Quantifying and Minimizing Water Quality Impacts

Thanks for joining us!
The session will begin shortly.
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Allison Lassiter
Assistant Professor, University of Pennsylvania,
@allisonlassiter

Managing Salinization in a Coastal Watershed: Critical Infrastructure and Partnerships for Climate Adaptation
Managing salinization in a coastal watershed: critical infrastructure and partnerships for climate adaptation

Allison Lassiter, Scott Moore, and Zoe Covello

Presented by:
Allison Lassiter
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1. Motivation + research questions
2. The case of Santa Ana Watershed Project Authority
   Trends in Total Dissolved Solids
   How interviewees define successful projects and partnerships
3. The problem of chloride
4. Conclusions and next steps
Motivation and research questions
Challenge: Increasing salinity in freshwater sources

• “Freshwater salinization syndrome”
  • Anthropogenic (fertilizers, road de-icers, contributions from wastewater)
  • Geologic
  • Often measured in aggregate as Total Dissolved Solids (TDS)

• Sea level rise bringing ocean salts inland
  • Captured in TDS measurements, but best isolated through chloride measurements

• Converging challenge in cities and towns around the globe, with vulnerability depending on: location of water sources, type of water source (surface or groundwater), land use, geology, and local climate shifts (timing and quantity of precipitation).
What will we do about widespread salinization?
Desalination will not work everywhere

- High-cost (scales with concentration of salt)
- Necessitates a good energy source
- Typically requires large land area
- Does not provide large volumes of water
- Waste brine disposal can present challenges
Is watershed-based salinity management a viable alternative?

• In the United States, two watershed-based, regional management organizations have salinity as a management target
  • Santa Ana Watershed Project Authority (SAWPA), located in Southern California
  • Delaware River Basin Commission (DRBC), located in the mid-Atlantic region

• What are the possibilities of regionalization as a salinity management tool? This research first focuses on SAWPA
Research Questions and Methods

- What are SAWPA’s most successful salinity management strategies?
  - Can we observe these through salinity monitoring data?
  - How would water managers define successful projects and partnerships?

- Evaluate Total Dissolved Solids (TDS), the primary management target in SAWPA, in the Santa Ana River over time

- Interview people from:
  - SAWPA
  - SAWPA member agencies
  - Regional Water Quality Board (Santa Ana, Central Valley)
  - SAWPA Mediator
  - SAWPA-adjacent agencies (Bureau of Reclamation, Metropolitan Water)
The case of the Santa Ana Watershed Project Authority (SAWPA)
SAWPA as a case of water management regionalization

- 4 member agencies:
  - Orange County Water District (OCWD)
  - Eastern Municipal Water District (EMWD)
  - Western Municipal Water District (WMWD)
  - San Bernardino Valley Municipal Water District (SBVMWD)
  - Inland Empire Utilities Agency (IEUA)

- Spans 4 counties: Riverside, San Bernardino, Orange, and a portion of Los Angeles County
Trends in TDS
Tracking TDS (orange) and Rainfall (blue) at Prado Dam
Interviewees’ perceptions of success
What is the most successful project?

The Brine Line
What is the most successful partnership?

• SAWPA itself and its five members → lack of litigation
• Relationship with the local regulator → cooperation while working to meet management targets
• Relationships with state and federal senators → bringing funding into SAWPA
The problem of chloride
Seawater intrusion in Orange County's groundwater, a source of drinking water
• **Groundwater Replenishment System (GWRS):** create highly treated, low-salinity wastewater

• Inject low-salinity wastewater at interface with ocean, protecting fresh drinking water

• Historically attempted to do this with Colorado River water, which proved to be too saline

• **GWRS Funding Sources:**
  - State Water Bond ($37M)
  - CA Department of Water Resources ($30M)
  - State Water Resources Control Board ($5M)
  - US Bureau of Reclamation's Title XVI program ($20M)
  - California Energy Commission ($300k)
  - EPA ($500k).
  - The remainder of the costs are shared between OCWD and OCSD
Conclusions and next steps
Will ongoing challenges push limit of cooperation?

