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Reversing terrestrial biodiversity declines due to habitat loss: a multi-model assessment

D. Leclère[*]; M. Obersteiner; Alkemade, R.; Almond, R.; Barrett, M.; Bunting, G.; Burgess, N. D.; Butchart, S. H. M.; Chaudhary, A.; Cornell, S.; De Palma, A.; DeClerck, F. A. J.; Di Fulvio, F.; Di Marco, M.; Doelman, J. C.; Durauer, M.; Ferrier, S.; Freeman, R.; Fritz, S.; Fujimori , S.; Grooten, M.; Harfoot, M.; Harwood, T.; Hasegawa, T.; Havlík, P.; Hellweg, S.; Herrero, M.; Hilbers, J. P.; Hill, S. L. L.; Hoskins, A. J.; Humpenöder, F.; Kram, T.; Krisztin, T.; Lotze-Campen, H.; Mace, G. M.; Matsui, T.; Meyer, C.; Nel, D.; Newbold, T.; Ohashi, H.; Popp, A.; Purvis, A.; Schipper, A. M.; Schmidt-Traub, G.; Stehfest, E.; Strassburg, B.; Tabeau, A.; Valin, H.; van Meijl, H.; van Vuuren, D. P.; van Zeist, W. J.; Visconti, P.; Ware, C.; Watson, J. E. M.; Wu, W. & Young, L.

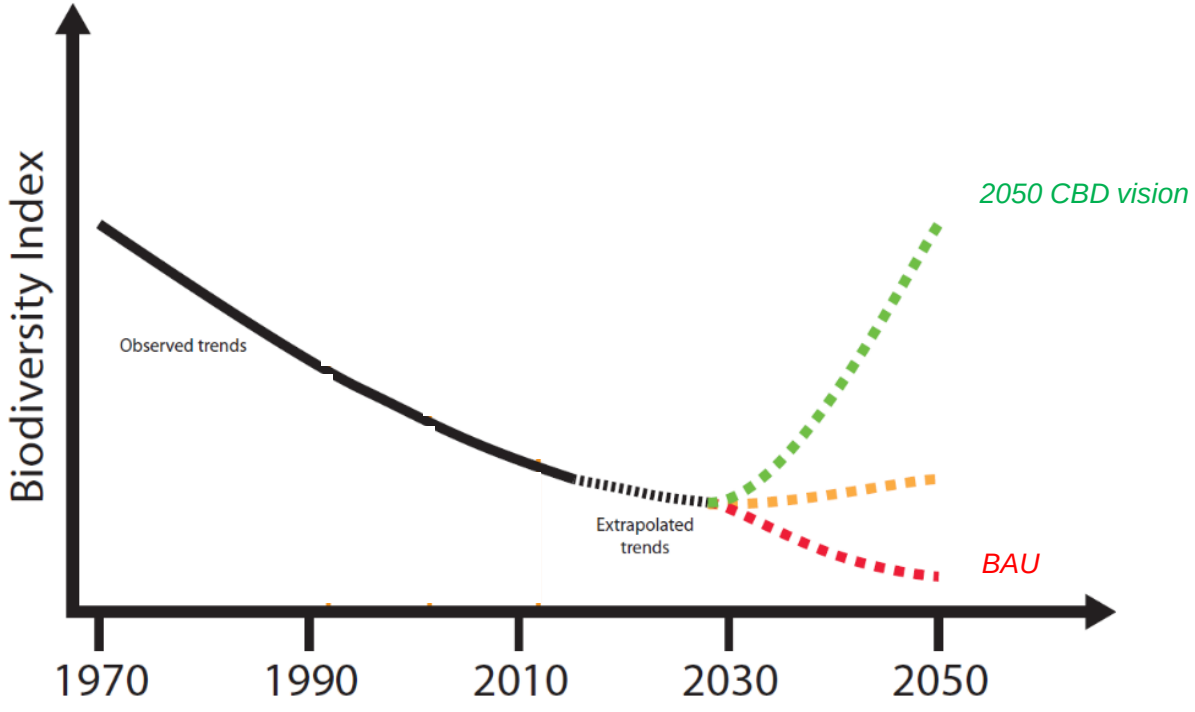
58 authors; 41 institutions

(*) **ESM program | International Institute of Applied System Analysis | Austria**

How to get to the 2050 CBD vision?

