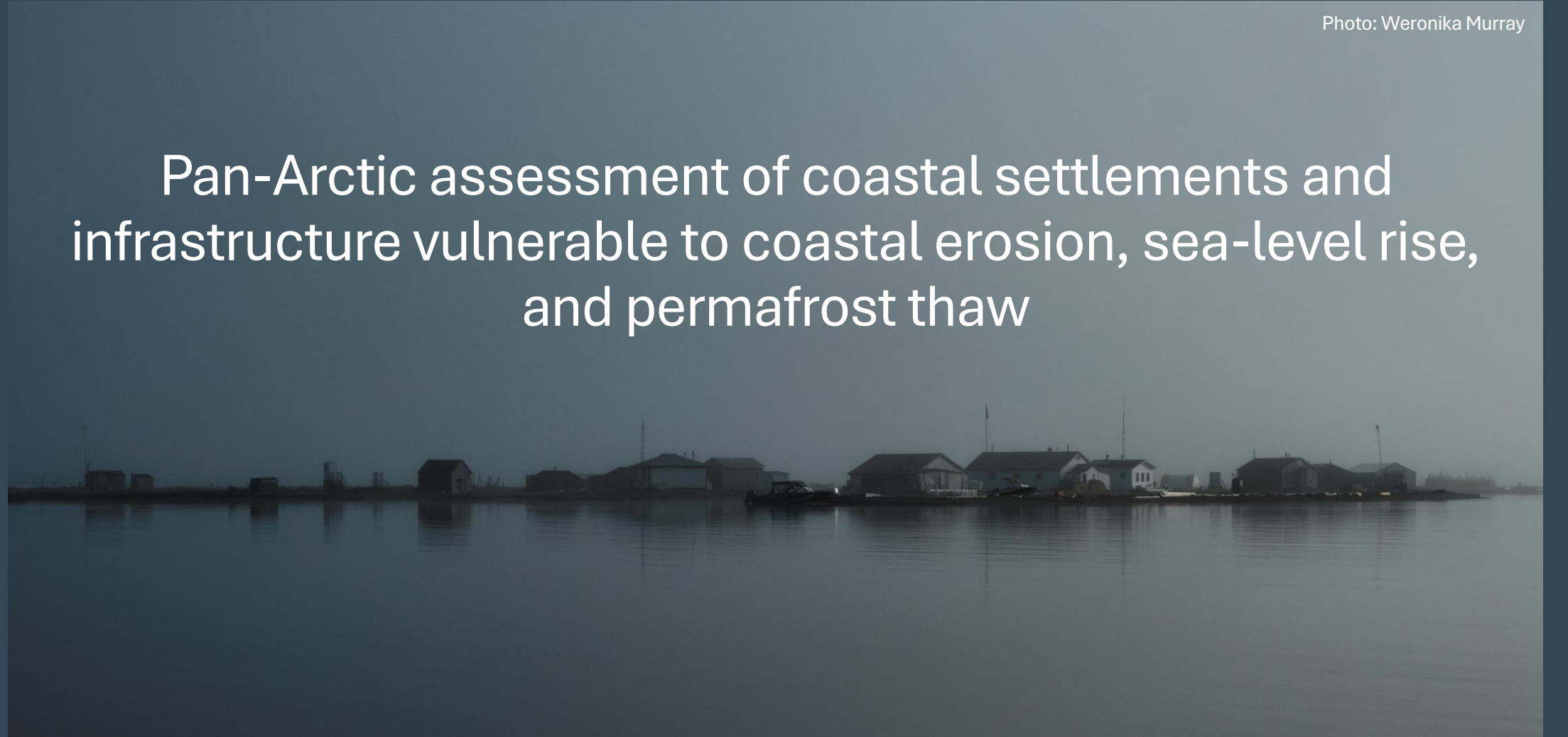

Pan-Arctic assessment of coastal settlements and infrastructure vulnerable to coastal erosion, sea-level rise, and permafrost thaw

b·geos

Rodrigue Tanguy

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Tanguy, R., Bartsch, A., Nitze, I., Irrgang, A., Petzold, P., Widhalm, B., et al. (2024). Pan-Arctic assessment of coastal settlements and infrastructure vulnerable to coastal erosion, sea-level rise, and permafrost thaw. Earth's Future, 12, e2024EF005013. https://doi.org/10.1029/ 2024EF005013