• External environmental stresses likely to worsen
  • High salinity in Colorado river water
  • Variability in State Water Project deliveries

• Upstream-downstream misalignment on importance of chloride

• Will brine disposal become a challenge?
  • More saline brine
  • Consequences of increasing brine disposal along the cost
  • Relationship with sewage management entities
Takeaways and Conclusions

• Regionalization is a good management strategy and can promote cooperation, but it is difficult to capture all relevant scales and actors in salinity management

• Regionalization is perhaps most effective in securing funding and resources to support collaborations

• Coastal salinization imposes political and institutional challenges that have yet to be addressed either by SAWPA or elsewhere
Next steps: Comparison with the Delaware River Basin Commission
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Arsenic Contaminated Ground Water Prompts a Community to Buy Water From Poorly Maintained Drinking Water Vending Machines
Arsenic contaminated ground water prompts a community to buy water from poorly maintained drinking water vending machines.

Ryan Sinclair PhD MPH, Nataly Escobedo Garcia MA, Thomas Hile MA
Oasis Mobile Home Park – Case Study

» Oasis Mobile Home Park – Case Study
  ~ Many environmental health issues
  ~ Water testing and federal agencies

» Drinking water vending machines
  ~ An EJ compromise
  ~ What is needed to improve this H₂O quality?

» Arsenic and Drought
  ~ Did drought increase concentrations of arsenic in ground water?
  ~ Water Scarcity and climate impacted communities

» Conclusions
Oasis Mobile Home Park

- 1,900 people near Salton Sea in the ECV of Southern California
- About 250 mobile homes
- Estimate MHI - $16,945
- Residents living in Oasis are majority Latino, with many Purépecha residents.
- Agriculture workers and several other occupations.
- Large family-centric households
Drinking water
- **Arsenic Content**
- Color
- Odor and residual chlorine
- Water Shutoffs
- Bacteria

**Water Shut-offs**
- Often more than 12 hours at a time
- Frequent water shut-offs without warning

**EPA Emergency order - Arsenic**
- Arsenic contamination (70-80ppb)
  - Declared Aug 2019
  - Lifted June 2020
  - Re-declared September 2020

**Alternative water**
- Issues with access and quality

**Discolored water**
- Possibly associated with super-chlorination or Fe.
- Yellow color or brown color

**Bacteria Detected in several samples**
- PVC pipes are often near surface
- Cross contamination
Frequent water leaks and shutoffs

Illegal dump sites

Demolished house debris
Habitability:
- Most are owned by residents
- Most trailers from 1960-1970s
- Mold, water leaks, insulation, dust

Water system leaks

Mold

Electrical Infrastructure

Dumpsites and trailer debris
Habitability:
- Mold, water leaks, insulation, dust

Two houses in Oasis MHP
ERMI = 14
ERMI = 17
Wastewater exposure:
- Consolidated septic systems
- PVC and ABS near surface
- Many leaks
- Some “straight pipe”

Long-term straight pipe creates shady areas - attracts children and dogs.
Timeline of events

2010 – faulty wastewater lagoon closed
2013 – nearby Los Duros closes
2014 – IRWMP helps other park water/wastewater
2014 – arsenic found in tap water
2015 - Concerned residents and LLU survey

Manager supplies low cost drinking water
CVWD supplies treated water from truck spigots
Manager dies
Probate
BIA determines no permit for 15 years
Community requests water delivery

Loose network of septic tanks used
LLU finds 8x MCL arsenic in water
USEPA resistance

LCJA contact resident advocates
Nearby D&D MHP USEPA action on Arsenic
#1 USEPA emergency order
USEPA declares drinking water safe
#2 USEPA emergency order

2010 – faulty wastewater lagoon closed
2013 – nearby Los Duros closes
2014 – IRWMP helps other park water/wastewater
2014 – arsenic found in tap water
2015 - Concerned residents and LLU survey

Timeline of events
LCJA action and Advocacy

Locally...

State policy...

