Climate extremes and ecosystem resilience in a future world

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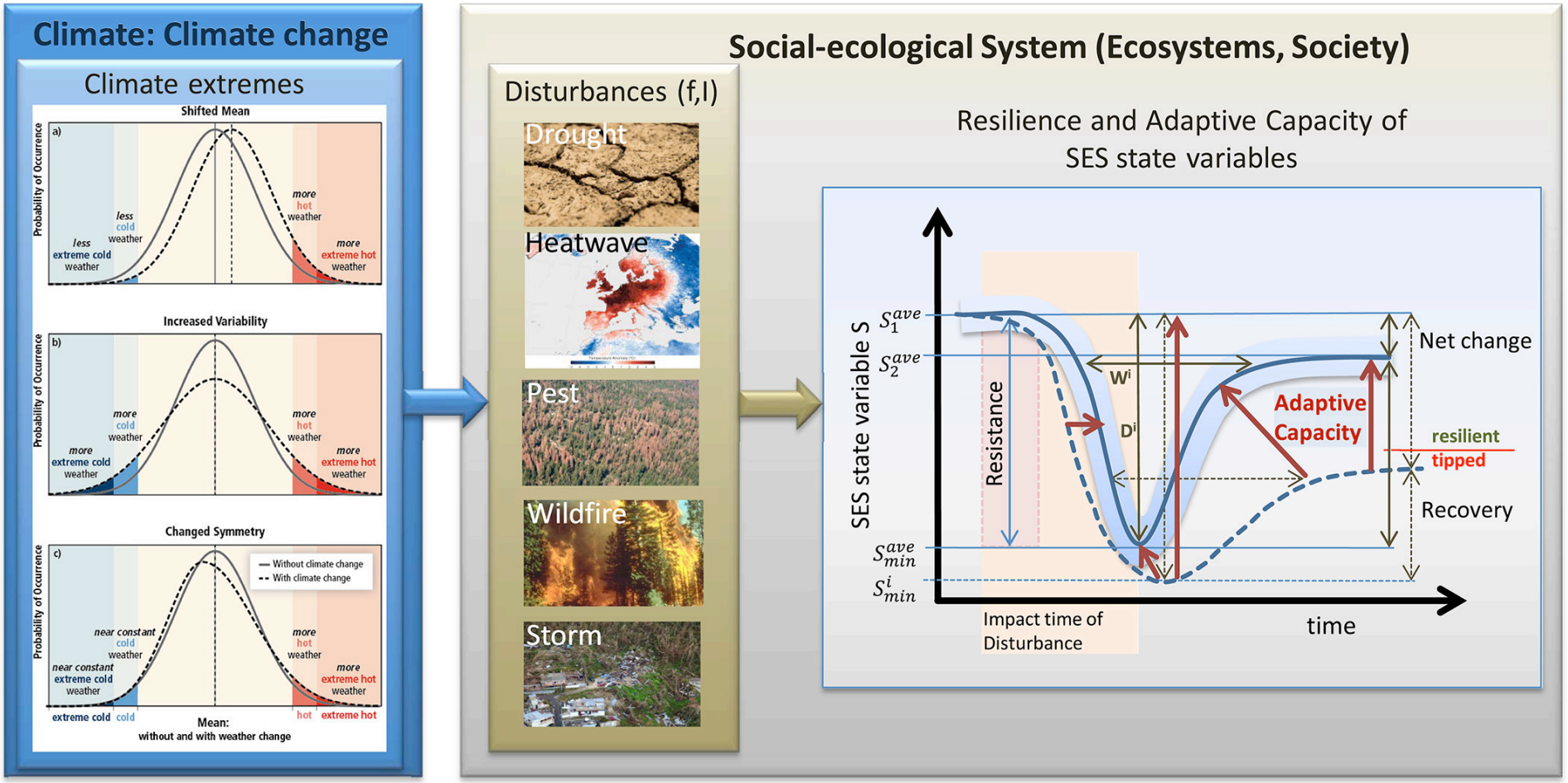
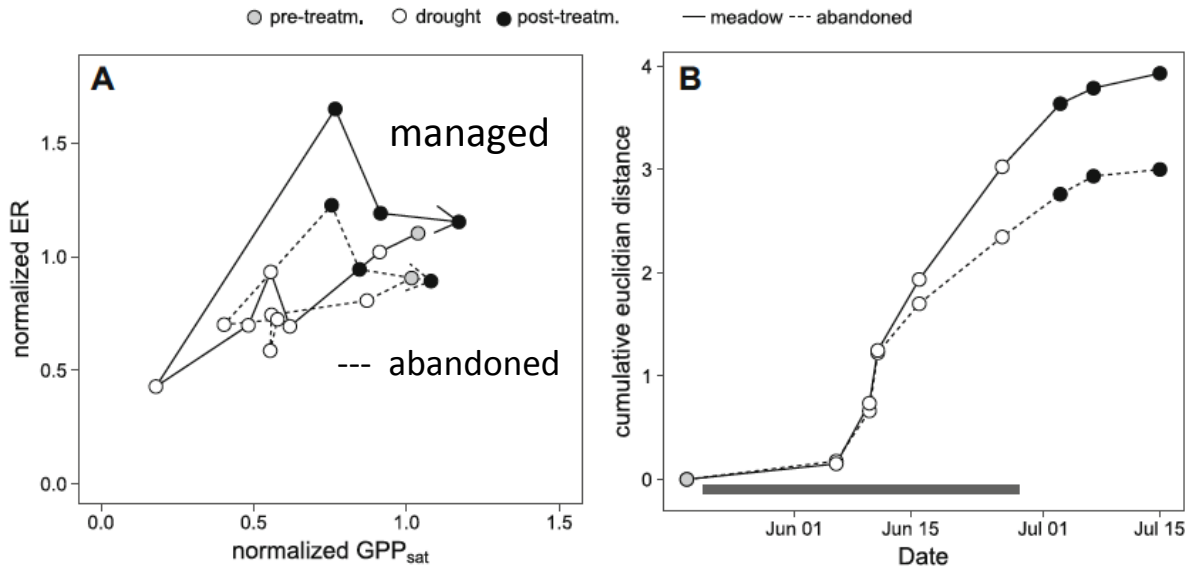
FWF ClimGrass ÖAW ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN

