SIGNAL

European gradients of resilience in the face of climate extremes

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Background

Topic

European semi-natural grasslands under the triple threat of climate change, land-use change and biotic invasions

Background

European semi-natural grasslands

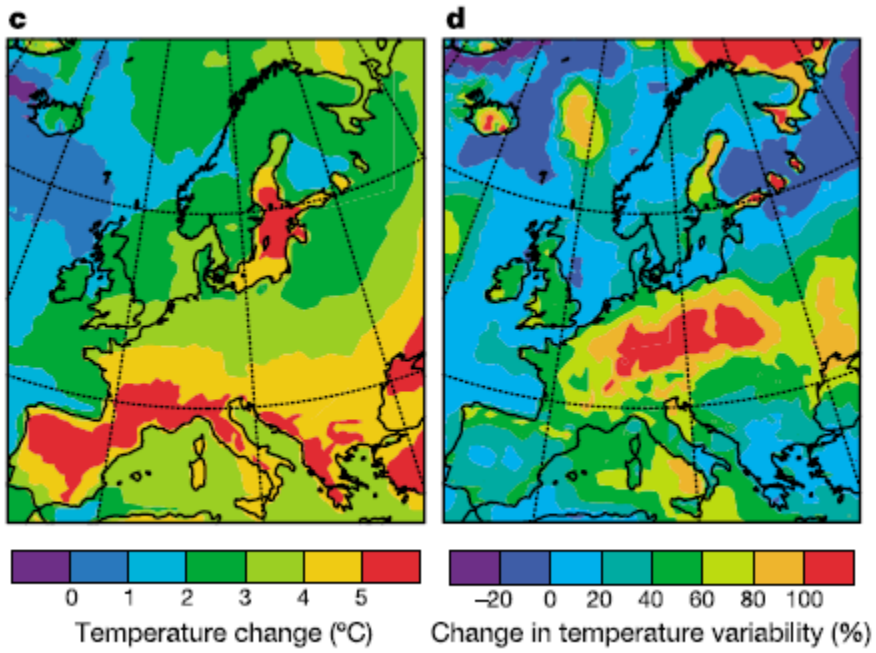
- Originated from millennia of low-intensity human land use
- Unique feature of Europe's cultural landscape
- Essential for agricultural production (meat & dairy products)
- Extraordinary importance for biodiversity conservation
  - *c. 20% of endemic vascular plants of Europe*
  - *Global plant diversity hotspots at small spatial scales**
  - *c. 75% of Europe's butterfly species*

* Wilson et al. (2012): Plant species richness: the world records. *J. Veg. Sci.* 23: 796–802.

Background

Threats 1: Climate change

- Most studies focused on changes in mean temperature or mean precipitation
- Frequency and magnitude of extreme climatic events are expected to increase



Schär et al. (2004), *Nature* 427: 332–336.

- **We study effects of extreme drought (1000-yr recurrence) during vegetation period**

Background

Threats 2: Land-use change

- Presently the **main cause of biodiversity loss** in Europe's semi-natural grasslands
- **Intensification** on productive sites (fertilisation, higher cutting frequency, lower cutting height)
- **Abandonment** (or afforestation) on marginal sites (low productivity, remote areas, rugged terrain)

▶ **We compare three management variants**
- 3 cm cutting height
- 10 cm cutting height
- Abandonment

Background

Threats 3: Biotic invasions

- Generally European **grasslands are rather resistant** against plant invasions; they belong to the least invaded habitat types
(Chytrý et al. 2009, Divers. Distrib. 15: 98-107)
- However, **locally extreme invasions** occur, whose reasons are not fully understood

Lupinus polyphyllus invasion in Rhön Mts., Germany

- **We study two invasive species**
  - *Lupinus polyphyllus* (legume; from N America)
  - *Senecio inaequidens* (non-legume; from S Africa)

5 Hypotheses

CLIMATE EXTREMES (here: droughts) suddenly shift European grasslands across thresholds of functional resilience and reduce ecosystem service provision (productivity, nutrient cycling, successional trajectory, conservation value). Resilience varies across the pan-European precipitation and continentality gradient.

NON-NATIVE INVASIVE SPECIES are additional pressures for grassland biodiversity and functioning, accelerating major system shifts in the face of extreme weather events. In turn, extreme weather events increase invasibility.

BIODIVERSITY (species richness and legume presence) increases functional resilience in the face of extreme weather events (drought). Key functional traits (i.e. legume) modify community response.

WITHIN-SPECIES-DIVERSITY (provenance/ecotypes from the European gradient) increases functional resilience in the face of extreme weather events.

MOWING TECHNIQUE (increased cutting height above soil) enhances diversity and consequently resilience against climate extremes.

Implementation

The SIGNAL Consortium

- **10 countries along a strong climatic gradient**
  - BiodivERsA: **DE (coordination)**, FR, BE, BG
  - Subcontracted: HU, TR
  - Self-financed: AT, CH, IT, IL

Implementation

Field experiment (start 2013)

- **10 countries, existing, agriculturally managed grasslands**
- **Fully factorial design**
  - drought vs. control (2)
  - cutting height 3 cm – cutting height 10 cm – abandonment (3)
  - no invader – *Lupinus polyphyllus* – *Senecio inaequidens* (3)