"By 2050, biodiversity is **valued**, **conserved**, **restored** and **wisely used** […]"

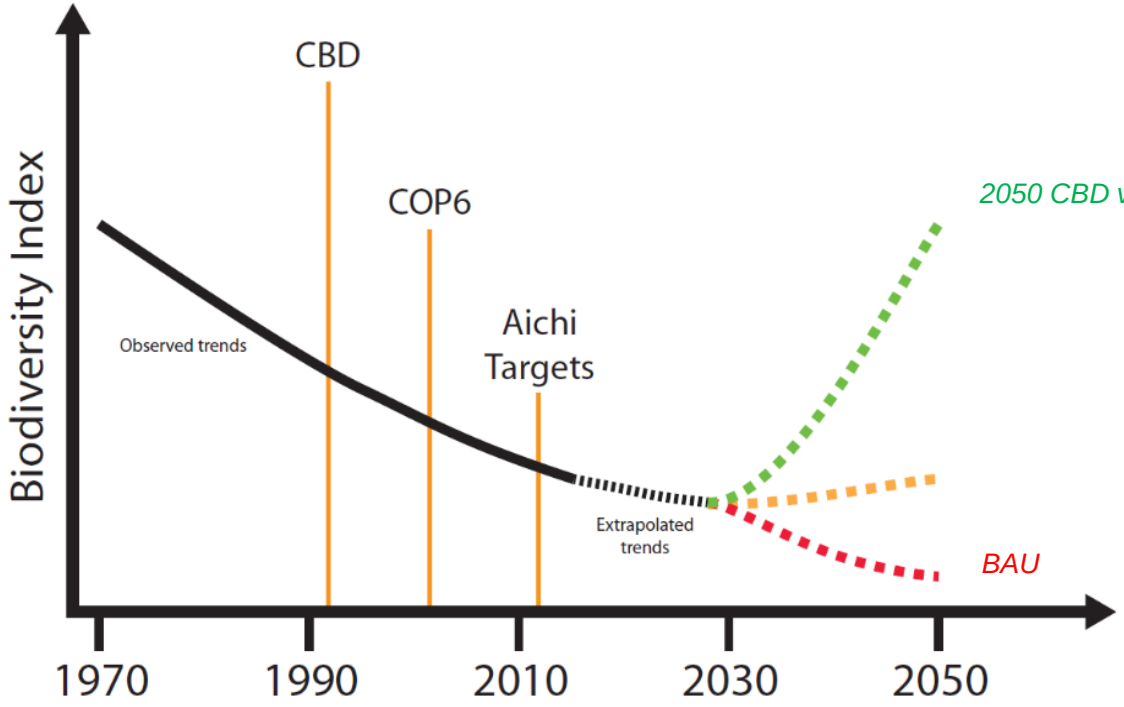
Reversing declining trends in biodiversity



Mace et al. (Nat. Sus., 2018)

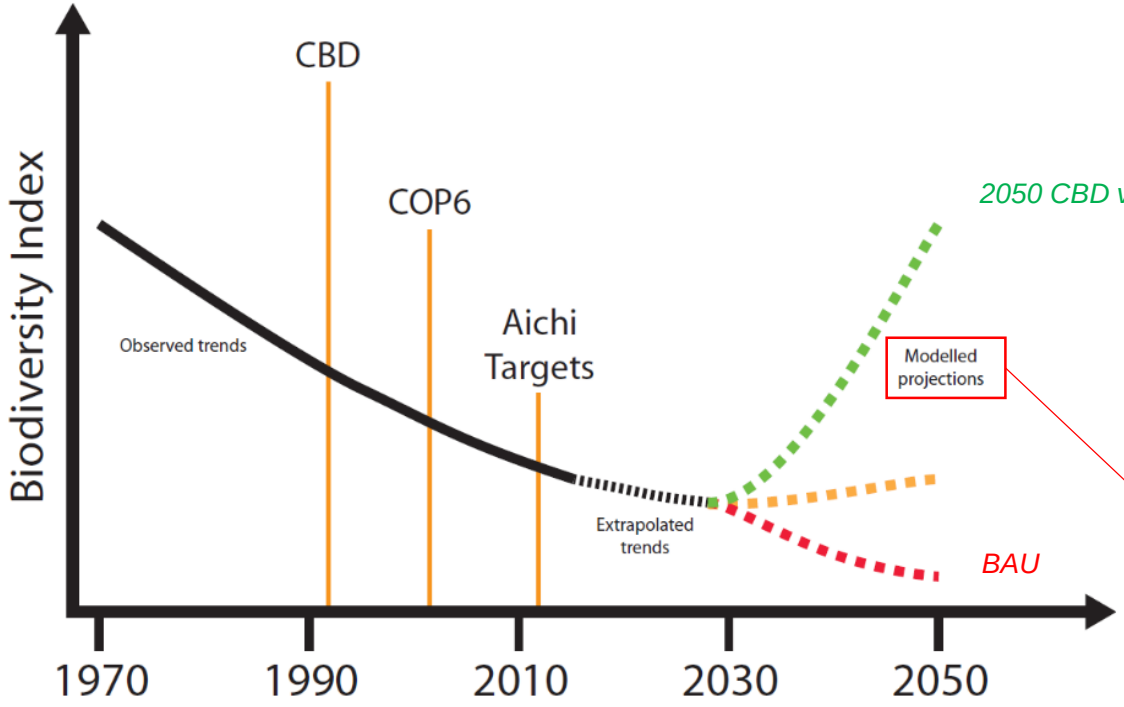
"By 2050, biodiversity is **valued**, **conserved**, **restored** and **wisely used** […]"

