Climate change and biodiversity – synergies and challenges The science perspective

Helge Bruelheide

Martin Luther University Halle-Wittenberg,
Institute of Biology / Geobotany and Botanical Garden
helge.bruelheide@botanik.uni-halle.de
http://www.botanik.uni-halle.de

German Centre
for Integrative Biodiversity Research (iDiv)
Halle-Jena-Leipzig

TreeDi

FOR 891 BEF China Biodiversity and Ecosystem Functioning

iDiv

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

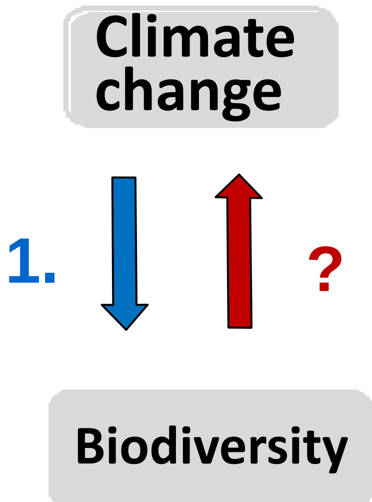
November 6, 2019 – Beijing, China

合作伙伴 德国 DEUTSCHE ZUSAMMENARBEIT

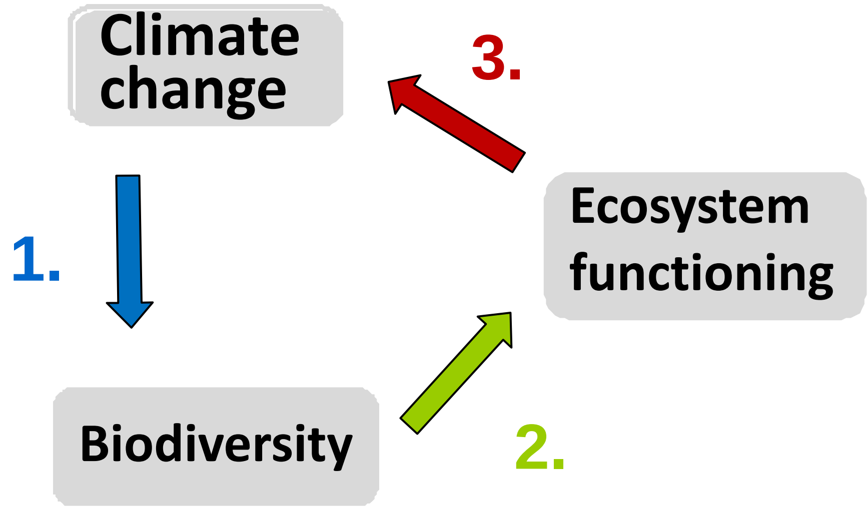
Ministry of Finance, P.R. China
中华人民共和国财政部

