

Appendix C Climate Change Scenario Selection Memorandum



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WaterSMART Solutions Ltd.

SSRB Hydrological Modelling: Climate Change Scenario Selection

Background

MacDonald Hydrology Consultants Ltd. (MacHydro) has been retained by WaterSMART Solutions Ltd. (WaterSMART) to develop a hydrological model for the South Saskatchewan River Basin (SSRB) for the SSROM Project. As part of this project, future climate change scenarios have been run with the aim of identifying potential future stress cases to run through the water management (SSROM) and Irrigation Demand Model (IDM). Future climate change scenarios were provided by Alberta Environment and Protected Areas (AEPA) based on work detailed in Eum and Gupta (2019). Based on discussion with the Working Group on August 1, 2023, all 12 future scenarios were run through the hydrological model under two land-cover scenarios (Current Conditions and No Glaciers). These scenarios were then analyzed at a high level to identify scenarios that provided stress to the system.

Scenario Selection

All scenarios were run through the hydrological model and outputs were analyzed at a high level and summarised into hydrologic indicators which capture the changing volume and timing of flow in major rivers within the SSRB. Given the stated goal of running these scenarios was to identify future conditions that could lead to additional stress on the system, scenarios were identified that resulted in lower water availability and/or a shift in timing to less summer water availability. Based on these outputs, and the stated goal of seeking out scenarios that lead to reductions in water availability in the SSRB, we recommend the following scenarios:

1. **IPSL-CM6A-LR (ssp126):** Driest annual hydrograph; largest reductions in Mean Annual Flow
2. **IPSL-CM6A-LR (ssp370):** Hottest and driest combination scenario; leads to large shifts in timing and more frequent low flow events in the late summer.
3. **BCC-CSM2-MR (ssp370):** A drier and hotter future scenario, with reductions in annual as well as late summer flows.

We additionally highlight that there are potentially large differences in water availability (especially during the late summer) between the Current Conditions and No Glaciers land cover scenarios. Glaciers provide important late summer flows. Under future climate scenarios, warming air temperatures are likely to lead to reductions in glacier area. As such, assuming current glacier coverage into the future will overestimate water availability; this overestimate will be greater under scenarios with greater air temperature increases. This is both because hotter air temperatures will lead to greater simulated glacier ice melt, and that these conditions would lead to greater glacier retreat than under a cooler future scenario. As such, in the stated goal of performing stress tests, we recommend consideration of the No Glacier land cover configuration as a lower bound for flows under each climate scenario.

SSRB Hydrological Modelling: Climate Change Scenario Analysis

Closing

Thank you for the opportunity to complete this work. Please do not hesitate to contact me if you have additional questions or concerns.

Sincerely,



Matthew Chernos, MSc, P.Ge.
Hydrologist

SSRB Hydrological Modelling: Climate Change Scenario Analysis

Appendix A: Hydrographs

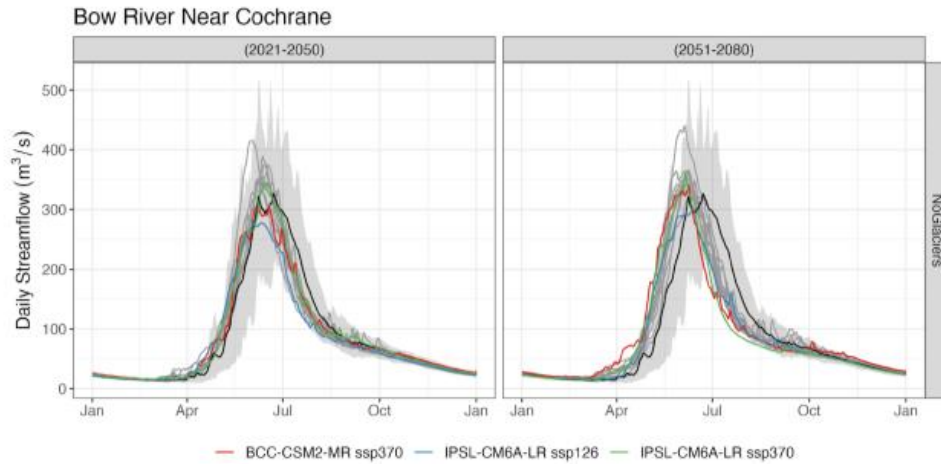


Figure 1. Annual hydrograph for Bow River near Cochrane; black line corresponds to Historical climate and shaded grey area to 10-90% quantiles.

