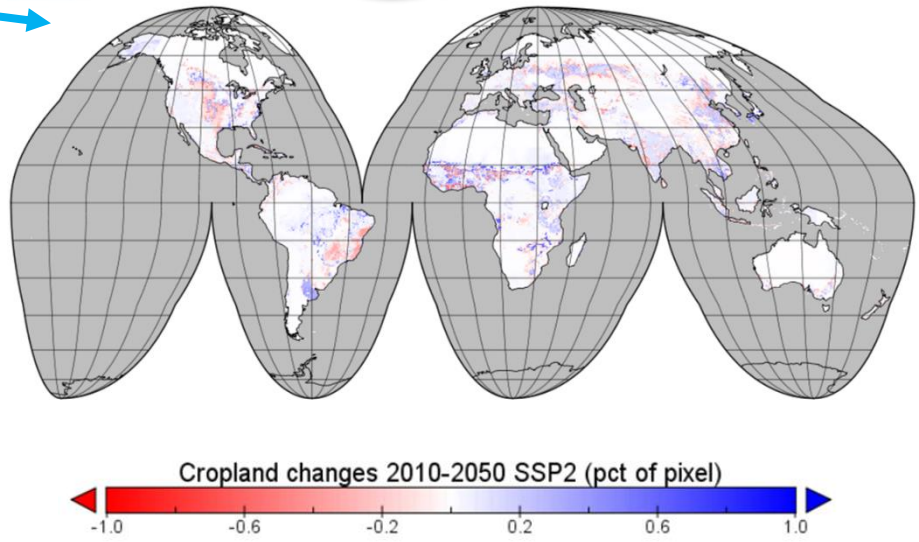
$$\Pr(y_i = j) = \frac{\exp(\mu_{i,j})}{1 + \sum_{j=1}^{J} \exp(\mu_{i,j})}$$

$$\boldsymbol{\mu}_j = \boldsymbol{X}\boldsymbol{\beta}_j + \boldsymbol{W}(\phi)\boldsymbol{X}\boldsymbol{\theta}_j + \boldsymbol{\iota}_N \alpha_j$$

Econometric Model

Δ land use (regional)

Δ land use high res.



Posterior projections of results along scenarios, 2010-2100 @ 5 arcminutes, 10 years

Countryside Species-Area model

Δ land use high res.

Leclère et al., in prep.

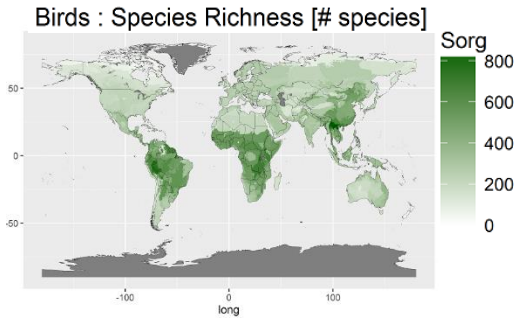
Δ habitat
Δ species richness
…

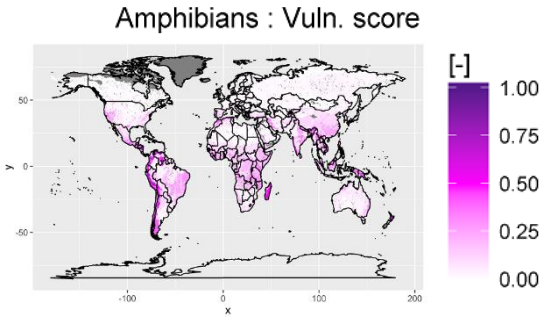
cSAR model

Translates land use into habitat quality, species richness & extinction risk

- $Species\ Richness = c \cdot (Habitat\ Size)^z$
- $Habitat\ size = total\ area \cdot \sum_{LCC} a_{LCC} \cdot h_{LCC}$
- *Affinity h_{LCC} of species for each land cover/use class LCC*
- *A refined version of Chaudhary et al. (2015) to account for LCC transitions & time dynamics of recovery*

Parameters for 5 taxa (Amphibians, Birds, Mammals, Reptiles, Plants) at the scale of WWF ecoregions

