Semi-Automated mapping of permafrost in the Yukon Flats - Alaska

Mats Lundh Gulbrandsen\textsuperscript{1} • Burke J. Minsley\textsuperscript{2} • Lyndsay Ball\textsuperscript{2} • Thomas Mejer Hansen\textsuperscript{1}

\textsuperscript{1} Niels Bohr Institute, University of Copenhagen  
\textsuperscript{2} Crustal Geophysics and Geochemistry Science Center  
USGS, Denver, CO
Outline

• Motivation
• Study area
• Method
• Results / Verification
• Conclusion
Motivation

The importance of mapping permafrost:

- **Hydro-geologic processes**
  - Enhance surface – groundwater interactions through taliks
  - Alter the contribution of groundwater to stream-flow.

- **Climate Feedback**
  - Permafrost soil may constitute a substantial carbon pool.

- **Arctic ecology**
  - Changes in the wetlands
  - Enhanced fire frequency and intensity.
Study area

Minsley, B. J., et al. (2012)
Study area

Minsley, B. J., et al. (2012)
Smart Interpretation
Smart Interpretation

Geophysical Data (M)
Smart Interpretation

Geological Knowledge (d)

Geophysical Data (M)

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Smart Interpretation

Geological Knowledge (d)

Geophysical Data (M)

Statistical Model \( h(d,M) \)

\[ h(d,M) \]

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Smart Interpretation

- Geological Knowledge (d)
- Geophysical Data Elsewhere \( M_{pred} \)
- Geophysical Data (M)
- Statistical Model \( h(d,M) \)

\[
M_{pred} = h(d,M) + \text{Geological Knowledge (d)} + \text{Geophysical Data Elsewhere}
\]

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Smart Interpretation

Geological Knowledge (d)

Geophysical Data Elsewhere $M_{\text{pred}}$

Predicted Geology with uncertainty $h(d_{\text{pred}}|M_{\text{pred}})$

Statistical Model $h(d,M)$

Geophysical Data (M)

$h(d,M)$

Köle (m)

Distance (m)

Log(0) (resistivity)
Where we are

Minsley, B. J., et al. (2012)
Where we are
K-means

- Define a number of cluster-centers
- Assign all points to the center they are closest to.
- Redefine the cluster-center by meaning over all within-cluster-points
- Repeat process for a number of iterations.
Using smart Interpretation

Yukon Flats line 10142

Elevation (m)

Easting (Km)

5.6  5.65  5.7  5.75  5.8  5.85

×10^5

Yukon Flats line 10142

Elevation (m)

Easting (Km)

5.6  5.65  5.7  5.75  5.8  5.85

×10^5

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(b) Twelvemile Lake

~900 - 1,800 y.a.? 

Direction of Yukon River migration

Yukon Flats line 10142

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Yukon Flats line 10020

(a) Fort Yukon
 depth = 0 m
Fort Yukon borehole
Twelvemile Lake

Minsley, B. J., et al. (2012)
Permafrost Thickness

Northing (Km)

Easting (Km)

Thicknes (m)
Conclusion

By combining a clustering algorithm with a semi-automatic attribute guided regression technique, it is possible, to fast, and reliably map the thickness of permafrost in the Yukon-flats region of Alaska.

This methodology can handle huge amounts of data. Thereat all data the same, and at the same time is consistent with the expert knowledge.
Thanks for Listening