

# Plant diversity – Driver or passenger along the global change track?

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# Global change (tracks)

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= Climate change + land use change  
trace gas conc., deforestation,  
temperature, urbanisation,  
precipitation forestry,  
agriculture

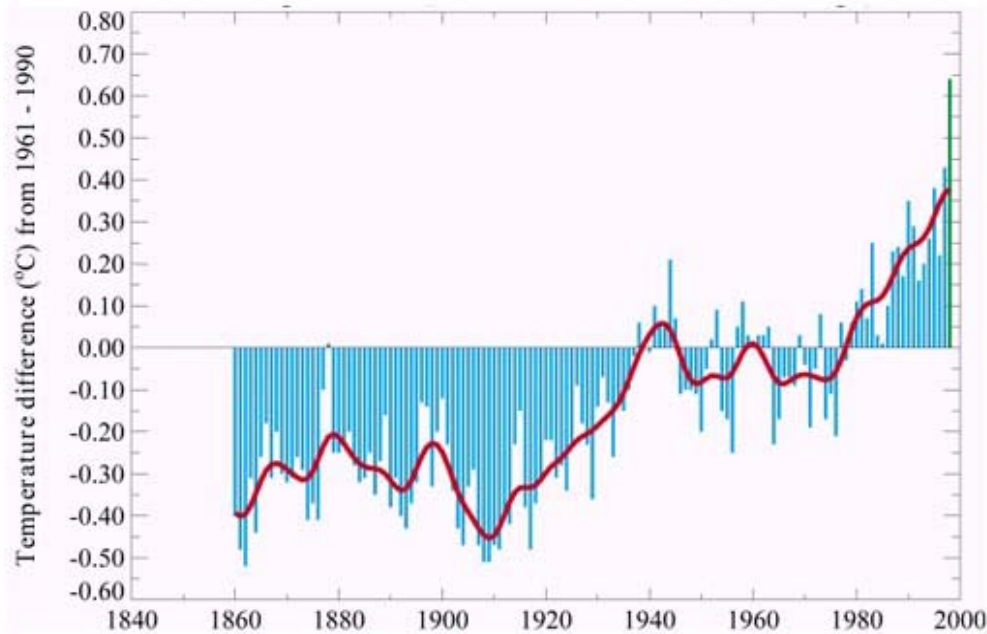
+ loss of biodiversity

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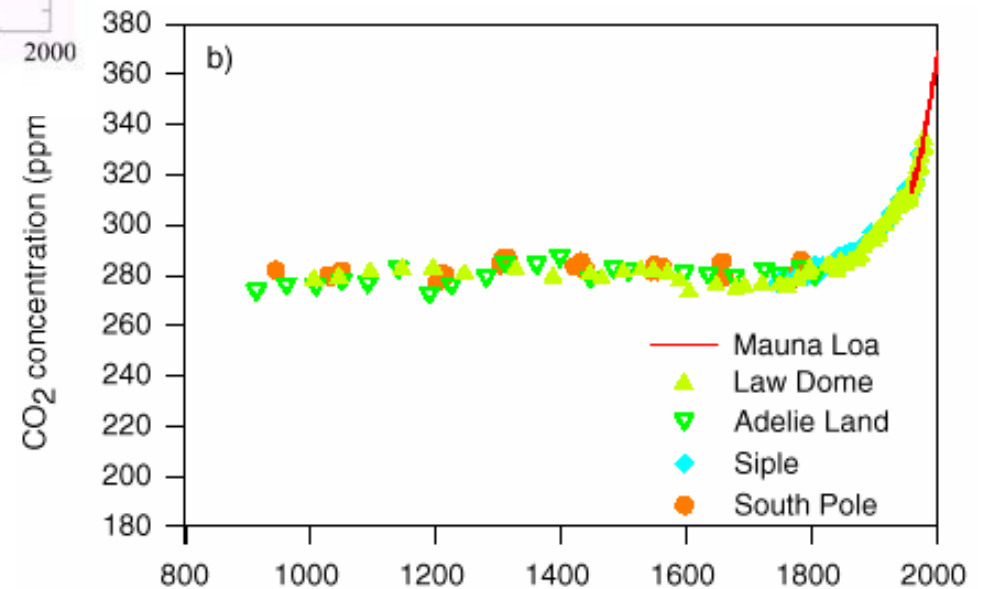
Σ large impacts anticipated on ecosystem functioning (EF)  
and on provision of ecosystem services to humankind

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# Climate change track



= Increase in  $T_{\text{air}}$  and trace gas concentrations in atmosphere (e.g.,  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ), increased variability in precip patterns, ....



