H01: Hydro-climatic Impacts and Adaptation

Conveners: Rajesh Shrestha[1], Yonas Dibike[1], Daniel Peters[1]

Co-chairs: Rajesh Shrestha[1], Yonas Dibike[1], Daniel Peters[1]

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Session Description

Climate change has the potential to affect the mean hydrologic state and its variability, such as the volume and extent of snowpack, the magnitude and timing of snowmelt driven spring freshet and rainfall driven stormflow, and the seasonality and extreme states of water fluxes. Coping with these likely impacts requires adaptation strategies, such as modification of current water management strategies, as well as mitigation measure, such as updating/upgrading existing water resource infrastructure.

This session aims to provide a platform for presenting research that assess the implications of climate variability/change on planning, allocation and operations of water resources, and adaptation/mitigation measures that address the potential negative/positive impacts. We seek presentations on hydro-climate impacts studies on water demand and supply, such as municipal, agriculture, hydroelectric power generation, floods and drought. Of particular interest are studies that examined adaptation/mitigation measures ranging from the local to regional scales. We also encourage contributions that address emerging implications of climate change, such as dry and wet regime changes, regional and seasonal shifts in water fluxes, change in the frequency of extreme events, effects on hydro-ecological connectivity, and new methods and tools for assessing impacts and evaluating adaptation/mitigation measures.

Primary Affiliation: Hydrology

NOTE: THIS DOCUMENT CONTAINS INFORMATION FOR ALL SESSION SUB-SECTIONS. PRESENTER ABSTRACTS ARE FOUND AT THE END OF THE DOCUMENT.

SCHEDULE MAY BE SUBJECT TO CHANGE.

ORAL SESSION H01a

Chairs: R. Shrestha, Y. Dibike & D. Peters **Room: EOSC 135**

Tuesday, May 30th

TIME	AUTHORS	TITLE
11:00	G.W.K. Moore	An assessment of the changing nature of the winter hydro-climate in Ontario and its impacts on risk management
11:15	B.W. Newton, T.D. Prowse, L.P. de Rham, T.W.D. Edwards	Extreme mid-winter hydro-climatic events in four major river basins in western Canada
11:30	P. Rokaya, L. Morales-Marin, H. Wheater & K.E. Lindenschmidt	Hydro-climatic Variability and implications for ice-jam flooding in the Athabasca River Basin in western Canada
11:45	C. Irambona, B. Music, D. Nadeau, T. Mahdi & I. Strachan	Impacts of boreal hydroelectric reservoirs on local hydroclimatology and precipitation recycling: A case study of the La Grande River watershed, Canada
12:00	Y. Dibike, A. Shakibaeinia, H.I Eum, T. Prowse & I. Droppo	Potential impacts of climate change on the hydrodynamic and sediment transport regime of the lower Athabasca River
12:15	M. Kompanizare, R. Petrone, D. Robinson & R. Rooney	Effect of climate change on hydrological connectivity among landscape units in the Athabasca Oil Sands Region

ORAL SESSION H01b

Chairs: R. Shrestha, Y. Dibike & D. Peters **Room: EOSC 135**

Tuesday, May 30th

TIME	AUTHORS	TITLE
16:00	D.L. Spittlehouse	Assessing the Risks of a Changing Climate to Forest Infrastructure
16:15	K. Siemens & T. Prowse	Applying the snowmelt runoff model to simulating streamflow for the upper Athabasca River
16:30	M.B Masud, T. McAllister, G. Goss & M. Faramarzi	Assessment of climate change impacts on crop production and water use in Alberta
16:45	M.K. MacDonald, T.A. Stadnyk, S.J Dery, M. Braun & K. Koenig	Uncertainty in runoff projections across the Hudson Bay Drainage Basin
17:00	L. Somers, J. McKenzie, S. Zipper, B. Mark, P. Lagos, O. Wigmore & M. Baraer	Climate change and enhanced recharge in a non-glacierized mountain catchment, Shullcas River, Peru
17:15	G. McDowell & M. Koppes	Principles for successful adaptation to ‘Peak Water’ in glaciated watersheds

