

Climate change and biodiversity – synergies and challenges

The science perspective

TreeDi



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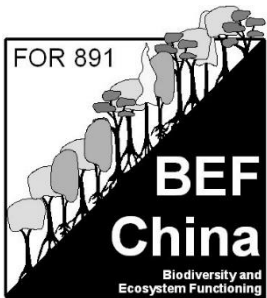
German Centre

for Integrative Biodiversity Research (iDiv)

Halle-Jena-Leipzig



iDiv



Sino-German Dialogue Forum on Biodiversity and Climate Change: Natural Resource

Management and Finance

November 6, 2019 – Beijing, China



合作伙伴
德国

DEUTSCHE ZUSAMMENARBEIT

Ministry of Finance, P.R. China

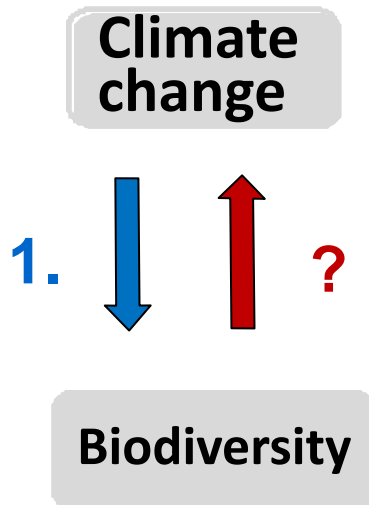
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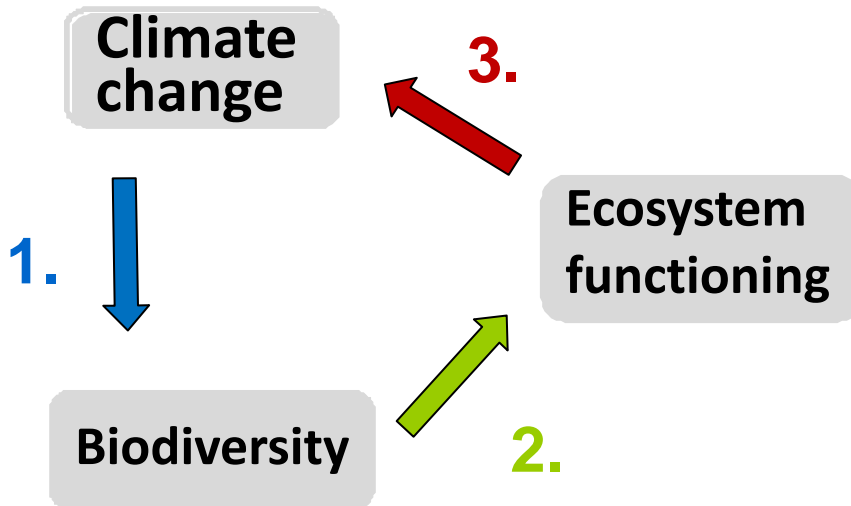


