Hydrological Modeling of Nechako River Basin's Flows

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1. Nechako River Basin

The Nechako River Basin (NRB) is a large and dynamic water system with far-reaching ecological, social, and cultural values. It spans an area of approximately 52,000 km^2 covering the hydrologic regions of the Coast Mountains and the Interior Plateau (Figure 1). Its main two tributaries are the Stuart and Nautley Rivers (Table 1).

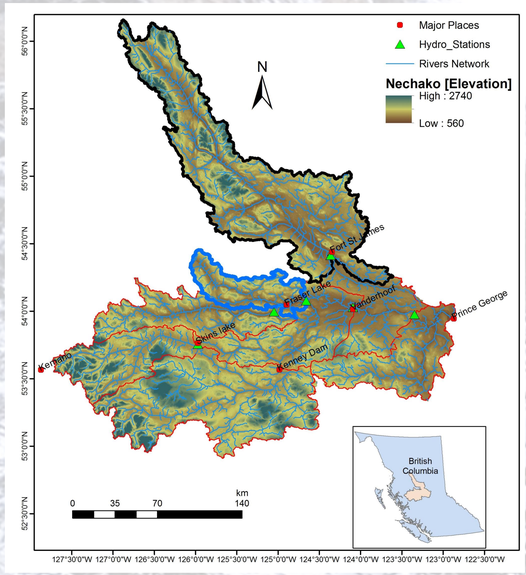

Figure 1: Map of the NRB with identification of the Stuart and Nautley sub-basins.

Sub-basin	Gauge Location Name	Gauged Area [km^2]	Mean Basin Elevation [m]
Stuart	Stuart River near Fort St. James	14200	1097
Nautley	Nautley River near Fort Fraser	6030	1070

Table 1: Geographical details of NRB's two major sub-basins.

2. Model and Calibration

The Variable Infiltration Capacity (VIC) hydrological model is employed to conduct historical and future simulations. It is run at ~25 km spatial resolution and at daily time scale using observational historical datasets and climate model projections of temperature and precipitation based on potential future greenhouse gas emissions into the mid-twenty-first century. The calibration of the model shows reliable performance of the VIC model for both the Stuart and Nautley Rivers when compared to the observed flows (Figure 2). The timing and magnitude of flows are well captured for both rivers.

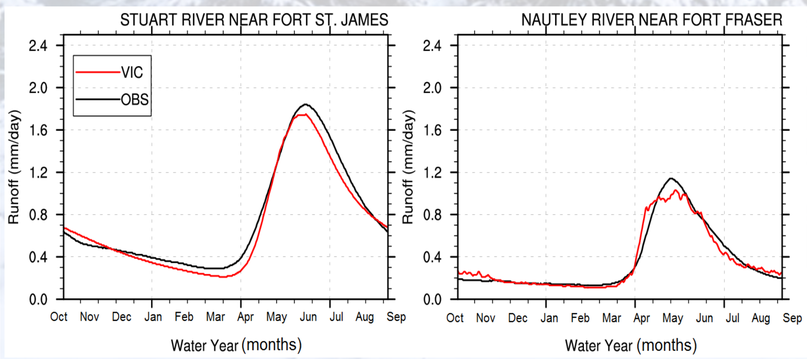

Figure 2: Simulated (VIC) and observed (OBS) daily runoff for the Stuart and Nautley Rivers for the calibration period (1979–1990).

3. Projected Changes in Rain and Snow

While the total precipitation increases up to 12% in the 2050s relative to the 1990s, the simulated changes show potential future increases of up to 30% in mean annual rainfall and nearly 30% decreases in mean annual snowfall (Figure 3).

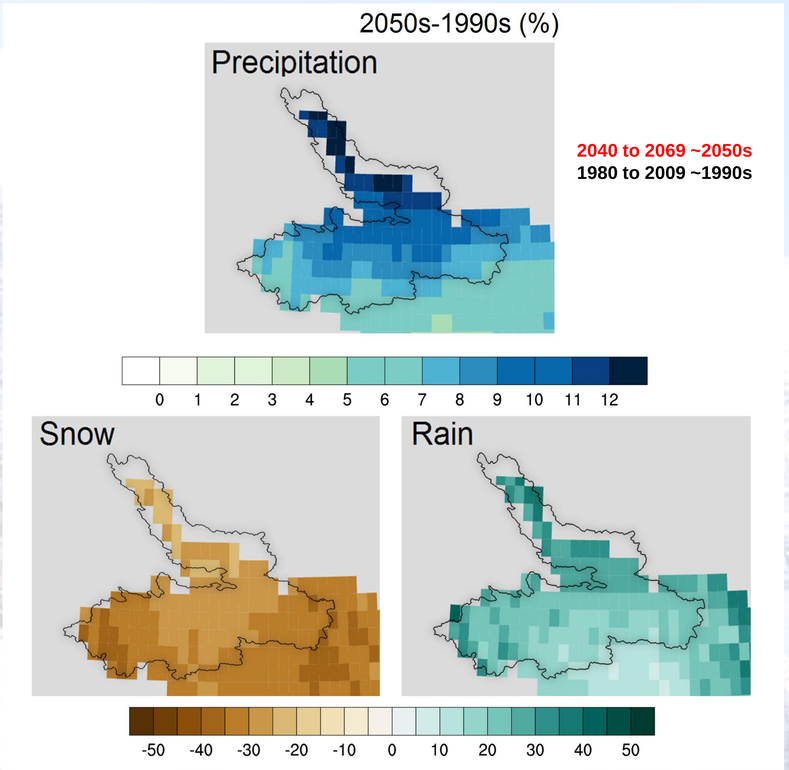

Figure 3: Future change (2050s–1990s; %) in the spatial distribution of mean annual total precipitation, snowfall and rainfall.