AWI

IGOT Instituto de Geografia e Ordenamento do Território UNIVERSIDADE DE LISBOA

Natural Resources Canada

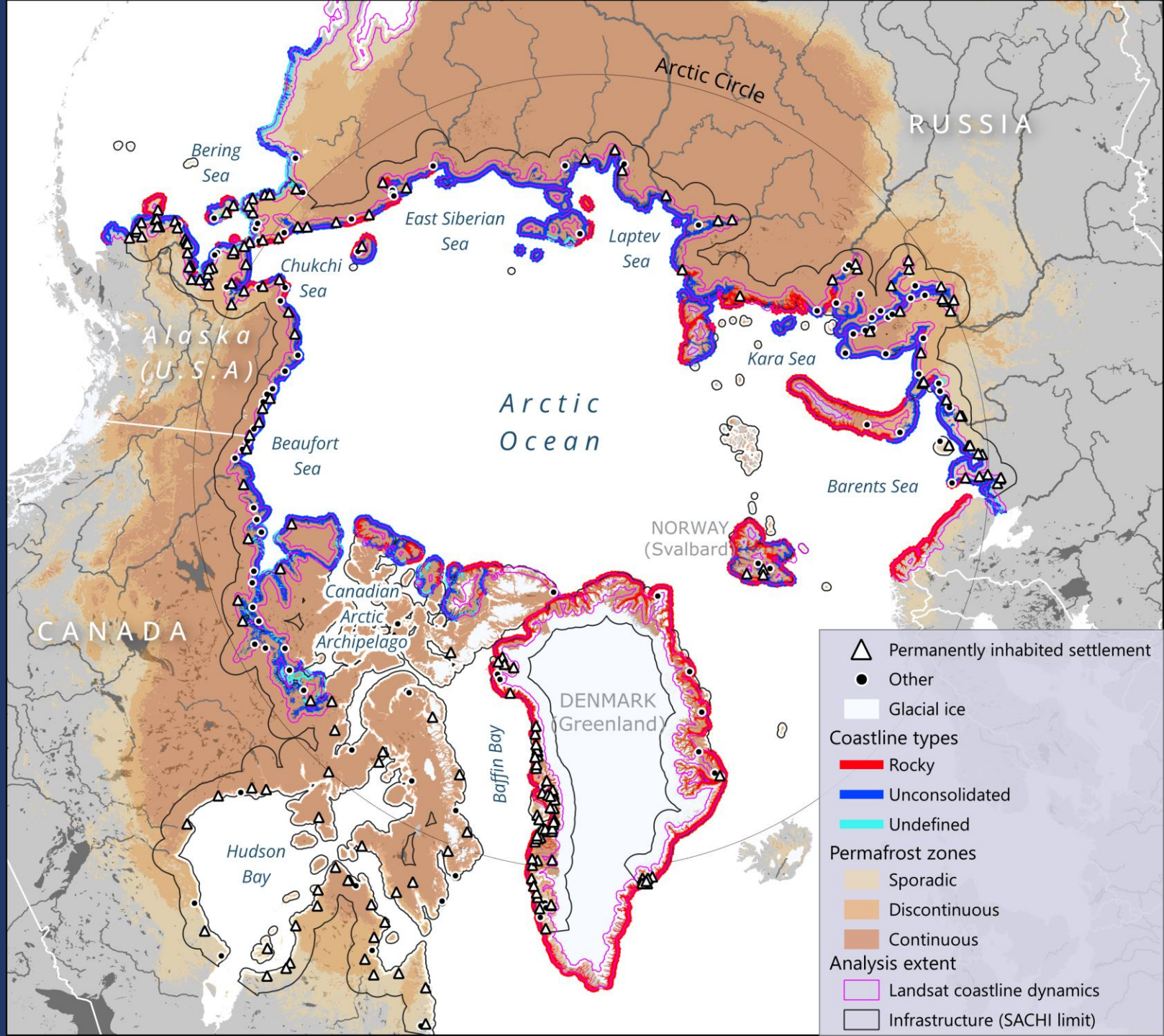
Utqiagvik (Barrow) Alaska, 2023

photo: Ben Jones

Photo: Ben Jones

Study area

Northern permafrost coasts



Validation sites

1

Infrastructure detection SACHI_V2

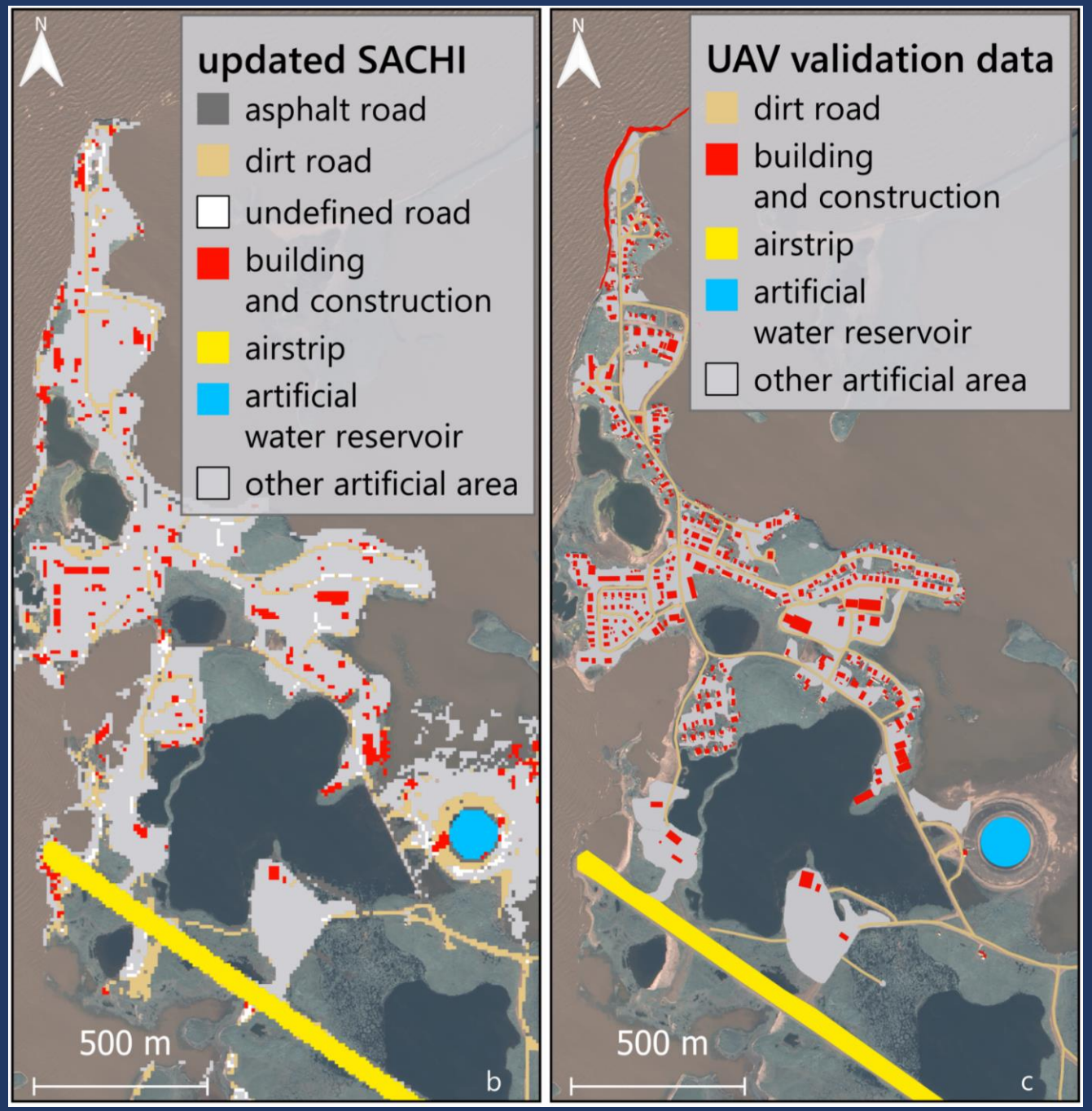
Sentinel 1 (SAR) & Sentinel 2

Machine Learning : XGBOOST & K-means
Deep learning : U-NET CNN in Keras

+ 40 % human presence than in OpenStreet Map

