Workshop Output WS 2.2.B

Title of workshop: Mountain grasslands under global change

Prepared by

Moderators	Michael Bahn, Richard Bardgett, Paul Illmer, Stefan Mayr
Participants*	All presenters of short talks, posters and the audience (ca. 80 additional participants)

* Workshop participants that have submitted contributions to the workshop

General questions to please be answered in the workshop reporting

1) What was the focus of the workshop? Methodological issues and advancements or thematic issues (systems knowledge, transformation knowledge, target knowledge). Please check and fill in the matrix in the output section.

Methodological issues and advancements	**Thematic issues**		
	System knowledge	Transformation knowledge	Target Knowledge
(x)	x		(x)

The workshop focussed on four topics which emerged from the submitted presentations:

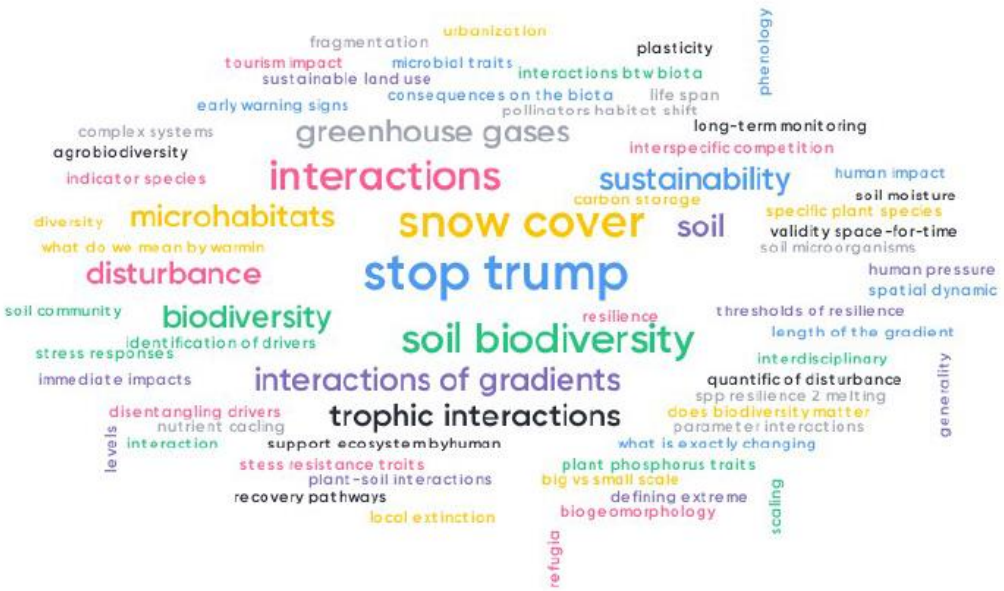
- Patterns and processes across environmental gradients
- Responses to warming
- Climate extremes
- Grassland management and land use change

2) Which key points were discussed in the workshop as a whole? (This should be more a synthesis and not simply a summary of the key points in each presentation)

   The below summary is based on a collective brainstorming of key issues requiring further study and the conclusions of group discussions (8-12 groups consisting of 5-10 participants each), which focussed on identifying the most pressing knowledge gaps and research needs. The most pressing / novel aspects are printed in bold.

Patterns and processes across environmental gradients

Keywords:

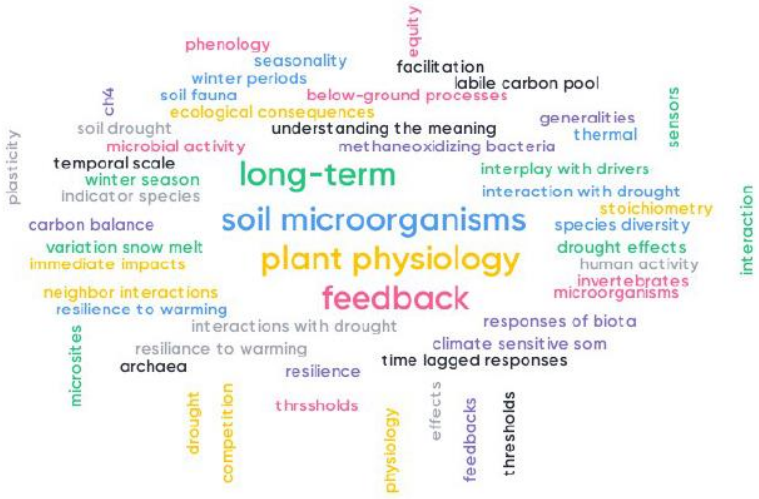


Conclusions:

- **Unravel how different community attributes (species, functional diversity) respond differently to environmental gradients.**
- Gradients are a useful tool for testing responses to environmental gradients, although they need to be well characterised. **Combine with experimental manipulations to disentangle mechanisms.**
- Consider response to land use and intensity along environmental gradients.
- Disentangle spatial and temporal variation along environmental gradients. Potential use of sensor data to detect spatial-temporal dynamics of environmental properties, and importance of spatial scale for assessment of responses of different organisms (e.g. soil microbes).

