Quantifying the Hydrological Effects of Agricultural Land-use and Climate Change in a Cold Semi-Arid Region

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Understanding the hydrological effects of agricultural land-use change is critical for adapting management practices to uncertain climate futures. However, separating the effects of land-use change from those due to climate change remains a challenge. The Budyko framework, which uses an aridity index to partition precipitation into evapotranspiration and streamflow, has been frequently used to separate the hydrological effects of climate change and human-induced land-use change. However, this approach does not capture some of the complicated climate-hydrologic characteristics of Canadian prairie regions, such as strong seasonality and large water storage changes. This research aims to adapt the Budyko framework to the Canadian Prairie region and to quantify the hydrological effects of summer-fallow area decline under recent climate change. This was accomplished by modifying the Budyko framework to account for off-season water storage (in snowpacks, wetlands, and soil moisture reserves) to better suit prairie growing seasons--where actual evaporation can exceed the precipitation because of stored water. The adapted framework is tested using a virtual basin approach built on the Cold Regions Hydrological Modelling platform. This study highlights the importance of disentangling the hydrological effects of land-use change and climate change in prairies and advances our knowledge of climate adaptation in agriculture.