SB 129 signed

Per USEPA

~30 families at risk of eviction

All the same issues remain +

Probate

Interim managers requiring cash rent payments

3. Of the amount appropriated in Schedule (1), $30,000,000 is available to provide emergency housing, develop quality affordable housing, and construct necessary infrastructure to relocate residents of Oasis Mobile Home Park in Riverside County.
Congressman action

- **Federal…**
- BIA acknowledged
  - OMHP operated without a lease for at least fifteen years
  - Multiple deficiencies and risk factors present in the wells and water distribution systems since 2007
- BIA will not take actions to close down the park

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The Honorable Darrell Issa
Representative from California
1130 Longworth Building
Washington, DC 20515

The Honorable Deb Haaland
Secretary
Department of the Interior
1849 C St NW
Washington, DC, 20240

Dear Secretary Haaland and Director LaCounte,

I am writing to express my extreme concern over the Bureau of Indian Affairs’ (BIA) oversight of ongoing public hazards in my district. In an effort to appropriately address this issue, I am requesting a full accounting of the BIA’s interactions and oversight of the Oasis Mobile Home Park (OMHP), located on Tribal land in Thermal, California.

For the past year and a half, my office and I have been working with local BIA officials in Riverside County to remedy two public health threats to my constituents. The
2016 Household Survey on water use in Oasis, Thermal, Mecca, Coachella City and North Shore.

Conducted by LLU, Alianza and the California Institute for Rural Studies

<table>
<thead>
<tr>
<th>Table 1: Household Water Use</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Running Water at Home</td>
</tr>
<tr>
<td>Use Tap Water from</td>
</tr>
<tr>
<td>Faucet for Cooking or</td>
</tr>
<tr>
<td>Drinking</td>
</tr>
<tr>
<td>Tap Water from Faucet</td>
</tr>
<tr>
<td>Treated before Use</td>
</tr>
<tr>
<td>Filter</td>
</tr>
<tr>
<td>Boil</td>
</tr>
</tbody>
</table>

| Water Turned Off without   |       |       |         |       |                |     |
| Warning                     | 2%    | 6%    | 8%      | 30%   | 3%             | 6%  |

| Number of Times in          |       |       |         |       |                |     |
| Previous 12 Months          | 2.7   | 3.1   | 4.1     | 8.9   | 1.8            | 4.8 |

<table>
<thead>
<tr>
<th>Buy Bottled Water</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill Water Jugs from Vending Machine</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>93%</td>
<td>96%</td>
</tr>
<tr>
<td>Fill Water Jugs at a Market or Store</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>93%</td>
<td>96%</td>
</tr>
<tr>
<td>Buy small Bottles of Water at Store</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Only 38% of people in Oasis drink from the tap.
- Almost 30% of people in Oasis had water turned off.

Everyone
- Fills 5-gallon jugs at a drinking water vending machines
- Buys small disposable bottled water
Findings:
- Most WVM in ECV are contaminated and neglected
- No visible record of maintenance
- Frequent occurrence of rust, biofilm, and damage
- Molecular detection of several pathogens

Recommendations to community
- Look for evidence of inspections and maintenance
  - County sticker and digital read out.
  - Do not use if you see rust, biofilm, slime, mold, or broken equipment

Conclusion: Lack of maintenance represents an environmental injustice that exacerbates the already difficult drinking water situation in the ECV.
Conclusions

» Arsenic contamination in drinking water
  ~ Increases water stress and water scarcity
  ~ Motivates households to purchase other sources of water
  ~ Motivated the USEPA to consider the Oasis MHP situation
  ~ Motivated many others to tackle the

» Arsenic and Drought
  ~ Did drought increase concentrations of arsenic in ground water?
    • “We don’t know yet”
    • Models show a marginal increase in concentration, but not for the type of aquifer in the ECV.
  ~ More important message: Water Scarcity is pronounced in vulnerable climate impacted communities.
    • Residents of Oasis MHP are on front lines of climate change
Nate Jones
Assistant Professor of Ecohydrology, The University of Alabama
@FloodHydrology

Microbial Contamination of Drinking Water Supplied by Private Wells After Hurricane Harvey
Microbial Contamination of Drinking Water Supplied by Private Wells after Hurricane Harvey

Nate Jones
Assistant Professor
University of Alabama

Kelsey Pieper
Assistant Professor
Northeastern University
Microbial Contamination of Drinking Water Supplied by Private Wells after Hurricane Harvey


Cite This: Environ. Sci. Technol. 2021, 55, 8382–8392

Read Online
What happens to a private well during a flood?