Climate change <-> biodiversity





Climate change <-> biodiversity





IPBES: 1 million species of plants and animals are faced with extinction

A EXTINCTION RISK

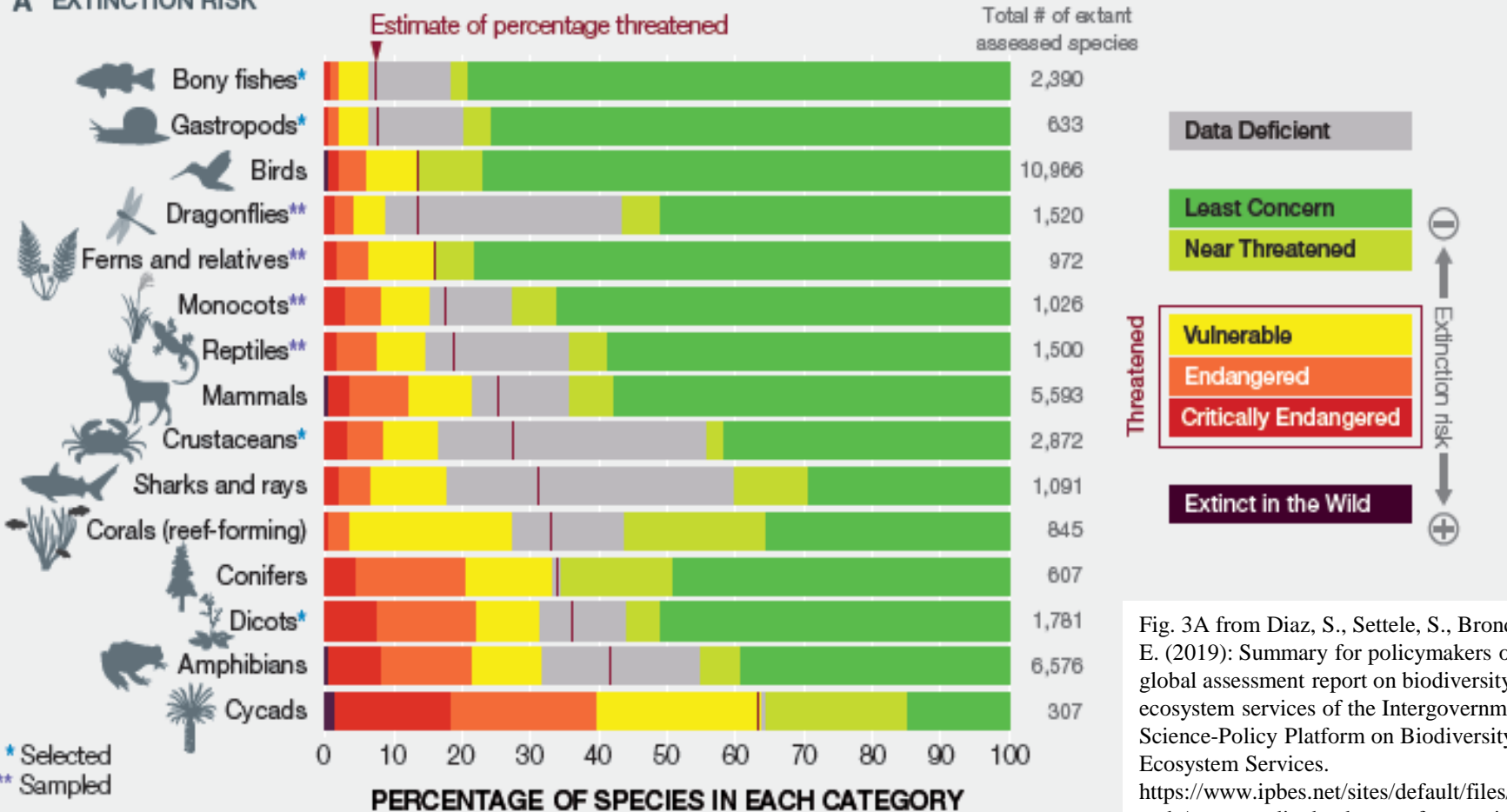
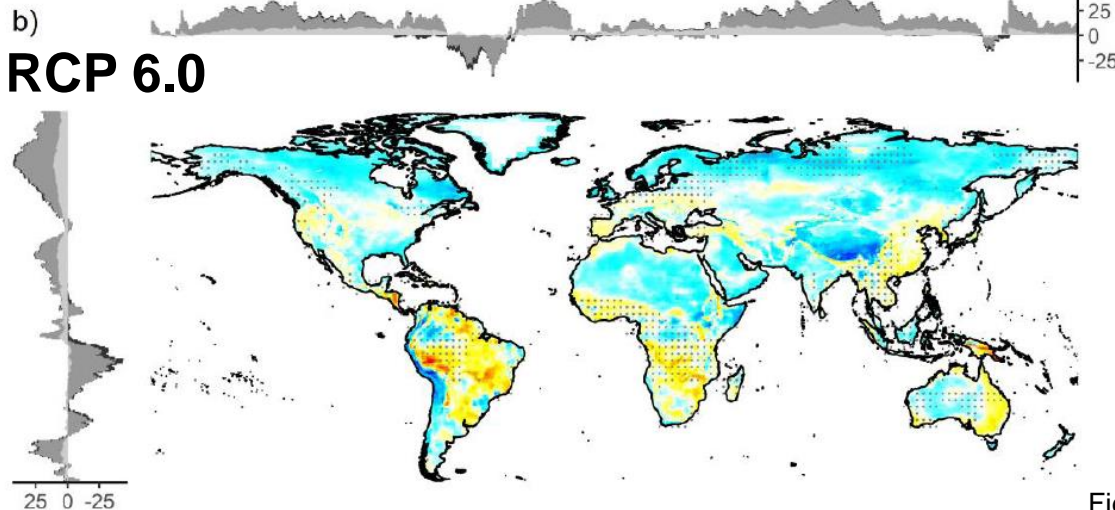
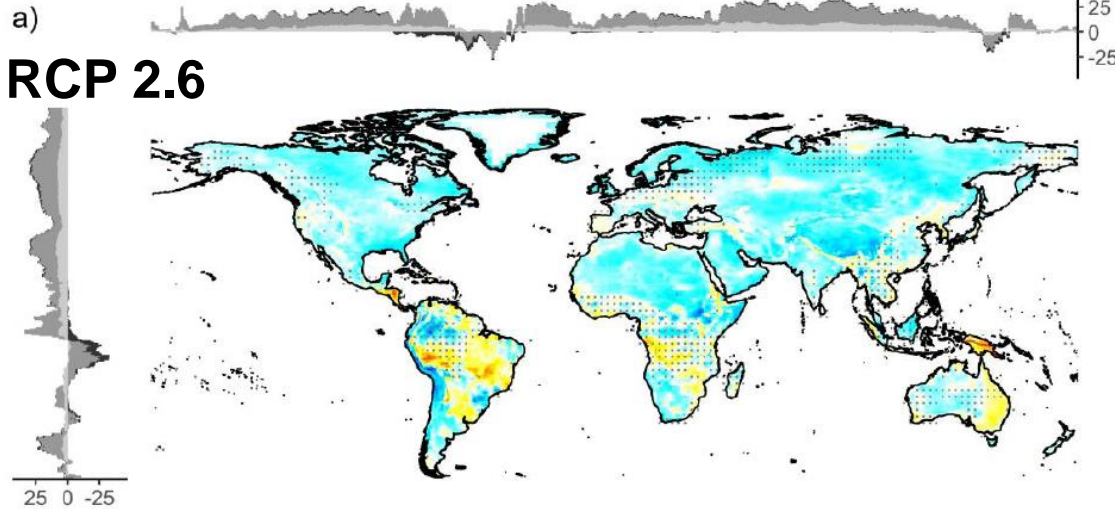


