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EDUCATION

- M.A.Sc., University of British Columbia, 2003, Department of Forest Resources Management (Hydrology)
- B.Eng., Royal Military College, 1991, Faculty of Engineering (Mechanical)

PROFESSIONAL HISTORY

- Hydrologist/Lead, Hydrologic Impacts, Pacific Climate Impacts Consortium, 2009-present: *Investigated impacts of climate change on hydrology and water resources; development of long-term climate change projections for water planning; development of long term driving data sets for hydrologic modeling studies; first-order investigation of climate change impacts on glacier melt and mass balance; communication and extension activities; Lead, Hydrologic Impacts Theme from 2010 to present.*
- Hydrologic Modelling Scientist, River Forecast Centre, BC Ministry of Environment, 2005-2009: *Modelling impacts of Mountain Pine Beetle infestation in the Fraser River basin, BC; seasonal runoff forecasting; set-up, calibration and validation of the UBCWM for drainages in BC; short-lead streamflow forecasting for BC rivers.*
- Consultant (hydrology), 2002-2005: *Hydrologic and water resources modelling; field meteorological and hydrometric data collection and management; data QA/QC; development of stream flow data sets.*
- Research Scientist, University of British Columbia, Faculty of Forestry, 2003-2005: *Investigation of forest harvesting and wildfire effects on streamflow and design flood events; water resources modelling.*
- Officer, Canadian Armed Forces, 1991-2000: *Participated in the strategic planning and co-ordination of military operations while working at the National Defence Headquarters, Ottawa, ON. Directed a \$12.5M equipment installation project at four military bases across Canada. Planned and led small unit operations during NATO field training exercises in Germany and as part of the United Nations Protection Force (UNPROFOR) in Bosnia.*

PUBLICATIONS AND EXTENSION

Peer Reviewed Publications:

- Werner, A.T., **M. A. Schnorbus**, R. R. Shrestha, A. J. Cannon, F.W. Zwiers, G. Dayon, and F. Anslow (2019). A long-term, temporally consistent, gridded daily meteorological dataset for northwestern North America. *Scientific Data*, 6, 180299.

