

**HYDROLOGIC IMPACTS  
MEETING REPORT**



**PACIFIC CLIMATE  
IMPACTS CONSORTIUM**

## INTRODUCTION

On Monday, March 3rd, 2014, the Pacific Climate Impacts Consortium (PCIC) held the final of three meetings focused on the themes of the consortium. These meetings are intended to both introduce some of the latest work of the themes, but also to gather feedback from users of the themes' work regarding modifications of planned work, or directions for the future activities. Each theme lead undertakes a biannual research planning process which defines concrete work targets for the coming two years and a broader direction for the three years following. The input gathered from users can help guide what should be added (or removed) from these research plans. This latest meeting focused on the Hydrologic Impacts (HI) theme, which is tasked with quantifying the hydrologic effects of climate change and climate variability within the Pacific and Yukon region of Canada.

## ATTENDEES

The attendees of the HI theme's meeting were selected for two purposes. First, they were chosen based on their potential to benefit from the activities of the HI theme and the possibility that they weren't familiar with that work. Second, it was hoped that invitees would be able to understand and provide critical feedback to the work presented at the meeting and to provide feedback and guidance regarding future activities. The invitees were comprised of private sector contractors/consultants, members of BC Hydro, members of Environment Canada and Fisheries and Oceans Canada, employees of various provincial ministries and regulators responsible for water management, representatives from non-government agencies, and members of local government.

## WHAT WAS PRESENTED?

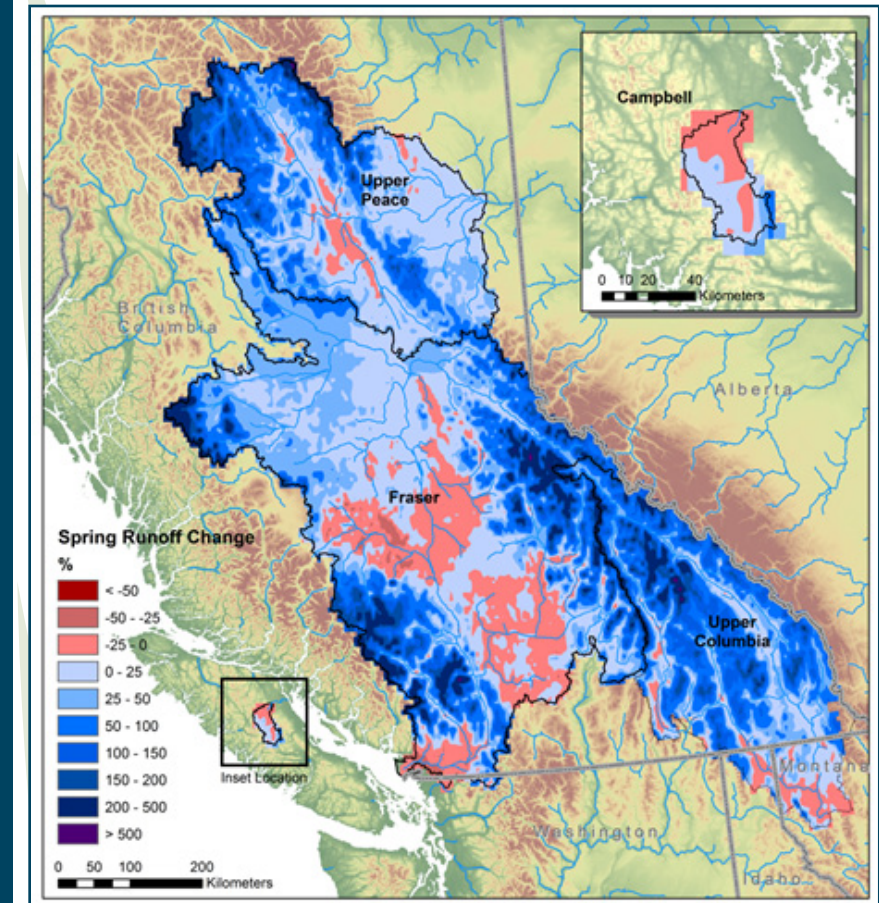
The format of the meeting was seminar style. The meeting consisted of four formal presentations, including time for questions and answers, followed by a lengthy discussion period. The overall arc of the meeting began with presenting the past and current work of the theme, providing a user perspective on using climate change scenarios in water resources management, followed by an exploration of available data products. This was followed by a plenary discussion with the aim of addressing how the hydrologic impacts theme can best serve the public.