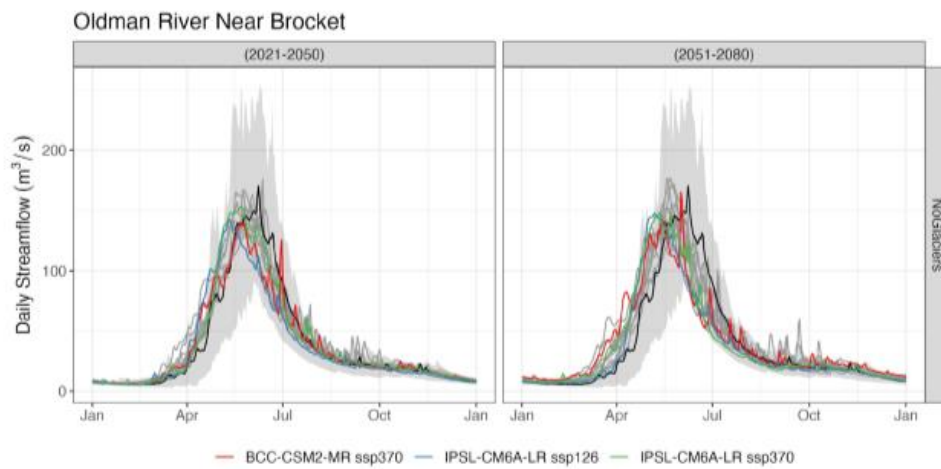


Figure 2. Annual hydrograph for Oldman River Near Brocket; black line corresponds to Historical climate and shaded grey area to 10-90% quantiles.

SSRB Hydrological Modelling: Climate Change Scenario Analysis

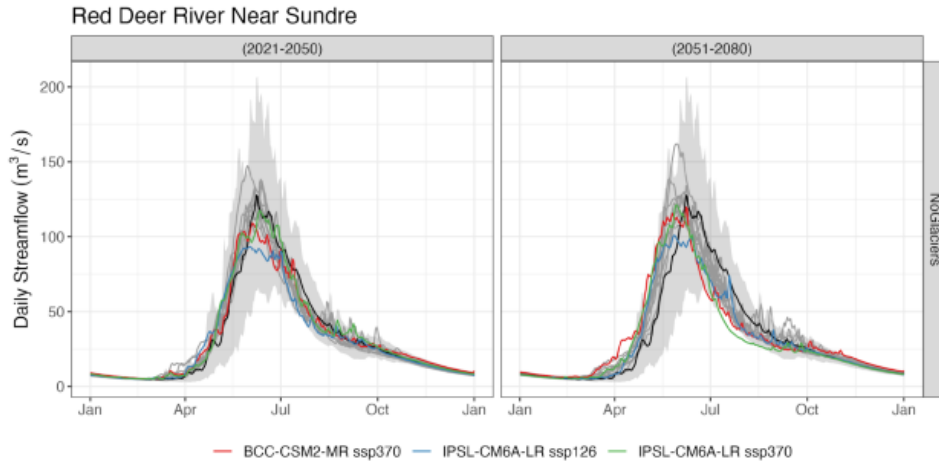


Figure 3. Annual hydrograph for Red Deer River Near Sundre; black line corresponds to Historical climate and shaded grey area to 10-90% quantiles.

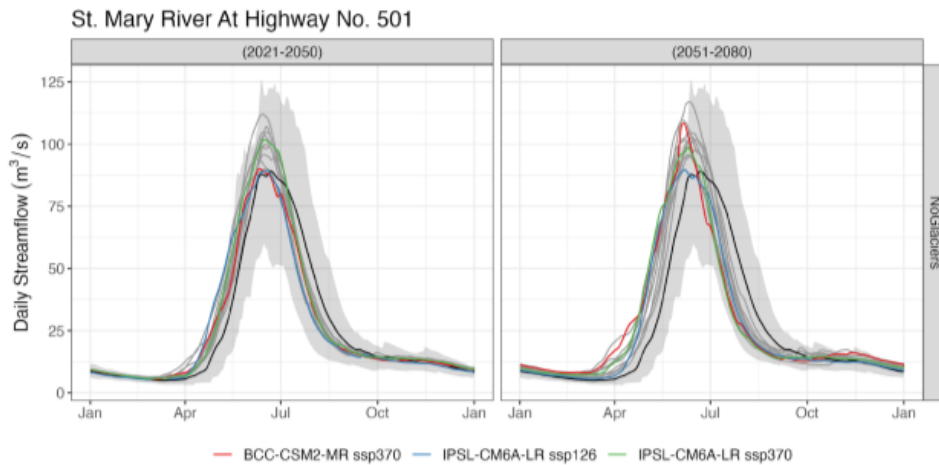


Figure 3. Annual hydrograph for St Mary River; black line corresponds to Historical climate and shaded grey area to 10-90% quantiles.