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SOIL ORGANIC CARBON STOCK IN THE GLACIER FORELAND OF MIDTRE LOVÉNBREEN, IN THE HIGH ARCTIC

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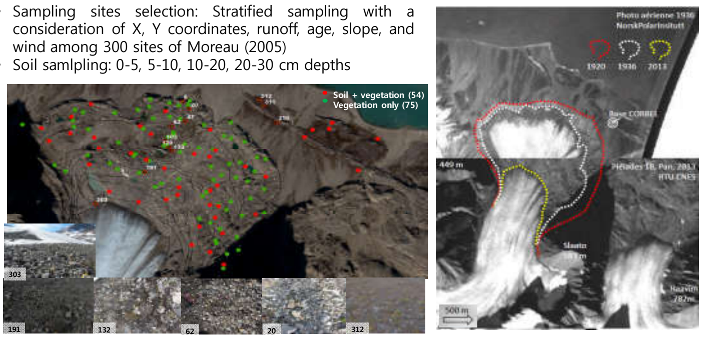
Introduction

Global warming leads to rapid retreat of glaciers in the high Arctic, exposing new land. Soil organic carbon (SOC) accumulation in the proglacial environment has initiated after microorganisms and plants have settled down. Studies in glacier forelands mostly focused on consequent changes in soil, plants, and microorganisms after glacier recession. However, the quantity and rate of SOC accumulation over the glacier foreland are affected not only by time but also by several environmental factors. Furthermore, proglacial land is dynamically reworked by runoff activity of glacier streams. Therefore, we were aiming to understand the distribution pattern of SOC and to produce a map of SOC stock in the foreland of the Midtre Lovénbreen, Spitsbergen, Norway (79°N, 12°W) with a consideration of the deglaciated years and several environmental factors such as microtopography, runoff activity, etc.

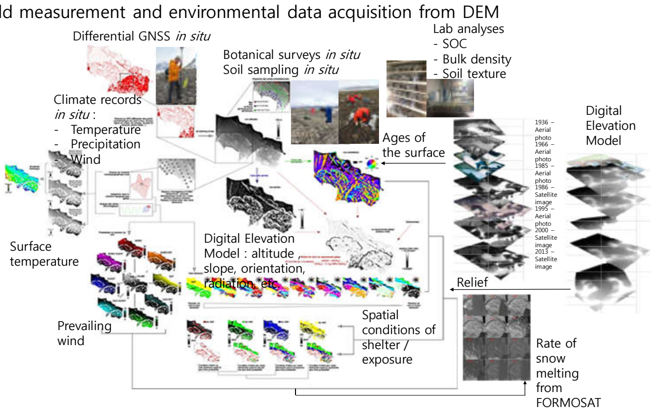
Materials and Methods

- Sampling sites selection: Stratified sampling with a consideration of X, Y coordinates, runoff, age, slope, and wind among 300 sites of Moreau (2005)
- Soil samlpling: 0-5, 5-10, 10-20, 20-30 cm depths

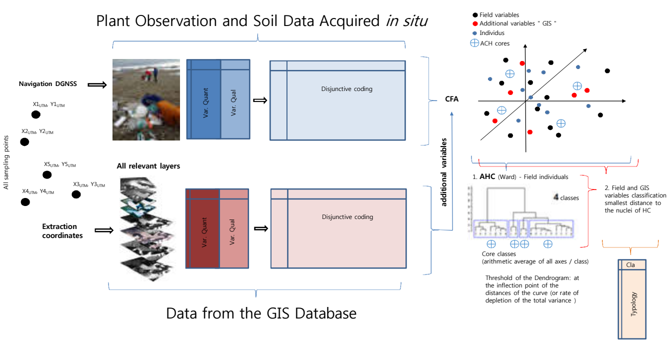


Glacier foreland of Midtre Lovénbreen, Brøgger Peninsula, Svalbard (79°N, 12°W)

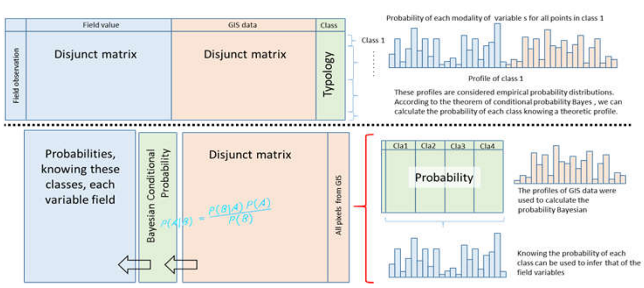
- Field measurement and environmental data acquisition from DEM



- Correspondence Factor Analysis (CFA) & Ascending Hierarchical Classification (AHC)