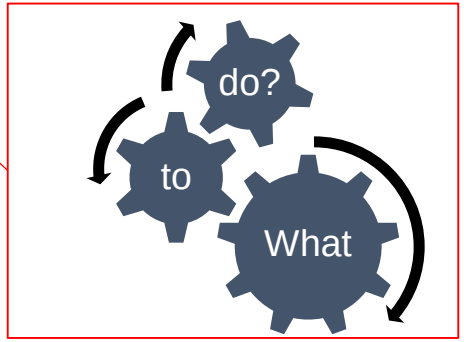
A need for ambitious but well coordinated action



Mace et al. (Nat. Sus., 2018)

What ambitious but well coordinated action?





Mace et al. (Nat. Sus., 2018)

The bending the curve initiative

- Combining current data, models and scenarios from the land-use & biodiversity modelling communities

- Fast track analysis on bending trends from habitat loss:

Can we bend the curve of biodiversity loss without jeopardizing other SDGs?

If yes, what can we robustly say about how to get there?

Leclère et al 2018;
http://pure.iiasa.ac.at/id/eprint/15241/

Scenarios exploring the actions space

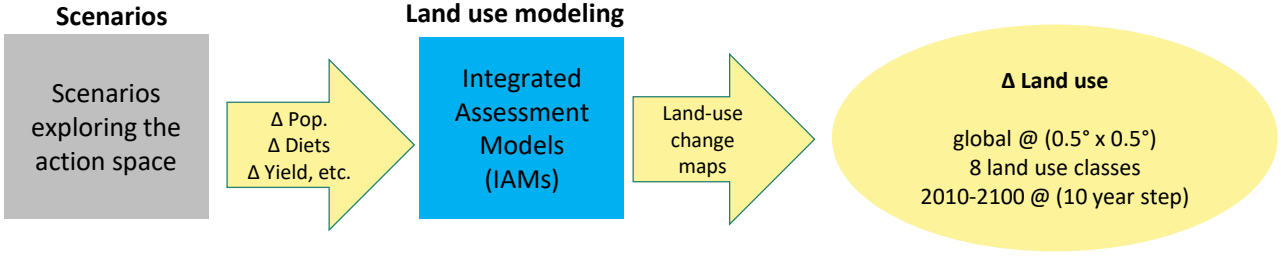
scenarios	Baseline assumptions	Additional efforts towards reversing trends in biodiversity					
	SSP2 (Middle of the Road)	Yield increases	Trade increases	Reduced waste	Diet shifts	Expansion of PAs	Increased restoration
a) baseline scenario							
Baseline (BASE)	x	-	-	-	-	-	-
b) single bundble of action scenarios							
Supply-side efforts (SS)	x	x	x	-	-	-	-
Demand-side efforts (DS)	x	-	-	x	x	-	-
Increased conservation efforts (C)	x	-	-	-	-	x	x
c) combined action scenarios							
Inc. conservation & supply-side efforts (C+SS)	x	x	x	-	-	x	x
Inc. conservation & demand-side efforts (C+DS)	x	-	-	x	x	x	x
Integrated action portfolio (IAP)	x	x	x	x	x	x	x

Based on variants of Shared Socioeconomic Pathways (SSPs)

New Assumptions

Leclère et al 2018;
http://pure.iiasa.ac.at/id/eprint/15241/

Multi-model assessment



Model name (Land use model/IAM)	Institution
Asia-Pacific Integrated Model (AIM/CGE)	National Institute For Environmental Studies (NIES, Japan)
Global Biosphere Management Model (GLOBIOM/MESSAGE)	International Institute Of Applied System Analysis (IIASA, Austria)
Integrated Model to Assess the Global Environment (IMAGE/MAGNET)	Netherlands Environmental Assessment Agency (PBL, Netherlands)
Model of Agricultural Production and its Impact on the Environment (MAgPIE/REMIND)	Potsdam Institute For Climate impact Research (PIK, Germany)