Fig. 3A from Diaz, S., Settele, S., Brondizio, E. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

https://www.ipbes.net/sites/default/files/downloads/spm_unedited_advance_for_posting_htn.pdf



1. Impact of climate change on biodiversity



Species decline in the (sub-)tropics

Two **different scenarios** for species richness estimates based on stacked climate-based species distribution models for the world's **amphibians,**



birds,



and **mammals**



for the year **2080 compared to 1995** assuming a basic dispersal scenario.

Fig. S2 from Hof, C., Voskamp, A., Biber, M.f., Böhning-Gaese, K., Engelhardt, E.K., Niamir, A., Willis, S.G., Hickler, T. (2018): Bioenergy cropland expansion may offset positive effects of climate change mitigation for global vertebrate diversity. PNAS 115: 13294–13299.

www.pnas.org/cgi/doi/10.1073/pnas.1807745115





1. Impact of climate change on biodiversity



Climate change is not the only driver of biodiversity loss

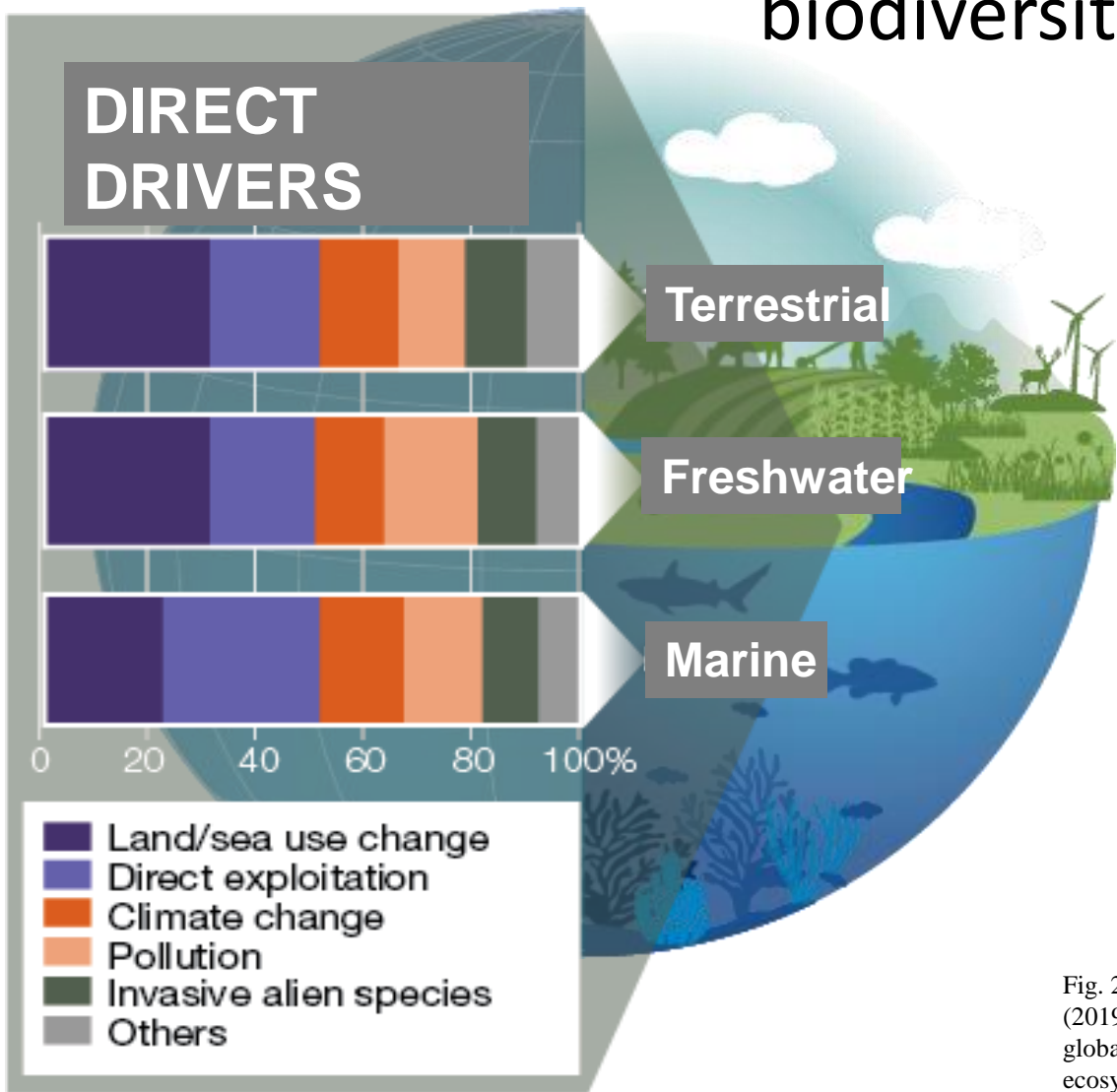


Fig. 2 from Diaz, S., Settele, S., Brondizio, E. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the IPBES



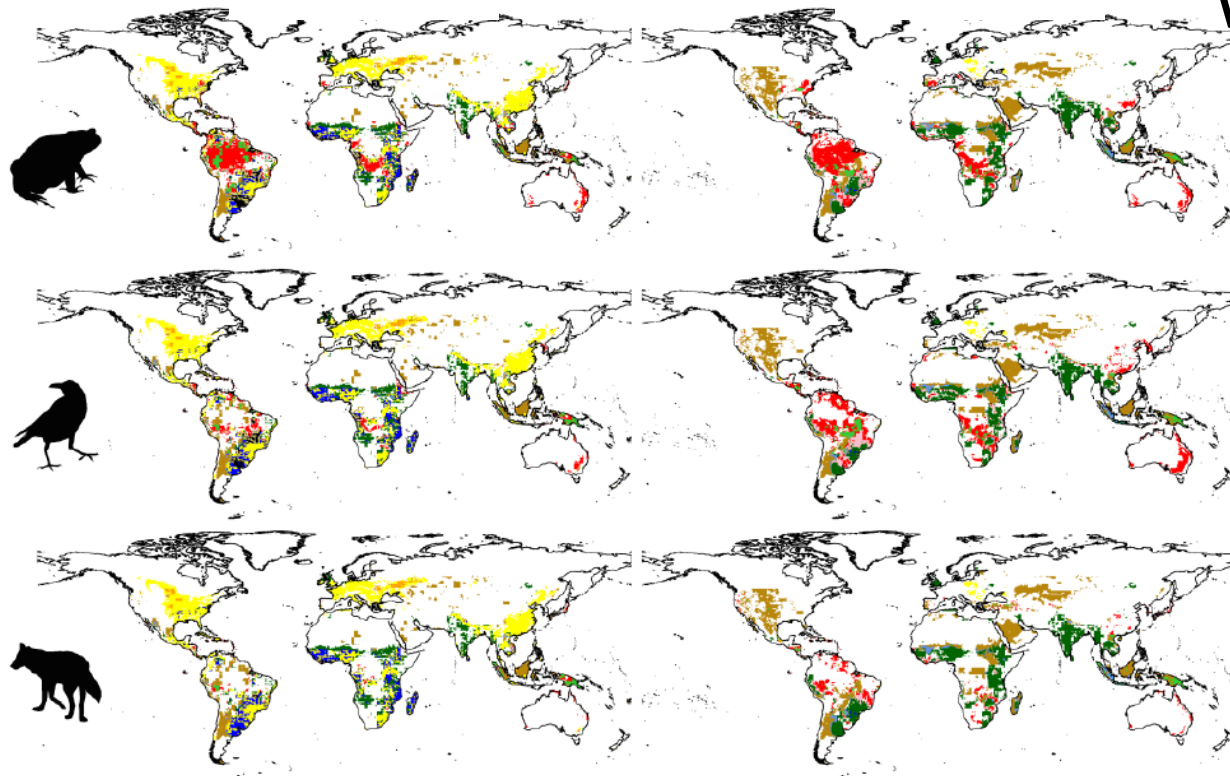
1. Impact of climate change on biodiversity



RCP 2.6

RCP 6.0

What is the bigger threat? Climate change or land use change?



Overlap of threat from climate and land-use change for **2080**, assuming a basic dispersal scenario.