- Snauffer, A M., W.W. Hsieh, A.J. Cannon, and **M.A. Schnorbus** (2018). Improving gridded snow water equivalent products in British Columbia, Canada: multi-source data fusion by neural network models. *The Cryosphere*, 12, 891–905, doi:[10.5194/tc-12-891-2018](https://doi.org/10.5194/tc-12-891-2018).
- Shrestha, R. R., A. J. Cannon, **M. A. Schnorbus**, and F.W. Zwiers (2017). Projecting future nonstationary extreme streamflow for the Fraser River, Canada. *Climatic Change*, 145, 289–303, doi:[10.1007/s10584-017-2098-6](https://doi.org/10.1007/s10584-017-2098-6).
- Shrestha, R.R., **M.A. Schnorbus**, D.L. Peters (2016). Assessment of a hydrologic model’s reliability in simulating flow regime alterations in a changing climate, *Hydrological Processes*, 30(15), doi: 10.1002/hyp.10812.
- Shrestha, R.R., **M.A. Schnorbus** and A.J. Cannon (2015). A dynamical climate model driven hydrologic prediction system for the Fraser River, Canada. *Journal of Hydrometeorology*, 16(3), doi: 10.1175/JHM-D-14-0167.1
- **Schnorbus, M.A.** and A.J. Cannon, (2014). Statistical Emulation of Streamflow Projections from a Distributed Hydrological Model: Application to CMIP3 and CMIP5 Climate Projections for British Columbia, Canada, *Water Resources Research* 50(11), 8907-8926, doi: 10.1002/2014WR015279.
- Shrestha, R.R., D.L. Peters, **M.A. Schnorbus** (2014). Evaluating the ability of a hydrologic model to replicate hydro-ecologically relevant indicators. *Hydrological Processes*, 28(14), doi: 10.1002/hyp.9997.
- Shrestha, R.R., **M.A. Schnorbus**, A.T. Werner, F.W. Zwiers (2014). Evaluating hydro-climatic impacts of climate change signals from statistically and dynamically downscaled GCMs and hydrologic models. *Journal of Hydrometeorology*, 15(2), doi: 10.1175/JHM-D-13-030.1.
- **Schnorbus, M.A.** and Y. Alila (2013). Peak flow regime changes following forest harvesting in a snow-dominated basin: Effects of harvest area, elevation, and channel connectivity. *Water Resources Research*, 49, doi: 10.1029/2012WR011901.
- Werner, A.T., **M. Schnorbus**, R.R. Shrestha, H. Eckstrand (2013). Spatial and temporal change in the hydro-climatology of the Canadian portion of the Columbia River basin under multiple emissions scenarios. *Atmosphere-Ocean* 51(4), 357-379.
- **Schnorbus, M.**, A. Werner and K. Bennett (2012). Impacts of climate change in three hydrologic regimes in British Columbia, Canada. *Hydrological Processes* 28(3): 1170-1189, doi: 10.1002/hyp.9661.
- Shrestha, R.R., **M.A. Schnorbus**, A.T. Werner, A.J. Berland (2012). Modelling spatial and temporal variability of hydrologic impacts of climate change in the Fraser River basin, British Columbia, Canada. *Hydrological Processes* 26, 1840-1860, doi: 10.1002/hyp.9283
- Bennett, K. E., A. T. Werner, and **M. Schnorbus** (2012). Uncertainties in hydrologic and climate change impact analyses in headwater basins of British Columbia. *Journal of Climate*, 25(17), 5711–5730, doi:10.1175/JCLI-D-11-00417.1.
- Alila, Y., R. Hudson, P.K. Kuraś, **M. Schnorbus** and K. Rasouli (2010). Reply to comment by Jack Lewis et al. on: “Forests and floods: A new paradigm sheds light on age-old controversies”. *Water Resources Research*, 46, W05802, doi:10.1029/2009WR009028
- Alila, Y., P.K. Kuras, **M. Schnorbus** and R. Hudson (2009). Forests and floods: A new paradigm sheds light on age-old controversies. *Water Resources Research*, 45, W08416, doi: 10.1029/2008WR007207.
- Redding, T., R. Winkler, P. Teti, D. Spittlehouse, S. Boon, J. Rex, S. Dube, R.D. Moore, A. Wei, M. Carver, **M. Schnorbus**, L. Reese-Hansen, S. Chatwin (2009). Mountain pine beetle and watershed hydrology. *BC Journal of Ecosystems and Management* 9(3): 33-50.

- **Schnorbus, M.A.**, and Y. Alila (2004a). Forest harvesting impacts on the peak flow regime in the Columbia Mountains of southeastern British Columbia: An investigation using long-term numerical modeling. *Water Resources Research*, 40, W05205, doi: 10.1029/2003WR002918.
- **Schnorbus, M.A.**, and Y. Alila (2004b). Generation of an hourly meteorological time series for an alpine basin in British Columbia for use in numerical hydrologic modeling. *Journal of Hydrometeorology*, 5(5), 862-882.
- Winkler, R.D., D. Spittlehouse, T. Giles, B. Heise, G. Hope, and **M. Schnorbus** (2004). Upper Pentiction Creek: How forest harvesting affects water quantity and quality. *Streamline Watershed Management Bulletin*, 8(1), 18-20.

