Progress in monitoring landcover and human presence in the Arctic based on satellite data

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November 24, 2022

Abstract

Landcover information is of relevance for a range of applications in Arctic environments including up-scaling of in situ measurements, permafrost monitoring and modelling and climate change impact assessment. But not only natural landcover types, also the identification of human impacted areas is required. A wide range of satellite records are available, but often there are coverage and resolution limitations. Due to the spatial heterogeneity typical for the Arctic, an as high as possible spatial resolution is needed. Sentinel-1 as well as Sentinel-2 offer 10m nominal resolution for specific bands and modes and are freely available across the entire Arctic. The multi-spectral information from Sentinel-2 is specifically of value for discrimination of tundra types. The Synthetic Aperture Radar mission Sentinel-1 provides added value through representation of land surface structure features. A combination of both allows significantly improved characterization of landcover over larger areas. Here, we review recent progress in monitoring the land surface close to Arctic coasts (focus region of HORIZON2020 Nunataryuk), specifically the distribution of human impacted areas beyond of what is represented in databases such as OpenStreetMap or global settlement maps. The added value of machine learning techniques will be discussed and results based on Sentinel-1 und Sentinel-2 presented. Further on, permafrost change information provided through the ESA CCI+ Permafrost project is combined with the novel maps. The CCI+ Permafrost datasets cover 1997-2018 for ground temperature, active layer thickness and permafrost fraction with 1 km gridding (partially derived from MODIS LST, https://climate.esa.int/en/projects/permafrost/data/) and therefore allow detailed assessment of areas with human presence over permafrost.

Progress in detection and monitoring of transportation infrastructure in the Arctic based on satellite data

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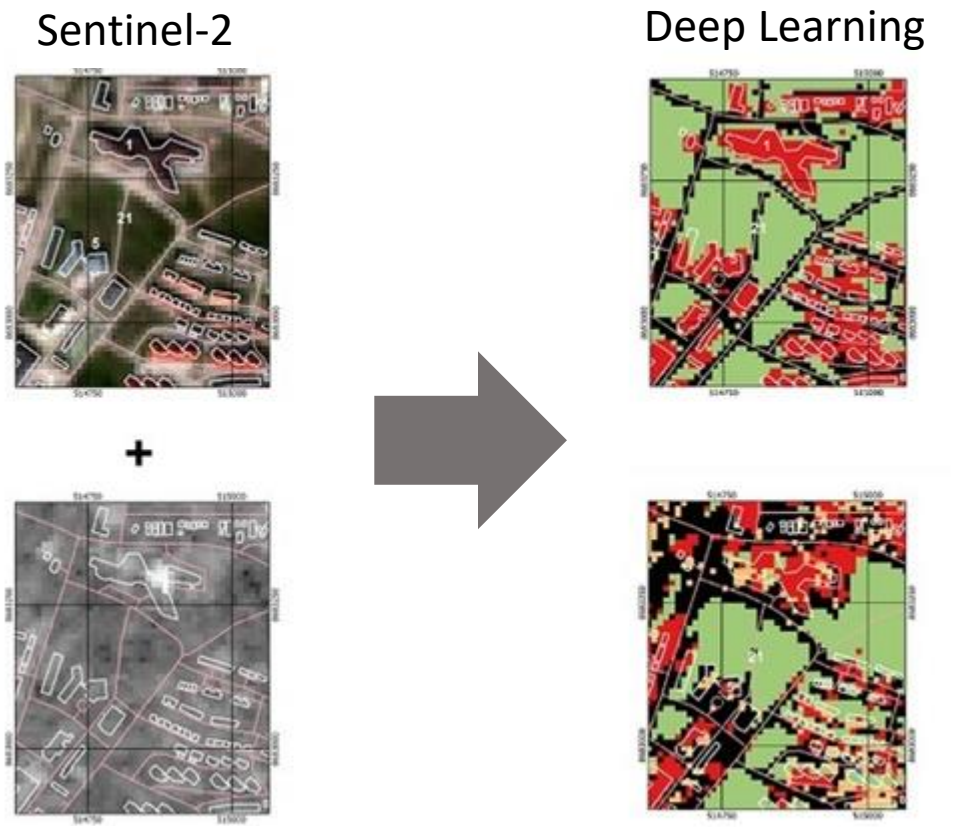
- Records of settlements and infrastructure for the entire Arctic are incomplete & inconsistent
- Satellite data with sufficient resolution needed

