Application of Isotope Techniques for Understanding of the Role of Peatlands in Boreal Hydrology: A Regional Perspective

[1,2] S.J. Birks
[1,3] J.J. Gibson
[1,3] Y. Yi
[1,3] S, Kumar

[1]Alberta Innovates-Technology Futures
[2]University of Waterloo, Department of Earth and Environment Sciences
[3]University of Victoria, Department of Geography

Wetlands cover approximately half of the natural landscape in the Athabasca Oil Sands Region (AOSR), and are a major component of the undisturbed boreal ecosystem. In the AOSR wetlands typically occur as complexes of several types of peat and non-peat forming wetlands occurring in close proximity, with surface or groundwater links. Peat forming wetlands (bogs and fens) are the least understood wetland classes but play a vital role in wetland complexes and in regulating watershed hydrology, carbon storage and habitat creation.

The land disturbance that is occurring around Fort McMurray will require reclamation efforts involving whole landscapes or watersheds. The creation of wetland complexes (including fens, and bogs) with a high degree of connectivity may be the most practical management approach and will result in maximum biodiversity of vegetation types, habitats and wildlife. Progress towards successful reclamation of peat forming wetlands has been limited in part by a lack of understanding of the natural functioning and requirements of this wetland type.

Here we present the results of regional surveys of 50 lakes and 36 fen-lake pairs conducted across the AOSR with the goal of better understanding the natural hydrological functioning of fens, the connectivity of fens with surrounding landscape units and their role in controlling the hydrology of boreal lakes. Isotope tracers and isotope mass balance models were used with a combination of GIS, climate analysis, conventional measurement and modeling approaches to quantify the runoff to the lakes in the regional survey and to determine the connectivity between lakes and adjacent wetlands. Variations in runoff to individual lakes across the region were strongly correlated to the basin landscape distribution, particularly the presence of bogs, fens and permafrost features. The $\delta^{18}O$, $\delta^{2}H$, pH and EC from the fen-lake pairs have provided interesting insights into the range of connectivity between fens and lakes and the potential alterations in water chemistry that occur. Clear differences in pH and water isotope composition of fen-lake pairs suggest alteration of the water as it passes through the peatland to the lakes. Distinctive groupings in the $\delta^{18}O$ separation between lakes and their associated fens appear to be related to differences in hydrological connectivity. The results of this survey show the potential for the isotopic signatures measured in lakes and fens to be used as an indicator of hydrological connectivity between these landscape types. Observed correlation between wetland and permafrost features across the region, and implications for wetland reclamation are discussed.