Leclère et al 2018;
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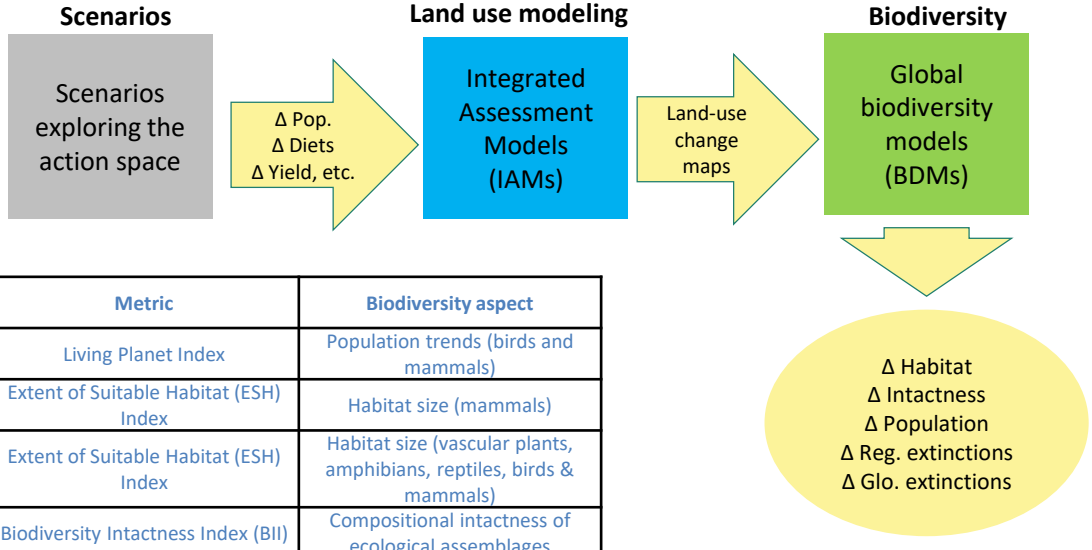
Multi-model assessment



Biodiversity model (BDM)	Metric	Biodiversity aspect
LPI model	Living Planet Index	Population trends (birds and mammals)
INSIGHTS model	Extent of Suitable Habitat (ESH) Index	Habitat size (mammals)
AIM-biodiversity	Extent of Suitable Habitat (ESH) Index	Habitat size (vascular plants, amphibians, reptiles, birds & mammals)
PREDICTS model	Biodiversity Intactness Index (BII)	Compositional intactness of ecological assemblages
GLOBIO model	Mean Species Abundance (MSA) Index	Compositional intactness of ecological assemblages
cSAR models (cSAR_US16 & cSAR_CB17)	Fraction of {globally/regionally} remaining species (F{R/G}RS) Index	Regional and global extinction species (vascular plants, amphibians, reptiles, birds & mammals)
BILBI model	Fraction of remaining species (FGRS)	Global extinction of vascular plants

Spatially (17 IPBES subregions) **& temporally explicit** (10 years, 2010-2100) **maps of biodiversity indices** (10 indices over 6 metrics & 8 BDMs)

(10 indices x 4 IAM) per scenario

Leclère et al 2018;
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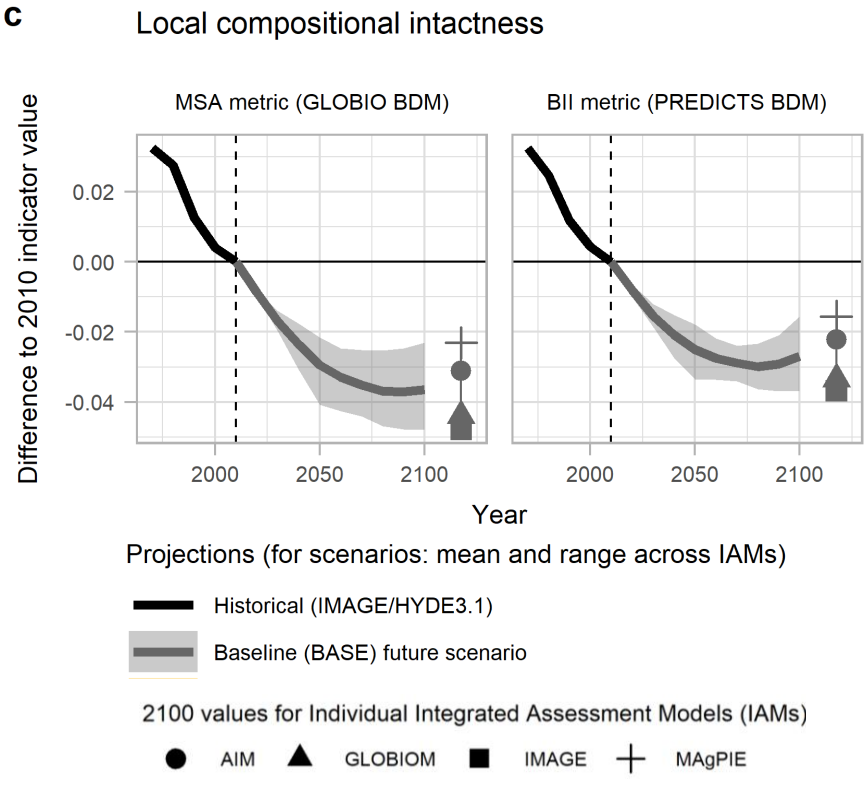
Multi-model assessment

