Groundwater inflow to the Lake Papineau Hydrosystem (Outaouais, Canada)

Simon Lavoie Lavallée, Marie Larocque, Sylvain Gagné & James Harris
Department of Earth Sciences & GEOTOP Research Center, Université du Québec à Montréal, Montreal, Quebec, Canada

ABSTRACT
The goal of this project is to quantify, for current and past hydrological conditions, the inflow and outflow of water from Lake Papineau, where limited data is currently available. The basic assumption is that Lake Papineau receives a significant contribution of groundwater, upon which its associated riparian wetlands are dependent. Lake Papineau, located in the Outaouais region between Montreal and Ottawa, covers an area of 13.5 km^2 and reaches a maximal depth of 90 m. A weather station (precipitation, temperature, snow cover, barometric pressure, and wind speed) was installed in November of 2016. Evaporation losses from the lake were quantified using theoretical equations, an evaporation pan and stable isotope ($\delta^{18}O$ and $\delta^{2}H$) analysis. Surface outflow has been measured at a hydrometric station since the beginning of 2016. Lake Papineau's water level has varied about 1 m since that time. Time series analysis of meteorological data and land use has also been used to help recreate past hydrological conditions of the lake watershed during the past century. Multiple techniques were employed in the spring and summer of 2018 to identify and quantify the exchanges between groundwater and the lake. Analysis of thermal infrared images, temperature and electrical conductivity profiles, and 222-radon analyses from water samples taken near the lakeshore helped identify areas of lacustrine groundwater discharge. Quantification of groundwater flows at the lake-sediment interface was made possible by seepage meters and differential mini-piezometers installed in the lakebed and interpretation of water level measurements taken from wells and piezometers around the lake. Additionally, pumping tests were conducted in wells and piezometers in order to measure the hydraulic conductivity of the area's geological formations. A three-dimensional conceptual model of the watershed's geometry was developed in ArcGIS using high-precision LiDAR data. To evaluate the Lake Papineau watershed response to changing meteorological conditions, past surface outflow rates were simulated with an artificial neural network and Budyko curves were used to interpret actual precipitation and evapotranspiration conditions and recreate past values.