+ 20% more infrastructure area than in SACHI_v1

Bartsch et al., 2023, Zenodo.
https://doi.org/10.5281/zenodo.1016063



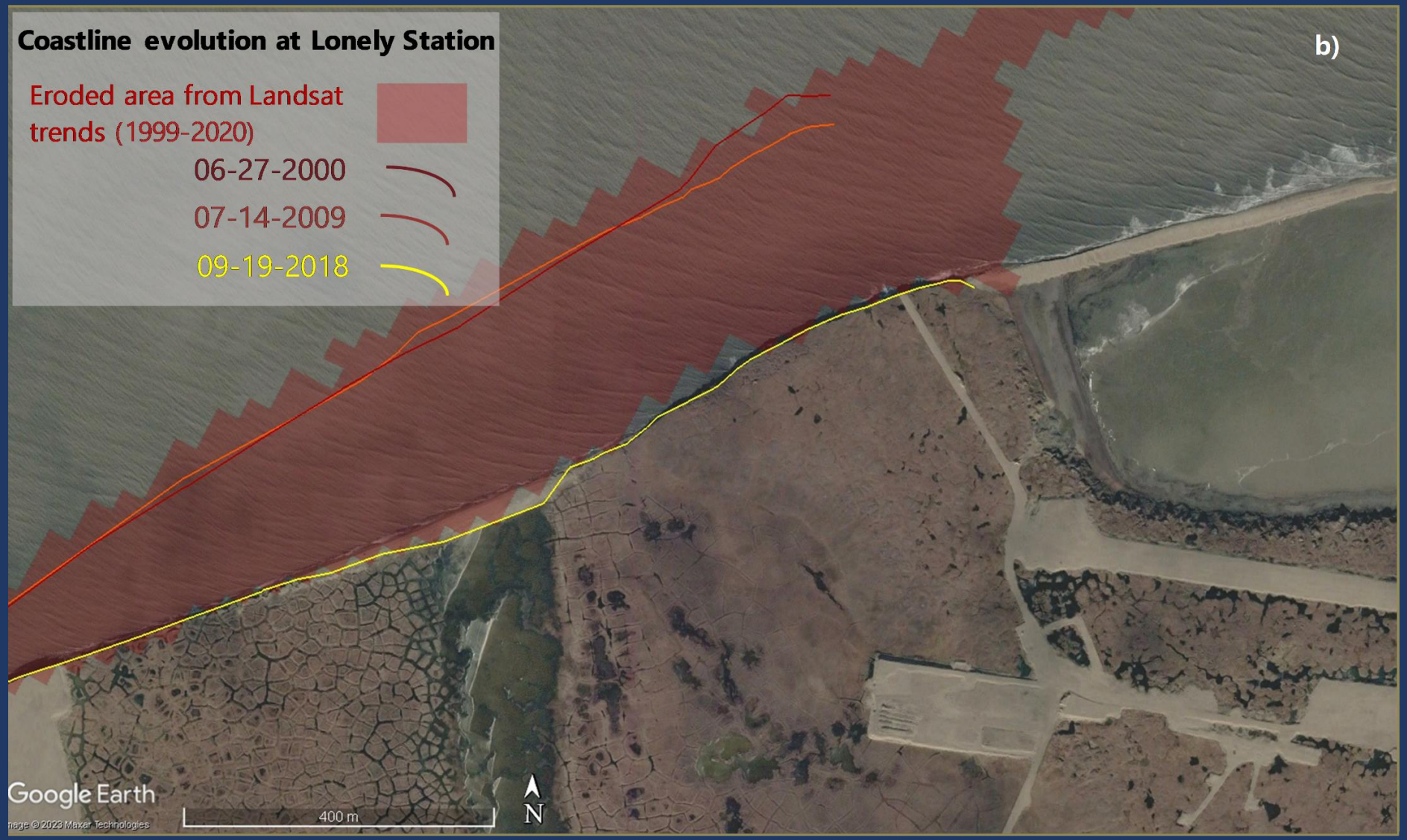
2

Coastline dynamics (2000-2020)

Landsat 7/8
TM, ETM+ and OLI sensors
(spatial resolution of 30 m)

Pixel change :
robust linear trends for multispectral indices.
Land to water = Erosion
Water to Land = Accretion
(Nitze et al. 2017)

Pixel classification :
probability threshold
(Bartsch et al. 2021)