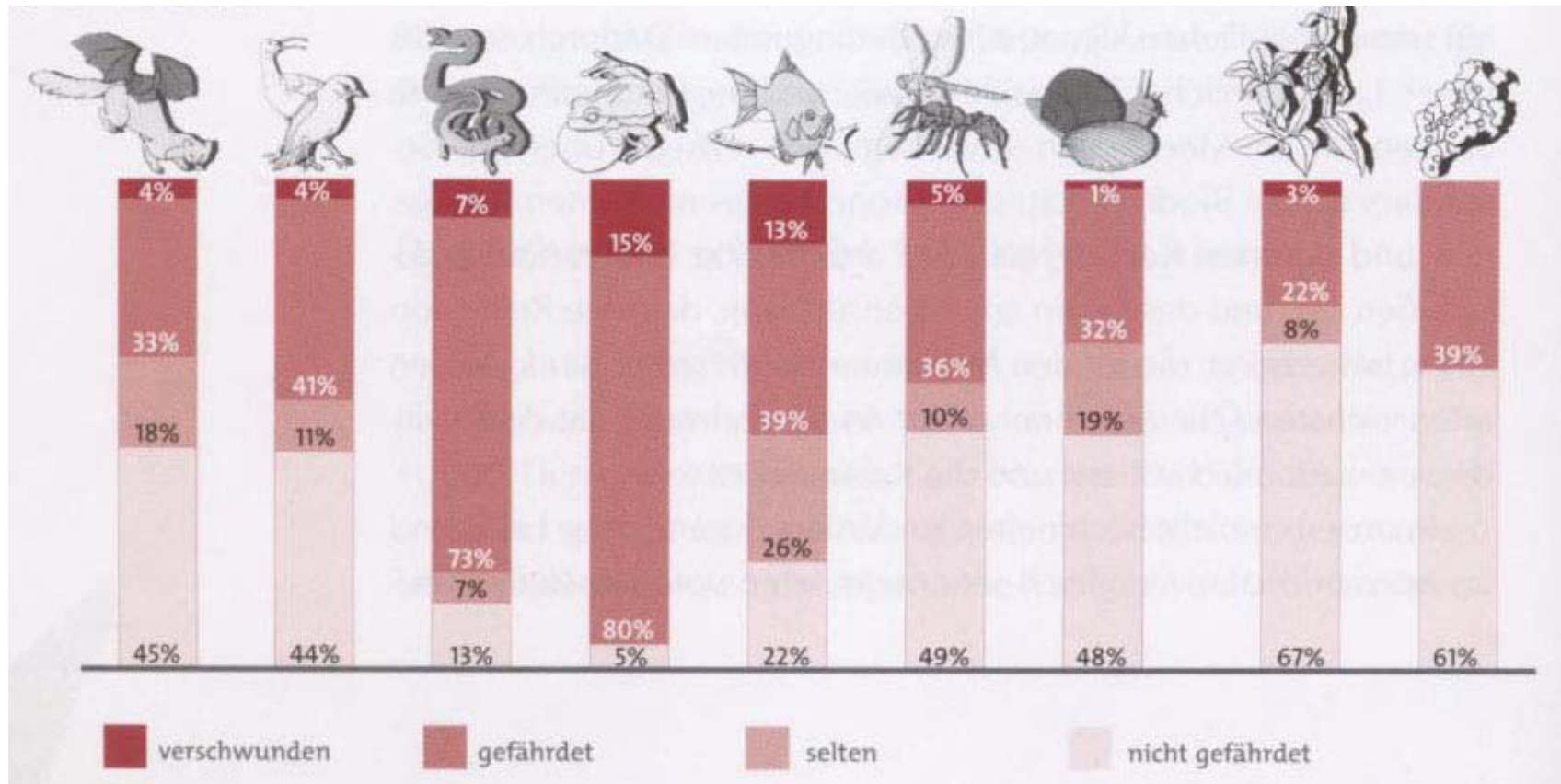
# Land use and land cover change track



= Profound changes in land surface cover, intensification of land use/mangement, erosion, ...



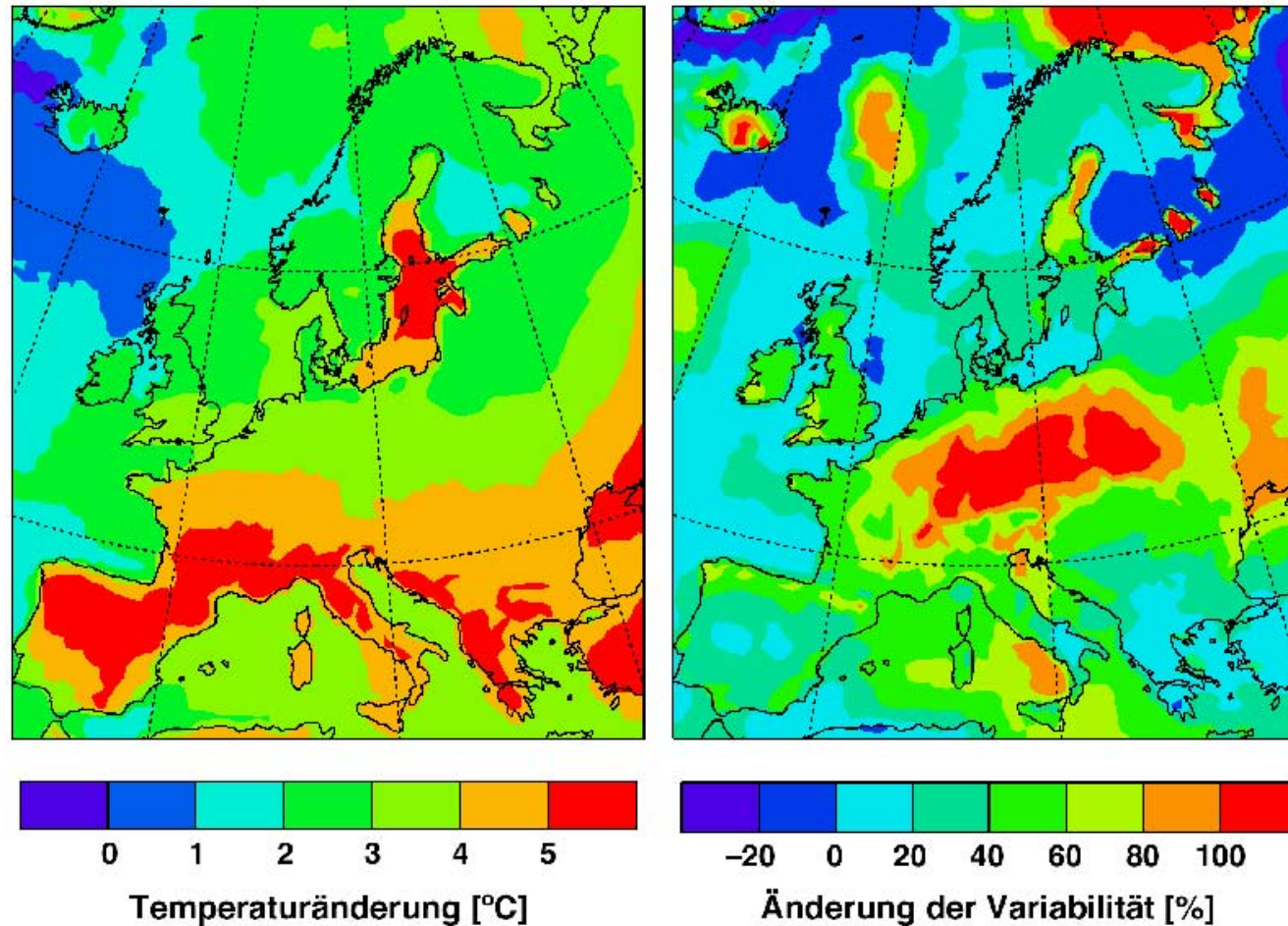
# Biodiversity track



= observed loss of known species (i.e., mainly plants, animals),  
unknown change for unknown species (e.g., microbes)



# Temperature track in Europe



(Schär et al. 2004)