In a future world

ecosystems will likely face an increase in the frequency and severity of **climate extremes, interacting with other global changes** incl. a.o. climate warming, elevated CO_2 and land-use changes

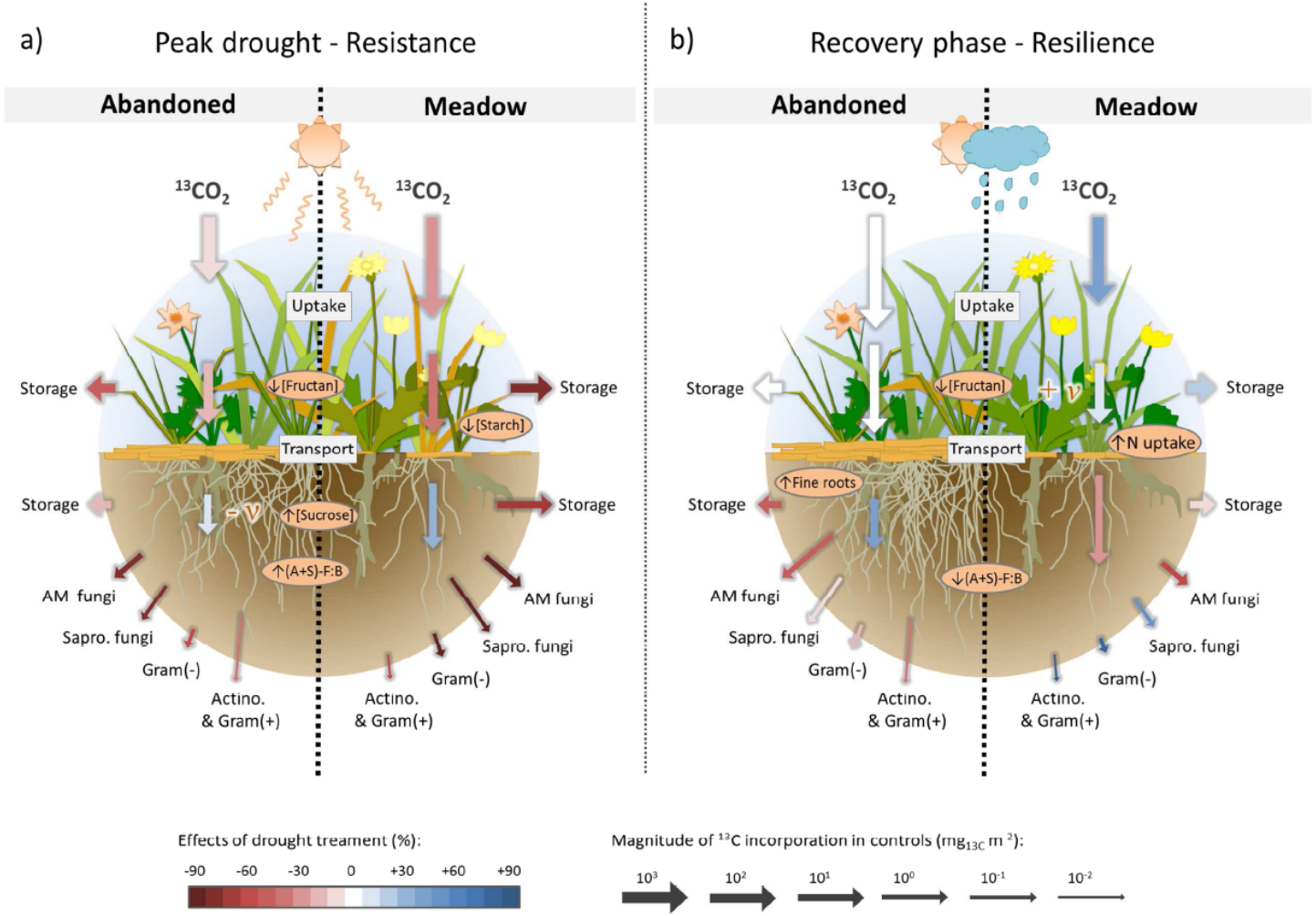


Land Use Alters the Drought Responses of Productivity and CO_2 Fluxes in Mountain Grassland