12 teams of modelers in action

me

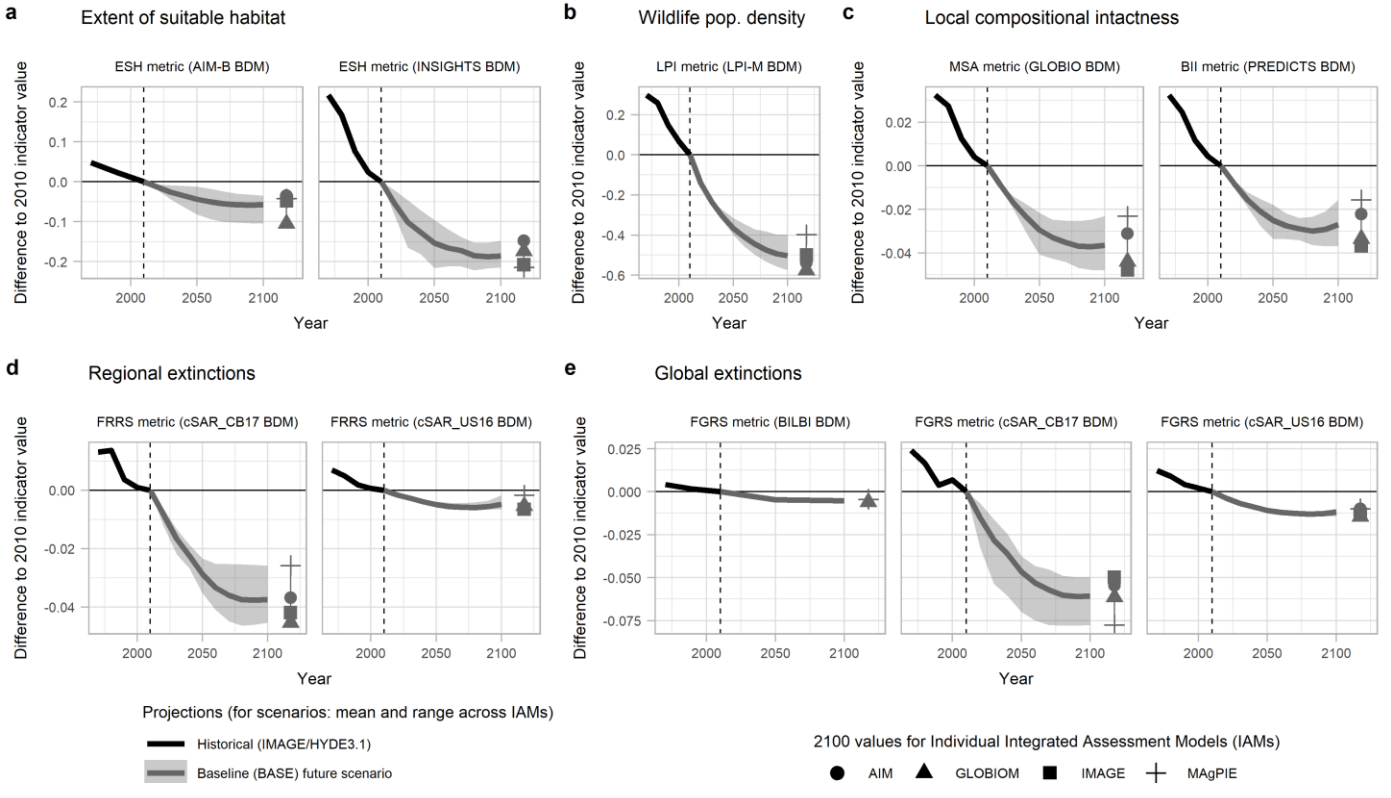
Results



Example for 1 scenario, 2 biodiversity metrics & 4 land-use models

Leclère et al. (in rev.) – do not circulate, tweet or quote

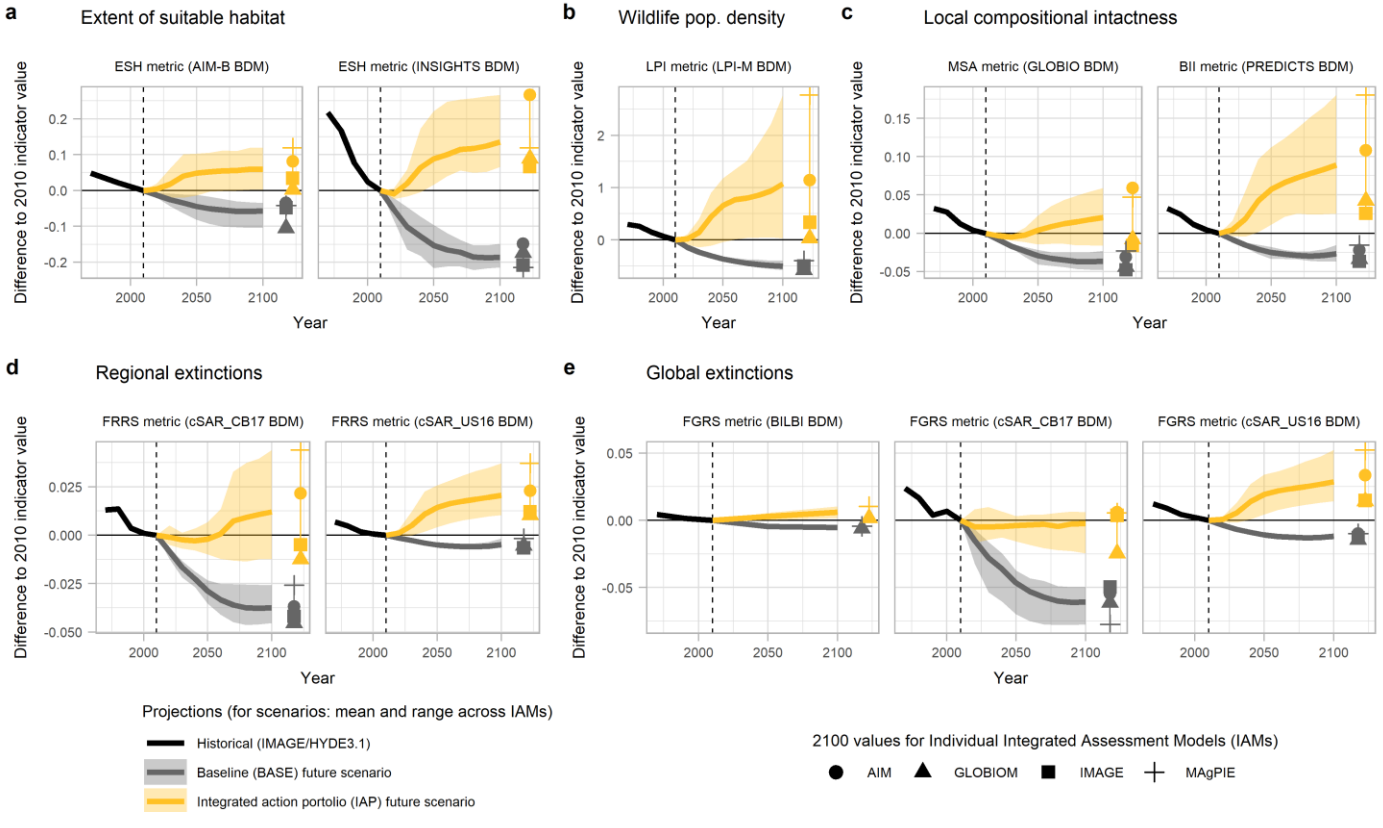