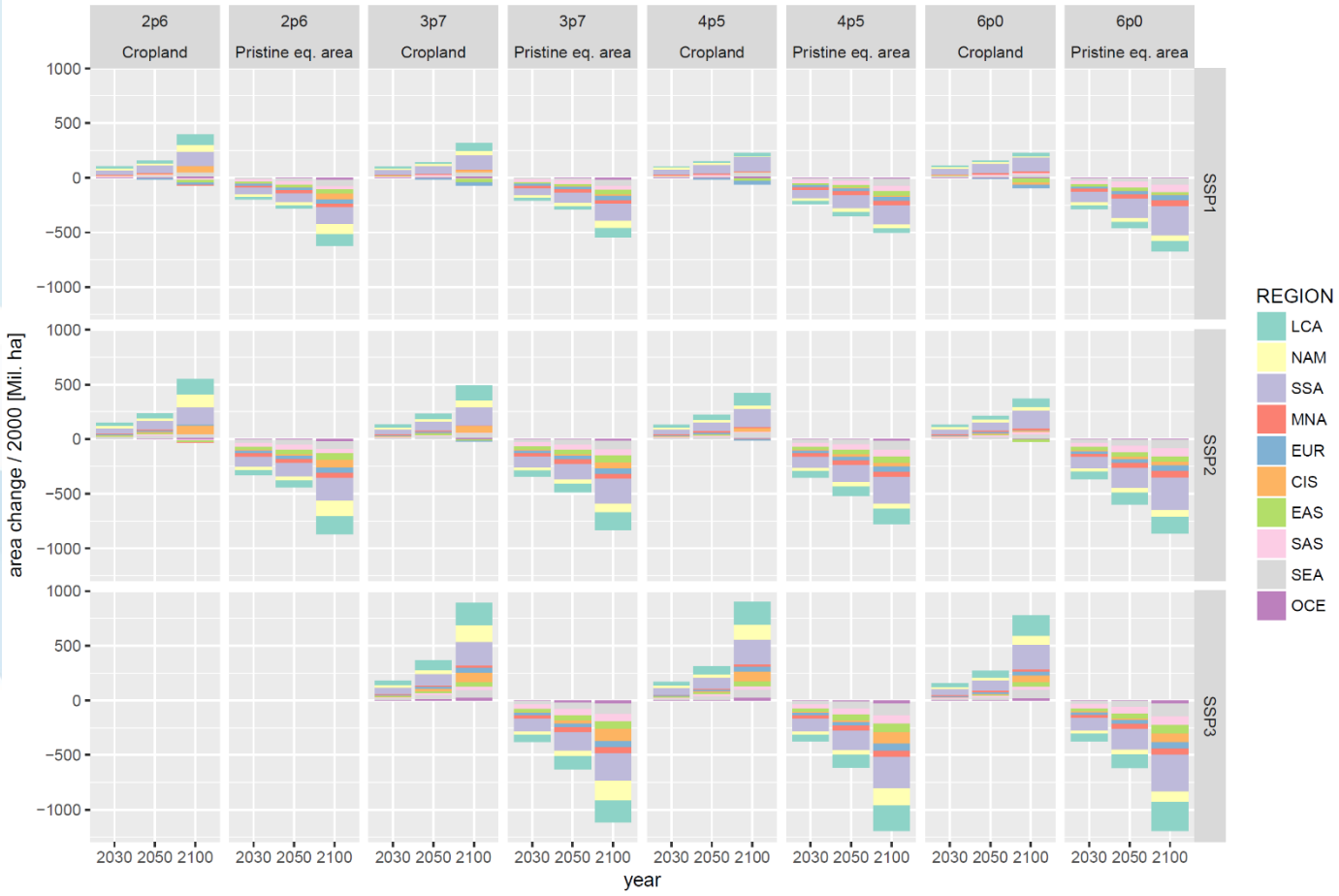




Projections of habitat change, species richness change and extinction of endemic species at risk in year 2000
@ 5 arcminutes spatial resolution, 10 years time step

Results

Results – changes in habitat



- Robust ↘ in habitat (all scenarios & regions)
- Scenario: SSP has more impact than RCP
- Impacts worse in Sub-Saharan Africa (SSA) & Latin and Central America (LCA)