Recent Conference Contributions

- Dayon, G. and **M. Schnorbus**, 2018: Stream temperature modelling on the Fraser River. Presented at 2018 CGU and CSSS, CIG, ES-SSA and CSAFM Joint Annual Scientific Meeting, Niagara Falls, ON, 10 –14 June.
- **Schnorbus, M.A.**, B. Menounos, A.T. Schoeneberg, F. Anslow, G. Jost and R.D. Moore, 2017: Implications of climate change for glaciated watersheds in western Canada, Abstract H41N-03, presented at 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.
- **Schnorbus, M.A.**, B. Menounos, A.T. Schoeneberg, F. Anslow, G. Jost and R.D. Moore, 2017: Improvements to a regional hydrologic model by incorporating glacier dynamics, Abstract H06-22, presented at 2017 CGU and CSAFM Joint Annual Scientific Meeting, Vancouver, BC, 28-31 May.
- Shrestha, R.R., D.L. Peters, **M.A. Schnorbus** (2015). How Robust are our Hydrologic Models in Simulating Streamflow Alterations in a Changing Climate?. *AGU fall meeting 2015*, San Francisco, California.
- Werner, A.T., **M.A. Schnorbus**, R.R. Shrestha (2015). Robust Simulation of Future Hydrologic Extremes under Climate Change, *BC-CWRA conference*, Richmond, BC.
- Shrestha, R.R., **M.A. Schnorbus**, A.J. Cannon (2015). Projecting climate change impacts on streamflow extremes using nonstationary generalized extreme value analysis. *AGU CGU Joint Assembly*, Montreal, QC.
- Peters, D.L., R.R. Shrestha, **M.A. Schnorbus**, W.A. Monk, D.J. Baird (2015). Ecological flows for a large hydroelectric reservoir regulated river system: will projected climate change bring about beneficial opportunities?. *AGU CGU Joint Assembly*, Montreal, QC.
- Werner, A.T., A.J. Cannon, **M.A. Schnorbus**, R.R. Shrestha (2015). Sources of Uncertainty in Replicating Hydro-climatic Extremes. *AGU CGU Joint Assembly*, Montreal, QC.
- **Schnorbus, M.A.** and F. Anslow (2014). Incorporation of Glacier Mass Balance Modelling in the Variable Infiltration Capacity Hydrology Model, with Application to Western Canada, *AGU Fall Meeting 2014: H43J-1090*, San Francisco, California.
- Kumar, S., M.R. Najafi, **M. Schnorbus**, R.R. Shrestha, A.T. Werner (2014). Asymmetry in hydrologic response to climate change in Western North America – A Land-Atmosphere Interactions Perspective. *AGU Fall Meeting 2014: GC11D-0589*, San Francisco, California
- Najafi, M.R., S. Kumar, F. Zwiers, N. Gillett, **M. Schnorbus**, A. Canon, R.R. Shrestha, A.T. Werner (2014), Anthropogenic Influence on Multi-Decadal Changes in Hydrology of Western Canada. *AGU Fall Meeting 2014: GC43B-0710*, San Francisco, California
- **Schnorbus, M.A.** and F. Anslow (2104). Incorporation of Glacier Mass Balance Modelling in the Variable Infiltration Capacity Hydrology Model: Application to Western Canada, *CGU Annual Scientific Meeting*, Banff, AB.

- Shrestha, R.R., D.L. Peters, **M.A. Schnorbus** (2014). Evaluating a hydrologic model simulated changes in ecologically relevant hydrologic indicators, *CGU Annual Scientific Meeting*, Banff, Alberta.
- Peters, D.L., R.R. Shrestha, **M.A. Schnorbus**, W.A. Monk, D.J. Baird (2014). Ecological Flows in a Changing Climate: Case Study of the Peace River, *CGU Annual Scientific Meeting*, Banff, Alberta.
- Shrestha, R.R., **M.A. Schnorbus** and A.J. Cannon (2013). A Dynamic Hydrologic Prediction System for the Fraser River Basin, Canada. *AGU Fall Meeting 2013: H23A-1232*, San Francisco, California.
- Werner, A.T., **M.A. Schnorbus**, R.R. Shrestha, A.J. Cannon (2013). Uncertainty in simulating hydrologic extremes using statistically downscaled climate data. *CMOS-CGU-CWRA National Conference: Session 2C9.5 ID 6583*, Saskatoon, SK.
- **Schnorbus, M.A.** and A. Cannon (2013). Statistical Emulation of Streamflow Projections: Application to CMIP3 and CMIP5 Climate Change Projections, *CMOS-CGU-CWRA National Conference: Session 2C3, ID 6498* Saskatoon, SK.

