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## Groundwater Dynamics in the Swedish Sub-Arctic Region: Inferring from Standardized Index Based on Model and Observation Data

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The Arctic and Subarctic regions are experiencing faster warming than the global average. This warming already increases the seasonal thaw depth of soils in permafrost areas, as evidenced by monitoring across the Arctic region. Accompanied by changes in the ground surface, diminishing permafrost could increase hydrological connectivity and groundwater flow, which in turn could influence the rate of thawing via impacts on soil thermal properties and advective transport of heat with groundwater. Yet, our basic understanding of the factors that drive groundwater dynamics in high-latitude landscapes remains limited. Here we report on a preliminary study in Abisko, Swedish sub-arctic that explores the meteorological factors that influence groundwater conditions. Standardized Precipitation Index (SPI), Standardized Groundwater Index (SGI), and Standardized Precipitation-Evaporation Index (SPEI) were used to calculate anomalies in precipitation and groundwater conditions from 1991-2018. These indexes indicate the dryness and wetness of a region. The SGI, SPI, and SPEI were computed using observational data from the Swedish Geological Survey, Swedish Meteorological and Hydrological Institute, and the output of LISFLOOD models. PET was calculated using the Thornthwaite method. The result shows that the observation-based SGI exhibits a strong correlation with the SPI-x, when more than six months of precipitation data are accumulated, demonstrating an R-value of 0.64 for SPI-6 and 0.58 for SPI-12. This indicates a time lag in groundwater response to precipitation, likely due to seasonal thaw cycles. Evapotranspiration also shows as an important factor although in cold regions where the correlation between SGI and SPEI-3 and SPEI-6 are 0.56 and 0.52, respectively. Evapotranspiration likely reduced the impact of precipitation based on this standardized index. Thornthwaite method might underestimate the PET value, thus, calculation with other methods might be beneficial. Although the model bias for SGI was low (0.14), the model has inadequate representation relative to observations, with a Mean Absolute Error (MAE) of 0.85 and a coefficient of determination ( $R^2$ ) of 0.15. The complexity of hydrology in this region results in poor model fit, which indicates that other than meteorological factors, snow depth, ground surface condition, and adjacent surface water potentially influence groundwater dynamics. Future research will examine those factors on groundwater interactions in sub-arctic climates with surrounding surface water to improve our understanding of groundwater dynamics in this region via observation and remote sensing techniques.

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### Supplementary materials

Supplementary material file

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