California Agriculture and Climate Change: Impacts, Policy and Solutions

Benjamin Z. Houlton
Professor and Chancellor’s Fellow
Member, UC Global Climate Leadership Council
Director, John Muir Institute of the Environment
Department of Land, Air and Water Resources
University of California, Davis
Climate change has entered our living room

Examples of recent climate change impacts on California forests and agriculture

- CA agriculture >$50 billion dollar industry, largest producer of nuts, fruits and vegetables and dairy in the US
- 2014 - 2016 record drought resulted in ~$6 billion (USD) in total economic losses in California (Howitt and Lund, 2015; Medellín-Azuara et al., 2016)
- In 2017, ~3000 – 6000 dairy cow fatalities due to a summer extreme heatwave, resulting in “state of emergency” declaration in much of the Central Valley
- The fires of 2018 resulted in >$15 – $19 billion (USD) of economic losses, with 97 fatalities reported
Climate impacts will increase in the future – need to consider local climate resilience

“Warming temperatures will make it difficult for most of the Central Valley to grow crops such as apricots, kiwis, peaches, nectarines, plums and walnuts. By the end of the century, only 23-46 percent of the Valley will be suitable for those crops.”
CA Climate Law and Policy**

- AB 32: GHG emissions to 1990 levels by 2020;
- SB 32: 40% of 1990 levels by 2030
- SB 100: Carbon neutral energy by 2045

**Policies include Cap and Trade, plus various regulations and incentives
1. Climate-smart dairies

- CDFA’s Dairy Digester Program, targeting a 40% methane reduction from manure ~ $9/ton of CO$_2$eq reduced
- Using this electricity and new research on cooling facilities can result in climate mitigation and adaptation
2. Healthy soils - croplands

Surface vs. Deep Soil Inventories of Carbon Sequestration

Conventional

Conventional + WCC

Compost + WCC

Tautges et al., Global Change Biology, 2019
2. Healthy soils - rangelands

Silver et al. 2018

Relative change in soil C stocks (Mg C ha$^{-1}$)

- All sites
- New Sites

Map showing mean annual precipitation ranges in California.
Working Lands Innovation Center ($4.7 million over three years, beginning July 2019, PI Houlton)

- UC Davis, UC Berkeley, UC Merced, UC-ANR/Cooperative Extension, LBNL, CSU-East Bay, USDA
- 27 demonstration sites -- corn, wheat, tomato, almond, alfalfa, vegetables, rangelands
- Additions of basalt, wollastonite, gypsum, compost, biochar to soil, singly and factorial
- Private and commercial growers and ranchers, tribes, small business development
- Analysis of carbon capture, GHG reductions, crop yields and quality, cap and trade offsets, economics
In 2014, Governor Brown authorized a new program called the State Water Efficiency and Enhancement Program (SWEEP). The program’s funding comes from the state’s cap-and-trade and bond revenue and is used to make grants to farmers and ranchers for practices that reduce both water and energy use. Coordinated by CDFA, SWEEP funded over 600 projects in 33 counties between 2014-2017.

**Cobenefits**

- Reduces energy costs
- Reduces energy CO₂ emissions
- Increases water use efficiency
- Reduces N₂O through precision deliver
4. Forest resilience bonds
Grasslands may be more reliable carbon sinks than forests in California

Pawlok Dass\textsuperscript{1,3}, Benjamin Z Houlton\textsuperscript{1,2}, Yingping Wang\textsuperscript{3} and David Warlind\textsuperscript{4}

1 Department of Land, Air and Water Resources, University of California, Davis, United States of America
2 John Muir Institute of the Environment, University of California, Davis, United States of America
3 CSIRO Oceans and Atmosphere, Private Bag 1, Aspendale, VIC 3195, Australia
4 Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden
5 Author to whom any correspondence should be addressed.

(A) Grass fraction of ACTUAL

(B) Tree fraction of ACTUAL
Where is California headed?

Decoupling: California’s Economy Grows as Emissions Fall

Since the state passed climate legislation establishing a cap-and-trade system in 2006, California’s gross domestic product per capita has grown more quickly than that of the nation as a whole, even as greenhouse gas emissions have fallen.

GREENHOUSE GAS EMISSIONS AND GDP
California relative trends, 1990-2015

Stepping off the gas

California has achieved its 2020 goal for reducing greenhouse gas emissions, but targets in 2030 and 2050 will require far more significant cuts.
However...global GHG reductions affect CA agriculture

Pathak et al., Agronomy, 2018
Paris Agreement

Anderson and Peters, Science, 2016
Key challenge of the 21st century: Negative carbon emissions while feeding people, and protecting agriculture, economy, planet.