Other Publications

- Cloutier, C., J. Locat, M. Geertsema, M. Jakob and **M. Schnorbus**, 2016. Potential impacts of climate change on landslides occurrence in Canada, In Ken Ho, Suzanne Lacasse, Luciano Picarelli (Eds.), *Slope Safety Preparedness for Impact of Climate Change*, CRC Press, 572 pp
- Shrestha, R.R., **M.A. Schnorbus**, A.J. Cannon. F.W. Zwiers, 2015: Simulating the Effects of Climate Change on Fraser River Flood Scenarios – Phase 2, Final Report prepared for BC Ministry of Forests, Lands and Resource Operations, Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 57 pp.
- Hamlet, A.F., **M. Schnorbus**, A. Werner, M. Stumbaugh and I. Tohver (2012). *A climate change scenario intercomparison study for the Canadian Columbia River Basin*. Technical Report prepared for Columbia Basin Trust – NW Power and Conservation Council, 66 pp.
- Hamlet, A.F., **M. Schnorbus**, A. Werner, M. Stumbaugh and I. Tohver (2012). *A climate change scenario intercomparison study for the Canadian Columbia River Basin*. Summary Overview prepared for Columbia Basin Trust – NW Power and Conservation Council, 13 pp.
- Murdock, T.Q., S.R. Sobie, R.R. Shrestha, **M.A. Schnorbus** (2012). *Concepts and approaches for regional climate change analysis*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 39 pp.
- Sobie, S.R., T.Q. Murdock, R.R. Shrestha, **M.A. Schnorbus** (2012). *Columbia Basin regional climate change analysis for Teck Resources Limited*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 179 pp.
- **Schnorbus, M.A.**, K.E. Bennett, A.T. Werner, and A.J. Berland (2011). *Hydrologic impacts of climate change in the Peace, Campbell and Columbia watersheds*, British Columbia, Canada. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC. 155 pp.
- Zwiers, F., **M.A. Schnorbus** and G. Maruszczka (2011). *Hydrologic Impacts of Climate Change on BC Water Resources: Summary Report for the Campbell, Columbia and Peace River Watersheds*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 24 pp.
- Shrestha, R.R., A.J. Berland, **M.A. Schnorbus**, and A.T. Werner (2011). *Climate change impacts on hydro-climatic regimes in the Peace and Columbia watersheds, British Columbia, Canada*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 37 pp.

- **Schnorbus**, M. and D. Rodenhuis (2010). *Assessing hydrologic impacts on water resources in BC: Summary report, Joint workshop, BC Hydro, 20 April 2010*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 37 pp.
- **Schnorbus**, M., K. Bennett and A. Werner (2010). Quantifying the Water Resource Impacts of Mountain Pine Beetle and Associated Salvage Harvest Operations Across a Range of Watershed Scales: Hydrologic Modelling of the Fraser River Basin. *Information Report: BC-X-423*, Natural Resources Canada, Canadian Forestry Service, Pacific Forestry Centre, Victoria, BC, 79 pp.
- Alila, Y, and M.A. **Schnorbus** (2005). *Hydrologic decision making tools for sustainable forest management in rain dominated coastal BC watersheds*. Forest Investment Account, Forest Science Program, Project Y051293, Final Technical Report, 43 pp.
- **Schnorbus**, M.A., R.D. Winkler, and Y. Alila (2004). Modelling forest harvesting effects on maximum daily peak flow at Upper Penticton Creek, *Extension Note 67*. BC Ministry of Forests, Research Branch, Victoria, BC.