The first presentation of the day was given by Markus Schnorbus, Lead of the Hydrologic Impacts Theme at PCIC, who presented on the past work and recent progress of the theme. The presentation focussed mainly on work in using the Variable Infiltration Capacity (VIC) hydrology model to assess the hydrologic effects of climate change, including examples for the upper Peace, upper Columbia, Fraser and Campbell River basins (Figure 1). He also presented recent results for the assessment of streamflow forecast skill in the Fraser River based on using downscaled dynamical weather forecasts. Recent progress with respect to modelling glacier mass balance and water temperature was also presented. This talk generated some fruitful discussion on the need for a better understanding of model uncertainty, including the possibility of using multiple hydrology models.

Stephanie Smith, Manager, Hydrology and Technical Services at BC Hydro,

*PCIC HELD THE LAST OF ITS THREE MEETINGS FOCUSED ON THE CONSORTIUM'S THEMES ON MARCH 3<sup>RD</sup>, 2014, TO SHARE ITS HYDROLOGIC IMPACTS WORK WITH USERS AND GATHER INPUT FOR THE DIRECTION OF FUTURE ACTIVITIES*

**Figure 1:** Projected change in spring (March, April and May) runoff in the upper Peace, Fraser, upper Columbia and Campbell River basins for mid-century (2041-2070). Change is shown as the median of eight projections from the A1B emissions scenario.



provided a user perspective on lessons learned from integrating climate scenarios into business decisions. As a utility mainly reliant on hydro-power generation, she emphasized the need for climate change studies in support of long term planning at BC Hydro. She also stressed the need to understand the impact of climate change on operations and activities such as power transmission and transmission infrastructure. The need for further inter-comparison studies (as results can differ between different models/researchers) was emphasized, and the needs, in this regard, to examine and validate internal model details. She also described challenges in determining how to incorporate climate change into the Columbia River Treaty review process. The ultimate goal of BC Hydro is to incorporate climate change information into a risk-based adaptation plan. Some concrete examples of using climate change information and scenarios in short- and long-term planning and communication activities were also presented.

Arelia Werner, PCIC hydrologist, provided an introduction to the new Hydrology Model output data portal, designed to disseminate large arrays of hydrologic data. The presentation provided an overview of the type of data provided and the current data holdings, as well as providing a demonstration of how to view, access, and download the data using the portal. The overall impression was that the audience was appreciative of the ease with which PCIC's modelling data could now be accessed. Nevertheless, there was discussion regarding how, or if, PCIC will provide guidance on using the data portal and ensure that the data is used correctly. The issue of the lack of availability of modelled streamflow data was raised. (Such streamflow data is now available from PCIC's Station Hydrologic Model Output Data Portal Page: <http://www.pacificclimate.org/data/station-hydrologic-model-output>.)

*SPEAKERS DISCUSSED USING THE VIC MODEL FOR ASSESSING THE HYDROLOGIC IMPACTS OF CLIMATE CHANGE, THE NEW HYDROLOGIC OUTPUT DATA PORTAL PAGE, WHAT THEY HAD LEARNED FROM INTEGRATING CLIMATE CHANGE INTO BUSINESS AND TREATY DECISIONS, AND PLANS FOR THE FUTURE*

The afternoon plenary discussion began with another formal presentation from Markus Schnorbus, who reviewed some possible future directions for the Hydrologic Impacts Theme. He raised a number of points for discussion, including the need to consider additional tools for assessing future hydrologic change (e.g. statistical emulation of VIC), the intent to expand the study area into new regions (e.g. the entire Columbia River basin, north-eastern BC, coastal BC), and the potential to address pressing water resource issues (power generation, natural resources extraction, fisheries, Columbia River Treaty, etc) and knowledge gaps (change to extremes, change to water temperature, effects of flow regulation, etc.). He also discussed the need to address certain deficiencies in modelling capability, including the ability to accurately represent glacier dynamics, water temperature, land cover change, and flow regulation and abstraction. This presentation generated discussion on how best to prioritize study basins and regions within the proposed study domain.