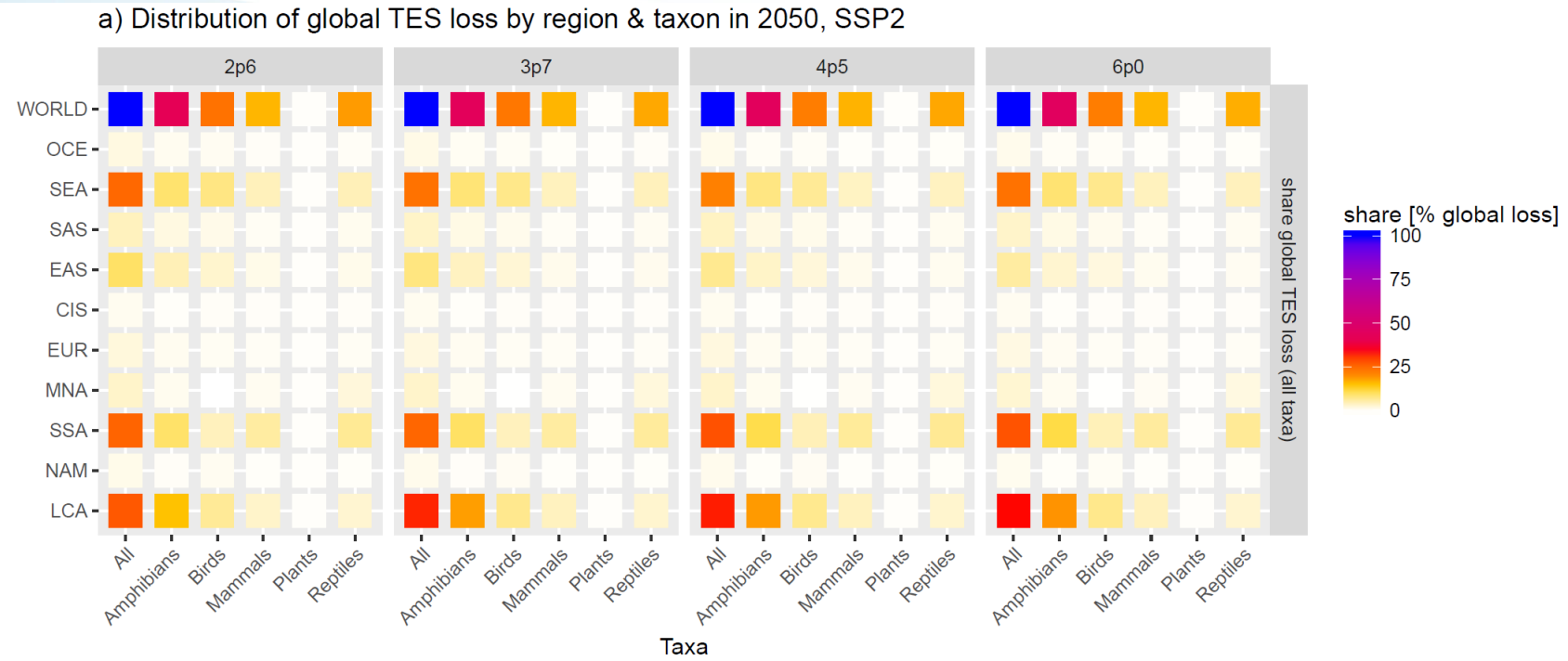
Leclère et al., in prep.
(preliminary results)

Results – biodiversity impact (global trends)

- Robust ↘ in average species richness (all scenarios, regions & taxa)
- Robust & highehr ↘ in species that are endemic and threatened in year 2000
- Scenario: SSP impact is equivalent to RCP
- Impacts are worse for Amphibians & Reptiles, and least worse for Mammals

Leclère et al., in prep.
(preliminary results)

