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

Acknowledgements

This document is a summary of four externally reviewed project reports published by the Pacific Climate Impacts Consortium in April 2011 as part of its applied research program assessing the hydrologic impacts of climate change. For both this summary document and the reports on which it is based, we gratefully acknowledge the support of the BC government and BC Hydro as well as Ouranos for their participation in these projects. We also wish to thank our external reviewers, whose insightful and constructive comments helped to improve the reports that are summarized by this document. In addition, we wish to thank Dave Rodenhuis, the former director of PCIC, for guiding the projects that are summarized here to their successful completion.

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Summary Report for the Campbell, Columbia and Peace River Watersheds

July 2011

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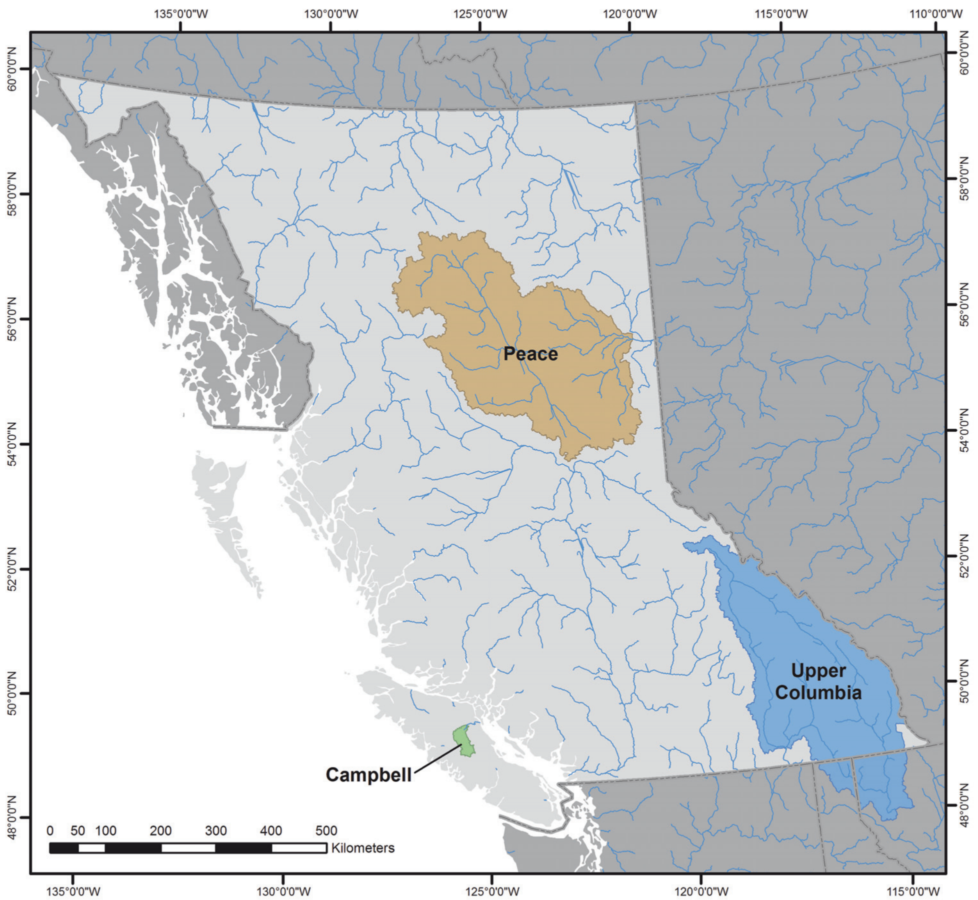

Figure 1: *Map of British Columbia showing major river systems as well as the PCIC study areas in green, blue and tan.*

Introduction

British Columbia´s climate has changed substantially over the past century, consistent with changes that have occurred globally. The authoritative Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states that “warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperature, widespread melting of snow and ice, and rising global average sea level” (IPCC 2007). Moreover, “most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations” (IPCC 2007). Our climate will continue to change in the coming decades, both as a result of natural factors that affect the system and the continued emissions of greenhouse gases into the atmosphere. Thus, we can expect that there will be further changes to global, regional and local temperature and precipitation patterns.

Increasing temperatures and altered patterns of precipitation will impact the hydrology of western North America, affecting hydroelectric power generation, municipal water supplies, flood management, fish habitat, agricultural irrigation, recreation and navigation.

The Pacific Climate Impacts Consortium (PCIC) has recently completed several research projects aimed at assessing the impacts of projected temperature and precipitation changes on streamflow for three important BC watersheds: the Campbell, the Upper Columbia and Upper Peace Rivers (Figure 1). Estimates of future streamflow for the 2050s (2041-2070) period were made for various locations within these watershed study areas.

Detailed results for these projects were published by PCIC in April 2011 as a set of internally and externally reviewed project reports (see References, p. 13). This summary report is a distillation of key results presented in those reports. It includes analyses of climate and hydrologic impacts for each of the selected watersheds as well as a summary of projected temperature and precipitation changes for all of British Columbia in the 2050s (Annex I, p. 14) and additional information regarding the research methodologies applied (Annex II, p. 16).

Watershed Descriptions

Campbell River

The Campbell River is a small coastal watershed that drains from the mountains of central Vancouver Island to the Strait of Georgia near the town of Campbell River. Natural streamflow in the Campbell River is fed by a mix of snow melt and rain, with peak flows in both the spring and fall and a low flow period in August and September.

Upper Columbia River

The Upper Columbia River basin covers most of the Canadian portion of the Columbia River in southwestern BC. It is bordered to the east by the Rocky Mountains and to the west by the Shuswap-Okanagan Highlands. Natural streamflow is affected by snow melt as well as glacial melt, peaking in the spring with a gradual recession in flow during the late summer and fall before experiencing an extended winter low flow period.

