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Evaluating BMP effectiveness in improving freshwater provisioning under changing climate in the upper Mississippi river basin

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Freshwater provisioning (FWP) is one of the critical ecosystem services that is sensitive to climate change and variability and agricultural management strategies. Best management practices (BMPs) are widely used to relieve the adverse impacts of agricultural production on hydrology and water quality. However, climate change may alter the BMP effectiveness in protecting hydrology and water quality. A relatively large number of studies have evaluated BMP effectiveness in improving water quality and attenuating peak flow, however the impact of climate change on BMPs effectiveness in improving FWP service is poorly understood. In this study, five BMP scenarios (no tillage, filter strips, cover crops, grassed waterways and combination of all BMPs) were simulated using Soil and Water Assessment Tool (SWAT). Then an index-based ecosystem service approach was adopted to quantify annual FWP services by using model outputs for each BMP scenario, in order to evaluate the BMP effectiveness in improving FWP service for 13 studied watersheds in the Upper Mississippi River Basin (UMRB) in the US. The effectiveness of each BMP was evaluated both for baseline climate (1975-2004) and projected near future climate (2021-2050) from three regional climate models (CCCma-CanESM2 RCA4, ICHEC-EC-EARTH RCA4 and ICHEC-EC-EARTH HIRHAM5) under two Representative Concentration Pathway scenarios (RCP4.5 and RCP8.5), with an objective to assess the impacts of future climate changes on BMP effectiveness. Results suggest that the annual FWP could be improved by implementing BMPs. The future climate change may reduce the BMP effectiveness due to altered runoff conditions under projected increased precipitation and temperature resulting in increased losses of pollutants from crop fields to streams and reduced freshwater availability. Results from this study may provide an insight for water resource managers to implement effective BMPs in responding to future climate change, in order to protect and improve FWP ecosystem service in the UMRB.