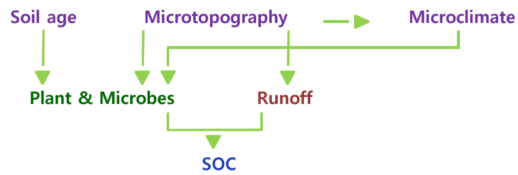


- Inferring class of each pixel from environmental variables



Research Approaches

- Factors affecting SOC distribution in the glacier foreland



Results

- SOC stock for 30 cm depth ranged from 1.5 to 15.4 Mg/ha in the foreland of Midtre Lovénbreen.
- The amount of SOC stock was greatly affected by the proportion of gravel to soil (Table 1).
- SOC content among 5-10, 10-20, and 20-30 cm did not differ, and bulk density through all depths did not vary either. Thus, SOC stock was closely related to the SOC content of the top soil (0-5 cm) (Table 1).
- Among several vegetation related parameters, the sum of vascular plants' frequency showed the highest correlation with the SOC content of top soil and SOC stock (Fig. 1).
- The active and intermittent runoff sites showed significantly lower SOC content compared to no runoff sites (Fig. 2). Glacier/snow meltwater would have washed out previously established vegetation and accumulated SOC.

Table 1. Pearson correlation between measured variables

	Gravel	Sand	Clay	SOC_{FE}	SOC_{hy}	SOC_{con}	BC	Li	Bryo	VP	TotCov	Freq	Age
Gravel	1.00												
Sand	0.50	1.00											
Clay	-0.52	-0.82	1.00										
SOC_{FE}	-0.52	-0.61	0.78	1.00									
SOC_{hy}	-0.58	-0.63	0.81	0.99	1.00								
SOC_{con}	-0.50	-0.47	0.53	0.81	0.79	1.00							
BC	-0.19	-0.22	0.20	0.31	0.26	0.53	1.00						
Li	-0.47	-0.20	0.29	0.48	0.49	0.42	0.21	1.00					
Bryo	-0.26	-0.25	0.31	0.43	0.39	0.50	0.73	0.50	1.00				
VP	-0.25	-0.23	0.28	0.36	0.32	0.48	0.87	0.33	0.86	1.00			
TotCov	-0.26	-0.25	0.27	0.39	0.35	0.57	0.97	0.37	0.84	0.95	1.00		
Freq	-0.57	-0.43	0.54	0.59	0.59	0.62	0.52	0.42	0.52	0.58	0.59	1.00	
Age	0.04	-0.26	0.08	-0.19	-0.15	-0.38	-0.04	-0.18	-0.10	-0.01	-0.05	-0.27	1.00

Gravel: gravel to soil ratio; SOC_{con}: SOC content for 0-5 cm depth; Sand: proportion of sand; Clay: proportion of clay; SOC_{FE}: SOC stock of fine earth (< 2 mm); SOC_{hy}: SOC stock calculated by a hybrid method; BC: coverage of black crust; Li: coverage of lichen; Bryo: coverage of bryophyte; VP: coverage of vascular plant; TotCov: the sum of coverage of black crust, lichen, bryophyte, and vascular plant; Freq: sum of each plant frequency; Age: years since deglaciation

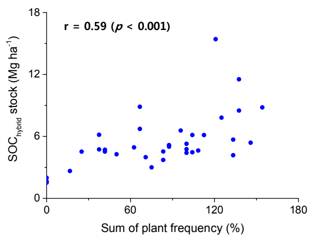


Fig. 1. A scatter plot with the sum of plant frequency and SOC_{hybrid} stock

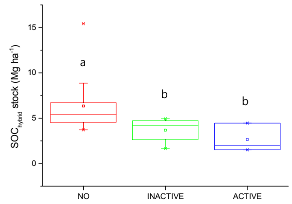


Fig. 2. The effects of runoff activity on the SOC_{hybrid} stock

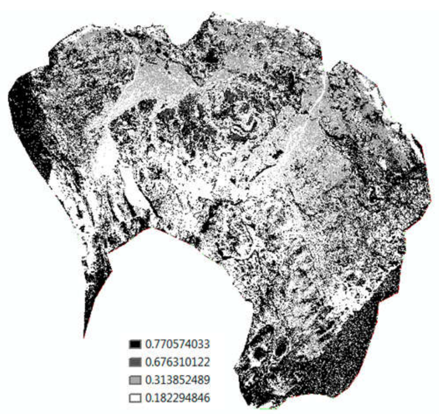


Fig. 3. A map of SOC concentration for the 0-5 cm depth in the glacier foreland of Midtre Lovénbreen

- We are going to test several methods of classification and statistical models such as Bayesian model, maximum-likelihood method, support vector machine, etc. to predict the SOC stock in pixels with no *in-situ* measurement through cloud computing in near future.
- We will also try to confirm our model in other glacier forelands in Spitsbergen.
- Understanding the relationship between SOC quantity and environmental parameters could allow us to view ecosystem development in the overall perspective.

Acknowledgements

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