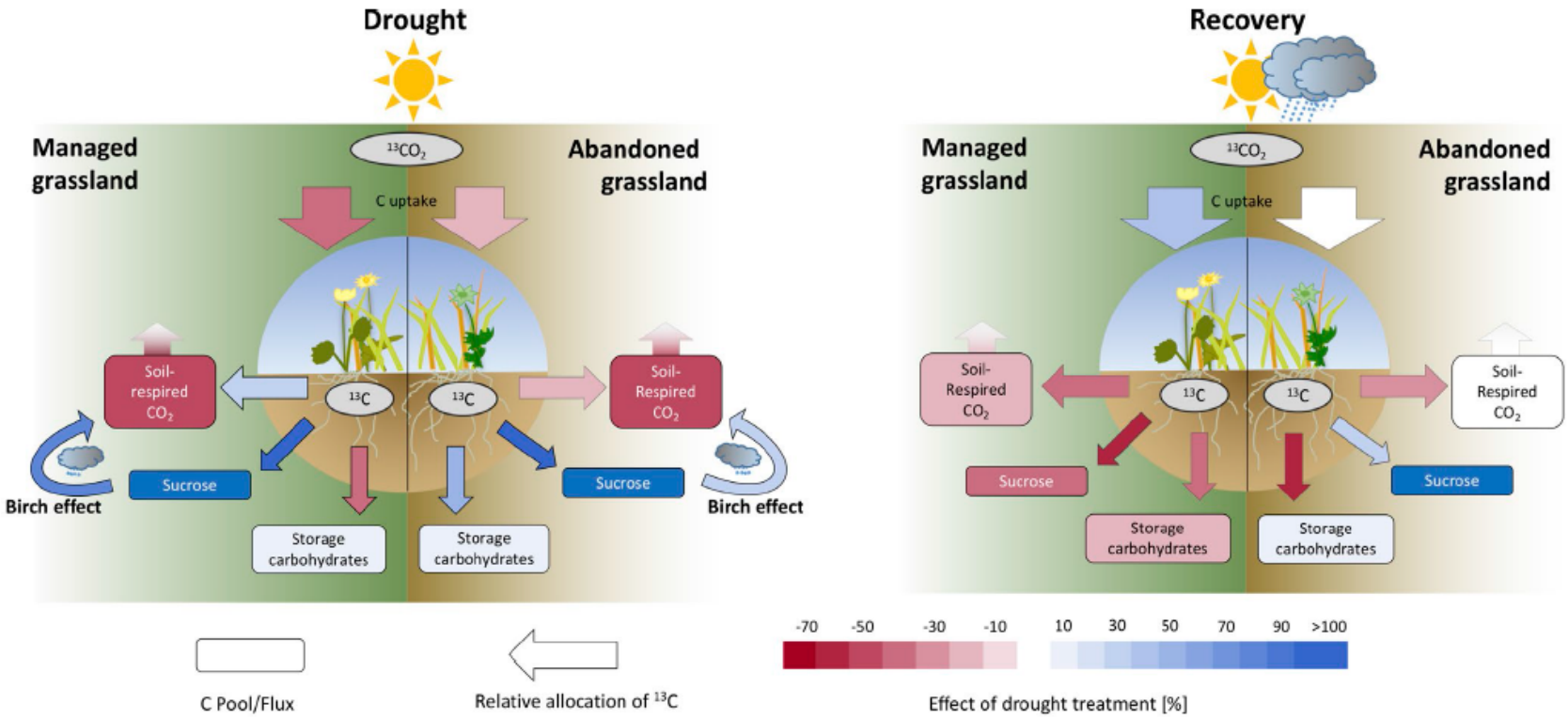


Ingrisch et al. (2018) *Ecosystems*

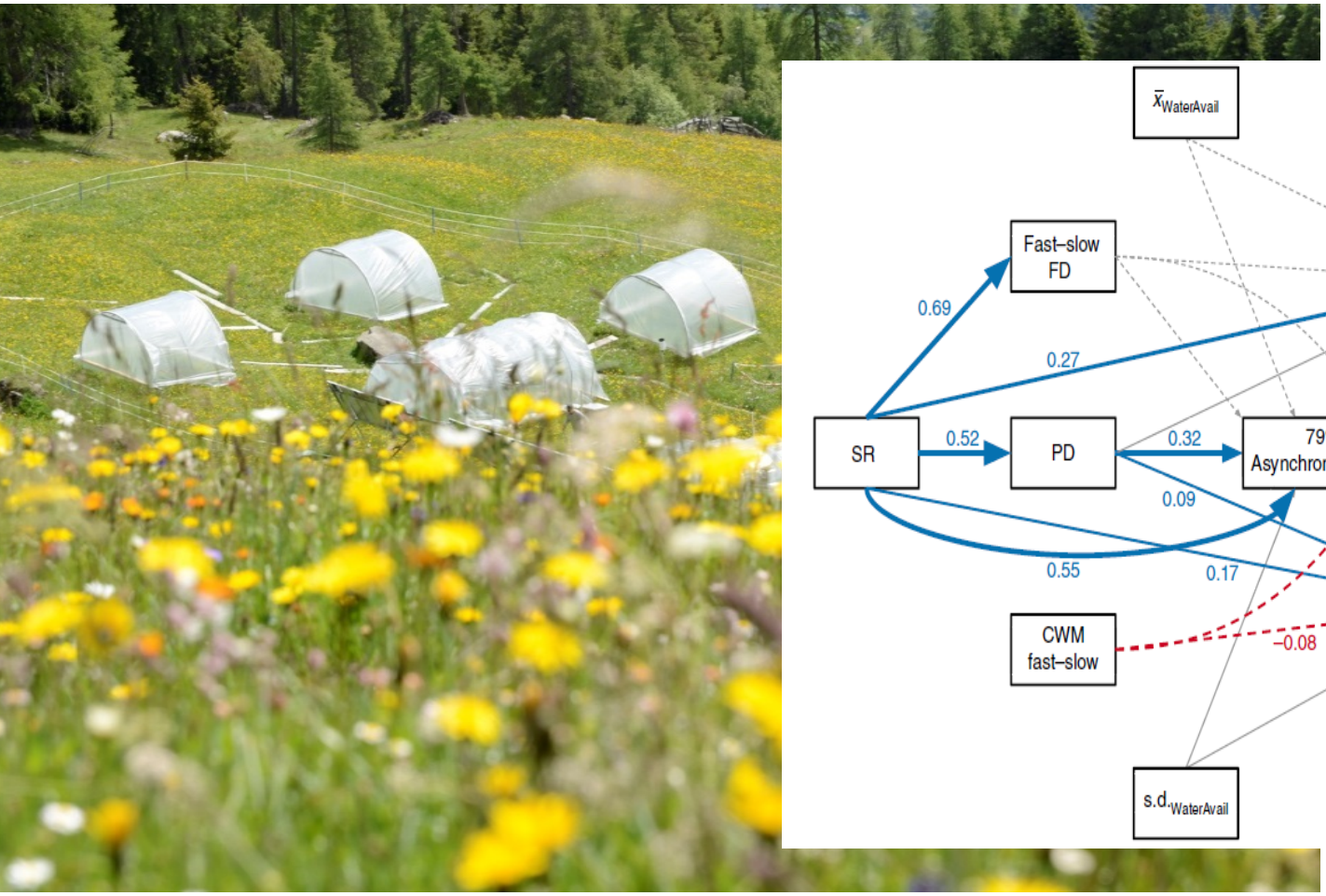
Abandoned grassland more resistant and managed grassland more resilient because of plant soil-interactions ...