CC = Climate

BC = Biofuel cropland

CR = Non-biofuel cropland

PA = Pastures

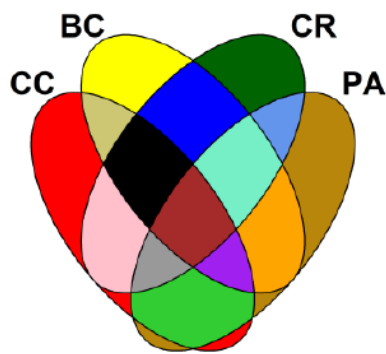
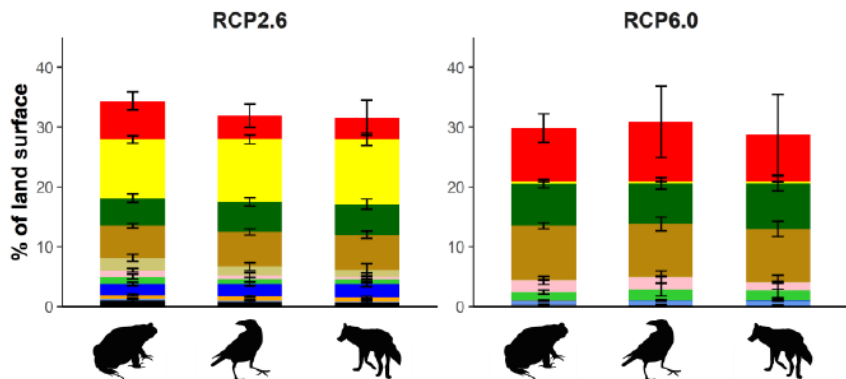
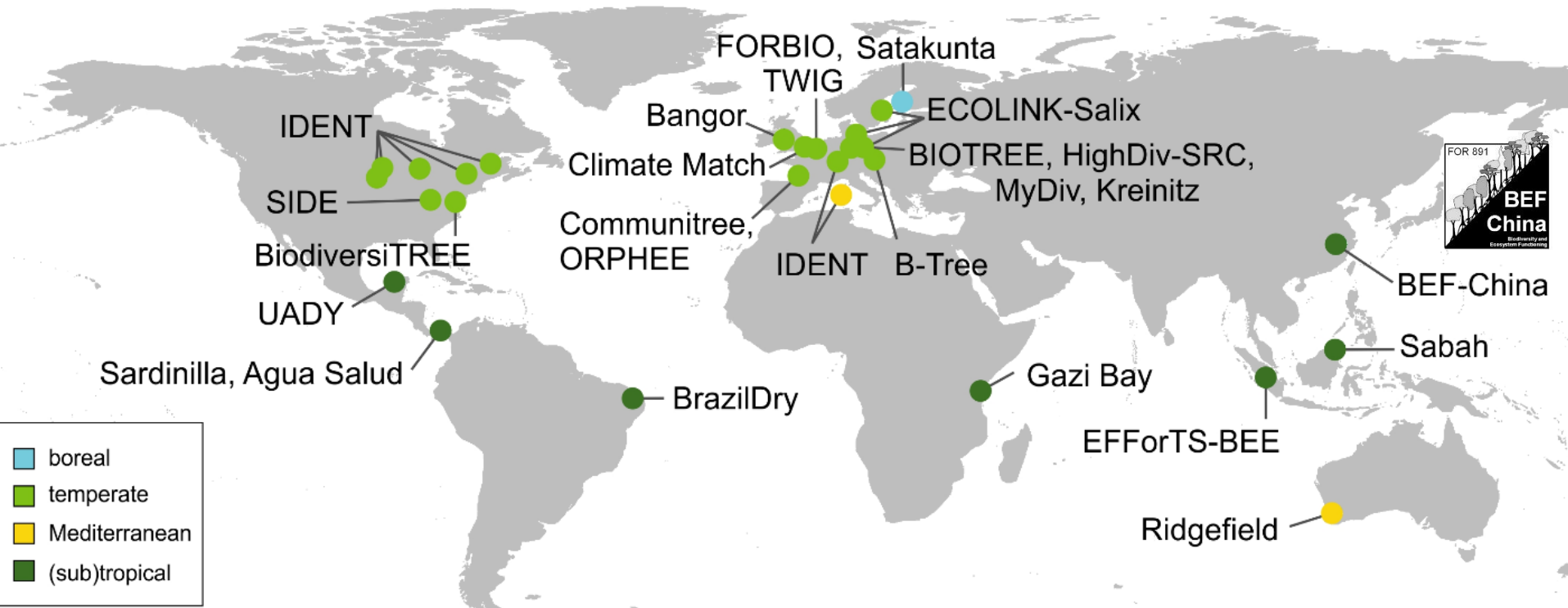


Fig. S2 from Hof et al. PNAS 115: 13294–13299. www.pnas.org/cgi/doi/10.1073/pnas.1807745115