The remainder of the afternoon was an open discussion on how the HI theme can best serve the public. This discussion was guided by a number of short presentations from select users and stakeholders intended to provide a number of different sectoral perspectives. David Campbell, Head of the BC River Forecast Centre, provided the perspective of the Water Management Branch, BC Ministry of Environment. Allan Chapman, hydrologist with the BC Oil and Gas Commission, provided an industry regulatory perspective. Monica Mannerstrom, with Northwest Hydraulics Consultants, provided a private sector consulting perspective. Matt Osler, an engineer with the City of Surrey, provided a local government perspective. Feedback was received from users involved in a wide range of water management activities, including water licensing and allocation, water supply management, public safety (flood protection, flood mapping, dam safety), flood and seasonal forecasting, engineering and design, policy and regulations, and risk assessment. Hence, it was also recognized that there is a need to reach a broad and diverse audience. Attendees raised a number of issues and concerns regarding how to manage water resources under the increasing recognition of non-stationary climate. A common theme was the challenge of incorporating climate change information into decision making, risk analysis, and the development of appropriate policy and regulations. A better understanding of uncertainty (including the description of methodology) and the need for more accessible literature and reporting was also often raised. Several knowledge gaps were identified, for example the need to model a wider range of temporal and spatial scales, and the need to consider vegetation changes in conjunction with changes and variation in climate.

*ATTENDEES RAISED ISSUES ABOUT MANAGING WATER RESOURCES IN LIGHT OF THE CHANGING CLIMATE AND THE CHALLENGE OF INCORPORATING CLIMATE CHANGE INFORMATION INTO DECISION MAKING*

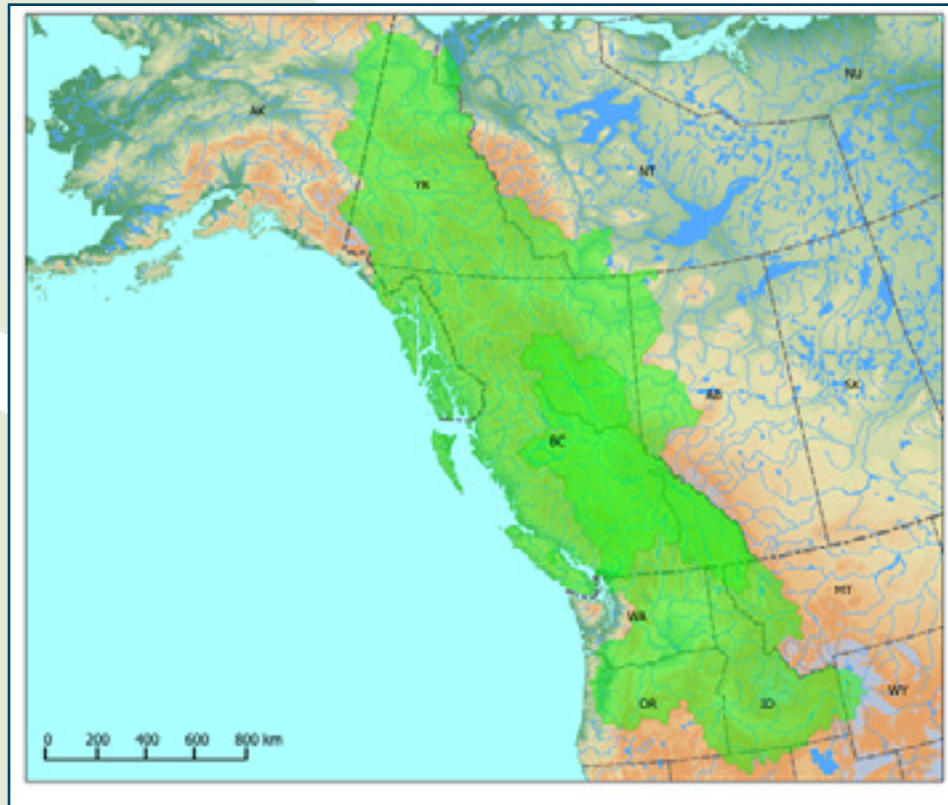
*THE NEED FOR A BETTER UNDERSTANDING OF UNCERTAINTY AND MORE ACCESSIBLE LITERATURE AND REPORTING WAS RAISED AND SEVERAL KNOWLEDGE GAPS WERE IDENTIFIED*

*PCIC WILL USE FEEDBACK GATHERED FROM THE HI MEETING TO HELP TO GUIDE THE DIRECTION OF THE THEME IN THE UPCOMING YEARS*

## FEEDBACK ON FUTURE DIRECTIONS

Many ideas and suggestions for the HI theme were proposed at the meeting, which will be useful in defining the direction of the theme in the upcoming years. Specific suggestions are listed below.