Limited research about well water quality after flooding.

Even more problematic if the well system is damaged and/or the septic system flooded.

Neighboring private wells.
Well water needs after a flood

“water was 7 feet over our well...under water for about a week”

Is my water safe? What do I do?
Well water quality one week following the flood

August 27, 2016 sampled five wells in Livingston Parish

Pathway(s) likely existed for surface water to influence well water during flood
• 3 wells were positive for total coliform bacteria

Beliefs that water was safe because wells are deep

Hurricane Harvey
Study Objectives

1. Impact of flooding on private wells
2. Drivers of well water contamination
3. Well disinfection and natural attenuation
Mobilizing our sampling campaign in Texas

8822 total samples

1528 NSF RAPID

4935 Brazoria County

2359 City of Houston
USGS Well Dataset

Geospatial Data

Dartmouth Flood Observatory
Inundation
1. Impact of flooding on private wells
2. Drivers of well water contamination
3. Well disinfection and natural attenuation

Study Objectives
Thousands of private wells were likely affected by flooding

Within 41 disaster-declared counties…

- 6.1% of population was reliant on private wells
  - But still an estimated 526,000 well users
- 2.9% (15,060 users) may have been inundated
Flood impacts were not isolated to private wells in rural counties

\%

% #

Rural > Urban  Rural < Urban
Flood impacts were not isolated to private wells in rural counties.
Flood impacts were not isolated to private wells in rural counties
1. Impact of flooding on private wells
2. Drivers of well water contamination
3. Well disinfection and natural attenuation

Study Objectives
Well water was contaminated after Hurricane Harvey

Residents that reported their wellheads were...

<table>
<thead>
<tr>
<th></th>
<th>Not submerged (n=275)</th>
<th>Submerged (n=201)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>~3%</td>
<td>37%</td>
</tr>
<tr>
<td>Total coliform</td>
<td>~33%</td>
<td>56%</td>
</tr>
</tbody>
</table>

n=602
Safety concerns and flood impacts associated with *E. coli*
1. Impact of flooding on private wells
2. Drivers of well water contamination
3. Well disinfection and natural attenuation

Study Objectives
Chlorination did not always eliminate contamination
Sampling and contamination decreased over time.
Contamination reduced by 1.5-2.7% each week
Take Home Points

1. Private well impacts contamination occurred in both urban and rural counties

2. Inundation (or proximity to inundation) correlated with contamination

3. Disinfection was not always effective, but we did observe natural attenuation over time
Next steps

1. Predictions of private well system locations!
2. Connectivity between floodwaters and well water
3. Physical, chemical, and biological drivers of well recovery
Thank you!

cnjones7@ua.edu
@FloodHydrology
Coming up Tomorrow!

Break-out 5 | 8:30-10am PT

- **SESSION 5.1**: The Cumulative Costs of Climate Change
- **SESSION 5.2**: Heat Vulnerability Affecting Workers, Healthcare, and Neighborhoods
- **SESSION 5.3**: Innovative Toolkits for Urban Heat Adaptation
- **SESSION 5.4**: Housing and Hazards: How Should We Protect Vulnerable Homes?

Break-out 6 | 10:15-11:45am PT

- **SESSION 5.1**: Emerging Research on Financial Adaptations to Climate Impacts
- **SESSION 5.2**: Wading into the Economic Impacts of Climate Change on Water
- **SESSION 5.3**: Equitable Adaptation to Climate-Related Flood Risks: Part 2
Thanks for tuning in!