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Spatial and Temporal Responses of Lakes in Northern Mongolia to Climate Change

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Lakes play a valuable role in the surface water resources of Mongolia. Understanding surface water dynamics and climate change over various spatiotemporal scales from local to regional are essential in Mongolia today. This study presents how lakes in the Mongolian Altai, Khuvsgul, and Khentii Mountain Ranges at high latitudes in northern Mongolia responded to the climate change during the past 50 years. The temporal trend shows that the lakes had extended in the area during the first three decades but reduced during the last two decades. However, Lakes Khoton and Khurgan in the Mongolian Altai and Lake Khangal in the Khentii increased in the area during 1970–2000 and since 2010, but decreased from 2000 to 2010. Lake Tolbo in the Mongolian Altai dropped in the area during 1970–2000, and continuously increased since 2000. Whereas Lakes Erkhel and Khargal in the Khuvsgul and Lake Gurem in the Khentii extended in 1970–2000 but reduced during 2000–2020. The spatial trend in lake area changes shows similar patterns for glacial lakes at an elevation above 2000 m a.s.l. in the Mongolian Altai and for tectonic and fluvial lakes at an elevation below 1500 m a.s.l. in the Khuvsgul and Khentii. Anomalies of seasonal variations in air temperature and precipitation in the lake basins show that the Lake Khangal basin in the Khentii is warmer and wetter than other lake basins. Moreover, the Lake Khargal basin in the Khuvsgul is cooler in winter and autumn but warmer in spring and summer compared to the basins. Whereas Lakes Tolbo, Khoton, and Khurgan basins in the Mongolian Altai are drier than others. The correlation analysis shows that hydrological dynamics of Lake Khargal in the Khuvsgul are strongly dependent on summer precipitation ($r = 0.71$), and autumn ($r = 0.67$) and summer ($r = 0.47$) air temperatures. However, the linear regression shows that the lake area is moderately related to the summer precipitation ($R^2 = 0.5318$) and the autumn air temperature ($R^2 = 0.4555$). Overall, the lakes in northern Mongolia show the distinct responses of hydrological dynamics to the changing climate depending on their physiographic conditions.