➢Sentinel-1/2 with 10 m promising

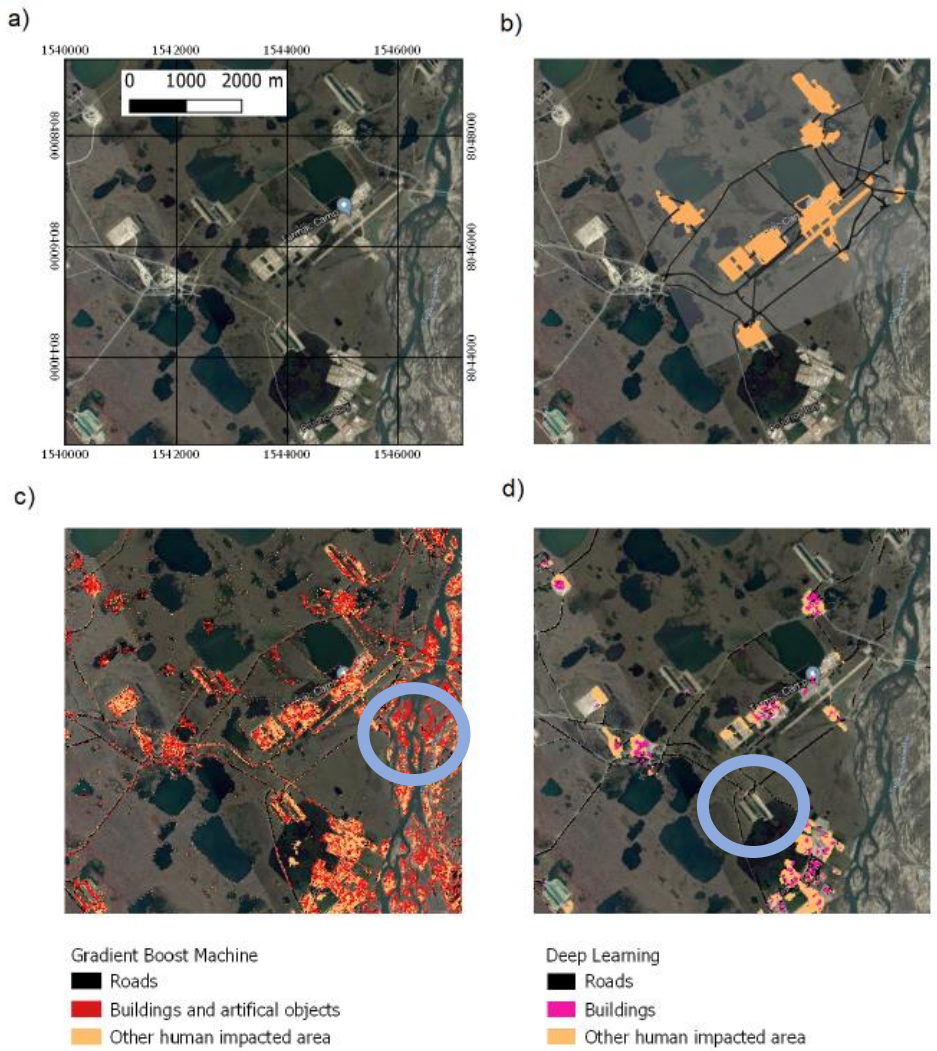
➢Machine learning methods promising



Bartsch, Pointer, Ingeman-Nielsen & Lu (2020), RS

Performance - Example Prudhoe Bay, Alaska

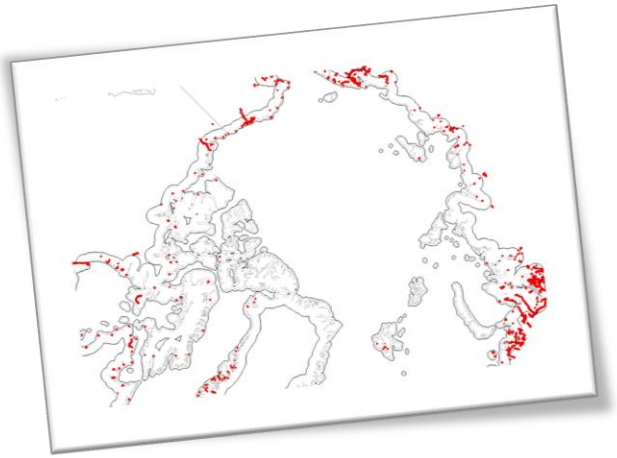
Google Hybrid background map



high-resolution validation dataset
(area C of the work in Raynolds et al. 2014)

Gradient Boost Machine classification result

Deep Learning result



within ~100 km from coast

