

Extreme events in arctic ecosystems: Diverse causes and challenges to observation

Gareth Phoenix

School of Biosciences, University of Sheffield, UK.



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Sheffield.



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Extreme events

Picture: Frost-drought mortality of heathland, Norway



- Large ecological impact disproportionate to their short duration
- Take organisms “past lethal thresholds
- Browning events: extreme events that cause die back and/or loss of biomass/productivity

Challenge: Diverse “Browning” events

Climatic events:

Extreme winter warming



Frost-drought



Icing



Drought / heatwave



Biotic events:

Caterpillar outbreaks



Caterpillar outbreaks



Snow mould



Lemming peaks



Physical disturbance events:

Fire



Fire after frost-drought



Retrogressive thaw slump

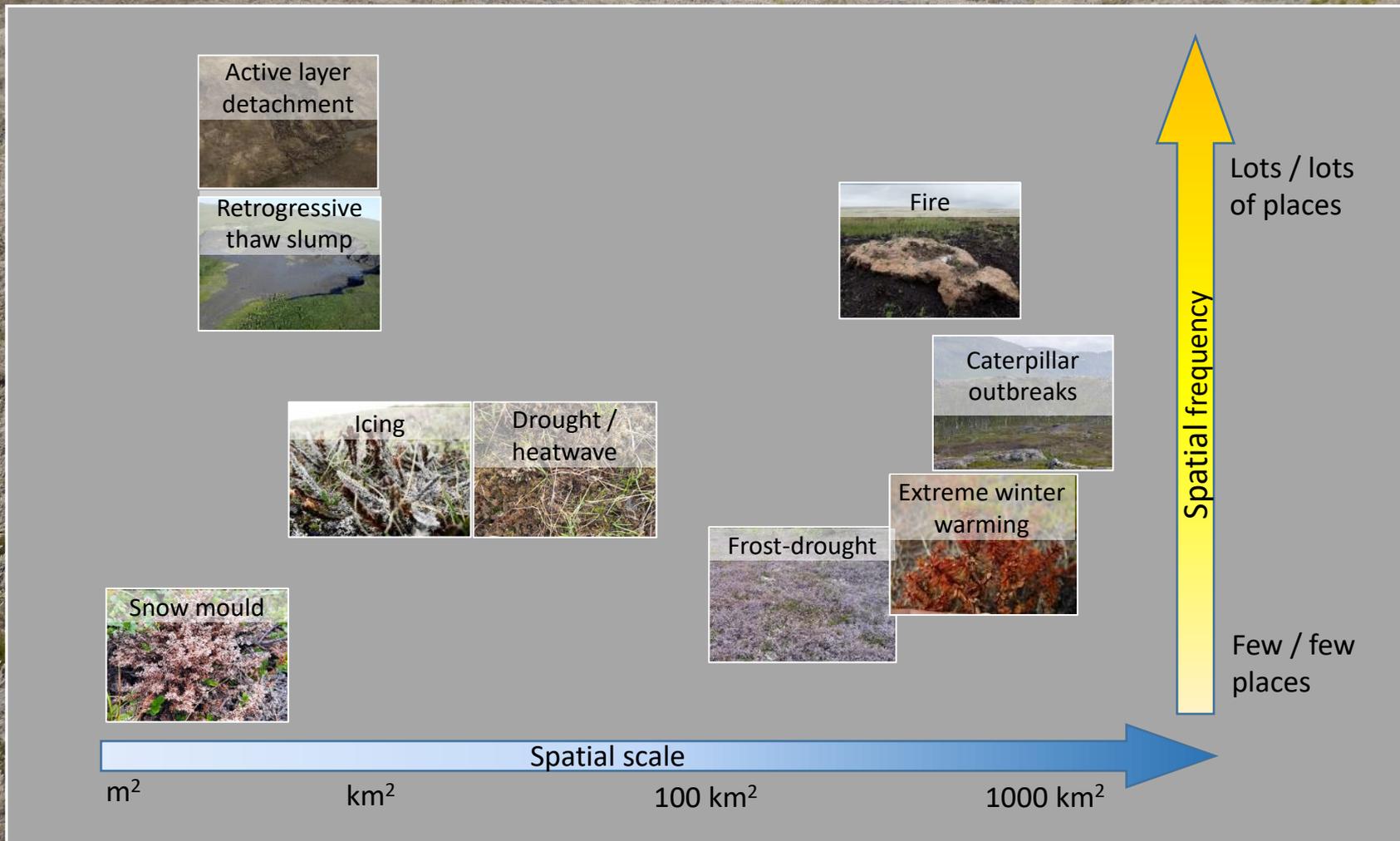


Active layer detachment



