

## **Preferential flow paths in paraglacial catchments: first order controls on the long-term stability of ‘biodiversity hotspots’ in a changing climate**

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Groundwater (GW) –fed streams within paraglacial floodplains are considered ‘biodiversity hotspots’, given their importance as an aquatic ecosystem and role in supporting valuable riverine habitat patches within paraglacial environments. However, it is anticipated that throughout the 21st Century hydrologic regimes of paraglacial systems in arctic, sub-arctic, and alpine regions globally will experience substantial changes, as a consequence of anthropogenic climate change. Declining glacial coverage, shrinking winter snowpack, earlier spring melt, rising permafrost melt and increasing relative importance of groundwater will all cause major changes in the water balance of paraglacial catchments. This research explored the importance of preferential flow pathways (PFPs) as conduits of subsurface flow across paraglacial floodplains, and their role in sustaining ‘biodiversity hotspots’. Furthermore, it considered the role of PFPs in hillslope-floodplain connectivity within paraglacial systems and the significance of colluvial deposits as a key water source to GW-fed streams on paraglacial floodplains. An intra-catchment scale field study within ungauged catchments was conducted in Denali National Park & Preserve, Alaska, during 2013 and 2014. The research utilised hydrogeomorphic and hydrochemical field techniques to address the aims outlined above. Surface infiltration and slug tests identified significant spatial heterogeneity in hydraulic conductivity (K) across the surface and subsurface of paraglacial floodplains, indicating the presence of PFPs. Furthermore, spatiotemporal variation in geochemical tracers (major ions) within surface and subsurface flow paths established the role of multiple, discrete flow paths (PFPs) in sustaining GW-fed streamflow on floodplains. Finally, hydrograph separations confirmed the significant contribution made by colluvial deposits (e.g. talus slopes) to sustaining GW-fed streamflow on paraglacial research. This research suggests PFPs are a fundamental first order control upon the occurrence of ‘biodiversity hotspots’ within paraglacial floodplains, and highlights their role as an important conduit for hillslope-floodplain connectivity. Given the expected changes in the hydrological dynamics of paraglacial catchments this research raises questions about the long-term stability of GW-fed streams, and whether the increasing relative importance of groundwater sources (e.g. from colluvium) can sustain flow of GW-fed streams. In addition glacial retreat and associated long-term declines in sediment yields could have negative implications for the development and renewal of PFPs across paraglacial floodplains, which would be detrimental to the persistence of ‘biodiversity hotspots’.