Model scenario: Generally warmer with larger variability

# Further relevance for plants?

Figure 3.23 Projected no. of growing days

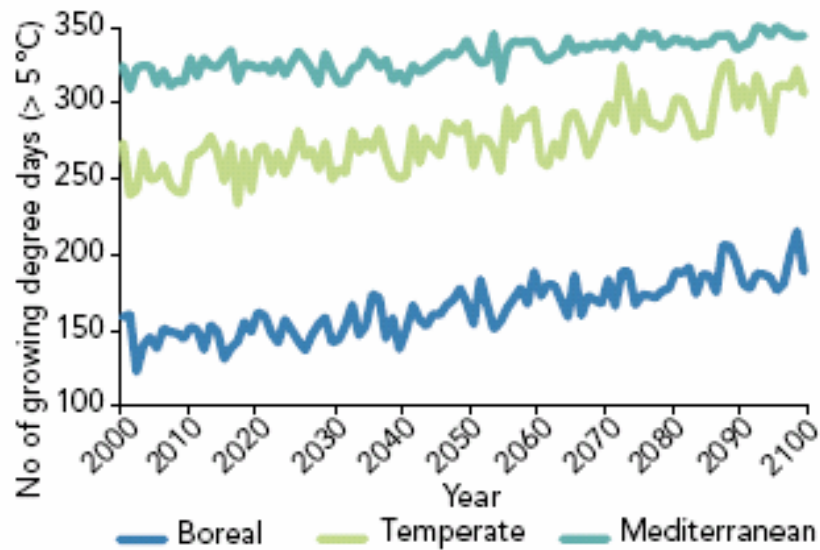
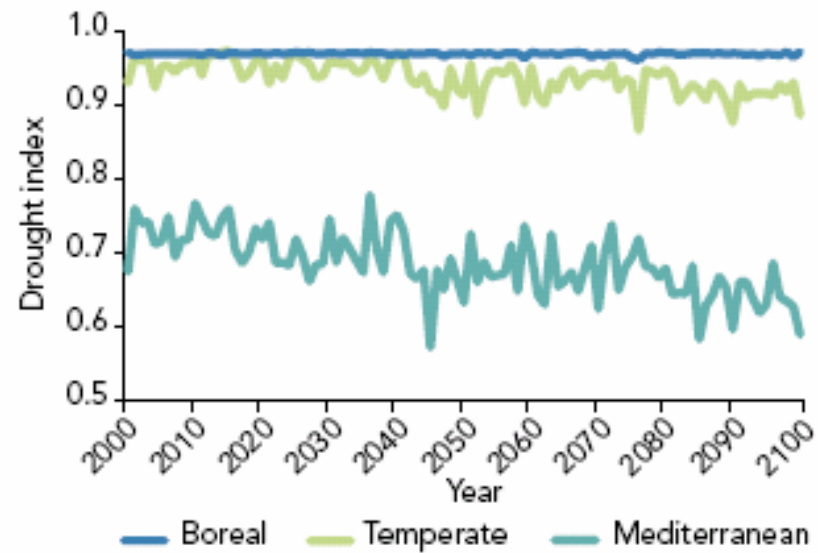


Figure 3.24 Projected drought stress



Based on LPJ runs: Generally longer growing seasons and pronounced droughts in Mediterranean regions

(Sitch et al. 2003)

# Role of BD in climate impact research?

Briefly: typically underdeveloped

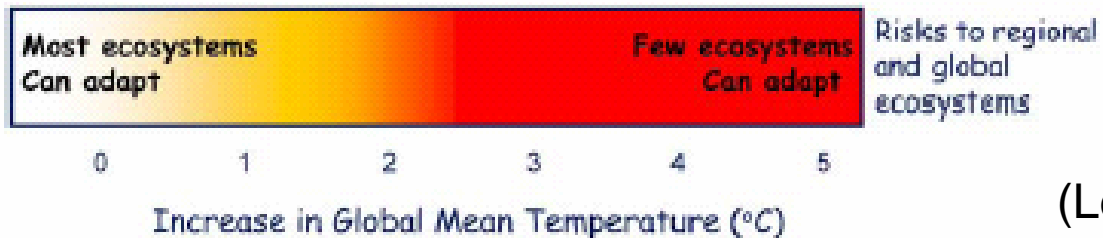
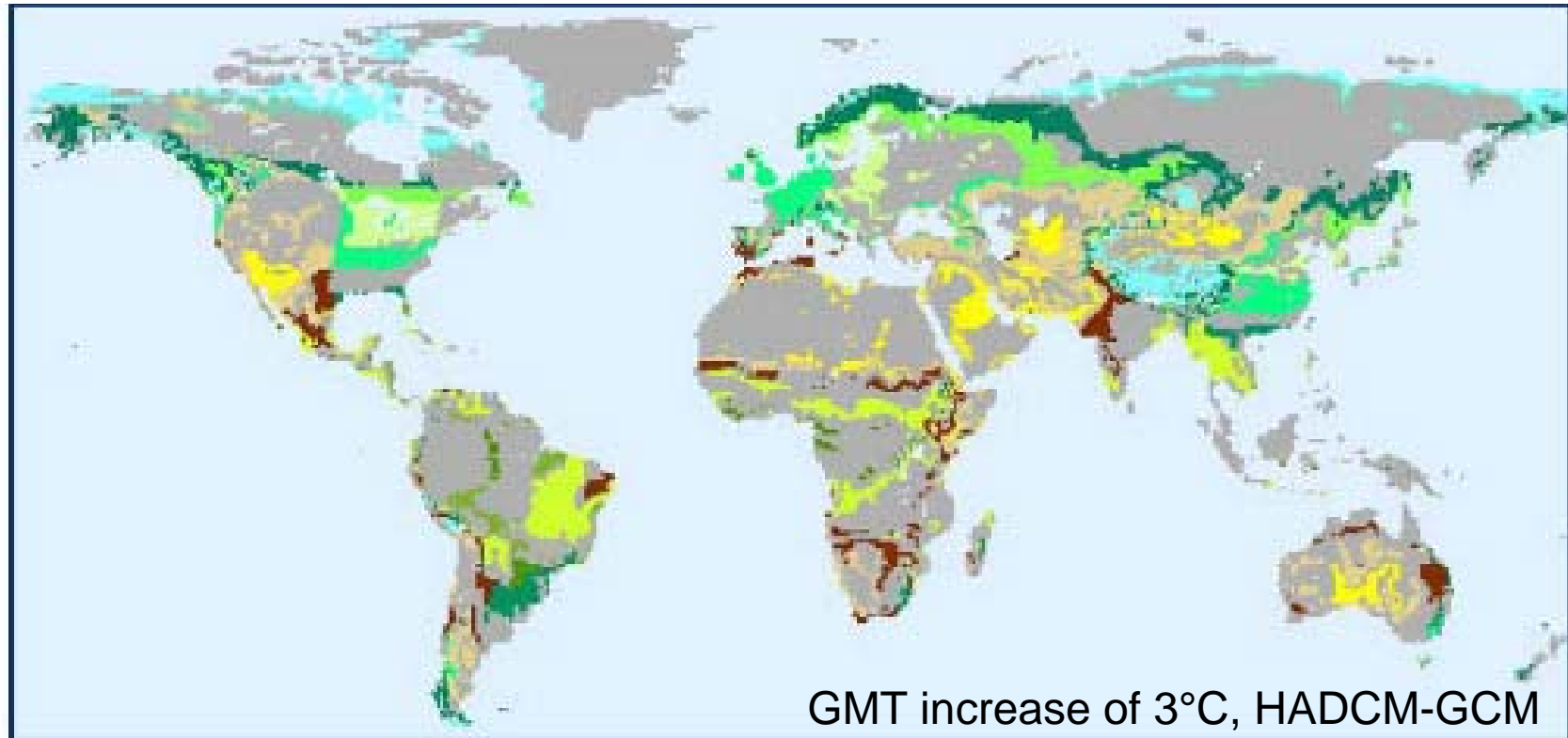
Why?