What if we don't raise ambition?



In the baseline scenario, continuous decline to at least last quarter of century

Leclère et al. (in rev.) – do not circulate, tweet or quote

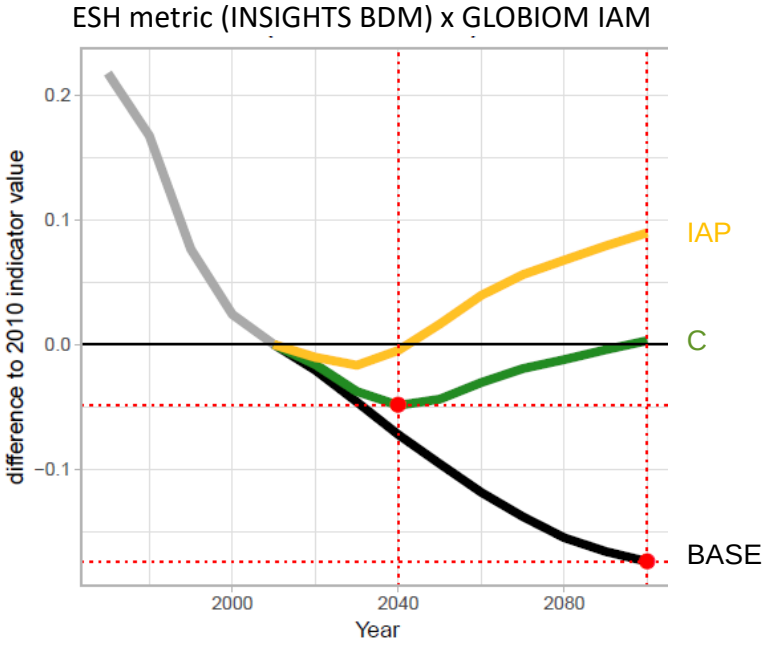
Yes, we can?



