Northwest Power and Conservation Council

November 30, 2011

DECISION MEMORANDUM

TO: Council Members

FROM:
John Shurts, General Counsel
John Harrison, Information Officer

SUBJECT: Decision on proposal for joint funding with the Columbia Basin Trust for a comparative analysis of U.S. and Canadian model projections of hydrologic response in the Canadian Columbia River Basin to changes in climate. Attached to this memorandum is the proposal for the comparative analysis from the Climate Impacts Group at the University of Washington and the Pacific Climate Impacts Consortium at the University of Victoria.

PROPOSED ACTION

The Columbia Basin Trust representatives have recommended that the Council and the CBT jointly fund a proposal by scientists at the University of Washington and the University of Victoria to compare and analyze their different approaches to modeling hydrologic response to climate change in the Canadian portion of the Columbia River Basin. The staff recommends that the Council approve the proposed comparative analysis.

The Council and CBT may be interested in having the staff pursue a variation described below that would essentially split the comparative analysis as proposed by the climate scientists into two steps (described below). The second step of the work would not occur until the Council and the CBT see the results of the first step and decide to proceed. If the Council agrees that the staff should pursue this variation, the staff would then carry this recommendation back to the CBT and the universities' representatives.

The proposal favored by the CBT would cost $44,000, with the cost shared equally by the two agencies -- or in other words, a $22,000 commitment by the Council from its own budget. We also assume approval of the variation suggested here would still involve a possible maximum

commitment of $22,000 from the Council -- and we suggest capping the possible commitment at that amount -- although the final total may be different depending on how the work proceeds.

EXPLANATION

This is a subject that the Council members discussed at the September meeting in Astoria, and then again with the board representatives of the Columbia Basin Trust at the November meeting in Coeur d'Alene. It stems from the fact that modeling of future runoff conditions in the Pacific Northwest by American climate scientists at the University of Washington's Climate Impacts Group differs to some extent from the modeling of the same conditions by Canadian scientists at the Pacific Climate Impacts Consortium at the University of Victoria in British Columbia. The differences stem from different assumptions and inputs relating to temperatures and precipitation and the effects of the changes in those parameters for specific decades in the future. For one example that we talked about at Coeur d'Alene, the modeling by the University of Victoria scientists incorporates potential effects to glaciers in the Canadian Columbia River Basin in a way that modeling by the University of Washington scientists does not. And these differences could yield different projections for flows at the international border.

As part of our joint workplan with the CBT, we asked the scientists at the two universities for a proposal that would allow them to work together to compare their different modeling efforts, identify key areas of convergence and difference in inputs and results, and assess the significance of the differences in terms of understanding possible changes in Columbia River flows. From a set of alternatives presented by the universities the CBT has expressed to the Council a preference for jointly funding the second option presented, a $44,000 study proposal by the two universities described by them as a comparison of hydrologic model projections from CIG and PCIC hydrologic studies for the Canadian Columbia River Basin. The CIG and PCIC scientists propose to identify key areas of consensus and divergence in the inputs and results. More precisely, they propose to compare the modeling results of a number of different projected impacts in the Canadian portion of the Columbia River Basin including: 1) changes in temperature and precipitation; 2) changes in daily precipitation and temperature extremes; 3) changes in snowpack; 4) changes in annual, monthly, and daily streamflow timing and volume at five to ten specified river locations; and 5) changes in hydrologic extremes such as the 100-year flood or 10-year, seven-day low flows. In addition to identifying areas of agreement and differences, and assessing the significance of the differences, the scientists' proposal includes writing a journal article about their findings and a shorter, less-technical, high-level summary report for the general public and policymakers.

After further discussions the staff recommends to the Council that the comparative analysis be funded jointly by the Council and the CBT. Both the Council and CBT would benefit from the technical information that would result from the proposed model comparison and the companion summary document for the general public. The Council would receive valuable information to incorporate in its modeling for the next fish and wildlife program and power plan, and both agencies would be able to use the summary document for public information purposes regarding the future of the Columbia River, as well as pursue together further transboundary

cooperation and understanding. The Council already possesses downscaled climate-impacts hydrologic data for the Columbia River from CIG, but not from PCIC. If the Canadian model efforts predict different flows or volumes at the international border, that would be useful information for the Council to know in modeling flows and power-system adequacy for the next fish and wildlife program and power plan, as well as to understand the reasons for the differences.[1]

But sensitive to concerns about the proposal expressed by some Council members, the staff also suggests the Council consider a possible variation that seems (to staff) inherent in the proposal from the climate scientists. In this variation the Council would work with the CBT and the university scientists to split the proposed comparative work into two steps or phases. In the first phase, the Council and CBT would ask for a report that identifies and explains the technical differences in the model inputs and outputs and includes a high-level summary of what the models forecast for the future of the Columbia River in Canada and the United States, including whether and how those forecasts differ. After reviewing the products from the first phase, the Council and the CBT, or either agency separately, could ask the scientists to proceed with the second phase of the work as proposed by the scientists, which would then involve running one or more of the scenarios developed for the Council by the Climate Impacts Group (for the Sixth Power Plan) through the Canadian models to see whether and how the results differ. And this second phase could also include the proposed technical journal article.

We have not yet explored this variation with the CBT or the universities' representatives. But it may be possible to divide the proposal in this way, and that what we (and they) might learn just from the first step in the analysis would yield sufficiently valuable information.

[1] At Coeur d'Alene Council members asked whether this information would be developed anyway by the federal agencies as part of their efforts to analyze future climate effects under the umbrella of the River Management Joint Operating Committee (RMJOC). The RMJOC is developing model studies of potential hydrologic changes in the Columbia resulting from climate-change impacts. And this effort, required by RPA 7 of the amended 2008/2010 Biological Opinion, addresses both the U.S. and Canadian portions of the basin. However, according to Alan Hamlet of the University of Washington's Climate Impacts Group, which is assisting the RMJOC in its studies, the RMJOC does not intend to assess the differences in the U.S. and Canadian modeling efforts or incorporate impacts on Canadian glaciers in its modeling.