Challenge: spatially discrete

Spatially discrete, with contrasting scales and contrasting



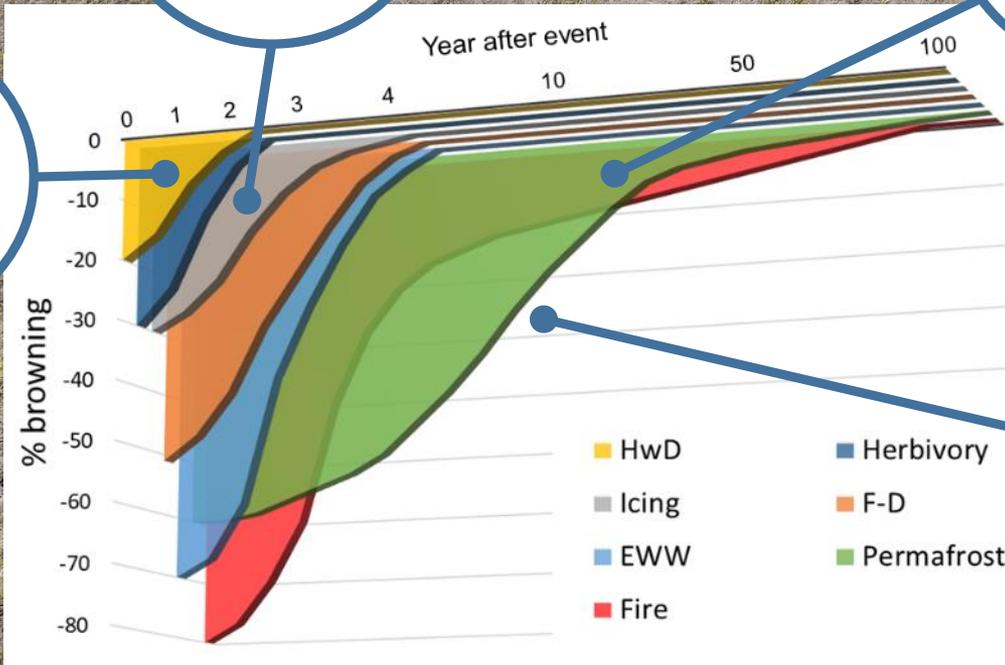
Challenge: temporally discrete:

Temporally discrete, but length of impact differs

Shorter events:
less time
to observe

Physical
disturbance
events take
longer to
recover

Climatic
and biotic
events can
recover
"quickly"



Recovery in
biomass,
not always
community



Challenge: hard to predict

But ground observation generally “reactive”

Widespread monitoring: more chance of collecting data prior to the event

Field simulation experiments: create predictable events for proactive research



Extreme winter warming

e.g. Bokhorst et al. (2011)

Global Change Biology

doi: 10.1111/j.1365-2486.2011.02424.x



Icing

e.g. Preece et al. (2012)

Physiologia Plantarum

doi:10.1111/j.1399-3054.2012.01640.x



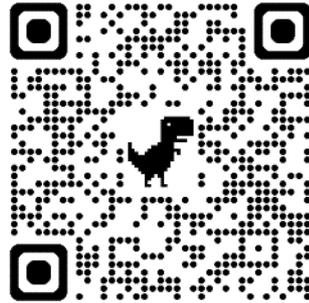
Extreme rainfall

e.g. Magnússon et al. (2022).