Upper Peace River

The Upper Peace River basin is located in the northeast interior of the province, draining from the northern Rocky Mountains and the Alberta Plateau. Natural streamflow in the area is predominantly fed by snow melt with peaking flows from May through July and a low flow period in winter and early spring.

Assessing the Tools

Global climate projections from a sample of eight global climate models (GCMs) were chosen based on commonly used performance metrics as detailed in Werner (2011). All of the selected models participated in, and were assessed by, the IPCC's Fourth Assessment Report (IPCC 2007). Also, simulations from these models have been used extensively in climate research published subsequent to the IPCC report. The projects summarized here used a set of 23 individual climate change simulations consisting of one simulation for each of three future emissions scenarios for each model (with one minor exception). The emissions scenarios used were the so-called SRES B1, A1B and A2 scenarios, which are described in the IPCC Special Report on Emissions Scenarios (Nakiećnović and Swart 2000). The B1, A1B and A2 scenarios envision futures with relatively low, medium and high increases in atmospheric greenhouse gas concentrations, respectively.

The models were chosen to broadly span the range of uncertainty in available projections of future climate change for British Columbia. Recent research shows that differences in climate response between the various global climate models (GCMs) is the largest source of uncertainty in both climate and hydrologic projections, while uncertainties attributed to downscaling and hydrologic modelling are of lesser magnitude. Depending on the time horizon considered, the choice of emissions scenario can also represent a significant source of uncertainty for these projections. However, for the 2050s period, province-wide climate projections obtained under the three different emissions trajectories (B1, A1B, and A2) are relatively indistinguishable. The use of an ensemble of GCMs coupled to three emissions scenarios explicitly addresses both emissions and GCM uncertainty by considering a wide range of potential wet/dry and warm/cool projected future climates for BC.

Results from global climate models must be further processed in order to produce projections of future climate conditions that are sufficiently detailed to assess hydrologic impacts in BC watersheds. Because global climate models produce estimates at a relatively coarse spatial resolution, downscaling to a finer resolution is required. Depending on which downscaling approach is applied, regional/local hydrologic impact estimates may also require additional detailed hydrologic modelling.

To assess the uncertainty that is introduced through downscaling, two very different approaches to downscaling and hydrologic modelling were applied and evaluated (see Annex II, p. 16). The first approach, and the one that provided most of the results presented in this summary report, was a more conventional approach using statistically downscaled global climate model results fed to a separate hydrologic model. An alternative approach using dynamically downscaled regional climate model results with an embedded land surface model was also applied. The application of this alternative approach was primarily diagnostic and served two purposes: 1) to demonstrate the feasibility of using this technique to quantify hydrologic impacts at the regional/local scale, and 2) to corroborate the findings of the conventional approach, thereby strengthening confidence in the utility of both methods.

A detailed comparison of the results obtained under the two different approaches is given in Shrestha et al. (2011).

Results for the Campbell River Study Area

Regardless of the model or emissions scenario considered, temperatures in the Campbell River study area are expected to increase for the 2050s, with changes ranging from 0.8°C to 2.6°C in winter and 1.4°C to 3.6°C in summer.

Precipitation changes are somewhat less consistent as there is less agreement in the direction of change among the individual projections. Annual precipitation changes over the watershed range from a modest reduction of 3% to an increase as high as 15%. On a seasonal basis changes in winter, spring and fall are projected to vary from a modest decrease of 4% to increases as high as 21%, with over slightly half the projections showing increased precipitation. The majority of projections generally suggest decreased precipitation in the summer, although individual projections range from reductions of up to 40% to increases of 6%.

Median changes in Campbell River annual streamflow are expected to be negligible for the 2050s. However, warmer temperatures in the future are expected to result in a significant change in the hydrological regime for this watershed as it transitions from a mixed rain-and-snow regime to one predominantly based on rainfall. A substantial reduction in winter snowpack, and hence in the amount of precipitation that is stored during winter and released in the spring and summer, is expected to result in increased discharge volumes during the winter season and a decrease in discharge volumes for the spring and summer. Figure 2 shows both the historical and future projected streamflow changes for the Campbell River watershed at Strathcona Dam. The top graph shows the total rate of discharge over the course of the 'water year' (October to September), where the black line represents the rate of modelled discharge for the historical baseline period (1961-1990) and the blue line represents the median of results for the 2050s (2041-2070) period, considering all models used in the PCIC hydrologic study. The thick blue-shaded area illustrates the range of agreement among the models. The bottom graph shows the same results but presents them as a change in discharge rate compared to the baseline period.

The figures describe the projected increase in monthly streamflow during the winter months as a result of the transition from snowfall to rainfall. As well, they illustrate the projected drop in spring and early summer discharge rates due to the loss in winter snowpack. It is important to note that the models appear to mostly agree on the direction of streamflow changes (i.e., increase or decrease from the baseline discharge) but differ somewhat on the actual magnitude of the changes, particularly with regards to winter streamflow, where the blue shaded area is much thicker than in the summer and early fall.

