

# Soil and permafrost carbon and nitrogen content map of the Herschel Island based on ecological units

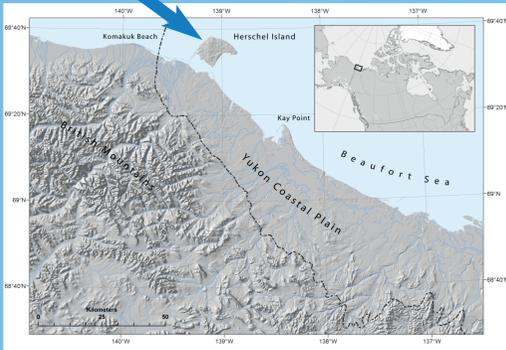
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## Study Area and Background



How much soil carbon and nitrogen is available for transport?

Current estimations of soil organic carbon (SOC) and total nitrogen (TN) are scarce and are based on rough extrapolations of soil pits. However, comprehensive estimations of organic matter over large areas in the subsurface are required to quantify fluxes of organic matter released by increasing rates of coastal erosion. The goal of this study is to combine field surveys with high resolution remote sensing imagery to compute an accurate estimate of the amount of organic matter available for erosion.

## RapidEye Imagery

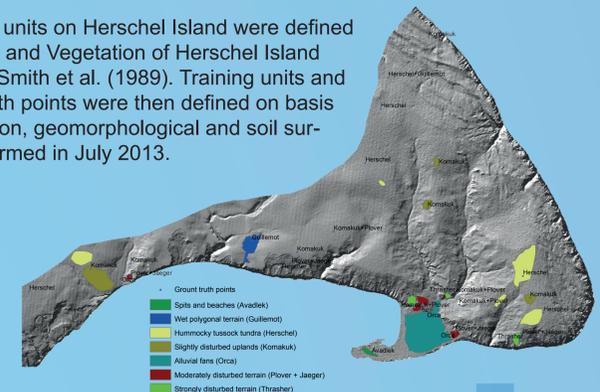
RapidEye multispectral imagery has 5 spectral bands. Beside Blue, Green, Red and Near IR, it covers the Red edge band (690 – 730 nm wavelength) which offers additional information about vegetation. The image was captured on the 15<sup>th</sup> of August 2011. A slope layer was added as a 6<sup>th</sup> layer to provide additional information on terrain characteristics.



## Ecological Units



Ecological units on Herschel Island were defined by the Soil and Vegetation of Herschel Island map from Smith et al. (1989). Training units and ground truth points were then defined on basis of vegetation, geomorphological and soil surveys performed in July 2013.



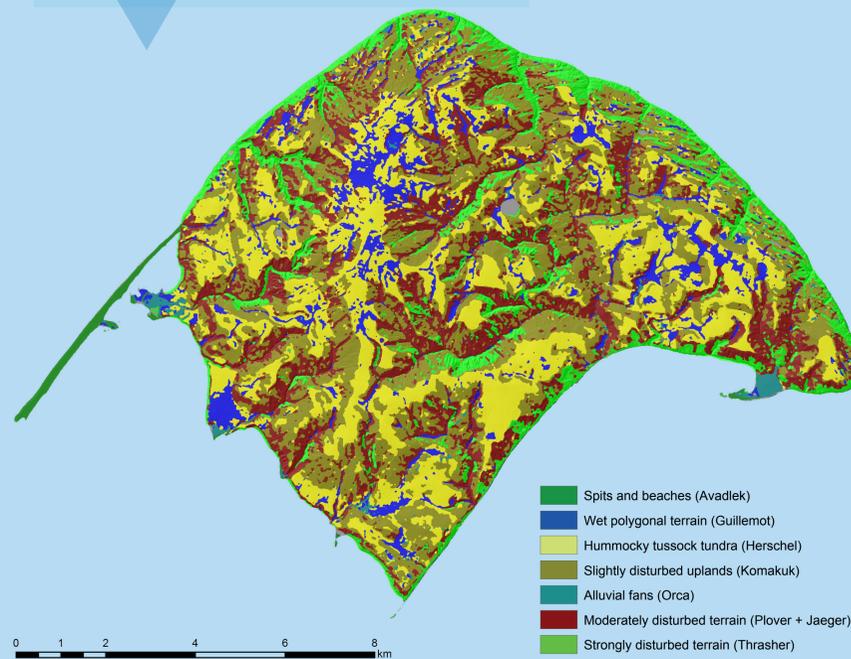
## Permafrost Coring



What are organic matter contents beyond the upper first metre of soil?

Pits were dug in the active layer and permafrost cores up to 2 metres in length were retrieved with a SIPRE corer. In total, 12 cores were drilled, at least one in each ecological unit. The cores were then sampled at each 10 cm for further analyses.

## Ecological Classification



Are there homogenous areas with similar terrain, soil and vegetation properties?