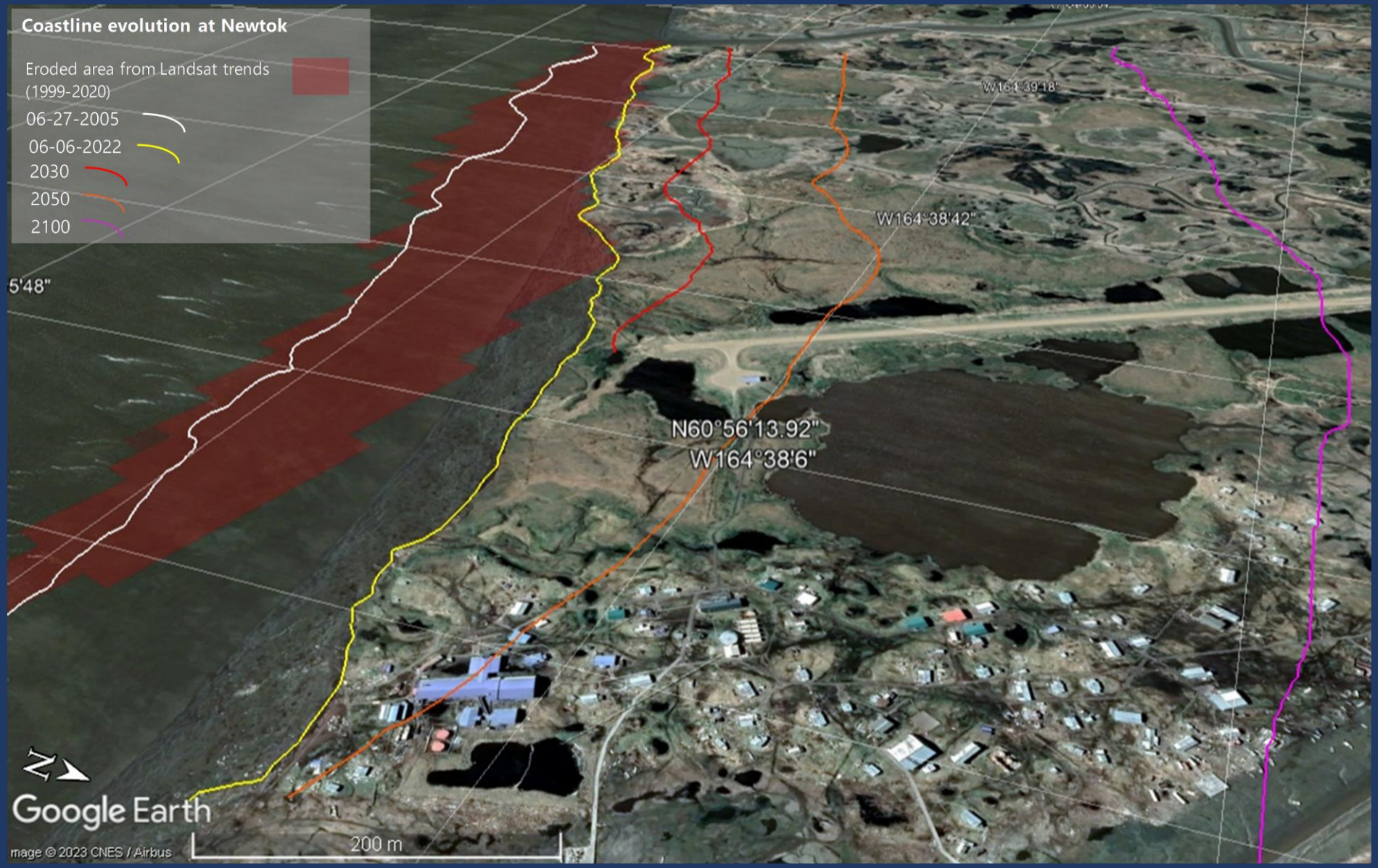
2.1

Coastline position extrapolation

Based on linear rates (2000-2020)

Landsat : -9.2 m/yr
Validation -12.9 m/y

- 2030
- 2050
- 2100



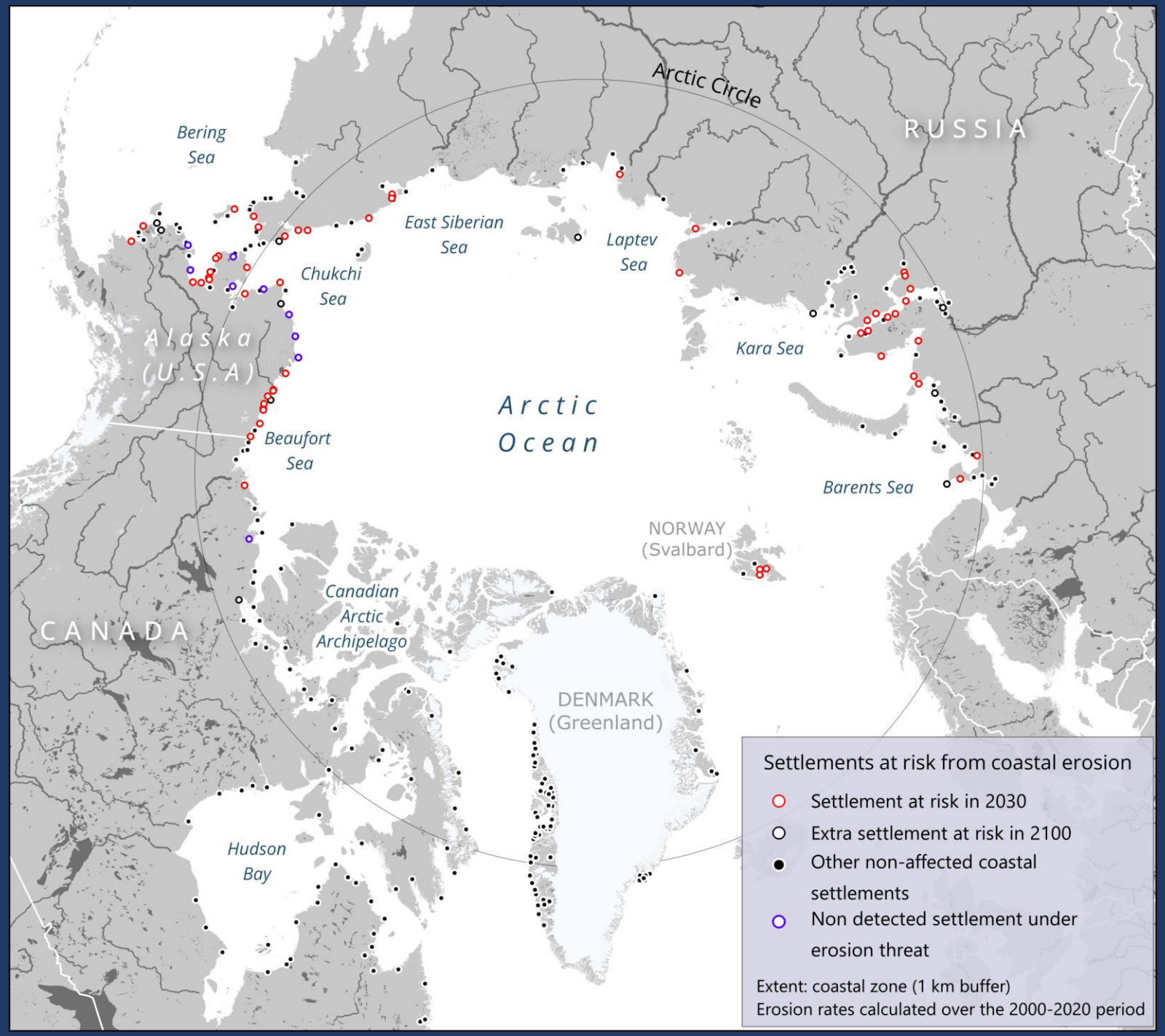
2.2

Circum-arctic identification of settlements at risk

(coastal erosion)

18 % (2030)
21 % (2100)

(of total coastal settlements)