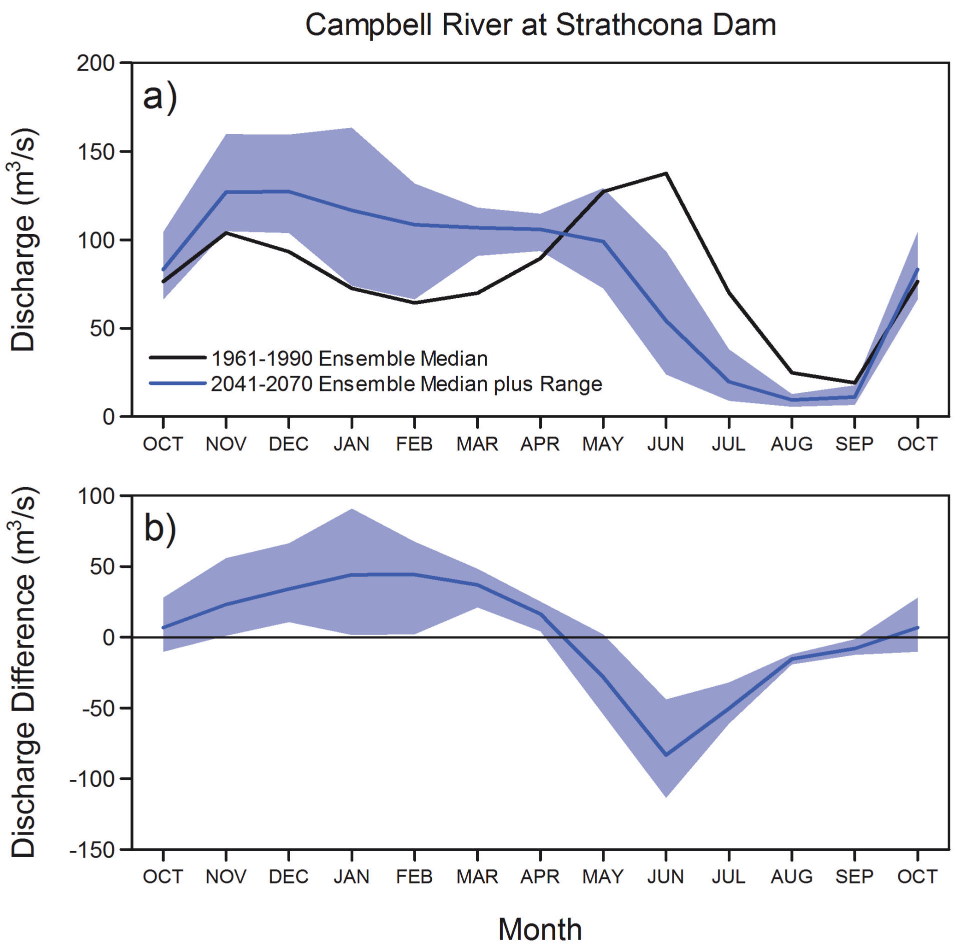

Figure 2: *Hydrographs showing median monthly discharge rates for the Campbell River at Strathcona Dam. The black line shows the modelled historical pattern of streamflow while the blue line represents the median discharge for all models and emissions scenarios used in the study. The blue shaded areas illustrate the range of results from the various global climate models and emissions scenarios used. The bottom graph shows the same results as the top graph but presents them as a change in discharge rate compared to the baseline period.*

Results for the Upper Columbia Study Area

As with the Campbell River study area, regardless of the model or emissions scenario considered temperatures in the Upper Columbia River study area are expected to increase for the 2050s, ranging from 0.8°C to 3.5°C in winter and 1.9°C to 5.0°C in summer.

On an annual basis, projected precipitation changes over the watershed are more robust than those for the Campbell. Most projections for the Upper Columbia indicate increased annual precipitation in the 2050s, with changes ranging from a slight decrease of 2% to a 19% increase among individual projections. Projections of precipitation changes for the Upper Columbia on a seasonal basis are also generally more robust than for the Campbell, with most projections showing increased precipitation in the winter, spring and fall (ranging from a 4% decrease to a 30% increase over all three seasons) and decreased precipitation in the summer (ranging from a decrease of 26% to a modest 5% increase).

Annual streamflow is expected to increase for the Upper Columbia River for the 2050s, regardless of the model or emissions scenario used. However, the magnitude of increase is somewhat less certain and varies depending on location within the watershed as well as the model being considered. The overall median increase in projected annual streamflow across all models for the locations studied on the Upper Columbia River is about 10%, ranging between 3% and 19% depending on location. Future projections of monthly streamflow are fairly consistent across locations within the study area and show an increase in monthly discharge during the late fall and winter period, an earlier onset of the spring melt and a substantially higher discharge during spring and early summer. There is also general consensus among the models that monthly discharge in late summer and early fall will be lower in the future than in the past.

Figure 3 shows both the historical and future projected streamflow changes for the Upper Columbia River at Mica Dam. The top graph shows the total rate of discharge over the course of the ‘water year’ (October to September) where the black line represents the modelled rate of discharge for the historical baseline period (1961-1990) and the blue line represents the median of results for the 2050s (2041-2070) period, considering all models used in the PCIC hydrologic study. The thick blue-shaded area illustrates the range of agreement among the models. The bottom graph shows the same results but presents them as a change in discharge rate compared to the baseline period.

The figures show fairly consistent increases in the rate of discharge except from late summer to early fall when model results show less agreement on magnitude, and even direction, of change. For this particular location all projections indicate increased peak monthly discharge in the future and most (16 out of 23) projections suggest the peak month will occur one month earlier in the year (from July to June).