Federal Ministry for Economic Cooperation and Development

Climate change <-> biodiversity



Climate change <-> biodiversity



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

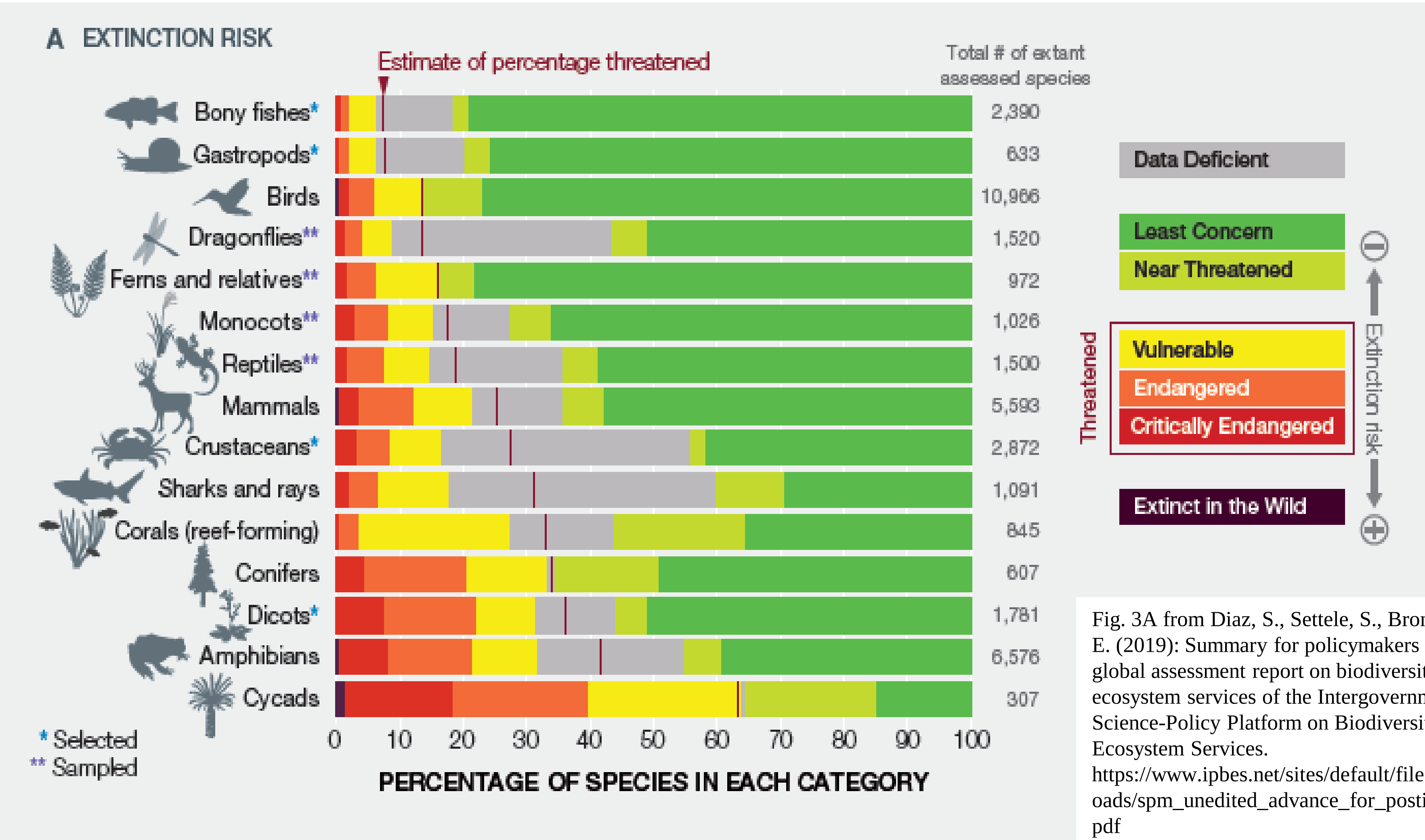
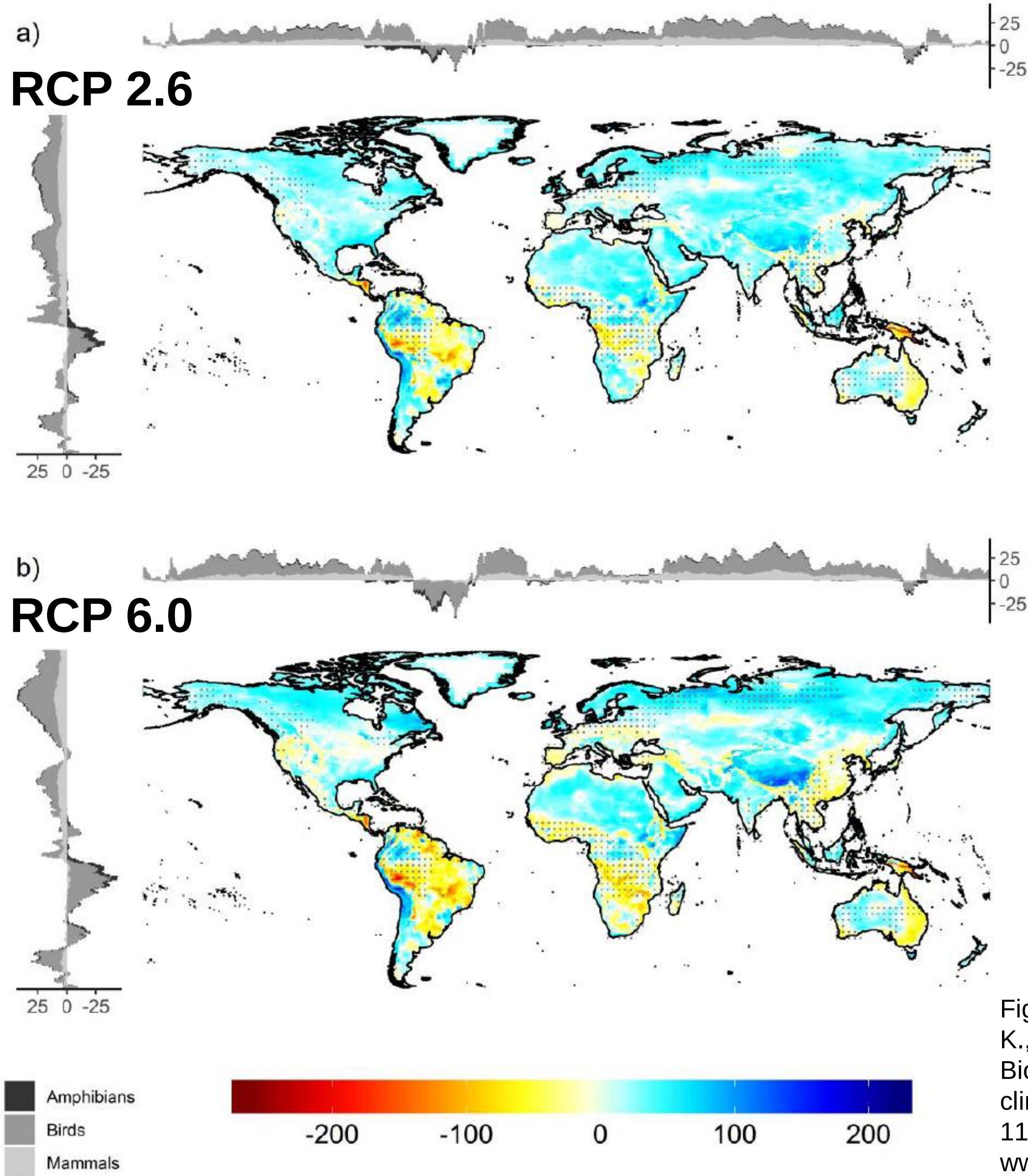