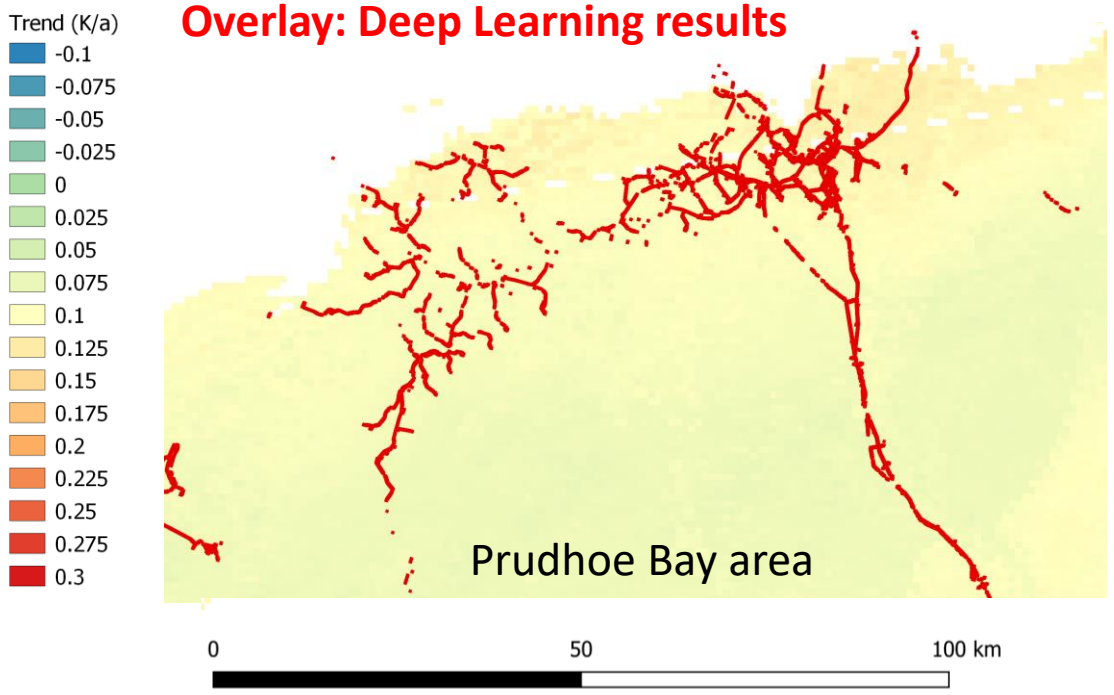
Bartsch, Pointer, Ingeman-Nielsen & Lu (2020), RS

Summary

- Gradient boosting machines and Deep Learning have both advantages and disadvantages
  - ➢ Combined approach needed
- Consistent mapping across the Arctic possible what allows for circumpolar permafrost thaw related assessment

Permafrost_cci CRDPv1 (just released): 1997-2018
(Obu et al. 2020, CEDA archive)

Trend at 2 m depth



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 77342