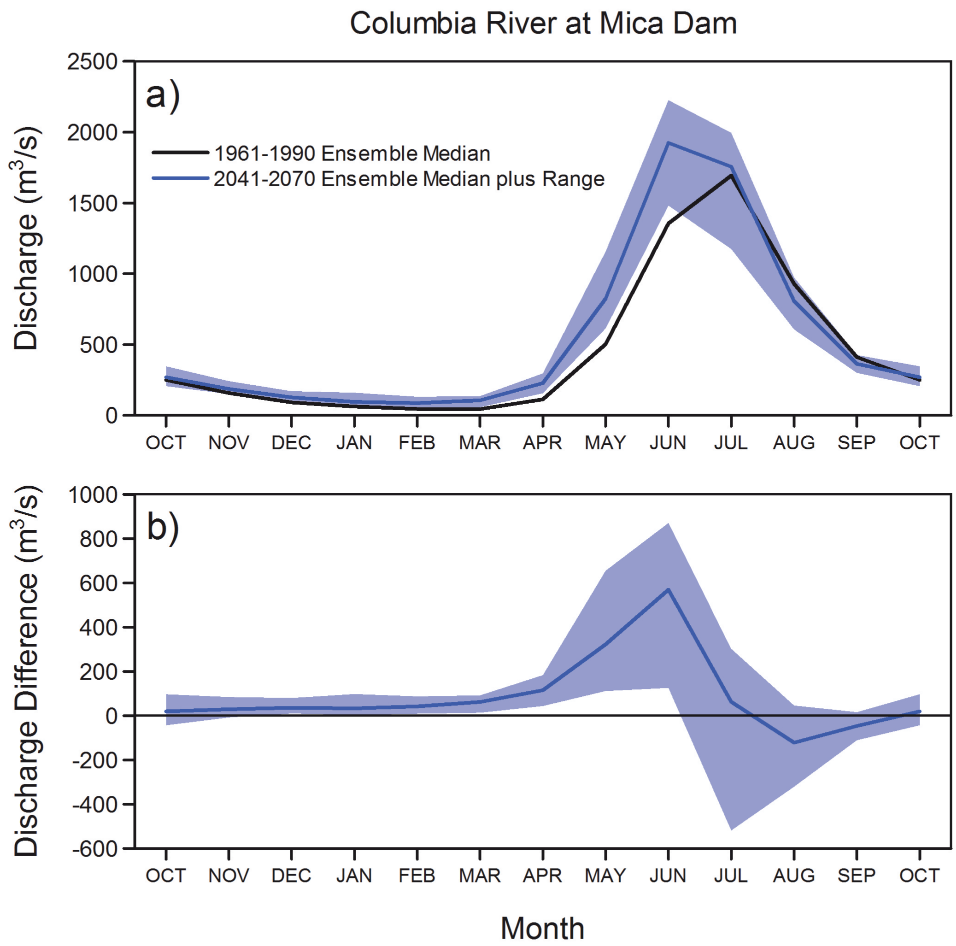

Figure 3: *Hydrographs showing median monthly discharge rates for the Upper Columbia River at Mica Dam. The black line shows the modelled historical pattern of streamflow while the blue line represents the median discharge for all models and emissions scenarios used in the study. The blue shaded areas illustrate the range of results from the various models and emissions scenarios used. The bottom graph shows the same results as the top graph but presents them as a change in discharge rate compared to the baseline period.*

Results for the Upper Peace Study Area

Similar to the results for the Campbell River and Upper Columbia River, annual mean temperatures in the Peace River study area are expected to increase for the 2050s, ranging from 1.1°C to 3.9°C in winter and 1.1°C to 3.8°C in summer.

On an annual basis, precipitation in the Peace River watershed is projected to increase in the 2050s, with estimates from individual projections ranging from a modest increase of 1% to increases as large as 22%. Approximately half of the projections show changes in annual precipitation greater than 10%. On a seasonal basis, projections display a consistent trend of higher precipitation in the winter, spring and fall, with individual projections ranging from 3% to 29% more precipitation. Precipitation projections are less consistent in the summer, with just over half of the projections suggesting an increase, but with individual projections ranging from a decrease of 18% to a 15% increase.

Consistent with the projected changes in precipitation, annual streamflow is expected to increase for the Peace River for the 2050s, regardless of the model considered. However, the magnitude of increase is somewhat less certain and varies depending on location within the watershed as well as model used. The overall median increase in annual streamflow for the locations studied along the Peace River is projected to be about 9%, ranging from about 5% to 12% depending on location. Monthly streamflow projections for the Peace River show consistently higher future discharge during fall and winter.

Like the Upper Columbia, there is some indication that the Peace River may experience an earlier onset of the spring melt and a reduction in streamflow during the late summer and early fall.

Figure 4 shows both the historical and future projected streamflow changes for the Peace River at Bennett Dam. The top graph shows the total rate of discharge over the course of the 'water year' (October to September) where the black line represents the rate of discharge for the historical baseline period (1961-1990) and the blue line represents the median of results for the 2050s (2041-2070) period, considering all models used in the PCIC hydrologic study. The thick blue-shaded area illustrates the range of agreement among the models. The bottom graph shows the same results but presents them as a change in discharge rate compared to the baseline period.

Looking at the future median (blue line) and range (blue shading) a fairly consistent increase in discharge is expected for the winter and early spring but a significant reduction in discharge for the summer. Looking at the monthly peak discharge in June, the median projection shows no discernible change in the magnitude of discharge, though individual model results vary significantly as evidenced by the thickness of the blue shading at the peak. Although there appears to be little indication that the peak month will occur any earlier in the spring for the Bennett Dam on the Peace River, projections for other locations in the watershed indicate a potential shift to an earlier peak in monthly discharge (e.g., Peace River above Pine River).

