Perspectives on Water in California

Moderated by:
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Executive Director, STEM-NET
Office of the Chancellor &
Dr. Steve Blumenshine,
Executive Director, CSU-WATER

https://www2.calstate.edu/impact-of-the-csu/research/stem-net
Speakers

Karl Longley & Walter Mizuno & Sarge Green (Ret.), California Council on Science & Technology (CCST)
Water Salinity & Direct Air Capture Research: Salinity & Removing Carbon from Air

Erick Orellana, Community Water Center
Water Justice in Rural California Communities

Jon Reiter, Golden State Clean Energy
Valley Clean Infrastructure Plan

Larry Dale, Lawrence Berkeley National Laboratories (LBNL)
The Number and Location of Irrigation Wells in the Central Valley
Water Salinity & Direct Air Capture
Research: Salinity & Removing Carbon from Air

Karl Longley, PE, ScD, Professor Emeritus, CSU, Fresno
Walter Mizuno, Professor Emeritus, CSU, Fresno
Sarge Green, Research Scientist, CSU, Fresno
THE PROBLEM
Water-supply sustainability risk index in 2050

Fig A: Water-supply sustainability risk index for the conterminous United States in 2050 linking water demand to population growth, increases in power generation, and climate change Modified from Roy and others (2012).

The ancient Hanging Gardens of Babylon in the palace of Nebuchadnezzar II (604-562 BC), one of the ancient Seven Wonders of the World

San Joaquin Valley Agriculture, Currently A Wonder of the World
Technology & Application Challenge

Waste brine streams are produced by desalting projects.

What do you do with it?

Image: Saltworks (www.saltworkstech.com/articles/how-to-manage-brine-disposal-and-treatment/)
Ideal Desalination Process Model

- Energy required minimized
- Chemicals required minimized
- Water recovery maximized
- Valuable constituent recovery maximized
- Cost minimized
- Carbon footprint minimized
- Use of saline water sources maximized
- Waste generated minimized
- Reliability maximized
- Complexity minimized

Agricultural Research Institute
Jordan Agricultural Research Center
Current Project – DWR Prop 204

Objectives:

1. **Optimize IX operation** (see diagram on next slide):
   
   A. Use environmentally friendly KCl to regenerate the IX resin.
      - K is a plant nutrient
      - Eliminates adding Na to the waste stream.

   B. Regenerate the resin using brine produced by the desalter, thereby reducing the amount of imported salt required and waste brine produced.
Production of Agricultural Water and Nutrients from Saline Water Sources

Current Focus - optimize the removal of Ca, Mg

Brackish water → Pre-filtration → Filtered water → EDR 1 → Multi-valent ions → CIX → KCl or KNO₃ regenerates CIX → KCl enriched soft water → AIX → K enriched soft water → RO & EDR 2 (future work) → Product water

- Organic sediment to processing
- NaCl stream to thermal separation process
- Nutrient recovery
- Solid NaCl
- K, Ca, Mg & Cl or NO₃
- K, NO₃, SO₄, HCO₃

Solar Power

Drainage water → Fertigation system

Solid by-products

NaCl & other constituents to separation process
CALDAC Vision:
A connected hub that integrates multiple DAC technologies, other carbon removal approaches, carbon utilization solutions, carbon-free, clean energy providers and energy storage solutions, water management, as well as geologic storage providers.
CALDAC - Water Sources for CO₂ Stabilization, Process Waters & Other Uses

- Ag. drainage water
- Brackish groundwaters
- Brackish surface waters
- Produced water (oil & gas industry)
- Industrial wastewater
- Municipal wastewater
Fig. 36. Locations of wells producing brackish groundwater from 0 to 3,000 feet below land surface in the Southwestern Basins region.