Nature Communications

doi.org/10.1038/s41467-022-29248-x

Monitoring “ready to go”: CAFF tool



caff.us/work/approach/extreme-events/

FECs Monitoring Extreme Events

EXTREME EVENTS

Extreme events can significantly impact ecosystems, physical landscapes and arctic societies, sometimes tipping ecological balances and changing ecosystem dynamics. CAFF and INTERACT has developed a tool to inspire long-term monitoring of extreme events and their impacts on arctic ecosystems. The tool describes various extreme events, providing suggested definitions and recommend methodology for monitoring both the extreme events themselves and their potential ecosystem impacts. Guidance on monitoring extreme events is based on existing literature and expert knowledge, while ecosystem impact guidance builds on prioritized Focal Ecosystem Components (FECs) from existing CBMP monitoring plans. Explore individual extreme events below.

The tool is not an internationally agreed protocol but represents a step towards standardizing extreme event monitoring efforts. We hope the tool will evolve over time as new knowledge emerges and scientific fields develop standardized protocols.

Guidelines Definitions References

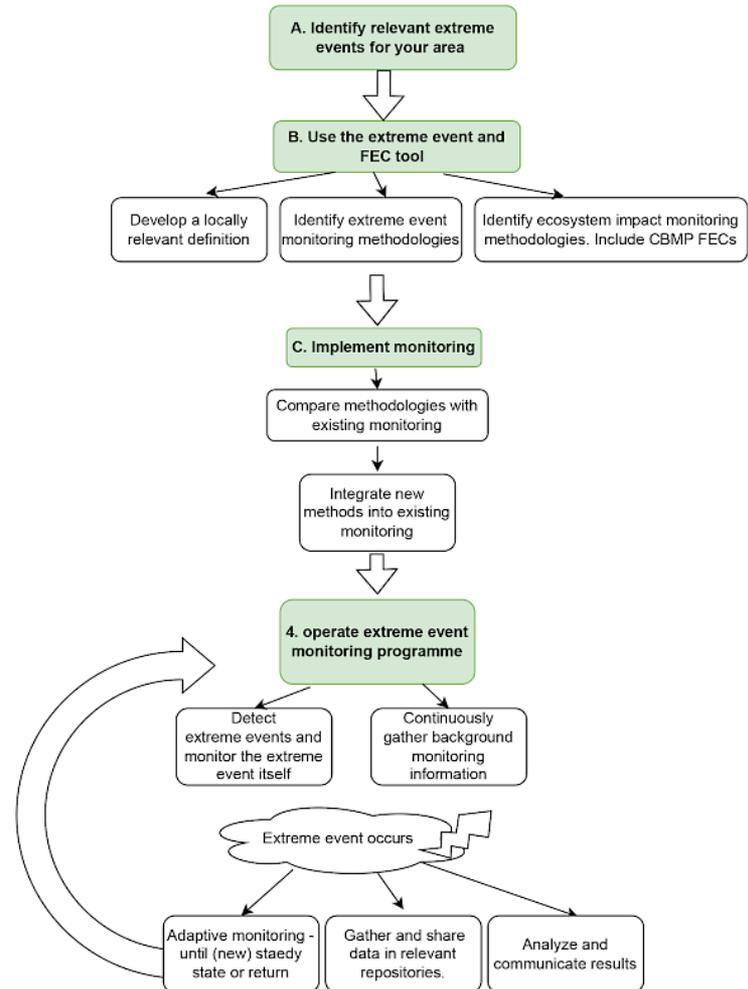
Spatial Scale Temporal Scale Export CSV

TEMPERATURE EXTREMES

PRECIPITATION EXTREMES

EXTREME ICE/SNOW COVER

ICING EVENTS



Conclusions

Challenge of extreme events

- Extreme browning events are diverse, sporadic, spatially and temporally discrete, and hard to predict
- Ground observations are mostly reactive
- Monitoring can improve reactive science

Priorities for ground-based monitoring

- More monitoring, with greater pan-arctic coverage, on more plant community types.
- More focus on the least studied extreme events.
- Collaborate with Indigenous knowledge holders.
- Create some predictable events (field simulations).