Field-based monitoring, assessment and forecast of the permafrost coast retreat along the Kara Sea

Arata Kioka[1,2], Vladislav S. Isaev[3], Masakazu Fujii[4], Takeshi Tsuji[1,5], Pavel I. Kotov[3], Stanislav A. Ogorodov[3,6], Osip Kokin[3,7], Michail Tsarapov[3] and Tatiana Mironova[3]

[1]*Kyushu University, Japan*

[2]*Universität Innsbruck, Austria*

[3]*Lomonosov Moscow State University, Russian Federation*

[4]*National Polar Research Institute, Japan*

[5]*Kyoto University, Japan*

[6]*Russian Academy of Sciences, Russian Federation*

[7]*N.N. Zudov State Oceanographic Institute, Russian Federation*

Recent years of increasing air temperature in the Arctic region have led to a significant increase in the retreat rate of the permafrost coast. This has threatened livelihoods and infrastructure along the coasts. The Kara Sea hosts more than 25% of the total Arctic coastline. Despite many works for more than six decades, little is understood about how the erosion of the permafrost coast in the Kara Sea may have changed over time and what the climatic and environmental drivers are. This is due to that satellite imagery alone is not satisfactory to investigate the dynamic interplay of permafrost coast and climatic factors. Thus, field-based continuous monitoring of the permafrost coast is essential to a better understanding of the permafrost coast dynamics. We have done fieldwork campaigns in the permafrost and sea-ice-affected coastline along Baydaratskaya Bay of the Kara Sea, western Siberia (Figure 1), by using handheld differential GPS mapping and satellite imagery for estimating annual rates of permafrost coast retreat. We have also made ground temperature measurements, subsurface resistivity measurements, and estimating wave energy flux of wind-driven ocean waves, for understanding the predominant climatic factors influencing the observed retreat rates. We identified temporal and spatial variations in the retreat rates, ranging between 1.0 and 1.9 m/yr over the studied coastline during 2005–2016 (Isaev et al., 2019). We found that wind-driven wave activity during sea-ice-free days influences the magnitude of coastal retreat in the study area, while the recent temperature rise has contributed less to enhancing coastal retreat. Although further continuous field-based monitoring is necessary, the amount of eroded sediment and the associated release of nutrients to the nearshore zone are likely controlled by the magnitude of wave activity, which may influence infrastructure along the permafrost coast and marine ecosystems in the proximal ocean.

Figure 1. Photos of the permafrost coastal cliffs along the Kara Sea that are subject to rapid coastal retreat (Isaev et al., 2019).

References

Isaev, V.S., A.V. Koshurnikov, A. Pogorelov, R.M. Amangurov, O. Podchasov, D.O. Sergeev, S.N. Buldovich, D.M. Aleksyutina, E.A. Grishakina and A. Kioka, Cliff retreat of permafrost coast in south-west Baydaratskaya Bay, Kara Sea, during 2005–2016, Permafrost Periglac. Process., 30(1), 35-47, 2019.