The Exportation of Agricultural Water in California and other Arid Regions of the US

What I will go over
- Project background
- Scope and methodology
- Water and groundwater management implications

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Context and Motivation
Agriculture
- California generates more agricultural revenue than any U.S. state
- 45% of U.S. vegetable revenues, 20% of dairy, over 70% of fruits, tree nuts, and berries
- California agriculture consumes 80% of the state’s developed water use
- Which has been increasingly become dependent on groundwater

Context and Motivation
Climate
- Historically severe droughts since 2010:
  - Great plains: record low rainfall
  - Washington, Oregon: record low snowpacks
- Climate change expected to increase drought severity and duration
- Increasing risk of multi-decadal droughts in Southwest and Central Plains

Project team
- Background in life cycle analysis (water, GHGs, energy, etc.)
- Team associated by the Berkeley Water Center
- Collaboration between geospatial, visualization, agriculture, and water supply expertise (and the neophytic enthusiasm of an undergrad)

Context and Motivation
- August 2015
- June 2011

Image source: Justin Sullivan
Getty Images
“Thee” drought image of decade →
(Lake Oroville in 2014)

Image source: Nature Ali
natureali.com
A less exciting, depleting groundwater basin →
(Kelso Valley, Kern County)

Image source: inhabitat.com
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Simple question:
How much water is leaving California in the form of agricultural and livestock products?

Scope and Methodology – Water Use

- States included: California, Texas, Arizona, New Mexico, Nevada, Wyoming, South Dakota, Nebraska, Kansas, Oklahoma, and Colorado
- Part 1: modeling water intensity (L/kg) variations over time in California (1998-2012)
  - Data: USDA Food and Ranch Irrigation Survey (FRIS) for irrigation quantities and yields for 9 crops
- Part 2: modeling water demands for 2012 production for over 70 products
  - Applied to 11 states with recent “exceptional” droughts: CA, TX, AZ, NM, NV, WY, SD, NE, KS, OK, CO
  - USDA National Agricultural Statistics Service (NASS) for production data
  - Product water intensities; Part 1, Mekonnen and Hoekstra (2011, 2012); Kendall et al. (2014)

Water Intensities
Using 2012 US Census Bureau Commodity Flow Survey:
- Created aggregated water intensities for agricultural categories (e.g., cereal grains, agricultural products*, meat, etc.)
- Determined in-state consumption, domestic and foreign exports of agricultural categories for each of the 11 states
- Combined consumption data with aggregated water intensities
- For California, analyzed regional data for domestic exports
*Disclaimer: Census Bureau gave us a very coarse estimate of where agricultural products were going!
Water Exports by State, a first pass

67% of Nebraska’s ag/livestock water exported

South Dakota exported 64% of water

California sold about 25% across state lines (~16 TL)

An obvious counterpart: What is being imported?

We haven’t gotten there yet...

Agricultural Water Sources

- California agricultural water users are heavily reliant on in-state water transmission projects and groundwater
- In-state transmission highly energy intensive; accounting for 2.3% of total state electricity consumption
- Farmers doubled use of groundwater to replace shortages in recent drought
Agricultural Water Sources

- California agricultural users are heavily reliant on in-state water transmission projects and groundwater.
- In-state transmission is highly energy intensive: accounting for 2-3% of total state electricity consumption.
- Farmers doubled use of groundwater to replace shortages in recent drought.
- Groundwater supplies 60% of Texas’s total water consumption.
- 80% of this groundwater goes to agriculture.
- These sources expected to decline 30% over next 30 years.
- Kansas withdrawing water 50-100x faster than recharge rate.
- These regions are responsible for over 50% of groundwater overdrafts since 1900.

Takeaways

- Most of California’s water is staying here, not true for other states (Nebraska, Kansas, South Dakota, Oklahoma).
- Expanding the stakeholdership of state agriculture, its products and posterity.
- Expanding our conversations, research scopes, policy solutions that take interstate and international connectivity and dependencies into account.
- There exists data gaps and uncertainties within trade data and water use data.

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Thank you!

Thoughts, questions, comments?