Hydro-ecological responses of Arctic tundra lakes to climate change and landscape perturbation

Summary

Project Leader

Wrona, Fred

Average annual air temperatures in the Northern Hemisphere have been the warmest 30-year period of the last 800 years (IPCC 2013) and there is growing evidence that the Arctic terrestrial cryosphere is also being significantly altered and is highly susceptible to the effects of a rapidly changing and increasingly variable climate (ACIA 2005; IPCC 2007a,b, 2013; AMAP-SWIPA 2011). Permafrost temperatures have increased in the past few decades, and these increases have been attributed to increased air temperature and changes in the timing and thickness of snowcover (IPCC 2013). While freshwater systems and related hydro-ecological processes are particularly sensitive to changes in climate and related impacts on cryospheric components, the specific nature and the magnitudes of the effects on ecosystem structure and function are not well understood. The occurrence of lake shoreline retrogressive thaw slumping (SRTS) has been increasing in the western Canadian Arctic over the past several decades, as has the incidence of the slumping of steep hillside terrains of fluvial valleys (Kokelj et al. 2013). The goals of this research are to: 1) conduct three integrated landscape-lake process and modeling studies that will improve our regional understanding of the sensitivities/responses of upland tundra lakes to CVC; 2) to develop and validate an integrated landscape-geochemical, lake-ice, hydro-ecological model applicable to cold regions/Arctic systems; 3) to evaluate how changes in atmospheric circulation and related hydro-climatic trends are affecting the spatial distribution of water resources (lentic and lotic) and the occurrence of extreme hydrologic events in high-latitude western and northern Canada; and, 4) to develop and test new and innovative automated water quality/hydrometric monitoring systems for application in the Arctic. The project is producing legacy data and products of direct benefit to the development of adaptation options for the conservation, protection and management of arctic freshwater ecosystems to present and future climate variability and change.

People

Network Investigators

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PhD Students
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Publications

Articles Published in Refereed Publications

Ahmed, R., Prowse, T.D., Bonsal, B.R. and Dibike, Y.B., 2013, Spatial and Temporal Variation in the Spring Freshet of Major Circumpolar Arctic River Systems: A CROCWR Component, Proceedings of the 19th International Northern Research Basins Symposium and Workshop, August 11-17, 2013, Southcentral Alaska, USA, 1, Published

Bawden, A., Linton, H., Burn, D.H. and Prowse, T.D, 2013, Recent Changes in Patterns of Western Canadian River Flow and Association with Climatic Drivers, Hydrological Processes, , Submitted

Bawden, A., Linton, H., Burn, D.H. and Prowse, T.D, 2014, Recent Changes in Patterns of Western Canadian River Flow and Association with Climatic Drivers, Hydrological Research, doi: 10.2166/nh.2014.032, (published online), Published

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Bawden, A.J., Linton, H.C., Burn, D.H. and Prowse, T.D, 2013, A Spatiotemporal Analysis of Hydrological Trends and Variability in the Athabasca River Region, Canada, Journal of Hydrology, , Accepted

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Linton, H.C., Prowse, T.D., Dibike, Y.D. and Bonsal, B.R., 2013, Spatiotemporal Trends in Climatic Variables Affecting Streamflow Across Western Canada from 1950-2010: A CROCWR Component, Proceedings of the 19th International Northern Research Basins Symposium and Workshop, August 11-17, 2013, Southcentral Alaska, USA, 1, Published

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Moquin, P.A. and Wrona, F.J., 2015, Effects of Permafrost Degradation on Water and Sediment Quality and Heterotrophic Bacterial Production of Arctic Tundra Lakes: an Experimental Approach, Limnology and Oceanography, , Accepted

Moquin, P.A., Mesquita, P.S., Wrona, F.J. and Prowse, 2013, Responses of Benthic Invertebrate Communities to Shoreline Retrogressive Thaw Slumps in Arctic Upland Lakes, Freshwater Science, , Accepted