... shifts in the plant resource economics spectrum and related belowground carbon partitioning to storage versus metabolic use ...



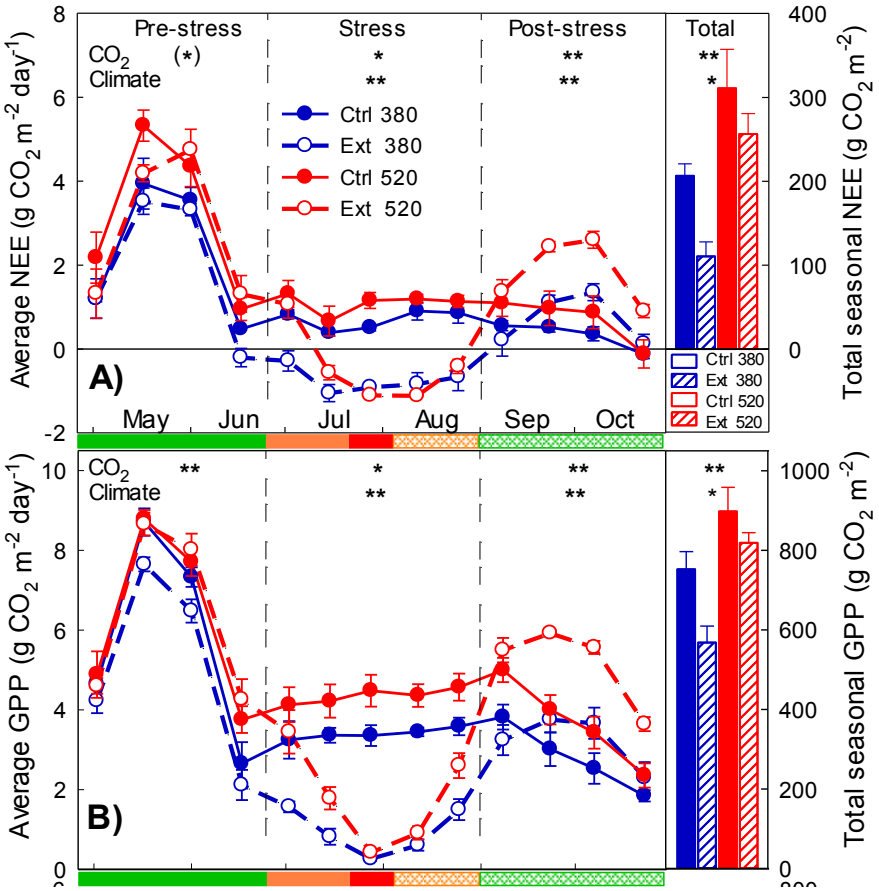
... and biodiversity effects on stability

