Hudson Bay Lowlands, Ontario

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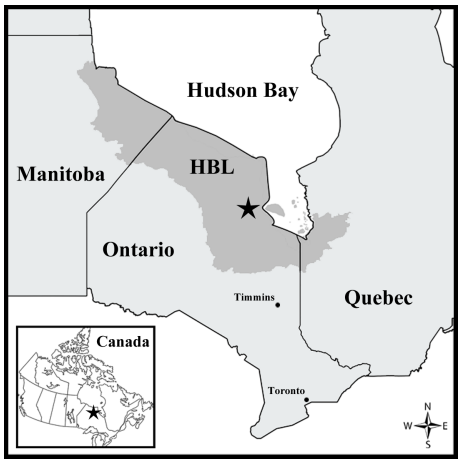

Figure 1. The Hudson Bay Lowlands (HBL, dark grey) of Canada.

Background Information:

The second largest contiguous peatland in the world, the Hudson Bay Lowlands (HBL, Figure 1), is mainly located in northern Ontario and Manitoba, where approximately 147 Gt (56%) of Canada's terrestrial soil carbon is sequestered in an expanse covering 320,000 km^2. Predicted shifts in temperature and precipitation regimes due to climate change in mid to high latitudes (IPCC, 2007) are expected to decrease total available soil moisture in peatlands, modifying their hydrology, biogeochemical processes and carbon stores. In addition to climate change, other natural and anthropogenic disturbances (*e.g.,* forest fires, peat harvesting, peatland dewatering, and resource extraction) demand the collection of baseline biogeochemical data for environmental monitoring and policy-making.

Main Research and Management Problems:

Ongoing NSERC-funded research is being conducted in the Hudson Bay Lowlands through partnerships between Canadian universities, Provincial Ministries, and corporate partners such as De Beers Canada Inc., alongside stakeholders such as the James Bay Cree First Nations, particularly the coastal community of Attawapiskat.

At the University of Waterloo, through Dr. Jon Price, researchers are studying the hydrological impacts of open-pit mining and dewatering to the surrounding peatlands and streams/tributaries. The research team at the Western University, led by Dr. Brian Branfireun, is providing data on the relative contributions of peatland-derived runoff to the total water, mercury and DOC fluxes of major tributaries to Hudson Bay/James Bay that predominantly drain the HBL, addressing a significant knowledge gap and providing important guidance for landuse management. The use of small-bodied fish as sentinel species for mercury exposure in lotic systems (in partnership with AMEC Earth and Environmental) is also part of Western's

monitoring program. Dr. Vicki Remanda and her students at Queen's University are working to characterize the geology below the muskeg and to identify hydrological linkages between upper (peatland), intermediate (sand and fine-grained overburden) and lower (bedrock) systems. At Carleton University, Dr. Murray Richardson, is investigating broad-scale changes in surface elevation caused by clay and peat subsidence (which may profoundly affect surface water storage, detention and runoff) through the use of remote sensing data, particularly IKONOS and Light Detection and Ranging (LiDAR).

The Ontario Ministries of the Environment (OMOE) and Natural Resources (OMNR) have also become research partners, investigating the permafrost, carbon, and greenhouse gas exchange dynamics in the unimpacted peatlands of the region using peatland depth surveys, meteorological monitoring, and continuous carbon dioxide and methane flux measurements (via eddy covariance).

Possible End-Users:

In addition to the researchers mentioned in the previous section, research in the Hudson Bay Lowlands of Northern Ontario would be of interest to the following stakeholders: Environment Canada, Ontario Ministry of Northern Development and Mines, Ontario Hydro, and University researchers with interests in northern peatland ecohydrology and biogeochemistry.

Site Conditions:

This main study site in the Hudson Bay Lowlands is at the De Beers Victor Mine, approximately 90 km west from the west coast of James Bay along the Attawapiskat River (52.821°, -83.884°). The HBL is characterised as a low-subarctic region (SL) with short, warm summers and long, cold winters (National Wetlands Working Group, 1997). The mean annual total rainfall at Lansdowne House (the nearest long-term meteorological monitoring station, 250 km southwest of the study site) between 1971-2000 is approximately 700 mm, with about 250 mm (34%) falling as snow. More than 75% of the rainfall (380 mm) falls between June and September. The mean daily temperature is 17.2°C and -22.3 °C in July and January, respectively. On average, the region experiences 153 days with a minimum temperature greater than freezing (0 °C).