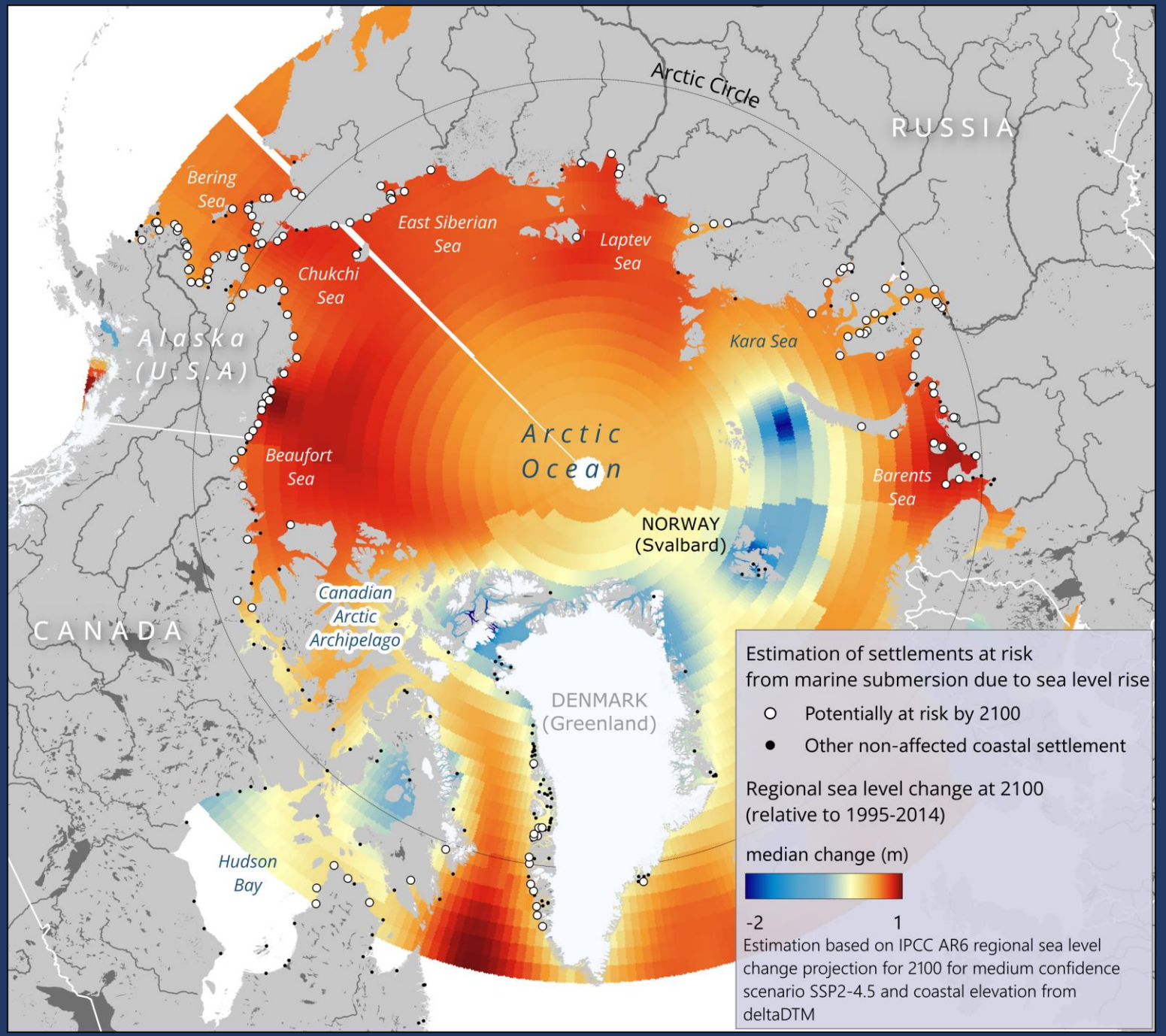
3

Sea Level Change in 2100

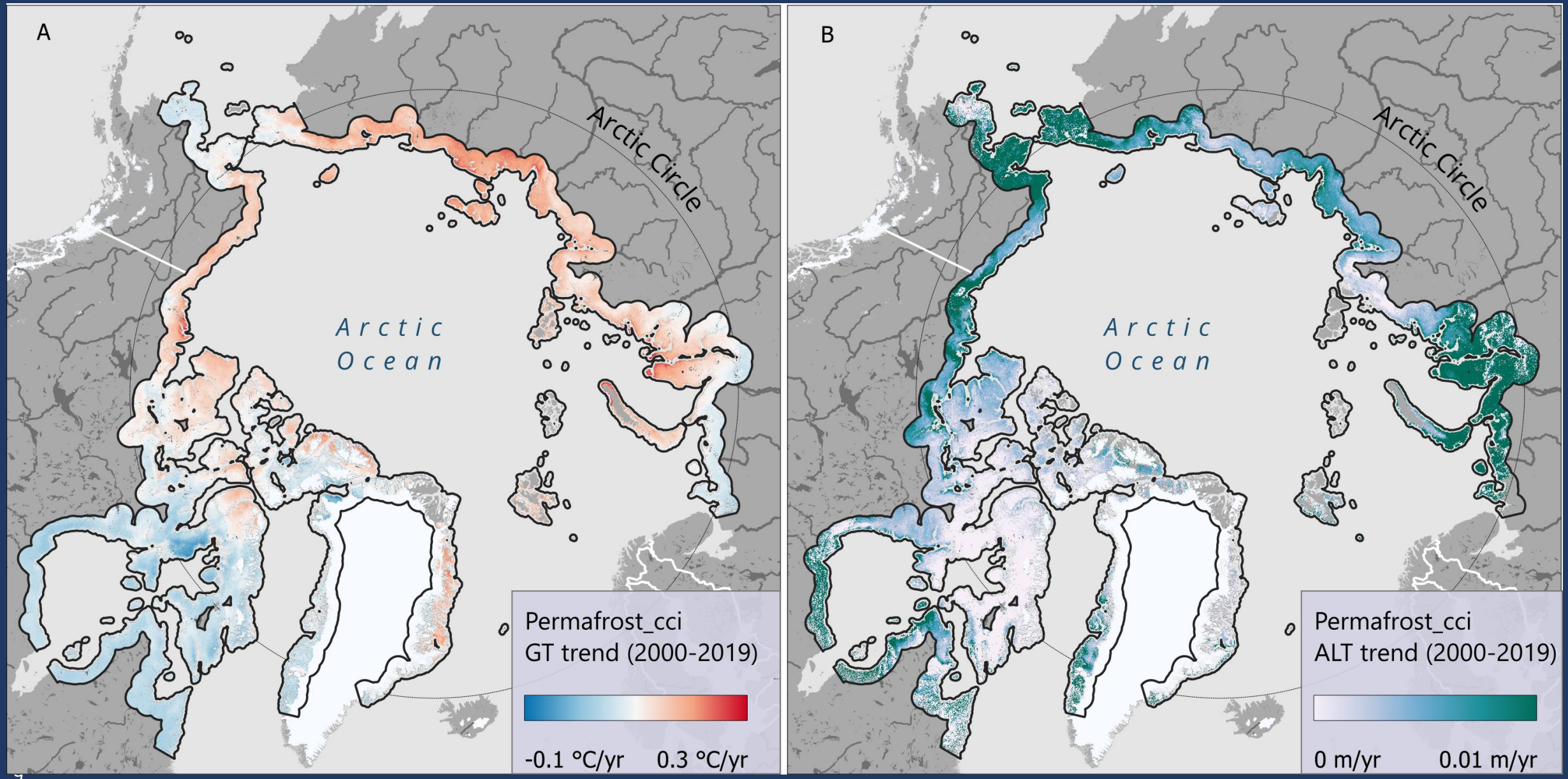
60% of coastal infrastructures < 10 m a.s.l