  ▶ 18 combinations x 9 countries x 6 replicates

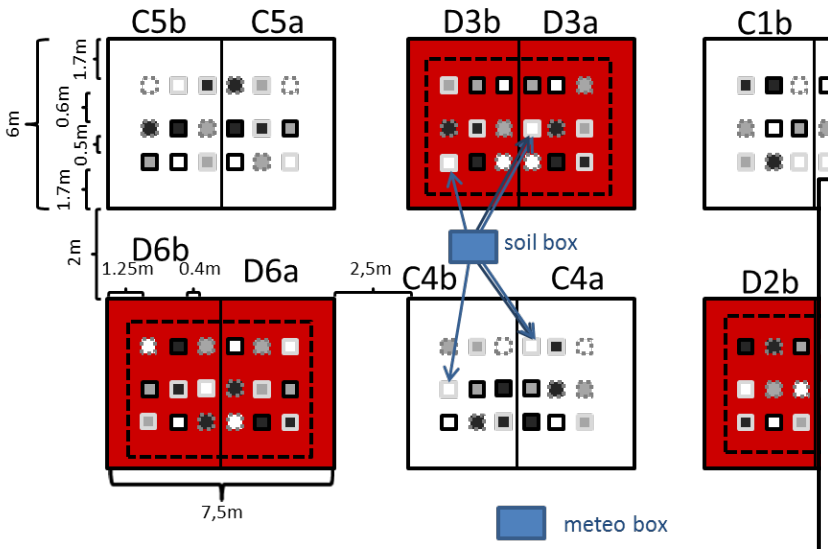
Implementation

Add-ons to the field experiment (in some sites)

- **ASSEMBLY:** small-scale community re-assembly after drought
- **DECOMPOSITION:** effects of neophytes on litter decomposition
- **ECOPHYSIOLOGY:** ecophysiological reaction of key resident species and Lupinus to drought
- **INVASIBILITY:** invasibility of communities after drought to a wider range of native species

Implementation

Field experiment: spatial arrangement



Climate (block level)

Local 1000-year **drought** (rainout-shelter)

Reference (untreated except during natural drought)

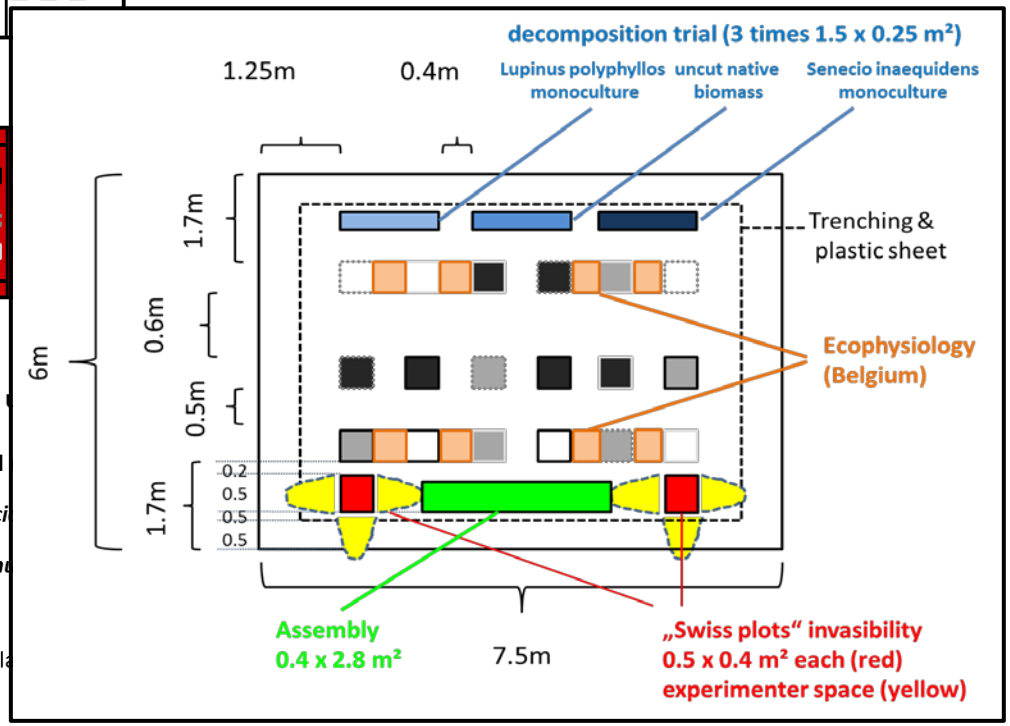
Invasion x Land

Semi-natural

Addition of *Seneci*

Addition of *Lupin*

plot labels: country code - climate block (see fig.) - invasion (am,Si,Lp) - l
e.g.: DE-D2a-am-3 or DE-C4b-Si-n




Implementation

Mesocosm experiment (start 2014)

- **5 countries, artificially arranged communities in plastic tubes (30 cm diameter)**
- **Factors studied**
  - drought vs. control
  - species richness level (1 species, 3 species, 6 species) (composed from 4 graminoids, 4 legumes, 4 non-legume forbs, all locally important)
  - without invader – with *Lupinus* – with *Senecio*
  - Additionally: within-species diversity of *Dactylis glomerata* s.l. (1 – 3 – 6 provenances/ecotypes out of 12 combined)

Implementation

Mesocosm experiment: spatial arrangement

Implementation

Other activities

- Literature **reviews and meta-analyses**
- Establishment of the first **pan-European vegetation-plot database of grassland communities** to analyse continental patterns in diversity, degree of invasion and importance of legumes (cooperation with European Dry Grassland Group/EDGG and European Vegetation Survey/EVS)
- **Extrapolation to continental scale by GIS** (and possibly RS)
- **Stakeholder involvement at European and national scale** to translate our findings into agricultural and conservation policies