- Goals of UN-FCCC and UN-CBD do not match, different scientific communities are involved
- No strong voice of CBD comparable to IPCC (despite the Ad-Hoc Technical Expert Group on Biological Diversity and Climate Change 2003 and follow-ups)
- Two attitudes prevail:  
biodiversity loss as response variable to GC or  
biodiversity as sole „reservoir“ for mitigation & adaptation options



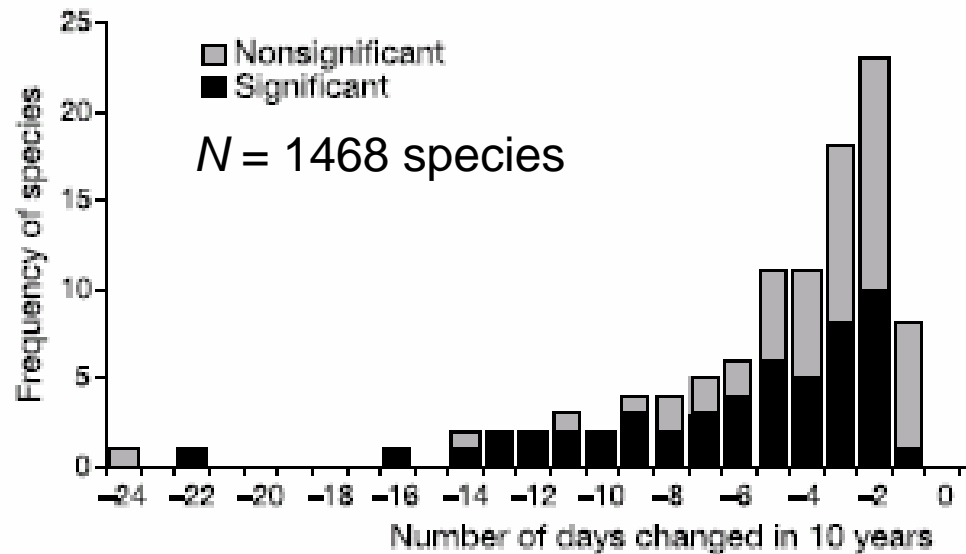
# Plant BD: Passenger along GC track

Ecological impact of climate change on ecosystem distribution



(Leemans and Eickhout 2004)