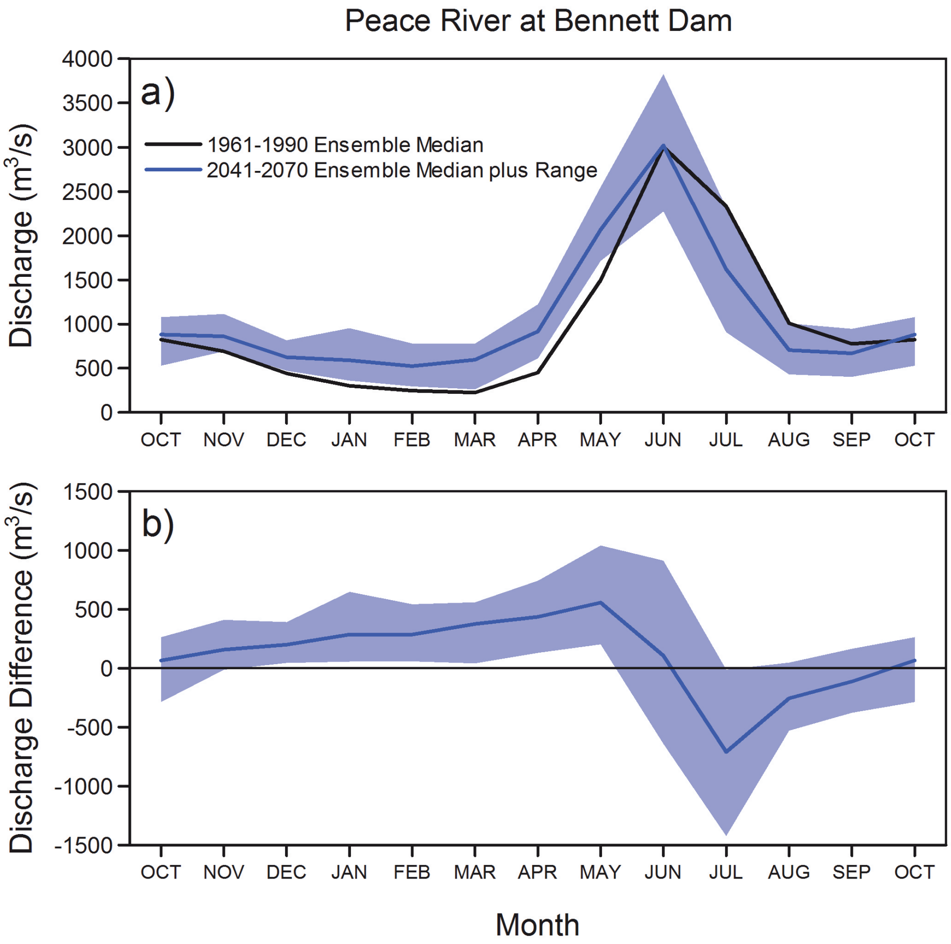

Figure 4: *Hydrographs showing median monthly discharge rates for the Peace River at Bennett Dam. The black line shows the modelled historical pattern of streamflow while the blue line represents the median discharge for all models and emissions scenarios used in the study. The blue shaded areas illustrate the range of results from the various models and emissions scenarios used. The bottom graph shows the same results as the top graph but presents them as a change in discharge rate compared to the baseline period.*

Two Approaches Compared

Figures 5 and 6 show maps of mean projected winter and summer runoff changes for the Peace watershed using the conventional approach (which uses statistically downscaled GCMs plus a separate hydrologic model) with the alternative approach (in which GCMs are dynamically downscaled using a higher resolution regional climate model). The changes are projected for the 2050s (2041-2070) relative to 1971-2000. In this example, both approaches use a common GCM, the Canadian Global Climate Model Version 3 (CGCM3) using the A2 emissions scenario. Therefore, differences can be attributed to the different downscaling and hydrologic modelling methods that have been used.

Due to the finer resolution of grid cells, the conventional approach provides more detail than the alternative approach. However, despite these differences, the maps show similar runoff changes in both cases, projecting comparable increases in winter runoff (depicted by green shading) and decreases in summer runoff (depicted by brown shading). The results show that despite the different downscaling and hydrologic modelling methods applied, both approaches provide qualitatively similar seasonal runoff change signals for the future climate in these watersheds. This indicates the robustness of projections when two very different methods for obtaining hydrological projections are used.