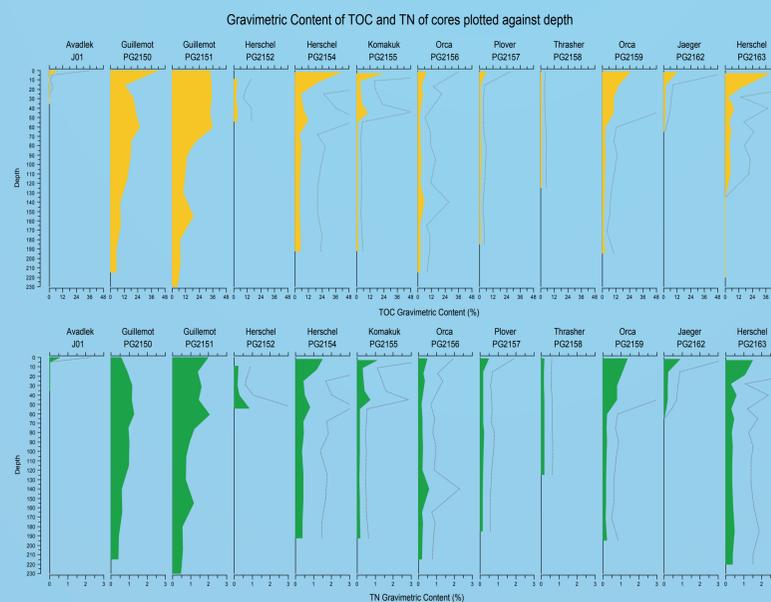
Most of the training units were collected during an expedition to Herschel Island in 2013. Training units for the Avadlek terrain unit were set on basis of satellite imagery. **21 training units** were defined in total. Ground truth points were set from core locations and observations from previous expeditions and amount to 40 in total. A maximum likelihood classification based on the training units, the RapidEye imagery and the slope layer was then used to map the ecological units over the entire island. The ground truth points agree at **75 %** with the classification.

## Total Organic Carbon and Nitrogen Analysis Results

How to upscale sample parameters to the whole core and from cores to the whole island?

Samples were analysed for total organic carbon (TOC) and total nitrogen (TN) contents with combustion method with Elementar Vario EL III. The results were upscaled to the whole core on basis of bulk densities of the samples. The contents are relatively homogenous within the same ecological units except for the Orca unit.

Core number	Ecological unit	SOC storage 30 cm (kg/m <sup>2</sup> )	SOC storage 1 m (kg/m <sup>2</sup> )	TN storage 30 cm (kg/m <sup>2</sup> )	TN storage 1 m (kg/m <sup>2</sup> )
J01	Avadlek	6.09	6.09	0.27	0.27
PG2150	Guillemot	23.54	90.56	1.46	5.04
PG2151	Guillemot	20.17	79.04	0.94	4.06
PG2163	Herschel	13.99	45.22	0.88	3.55
PG2152	Herschel	6.69	33.65	0.53	5.80
PG2154	Herschel	14.65	36.81	1.01	2.60
PG2155	Komakuk	11.51	39.40	0.86	3.43
PG2156	Orca	8.38	28.45	0.63	2.63
PG2159	Orca	22.44	57.47	1.52	4.31
PG2162	Jaeger	10.74	16.91	0.99	1.75
PG2157	Plover	1.43	11.91	0.21	2.31
PG2158	Thrasher	3.04	20.75	0.59	3.71



## Results and Outlook

Ecological unit	Area (km <sup>2</sup> )	SOC storage 30 cm (Gg)	SOC storage 1 m (Gg)	TN storage 30 cm (Gg)	TN storage 1 m (Gg)
Avadlek	1.08	6.6	6.6	0.3	0.3
Guillemot	8.64	188.9	732.8	10.4	39.3
Herschel	28.18	331.9	1086.7	22.8	112.2
Komakuk	35.01	403.0	1379.6	30.3	120.2
Orca	1.25	19.3	53.9	1.4	4.4
Plover + Jaeger	24.14	147.0	348.0	14.5	49.0
Thrasher	12.59	38.3	261.3	7.4	46.7
<b>Herschel Island</b>		<b>1,135</b>	<b>3,869</b>	<b>87</b>	<b>372</b>

The average storage values for units SOC and TN were multiplied by unit area to get a total storage for each unit. The highest values were found in the Herschel and Komakuk units, which is linked to their relatively high areas, SOC and TN contents. Despite its small area, the Guillemot unit contributes significant amount because of peat abundance. The Orca and Avadlek units have generally lower contents, which can be linked to their small areas. Disturbed units have lower values, despite extensive areas which hints at possible strong degradation of the SOC during previous disturbance episodes.

There is **3.9 Tg** of SOC and **0.4 Tg** of TN in the first metre of soil of the whole Herschel Island

Photos: M. Fritz, 2013