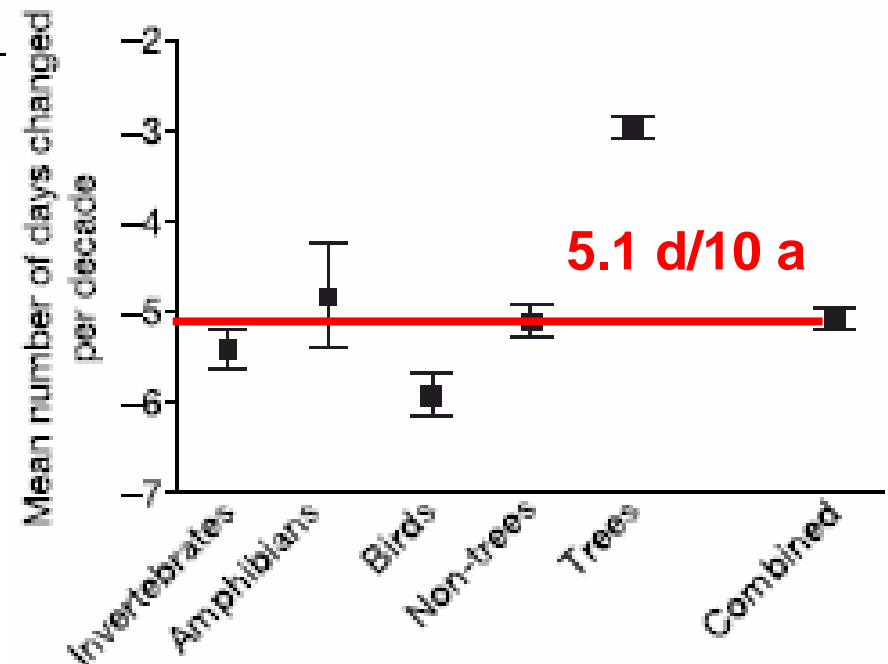
# Plant BD: Passenger along CC track



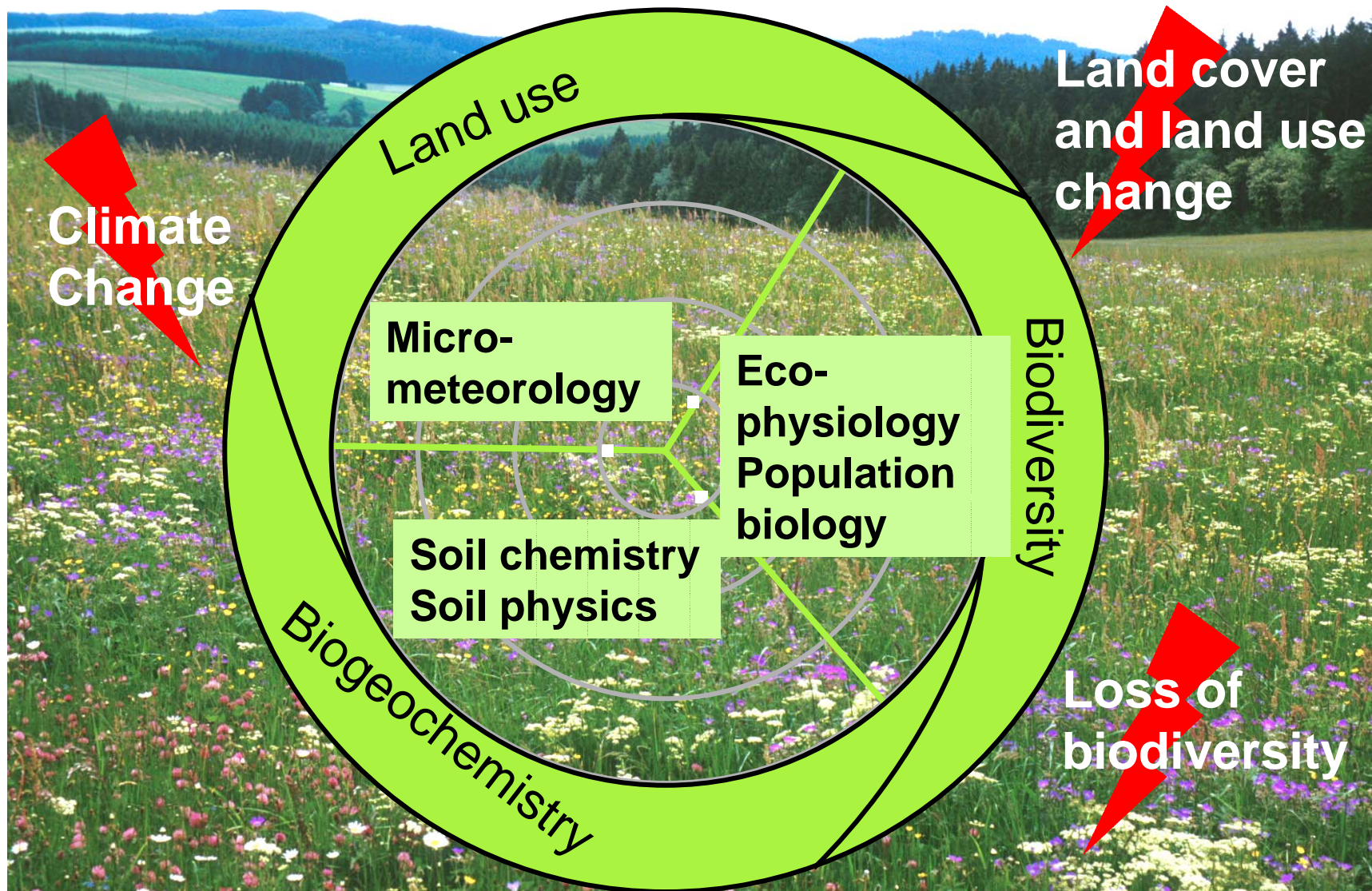
Phenology (earlier spring):  
Globally by 2.3 d/10 a  
Temperate zone by 5.1 d/10 a

(Meta-Analyses: Roots et al. 2003;  
Parmesan and Yohe 2003)

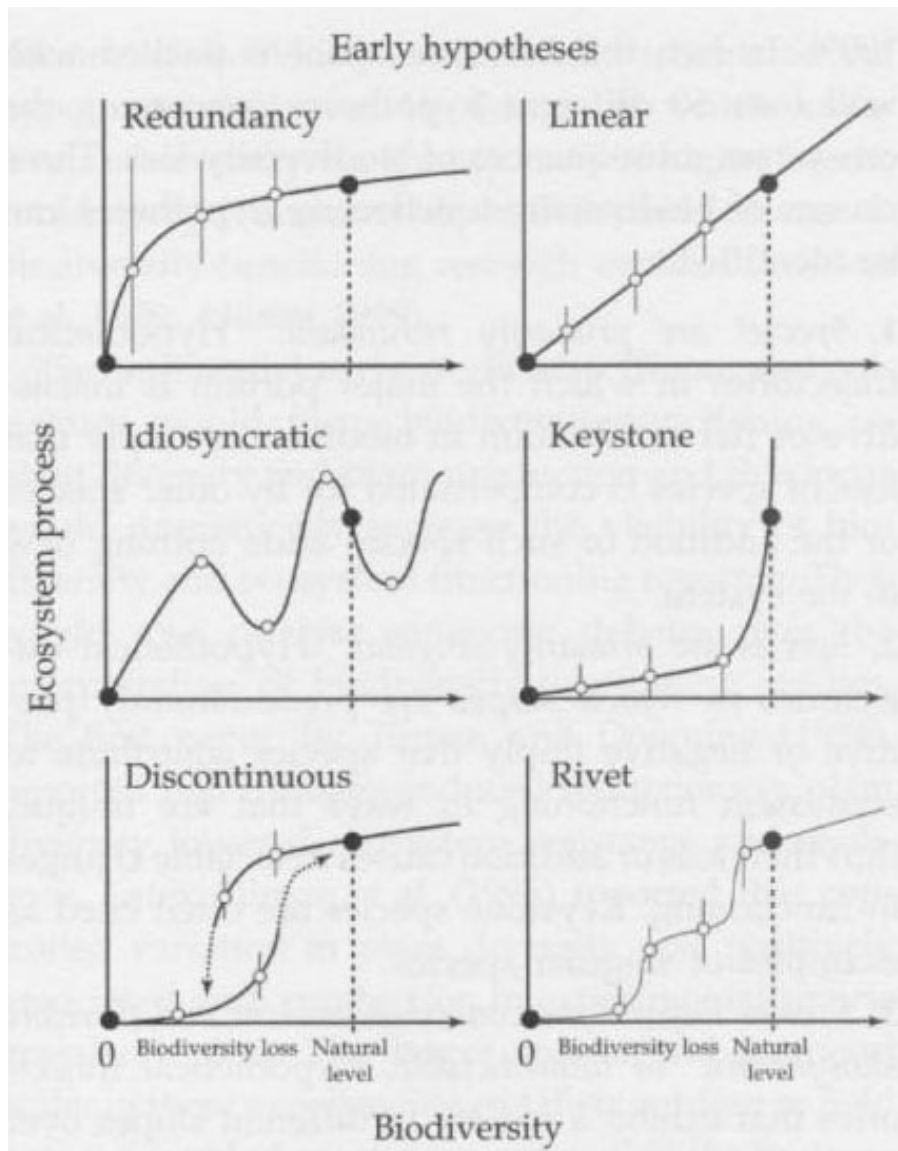
Fingerprint of global warming  
= underlying consistent shift  
among species not due to  
land use change