1. Hydrologic impacts need to be modelled and analysed to address:
  - a. Effects on multiple time-scales, including annual, seasonal and daily;
  - b. Extreme events (floods, low flow and droughts);
  - c. Changes in seasonal and inter-annual variability; and
  - d. Change over timeframes of decades to a century.
2. Better quantification of uncertainty:
  - a. Quantify and document model uncertainties;
  - b. Conduct further validation of VIC simulation with historical trends and past changes; and
  - c. Adopt a multi-model approach and/or engage in model inter-comparison studies.
3. Complement current hydrologic modelling with alternative tools or models to address hydrologic processes dominant at smaller spatial scales.
4. Prioritize basins and study regions for modelling and analysis. Suggestions include:
  - a. Focus on the following high priority basins/regions:
    - i. Columbia basin (hydro-power generation, and the Columbia River Treaty);
    - ii. North-eastern British Columbia (oil and gas extraction and hydro-power generation);
    - iii. Coastal region (public safety due to flooding); and
    - iv. Okanagan basin (water supply).
  - b. Select a limited number of representative case-study basins versus attempting to model the entire domain (Figure 2); and
  - c. Conduct a cost-benefit analysis to prioritize study basin/regions.
5. In addition to modelling deficiencies already identified, the following physical processes should be included in future work:



**Figure 2:** Proposed study domain for the Hydrologic Impacts theme.

- a. Groundwater-surface water interactions; and
  - b. Collaboration on river hydraulics to address sea level and tidal effects on flooding.
6. Improve communication of modelling results:
- a. Provide streamflow data on the data portal;
  - b. Provide more accessible background documentation of modelling methodology and results;
  - c. Continue publishing in peer-reviewed literature to support defensible methodology; and
  - d. Present applied research to reach as broad an audience as possible.

## SUMMARY

Taken as a whole, the meeting served to reinforce the current and proposed direction the HI theme, and many of these suggestions can be fit into the existing research plan. Some ideas that arose from the discussions were potentially valuable but lay outside of what the HI theme has resources or expertise to undertake.

Finally, PCIC would like to thank those who took the time out of their schedules to participate in the meeting and for their help in defining the direction of the HI theme. From PCIC's perspective, the session was highly productive.

## Participant List, HI Meeting The Inn at Laurel Point, Victoria, BC — March 3<sup>rd</sup>, 2014

First Name	Last Name	Organization
Yapo	Alle-Ando	Teck Resources Ltd.
Jim	Barnes	BC Ministry of Transportation and Infrastructure
Leif	Burge	SNC Lavalin
David	Campbell	BC Ministry of Environment
Alex	Cannon	Pacific Climate Impacts Consortium
Allan	Chapman	BC Oil and Gas Commission
Stewart	Cohen	Environment Canada
Mariza	Costa-Cabral	Northwest Hydraulic Consultants
Cassbreea	Dewis	Pacific Climate Impacts Consortium
Adam	Gobena	BC Hydro
Brenda	Goehring	BC Hydro
James	Hiebert	Pacific Climate Impacts Consortium
Matthias	Jakob	BGC Engineering Inc.
Renata	Kurschner	BC Hydro
Ted	Lewis	Rescan Environmental Services
Steve	Litke	Fraser Basin Council
Tamsin	Lyle	Ebbwater Consulting
Monica	Mannerstrom	Northwest Hydraulic Consultants
Kate	Miller	Cowichan Valley Regional District
Tamsin	Mills	City of Vancouver
Trevor	Murdock	Pacific Climate Impacts Consortium
Dirk	Nyland	BC Ministry of Transportation and Infrastructure
Roger	Ord	SNC Lavalin
Matt	Osler	City of Surrey
David	Patterson	Fisheries and Oceans Canada
Dave	Roche	Kerr Wood Leidal
Magdalena	Rucker	BC Hydro
Markus	Schnorbus	Pacific Climate Impacts Consortium
Rajesh	Shrestha	Pacific Climate Impacts Consortium
Stephanie	Smith	BC Hydro
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Stephanie	Tam	BC Ministry of Agriculture
Areliia	Werner	Pacific Climate Impacts Consortium
Thomas	White	BC Ministry of Environment
Steve	Young	City of Victoria
Glen	Zachary	Urban Systems
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