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LETTER

Scenarios of climate adaptation potential on protected working lands from management of soils

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Abstract

Management of protected lands may enhance ecosystem services that conservation programs were designed to protect. Practices that build soil organic matter on agricultural lands also increase soil water holding capacity, potentially reducing climatic water deficit (CWD), increasing actual evapotranspiration (AET) and increasing groundwater recharge (RCH). We developed nine spatially-explicit land use and conservation scenarios (2001–2100) in the LUCAS land use change model to address two questions for California working lands (cropland and rangeland): How does land use change limit opportunities to manage soils for hydrologic climate adaptation benefits? To what extent and where can soil management practices increase climate adaptation on protected working lands? Hydrologic benefits [$\Sigma(\Delta$CWD, ΔAET, ΔRCH)] due to soil management were simulated in the Basin Characterization Model (a state-wide water balance model) for two Representative Concentration Pathway 8.5 climate models. LUCAS simulated land conversion and new conservation easements with potential for maximum hydrologic benefits. Climate drove differences in lost potential for water benefits due to urbanization (33.9–87.6 $m^3 \times 10^6$) in 2050. Conflict between development pressure and potential hydrologic benefits occurred most in Santa Clara County in the San Francisco Bay Area and Shasta County in Northern Sacramento Valley. Hydrologic benefits on easements were similar in magnitude to losses from development. Water savings from management of California Land Conservation (a.k.a. Williamson) Act contract lands were an order of magnitude greater, totaling over 460 $m^3 \times 10^6$ annually in a drier climate by 2050. Few counties provide most benefits because of soil properties, climate and land area protected. The increase in hydrologic benefits varies by agricultural practice and adoption rate, land use type and configuration, and terms of conservation agreements. The effectiveness of programs designed to improve climate adaptation at county to state scales will likely increase by taking this variability into consideration.

Introduction

According to the recent California Fourth Climate Change Assessment, climate change in California will have multiple consequences including lower and less reliable water supply (Schwarz *et al* 2018) and species range shifts (Keeley *et al* 2018). These climate-driven changes can limit the provision of ecosystem services from working lands, thus reducing the efficiency of land protection programs, including conservation easement programs (Rissman *et al* 2015). Given climate and other ecological stressors, preservation alone may not sustain ecosystem services, and lack of land management can lead to reduced landscape resilience (Stroman and Kreuter 2015, Runting *et al* 2017). Since land management can alter ecosystem

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