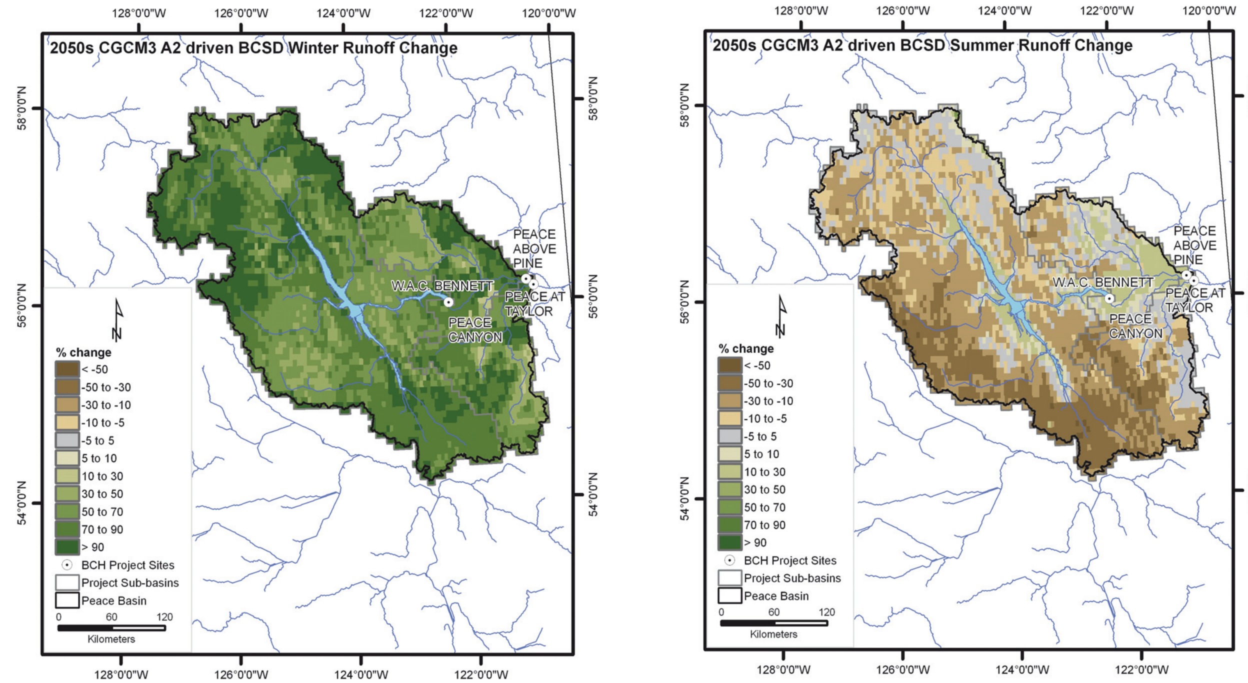

Figure 5: *Maps showing mean runoff changes (%) for winter and summer in the Peace watershed with the conventional approach using statistically downscaled GCMs with the VIC hydrologic model. The changes are projected for the 2050s (2041-2070) relative to the 1980s (1971-2000) for the CGCM3 A2 emissions scenario.*

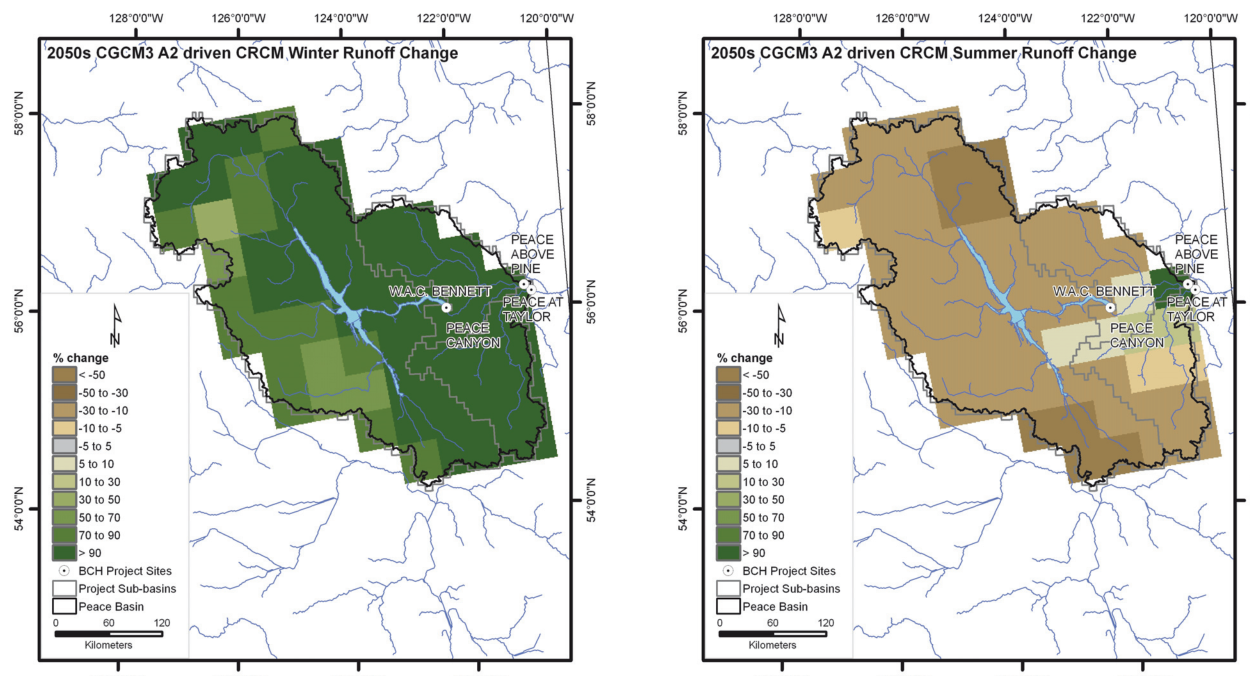

Figure 6: *Maps showing mean runoff changes (%) for winter and summer in the Peace watershed with the alternate approach using dynamically (RCM) downscaled GCMs. The changes are projected for the 2050s (2041-2070) relative to the 1980s (1971-2000) for the CGCM3 A2 emissions scenario.*

Conclusion

This study utilized multiple global climate models driven by three emissions scenarios to project potential climate change in British Columbia for the 2050s time period (2041-2070). All projections show significant warming, but they do vary in important ways depending on the choice of climate model.

The projections for the 2050s range from a future with relatively less warming and moistening ("cool/dry") to relatively more warming and moistening ("warm/wet"). This methodology explicitly addressed both emissions and global climate model uncertainty regarding projected future climates for BC. Global climate projections were subsequently downscaled and used to drive a hydrologic model at a spatial resolution higher than the native resolution of the source global climate models. The resultant hydrologic projections were captured for three study areas in British Columbia (the Peace, Campbell and Upper Columbia), allowing us to study projected hydrologic changes across a range of climatic and physiographic regimes. Streamflow projections were made for a number of specific sites within the study areas. Key results from three of those sites, the Campbell River at Strathcona Dam, the Peace River at Bennett Dam, and the Columbia River at Mica Dam, have been summarized in this report.