In the most ambitious scenario, trend reversal is achieved by 2050 for >90% of model combinations

Leclère et al. (in rev.) – do not circulate, tweet or quote

How do we get there?



For each scenario and model combinations:

- What is the <u>date when peak loss is reached</u> over the 21st century?
- What <u>share of losses is avoided</u> as compared to the reference scenario?
- What is the <u>speed of the recovery</u> after the peak loss has been reached?

➔ **How are these impacted by action scenarios?**

Leclère et al. (in rev.) – do not circulate, tweet or quote

How do we get there?

Increased conservation efforts are key …

More and better managed PAs and restoration and landscape-level conservation planning:

- Advances the date of biodiversity trend reversal by several decades
- Allows biodiversity to not only stabilize, but also recover

… but are not enough!

Only additionally tackling the drivers of habitat loss (e.g. diet shift, reduced waste, sustainable increases in trade and crop yields) allows:

- Securing biodiversity trend reversal by 2050
- Avoiding reducing habitat losses until then
- Keeping food prices under control & generating large synergies with health, GHG emissions, water use, fertilizer application etc.

Limits

Large uncertainties need to be recognized

Focus on trends in relative change through time (more robust)

Main modeling features responsible for differences across models identified

… but within-model uncertainties not accounted for (model evaluation needed)

Will the biodiversity trends bend in reality?

A major threat (land-use change) & several facets of biodiversity accounted for

… but other threats matter (and might even more in the future)

… and bending additional aspects of biodiversity (e.g., functional) might need more

What about the future we want?

Next step: looking climate impact & at trade-offs / synergies with mitigation!

Conclusions

Reversing terrestrial biodiversity declines from habitat loss by 2050 might be feasible

But not without ambitious and integrated action

Both bold conservation and tackling drivers of land use change should be part of post-2020 strategy

What about the future we want?

Next step: looking at trade-offs and synergies with climate mitigation scenarios!

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Thank you!

Questions?

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@Leclere_David

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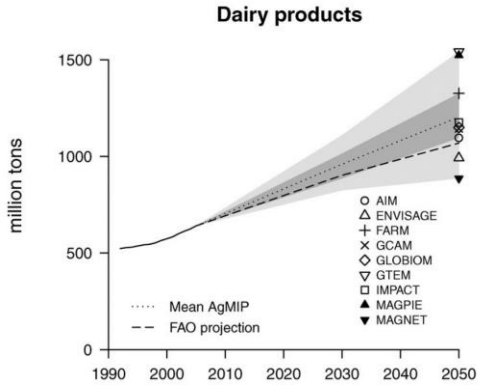
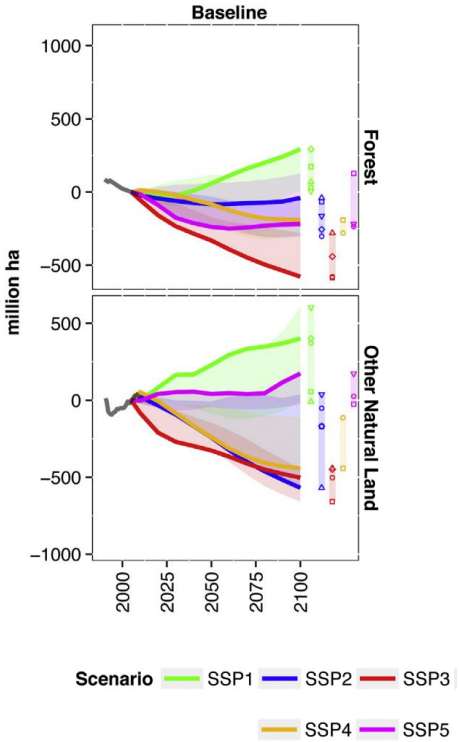
Scenarios exploring the space of actions