BEF (Biodiversity-ecosystem functioning) forest experiments worldwide

March 2019: 25 experiments, 1,116,250 trees, 821 ha



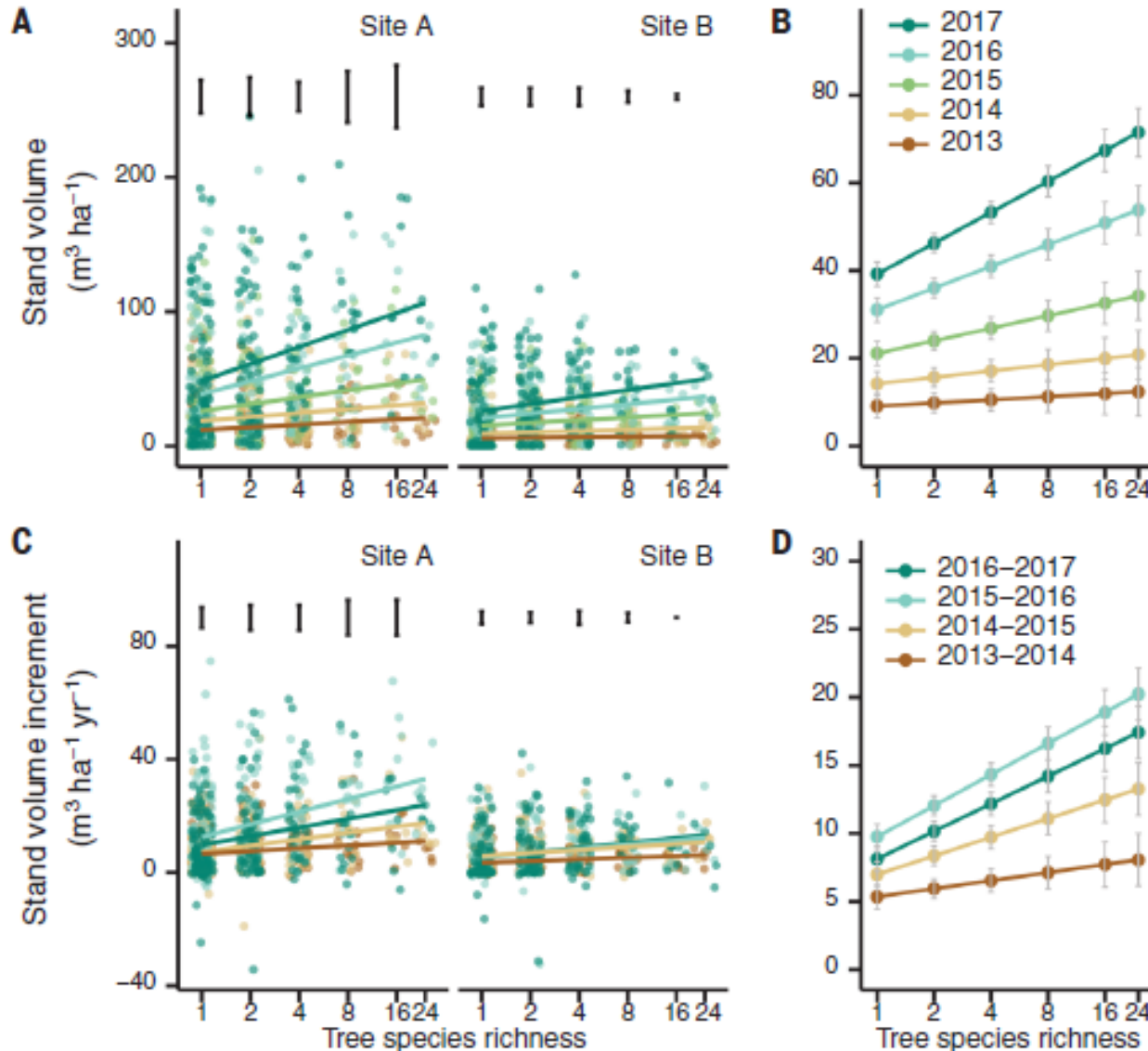
<http://www.treedivnet.ugent.be/experiments.html>

And Fig. 1 from: Grossman, J.J. Vanhellefont, M., Barsoum, N., Bauhus, J., Bruelheide, H., Castagneyrol, B., Cavender-Bares, J., Eisenhauer, N., Ferlian, O., Gravel, D., Hector, A., Jactel, H., Kreft, H., Mereu, S., Messier, C., Muys, B., Nock, C., Paquette, A., Parkers, J., Perring, M.P., Ponette, Q., Reich, P.B., Schuldt, A., Staab, M., Weih, M., Zemp, D.C., Scherer-Lorenzen, M., Verheyen, K. (2017): Using the tree diversity experiments of TreeDivNet to reveal the relationships between biodiversity and tree performance and damage worldwide. - Environmental and Experimental Botany 152: 68-89