Fig. 3A from Diaz, S., Settele, S., Brondizio, E. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipbes.net/sites/default/files/downloads/spm_unedited_advance_for_posting_htn.pdf

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

Climate change is not the only driver of biodiversity loss

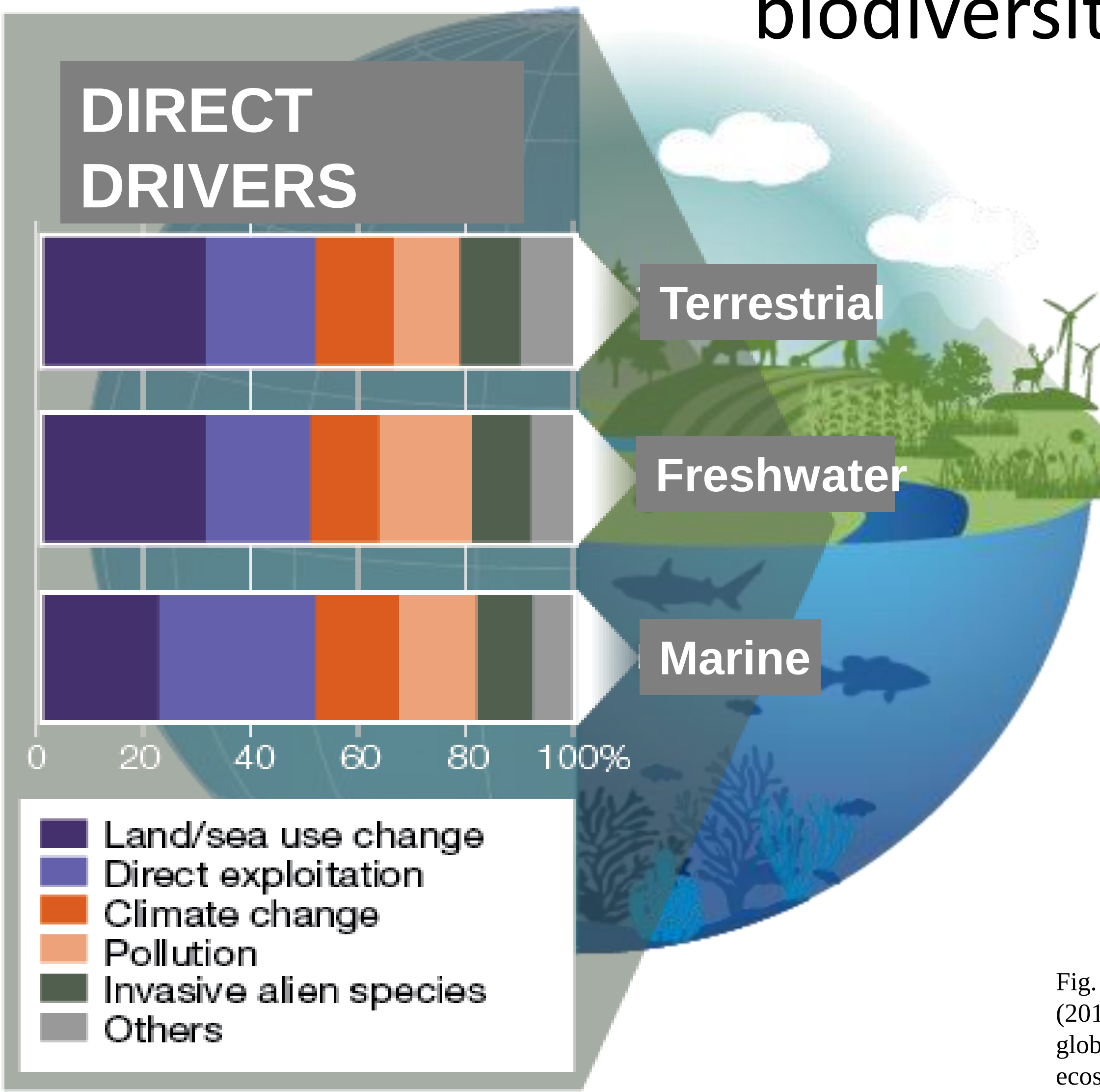
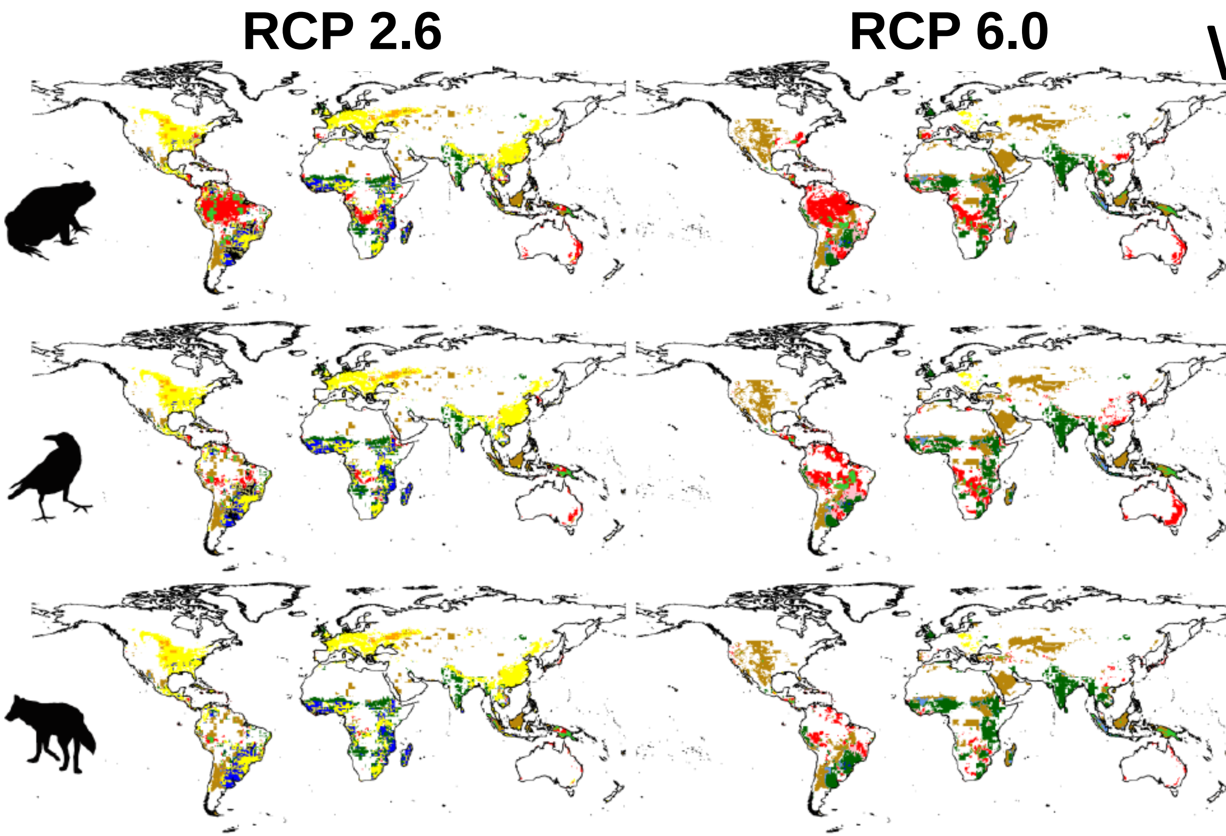


