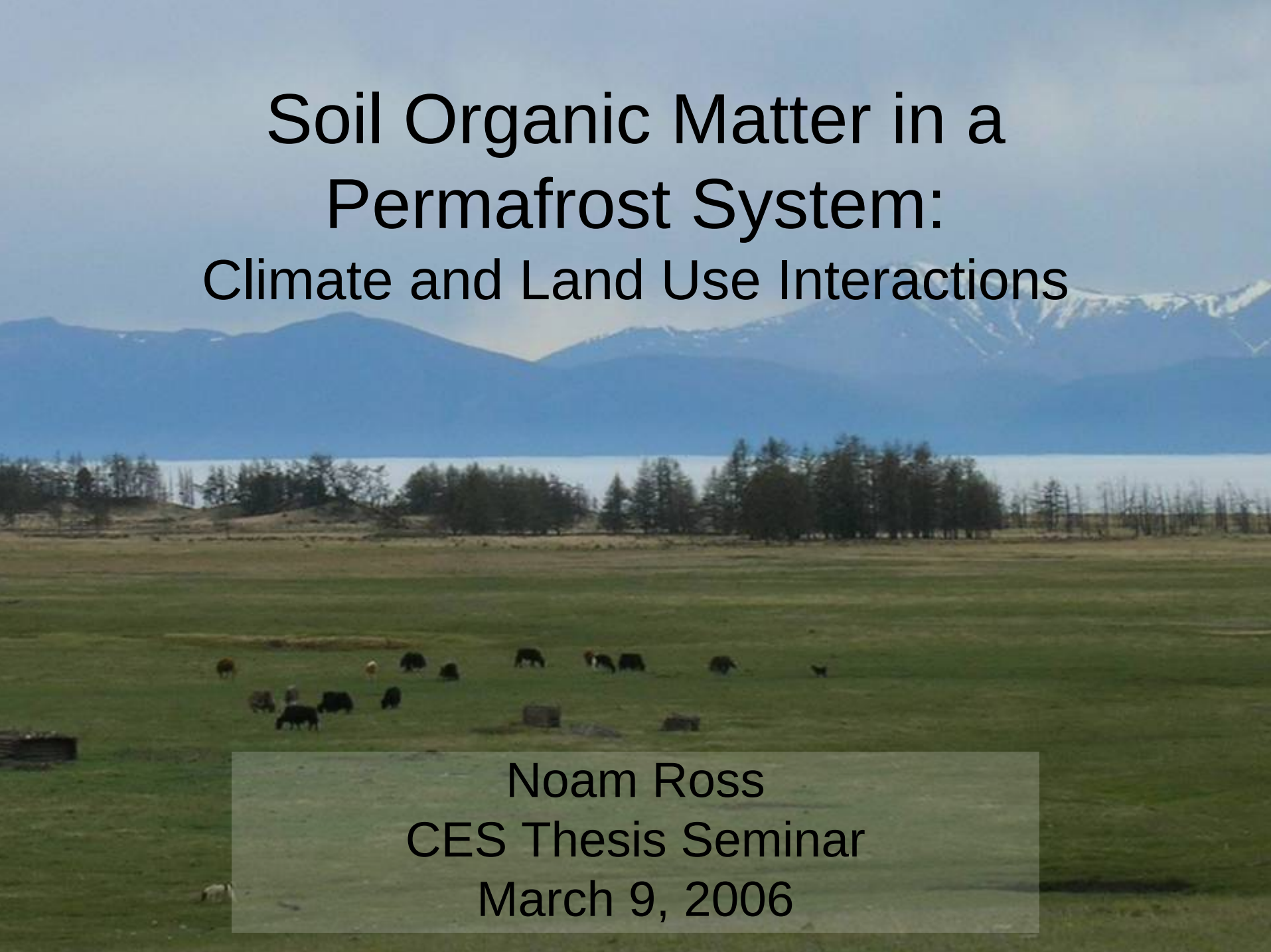
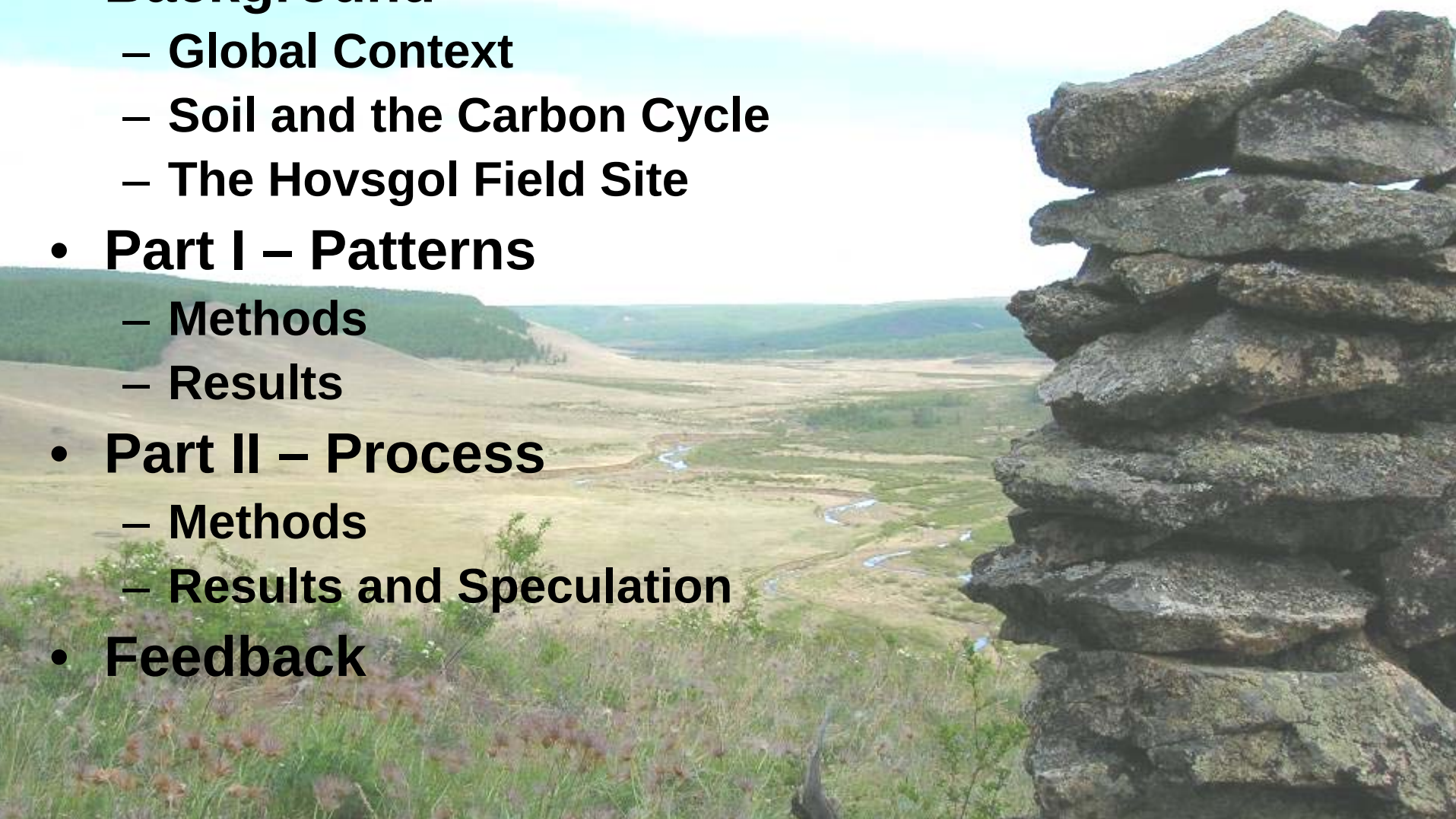


Soil Organic Matter in a Permafrost System:
Climate and Land Use Interactions

Noam Ross
CES Thesis Seminar
March 9, 2006

A Road Map

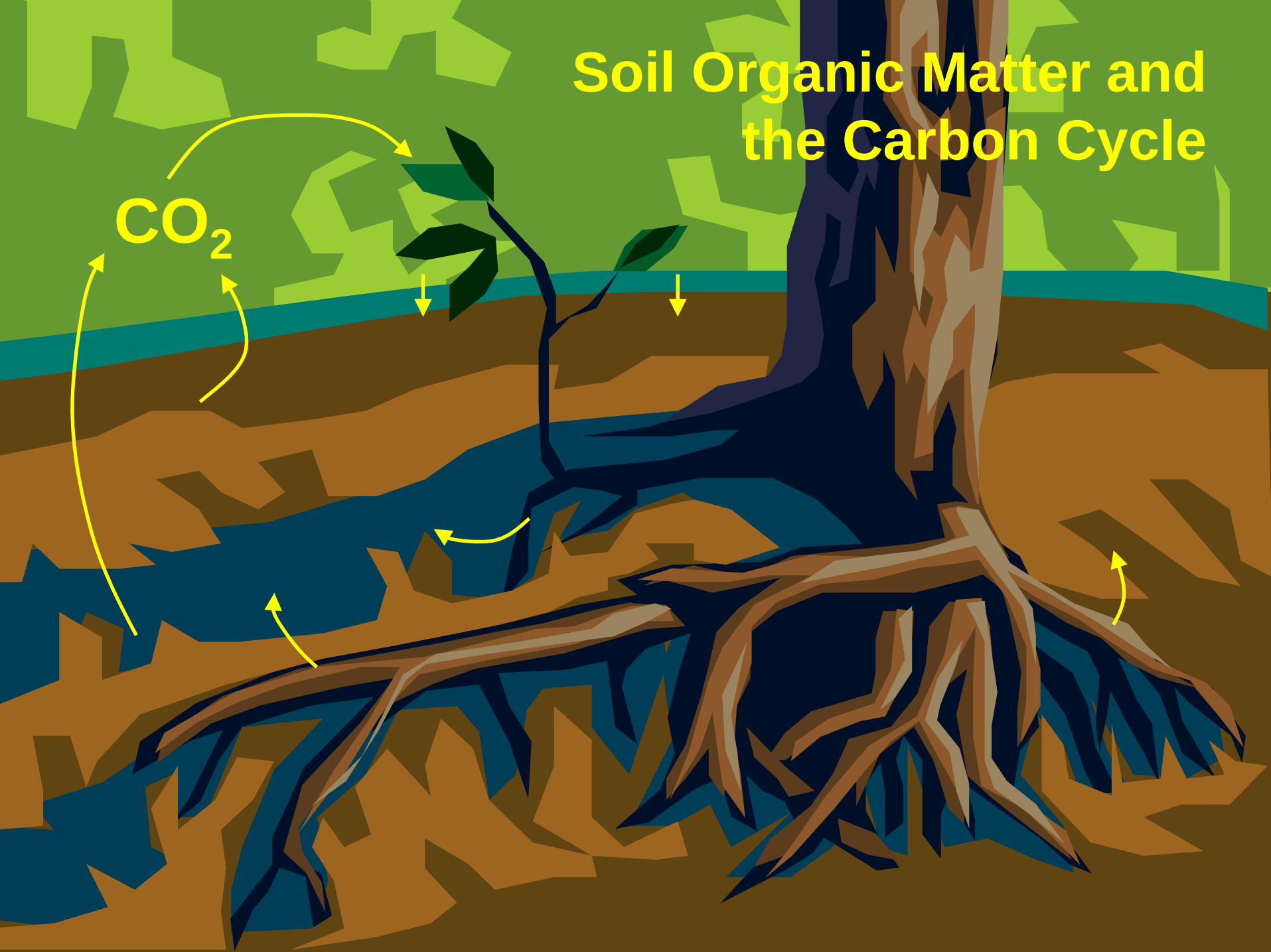


- **Background**
  - **Global Context**
  - **Soil and the Carbon Cycle**
  - **The Hovsgol Field Site**
- **Part I – Patterns**
  - **Methods**
  - **Results**
- **Part II – Process**
  - **Methods**
  - **Results and Speculation**
- **Feedback**

