Effects of climate change on the distribution of plant species

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Possible impacts of climate change on the flora

- Phenologische changes
- Genetic adaptations
- Change of biotic interactions (e.g. competition, pollination, herbivory, …)
- Change of distribution and dispersal patterns
- Change in abundance, regional loss

- Impacts on society through altered ecosystem services
- New conservation strategies, risk management
Impacts on European plant species richness

Mean species loss in Europe: 27–42%

25 year of monitoring in Central German dry grasslands

Observed changes in the vegetation of Central German dry grasslands

Phenological changes in plants

Methodology

Species selection → European range

Modelling with regional climate change scenarios → Model calibration

Risk analysis ← Validation

Land cover soil climate

Climate data from Badeck, Pompe, Kühn, Glauer, 2008, *Naturschutz & Landschaftspflege* 40(10), 343-345
Why European distribution data

Beech (Fagus sylvatica), Floraweb

Beech (Fagus sylvatica), Atlas Florae Europaeae

→ Overestimation of range loss
Soil and land cover increases model fit

Projections for selected species, +4°-scenario

Range changes,

Based on Daten from Pompe, Kühn et al., BfN final report
Projections for selected scenarios

Caltha palustris (marsh merrigold)

Based on Daten from Pompe, Kühn et al., BfN final report
Assumptions on dispersal ability

- No dispersal kernel available for most species
- Unknown influence of climate change on dispersal kernels
- Two extreme assumptions:
  1. Full dispersal
  2. No dispersal

Two Hypothesis:
1. Human traffic facilitates dispersal
2. Fragmentation inhibits dispersal
   → No. 1 is probably relevant for common species
   → No. 2 is probably relevant for rare and specialist species
Changes in species richness in Germany (per grid cell)

Species gain and loss

Losses
+ 2°: 15 ± 5%
+ 3°: 20 ± 6%
+ 4°: 35 ± 10%

Gains
+ 2°: 14 ± 6%
+ 3°: 17 ± 7%
+ 4°: 21 ± 8%

Pompe, Badeck, Hanspach, Klotz, Thuiller & Kühn, 2008, Biology Letters 4, 564–567
Impact of climate change on the flora

Modelled scenario 2080, +4°C
→ n= 845 species
→ 2995 grid cells (FLORKART).

Pompe, Badeck, Hanspach, Klotz, Thuiller & Kühn, 2008, Biology Letters 4, 564–567
Impacts on „red list species“ in Germany

Species loss

→ red-list species (gey) are much more impacted than not listed species (white)

Using data from:
Species turnover in Germany until 2080

Biological interactions and climate change

- Butterfly *Boloria titania* (Titania’s fritillary) feeds monophagously as larvae on *Bistorta officinalis* (Adderwort)
Niche spaces of *Boloria titania* and *Polygonum bistorta* show today only small areas of overlap.

Two separate ecological niche models for the butterfly and its host plant based on climate, land use and soil characteristics. AUC’s > 0.93

Future climate change leads to reduction and fragmentation of original distribution and a shift of climate space to the north.

Projected changes in niche space of *Boloria titania* and *Ploygonum bistorta* for 2080

- Niche space of *B. titania* would increase
- But mismatch of both niche spaces increases, too
- Serious decrease of overlap in the butterfly’s original distribution (Alps and Baltic States).
- Potentially new areas in the north could only be colonised in the unlikely case of high dispersal ability of *P. bistorta*.
- Climate change can disrupt trophic interactions.

Summary

• Species respond idiosyncratically
  → no migrating habitats or communities!
• Moderate climate change (2°C)
  – 60% of the species lose more range than they gain.
  – 7% of the species lose >2/3 of their range.
• Strong climate change (4°C)
  – 68% of the species lose more range than they gain.
  – 20% of the species lose >2/3 of their range.
• Trees and dwarfs shrub, insect pollinated species and species with high moisture requirements are at high risk.
• Biological interactions have substantial influence on species‘ sensitivity to climate change.
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EU-Projects ALARM: Assessing LArge-scale environmental risks for biodiversity with tested methods

www.alarmproject.net, for providing scenarios

& MACIS: Minimization of and Adaptation to Climate change Impacts on biodiverSity www.macis-project.net

Thank you for your attention!

www.ufz.de/klimawandel-flora/