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Hydrology and Earth System Sciences Discussions

Interactive comment on "Uncertainty in the impacts of projected climate change on the hydrology of a subarctic environment: Liard River Basin" *by* R. Thorne

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I thank the reviewer for their helpful comments which certainly permit the enhancement of the manuscript. I have provided a point-by-point response to comments below:

My major concerns with the manuscript in its current form are the following: 1) The manuscript is poorly structured, methods, results and discussions are mixed, which makes it difficult for the reader to follow.

The manuscript has been revised as suggested by the reviewer.

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2) Limited analysis of the hydrological impacts. As mentioned above, it would have been interesting to also look on impacts of, for instance, high flows or year-to-year variability.

The year-to-year variability was excluded from the GCM scenario data as it would add further uncertainty to the results. For this study, the effect of different scenarios and degree of warming was analyzed without further complications from model uncertainties and the introduction of variability. Additionally, in keeping with the other manuscripts of this symposium, the introduction of variability would make cross investigation difficult. However, an analysis on the impacts of high flows has been included.

3) I also miss a more detailed analysis on the reasons for the observed differences in the seasonal runoff. Here it would have been valuable to look on the separate/ combined effects of temp and precip as well as their temporal variation (e.g., uniform impact or rather 'focused' impact on individual days).

Known atmospheric feedbacks make temperature and precipitation vary with each other and separating them makes it unrealistic due to the physics in the GCMs. Although the analysis is possible, this exercise might not be very valuable.

4) The author assumes that the calibrated model parameters for the hydrological model for current conditions also can be used for future conditions (p. 3133, 10f). This is a convenient assumptions made in many studies, but certainly not always valid. Especially in subarctic regions one has to assume major effects due to land cover changes and even more due to changes in permafrost.

The reviewer's point is valid, the environment will change in the future, but to incorporate such change would create difficulties in evaluating uncertainties. The purpose of the study is to examine the uncertainty on the hydrological impacts of the Liard River Basin from different climate change scenarios. It was not the intent of the study to achieve a realistic picture of change in the basin as many properties were held constant. These points are now further highlighted in the manuscript.

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5) It is interesting to look on the spatial distribution of climate variables and their change (Figs 4-6) but it is surprising that these spatial variations are not followed up with respect to their hydrological impacts and that the hydrological impacts are only analyzed in a lumped way.

The spatial variations of the hydrological responses are beyond the scope of this study. Previous analysis conducted by Woo and Thorne (2006) have shown that it is dependent on the temperature and precipitation input and varies from year-to-year.

6) Goodness of model fit: an efficiency of 0.75 (p.3132, 26) sounds ok, but one has to recognize that the high seasonality of the runoff makes in rather easy to achieve high efficiency values and I would, thus, have expected a better fit. Also from Fig 1 it seems that the model performs rather poorly for some years.

As stated previously, the purpose of the study is not to model the flow realistically, just to use the hydrological model as a tool. With the calibration, it is shown, along with previous studies (i.e. Woo and Thorne, 2006; Thorne and Woo, 2006), that the model performs well in the Liard Basin, and I feel confident using this model to simulate results from the climate change scenarios. These points are now further highlighted in the manuscript.

7) A change in evaporation is mentioned, but I miss the information on how evaporation is calculated.

Evaporation is computed using the Spittlehouse and Black method (Spittlehouse, 1989), a modified form of the Priestley and Taylor approach. However, analyzes on the changes in evaporation have been removed from the manuscript, so no further details on the methodologies for evaporation have been added.

8) The potential effects of uncertainties of the hydrological model are not addressed in enough detail.

To avoid the potential effects of uncertainties caused by the hydrological model, param-

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eters were held constant and it is assumed that there is no change in the land cover response to climate. This point is now further highlighted in the manuscript.

9) Given the active research in the area of hydrological impacts the reference list is surprisingly short.

Further references are included to expand on the active research conducted on uncertainties in hydrological impacts.

10) Reading the conclusions, I wonder what we can learn from this study and what the main scientific contribution might be.

This study uses a well-tested, semi-distributed hydrological model to examine a large, complex, mountainous subarctic environment located in an area influenced by climatic warming. Very little research has been conducted on the hydrological impacts of this environment to warming.

Analyzes have shown that the hydrological impacts are highly dependent on the GCM scenario. Uncertainties between the GCM scenarios are driven by the inconsistencies in projected spatial variability and magnitude of precipitation rather than warming temperatures. Despite these uncertainties, all scenario simulations project that the subarctic nival regime will be preserved in the future but the magnitude of change in river discharge is highly uncertain. Generally, spring freshet will arrive earlier, autumn to spring discharge will increase whereas summer flow will decrease, leading to overall increase in annual discharge. Change in the peak discharge varies between the scenarios but all show an earlier occurrence.

References:

Spittlehouse, D.L.: Estimating evapotranspiration from land surfaces in British Columbia. In: Estimation of Areal Evapotranspiration, IAHS Publication No. 177, 245-253, 1989.

Thorne, R. and Woo, M.K.: Efficacy of a hydrologic model in simulation discharge from

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a large mountainous catchment. J. Hydrol., 330, 301-312, 2006.

Woo, M.K. and Thorne, R.: Snowmelt contribution to discharge from a large mountainous catchment in subarctic Canada. Hydrol. Process., 20, 2129-2139, 2006.

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