2. Impact of biodiversity on ecosystem functioning

Positive biodiversity – productivity relationships



More species-rich forests accumulate more biomass

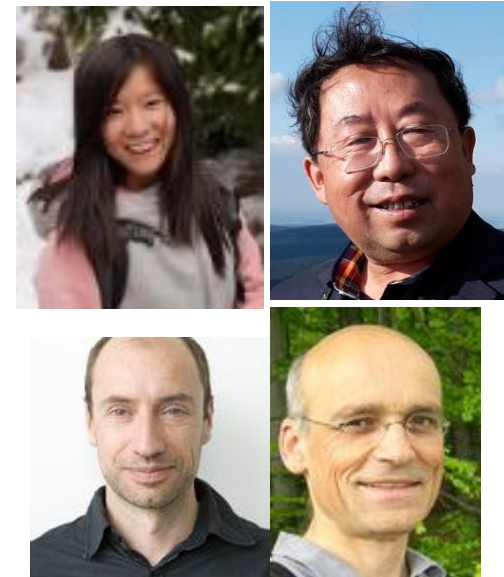


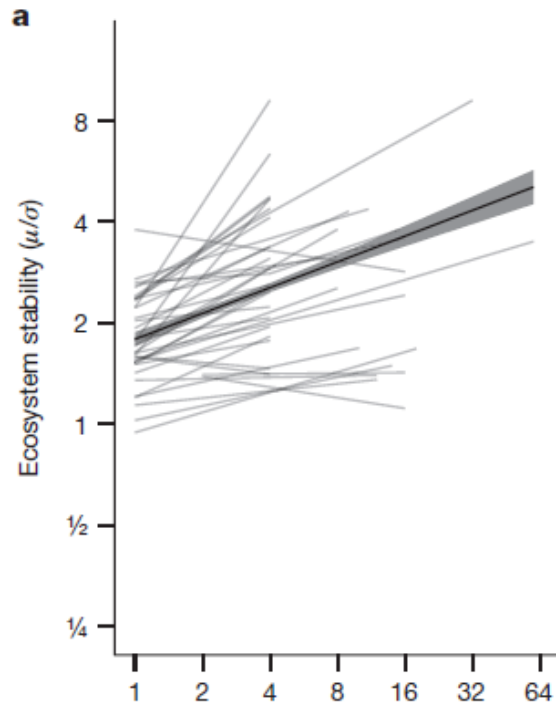
Fig. 1 from Huang, Y.Y., Chen, Y.X., Bruelheide, H., Ma, K.P., Niklaus, P.A., Schmid, B. (2018): Impacts of species richness on productivity in a large-scale subtropical forest experiment.- Science 362 (6410): 80–83. DOI: 10.1126/science.aat6405



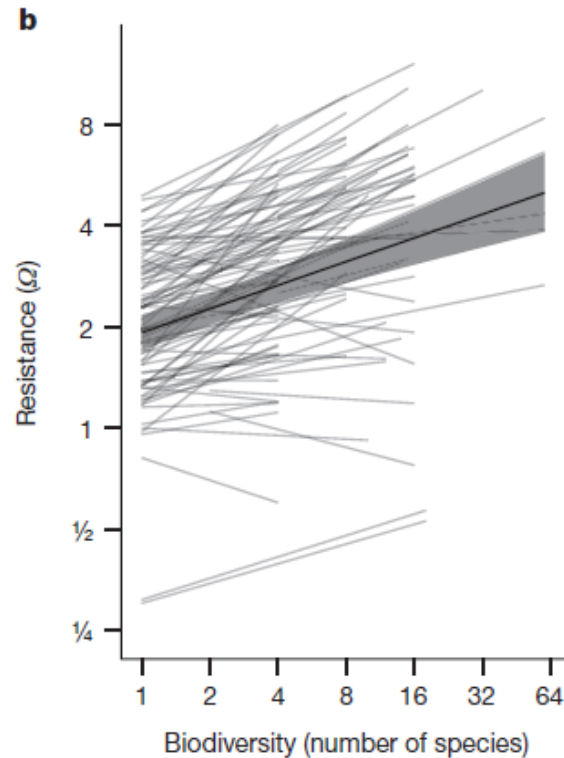
Biodiversity increases stability in climatically extreme years

by increasing resistance, but not resilience

Stability



Resistance



Resilience

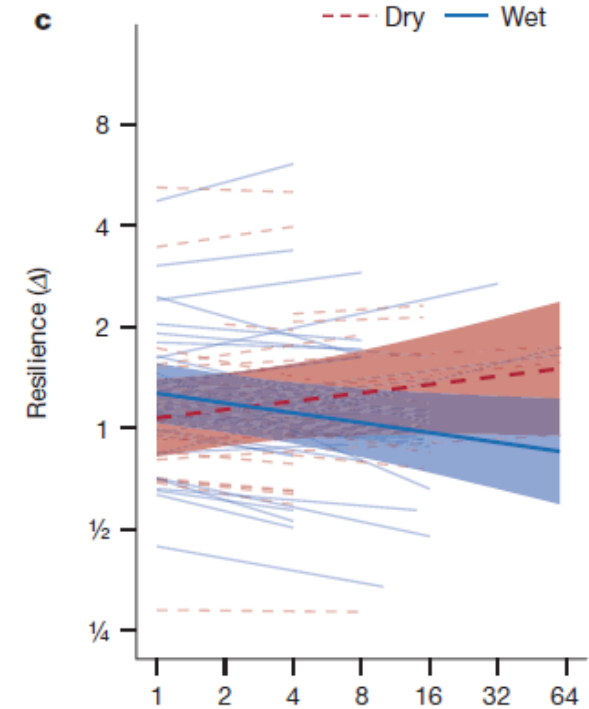


Fig. 1 from Isbell, F, & Eisenhauer, N. (2015): Biodiversity and the resistance and resilience of ecosystem productivity to climate extremes. - Nature 526: 574-577.