Moquin, P.A., Mesquita, P.S., Wrona, F.J. and Prowse, T.D., 2014, Responses of Benthic Invertebrate Communities to Shoreline Retrogressive Thaw Slumps in Arctic Upland Lakes, Freshwater Science, v.33, no.4, 1108-1118, Published

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Newton, B.W., Prowse, T.D. and Bonsal, B.R., 2013, Evaluating the Distribution of Water Resources in Western Canada using Synoptic Climatology and Selected Teleconnections. Part 2: Summer Season, Hydrological Processes, , Accepted

Newton, B.W., Prowse, T.D. and Bonsal, B.R., 2014, Evaluating the Distribution of Water Resources in Western Canada using Synoptic Climatology and Selected Teleconnections. Part 1: Winter Season, Hydrological Processes, v.28, 4219-4234, Published

Newton, B.W., Prowse, T.D. and Bonsal, B.R., 2014, Evaluating the Distribution of Water Resources in Western Canada using Synoptic Climatology and Selected Teleconnections. Part 2: Summer Season, Hydrological Processes, v.28, 4235-4249, Published

Prowse, T.D., Alfredsen, K., Beltaos, S., Bonsal, B., Bowden, W.B., Duguay, C., Korhola, A., McNamara, J., et al., 2011, Effects of Changes in Arctic Lake and River Ice, In Arctic Cryosphere - Changes and Impacts, T.V. Callaghan, M. Johansson, and T. Prowse. (eds.), Ambio 40(S1), doi:10.1007/s13280-011-0217-6, Published

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Prowse, T.D., Alfredsen, K., Beltaos, S., Bonsal, B.R., Duguay, C., Korhola, A., McNamara, J., Vincent, W.F., et al., 2011, Arctic Freshwater Ice and its Climatic Role, In Arctic Cryosphere - Changes and Impacts, T.V. Callaghan, M. Johansson, and T. Prowse. (eds.), Ambio 40(S1), doi:10.1007/s13280-011-0214-9, Published

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von de Wall, S., Prowse, T.D., Wrona, F.J. and de Rham, L., 2012, An Assessment of Annual Peak Spring Break-up and Open Water Levels on Canadian Rivers, Hydrological Processes, , Submitted

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Brooks, R.N., Prowse, T.D. and O'Connell, I.J., 2011, Quantifying Freshwater Ice Across the Northern Hemisphere Using GIS and a Degree-day Ice Growth Model, Proceedings, WDCAG Annual Meeting 2011. Burnaby, BC, n/a, Submitted

Non-Refereed Contributions

Ahmed, R., Prowse, T.D., Dibike, Y.B. and Bonsal, B.R., 2012, Spatio-Temporal Variation in the Spring Freshet of Major Circumpolar Arctic River Systems: Atmospheric Variability Teleconnections, Annual Conference of the Canadian Geophysical Union/Canadian Water Resources Association. June 5-8, 2012; Banff, Alberta, 1, Published

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Ahmed, R., Prowse, T.D., Dibike, Y.B. and Bonsal, B.R., 2012, Annual Spring Runoff Measures in Four Major Arctic Rivers, ArcticNet ASM 2012, December 10-14, 2012,Vancouver, British Columbia, 1, Published

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Barrett, D.C., Prowse, T.D. and Wrona, F.J., 2014, Measuring and Modelling Changes in Under-ice Dissolved Oxygen Content of Canadian Arctic Lakes with Changing Climate Conditions, Poster Presentation, NSERC CREATE Connaught Summer Institute in Arctic Science, July 2014, Alliston, ON, 1, Published

Bawden, A.J., Burn, D.H. and Prowse, T.D, 2013, Spatio-temporal Changes in Western Canadian Water Availability: A CROCWR Component, Annual Meeting of the Canadian Geophysical Union, the Canadian Water Resources Association, and Canadian Meteorological and Oceanographic Society, May 26-30, 2013, Saskatoon, SK, Canada, 1, Published

