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Water Source Dynamics of High Arctic River Basins

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Meltwater from snow and glaciers exerts a strong influence on aquatic habitat conditions in many headwater catchments, yet there is currently limited understanding of spatiotemporal variability in water source dynamics of Arctic river systems that in turn determine stream physicochemical properties. Furthermore, identification of space-time dynamics in water source contributions to stream flow provides important insights into catchment hydrological functioning. This research gap was addressed by characterising the seasonal evolution of water source contributions (snow/glacial melt and soil/groundwater) to river flow at seven sites spanning a range of catchment glaciation (0-61 %) across north-west Svalbard during the 2010 and 2011 meltwater seasons.

Hydrochemically-informed end-member mixing analysis demonstrated that 'quickflow' (i.e. snow and glacier runoff) meltwaters dominated river flow in 2010 in glacierized river basins (typically >85%), while discharge in a non-glacial system (i.e. no catchment glaciation) was maintained initially by snowmelt but become increasingly dependent on subsurface soil water inputs which comprised more than 75% of flow volume in late summer. In 2011, river discharge increased under warmer and wetter climatological conditions. Flow contributions from soil water were higher than in 2010, comprising up to 100% of total flow at some sites following the loss of seasonal snowpacks.

In the context of future warming scenarios, these results provide the basis for analogue modelling of the impact of climate-induced hydrological changes on water availability and flow regimes in polar regions during the 21st century. A decline in glacial meltwater inputs and progressive shift towards the dominance of non-glacial water sources may affect ecosystem functioning and have important implications for local and regional biodiversity. Further work is currently ongoing as part of a broader linked investigation that will provide insight into the hydroecological response of Arctic rivers to climate change.