Distribution of Shallow Groundwater Salinity in Western San Joaquin Valley

Source: USGS CA Water Science Center and CA Oil, Gas, and Groundwater Program
An interesting read on the California brackish water situation you can Google Mavens brackish water):
Addressing Drinking Water Challenges in California Disadvantaged Communities
Erick Orellana
Our Mission
Act as a catalyst for community water solutions through organizing, education and advocacy in California.

Our Vision
Ensure that ALL Californians have access to safe, clean and affordable water.
Nearly 1M people in California are impacted by unsafe drinking water each year.

Public water systems out of compliance with drinking water standards (as of Feb 2019) are denoted by a star.

Source: Human Right to Water Portal, CA State Water Resources Control Board
Communities
Water Quality
Infrastructure
Water Affordability
Climate Change
AGUA Coalition
Community-Driven Policy Advocacy

- Consult community to understand their priorities
- Educate communities about project funding and implementation process
- Policy for community, by community
Technical Assistance Projects

- West Goshen, CA (Central Valley - Tulare County)
- East Orosi, CA (Central Valley - Tulare County)
- N of Moss Landing (Central Coast - Monterey County)
- Springfield (Central Coast - Monterey County)
San Joaquin Valley, West Goshen
Safe and Affordable Drinking Water Fund (SB200)

- Signed into law by Governor Newsom in July 2019
- $1.4 billion over 11 years
- Provide universal access to safe drinking water focused on most vulnerable communities and households
- Includes funding for ~2M people not served by public water systems including domestic wells
Safe Water Resources
Questions?

- Sign-up to receive monthly newsletters on water justice: CommunityWaterCenter.org

- Follow us on social media!

Erick Orellana, Senior Policy Advocate
Erick.Orellana@communitywatercenter.org
What is the ‘Valley Clean Infrastructure Plan’?

- Public-Private Collaboration between WWD and GSCE to develop solar and transmission assets on WWD-owned retired lands and privately-owned fallowed lands

- WWD will contribute land, serve as CEQA lead agency and have a right to co-invest

- GSCE will source private lands for scale, secure transmission corridors, permit solar generation, solar storage and transmission

- GSCE will develop and build transmission to serve all lands in the VCIP program
By 2040, water trading, new supplies, and increased productivity can temper the impacts of farm water reductions.
Volatile Surface Water in Westlands

Precipitation v. Federal Agricultural Allocation
1952-2020

Year

Precipitation (inches)

Allocation
Unique Opportunity and Timing for Westlands

- California has committed its utilities to **100% renewable energy by 2045**
  - Overlaps SGMA implementation period
  - DWR was added to the mandate in 2022

- California is **already behind** in developing renewable energy
  - Plans call for 6,000 - 7,000 MWs of new generation and storage per year
  - CA in past decade has only succeeded in adding an average of 1,000 MWs of solar and 300 MWs of wind each year

- Studies show that **500,000 – 750,000 acres** of new solar energy may be needed between now and 2045; desert areas of California have habitat and species challenges
Westlands has **more contiguous retired and fallowed lands** in the San Joaquin Valley (SJV) than any other region.

Estimates show that there are as much as:

- **60,000+ acres** (estimate) of District owned lands that are fallowed or retired (approximately 10% of the District); plus
- **200,000+ acres** (estimate) of similar privately owned lands.

Landowners can **unlock the value** in underutilized open lands:

- Retain water for farming
- Generate non-water related revenue
- Cost avoidance for the owner (taxes and maintenance)

*Westlands’ Long-Term Liability has become a Valuable Asset*
CAISO’s Transmission Plans Run through Westlands

- CAISO (grid operator) and other CA regulatory agencies expect approximately 25% of renewable power needs in the SJV.

- 500,000-750,000 acres required for solar power will increase significantly if/when hydrogen power production becomes commercially viable.