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di Cenzo, P.D., Paquette-Struger, B., Wrona, F.J., Prowse, T.D., de Rham, L., Garies, J., Hille, E., Ross, D., Hurst, W, Guay, J. and Lennie, J., 2013, Development of a Fully-automated Arctic Lake Monitoring System for Hydro-ecological Research Applications, ArcticNet 2013 ASM, December 9-13, Halifax, NS, Canada, 1, Published

di Cenzo, P.D., Wrona, F.J. and Pietroniro, A., 2011, Arctic Freshwater Systems: Hydrology and Ecology, NWT IPY Results Conference, January, 2011, Inuvik, NT, n/a, Published

di Cenzo, P.D., Wrona, F.J., Prowse, T.D., de Rham, L., Paquette-Struger, B., Barrett, D. and Pesklevits, J., 2014, Development of a Fully-Automated Arctic Lake Monitoring System for Hydroecological Research Applications, Poster Presentation, Arctic Change 2014 / ArcticNet ASM 2014, December 8-12, 2014, Ottawa, ON, 1, Published

Gantner, N., Ross, D., Wrona, F.J., diCenzo, P.D., Hille, E. and Reist, J.D., 2011, Trophic Interactions in Northwestern Canadian Tundra Lakes - Can Climate Induced Permafrost Thaw Slumping affect Fisheries Habitat?, Canadian Conference For Fisheries Research (CCFFR), January 6-8, 2011, Toronto, Ontario, Canada, 1, Published

Gantner, N., Ross, D., Wrona, F.J., Hille, E., Peters, D.L., di Cenzo, P.D., de Rham, L., Prowse, T.D. and Reist, J., 2011, Trophic Interactions in Northwestern Canadian Tundra Lakes - Can Climate Induced Permafrost Thaw Slumping affect Fisheries Habitat?, NWT International Polar Year (IPY) Results Conference, January 19-21 2011, Inuvik, NT, 1, Published

Hille, E., Peters, D.L., Wrona, F.J. and Kokelj, S., 2012, The Hydrological and Geochemical Responses of Tundra Lake Catchments to Shoreline Retrogressive Thaw Slumping in the Upland Region North-East of Inuvik, NT, Canada, IPY 2012: From Knowledge to Action, April 22–27, 2012 Montreal, QC, 1, Published

Hille, E., Peters, D.L., Wrona, F.J. and Kokelj, S., 2012, Validation of Two Simple Evaporation Models for Tundra Upland Lakes, Inuvik, NT, Canada, IPY 2012: From Knowledge to Action, April 22–27, 2012, Montreal, QC, 1, Published

Hille, E., Peters, D.L., Wrona, F.J. and Kokelj, S., 2013, Catchment-level Processes Driving the Geochemistry of Small Tundra Lakes affected by Shoreline Retrogressive Thaw Slumping, Mackenzie Delta Uplands, NT, ArcticNet 2013 ASM, December 9-13, Halifax, NS, Canada, 1, Published

Linton, H.C., Prowse, T.D., Dibike, Y.B. and Bonsal, B.R., 2012, Spatial and Temporal Trends in Hydro-climatic Variables Across the Mackenzie River Basin, ArcticNet ASM 2012, December 10-14, 2012,Vancouver, BC, 1, Published

Linton, H.C., Prowse, T.D., Dibike, Y.B. and Bonsal, B.R., 2012, Climatic Redistribution of Western Canadian Water Resources (CROCWR): Spatial and temporal variation in the hydro-climatology of Western Canada, American Geophysical Union Fall Meeting 2012. December 3-7, 2012, San Francisco, California, 1, 1, Published

Linton, H.C., Prowse, T.D., Dibike, Y.D. and Bonsal, B.R., 2013, Temporal and Spatial Variations in Hydroclimatic Variables Affecting Streamflow Across Western Canada: A CROCWR Component, Annual Meeting of the Canadian Geophysical Union, the Canadian Water Resources Association, and Canadian Meteorological and Oceanographic Society, May 26-30, 2013, Saskatoon, SK, Canada, 1, Published

Moquin, P., Wrona, F.J., di Cenzo, P.D., Gareis, J., Hurst, W. and Ross, D., 2012, Bacterial Production in Response to Thermokarst Slumping: An Experimental Approach, ArcticNet ASM 2012, December 10-14, 2012,Vancouver, BC, 1, Published