4. Projected Changes in Runoff and Snowmelt

The spatial distribution of mean annual runoff change (Figure 4) shows spatially varying increases of 5% to 10% in the northern portions of the NRB in the 2050s relative to the 1990s. Snowmelt decreases up to 25% in most of the region. Such future decrease in snowmelt arises mainly from declines in future snow accumulation.

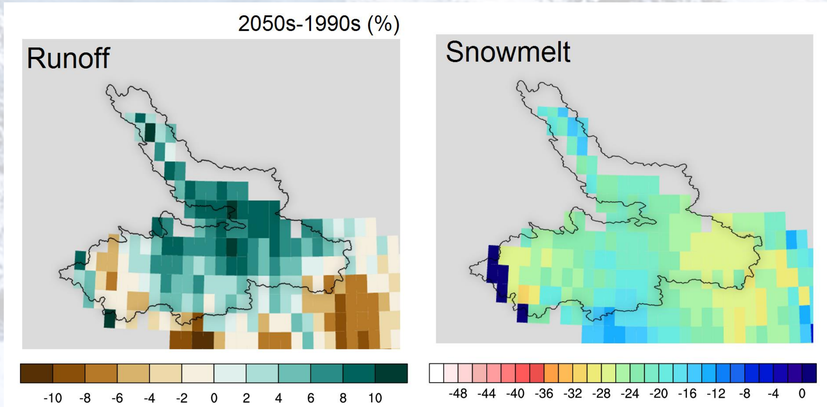

Figure 4: Future change (2050s–1990s; %) in the spatial distribution of mean annual runoff and snowmelt.

5. Projected Changes in Stuart and Nautley River Runoff

The timing of half the annual flow shows seasonal shifts approaching 25 days earlier (Figure 5) with the uncertainty of nearly 10 days. The flows increase in early spring and are followed by an earlier and steeper recession in summer.

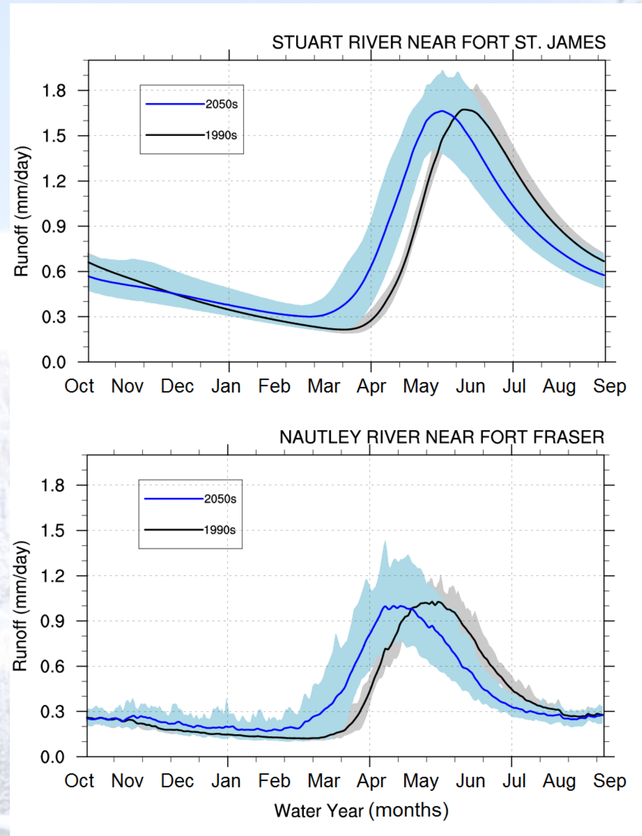

Figure 5: Projected change in runoff for the Stuart and Nautley Rivers for the 2050s.

The seasonal shifts are mainly induced by the changing phase of projected precipitation in winter and spring, along with a transition of snowmelt-dominated and hybrid regimes to hybrid and rainfall-dominated regimes in some regions due to increases in air temperature.

6. Conclusions

The projected changes in NRB flows have significant implications for the water resource management of the region. The water availability diminishes during the period of highest demand (summer) in the 2050s, and water managers may experience greater year to year variability and uncertainty in flows because of reduced snowpacks. This ongoing research will also provide vital information on the impacts of changing hydrological regimes on aquatic habitat and the survival of keystone fish species (e.g., salmon and white sturgeon).

Acknowledgments

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Further Reading:

Islam SU, Déry SJ, Werner AT. (2017), Future climate change impacts on snow and water resources of the Fraser River Basin, British Columbia, Journal of Hydrometeorology, 18(2), 473-496.