Assessment of meteorological and agricultural drought indices under climate change scenarios in the South Saskatchewan River Basin, Canada

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Climate change generally has amplified the severity of droughts with potentially adverse impacts on agriculture. This study assessed future changes in meteorological and agricultural drought in the Southern Saskatchewan River Basin (SSRB) of western Canada using an array of drought in-dices, including the Standardized Precipitation Index (SPI), Standardized Precipita-tion-Evapotranspiration Index (SPEI), and Self-Calibrated Palmer Drought Severity Index (scPDSI), Soil Moisture Deficit Index (SMDI) and Evapotranspiration Deficit Index (ETDI). These indices were evaluated using multiple regional climate model (RCM) projections assuming 1.5, 2.0, and 3.0℃ thresholds of global warming. A modified Soil and Water Assessment Tool (SWAT-M) was used to simulate soil water content (SWC), actual evapotranspiration (AET), and potential evapotranspiration. The results of sensitivity analysis using the SUFI-2 method in SWAT-CUP showed that the model performed well with BIAS lower than 10% and NSE and R higher than 0.7 and the range of SWC output closely matched the observed SWC. According to the RCM projections, annual precipitation increases for all three global temperature thresholds while annual mean temperature increases at a greater rate than the rise in global mean tempera-ture. The projected PDSI and the SPEI suggest that drought duration and severity will exceed historical values while SPI remains largely unchanged. Furthermore, severe drought conditions (SMDI < 2.0) are more frequent under the 3.0 ◦C global temperature scenario. The mean ETDI was historically 0.58 while the projected value is 0.2, 0.1, and -0.2 for the first to third scenarios, re-spectively. Simulated values, spatial maps, and heat maps of SMDI and ETDI illustrated that Canesm2.CRCM5 projects the driest conditions among all RCMs. Agricultural drought indices, which incorporate SWC data, show more significant effects than indices meteorological drought. The increasing dryness will potentially impact agricultural crop production, particularly under the third scenario (3°C) in the SSRB.