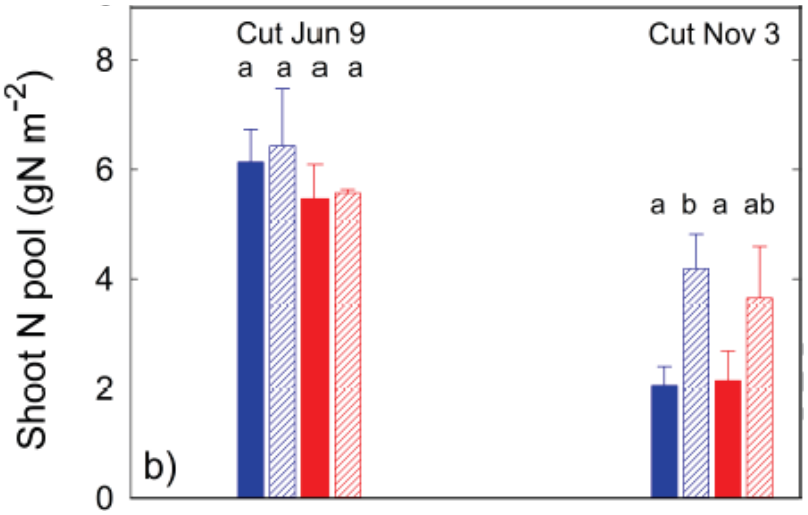


Effects of climate extremes in warmer future under elevated CO_2

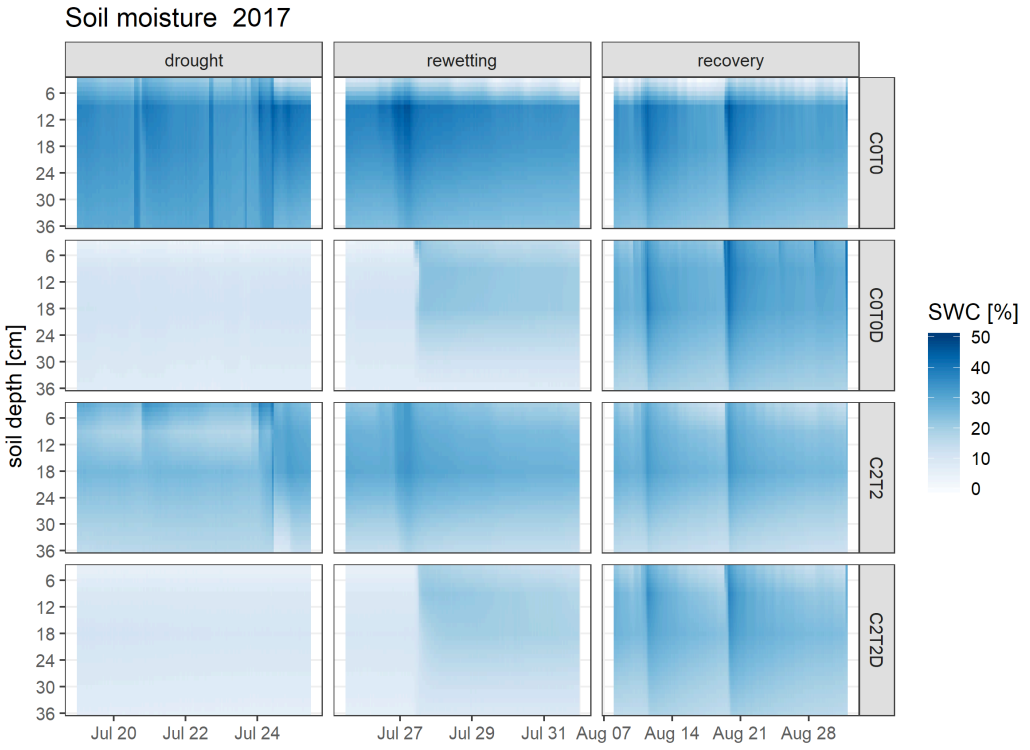
Roy et al. (2016) PNAS

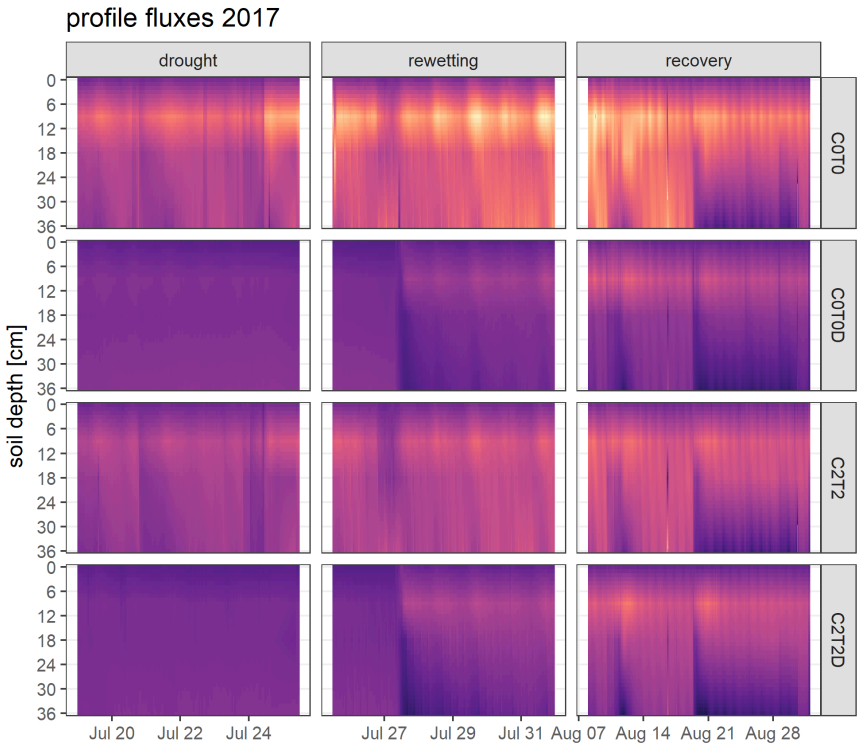
Elevated CO_2: faster recovery of CO_2-uptake after drought





Antagonistic effects of warming and eCO_2 on soil moisture and soil CO_2 fluxes - and extended drought legacies

