

Thermokarst Lake and Baydzherakh Area Changes on Yedoma Uplands, Yakutian Coastal Lowlands: Repeat Inventory Using High Resolution Imagery

Veremeeva A.¹, Günther F.²

¹ *Institute of Physicochemical and Biological Problems in Soil Sciences, Russian Academy of Sciences, Pushchino, Russia, averemeeva@gmail.com*

² *Department of Periglacial Research, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam, Germany*

Yedoma deposits are widespread on the lowlands of North-East Siberia. Besides the large fraction of polygonal ice wedges and intrasedimentary ground ice, these mostly silty Late Pleistocene sediments contain considerable amounts of buried and well-preserved organic matter. The very high total ground ice content of up to 90 % by volume renders Yedoma deposits extremely vulnerable to climate warming. Widespread ice wedge degradation throughout the Arctic (Liljedahl et al. 2016) resulted in relief changes on Yedoma uplands such as land subsidence, formation of baydzherakhs (thermokarst mounds) on slopes, and alterations of pond and thermokarst lake areas (Günther et al. 2016). In order to track dynamics of these processes in the tundra zone of the Kolyma lowland at Cape Maly Chukochy, located in the East Siberian Sea coast (N 72.08°, E 159.9°), we used a set of very high resolution remote sensing imagery (GeoEye, WordView-2, and historical air photos). The study site is located within the Chukochya Yedoma region and characterized by a high areal percentage of preserved Yedoma uplands of up to 60% (Veremeeva & Glushkova, 2016).

Analysis of climatological data from Chersky (about 150 km SE from the study site) shows not only an increase of 2 °C of mean annual but also of mean summer air temperature since the 1960s. Precipitation during summer has slightly increased, but in the last 5 years it has increased twofold when compared to the average trend. This precipitation increase has been also shown for the entire Kolyma Lowland by Sakai et al. (2016). Climate warming resulted in an increase of active layer thickness on Yedoma uplands that has been measured continuously at the study site since 1996.

Yedoma uplands at Cape Chukochy are surrounded by drained slopes and represent flat bogged areas featuring a high number of ponds with an average size of 5-10 and a maximum of 30 m in diameter. These poorly drained surfaces are considered as the only areas for potentially

strong thermokarst development in the future and still cover about 25% of the area. Our image dataset revealed a doubling in the number and areal coverage of ponds from 1972 to 2009 and a further twofold increase until 2013. We also found that the area of lakes that formed within Yedoma deposits increased by 7-10 % while the area of residual lakes in Alas thermokarst depressions decreased. Geomorphometric analysis of a detailed DEM created from WorldView stereo imagery shows that the bottom of thermokarst lakes that completely fill out their own depression, extends down to the lower base of Yedoma deposits. This suggests that their current growth is mainly of lateral nature and therefore a result of thermoabrasion and thermodenudation along the lake margins. Simultaneously, baydzherakh coverage estimates show increasing baydzherakh fields on Yedoma upland slopes of 20 % by 2013.

This increase of thermokarst ponds number and area, Yedoma lakes and baydzherakh fields highlights the activation and acceleration of ice wedge degradation on Yedoma uplands in response to increasing air temperatures and precipitation in the Kolyma Lowland.