- As of 2022, DWR is subject to renewable power requirements.
WWD is Strategically Located
VCIP is an Innovative Approach to Creating Value for WWD, Energy Customers, Landowners, & Local Communities

SOLAR FOR THE CLEAN ENERGY FUTURE | Approximately 20,000 MW (PV) and hundred of miles of transmission lines to help meet California’s future needs in an efficient and cost-effective manner

GARNERING BROAD SUPPORT | Strong support from a wide variety of parties, including environmental groups, labor, state and local governments, and agriculture groups

WATER BENEFITS | Saving water for productive farms while using less productive lands for solar provides a mutual benefit to the agricultural community

JOBS & ECONOMIC DEVELOPMENT | Potential for thousands of high paying jobs over the next 15+ years, plus economic development from opportunities for manufacturing, fabrication, assembly, and research and development.
Thank you
The Number of Irrigation Wells in the Central Valley

& Potential to Generate Electricity

Dr. Larry Dale, Scientist, Economist
Lawrence Berkeley National Laboratory, Ret.
larry.l.dale@gmail.com

Dr. Sarah Lewis MacDonald, GIS Consultant
Envision Geo

Dr. Damian Park, Economist
Santa Clara University
CEC Project to Evaluate New Technology: Aquifer Pumped Hydro (APH)

Two parts to APH project:

- Show how irrigation wells can generate electricity
  - using APH technology
- Count up the number of irrigation wells
  - showing the scope of APH technology

- Wells can generate electricity
  - Demonstration projects in Antelope Valley
    - Work out efficiency, cost, generation levels under different conditions

- The number of wells determines the scope (generation potential)
  - No good State well inventory
  - Steps to obtain a better well inventory
Irrigation Wells Can Generate Electricity

How APH Works: Generator is Pump Run in Reverse

- Well motor becomes a generator when rotated in reverse
- Idle wells provide existing infrastructure to generate electricity
- Water cycles up and down from aquifer to water storage reservoir
APH cost competitive with Li batteries

• Retrofit equipment:
  • Surface storage or access to surface water.
  • A variable frequency drive (VFD) to start motor.
  • A VFD regeneration drive
  • Utility connection interface.

• Ongoing demonstration projects, preliminary evidence suggest:
  • Irrigation wells can generate between .05 and .5 MW

• Unit cost of APH in is competitive with Li batteries
APH potential and the number of irrigation wells

- USDA census
  - Individual raw survey data difficult/impossible to access.
  - Census undercounts farms (PPIC 2023 study)

- Electricity accounts
  - Data difficult/impossible to access
  - Diesel wells not counted
  - Not all agricultural wells included?

- Districts and GSA’s
  - Data difficult/impossible to access
  - Reports rely on well completion reports

- Northern Regional Office (NRO) Well Counts
  - Limited coverage (Northern Sacramento Valley only)
  - Hard to replicate

- Well completion reports (WCR) Well Counts:
  - Cover entire Valley
  - Not all wells counted
Many wells aren’t reported

• Compare municipal wells with municipal well completion reports
  • 2.4 municipal wells for every municipal well report
  • Similar ratio of irrigation wells to irrigation well reports?
    • Well survey can test that assumption

<table>
<thead>
<tr>
<th>Completion Reports (DWR)</th>
<th>Irrigation Wells(^{1,2})</th>
<th>Municipal Wells(^{1,4})</th>
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<tbody>
<tr>
<td></td>
<td>31,842</td>
<td>4,590</td>
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<tr>
<td>Operating Wells</td>
<td>NA</td>
<td>10,882</td>
</tr>
<tr>
<td>Wells per Completion Report</td>
<td></td>
<td>2.4</td>
</tr>
</tbody>
</table>

1. DWR Bulletin 118 (2020)
https://www.arcgis.com/home/item.html?id=425b3d23264b45af8f1ca71017049bff
2. USGS Circular 1401-a (1991)
3. DWR Bulletin 118 (2020)
https://www.arcgis.com/home/item.html?id=425b3d23264b45af8f1ca71017049bff
4. SWRCB GAMA. Div. Drinking Water 2023
https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/
Options for Counting Irrigation Wells