Fig. 2 from Diaz, S., Settele, S., Brondizio, E. (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the IPBES

1. Impact of climate change on biodiversity



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

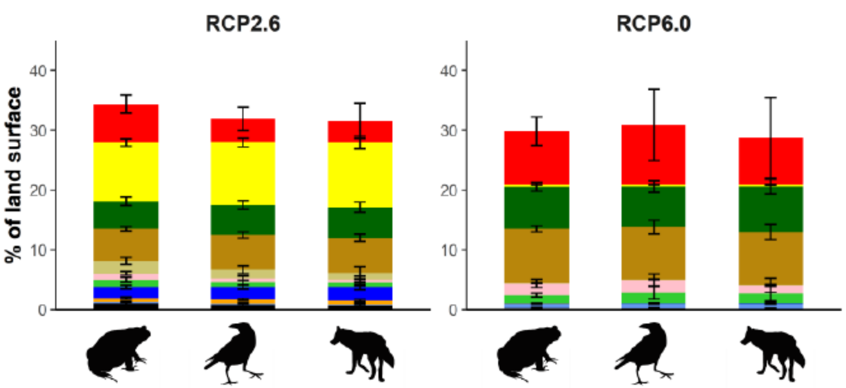
Overlap of threat from climate and land-use change for **2080**, assuming a basic dispersal scenario.