Moquin, P.A., Mesquita, P.S., Wrona, F.J. and Prowse, T.D., 2013, Responses of Benthic Invertebrate Communities to Shoreline Retrogressive Thaw Slumps in Arctic Upland Lakes, ArcticNet 2013 ASM, December 9-13, Halifax, NS, Canada, 1, Published

Newton, B.W. and Prowse, T.d., 2012, Methods in Synoptic Climatology: Principal Components Analysis and Self-Organizing Maps, 2012 Annual Meeting of the Western Division, Canadian Association of Geographers, Kelowna, BC., 1, Published

Newton, B.W., Linton, H.C., Prowse, T.D. and Bonsal, B.R., 2014, Atmospheric Drivers of Spring Snowmelt Trends on the Headwaters of the Mackenzie River, NSERC CREATE Connaught Summer Institute in Arctic Science, July 2014, Alliston, Ontario, 1, Published

Newton, B.W., Prowse, T.D. and Bonsal, B.R., 2012, The Role of Synoptic Climatology on Rivers Originating on the Leeward Slopes of the Rocky Mountains in Canada, CGU-CWRA Joint Conference, Banff, AB, June 2012, 1, Published

Newton, B.W., Prowse, T.D. and Bonsal, B.R., 2012, The Influence of Teleconnections on Synoptic-Scale Circulation Patterns Affecting Western Canadian Water Resources, NOAA's 37th Annual Climate Diagnostics and Prediction Workshop in Ft. Collins, Colorado, October, 2012, 1, Published

Newton, B.W., Prowse, T.D. and Bonsal, B.R., 2012, Redistribution of Western Canadian Water Resources (CROCWR): The Role of Synoptic-Scale Circulation on Rivers Originating on the Leeward Slopes of the Rocky Mountains, AGU Fall meeting, San Francisco, CA, December 2012, 1, Published

Newton, B.W., Prowse, T.D. and Bonsal, B.R., 2013, Synoptic-Scale Circulation Characteristics Controlling Water Availability in Western Canada: A CROCWR Component, Annual Meeting of the Canadian Geophysical Union, the Canadian Water Resources Association, and Canadian Meteorological and Oceanographic Society, May 26-30, 2013, Saskatoon, SK, Canada, 1, Published

Newton, B.W., Prowse, T.D., and Bonsal, B.R., 2012, Atmospheric Circulation Patterns Affecting Water Availability of Rocky Mountain Tributaries to the Mackenzie River, ArcticNet ASM 2012, December 10-14, 2012,Vancouver, BC, 1, Published

Paquette-Struger, B., Wrona, F.J., Prowse, T.D., di Cenzo, P.D., Moquin, P., de Rham, L., Hille, E., Ross, D., Hurst, W. and Lennie, J., 2012, Geochemical, Biological and Limnological Responses of Arctic Lakes in Relation to a Changing Cryosphere, ArcticNet ASM 2012, December 10-14, 2012,Vancouver, BC, 1, Published

Peters, D.L., Hille, E., Wrona, F.J. and Kokelj, S.V., 2013, Hydrology of Arctic Tundra Lakes in a Region Impacted by Permafrost Disturbance, ArcticNet 2013 ASM, December 9-13, Halifax, NS, Canada, 1, Published

Peters, D.L., Turner, K., Hille, E., Wrona, F.J. and Kokelj, S.V., 2014, Isotope Hydrology of Arctic Tundra Lakes in a Region Impacted by Permafrost Disturbance, Poster Presentation, Arctic Change 2014 / ArcticNet ASM 2014, December 8-12, 2014, Ottawa, ON, 1, Published

Prowse, T.D., Wrona, F.J., de Rham, L., di Cenzo, P.D., Barrett, D., Dibike, Y. and Saloranta, T., 2014, A Program to Evaluate Changing Northern Lake Ice Regimes, Poster Presentation, Arctic Change 2014 / ArcticNet ASM 2014, December 8-12, 2014, Ottawa, ON, 1, Published