POSTER SESSION H01

Chairs: R. Shrestha, Y. Dibike & D. Peters **Room: ESB Atrium**

Monday, May 29th

Poster No.	AUTHORS	TITLE
P02-H01	C. Muneepeerakul & R. Muneepeerakul	Optimal use of weather index insurance with traditional coping strategies across geographical scales

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SUBMITTED ABSTRACTS

H01-01: Impacts of Boreal Hydroelectric Reservoirs on Local Hydroclimatology and Precipitation Recycling: A Case Study of the La Grande River Watershed, Canada

Céleste Irambona[1], Biljana Music[1], Daniel F. Nadeau[2], Tew-Fik Mahdi[3], Ian B. Strachan[4]

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Abstract
Located in northern Quebec, Canada, the La Grande River hydroelectric complex comprises eight hydroelectric reservoirs covering a maximal area cover of 9782 km^2. This study investigates the changes brought by the impoundment of these reservoirs on the local hydroclimatology and precipitation recycling. Two 30-year climate simulations, corresponding to pre- and post-impoundment conditions, were used. They were generated with the fifth-generation Canadian Regional Climate Model (CRCM5), fully coupled to a 1D lake model (FLake). Seasonal temperatures and annual energy budget were generally well reproduced by the model, except in spring when a cold bias, probably related to the overestimation of snow cover, was observed. The difference in 2-m temperature shows that reservoirs induce localized warming in winter (+0.7 ± 0.02 °C) and cooling in the summer (−0.3 ± 0.02 °C). The available energy at the surface increases throughout the year, mostly due to a decrease in surface albedo. Fall latent and sensible heat fluxes are enhanced due to additional energy storage and availability in summer and spring. The changes in precipitation and runoff are within the model internal variability. At the watershed scale, reservoirs induce an additional evaporation of only 5.9 mm $year^{-1}$ (2%). We use Brubaker's precipitation recycling model to estimate how much of the precipitation is recycled within the watershed. In both simulations, the maximal precipitation recycling occurs in July (less than 6%), indicating weak land-atmosphere coupling. Reservoirs do not seem to affect this coupling, as precipitation recycling only decreased by 0.6% in July. [245 words]

Presentation type: Oral Presentation

H01-02: **Principles for Successful Adaptation to 'Peak Water' in Glaciated Watersheds**

Graham McDowell[1]*, Dr. Michele Koppes[2]

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Abstract: Mountain glaciers are well known for their role in regulating freshwater flows, a function crucial for the 370 million people living in glacial meltwater-influenced watersheds as well as the aquatic and riparian ecosystems shaped by meltwater streams. The 'peak water' hypothesis suggests that a warming climate will increase glacial melt runoff until a discharge peak is reached; discharge will then decrease to levels less than pre-warming values as glaciers shrink. This idealized pattern of glacio-hydrological change is beginning to inform adaptation planning across many glaciated mountain ranges. However, i) the physical basis of this theory may not be relevant in certain contexts, ii) a purely physical/hydrological basis for adaptation planning is likely to be insufficient, and iii) a predominant focus on human drinking water and hydropower needs may lead to adaptation plans that do not adequately address the vulnerability of aquatic and riparian ecosystems to glacial change. For these reasons, we propose three general principles aimed at informing successful adaptation to glacio-hydrological change in glaciated watersheds. These principles are based on a synthesis of the literature on human dimensions of climate change and socio-ecological systems. Principle 1: Physically-based glacio-hydrological insights are essential for anticipatory adaptation planning, but the validity of peak water as a basis for adaptation initiatives should not be assumed; it must be based on the analysis of watershed-specific glaciological and hydro-meteorological conditions. Principle 2: Adaptation planning for glacio-hydrological change should consider the complex interplay between environmental change and existing socio-economic, cultural, and political conditions; relationships between people and the environment are non-linear, non-deterministic, and therefore not deducible from hydrological models alone. Principle 3: To avoid mal-adaptation, responses to glacio-hydrological change must be attentive to tradeoffs and complementarities between human and ecological water needs; here, a socio-ecological systems approach provides a well-established framework for research and adaptation planning.