CC = Climate

BC = Biofuel cropland

CR = Non-biofuel cropland

PA = Pastures



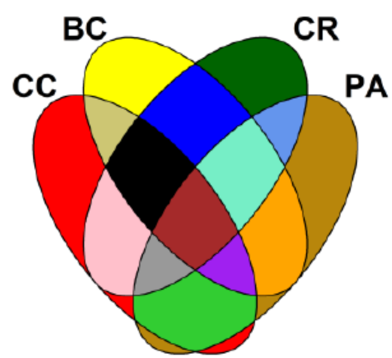
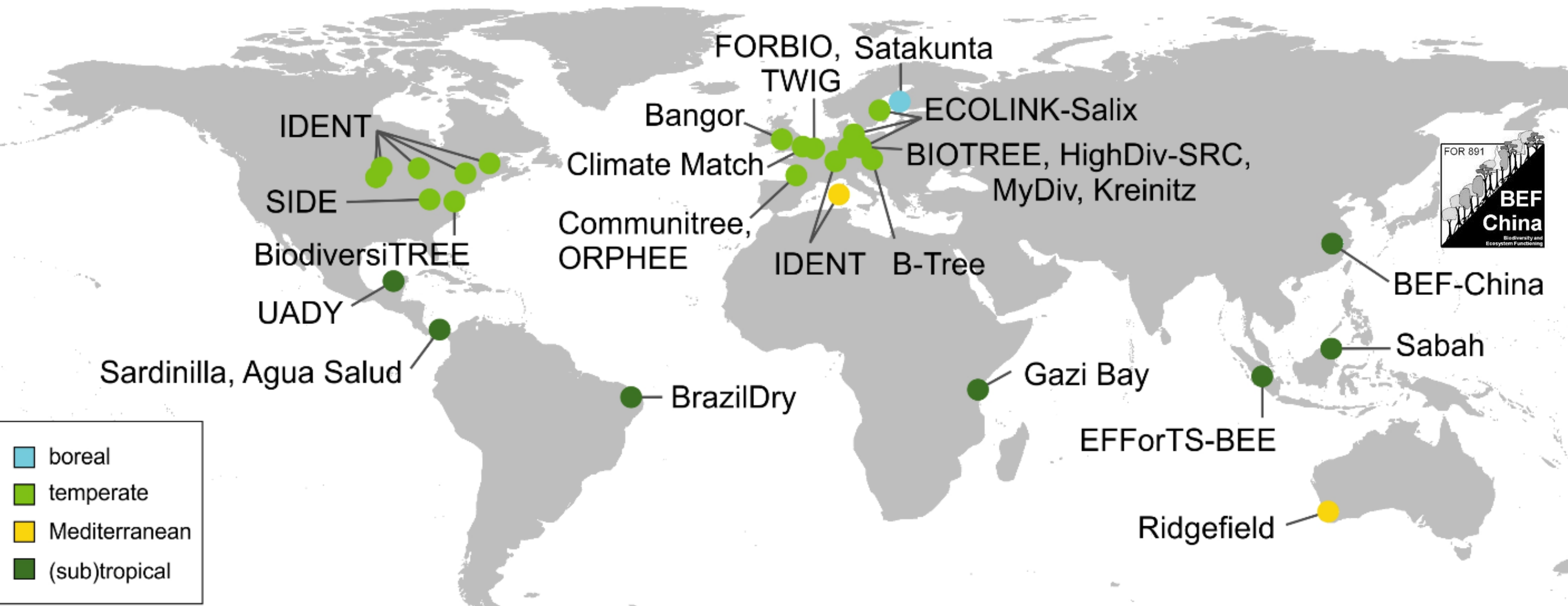


Fig. S2 from Hof et al. PNAS 115: 13294–13299. www.pnas.org/cgi/doi/10.1073/pnas.1807745115