Global Context

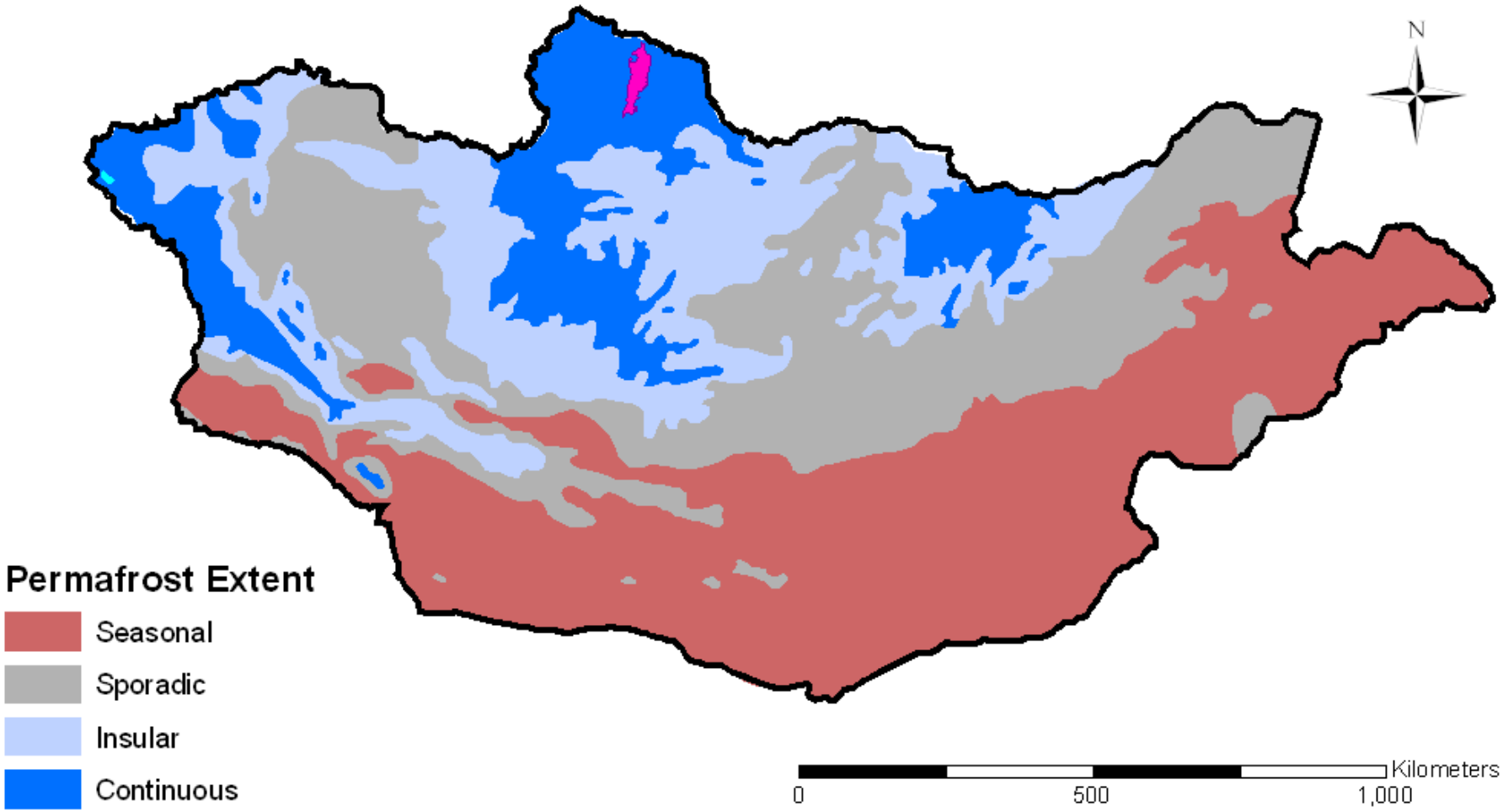
Land Use Change

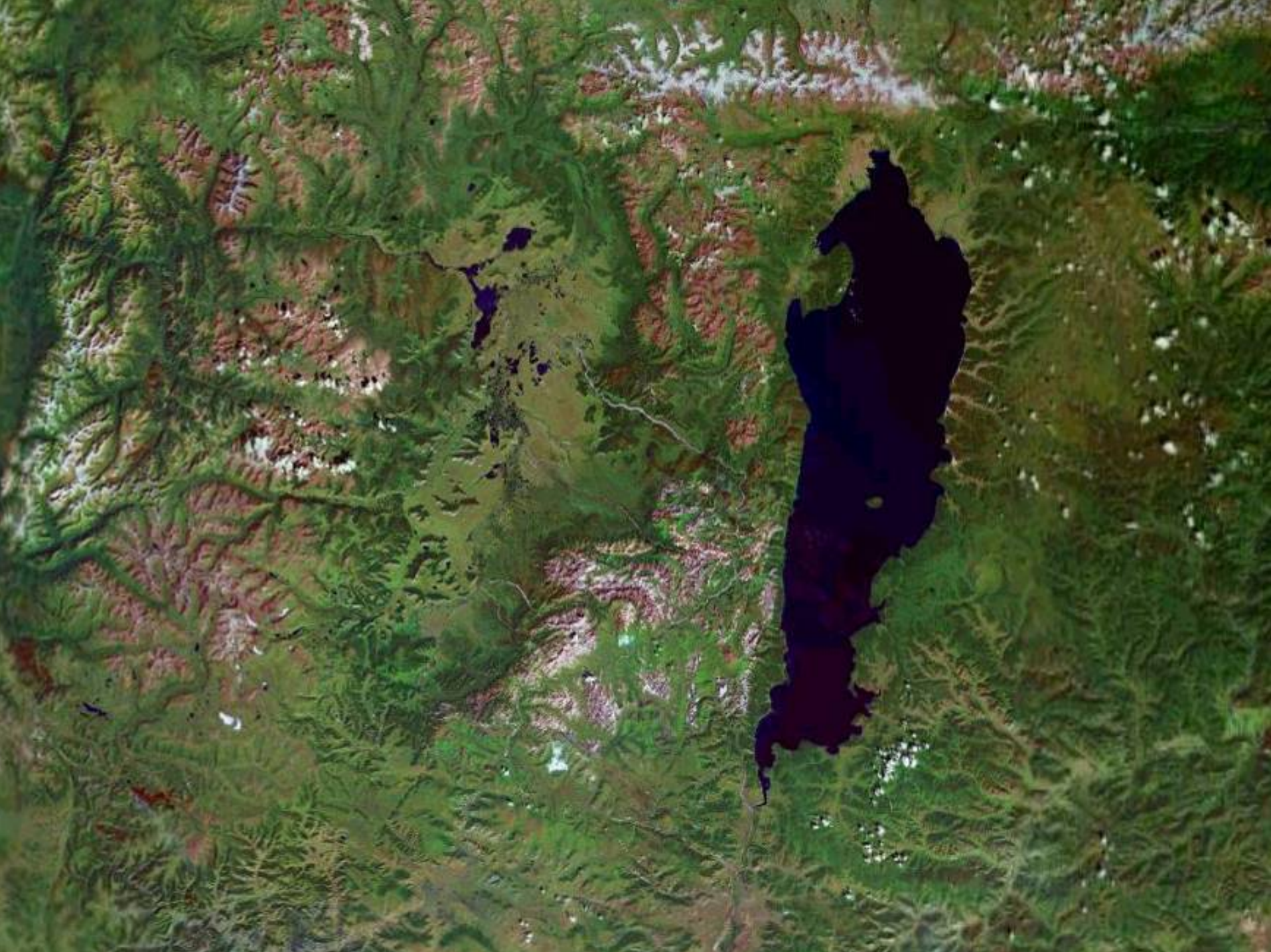
Global Warming


Soil Organic Matter and the Carbon Cycle
CO_2

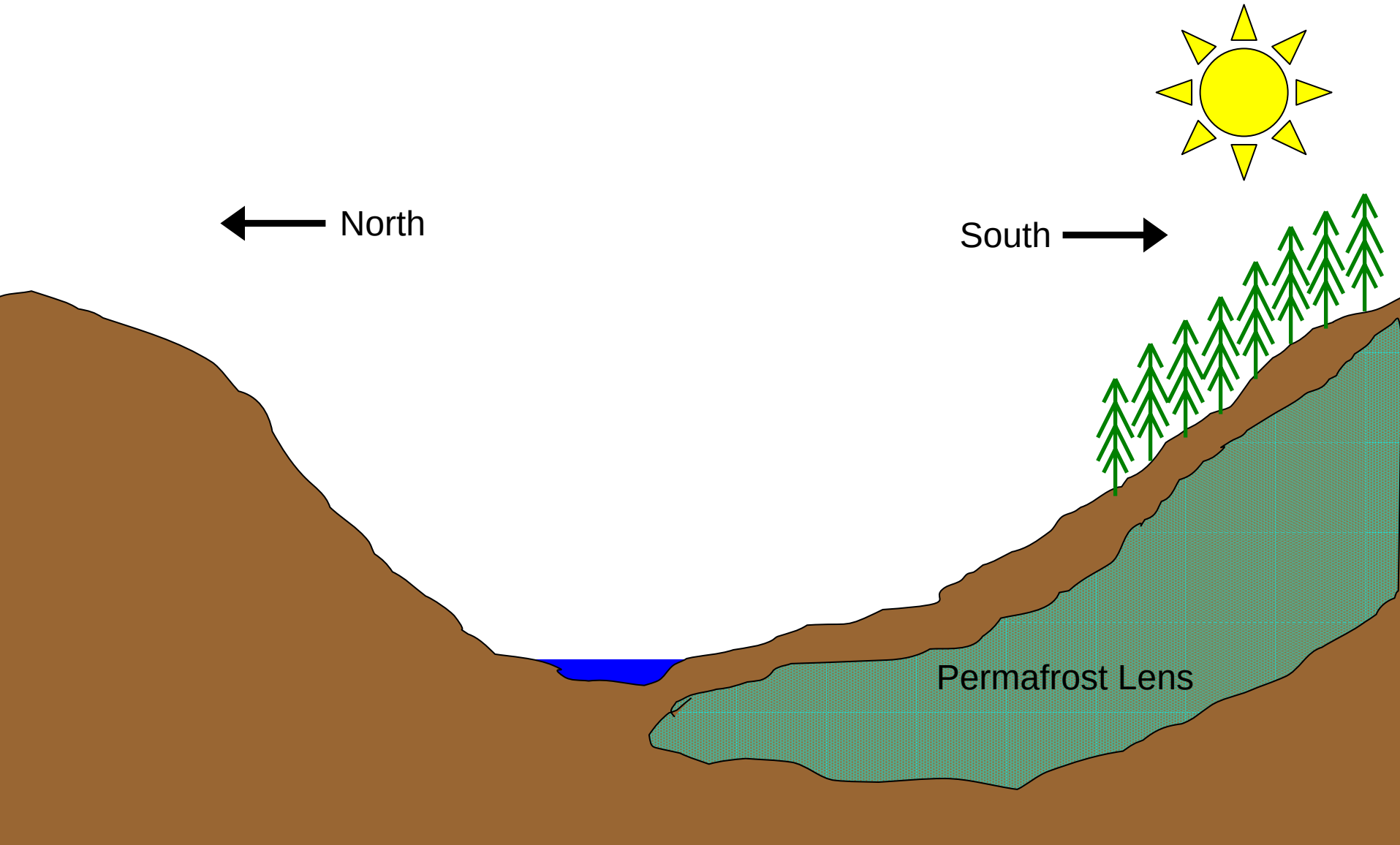

Mongolia

Permafrost Soils in Mongolia

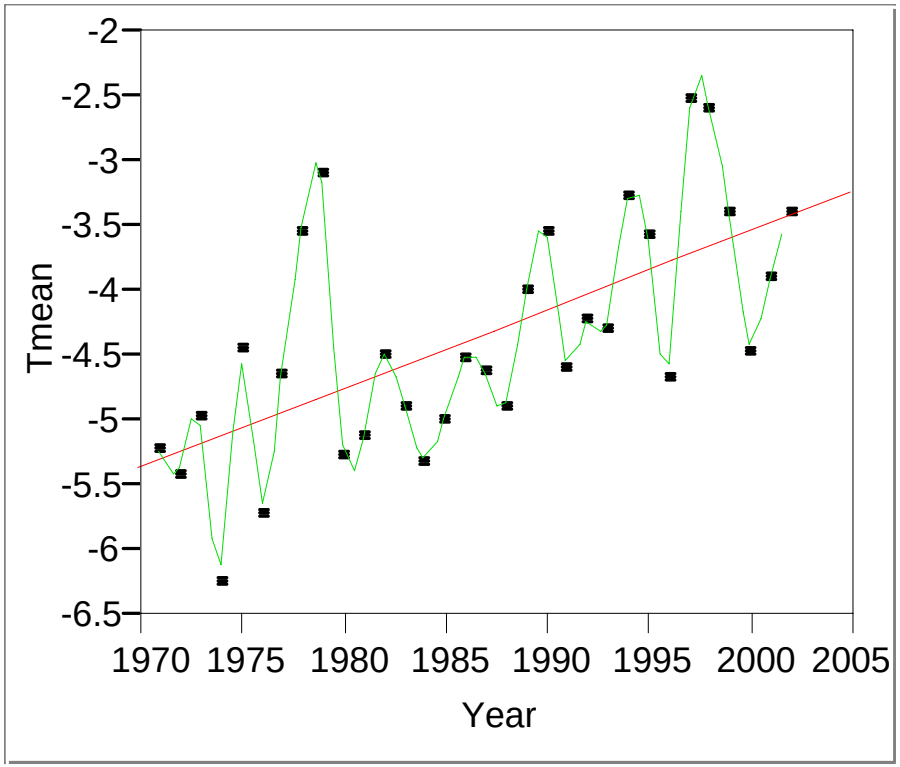




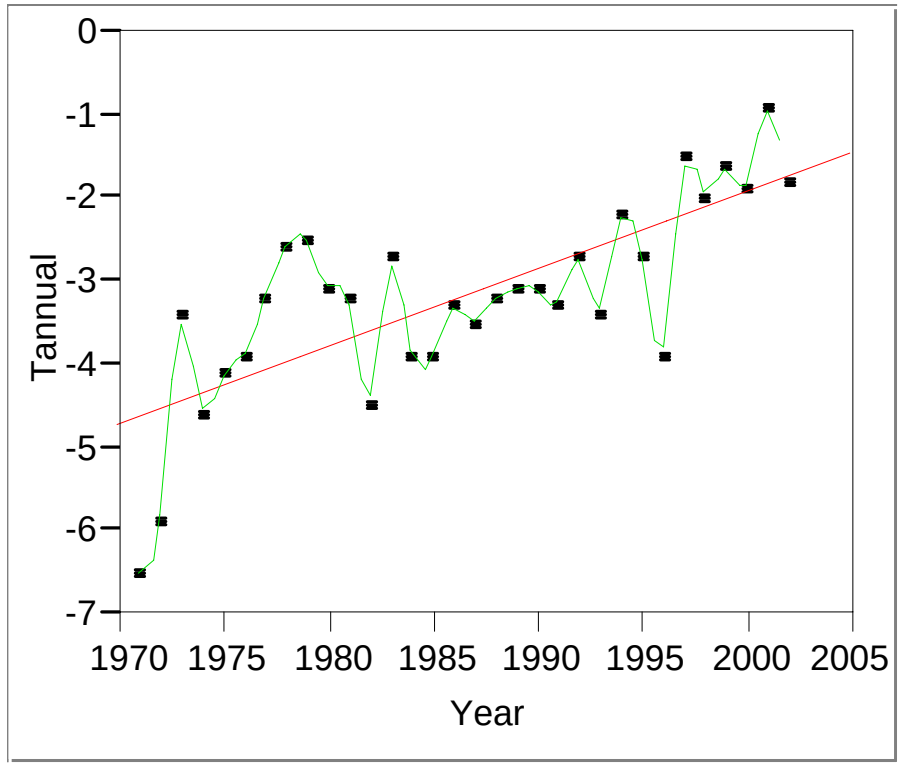
Valley Profile



