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Investigating the uncertainty of potential evapotranspiration modelling in climate change impact studies on water resources in Canada, United States and Mexico

Gabrielle Dallaire, Annie Poulin, and Richard Arsenault
Department of Construction Engineering, École de technologie supérieure, Montreal, Canada.

In the context of climate change, more severe and extended periods of low flows are expected, which will affect the quantity and quality of water sources. Evapotranspiration is an important process in the water cycle and is particularly significant during low-flow events. Therefore, it is important to study the effects of uncertainty in evapotranspiration modelling in the hydroclimatic modelling chain to understand the impacts of climate change on the water availability. As evapotranspiration is a rather hard and expensive process to measure, formulas are used to determine potential evapotranspiration (PET), which is the maximum water quantity that can be evaporated and transpired without any limiting factors. The objective is to determine the contribution of PET formulas to uncertainty in the full modelling chain in the context of climate change. Eleven simple PET formulas that only require minimum and maximum temperatures as well as the latitude are used. These formulas are applied to 2080 watersheds in North America (235 in Canada, 1825 in United States, and 20 in Mexico). As PET is directly related to climatic conditions, studying a large quantity of watersheds that cover many climatic zones increases the robustness of the conclusions. Three global hydrological models (GR4J, HMETS and Mohyse) calibrated with the Nash-Sutcliffe criterion are employed for the hydrologic modelling aspect of the work. Subsequently, the study of transferability under future climate is conducted with simulations from ten climate models and two different greenhouse gas emission scenarios. These simulations outputs (precipitations and temperatures) are post processed with two bias correction methods and are then introduced into the three hydrological models. The PET contribution in the global modelling chain in climate change and its uncertainty are estimated with different analyses such as variance decomposition. The analysis of different low-flow indices allows studying the climate change trends as expressed through the PET formulas. For instance, low-flow values over a period of several consecutive days for a certain recurrence period are compared to see if changes in the PET affect low-flows. Results show that the PET increases and the low-flow decreases are different according to climatic zones. Despite a great variability between the different formulas, results show similar trends under climate change. This project also shows that some specific formulas do not adapt well to future climate. This project results in a better comprehension and an increase in knowledge regarding the impacts of the PET formula choice in hydroclimatic modelling chain under climate change. The conclusions can be used for water resources management to identify adequate adaptation measures, such as preventing the drying up of water resources during low-flow periods.