BEF (Biodiversity-ecosystem functioning) forest experiments worldwide

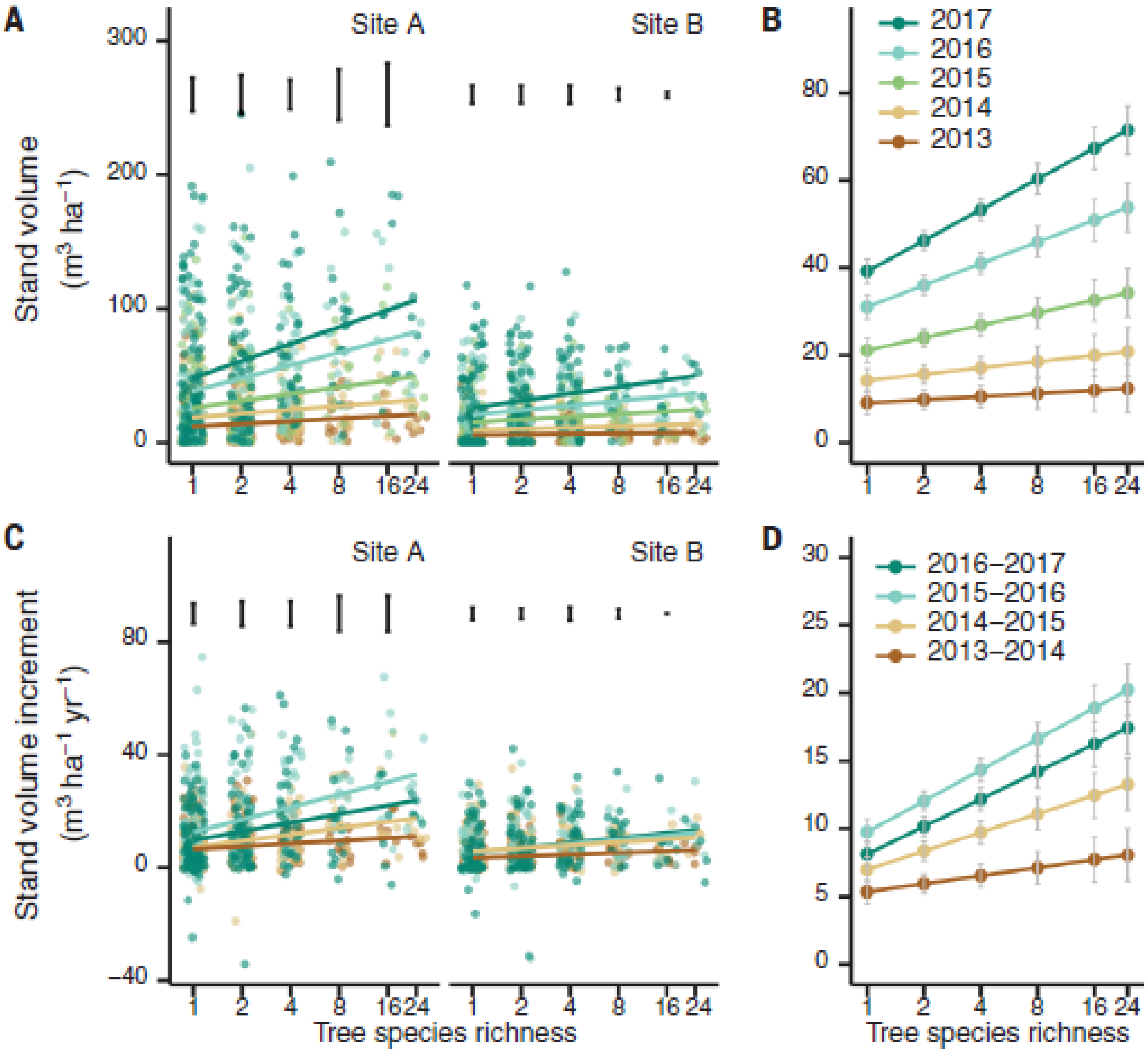
March 2019: 25 experiments, 1,116,250 trees, 821 ha



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

And Fig. 1 from: Grossman, J.J. Vanhellemont, 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

Positive biodiversity – productivity relationships



More species-rich forests accumulate more biomass

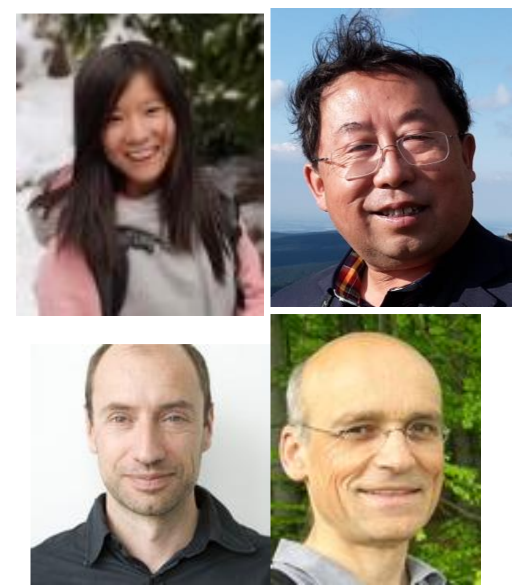


Fig. 1 from Huang, Y.Y., Chen, Y.X., …. Bruelheide, H., Ma, K.P., Niklaus, P.A., Schmid, B. (2018): Impacts of species richness on productivity in a large-scale subtropical forest experiment.- Science 362 (6410): 80–83.
DOI: 10.1126/science.aat6405

