

Stable isotope hydrology and water budget of small endorheic lakes in cold semi-arid Northern Central Asia: identifying hydrological processes in transitional climate zone

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Burabay National Nature Park (BNNP) is a small ecozone in the northern part of Central Asia (northern Kazakhstan) embedded into the system of endorheic basins draining into tectonic lakes. The park is located in the transitional zone between the southern part of boreal Siberian forests (energy-limited) and arid Kazakh steppe (water-limited). The water levels in these lakes have experienced significant fluctuations over last ~ 100 years with a long-term decline trend. Here, we present the analyses of a dataset of the stable hydrogen and oxygen isotope compositions of water samples collected over one hydrological year in the watersheds of BNNP. This current study aims to provide a deeper understanding of the reasons behind the lake level fluctuations: 1) to verify our previous long-term lake evaporation model, 2) improve our water balance estimates, and 3) to identify hydrological connectivity and lateral interactions of lakes with their watersheds using stable isotope tracers. The stable isotope composition of limited number of collected precipitation samples (annual means: δ^{18} O -15.9±6.9 % and δ^{2} H -115.44 \pm 45.1 ‰) confirms the estimates based on gridded interpolated regional dataset (annual means: δ^{18} O -14.4 % and δ^2 H -105.8 %) as well as empirical models, reflecting cold and arid conditions. The slopes of evaporation lines (LEL) for this region obtained by regression analysis of lake water samples range from 4.57 (steppe lakes) to 6.21 (forest lakes) with the mean slope of 6.04 for all lakes which are close to the range reported for the other mid-latitude regions. The individual slopes calculated theoretically based on stable isotope data (such as surface water, atmospheric composition, and precipitation) and relative humidity observations range from 5.13 to 6.12. The results of the stable isotope mass balance expressed as evaporation/inflow (E/I) ratio for the study lakes are in good agreement with catchment water budget calculations (E/I). The E/I ratios calculated form isotope mass balance for three lakes are: 0.34 (Burabay Lake), 0.69 (Ulken Shabakty Lake) and 0.53 (Shortandy Lake) and are not significantly different from water budget estimates, E/I ratios, for Burabay Lake (0.33) and Shortandy Lake (0.54) but very different for Shortandy Lake (0.77). This inconsistency between the calculations results for Ulken Shabakty Lake (a terminal basin) obtained using different methods can be explained by the observed recent water level rise and by 'fill and spill' hypothesis described before only on slope scale and for boreal prairie wetlands areas elsewhere. The studied lake system has ecohydrological features of both boreal Siberia and semi-arid steppe. Each type of traits dominates and strengthens depending on current hydroclimatic conditions (wet or dry phase). This study contributes to better understanding the water budget in the most continental climate on the Earth.