# Plant BD: Only passenger or also driver?



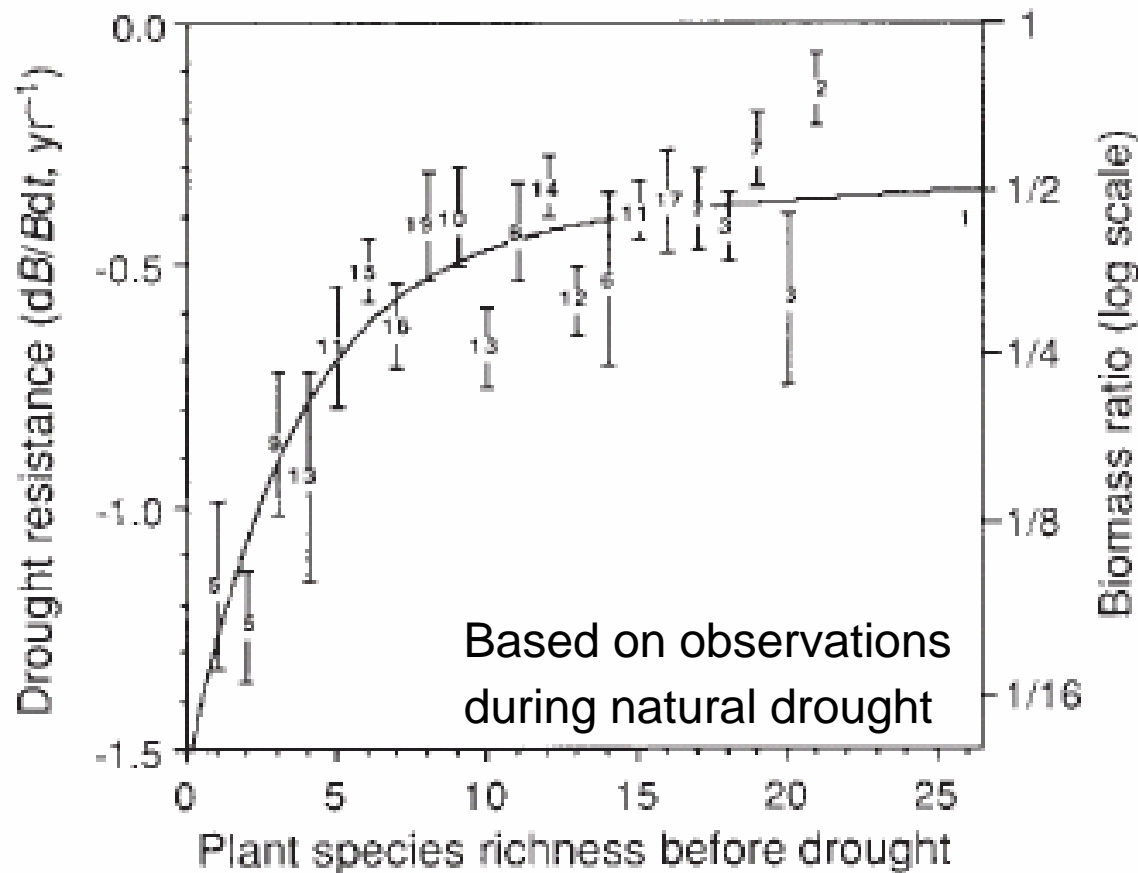
# Plant BD: Driver along the GC/CC track?



Central hypotheses  
= BD as buffer/insurance  
against impacts of  
environment or global  
change, e.g., extreme  
climate events.

(Loreau et al. 2002)

# Field evidence is rare

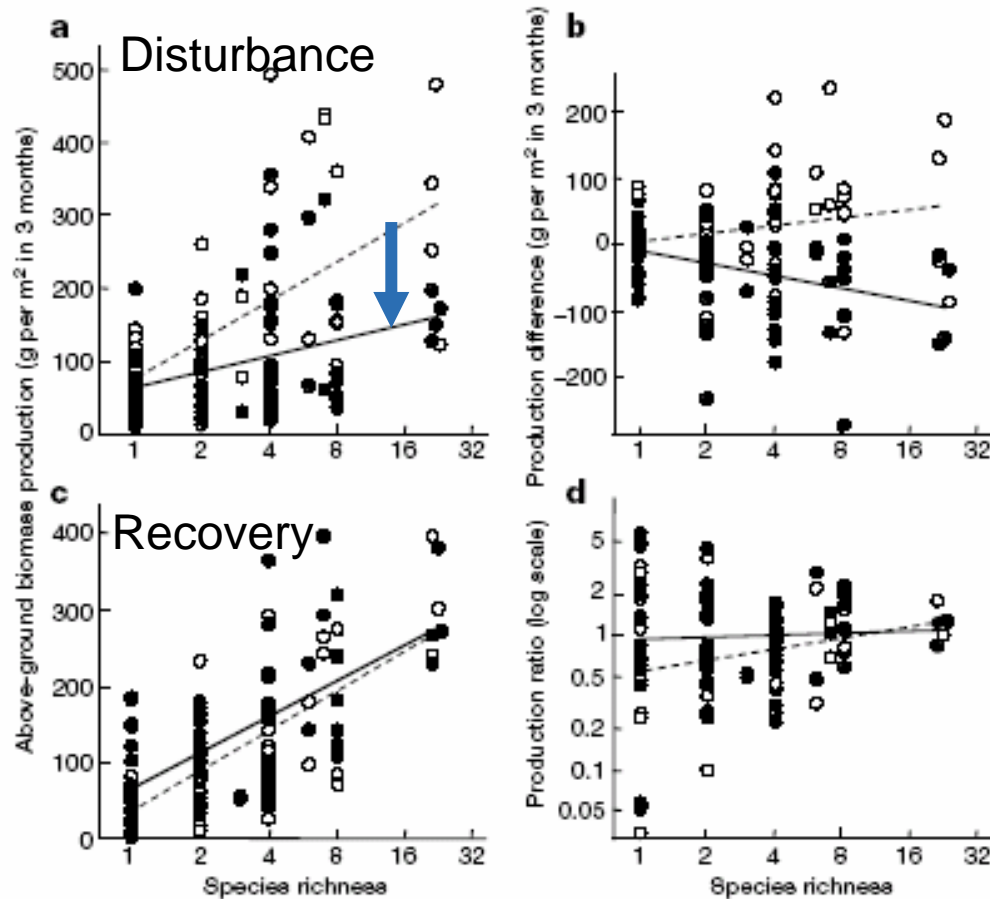


(Tilman and Downing 1994)

Higher productivity<sub>above</sub>, higher drought resistance, thus higher stability against drought with increasing species diversity.