Biodiversity increases stability in climatically extreme years

by increasing resistance, but not resilience

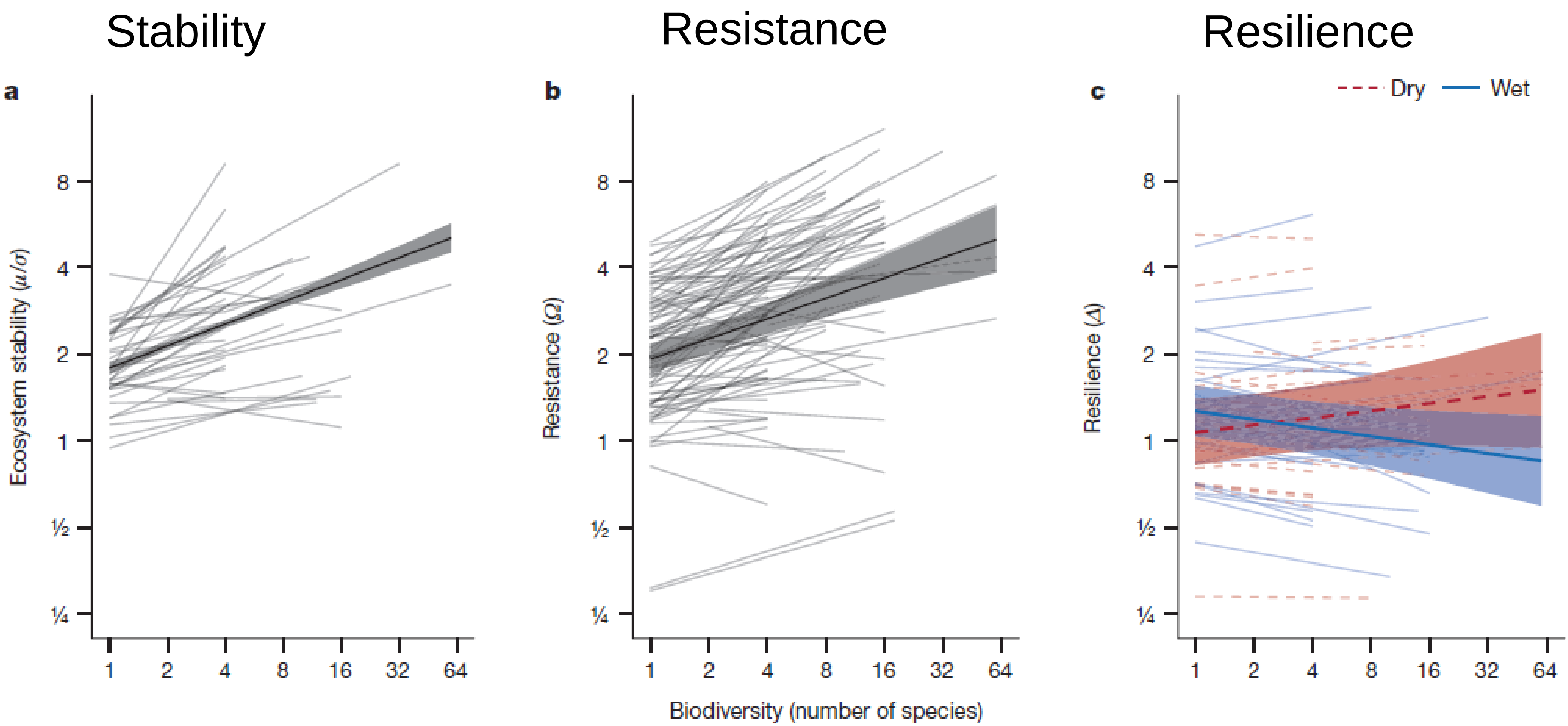


Fig. 1 from Isbell, F, ….. & Eisenhauer, N. (2015): Biodiversity and the resistance and resilience of ecosystem productivity to climate extremes. - Nature 526: 574-577.

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)