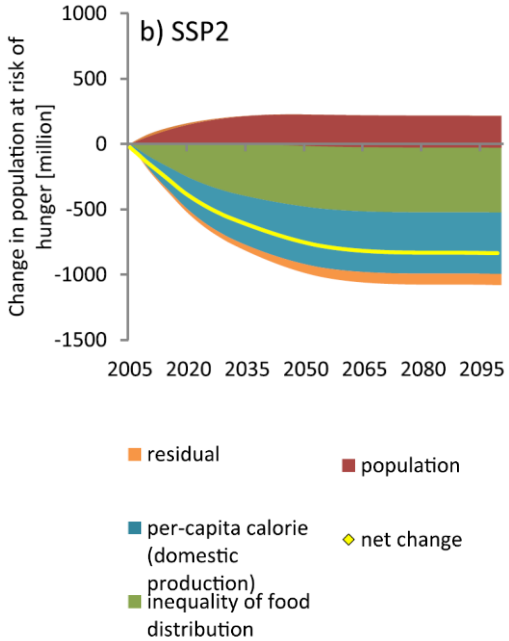
Valin et al. (2014)



Popp et al. (2017)



Hasegawa et al. (2015)



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~~SSP2~~ ➔ SSP1

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Linear transition 2020-2050:

- from 0% to 50% substitution of BASE animal calories demand by vegetal calories (more ambitious than SSP1)
- from 0% to 50% reduction of BASE waste throughout the supply chain (~ SSP1)

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More ambitious than any SSP:

- In 2020: from 15% to 40% of terrestrial area under PA (no biodiversity-decreasing land use change allowed)
- In 2020: tax/subsidy on biodiversity impact of land use change, starting with low tax value & increasing to 2100

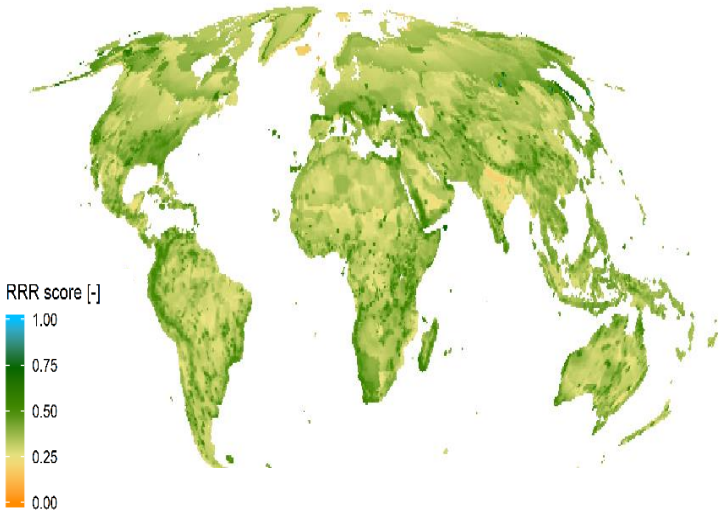
Scenarios exploring the space of actions

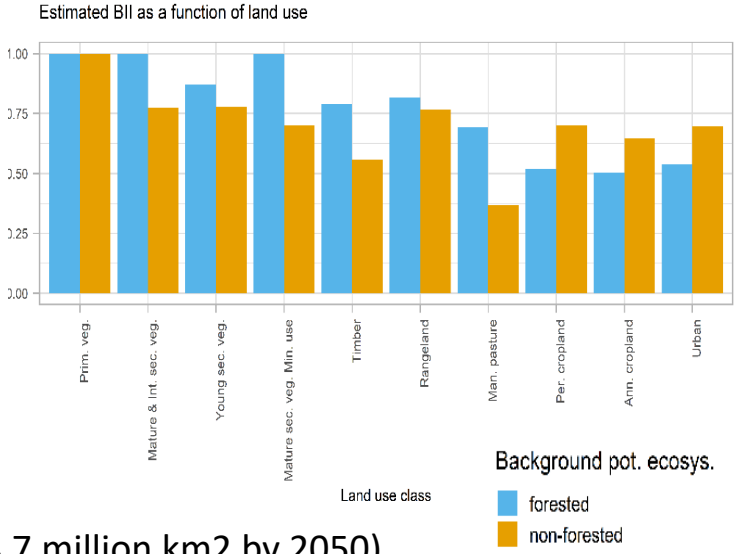
- Increased extent of protected areas in 2020 (to all WDPAs + KBAs + Wilderness areas), where no further biodiversity-detrimental land use change is allowed

i.e., by 2020, 40% of terrestrial areas effectively protected

Scenarios exploring the space of actions

- Gradually from 2020 to 2100, the biodiversity gains (losses) from land-use changes are subsidized (taxed) everywhere
  - BII used to evaluate the effect of various land uses in a pixel
  - Range-size rarity used to estimate the differences across pixels in biodiversity





leading to large restoration (2.7-14.7 million km2 by 2050)

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