32-Year Temperature Trends, Hovsgol Lake



Hatgal Station, South End of Lake



Hankh Station, North End of Lake

Part I: Pattern

How do the presence of permafrost and the intensity of grazing affect patterns of soil organic carbon storage?

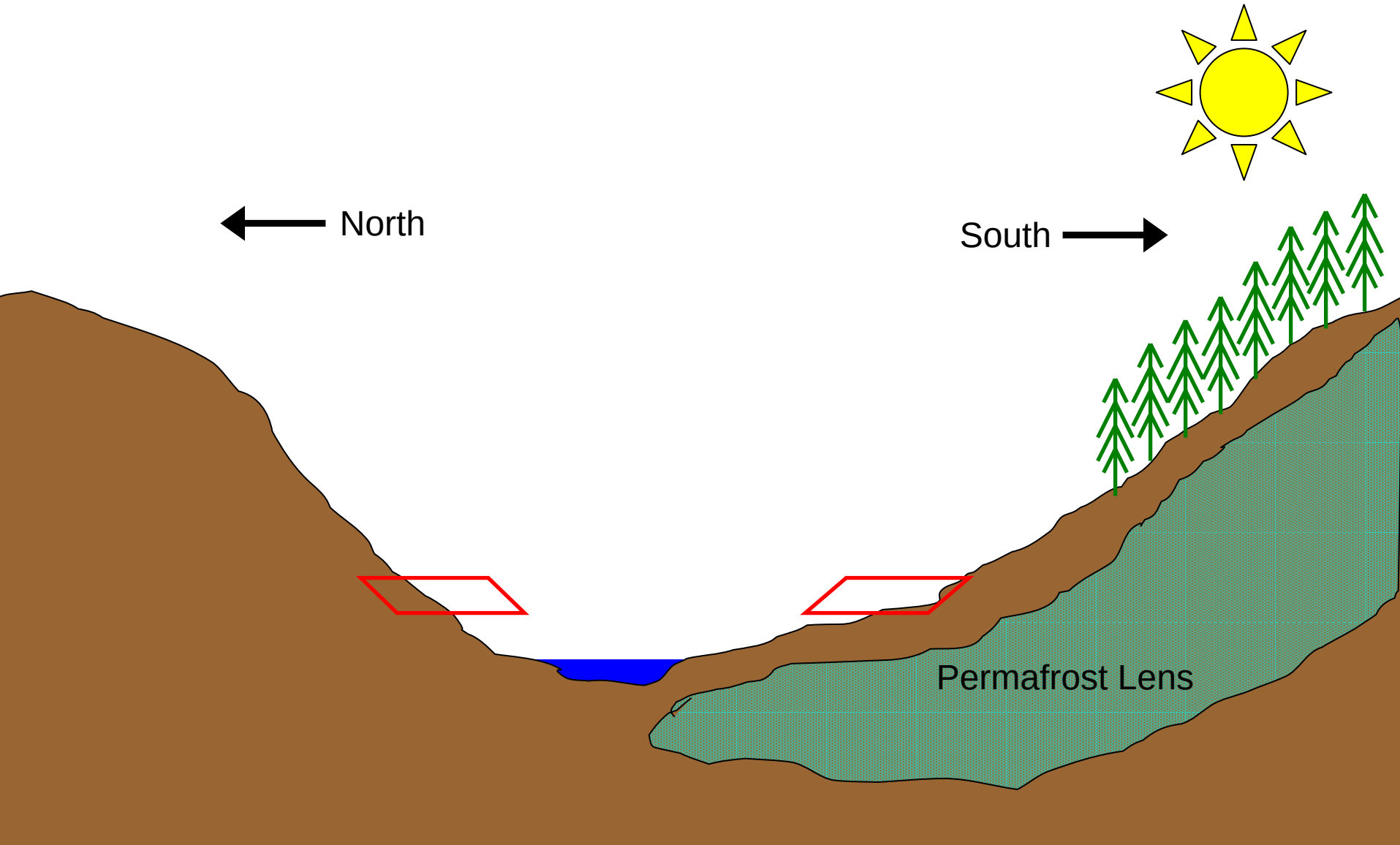
Hypothesis:

Permafrost will be associated with greater carbon stores.

