学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Thermokarst lake dynamics in the continuous and isolated permafrost zones, Mongolia
（モンゴル連続永久凍土帯と点在的永久凍土帯におけるサーモカルスト湖の変動）

Thermokarst lakes are one of the most common features on the moist depressions and valleys in Mongolian permafrost zones, although the spatiotemporal changes of thermokarst lakes have not been investigated in the region so far. Such lakes initiate when the ground subsides following thaw of ice-rich permafrost, and important indicator of permafrost degradation. After a thermokarst lake has formed, the lake size may change due to continued permafrost thaw, variations in air temperature, potential evapotranspiration and precipitation. 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 Mongolia.

This study used Corona (1962-1968), Landsat (1999-2001), and ALOS (2006-2007) satellite imagery to quantify lake changes at seven study sites in the continuous and isolated permafrost zones. Lakes larger than 0.1 ha (1000 m^2) were analyzed using remote sensing and geography information techniques. Between 1962 and 2007, the total number and area of lakes increased by +21% (347 to 420), and +7% (3680 ha to 3936 ha) in the continuous permafrost zone, respectively. These changes correspond to the appearance of 85 new lakes (166 ha) during the last 45 years. In contrast, lakes in the isolated permafrost zone have decreased by −42% (118 to 68) in number and −12% (422 ha to 371 ha) in area from 1962 to 2007. The changes in lake area and number are likely attributed to shifts in climate regimes and local permafrost conditions. Since 1962, the mean annual air temperature and potential evapotranspiration have increased significantly in the northern continuous permafrost zone compared to the southern isolated permafrost zone. Due to ongoing atmospheric warming without any significant trend in annual precipitation, patches of ice-rich subsurface have thawed, and the number and area of lakes have accordingly developed in the continuous permafrost zone. Shrinking of thermokarst lakes in the isolated permafrost zone may be due to disappearing permafrost, deepening of the active layer, and increased water loss through surface evaporation and subsurface drainage.

This study provides the first baseline information of thermokarst lake changes across Mongolia, filling the gap in sub-Arctic lake inventories at regional scales such as the southern fringe of Siberian permafrost region. Future research should focus on the temporal and spatial assessment of lake area changes across this region to better understand the detailed processes of lake area dynamics.