Presentation type: Oral presentation

H01-03 An assessment of the changing nature of the winter hydro-climate in Ontario and its impacts on risk management

G.W.K. Moore[1]

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Abstract

The winter hydro-climate of Ontario is characterized by a complex and spatially varying combination of snow and rain. Much of this complexity stems from the presence of Great Lakes that are a source of heat and moisture during the winter months. Lake effect snowfall can result in heavy snowfall in localized downstream regions. In addition the average mean winter temperature in the region is close to freezing and so there is enhanced sensitivity as to the phase of the precipitation. The region has warmed by 1-2.5 ^{o}C during the winter over the past 30 years and so there is concern that the character of the winter hydro-climate may be changing. Here we use analysis and reanalysis fields as well as the results of AMIP model runs, with horizontal resolutions ranging from 100 km to 9 km, to investigate the changes that have occurred in the winter hydro-climate of the region. It is shown that a horizontal resolution below ~40 km is needed to resolve the observed spatial gradients in snowfall and rainfall in the region. Over the past 30 years, the mean and 95th percentile snowfall rates in the southern part of the region have decreased by as much as 20% with an increase of a similar magnitude in both these parameters in its northwest. There has also been an increase in the mean and 95th percentile rainfall rates across much the region that exceeds 100% in the vicinity of Lake Superior, the largest and most northern of the Great Lakes. These changes are attributed to the warming that the region has experienced and are expected to continue into the future. They have and will continue to impact a number of societal functions including winter road maintenance as well as influencing the management of property risks such as flooding. [299 words]

Presentation type: Oral Presentation

H01-04 **Effect of climate change on hydrological connectivity among landscape units in the Athabasca Oil Sands Region**

Mazda Kompanizare[1], Rich Petrone[2], Derek Robinson[2], Rebecca Rooney[3]

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Abstract

Reclamation of impacted boreal environments requires the maintenance of hydrologic conditions that ensure pre-disturbance ecological and hydrological functioning. In such environments, hydrological connectivity of the surface layers among landscape units (i.e. forests, wetlands, ponds) has an important role. To assess the effect of climate change on hydrologic connectivity, we simulated the surface and groundwater flow in a selected watershed in the Athabasca Oil Sands Region using the model GSFLOW. The area was divided into 2388 (2 x 2 km) hydrologic response units. The model was calibrated for the period of Jan 1979 to July 2014, using a parallel-DDS method in Ostrich (Matott, 2016). The calibration was done through a multi-objective function, using daily, monthly, annual and total streamflow and snow depth in eight sub-basins. We then forecast surface and groundwater flows through 2014 to 2080, based on the expected gradual increase in precipitation and temperature for this region (IPCC 2013). In each scenario, daily precipitation and temperature were generated for 40 points using the Markov Random Space method and cyclostationary functions, respectively. The hydrologic connectivity among units was calculated according to preferential-flow reservoir storage and cascading connection. We examined the daily spatio-temporal distribution of hydrological connectivity in our study area, and found that the daily proportion of connected units expanded by over 30%, beginning about 20 days sooner and ending about 30 days later in 2080 than in 2016. Additionally, we found that the proportion of each year that each unit was connected increased throughout much of the sub-watershed by at least 5%, and in some areas by as much as 20% over the current duration of hydrological connectivity. In summary, we predict that surficial layers will be hydrologically connected on average for 15% longer in the future, with consequences for reclamation and water supply. [295 words]

Presentation type: Oral Presentation

H01-05 **Climate change and enhanced recharge in a non-glacierized mountain catchment, Shullcas River, Peru**

Lauren Somers[1*], Jeffrey McKenzie[1], Samuel C. Zipper[1], Bryan Mark[2], Pablo Lagos[3], Oliver Wigmore[4], Michel Baraer[5].