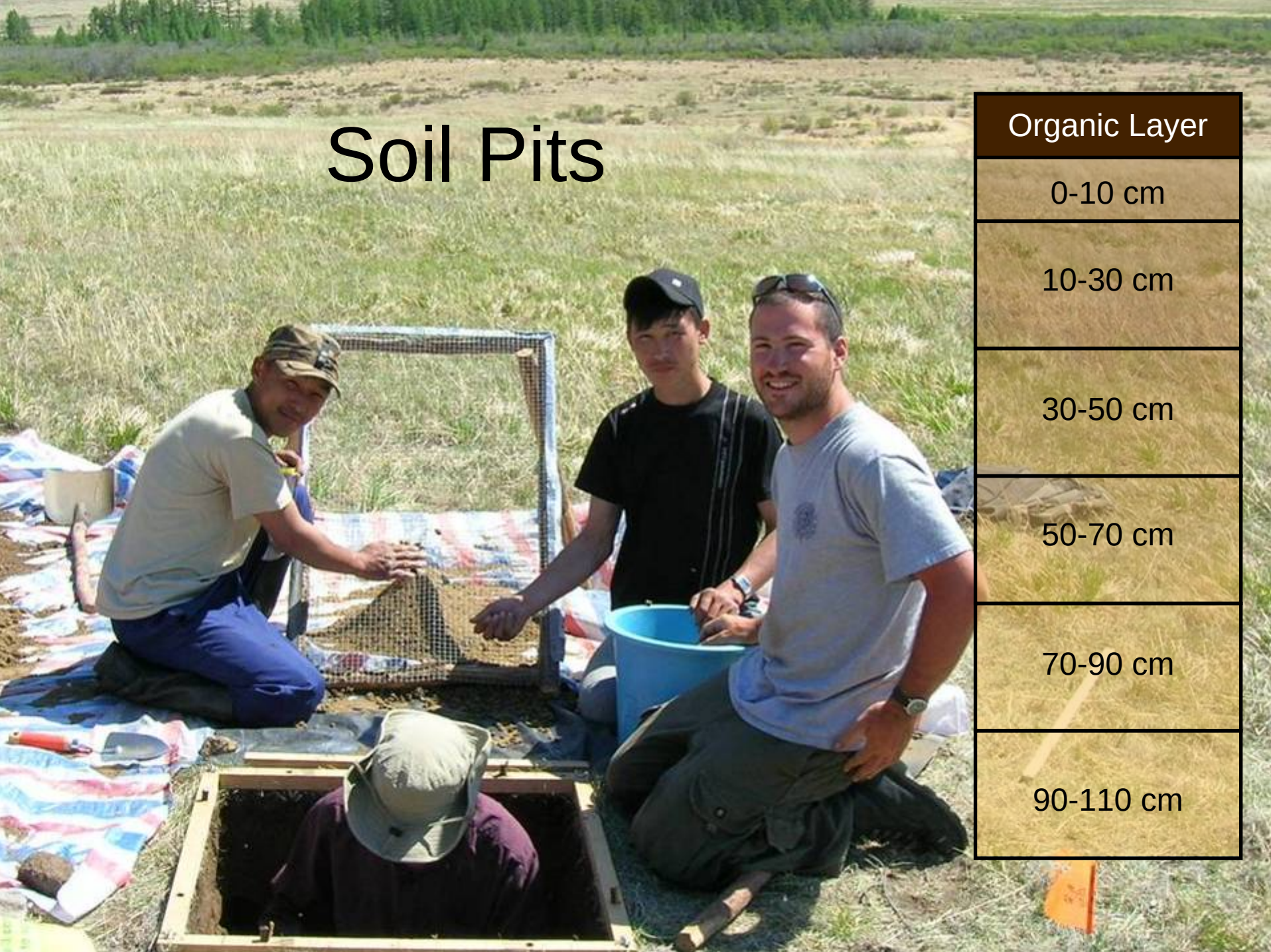
Grazing will be associated with smaller carbon stores.


Turag Valley
0.21 livestock/ha
Dalbay Valley
0.068 livestock/ha

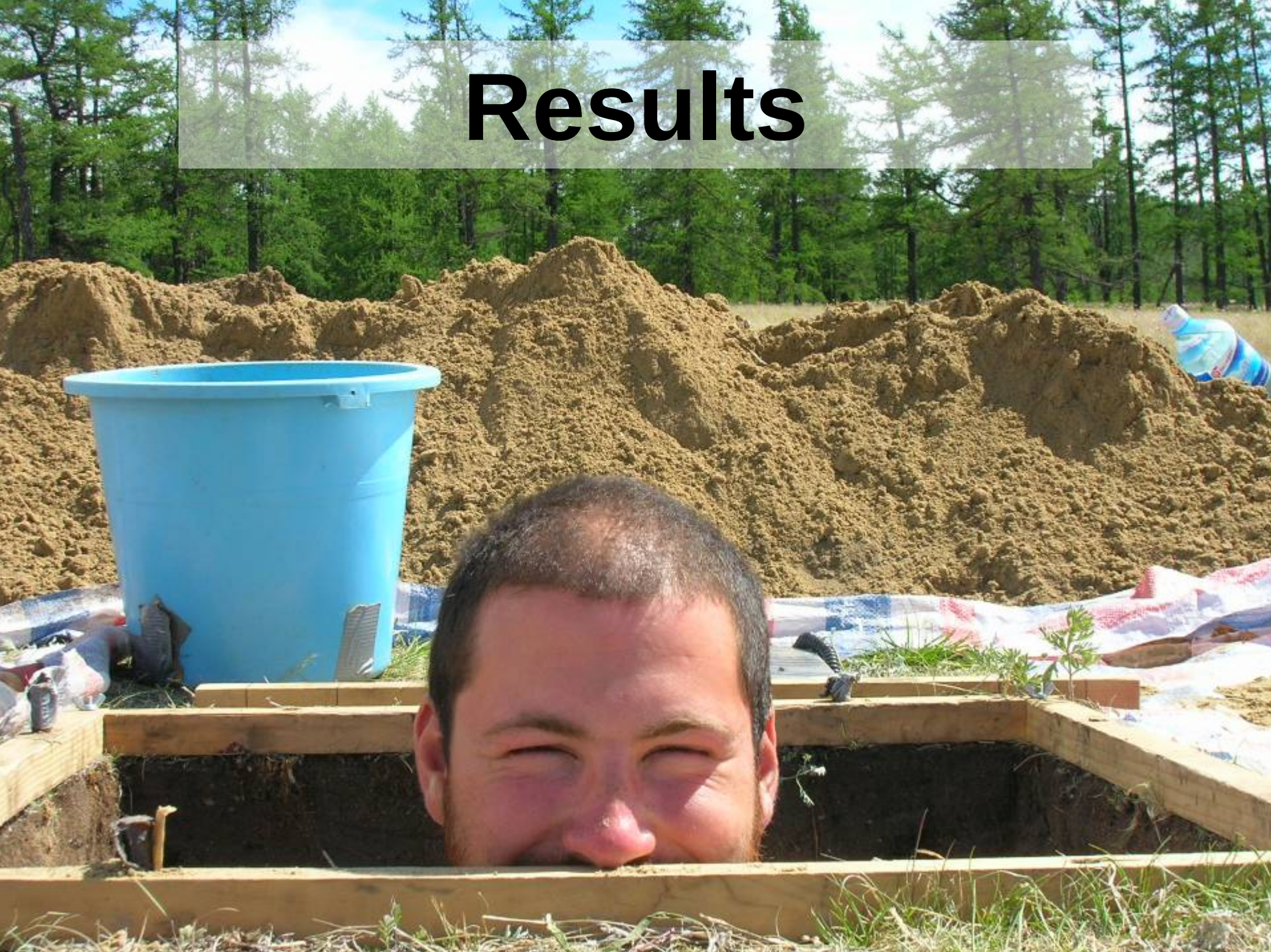
Valley Profile



Soil Pits



Results



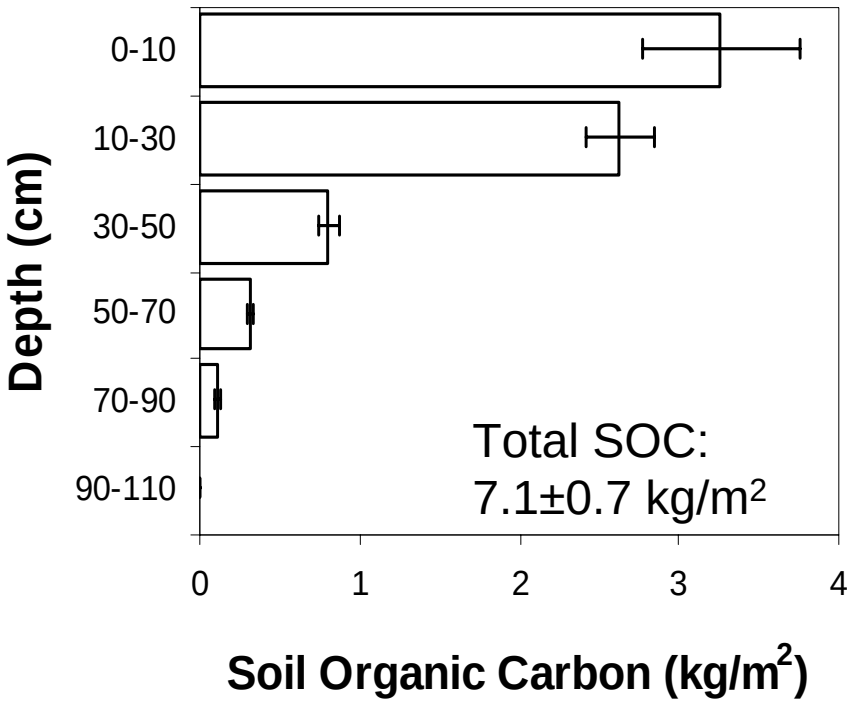
Permafrost-free Soil Profiles

Dalbay Valley - Light Grazing

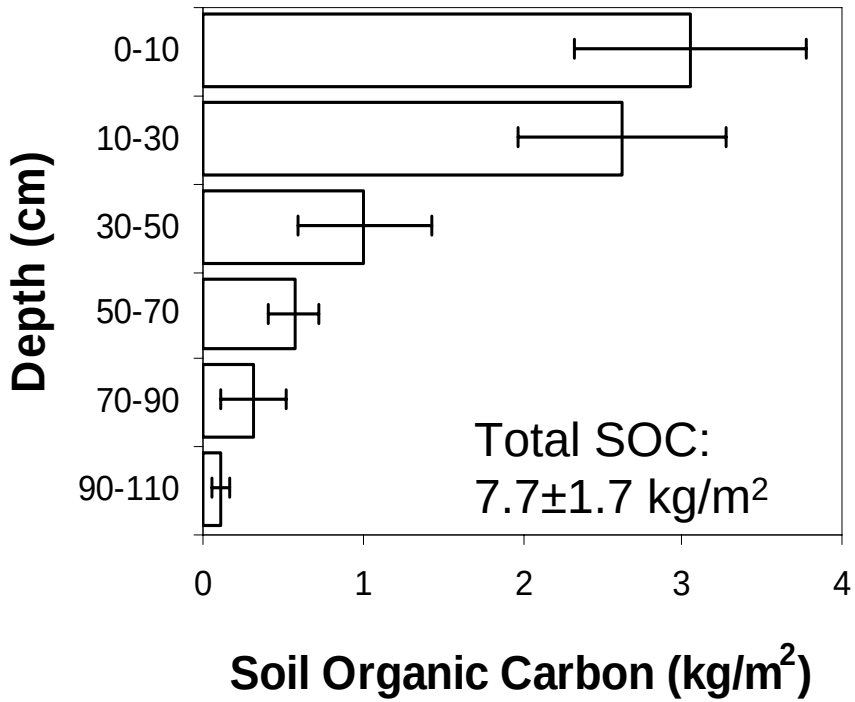
Turag Valley - Heavy Grazing

Permafrost-free Sites

Light Grazing



Heavy Grazing



On south facing, permafrost-free slopes, grazing intensity appears to have little effect on the amount or distribution of soil carbon.