# Experimental evidence is rare



Roofs for 8 weeks,  
July to Sept. 98,  
no data on below-  
ground productivity

(Pfisterer and Schmid 2002)

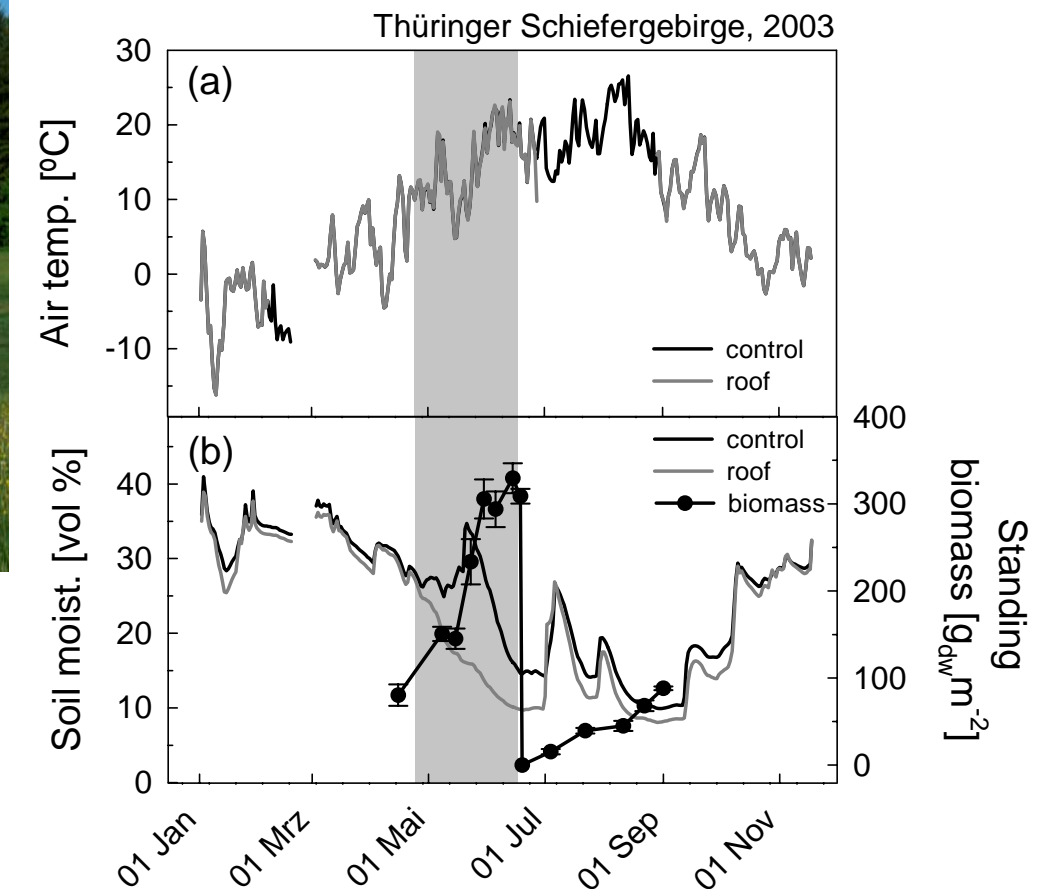
Effect of plant diversity on stability and resilience of above-ground productivity in grasslands after experimental drought.

# Plant BD: Driver along the GC/CC track?

## Simulated drought:

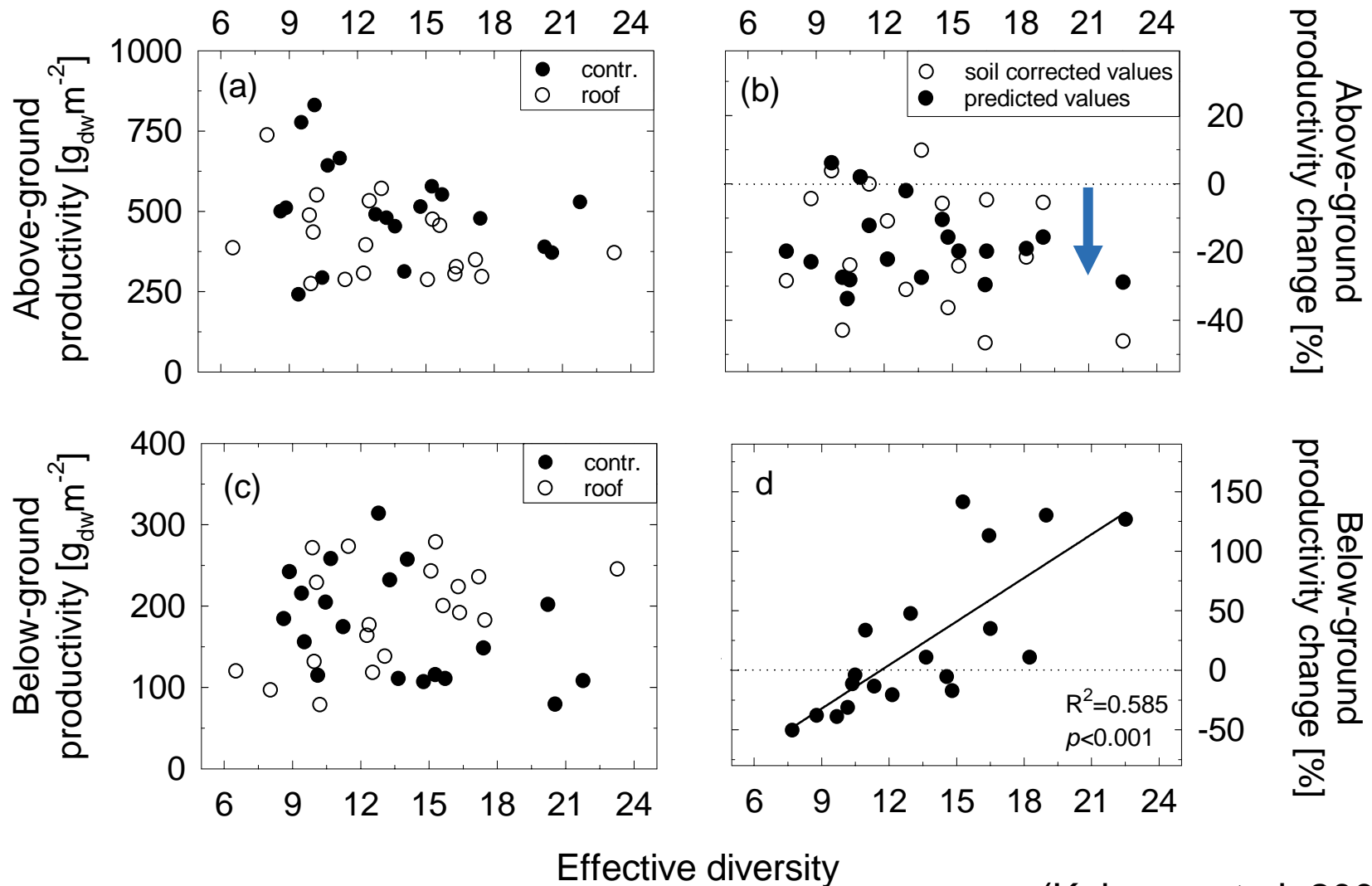


extensively managed  
meadows with 10 – 35  
species in the Thüringer  
Schiefergebirge