45 % of settlements potentially affected

Based on IPCC AR6 projections

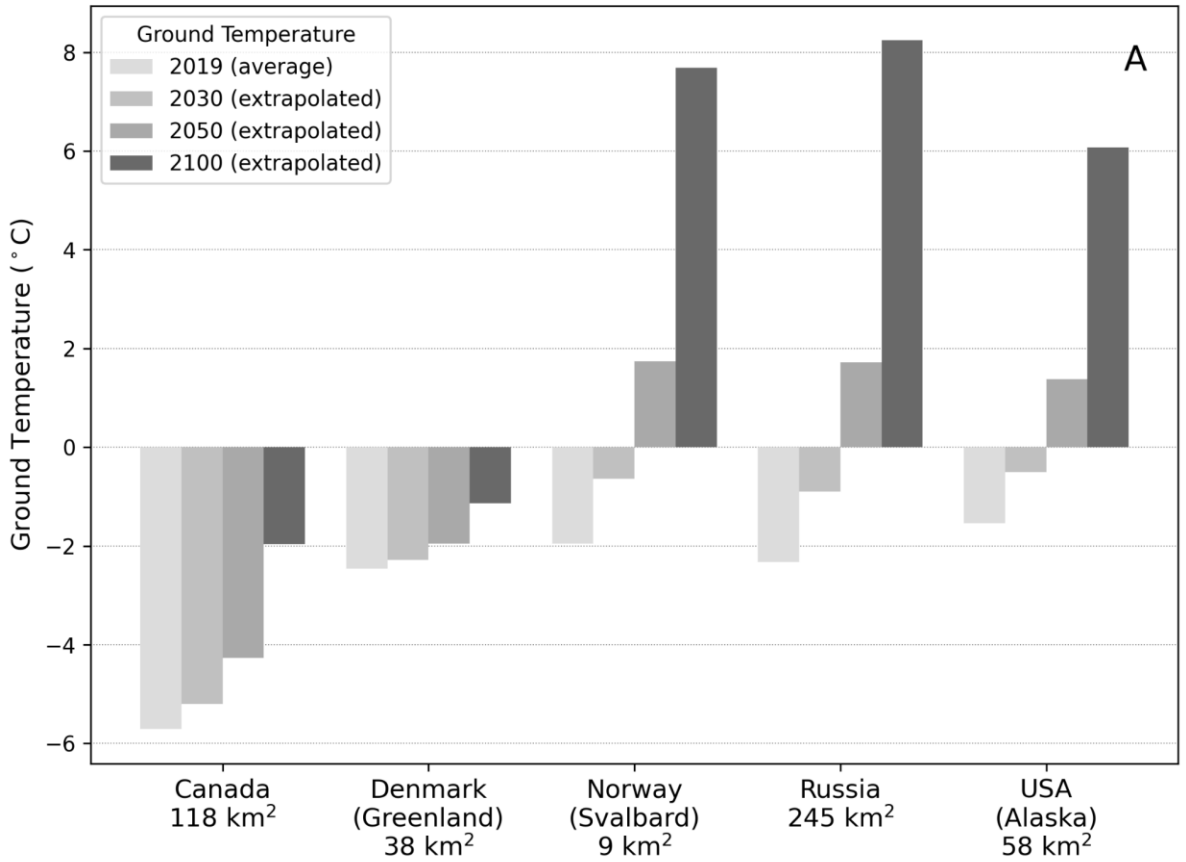


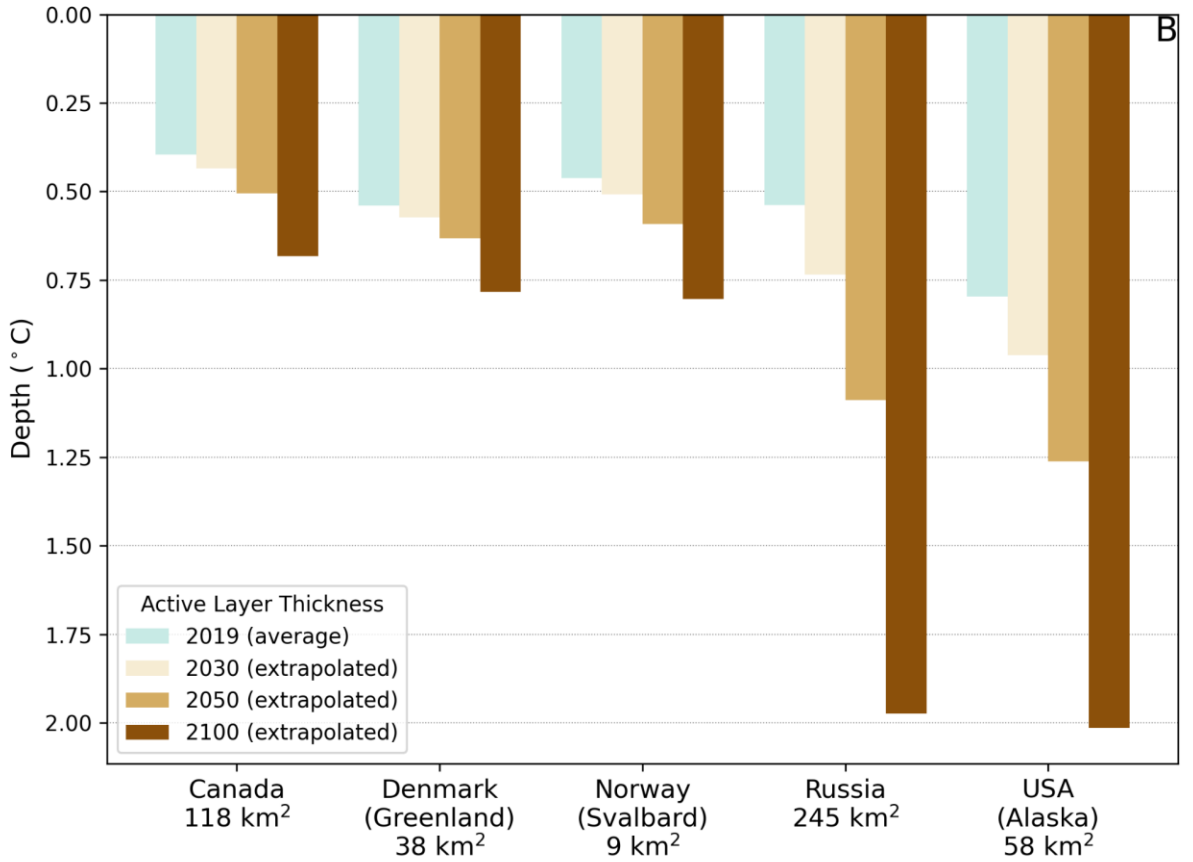
4 Permafrost properties changes 2000-2019