Peat depth in the region ranges from 0 to 3 m and is underlain by low conductivity, fine-grained sediments derived from calcite and dolomite from the Paleozoic era (Mcdonald, 1969; Riley, 2011). Peatland formation is predominantly driven by an interplay of isotatic uplift, climate, and hydrology, beginning with a basal tidal marsh and then rapidly developing into a *Larix*-dominated swamp, *Picea*-forested bog and finally a non-forested bog (Glaser *et al.,* 2004). Bioherms, sedimentary outcrops of karst limestone from the Tyrell Sea, are one of the only upland features in this largely flat terrain, where topographic gradients are very low (typically 0.57 m km^{-1} towards Hudson Bay) (Mcdonald, 1969). Sporadically discontinuous permafrost, including palsas (elevated regions of peat with a permafrost core), can be found throughout the landscape.

The main wetland types in the HBL include raised-bogs, poor-to-rich fens, swamps, riparian channel fens, and shallow open bodies of water (National

Wetlands Working Group, 1997). Bogs in this region have a water table at or below the surface for most of the year. The vegetation is characterised by a sparse cover of dwarf *Picea mariana* (<4 m in height) and *Larix laricina*; smaller shrubs such as *Chamaedaphne calyculata*, *Rhododendron groenlandicum*, *Rubus chamaemorus* and *Eriophorum angustifolium* are also present. The ground layer consists of a dense layer of mosses (*Sphagnum spp.)*. Small-scale (1-5 m wide, ±0.5 m high) microtopography (hummocks, hollows and lawns) is ubiquitous in this environment.

Fen sites are markedly wetter than the raised bogs, with the water table above the surface for the majority of the year. Vegetation in fens is comprised of sedges (*Carex spp*. and *Scirpus spp*.), brown mosses (*Tomenthypnum nitens, Aulacomnium palustre, Drpanocladus aduncus*) and plants such as *Sarracenia purpurea, Drosera intermedia,* and *Equisetum fluviatile. Sphagnum spp.* are largely absent from fens, as is microtopography.

Monitoring and Data:
Meteorological, hydrological, physicochemical, biological (flora and fauna surveys), land use and land cover, GIS and remote sensing from the area surrounding the study site are available.

Publications:

From the research group:

Richardson M, Ketcheson SJ, Whittington PN, Price JS. In Press. Runoff generation in a northern peatland complex: the influences of catchment morphology and scale *Hydrological Processes*.

Ulanowski T, Branfireun B. Submitted. Small-scale variability in peatland pore-water biogeochemistry, Hudson Bay Lowlands, Canada. *Science of the Total Environment*

Whittington PN, Ketcheson SJ, Price JS, Richardson M, Febo A. In Press. Areal differentiation of snow accumulation and melt between peatland types in the James Bay Lowlands. *Hydrological Processes*

Whittington PN, Price JS. In Press. Impact of mine dewatering on peatlands of the James Bay lowlands: The role of bioherms. Diamond mining and the fate of peatlands. *Hydrological Processes*

General Publications and Site Descriptions:

Glaser PH, Hansen BCS, Siegel DI, Reeve AS, Morin PJ (2004) Rates, pathways and drivers for peatland development in the Hudson Bay Lowlands, northern Ontario, Canada. *Journal of Ecology* 92: 1036-1053.

Mcdonald BG (1969) Glacial and interglacial stratigraphy, Hudson Bay Lowlands. *Geological Survey of Canada Paper* 68: 12.

Riley JL (2011) Wetlands of the Hudson Bay Lowlands: a regional overview. *Nature Conservancy of Canada*. Toronto, Ontario.

Tarnocai C (2006) The effect of climate change on carbon in Canadian peatlands. *Global and Planetary Change* 53: 222-232.

Wieder RK, Vitt DH (2007) *Boreal Peatland Ecosystems*. Springer: London.