THERMOKARST LAKE CHANGES BETWEEN 1962 AND 2008 IN MONGOLIA

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Thermokarst lake is one of the most common features on the moist depressions and valleys with ice-rich permafrost regions of Mongolia, of the southern boundary of Siberian permafrost regions. These lakes initiate when the ground subsides following thaw of ice-rich permafrost (van Everdingen, 2005). After a thermokarst lake has formed, the lake size may change due to continued permafrost thaw, variations in air temperature, potential evapotranspiration and precipitation. Most of the previous studies investigated changes in thermokarst lakes across permafrost regions of the Siberia (Smith et al., 2005; Karlsson et al., 2014), however, the spatio-temporal changes of these lakes have not been observed in Mongolian permafrost regions. Therefore, quantifying changes in number and areal extent of thermokarst lakes is of importance for understanding the influences of permafrost degradation and climate warming on thermokarst lake changes in this region.

In this study, we used high resolution CORONA, and ALOS/AVNIR-2 satellite images from 1962 to 2008 and remote sensing techniques. The areas of a total of 1071 lakes were precisely outlined at eight sites on the continuous and isolated permafrost zones in Mongolia. We categorized the thermokarst lake areas into eight distinct classes in order to better understand the lake dynamics of individual lake size categories.

We found significant differences in the spatio-temporal dynamics of thermokarst lakes in the continuous and isolated permafrost zones. This difference concerns the lake size classification. The results indicated that total number and area of thermokarst lakes' activity had increased in the continuous permafrost zone. In contrast, the isolated permafrost zone had a reduction in those lakes. Since the 1960s, the small lakes (<25 ha) increased by 163 ha in the continuous permafrost zone, while they decreased by 129 ha in the isolated permafrost zone, respectively. The lakes larger than 25 ha, on the other hand, remained almost stable in both the zones. Furthermore, a total of 91 new lakes (343 ha) were detected, especially in the continuous permafrost zone.

These changes observed for the lakes can be explained by climate variations and permafrost degradation. Even though no significant trend in summer precipitation was found in the last 50 years, despite, there was a significant increasing trend in potential evpotranspiration in the isolated permafrost zone rather than continuous permafrost zone. The mean annual air temperature increased significantly in the northern part of the country, while it increased only slightly in the southern parts. Due to ongoing atmospheric warming, patches of ice-rich subsurface, controlling the dynamics of small lakes, have thawed, and the area and number of small lakes (<25 ha) have accordingly increased in the continuous permafrost zone. Increasing potential evapotransipation and disappearing permafrost in the isolated permafrost zone likely caused the decrease in the area and number of such lakes. Small lakes (<25 ha) are especially sensitive to climatologic variations, thus they are useful indicators of permafrost degradation and disappearance in Mongolia.

References:

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