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Abstract

As Andean glaciers rapidly retreat due to climate change, the balance of groundwater and glacial meltwater sources to stream discharge in tropical, proglacial watersheds will change, potentially increasing vulnerability of water resources. We aim to examine both the relative influence of groundwater on Andean stream flow, and the processes of precipitation infiltration. The Shullcas River watershed, near Huancayo, Peru, is fed only partly by the rapidly receding Huaytapallana glaciers; our hydrochemical mixing model shows 2014 dry season flow was <20% glacier melt. To potentially increase precipitation infiltration and therefore increase groundwater derived baseflow, the regional government and not-for-profit partners have installed trenches along large swaths of hill slopes in the Shullcas watershed. Our study focuses on a non-glacierized sub-catchment of the Shullcas River watershed, and has two objectives: (1) create a model of the Shullcas groundwater system and assess the controls on stream discharge; and (2) investigate the impact of the infiltration trenches on recharge and baseflow in the catchment. We first collected hydrologic data from the field including a longitudinal discharge profile (August 2016), a year-long hydrograph (2015-2016), meteorological measurements (2011-2016), and spot infiltration measurements. We then constructed a three-dimensional groundwater model, calibrated to the measured dry season baseflow. Finally, we use a one-dimensional model to evaluate the impact of trenched hillslopes on infiltration and runoff processes. Simulations show that trenched hillslopes received approximately 8% more recharge, relative to precipitation, compared with unaltered hillslopes. A one way coupling of the recharge model to the regional groundwater model of the basin indicates that incorporating trenched hillslopes (~2% of basin area) slightly increases baseflow in the mid-late rainy season but has negligible impact on dry season base flow. The results of this study may have important implications for Andean landscape management and water resources. [293 words]

Presentation type: Oral Presentation

H01-06 Simulations of hydro-climate variables on the Great Lakes basin based on future climate scenarios using a Regional Climate Model

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Abstract
Changes in the future hydro-climate regime of the Great Lakes are an important area of study at Environment and Climate Change Canada (ECCC) as these changes will have significant impact on the environment, economy, and overall quality of life of the region.

Unfortunately, the current resolution of General Circulation Models (GCMs) generally result in the Great Lakes not being modelled as water bodies. Thus, regional climate model (RCM) results are crucial in properly simulating the unique nature of the area given the large percentage of lake area in the basin. Although simulations from GCMs using the CMIP3 series of future climate scenarios have been produced for a few years, only recently have results been available from RCMs based on the CMIP5 scenarios.

For this study, current and future climate simulations of temperature and precipitation are used to run the hydrological model WATFLOOD, which has a long history of simulations in the Great Lakes basin. The climate simulations are based on CMIP5 scenarios driven by various members of the Coordinated Regional Climate Downscaling Experiment (CORDEX) for both the RCP4.5 and RCP8.5 scenarios.

The results of the hydrological model are examined on a monthly basis in terms of differences between the current climate and future climate simulations. The hydro-climate variables examined are streamflow (both in terms of overall total as well as both higher extremes and extended low flow), snow water equivalent, evaporation, soil moisture, and finally Great Lake water levels.

Presentation type: Oral Presentation

H01-07 Optimal use of weather index insurance with traditional coping strategies across geographical scales

Chitsomanus Muneepeerakul[1] and Rachata Muneepeerakul[1]

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Abstract
In coping with impacts of climate uncertainty on agriculture, weather index insurance can provide farmers with additional financial resilience at low transaction cost, while avoiding moral hazard and adverse selection that plague traditional crop damage-based insurance. However, there are instances that weather index insurance causes unintended consequences, namely preferences for monoculture and non-irrigated land. We argue that this is not necessarily the case as weather index insurance pays indemnity solely based on the climate outcomes and not the actual crop damage, allowing, in theory, farmers' creativity to benefit from good agricultural practices. This research demonstrates an optimal use of index insurance with traditional coping strategies, namely crop diversification and irrigation, under various climatic and financial settings from an individual farm level to larger collective scales.