($P > 0.65$)

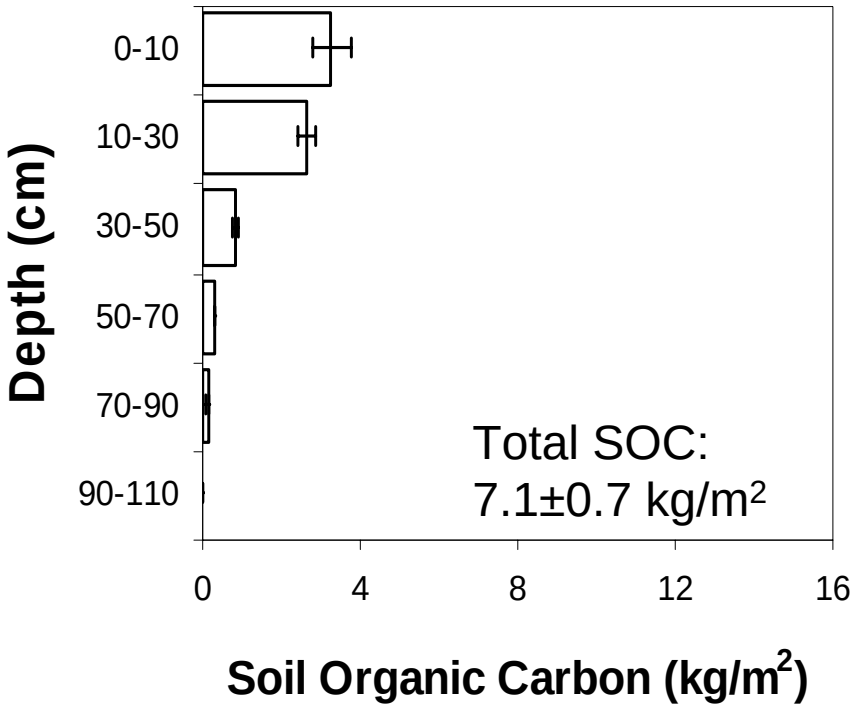
Soil Profiles – Light Grazing

North Slope – No Permafrost

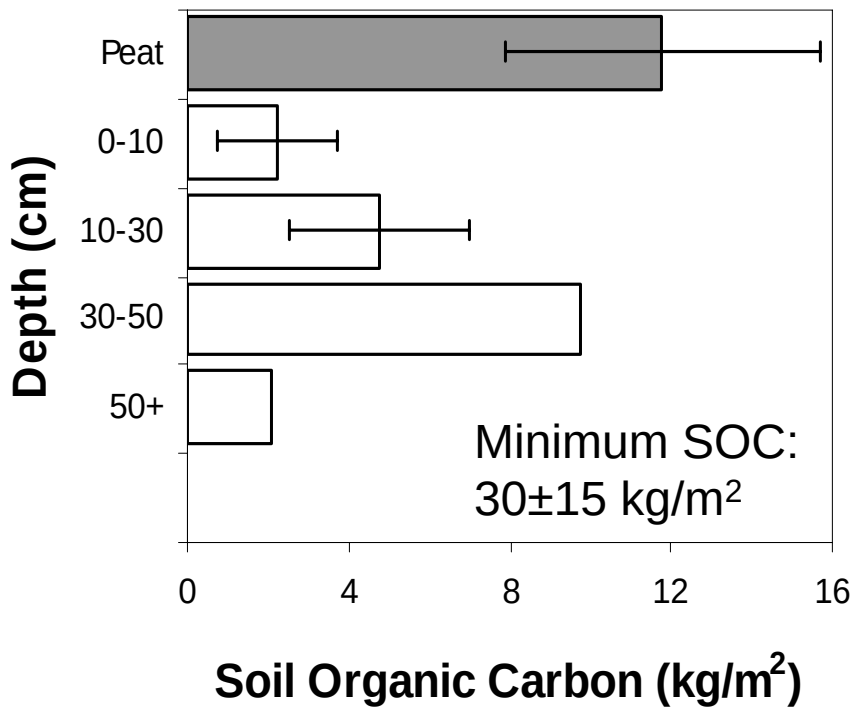
South Slope - Permafrost

Lightly Grazed Sites

No Permafrost



Permafrost



In little-grazed areas, the presence of permafrost is associated with much greater soil carbon.

($P < 0.01$)