The robustness of the results was assessed using two very different downscaling and hydrologic modelling approaches. The main results presented in this report were obtained from global climate model projections that were statistically downscaled in order to provide input into a high-resolution spatially distributed hydrologic model. Qualitatively consistent results were obtained from an alternative approach in which a regional climate model with an embedded hydrologic model was used to dynamically downscale global climate projections, lending greater confidence in the utility of these results for policy and planning purposes. Province-wide climate and hydrological projections for the 2050s are not sensitive to differences between the B1, A1B and A2 emissions scenarios. However, it is anticipated that hydrologic projections for the end of the 21st century will depend on the emissions pathway that we collectively follow as a global community.

References

IPCC, 2007: Summary for Policymakers. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to Fourth Assessment report of the Intergovernmental Panel on Climate Change, Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averty, M. Tignor and H.L. Miller (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Nakićenović, N., and R. Swart (eds.), 2000: *Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Rodenhuis, D., B. Music, M. Braun, and D. Caya, 2011: *Climate Diagnostics of Future Water Resources in BC Watersheds*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 72 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, 157 pp.

Shrestha, R.R., A.J. Berland, M.A. Schnorbus, 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.

Werner, Arelia T., 2011: *BCSD Downscaled Transient Climate Projections for Eight Select GCMs over British Columbia, Canada*. Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 63 pp.

Annex I: Climate Projections for BC (2041-2070)

Based on median results from 23 downscaled climate projections (eight global climate models, each of which was run using up to three different emissions scenarios), the climate in British Columbia is projected to change in the following ways by the 2050s (2041-2070) compared to the historical period 1961-1990:

Temperature

- Annual temperature is projected to increase by 2.3°C on average in BC.
- Warming is projected to be greatest in winter (2.7°C) and least in the spring and fall (2.1°C).
- The northern half of the province is projected to experience more warming in winter than the south.
- The southeast portion of BC is projected to see more warming in summer than other areas of the province.
- Warming is projected to be relatively uniform across all regions of the province in spring and fall.

Median Temperature Change Projected for the 2050s

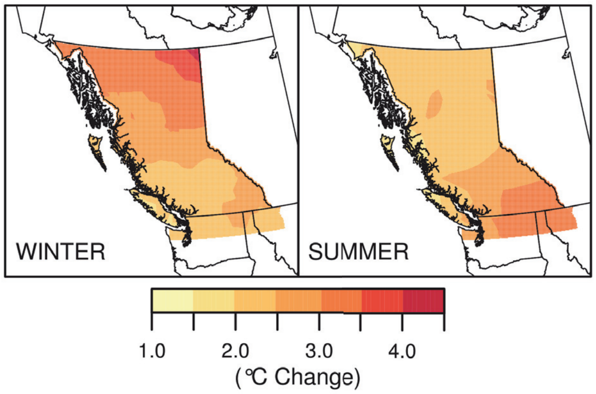

Figure 7: *Maps showing median temperature changes (°C) for both winter and summer in British Columbia for the 2050s (2041-2070) period using values provided by the 23 downscaled global climate model simulations used in the PCIC study.*

Precipitation

- Annual precipitation is projected to increase by approximately 8% over all of BC.
- By season, precipitation is projected to increase most for the spring (13%) but decrease slightly for the summer (-1%).
- Regionally, precipitation in the northern and eastern portions of the province is expected to increase more than other areas in the winter, spring and fall. Precipitation in the southwest is projected to decrease more than in other areas in the summer.

Median Precipitation Change Projected for the 2050s

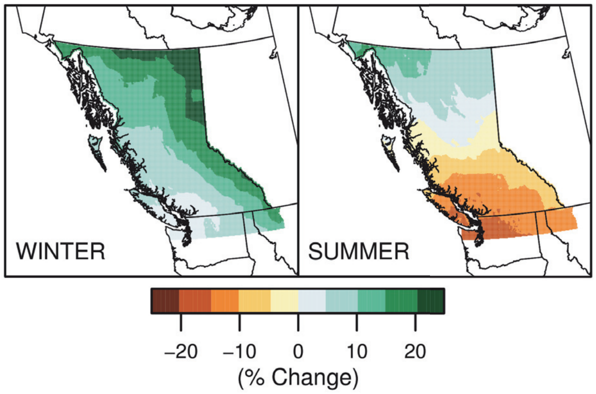

Figure 8: *Maps showing median precipitation changes (%) for both winter and summer in British Columbia for the 2050s (2041-2070) period using values provided by the 23 downscaled global climate model simulations used in the PCIC study.*

Figure 7 and Figure 8 show maps of median projected summer and winter temperature and precipitation changes for all of British Columbia in the 2050s. Looking at the temperature changes in Figure 7 we see greater temperature increases in the northeast portion of the province during the winter. In summer the global climate models predict more warming in the south, with generally less warming projected than for the winter. Likewise, in Figure 8 we see greater precipitation increases in the northeast for winter but significantly drier conditions for Vancouver Island and the lower mainland in summer. It is worth repeating that these projections are subject to considerable uncertainty.

Table 1 and Table 2 show minimum, maximum and median temperature and precipitation changes for British Columbia for the 2050s (2041-2070) period for all 23 downscaled climate projections used in the PCIC study and arranged by season, including annual values.

Table 1: *Temperature Changes averaged over British Columbia for the 2050s*

	Temperature Change (°C)				
	Winter	Spring	Summer	Fall	Annual
Minimum	0.6	1.1	1.4	1.3	1.4
Median	2.7	2.1	2.5	2.1	2.3
Maximum	3.6	3.2	4.4	3.9	3.7

Table 2: *Precipitation Changes averaged over British Columbia for the 2050s*

	Precipitation Change (%)				
	Winter	Spring	Summer	Fall	Annual
Minimum	5	0	-21	1	0
Median	12	13	-1	12	8
Maximum	26	19	5	27	18

In addition to providing an estimate on overall future climate conditions in British Columbia, global climate model results are a necessary starting point for assessing hydrologic impacts. Results from these models are used as input to higher resolution hydrologic models or regional climate models for examining changes in watershed attributes such as streamflow.