Presentation type: Oral Presentation

H01-08 Hydro-climatic Variability and implications for ice-jam flooding in the Athabasca River Basin in western Canada

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Abstract
The flow regimes of northern rivers are influenced by river ice processes, including ice jams, which often lead to much higher water levels than open water conditions. The breakup of ice covers is particularly effective in replenishing the higher elevation basins of inland deltas such as the Peace-Athabasca Delta, a socio-economically and ecologically important delta in western Canada. However, streamflows in the Athabasca River have been continually decreasing, which has impeded the mechanical breakup of ice jams, resulting in a reduced frequency of ice-jam floods. This paper studies hydro-climatic variability and its implications for river ice processes, including ice-jam flooding, in the Athabasca River basin. A minimum breakup flow was established using a 1D numerical model and future flows were simulated using the Canadian Regional Climate Model, driven by two different global circulation models. The study enhances our understanding of the effects of climate change on ice-jam flooding, especially in the case of northern rivers where climate change is most pronounced and where river systems are comparatively more vulnerable to the changing climate.

Keywords: Ice-jam floods; Athabasca river; hydro-climatic variability; RIVICE; MESH

Presentation type: Oral Presentation

H01-09 Uncertainty in runoff projections across the Hudson Bay Drainage Basin

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Abstract
The Hudson Bay Drainage Basin (HBDB) comprises over a third of Canada's land mass and contains important hydroelectric infrastructure and agricultural land. Projecting future runoff in the HBDB is critical for forecasting generating potential and irrigation supplies. Projected changes to the HBDB runoff regime are characterized for 2021-2070 relative to a 1981-2010 reference period with a regional implementation of the Arctic-HYPE continental scale hydrological model. Existing flow regulation practices are held constant. Historical calibration is performed over a split-sample period from 1971-2005 to span the range of climatic conditions. Nineteen simulations from the CMIP5 climate modeling experiment are used for meteorological forcing. Results from both representative concentration pathway (RCP) 4.5 and 8.5 scenarios are discussed. Annual runoff over the majority of the HBDB is projected to increase from the reference period, with greatest increases projected to occur in Québec and on Baffin Island. Agreement in the sign of change in runoff projections across the HYPE-CMIP5 simulations is greatest in the most northern regions of the HBDB, with over 90% of simulations agreeing on increased runoff. Little change in annual runoff is projected to occur across the southwestern HBDB (Alberta through northwestern Ontario). Runoff projections are most uncertain in this region because the extent to which enhanced evaporation will offset precipitation projection is indeterminate. Simulations under RCP 8.5 scenarios provide greater runoff increases and stronger agreement than the RCP 4.5 simulations in the northern and eastern parts of the HBDB, but weaker agreement across the southwest. These results have implications for future floods, water supply and water resources management for hydroelectric generating capacity in Canada.

Presentation type: Oral Presentation

H01-10 Assessment of climate change impacts on crop production and water use in Alberta

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Abstract
Water and food security is a challenging issue for sustainable environmental management, especially when water and food demands are moving in the opposite directions under the influence of climate change. Alberta is an important region for crop production in Canada, and it has an export-oriented economy which is highly connected to water. However, as like other semi-arid regions in the world this region is facing water use challenges. In this study, we attempt to conduct a provincial scale comprehensive research on the potential impact of prospective climate change on crop production and crop water use for the 2041-2065 period against historical 1985-2009 period using an ensemble of Global Climate Models and Representative Concentration Pathways. This study is developed, to model rainfed and irrigated barley yield and consumptive water use with uncertainty analysis, based on a previously calibrated and validated hydrological model of Alberta. Crop water consumption, which is the ratio of evapotranspiration and yield, is assessed in terms of blue and green water use in crop production. A physically process based semi-distributed model Soil Water Assessment Tool is used at a sub-basin level, and the results are then aggregated at a municipal level to address broader implications. The results of this study are helpful in identifying climate change induced hot spots, where crop production is affected and formulating adaptive measures at the municipal level.