Responses to warming

Keywords:



Conclusions:

- **Seasonal effects of warming: consider all seasons, including winter**
- **Long-term perspective:** Lack long term studies and need long term datasets to detect responses to warming, and detect shifts in ecosystem states (including soil and shifts in labile/recalcitrant pools).
- Explore use of omic and stable isotope technology to identify underlying mechanisms for responses to warming (linking species to function/metabolism), and role of aboveground-belowground interactions.
- Need for high temporal resolution data and potential use of sensors

Climate extremes

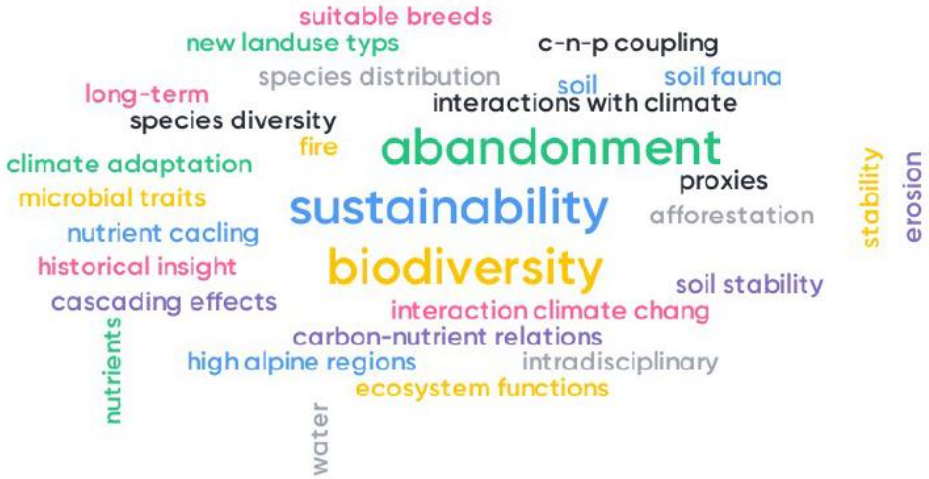
Keywords:

Conclusions:

- Definition of extreme ecological events (fire, reduced snow cover and frost frequency) in the context of mountain environments and require long term data/monitoring to identify
- Improve understanding of the **impact of intensity versus frequency of climate extremes**
- Need to identify **early warning signals** for abrupt changes in communities/ecosystems and identify mechanisms involved, including resilience (both extrinsic and intrinsic factors).
- **Effects of species composition on resilience** to extremes (e.g. life history strategies, role of roots).
- Coping with **co-occurring climate extremes** (e.g. floods/droughts/freeze-thaw) and **interactions of press and pulse perturbations**.
- **Understanding mechanisms underlying ecological memory**

Grassland management and land use change

Keywords:



Conclusions:

- **Management strategies for building resilience at different scales** – field, farm, landscape (e.g. grazing management) and recognise that context dependence (comparative studies)
- Socio-ecological approach required across spatial scales (plant to catchment) and recognise diversity of management intensities and options.
- Guided by stakeholder perceptions (management adapted for different stakeholders) including tourism, agriculture, and environmental protection.
- Knowledge transfer – transfer scientific knowledge into practical management
- Listen to local knowledge to identify optimal management strategies.

3) What is your opinion on the current state of knowledge concerning your topic(s) (focusing on mountain regions)? *Please check and fill in the matrix on the following page.*

   We performed a survey via Mentimeter.com and asked all workshop participant in advance for rankings of the respective questions. The survey was closed after the workshop.

Overall assessment of the state of:

What is your personal opinion on the current state of knowledge concerning the topic(s) addressed in your workshop. Please tick the appropriate field. Brief explanations are appreciated.

The following table is based on the outcome of the mentimeter survey amongst the workshop participants, including the moderators. 15 colleagues participated, Results are indicated in %.

State of knowledge	Very good	Good	Poor	Very poor	Not appropriate	*Comments*
Global	0	53.3	40.0	6.7	0	
Regional	0	64.3	35.7	0	0	*Which region?*
Scattered case study-based knowledge	14.3	57.1	21.4	7.1	0	*Where?*
Knowledge about past states/trends	0	7.1	64.3	28.6	0	
Knowledge about current situation	0	71.4	21.4	0	7.1	
Knowledge about future states/trends/thresholds	0	21.4	57.1	21.4	0	
Knowledge about the system	0	64.3	28.6	0	7.1	
Knowledge about shaping pathways to more sustainable development (transformation knowledge)	0	15.4	61.5	15.4	7.7	
Knowledge about envisaged goals (target knowledge)	0	23.1	53.8	7.7	15.4	