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Influence of catchment characteristics on the spatio-temporal dynamics of streamwater temperatures in montane headwaters

Jonathan Dick, Doerthe Tetzlaff, and Chris Soulsby

University of Aberdeen, Northern Rivers Institute, Geography and Environment, Aberdeen, United Kingdom (jonathan.dick@abdn.ac.uk)

Streamwater temperature is an important physical parameter in riverine ecosystems. It governs many processes; from water quality to biogeochemical dynamics, and is thus essential to consider when producing river basin management plans. The thermal regimes of streams are determined by a complex series of inter-linkages which can be categorised in one of the three groups: atmospheric conditions, terrestrial controls and stream geomorphology. The climatic conditions are the most important factors as they are the drivers of the processes of heat fluxes at the air-surface interface, however terrestrial and aquatic factors such as elevation, aspect and vegetation are the main modulators of the atmospheric processes.

Here we will couple spatially distributed streamwater, groundwater and riparian wetland surface water temperatures to provide insight into dynamics and controls of thermal dynamics at different spatial and temporal scales. The study is located in a 3.2 km2 upland watershed in the North East Scottish Highlands, and covers an 18 month period of measurements. The objectives are to characterise the streamwater thermal fingerprints of the three different headwaters with contrasting landscape description units (fen dominated, steep valley and a wetland dominated corrie), and infer the controls on the spatial and temporal patterns of water temperature throughout the catchment stream network.

Results indicate that the temperature of the stream represents the energy balance of the source areas when the riparian zone is connected with the stream network and not just the energy balance of the stream network alone. There are significant differences between the characteristically different headwaters with a significant reduction in the diurnal temperature variability in the largest headwater catchment. The headwater catchment also contains the greatest percentage of wetland soils suggesting groundwater contributions act in the dampening of streamwater temperatures draining that catchment. The streamwater temperature fingerprint of the catchment as a whole is more homogenous and similar to the profile seen from the largest headwater. This would suggest that downstream of the confluence of the three headwaters has similar water sources to the larger wetland dominated headwater.

These findings have significant implications for understanding the thermal dynamics of “natural” or “reference” river systems aiding the management actions required to maintain good status.