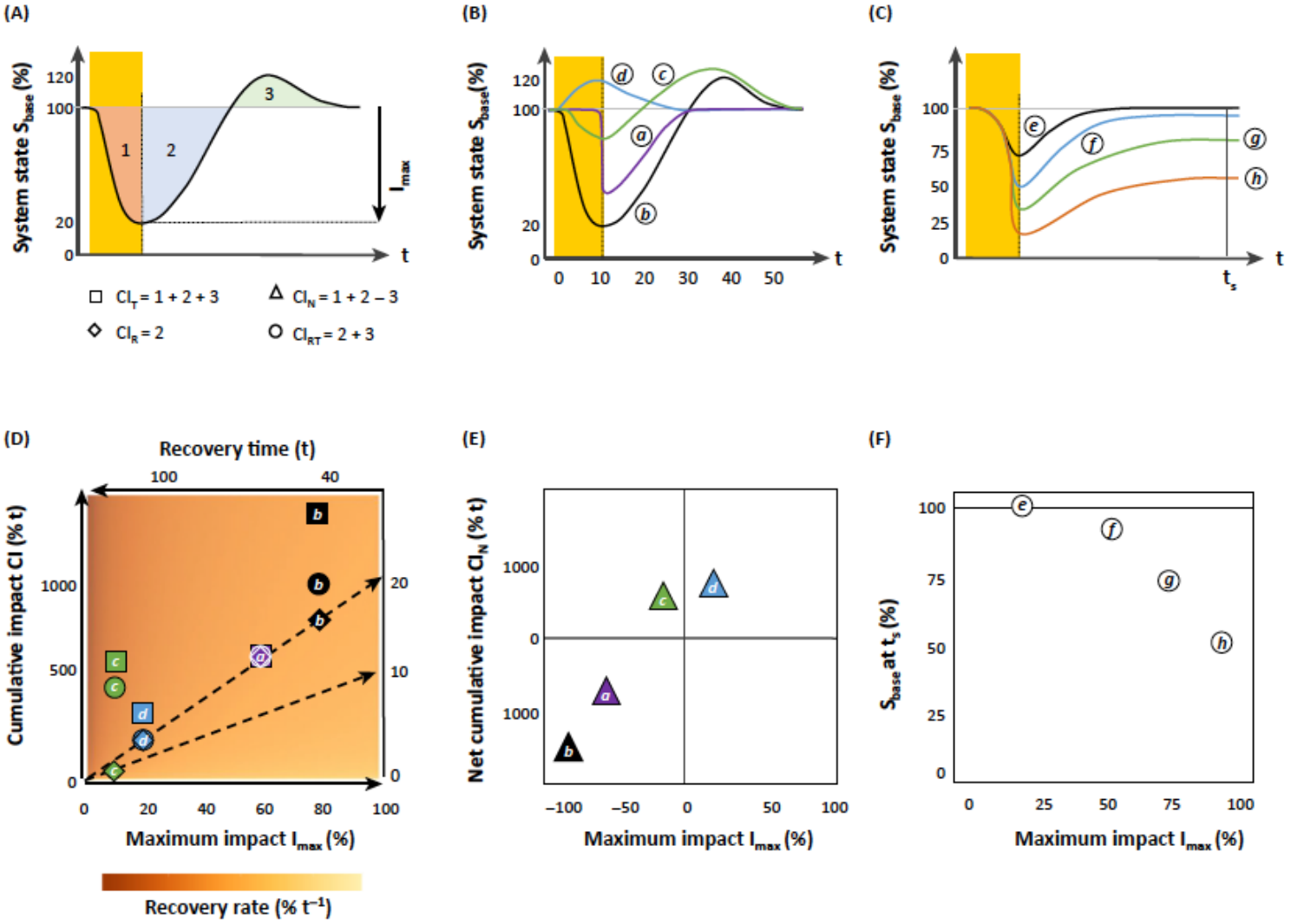




ClimGrass

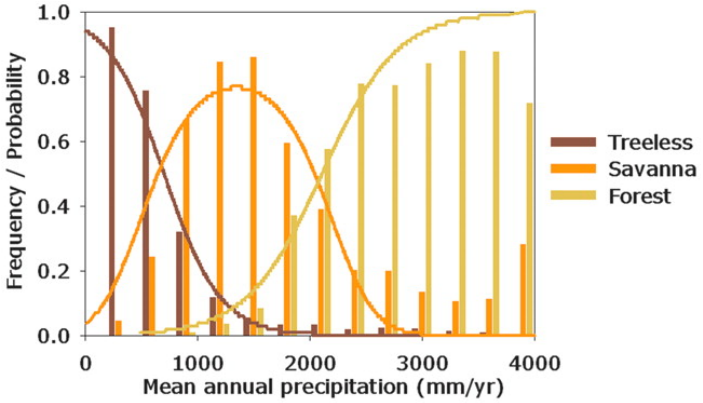
Reinthaler et al., in prep.

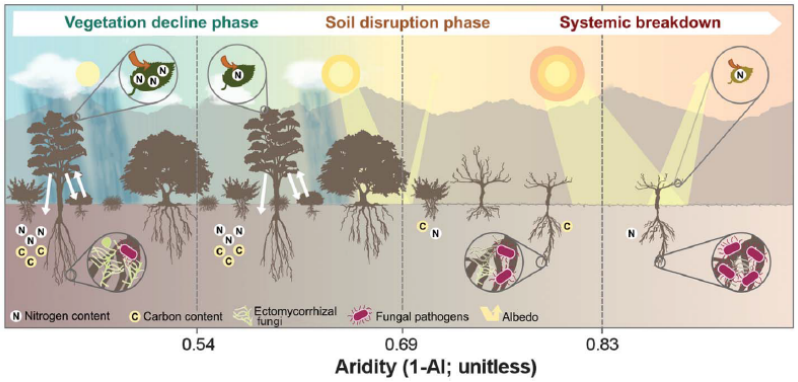
Bivariate framework for a comparable quantification of resilience across ecosystems and disturbances