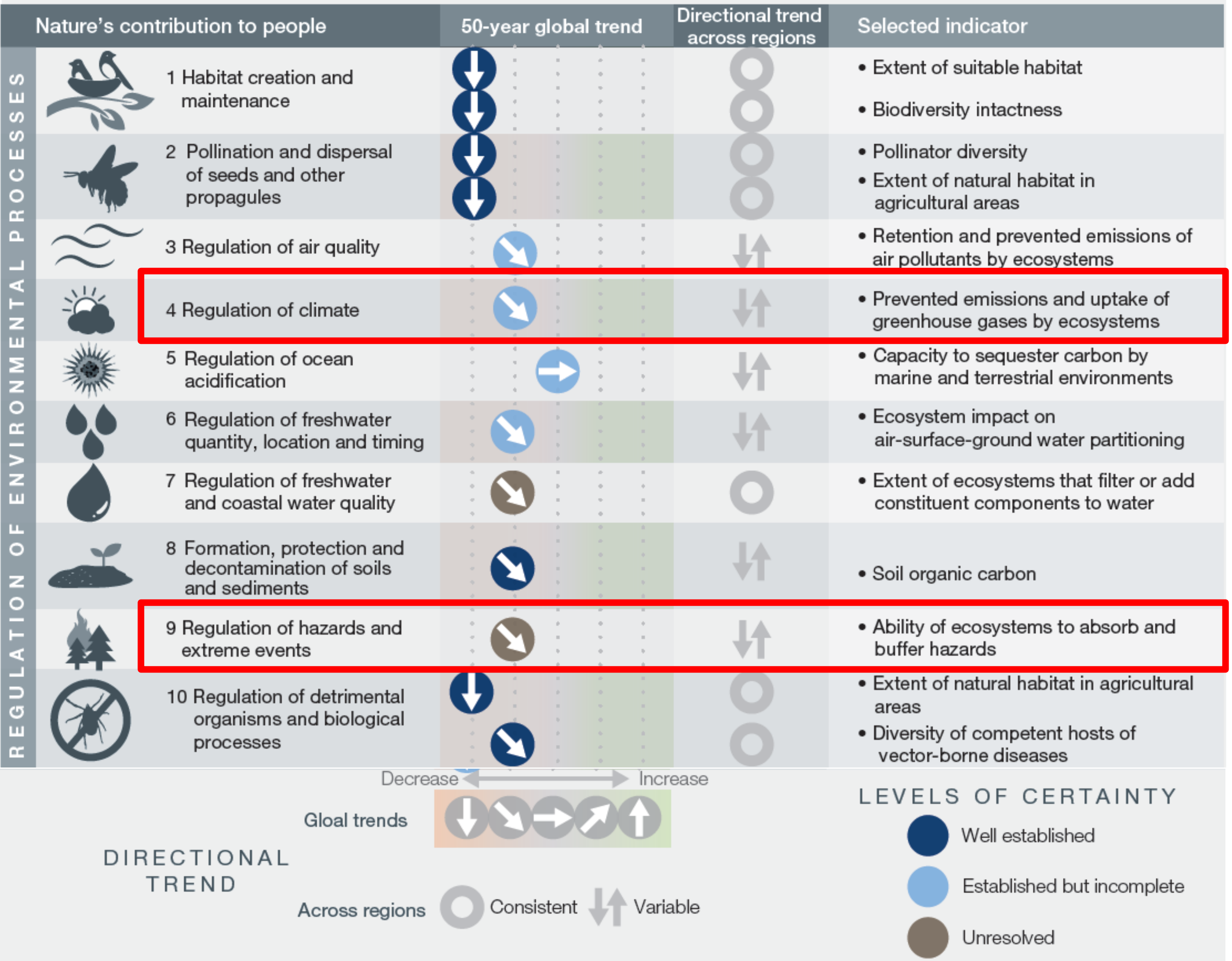
via vegetation height, crown shape, leaf size, leaf angle, stomata density, stomata size.

Biodiversity increases evapotranspiration

Australia near Perth; a fence separating shrub vegetation and agriculture

Photograph: courtesy of Axel Kleidon

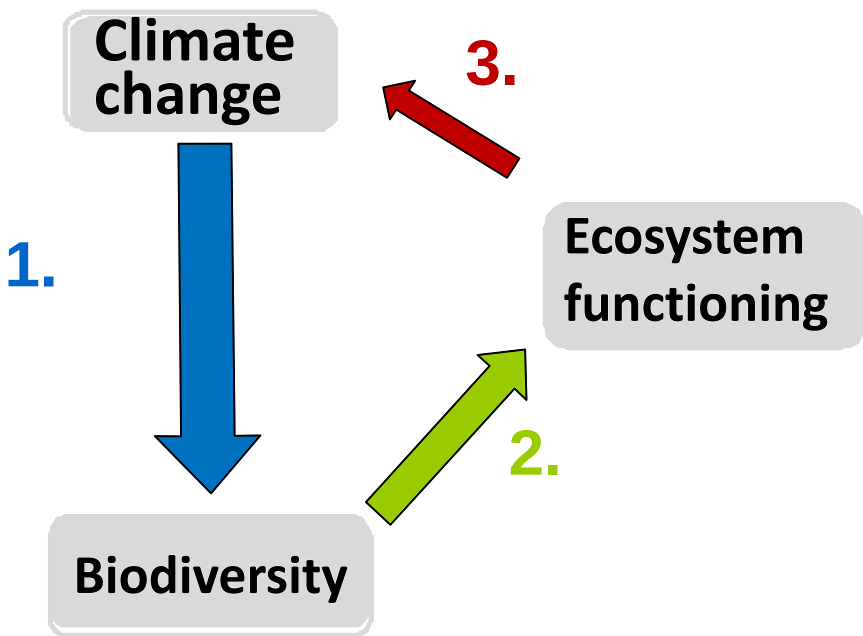
IPBES: Decline in biodiversity's contribution to climate



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 knowldege

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.

Acknowlegdments

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

Confucius; 551-479 BC