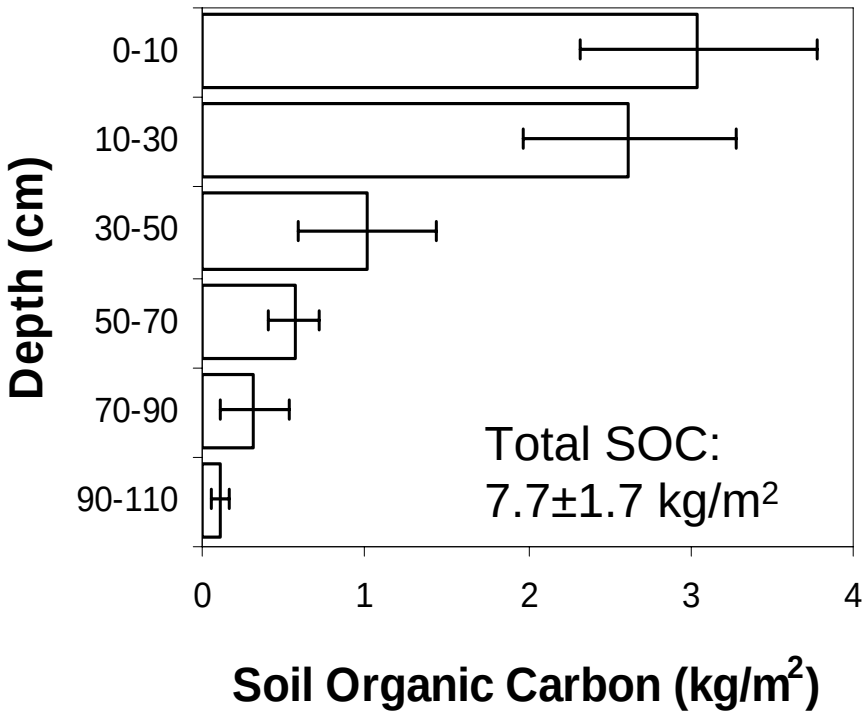
Soil Profiles – Heavy Grazing

North Slope – No Permafrost

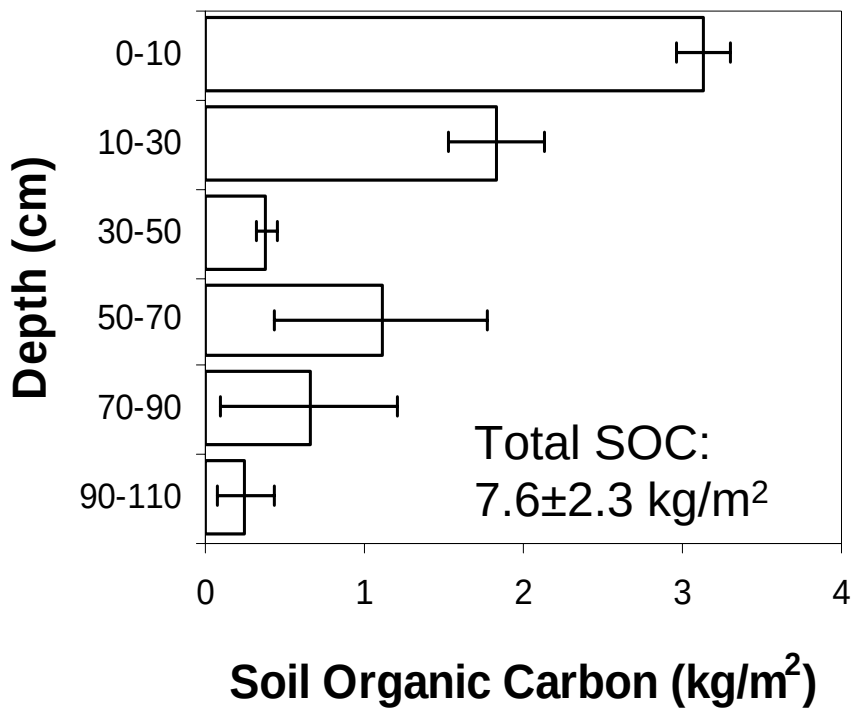
South Slope - Permafrost

Heavily Grazed Sites

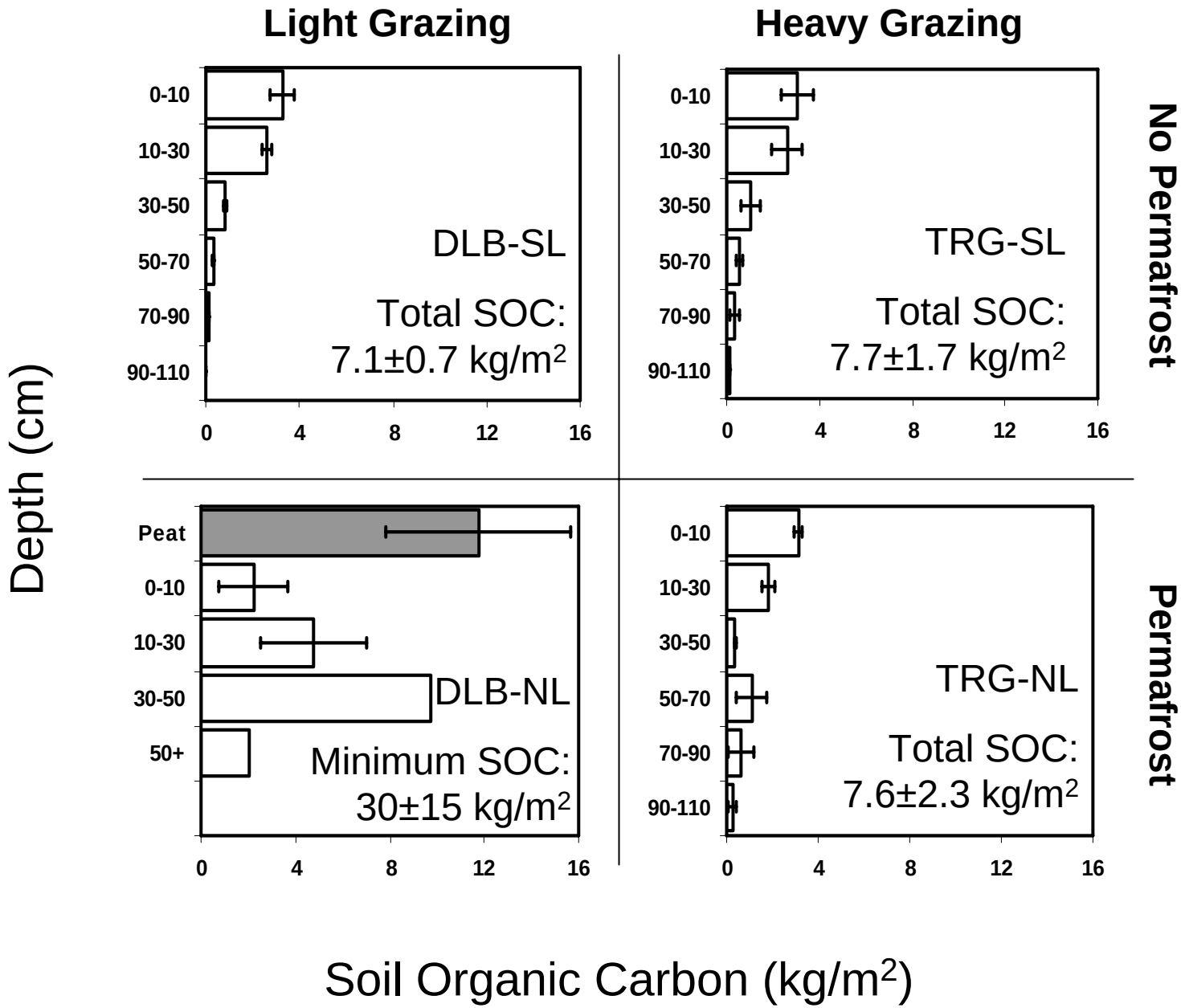
No Permafrost



Permafrost



In heavily grazed areas, underlying permafrost is not associated with greater soil carbon ($P > 0.8$), though there is a different distribution ($P < 0.05$)


Light Grazing
Heavy Grazing
No Permafrost
Permafrost
Depth (cm)
Soil Organic Carbon (kg/m2)
0-10
10-30
30-50
50-70
70-90
90-110
DLB-SL
Total SOC:
7.1±0.7 kg/m2
TRG-SL
Total SOC:
7.7±1.7 kg/m2
Peat
0-10
10-30
30-50
50+
DLB-NL
Minimum SOC:
30±15 kg/m2
TRG-NL
Total SOC:
7.6±2.3 kg/m2
0
4
8
12
16

Part II: Process

System State Change – A Conceptual Model

Grazing

Low Plant and Litter Cover

Poor Insulation

High Soil Temperatures

Receding Permafrost

Good Drainage

Low Soil Moisture

High Oxygen

Low Soil Organic Matter

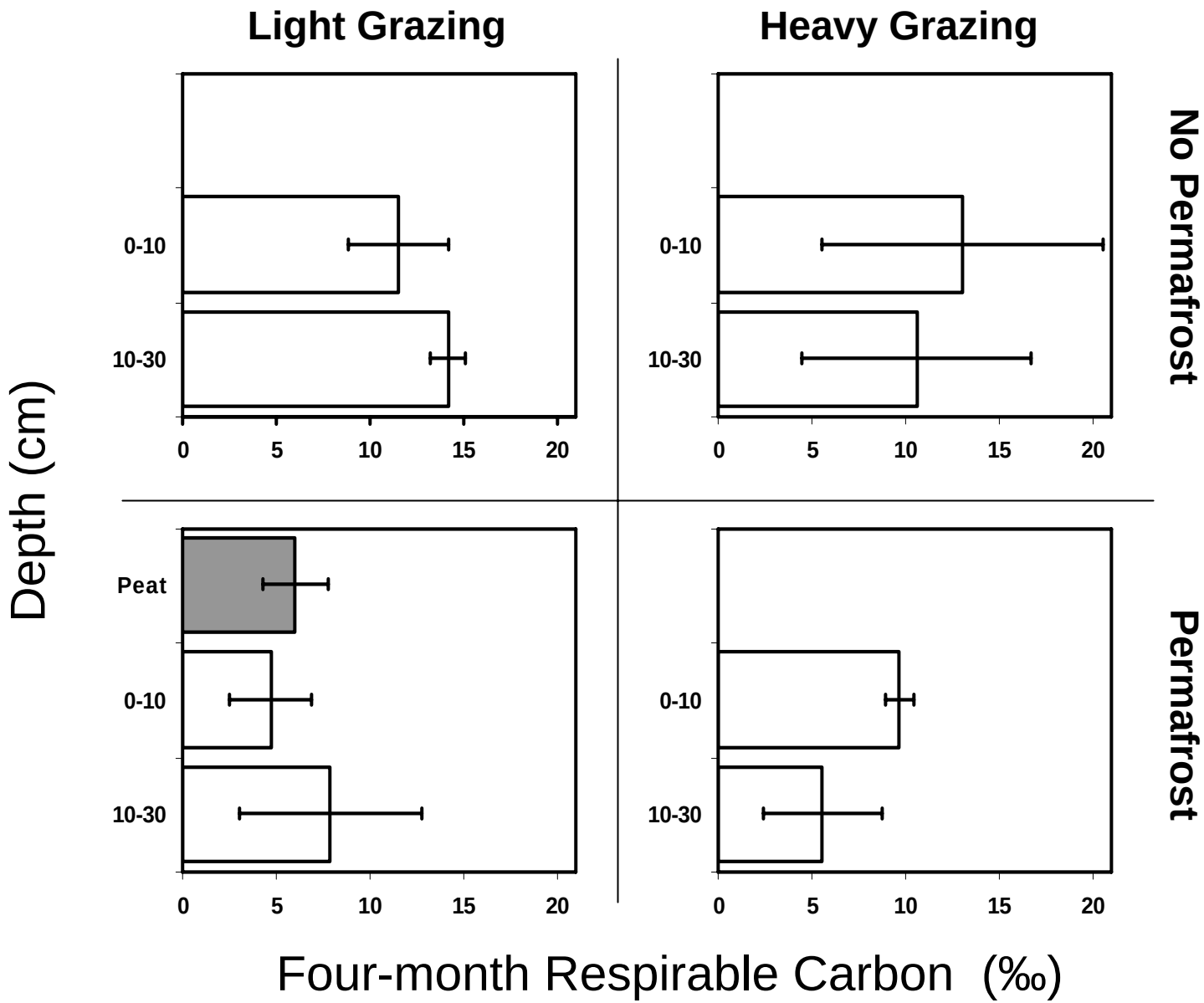
Fast Decomposition

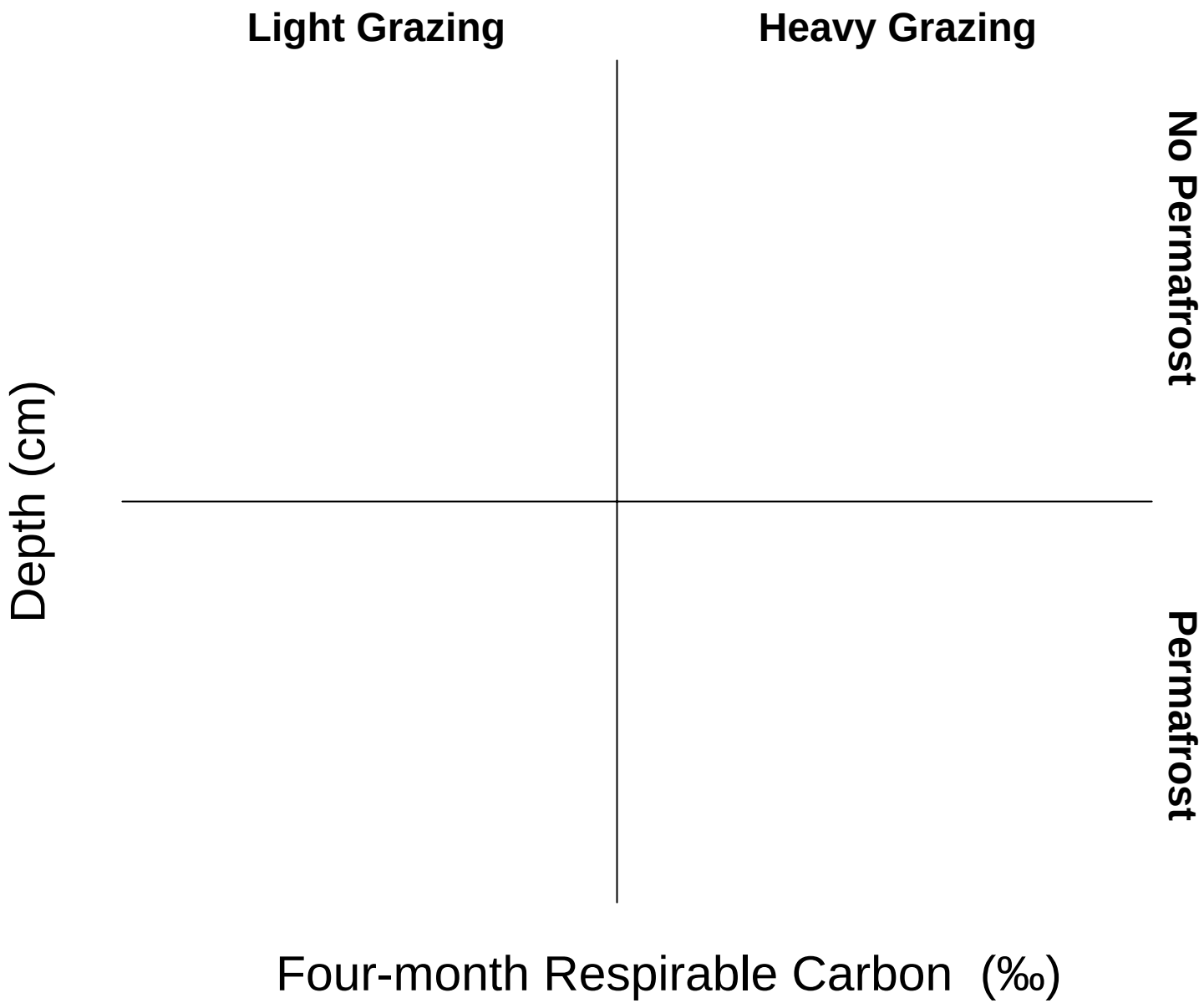
Hypothesis:

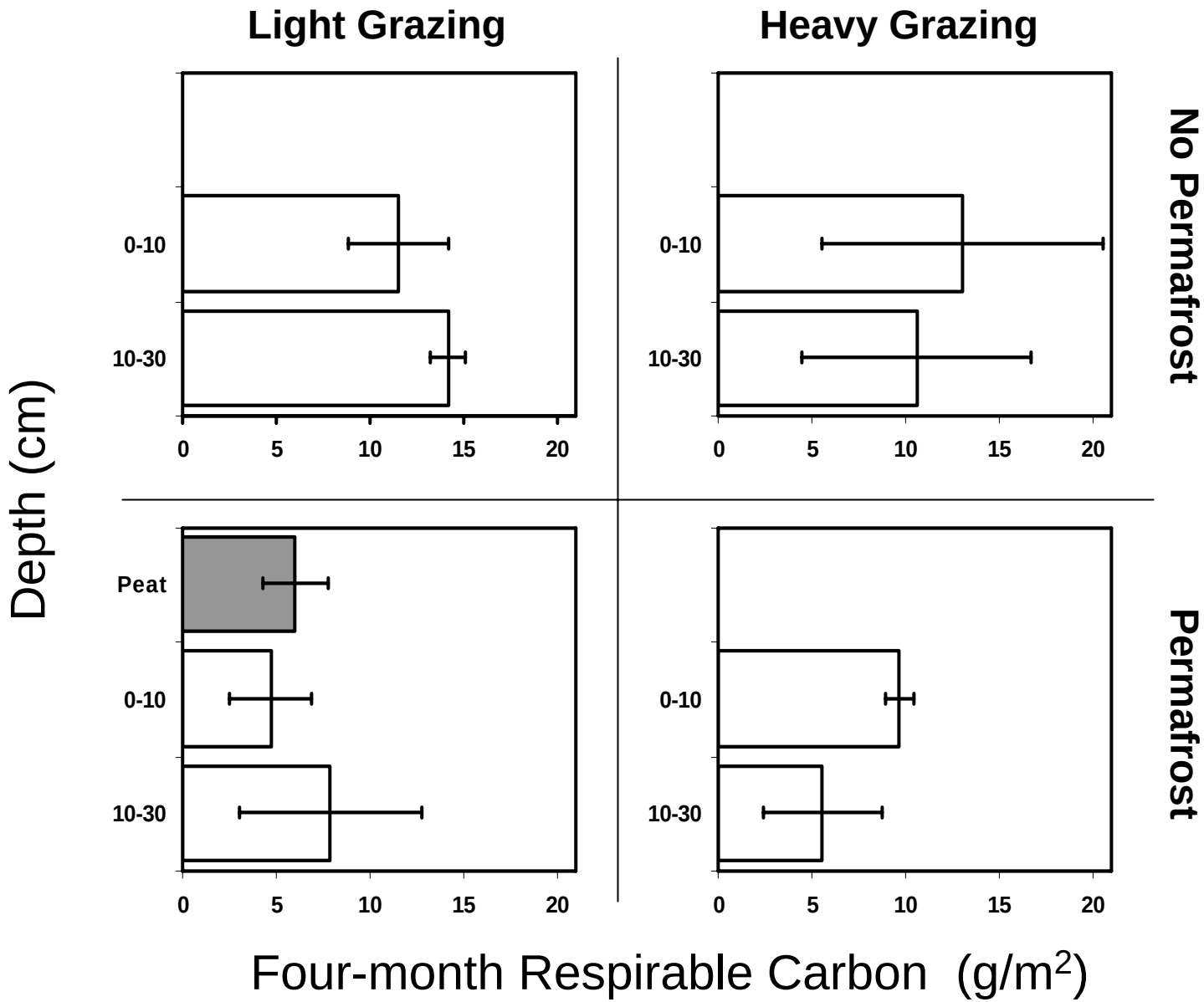
If patterns of soil organic matter distribution are due to differing rates of decomposition, greater soil organic matter will be associated with greater lability.

Methods – Soil Lability

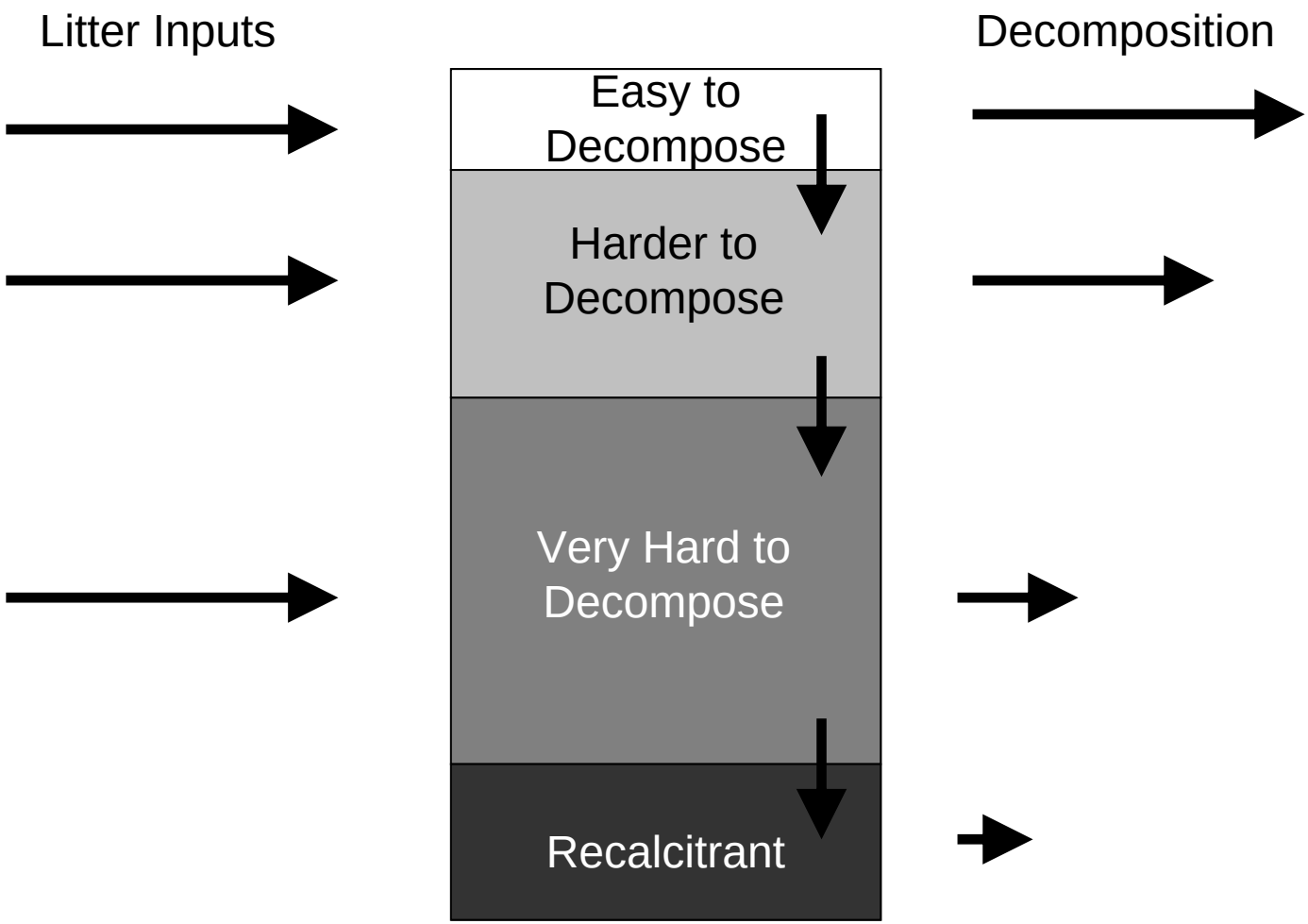
- Soil samples were incubated at 25ºC, 100% humidity with 60% pore water
- Rates of CO_2 respiration were measured monthly.
- Rates were integrated to calculate total carbon respired.


Light Grazing
Heavy Grazing
No Permafrost
Permafrost
Depth (cm)
Peat
0-10
10-30
0
5
10
15
20
Four-month Respirable Carbon (‰)

