Shallow groundwater systems in sub-humid, low-relief Boreal Plain landscapes: Interactions between glacial landforms, climate, and topography

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The Boreal Plain (BP) region of Canada is experiencing unprecedented anthropogenic disturbances, in the forms of climate change, forestry, agriculture, and oil-and-gas exploration and operations. The BP is characterized by low-relief, heterogeneous glacial landforms, with large contrasts in storage and transmissivity. When coupled with a sub-humid climate, these characteristics result in complex groundwater-surface water interactions. Understanding the controls on, and natural variability of, water-table position and groundwater movement and quality under varying physical and climatic scenarios is important as water security, ecosystem sustainability, and environmental quality become the focus of land management and reclamation efforts.

We test the influence of interactions between glacial deposit types, climate, and topography on recharge, storage, and local to regional groundwater flow. Additionally, we identify chemoscapes and isoscapes as tools to geochemically characterize the region and assess variability in scale of groundwater flow and landform connectivity. We collected hydrogeological, geochemical, and isotopic data from 1998 to present, a period which includes both wet and dry climate cycles. Data were collected from surface waters to 40 m depth, along a 50 km transect encompassing pond-wetland-forestland complexes across the major glacial depositional types typical of the BP (i.e., coarse-textured glaciofluvial outwash, fine-textured stagnant ice moraine, and lacustrine clay plain). Sites range from isolated headwater complexes to large regional discharge complexes. High spatial variability of water-table fluctuations and responses to climate signals illustrate the strong spatial controls that surficial geology and topography exert over scales of groundwater flow within and between glacial landforms across the BP. Scale of groundwater flow varies from local to intermediate in the coarse outwash, and is predominately local in the fine-textured landforms. Chemoscapes and isoscapes delineate areas with characteristic water storage and transmission properties, which in turn control scales of groundwater flow and hydrologic responses to climate.

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