Two main pathways

Carbon-climate link

Biodiversity Increases productivity and soil carbon storage
-> increased carbon sequestration from the atmosphere

Surface energy exchange

Biodiversity decreases albedo (fraction of reflected shortwave radiation)

Biodiversity increases evapotranspiration (sensible heat flux) via vegetation height, crown shape, leaf size, leaf angle, stomata density, stomata size.



Biodiversity increases evapotranspiration



Australia near Perth; a fence separating shrub vegetation and agriculture

Photograph: courtesy of Axel Kleidon



IPBES: Decline in biodiversity's contribution to climate

Nature's contribution to people		50-year global trend	Directional trend across regions	Selected indicator
REGULATION OF ENVIRONMENTAL PROCESSES	1 Habitat creation and maintenance	↓	○	• Extent of suitable habitat • Biodiversity intactness
	2 Pollination and dispersal of seeds and other propagules	↓	○	• Pollinator diversity • Extent of natural habitat in agricultural areas
	3 Regulation of air quality	↘	↕	• Retention and prevented emissions of air pollutants by ecosystems
	4 Regulation of climate	↘	↕	• Prevented emissions and uptake of greenhouse gases by ecosystems
	5 Regulation of ocean acidification	→	↕	• Capacity to sequester carbon by marine and terrestrial environments
	6 Regulation of freshwater quantity, location and timing	↘	↕	• Ecosystem impact on air-surface-ground water partitioning
	7 Regulation of freshwater and coastal water quality	↘	○	• Extent of ecosystems that filter or add constituent components to water
	8 Formation, protection and decontamination of soils and sediments	↘	↕	• Soil organic carbon
	9 Regulation of hazards and extreme events	↘	↕	• Ability of ecosystems to absorb and buffer hazards
	10 Regulation of detrimental organisms and biological processes	↓	○	• Extent of natural habitat in agricultural areas • Diversity of competent hosts of vector-borne diseases

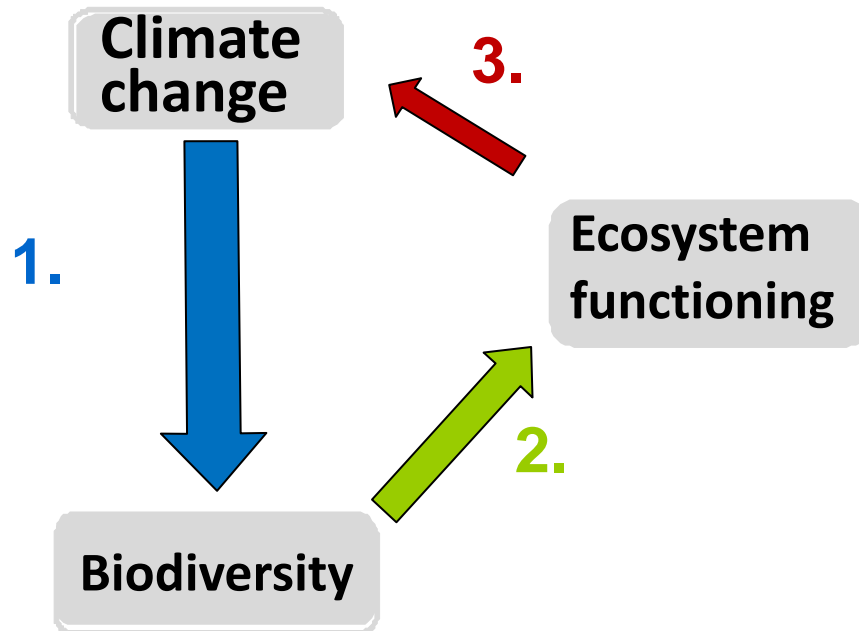
Global trends in the capacity of nature to sustain contributions to good quality of life from 1970 to the present.



Fig. 1 from Diaz, S., Settele, S., Brondizio, E. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the IPBES.



Conclusions



State of knowledge

1 > 2 > 3

1. Climate change -> biodiversity

Ample evidence. Models are well established, but depend on co-drivers (such as land use change)

2. Biodiversity -> ecosystem functioning

Well established relationships at the local scale, but much less is known at the landscape scale and for crop systems.

3. Ecosystem functioning -> climate

Vegetation effects on climate are well established, but knowledge on the role of species diversity is limited.



Acknowledgments

When it is obvious that the goals cannot be reached,
don't adjust the goals, adjust the action steps.

Confucius; 551-479 BC