Presentation type: Oral Presentation

H01-11 Assessing the Risks of a Changing Climate to Forest Infrastructure

David L. Spittlehouse

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Abstract
Future changes in temperature and precipitation could increase the risk of damage to forest infrastructure such as culverts, roads and bridges. Engineers Canada's protocol to evaluate infrastructure vulnerability was applied to the In-SHUCK-ch and Tum Tum forest roads in southern BC. The evaluation was challenged by the limited amount of historic weather and hydrologic data for remote areas. Downscaled global climate model projections and hydrologic modelling were available from the Pacific Climate Impacts Consortium. By 2050s, the region will experience increases in temperature of 2 to 4C, 5 to 15% increase in winter precipitation and 10 to 25% decrease in summer precipitation. 1 in 20 year warm temperature extremes will become 1 in 5 year events and 1 in 20 year precipitation extremes become 1 in 10 year events. The 20-year return 1- and 3-day annual maximum precipitation is projected to increase by 10 to 30%. An increase in fall and winter precipitation will not be sufficient to offset the effect of warming on the winter snow regime resulting in lower snow packs and a shorter snow season. Early snow melt will result in earlier peak flow and annual and daily maximum discharge could increase in some areas. There will also be an increase in the risk of landslides and debris flows. These changes indicate a potential need for larger stream crossings (culverts and bridges). Changes in freeze/thaw conditions, snow cover and precipitation intensity this will affect road surface maintenance. A shorter snow season along with warmer summers and reduced precipitation result in an increase in the risk of forest fire and the risk to infrastructure.

Presentation type: Oral Presentation preferred but poster OK

H01-12 Potential Impacts of Climate Change on the Hydrodynamic and Sediment Transport Regime of the Lower Athabasca River

Yonas Dibike[1], Ahmad Shakibaeinia[2], Hyung-Il Eum[3], Terry Prowse[1], and Ian Droppo[4]

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Abstract
The potential effects of a changing climate on the hydrodynamic and sediment transport regime of the lower Athabasca River (LAR) in Alberta are investigated. Future climate scenarios for the region suggest a potential increase in mean air temperature and precipitation by about 2.8 - 7.1oC and 8 - 25 % respectively by 2071-2100 (2080s) compared to the 1971-2000 (1980s) baseline period. These climatic changes are projected to cause significant shift in the hydrologic regime of the LAR with spring flows expected to increase by about 11-62% and 26-71% by the end of the century for a moderate and high emissions scenarios respectively with corresponding decreases in summer flows. The effects of such changes are examined using the MIKE-11 hydrodynamic and sediment transport modelling system with inflow boundary conditions corresponding to the changing hydro-climatic regime. The results suggest that there will be an overall increase in flow velocity, water level and, suspended sediment concentration (SSC) and transport for most seasons except in the summer months when there may be some decreases. The projected changes in SSC will result in an overall increase in mean annualsediment load in the LAR and to the Peace Athabasca Delta (PAD) by over 50% towards the latter part of this century (2080s) compared to the 1980s base-line period. Implications of such potential changes in the transport characteristics of the river system to the mobilization and transport of various chemical constituents and their effects on the region's aquatic ecosystems are subjects of other ongoing investigations.

Presentation type: Oral Presentation

H01-13 Assessing thermal habitat management strategies using the process-based Ecofish Water Temperature Model (ETMP)

David West[1] & Yehya Imam[1]

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Abstract
Changes in watershed land use, flow management, and climate can significantly alter aquatic thermal habitat. Salmonids are particularly sensitive to these changes due to their complex life-stages and narrow thermal tolerances. Stream temperature models can assist managers in quantifying the magnitude of impacts and assessing mitigation options. However, existing models often have too coarse of resolution or are too data intensive. As such, we have developed a process-based stream temperature model (ETMP) suitable for modelling each component of the stream heat budget. To model heat transport in streams, ETMP simulates the downstream and temporal evolution of flow velocity, flow area, and surface width using the kinematic-wave approximation of the one-dimensional unsteady hydraulic equations. While heat is transported along the stream, ETMP simulates heat transfer due to solar radiation, long-wave radiation, latent and sensible heat flux, friction, conduction through the streambed, inflows, and any in-pipe flow. The model relies on measured or estimated hydraulic geometry, shade conditions, cloud cover fraction, air temperature, relative humidity, wind speed, atmospheric pressure, inflow temperatures, and groundwater temperature. We have applied ETMP to assess the effects of six hydroelectric projects including run-of-river and reservoir storage with 15 min time step, 50 m nodal spacing, and validation accuracies of 0.5 - 1.0ºC RMSE. The model has supported the design of flow regimes that minimize impact on various life-stages of salmonids by assessing economic and ecological trade-offs. Current model developments include integration of a more robust shade model, hyporheic exchange model, and ice formation prediction. [246 words]