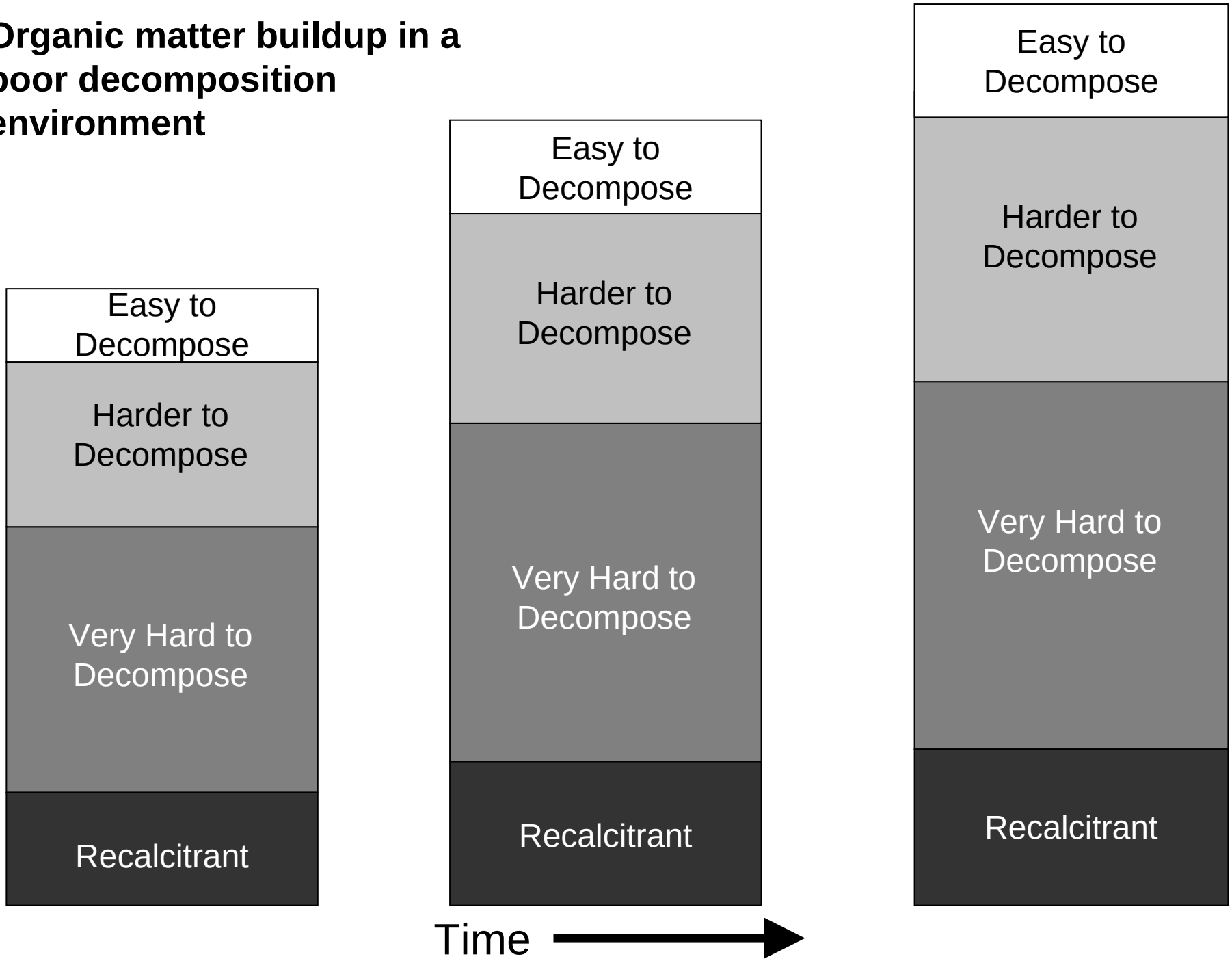

Light Grazing
Heavy Grazing
No Permafrost
Permafrost
Depth (cm)
Four-month Respirable Carbon (‰)


Light Grazing
Heavy Grazing
No Permafrost
Permafrost
Depth (cm)
Peat
0-10
10-30
0
5
10
15
20
Four-month Respirable Carbon (g/m2)

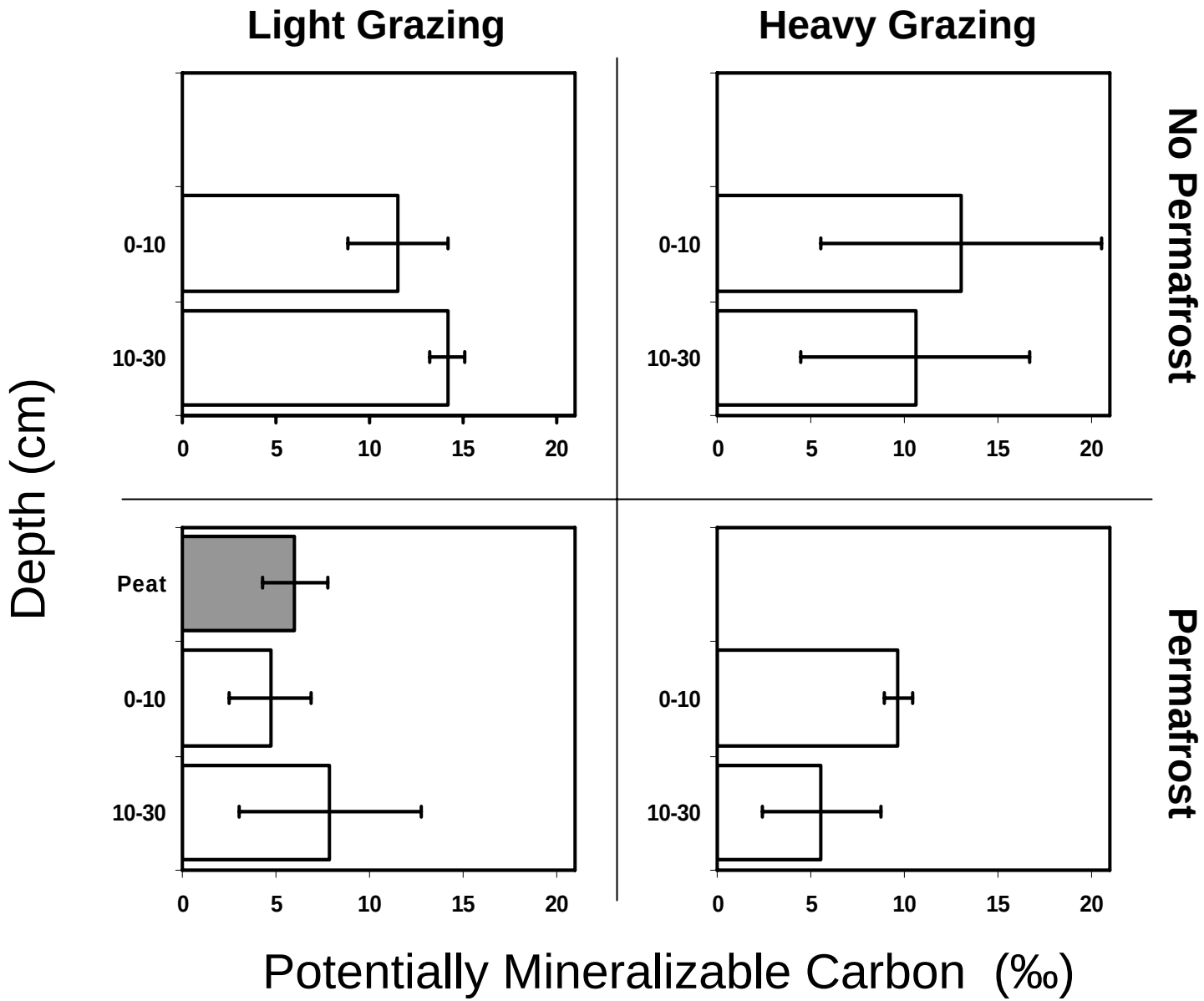
Organic Matter Decomposition: Multiple Pools



Organic matter buildup in a poor decomposition environment



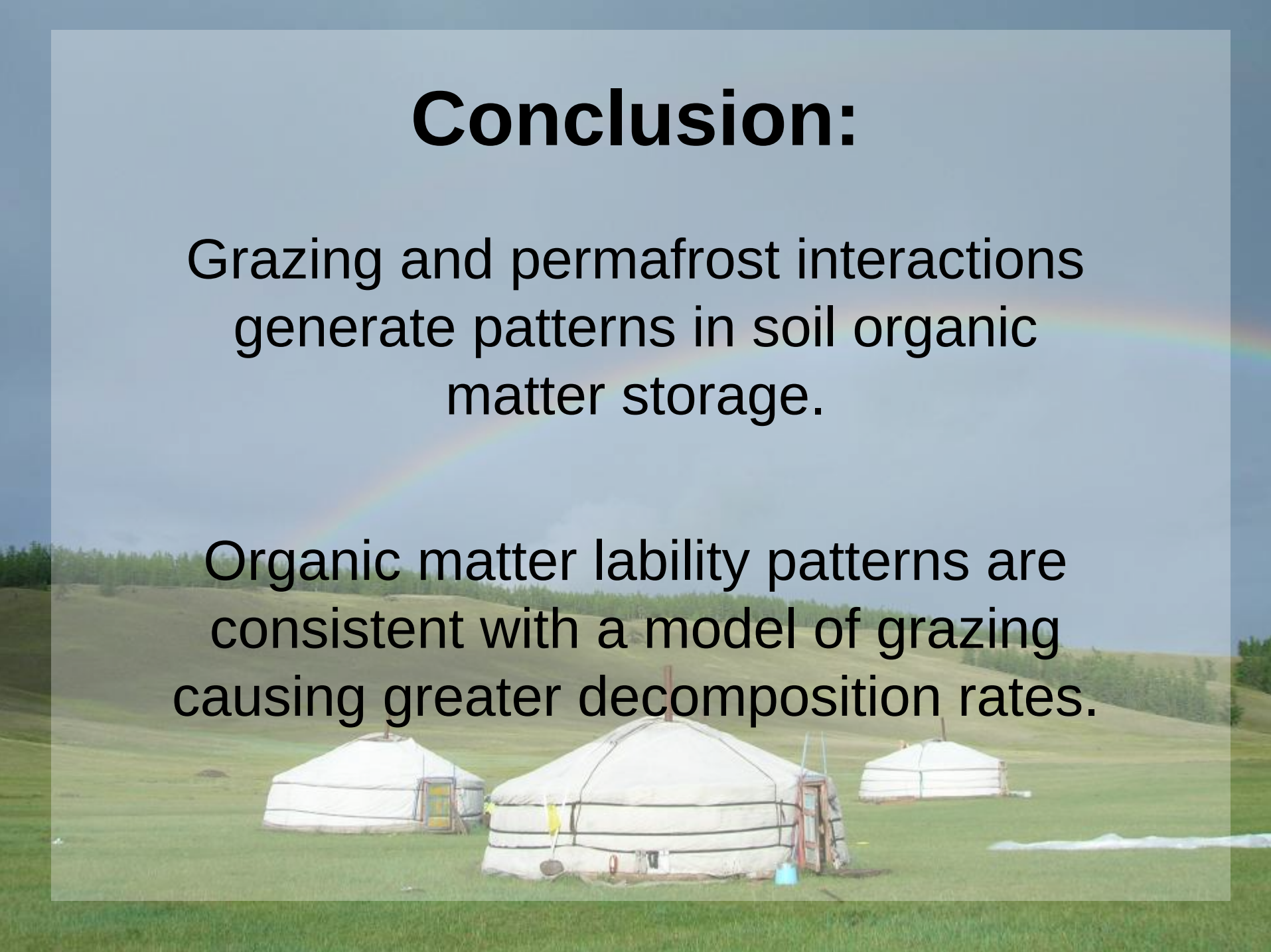
Labile Fraction of Soil Organic Matter



Conclusion:

Grazing and permafrost interactions generate patterns in soil organic matter storage.

Organic matter lability patterns are consistent with a model of grazing causing greater decomposition rates.



Too Many Thanks

- Steven Hamburg – For teaching and guiding me for four years
- Indy Burke, CSU – For tearing up my first thesis proposal
- Gus Shaver, MBL – For advice and humor
- Clyde Goulden, Academy of Natural Sciences - $$$!
- Matt Vadeboncoeur – You're like having an extra brain. And a great friend.
- Dave, Joe, Heather, Indrek – For wrestling the machines with me.
- Hovsgol GEF Field Team:
  - Oggie, Ariuna, and Bathishig – My Mongolian colleagues
  - Idree and Bulgan – For digging, wrestling, and yak-slaughtering
- Mother Earth – Duh
- My UEL companions – Patti, Betsy, Lou, Kurt, everyone upstairs, downstairs, night and day. It ain't about soup, it's about community. And Emily, Allie, and everyone in the Big MacMillan.
- P-house and the rest of the motley crew.
- The Clan
  - Dr. Ross and Dr. Ross – My greatest teachers, scientific and otherwise
  - Karen and Jon – Who rocks more?


Questions?