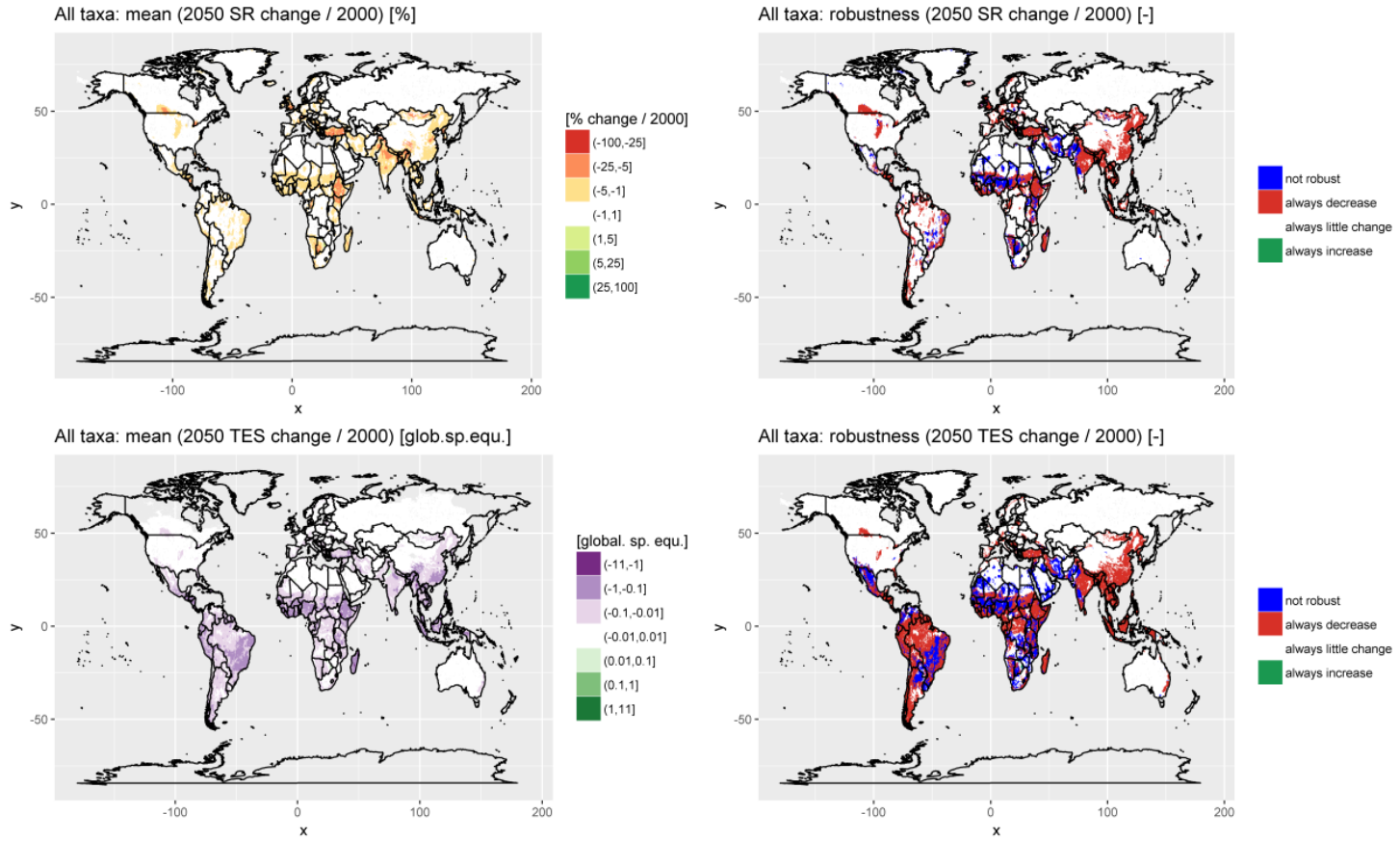
Results – biodiversity impact (regional trends)



- Impacts worse in Sub-Saharan Africa (SSA), Latin and Central America (LCA), Southern Asia (SAS) and South-Eastern Asia (SEA) regions
- Impacts are worse for Amphibians & Reptiles, and least worse for Mammals

Leclère et al., in prep.
(preliminary results)

Results – biodiversity impact (hotspot mapping)



- Hotspots of biodiversity loss can be mapped
- Hotspots can be more or less robust across scenarios

Leclère et al., in prep.
(preliminary results)

Concluding remarks

Concluding remarks

- Projected land use futures (tackling SDG2 & SDG13) are not biodiversity friendly & follow mostly past trends.
- Prelim. results show mitigation can be beneficial, counteracting effects:
  - **+** reduced agricultural land expansion (in particular grassland)
  - **-** increased afforestation & forest management for C seq. & bioenergy

  ➔ Refinement needed to disentangle more clearly effects
- More explorative scenarios are needed to diagnose what it would take to achieve SDG 2, 13 and 15 altogether
- Many more biodiversity facets to explore:
  - other taxa (e.g., insects)
  - other metrics (e.g., abundance, functional diversity, ecosystem services)

Thank you!

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ISWEL
Integrated Solutions for Water-Energy-Land

Partnership:

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