Presentation type: Oral Presentation

H01-14 Applying the Snowmelt Runoff Model to Simulating Streamflow for the Upper Athabasca River

Kyle Siemens[1]* and Terry Prowse[2]

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Abstract
The Snowmelt Runoff Model (SRM) is a simple conceptual hydrological model intended for application in snowmelt dominated basins. It has been used in over 100 basins worldwide. Three variables are required to run the model: snow cover area, air temperature, and precipitation. The use of remotely sensed snow cover area provides reduced uncertainty in snow melt estimates over attempts to estimate snow cover based on observed meteorological variables. Use of a degree-day model to determine melt volume allows the model to be applied in basins where observations are sparse and temperature is likely to be one of the few variables measured. Here we apply SRM to simulate discharge for the Upper Athabasca River basin, using the observed discharge at the Hinton stream gauge to calibrate and verify the model. Snow cover area was derived from the MOD10 snow product produced by the National Snow and Ice Data Centre (NSIDC), creating a 250 m grid of snow cover fraction over the study region. The ANUSPLIN dataset was utilized to provide historical temperature and precipitation input to the model. The ~10 km resolution ANUSPLIN dataset was linearly interpolated onto the snow cover fraction grid. There are several parameters that must be determined prior to running the model. Initial estimates could be determined for several parameters based on historical discharge and meteorological data. Parameters were further refined by running a calibration algorithm over several calibration years, and manually making small adjustments to best simulate the hydrograph. The calibrated model was then run over several verification years to assess model performance, and determine the suitability of the model for predicting runoff under future climate scenarios. Overall, results were highly promising for use in assessing the hydrological effects resulting from a warming climate and modified snow regimes. [292 words]

Presentation type: Poster

H01-15 Extreme mid-winter hydro-climatic events in four major river basins in western Canada

Brandi W. Newton[1*], Terry D. Prowse[2], Laurent P. de Rham[2], and Thomas W. D. Edwards[3]

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Abstract
Winter snowpack provides the majority of annual streamflow to the Fraser, Peace, Athabasca, and Saskatchewan Rivers, particularly in the mountain headwater regions of these basins. Above-freezing air temperatures and rain on snow during the winter can generate a number of hydro-climatic extremes including the premature or mid-winter break-up of river ice, flooding, and avalanches, and can lead to snowpack depletion, affecting spring/summer meltwater runoff volume. This research evaluates trends in winter (Dec-Feb) above-freezing mean and maximum surface air temperatures and frequency of winter days with rain on snow from 1946 to 2012 using a high-resolution gridded dataset. Rain on snow is evaluated using a temperature-index model that treats precipitation on days above a certain threshold (critical temperature) as rain and below the threshold as snow. Furthermore, the rain on snow model is preceded by a temperature-index autumn snow accumulation model with a critical temperature of 1°C to ensure there is snow on the ground at each grid point prior to running the rain on snow model. Results indicate statistically significant increases in mean daily temperatures above 0°C in the headwaters of the Fraser, Peace, Athabasca and Saskatchewan rivers and widespread increases in maximum daily temperatures above 0°C in all basins. Results from the rain on snow model indicate an increasing frequency of days when rain on snow is projected to have occurred in the headwaters of the Fraser, Peace, and Athabasca Rivers while rain on snow does not appear to be an important process in the Saskatchewan River basin. These results are consistent with known mid-winter river ice break-up events in these four basins and provide basin-wide descriptions of climatic conditions that triggered the break-up events. [276]

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