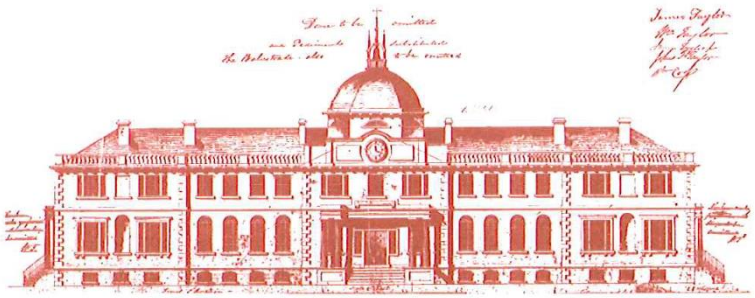

Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Mina Nasr

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

September 23, 2015
Forestry / Geology Bldg., Room 202

GEOSPATIAL ANALYSIS OF TOTAL MERCURY CONCENTRATIONS IN STREAM AND LAKE SEDIMENTS ACROSS CANADA

Abstract

This study focused on the geospatial analysis and mapping of total mercury concentration (THg, dry weight) of bulk stream and lake sediments across Canada, as per the combined sediment surveys of the Geological Survey of Canada, Quebec, and Nova Scotia (total number of samples = 254,133). The objective was to quantify how THg varies by topography, stream and lake morphology, vegetation/land cover type, geology, sediment composition including other elements and organic matter contents (loss on ignition: LOI), atmospheric Hg deposition, and climate.

Upland sediments have higher mean THg (streams: 97.8 ± 1.4 SE; lakes: 113.2 ± 1.1 SE, ppb) than lowland sediments (streams: 90.1 ± 2.2 SE; lakes: 90.4 ± 0.2 SE, ppb). Lake sediment THg increases with increasing lake depth and decreasing lake area (p-value < 0.0001). Stream sediment THg increases with increasing stream depth and decreasing flow rate, order, and width (p-value < 0.0001).

Mean sediment THg decreases from forests to tundra, barrens, and ice- and snow-covered basins (p-value < 0.0001). In wetland dominated basins, sediment THg decreases by approximately a factor of 2 as the wet-area portion per basin increases from 0 to 40 %. Swamp dominated basins have higher sediment THg than marsh and bog/fen dominated basins (p-value < 0.0001). Highest sediment THg occurs downstream from high Hg-containing geogenic and anthropogenic sources, with sediment THg related to other heavy metals such as copper and zinc (p-value < 0.0001).

The examination of 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentiles of sediment THg displays parallel trends with increasing LOI, being lowest at LOI = 0 and highest at 30-50 %. This suggests that geogenic THg contribution to sediments decreases as the organic THg contribution increases. The latter is positively related to atmospheric Hg deposition and precipitation rates, and more so for lakes than for streams. The regression coefficient between lake sediment THg and mean atmospheric Hg deposition and precipitation rates amounts to 0.432 (p-value < 0.0001) per National Topographic System (NTS, 1:250,000) tile.

The standardized fish Hg concentration (Fish Mercury Datalayer for Canada: FIMDAC) is positively related to lake sediment THg but negatively related to July temperature. This association explains 38.2 % of the fish Hg concentration variation per NTS tile. Hence, changes in climate and atmospheric Hg deposition rate may affect sediment-induced Hg bioaccumulation in fish.