Annex II: Methodologies

Two quite different methodological approaches were used to estimate the hydrologic impacts of climate change on the three selected watersheds for the 2050s compared to the baseline period 1961-1990:

Conventional Approach	Alternative Approach
The 'conventional' approach used a set of eight pre-selected global climate models driven by three emissions scenarios (B1, A1B, A2) representing relatively low, medium and high atmospheric greenhouse gas concentration increases in the future. This produced an ensemble of 23 raw projections for temperature and precipitation at a global-scale. Global climate models provide these projections in the form of average temperature and precipitation changes in grid cells, where individual grid cells are approximately 300 km x 300 km (~90,000 sq. km or 9 million hectares) in size. These grid cell values are then statistically downscaled to a watershed-scale resolution of approximately 6km x 6km grid cells using a technique called Bias Corrected Spatial Disaggregation before being fed into the Variable Infiltration Capacity hydrologic model for estimating streamflow. This approach is discussed in detail in Werner (2011) and Schnorbus et al. (2011).	The 'alternative' approach used projections from a single global climate model driven by a single emissions scenario (A2) that were dynamically downscaled using different versions of the Canadian Regional Climate Model. This approach produced results at a regional-scale resolution using approximately 45 km x 45 km grid cells (2,025 sq. km or 202,500 ha). Values for streamflow and runoff were obtained from the hydrologic model embedded in the regional climate model. However, the relatively large grid cells used in this approach made it unsuitable for assessing the Campbell River watershed which covers about 1,200 sq. km. Thus, only the Upper Columbia and Peace Rivers were evaluated using this approach. For a more detailed discussion on this approach see Rodenhuis et al. (2011).

The first method has been widely used for hydrologic impacts studies at the regional/local scale while the second approach has typically been applied for hydrologic studies of much larger watersheds. Its use here was primarily diagnostic – to corroborate results provided by the conventional approach and to test its ability to generate its own set of results at a regional/local scale. An intercomparison of the results obtained with the two approaches is described in Shrestha et al. (2011).

Figure 9 illustrates the process of going from emissions scenarios and global climate model results to hydrologic impacts.

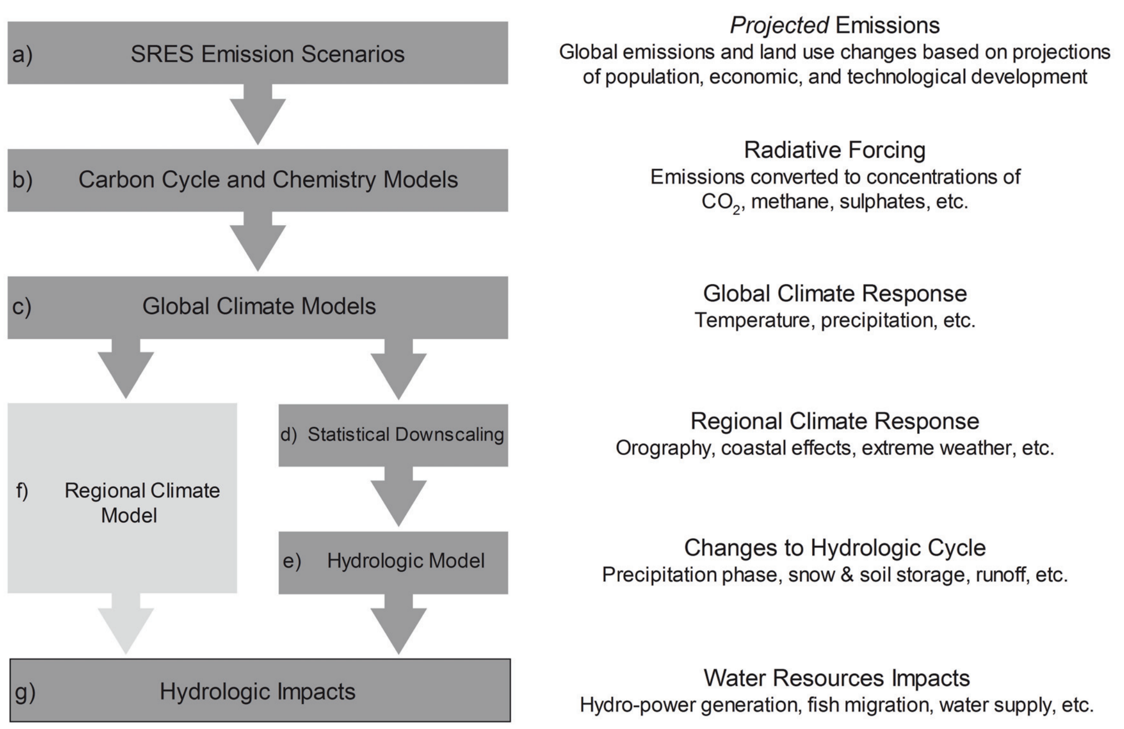

Figure 9: *Methodological pathways for quantifying hydrologic impacts due to climate change. a), b) and c) represent the steps in the transition from emission scenario to global climate response, the necessary starting point to an analysis of future climate conditions. Global climate model results can then be statistically downscaled (d) and fed into a hydrologic model (e) or dynamically downscaled using a regional climate model (f) in order to assess regional/local hydrologic impacts such as changes in streamflow (g).*

The Pacific Climate Impacts Consortium

The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change in the Pacific and Yukon region of Canada. PCIC operates in collaboration with climate researchers and regional stakeholders on projects driven by user needs and we strive to ensure the results are publicly accessible.

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