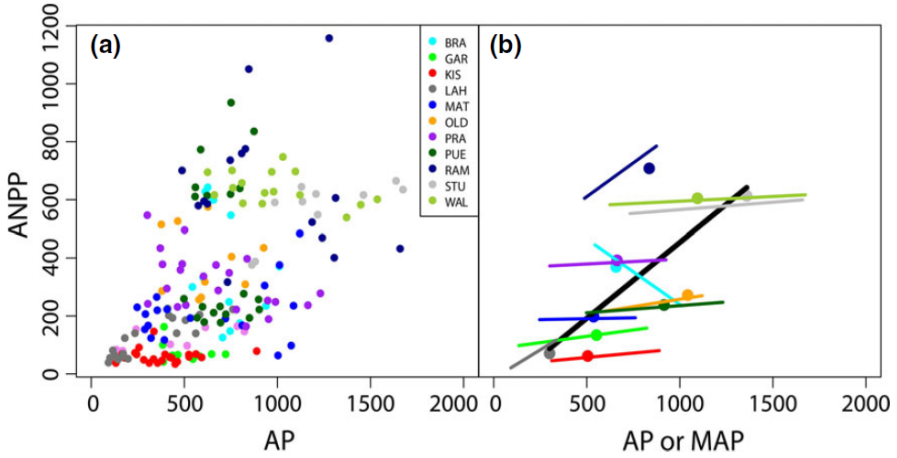
How well do we understand tipping points and the underlying mechanisms?