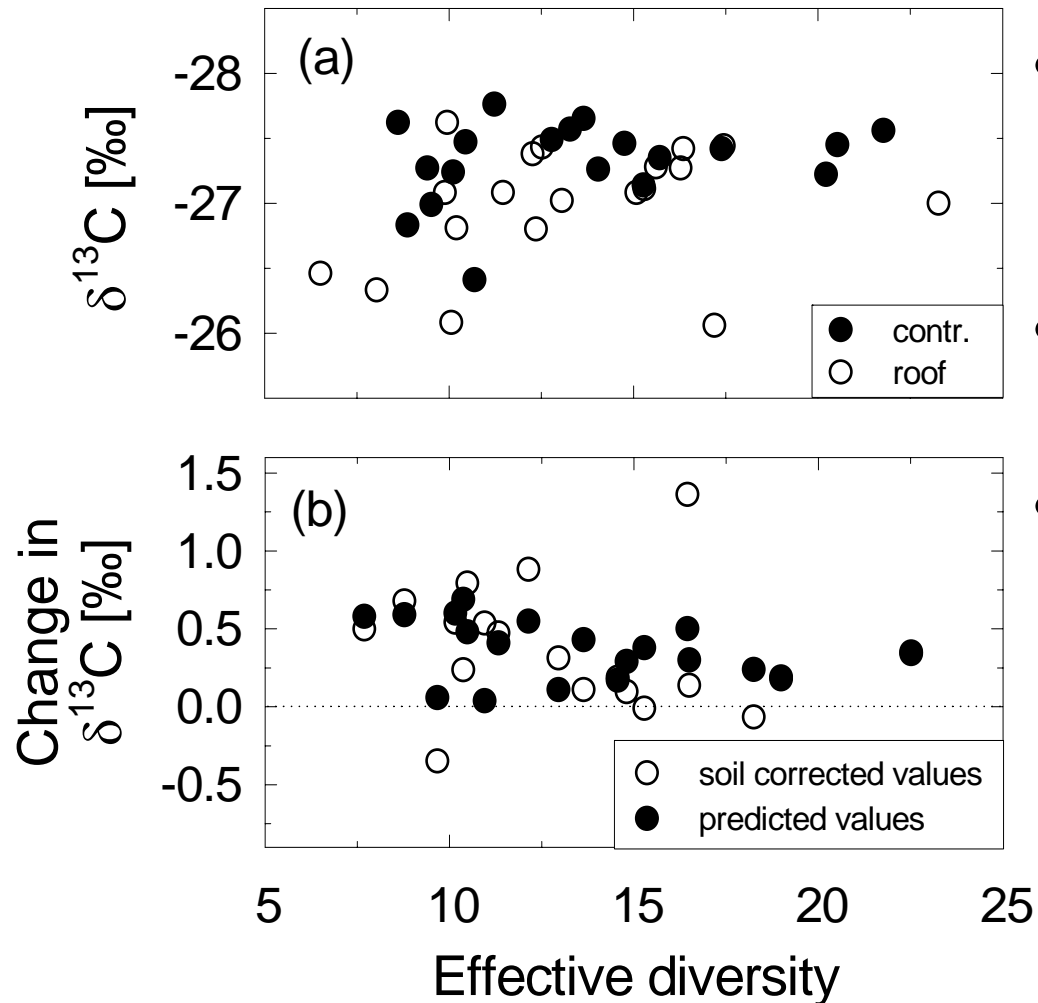
(Kahmen et al. 2005)

# BD as insurance against drought?



(Kahmen et al. 2005)

# Ecophysiological mechanism behind?



- Obj.:  $\delta^{13}\text{C}$  as indicator for drought stress in plants
- No significant change in  $\delta^{13}\text{C}$  values
- But reduction of soil moisture only short time compared to life span  
→ no proof of no effect

(Kahmen et al. 2005)

# What did we learn from these studies?

- Strong diversity effects on productivity following drought (need to look at right compartment though).
- Drought tolerant species seem to enhance root productivity and as a result maintain overall community productivity.
- Potential positive impacts on other ecosystem services and functions, e.g., soil nutrients, water, erosion, ...
- Evidence for insurance hypothesis, BD might buffer, i.e., “corrects deviation from CC track (to some extent)”.



# Next steps for us ...

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NCCR Climate, WP 3: Project Plant/Soil



- To quantify **effects of drought** on the community structure as well as on the quantity and **quality** of the harvested biomass in grasslands at various altitudes, representative for Switzerland
- To quantify the **effects of drought** and heat on root growth and on the **dynamics of carbon and nitrogen** in the plant/soil/atmosphere system
- To identify key processes and fluxes to improve existing models and to **provide input parameters for the simulation** of grassland productivity in a long-term perspective

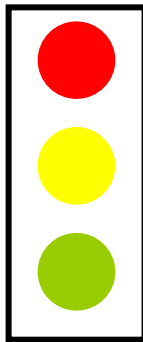
# Plant BD: Passenger or driver?

## Passenger's view

Climate change

- Temperature
- Trace gas conc.
- Growing season
- Extreme events
- ...

## Driver's view



Conventions

Adaptation

Mitigation

Biodiversity and  
ecosystem functioning

- Community composition
- Migration
- Reproduction
- ...
- NPP
- Soil fertility
- Water quality
- ...

Composition, physiology, albedo, stability

# Future challenges

Understand functionally diverse communities, not only grasslands, in regard to climate change

- their unknown functional physiology adds large uncertainty to global models,
- they are more likely to adapt to climate change and climate variability than species-poor communities,
- they might offer better (cheaper, clever) options for mitigation or adaptation to climate change.

Implement UN-FCCC and CBD jointly, well coordinated, to gain mutual benefits