4.1 Extrapolated permafrost properties

- By 2100 77% of infrastructures overlying unfrozen ground



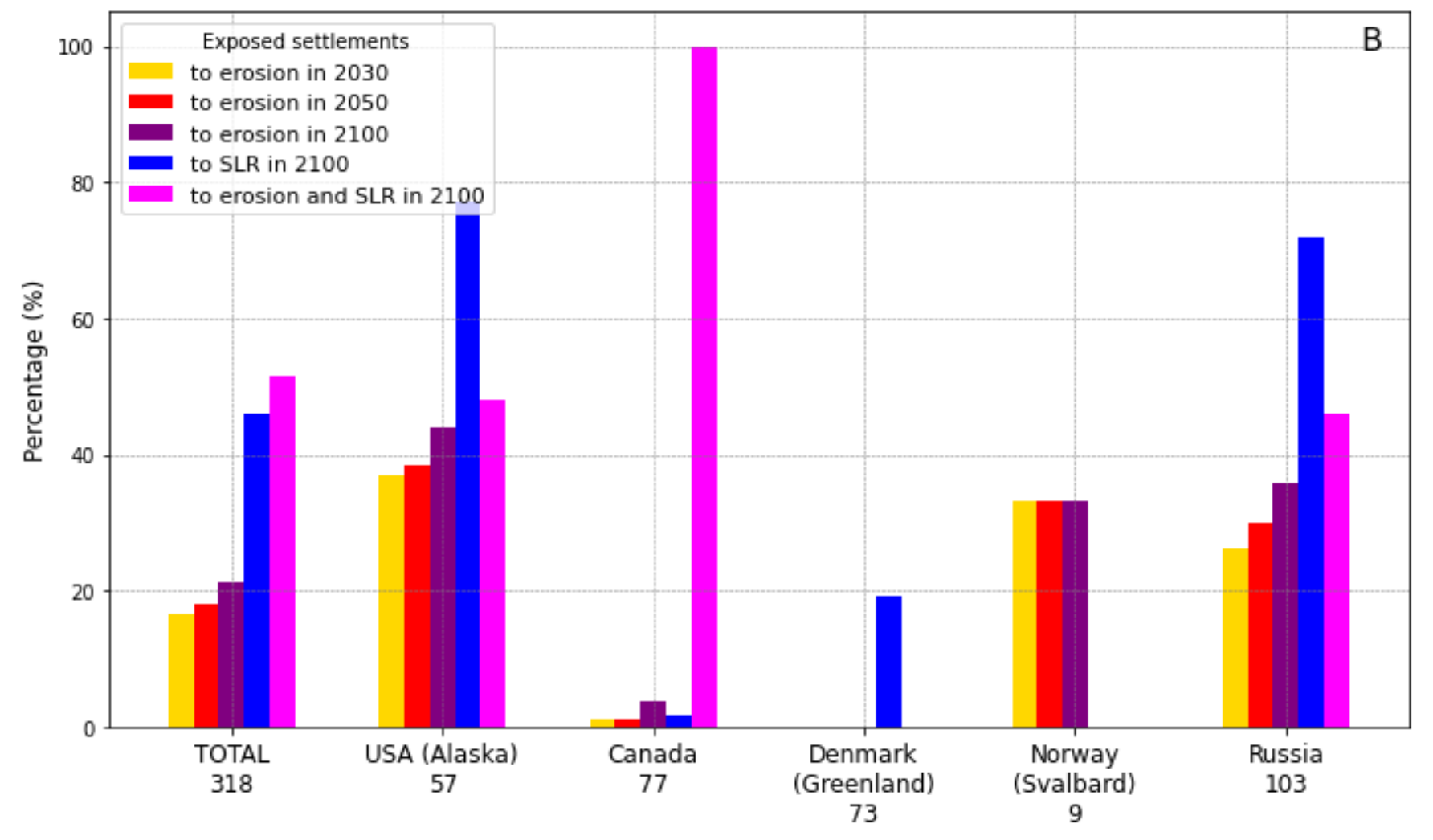


Based on ESA-Permafrost_cci data

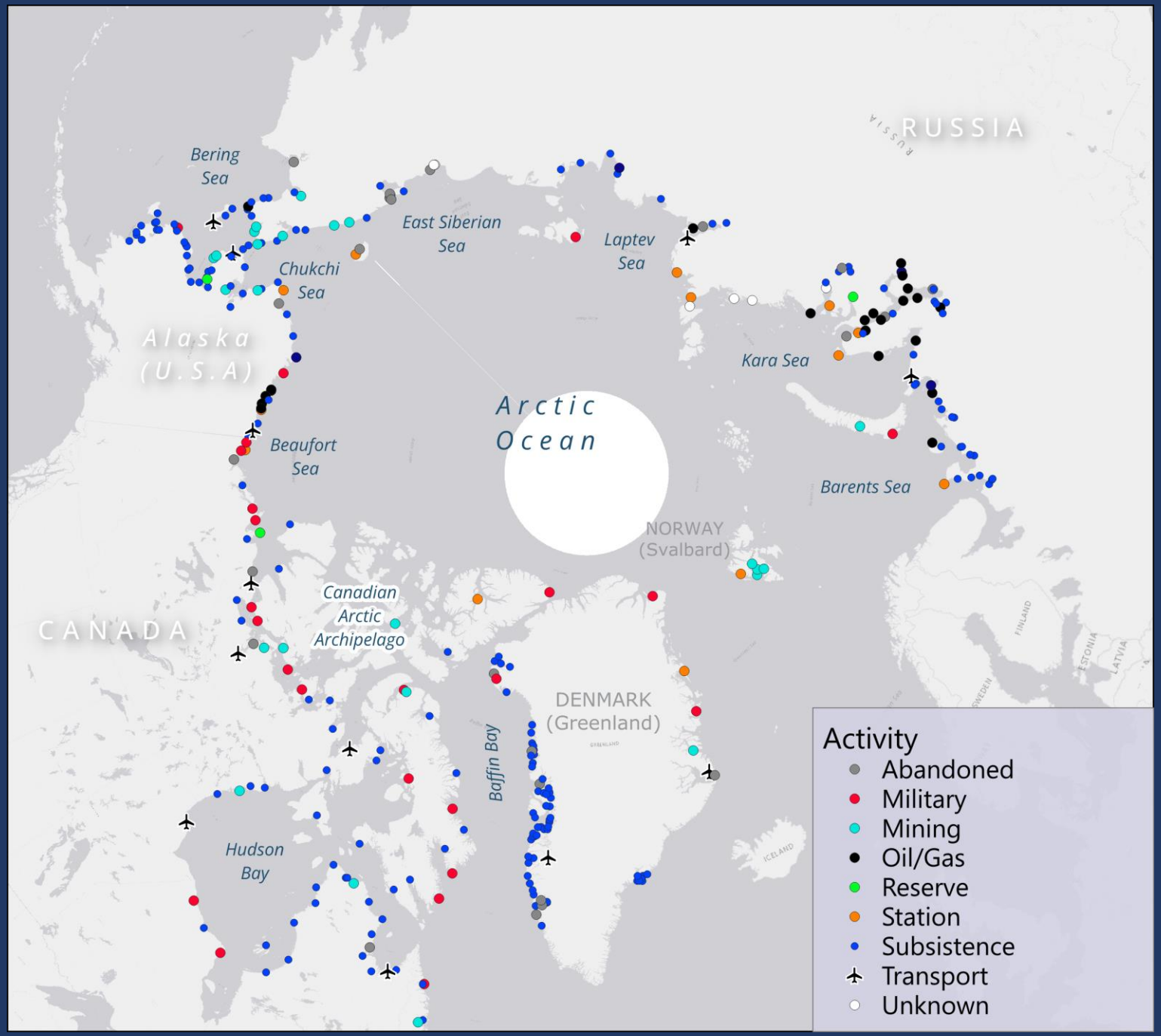
5

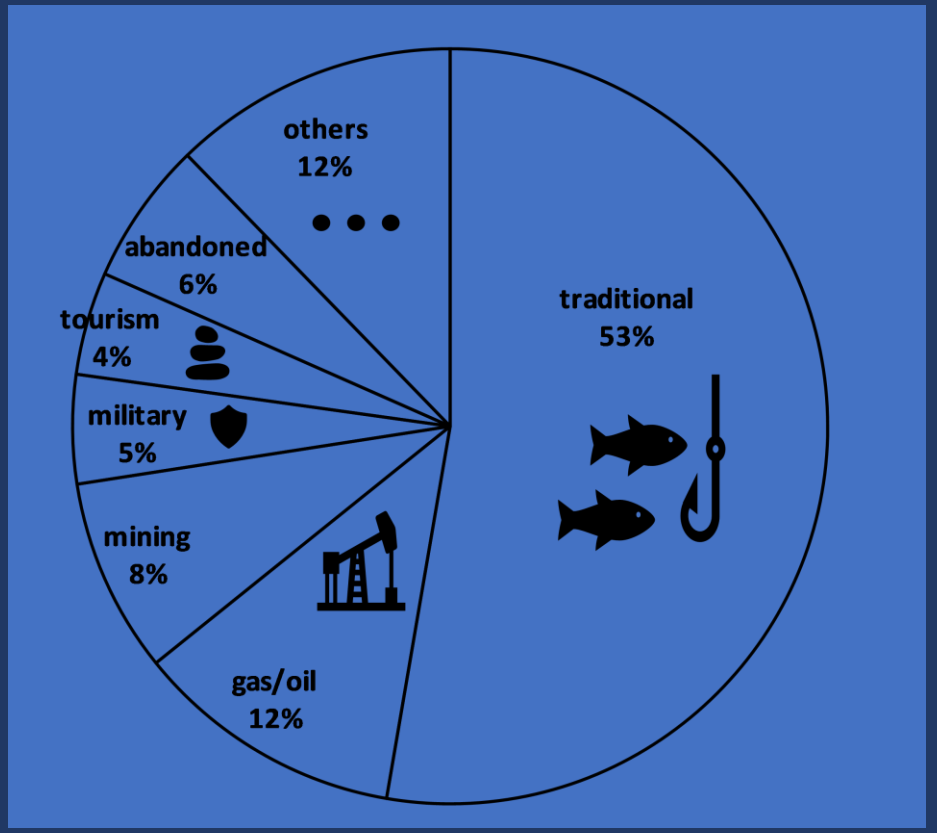
Exposed infrastructures / settlements

Summary



Activity


RUSSIA
Bering Sea
East Siberian Sea
Laptev Sea
Chukchi Sea
Alaska (U.S.A)
Kara Sea
Arctic Ocean
Beaufort Sea
Barents Sea
NORWAY (Svalbard)
Canadian Arctic Archipelago
CANADA
DENMARK (Greenland)
Baffin Bay
Hudson Bay
ICELAND
Activity
Abandoned
Military
Mining
Oil/Gas
Reserve
Station
Subsistence
Transport
Unknown


others 12%
abandoned 6%
tourism 4%
military 5%
mining 8%
gas/oil 12%
traditional 53%

Conclusions

Extrapolation of linear trends

Conservative results

Tsunamis hazard in Greenland

Adaptation capacity (indigenous vs industry)

Contribution of coastal land subsidence ?

Circum-arctic acceleration of coastline retreat ?

Infrastructures SACHI v2

ESA Permafrost_cci

AWI Arctic Landscape change Explorer

esa

EO4PAC – Earth Observation for Permafrost dominated Arctic Coasts

Natural Resources Canada

Thanks for your attention !