Wrona, F.J. and Prowse, T.D., 2013, Effects of a Changing Cryosphere on Northern Lentic Ecosystems, The Arctic Science Summit Week 2013, April 13-19, 2013, Krakow, Poland, 1, Published

Wrona, F.J., Prowse, T.D., diCenzo, P.D., deRham, L., Peters, D. and Dibike, Y., 2014, Effects of a Changing Cryosphere on the Hydrology, Geochemistry and Ecology of Western Arctic Tundra Lakes, Invited presentation, Joint Aquatic Sciences Meeting 2014 (JASM 2014) – Binding Genes to Ecosystems: Aquatic Science at a Time of Rapid Change, May 18-23, 2014, Portland, Oregon, USA, 1, Published

Wrona, F.J., Prowse, T.D., McCauley, E., Peters, D.L., Reist, J., dicenzo, P.D., de Raham, L., Hille, E., Ahmed, R., Newton, B., Linton, H., Moquin, P., Paquette-Struger, B. and Kokejl, S., 2012, Hydrol-Ecological Responses of Arctic Freshwater Systems to a Changing Cryosphere, ArcticNet ASM 2012, December 10-14, 2012,Vancouver, BC, 1, Published

Specialized Publications

Ahmed, R., 2015, Spatio-temporal Variation in the Spring Freshet of Major Circumpolar Arctic River Systems, Master's Thesis, University of Victoria, Victoria, BC, 334p, Published

Brooks, R.N., Prowse, T.D., O'Connell, I.J., 2011, Developing a Freshwater Ice Thickness Model for the Northern Hemisphere, Poster presented at Open Science Conference of the World Climate Research Program, Oct 24-28, 2011. Denver, Colorado. *WCRP Outstanding Poster Presentation certificate; *Top five scientific contributions for the entire WCRP by early-career scientists and students, 1, Published

Hille, E., Peters, D., Wrona, F.J., Kokelj, S., 2011, The Effects of Permafrost Disturbance on Lake Water Quantity and Quality, ArcticNet IRIS 1 & FJMC Community-Based Monitoring Workshop, Inuvik, NT, April, 2011. (poster), 1, Published

Hille, E., Peters, D., Wrona, F.J., Kokelj, S., 2011, Climatic Factors Driving the Hydrological and Geochemical Responses of Arctic Tundra Lakes to Landscape Perturbation, Canadian Geophysical Union Annual Scientific Meeting, Banff, AB, May, 2011. (poster), 1, Published

Hille, E., Peters, D., Wrona, F.J., Kokelj, S., 2011, Climatic Factors Driving the Hydrological and Geochemical Responses of Arctic Tundra Lakes to Landscape Perturbation, Inuvik Petroleum Show, June, 2011. (poster), 1, Published

Linton, H.C., 2014, Spatial and Temporal Variations in Hydroclimatic Variables Affecting Streamflow Across Western Canada, Master's Thesis, University of Victoria, Victoria, BC, 453p, Published

Moquin, P., 2011, Effects of Shoreline Retrogressive Thermokarst Slumping on the Productivity and Food Web Structure of Upland Arctic Lakes – An Experimental Approach, M.Sc. Thesis, Department of Geography, University of Victoria, 115 pp., Published

Newton, B.W., 2013, Evaluating the Distribution of Water Resources in Western Canada using a Synoptic Climatological Approach, MSc Thesis, December 2013, Department of Geography, University of Victoria, 138p, Published

von de Wall, S.J., 2011, An Assessment of the River Ice Break-up Season in Canada, M.Sc. Thesis. Department of Geography, University of Victori,, 84 pp, Published

Wrona F.J., Prowse, T.D., McCauley, E., Peters, D.L., Kokelj, S.V., di Cenzo, P.D., Dibike, Y., de Rham, L., Flanagan, K., Gantner, N., Mesquita, P.S., Thompson, M.S., Hille, E., Moquin, P., 2011, Arctic Tundra Lakes: Ecosystems in Transition, ArcticNet IRIS 1 & FJMC Community-Based Monitoring Workshop, Inuvik, NT, April 2011, 1, Published