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Contrasting trends in hydrologic extremes for two sub-arctic catchments in northern Sweden - Does glacier melt matter?

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Climate warming in the high-latitude environments of Sweden is raising concerns about its impacts upon hydrology. In order to manage future water resources in these snowmelt-dominated high-latitude and altitude catchments there is a need to determine how climatic change will influence glacial meltwater rates and terrestrial hydrology. This uncertainty is particularly acute for hydrologic extremes (flood events) because understanding the frequency of such unusual events requires long records of observation not often available for high-latitude and altitude catchments. This study presents a statistical analysis of trends in the magnitude and timing of hydrologic extremes (flood events) and the mean summer (June-August) discharge in two sub-arctic catchments, Tarfalajokk and Abiskojokk, in northern Sweden. The catchments have different glacier covers of 30% and 1%, respectively. Statistically significant hydrologic trends (at the 5% level) were identified for both catchments on an annual and on a seasonal scale (3-months averages) using the Mann-Kendall trend test and were related to observed changes in the precipitation and air temperature. Both catchments showed a statistically significant increase in the annual mean air temperature over the comparison time period of 1985-2009 (Tarfalajokk & Abiskojokk $p<0.01$), but lacked significant trends in the total precipitation (Tarfalajokk $p=0.91$, Abiskojokk $p=0.44$). Despite the similar climate evolution over the studied time period in the two catchments, data showed contrasting trends in the magnitude and timing of flood peaks and the mean summer discharge. Hydrologic trends indicated an amplification of the hydrologic response in the highly glaciated catchment and a dampening of the response in the non-glaciated catchment. The glaciated mountain catchment showed a statistically significant increasing trend in the mean summer discharge that is clearly correlated to the decrease in glacier mass balance and the increase in air temperature. However, the catchment showed also a significant increase in the flood magnitudes, which are clearly correlated to the occurrence of extreme precipitation events, indicating a shift of the dominant storm runoff mechanism towards rainfall-dominated floods. Conversely, the non-glaciated catchment showed a significant decrease in the mean summer discharge and the flood magnitudes, which can be explained by a reduction of the winter snow pack due to higher temperatures in the winter and spring and an increasing soil water storage capacity or catchment storage due to progressively thawing permafrost. The results of this study indicate that the hydrologic response to climate change in both catchments is largely determined by the storage-discharge relationship and that catchment glaciation should be considered when assessing climate-related impacts in subarctic catchments.