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Retrogressive thaw slumps in areas with tabular ground ice on Kolguev (Barents Sea) and Novaya Sibir' (East-Siberian Sea) Islands

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The activation of retrogressive thaw slumps is associated with slope surface stability disturbances, or with an increase in the depth of seasonal thawing, that can reach the top of surface-near ground ice. Most retrogressive thaw slumps are confined to terraced slope surfaces that have been undercut and started to retreat due to lateral river erosion or wave action along lake, river or sea shores. Subsequent long-term retrogressive that slump growth depends on constant removal of material from the slope foot by river water or sea waves.

We have studied the current dynamics of coastal destruction and retrogressive thaw slumps in the western (Kolguev Island) and one of the eastern-most (Novaya Sibir' Island) occurrences of tabular ground ice in the Eurasian Arctic. A wide set of multi-temporal optical earth observation data of high and very-high spatial resolution (SPOT 6 & 7, GeoEye, WorldView, Kompsat, Prism, Formosat, and Resurs) was used. We modified the TanDEM-X DEM (12 m) for relief reconstruction of earlier stage relief settings to ensure consistent orthorectification of oblique viewing satellite imagery. All raw images were terrain-corrected and georeferenced using a comprehensive block adjustment.

In the western part of Kolguev Island retrogressive thaw slump average retreat rates of different thermocirque features varied from 0.7 to 7.9 m/year in 2002-2018. Maximum rates reached 14.5-15.1 m/year. On the Novaya Sibir' Island thermocirques averaged retreat rates in 2007-2018 varied from 3.3 to 8.5 m/year, maximum rates were up to 15.5 m/year.

Besides dependence of thermocirque occurrence on local ground ice conditions, external forcing on coastal dynamics and thermocirque retreat has been analysed for air temperature and sea ice fluctuations through sums of positive daily mean air temperature and the duration of the open-water period variability for specific periods bracketed by image acquisition dates. Ice conditions in

the coastal zone (app. near 50 km of coastal line) of the studied areas were analyzed according to microwave satellite OSI-450 and OSI-430 datasets. We assumed the open-water season as the period when sea ice concentration was less than 15%. Around Kolguev Island, over the 2006-2018 there has been not statistically significant linear trend for open-water period - median value of linear trend is 2.5 days/year with different sea ice conditions off the south and north coasts of the island. At the same time, an increase in the annual sum of positive daily mean air temperature is noted. For the period 2006-2018, the linear trend was 23.2 degree/year. That is why, for Kolguev Island, we expect at least a sustained level of substantially stronger retreat rates when compared with the past, if not a further increase in thermal denudation intensity and thermocirque growth, and strong and steady rates of coastal destruction due to wave action. Further research will focus on identifying commonalities and differences between the two study regions with respect to hydrometeorological and permafrost conditions.

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