1. Remote sensing
   • Satellite photo data

2. Count wells in the field
   • Drive or fly by counts

3. Farm or District level survey (combine steps 1-2)
   • Locate priority survey regions
     • Use WCR’s and NRO’s as well proxies
     • Minimize required sample size
   • Design Survey instrument
     • Simple, satellite maps for easy reference
   • Assess Accuracy: Follow up drive by to assess accuracy
WCR density regions

• Total of 21,000 sections in the Central Valley proper
  • Mostly flat area outlined in the map on the right.
  • **Average of about 2 wells** (reported) per section

• About 30% of Valley has under 1 well per section
  • White areas on map (outlined in blue)
  • **Low Well Density**

• About 45% of Valley reports 1-4 wells per section
  • Yellow areas on map
  • **Medium Well Density**

• Remaining 25% reports > 5 wells per section
  • Green areas on map (outlined in red)
  • Some areas with over 20 wells per section
  • **High Well Density**
Note: WCR and NRO counts have similar well density regions
Sacramento Valley
• Low well density (white or pale orange)
  • Larger parcels <26 parcels per section
  • Foothills west side: larger farms
• High well density (red or brown)
  • Smaller parcels (<26 parcels per section)
  • Middle Valley, smaller farms or ranchettes

San Joaquin Valley
• High well density
  • East side, > 26 parcels
  • smaller farms, Orange Cove
• Low well density
  • West side, < 26 parcels,
  • larger farms: Westlands
Explanatory Variable: Well Size

- Low Well Density (shaded blue)
  - Large wells (>20” casing)
  - East side San Joaquin Valley

- High Well density (shaded green)
  - Smaller wells (< 20” casing)
  - West side San Joaquin

- Inverse correlation between large well size and low well density
WCR Density
Explanatory Variables: Water Supply

- High density regions
  - Largely groundwater (Green, olive, gray)
    - Orchard land
    - North, south and east of the Rice acreage

- Low density regions
  - Some areas mostly surface water (purple, blue)
    - Rice areas of Sacramento
  - No water supply (light green)
    - Foothills, rangeland, urban area
Summary: Variability of well density measures

<table>
<thead>
<tr>
<th>Region</th>
<th>Sections</th>
<th>Well Density (Wells/sec)</th>
<th>Stan. Dev</th>
<th>Well Ratio (Wells/WCR)</th>
<th>Stan. Dev</th>
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</thead>
<tbody>
<tr>
<td>DWR North. Region</td>
<td>2714</td>
<td>1.92</td>
<td>2.70</td>
<td>1.27</td>
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<tr>
<td>Irrigated Region</td>
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<td>3.67</td>
<td>2.96</td>
<td>1.47</td>
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<td>Orchard Sub Region</td>
<td>219</td>
<td>4.53</td>
<td>3.36</td>
<td>1.32</td>
<td>1.60</td>
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<tr>
<td>Field, Other Sub Region</td>
<td>57</td>
<td>3.65</td>
<td>2.26</td>
<td>1.67</td>
<td>1.67</td>
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<tr>
<td>Rice Sub Region</td>
<td>61</td>
<td>2.25</td>
<td>1.83</td>
<td>1.79</td>
<td>1.57</td>
</tr>
</tbody>
</table>

1. Shows how measures of well density vary across land use regions.
   • Uses two measures: SD of well density and SD of well/WCR ratio
2. Well field data from DWR’s northern office suggests we require less survey data than we thought to get a reliable well count.
Survey Instrument

Key Issues:

• Who to Survey?:
  • Farm
  • District or GSA

• How to secure confidential data transfer
  • Internet log on
  • Simple (mark well location)
  • Test on focus groups

• Assess survey accuracy
  • Post survey drive by

• Provide APH follow up
  • Evaluate cost and benefits of APH
Questions?
Speakers Contacts

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Next Steps/Closing Remarks

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