Gradients





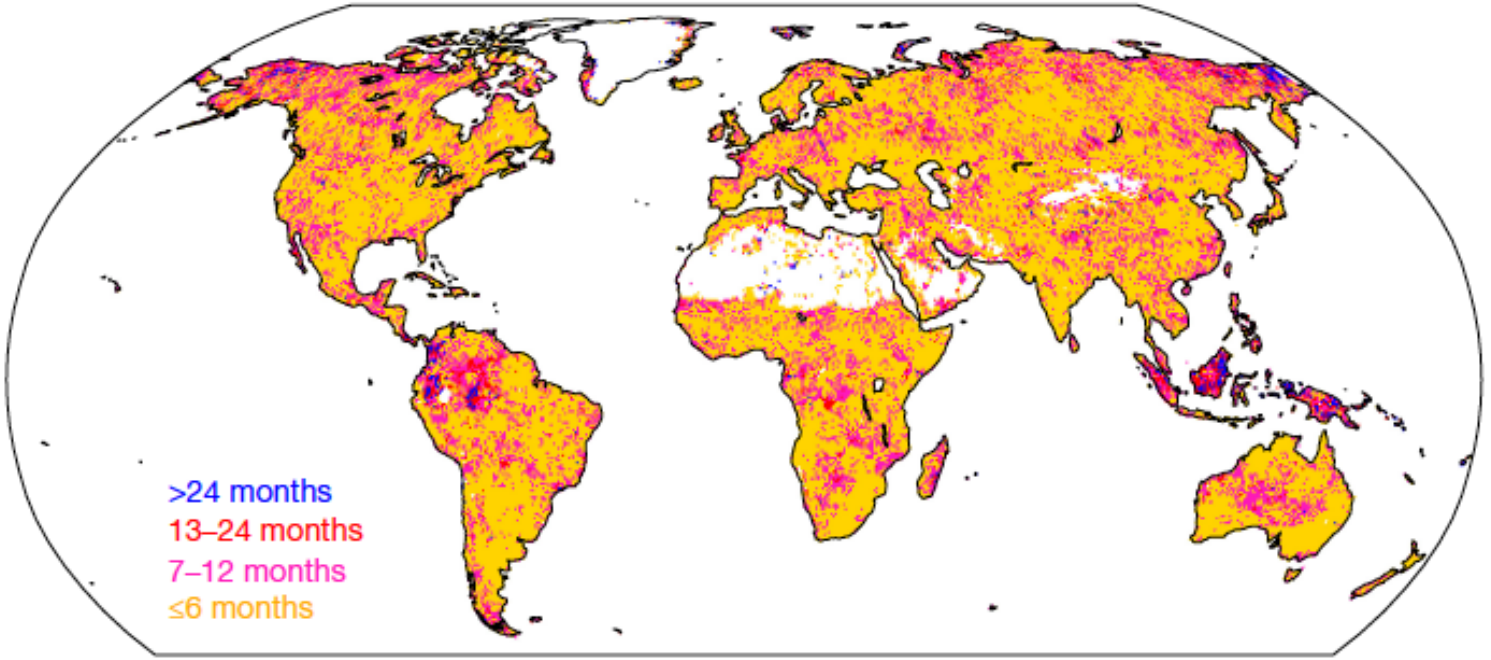
Experiments



Hirota et al. (2011) *Science*, Berdugo et al.(2020) *Science*

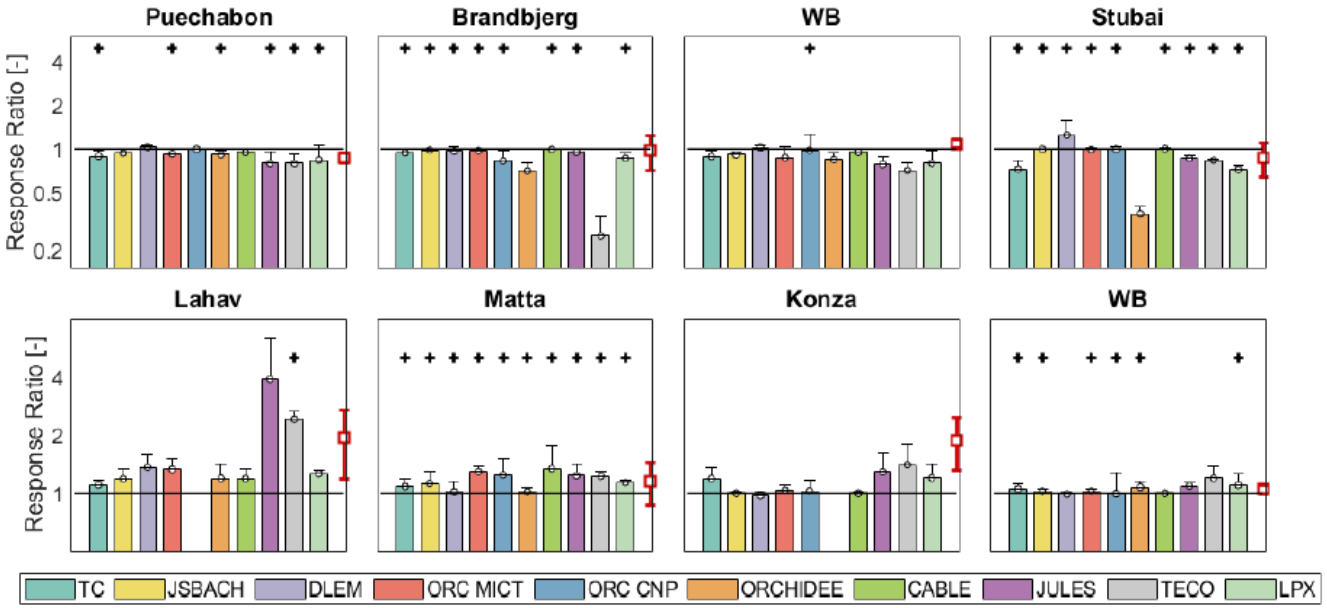
Estiarte et al. (2016) *Global Change Biology*

How can we project the future based on observations from the past, and models based on such observations?



Schwalm et al. (2017) *Nature*

How can we project the future based on observations from the past, and models based on such observations?



54% (drought) and 48% (irrigation) of models
not statistically different from experimental observations

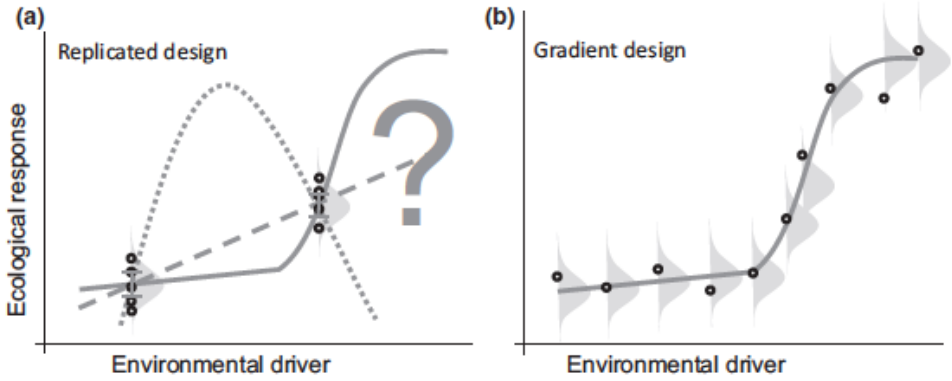
Experiments and meta-analyses need to move towards regression-based approaches to capture nonlinear effects

Experiments

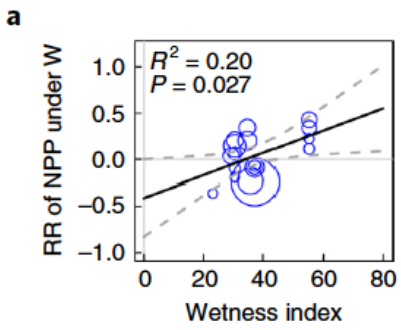
ECOLOGY LETTERS
Ecology Letters, (2018) doi: 10.1111/ele.13134

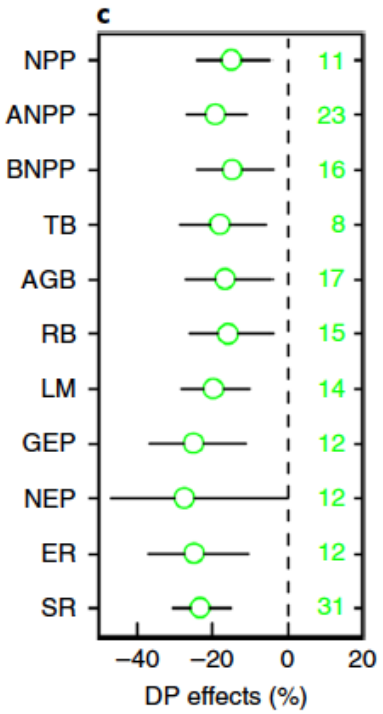
LETTER

To replicate, or not to replicate – that is the question: how to tackle nonlinear responses in ecological experiments



Meta-analyses





Kreyling et al. (2018) *Ecology Letters*

Song et al. (2019) *Nature Ecology & Evolution*

Conclusions

To understand and project the consequences of climate extremes in a future world *(increased frequency and severity of extreme events, compound events, interactions with other global change factors)* we need to

- Establish a new generation of (co-ordinated) experiments and meta-analysis pursuing regression-based approaches
- Test for interactive effects of multiple drivers on threshold responses
- Account for implications of human intervention and advance the understanding of the adaptive capacity of social-ecological systems to absorb climate extremes