A Climate Change Scenario Intercomparison Study
For the Canadian Columbia River Basin

Alan F. Hamlet, Climate Impacts Group, University of Washington
Markus Schnorbus, Pacific Climate Impacts Consortium, University of Victoria

Project Background and Motivation

Given the importance of the Canadian portion of the Columbia River basin to climate change impacts throughout the basin, and to local impacts in British Columbia, there is great interest in the hydrologic sensitivity of this region to climate change. Several different studies have quantified a range of hydrologic responses to regional climate change for the Pacific Northwest region of North America. This range of responses relates, in part, to scientific uncertainty in temperature and precipitation projections for specific decades in the future. Figure 1, for example, shows a summary of hydrologic projections for natural flow in the Columbia River at Revelstoke Dam produced using the Variable Infiltration Capacity (VIC) Hydrologic model from a study by the Climate Impacts Group (CIG) (Hamlet et al. 2010. The uncertainties in these projections relate directly to the *inputs* to the hydrologic model since the hydrologic model used is identical for each ensemble member in the analysis.

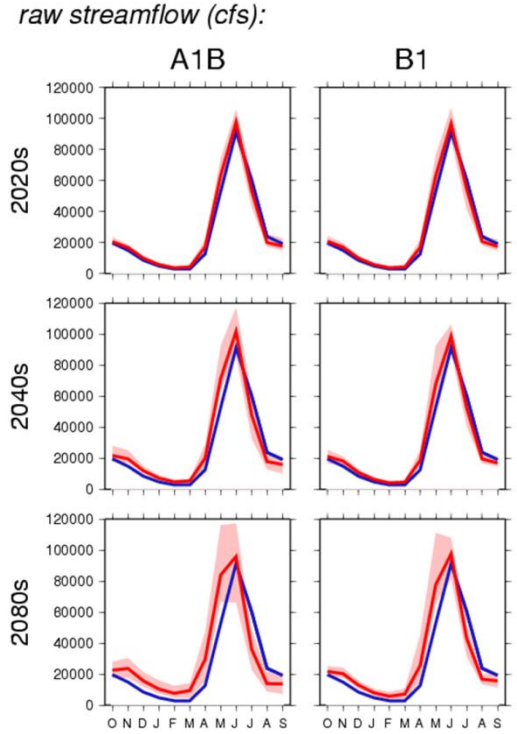

Figure 1. Simulated natural streamflow for the Columbia River at Revelstoke Dam. Blue traces show the historical monthly mean flow, pink bands show the range of future projections from 10 future climate change scenarios, and the red lines show the averages for the future projections. Source: http://www.hydro.washington.edu/2860/products/sites/?site=1017

Researchers at the Pacific Climate Impacts Consortium (PCIC) have employed different versions of the VIC model. Key differences include a different calibration process, and, in some versions, the inclusion of elements of the hydrologic cycle that were not included in the CIG analysis (e.g. the effects of glaciers on the hydrologic cycle). Other research groups, including a team of researchers at University of British Columbia, have used a completely different hydrologic

model to make future projections for the basin, also including glaciers. In addition, different downscaling approaches have been used to provide temperature and precipitation inputs for different modeling efforts, which also has the potential to affect the results.
The differences in results between these various hydrologic investigations represent scientific uncertainties related to choice of hydrologic model, elements of the hydrologic cycle included in the model, model calibration strategies, and different downscaling methods. Although differences in the results from different modeling efforts are expected, a thorough investigation of the uncertainty resulting from these assessment choices has so far not been undertaken.
In this study, we propose to compare hydrologic model projections from CIG and PCIC hydrologic studies for the Canadian Columbia River basin, identifying key areas of consensus and divergence in the results.

Methods

The study domain will include the Columbia River basin upstream of the international boundary in British Columbia.
The study will compare a number of different projected impacts including:

- Changes in temperature and precipitation
- Changes in daily precipitation and temperature extremes
- Changes in snowpack
- Changes in annual, monthly, and daily streamflow timing and volume (e.g. changes in seasonal streamflow, streamflow center of timing, etc.) at 5-10 specified river locations.
- Changes in hydrologic extremes such as the 100-year flood (Q100) or 10-year seven-day low flows (7Q10)

Two different hydrologic model implementations will be compared in the study:

- 1/16th degree VIC without glacier impacts (CIG, Hamlet et al. 2010)
- 1/16th degree VIC with glacier impacts (PCIC, REF)

For three future time periods (2020s, 2040s, and 2080s), three different downscaling approaches will be compared for the ECHAM5 A1B emissions scenario:

1. **Hybrid Delta** (HD)
2. **Bias Correction and Statistical Downscaling** (BCSD)
3. **Dynamic Downscaling** using the WRF regional scale climate model implemented at 12km resolution

Results from the two different hydrologic modeling studies discussed above will be compared and summarized and areas of consensus and divergence will be identified for specific metrics discussed above.
In addition, ensemble results for the 2040s A1B scenarios and BCSD downscaling approach will be compared for the same streamflow locations.
[Include reservoir model simulations?]

Products

Primary products will include a journal article to a special addition focused on climate change impacts in the Columbia River basin (Sean Fleming, editor) and a shorter, less-technical, high-level summary report for the general public and policy makers.

Schedule

Project completion by March, 2012

Budget

Three months for a post-doc or staff researcher. One month combined salary for administration and participation by Hamlet and Schnorbus. $2500 in publication costs. Total with 54% UW overhead about $44k.

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