Photo: Community Water Center, Erin Lubin

Just Water?
Social Disparities in Nitrate Contaminated Drinking Water in California's Central Valley

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Tooleville, CA



Photo: Community Water Center

Summary of Findings

- Economies of scale do not fully explain disproportionate nitrate exposure
- Higher nitrate levels in small community water systems (CWS) with:
  - higher proportions of Latinos
  - higher renter populations

Outline

- Background
- Research Question
- Study Area
  - San Joaquin Valley
- Key Terms
- Methods
- Results
  - Descriptive statistics
  - Model results
- Discussion

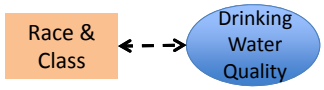
Access to Clean Drinking Water is a Challenge in the U.S.

Access to Clean Drinking Water Matters…

- Relationship with groundwater contamination
- Public Health
  - Communities and individuals face exposure to contaminants
  - Associated health effects
    - e.g. Gastrointestinal diseases, reproductive effects and cancer, etc
- Economic impacts/community well being
  - Cost of mitigation
  - Health costs

Little research on drinking water and impacted populations in the U.S.

- Need for analysis of association of quality & vulnerable groups



Environmental Injustice
Disproportionate impact of an environmental harm felt by [low income communities, or people of color].

Research Question

In California's San Joaquin Valley (SJV), at a water system level:

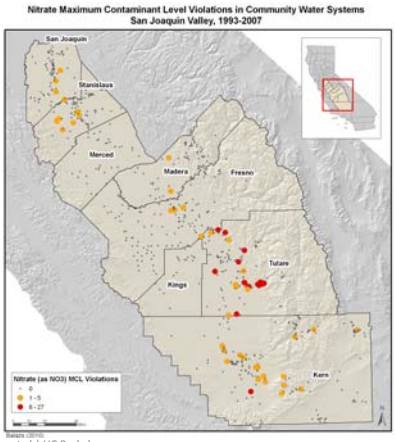
are there **higher concentrations of nitrates** in **low income communities, and/or communities of color**?

Nitrate in CA Drinking Water

- Total Coliform
- Arsenic
- Dibromochloropropane (DBCP)
- Nitrate
  - Groundwater contaminant
  - Acute
    - Infants and pregnant women at risk
    - Health outcomes: methemoglobinemia ("blue baby syndrome"), reproductive toxicity, etc.
  - High costs of mitigation
    - Treatment, consolidation or new wells

Nitrate as a problem in the SJV

- Agriculture uses large amounts of nitrate fertilizers
- Major source of groundwater contamination
- 95% of pop. relies on gw
- High nitrate levels in drinking water
  - 75% of all nitrate MCL violations



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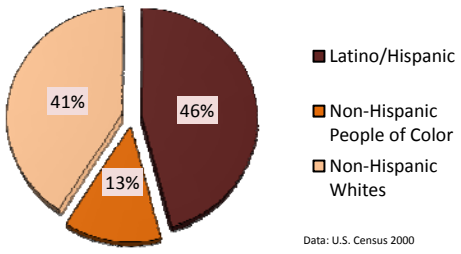
The San Joaquin Valley



Data: U.S. Census 2000

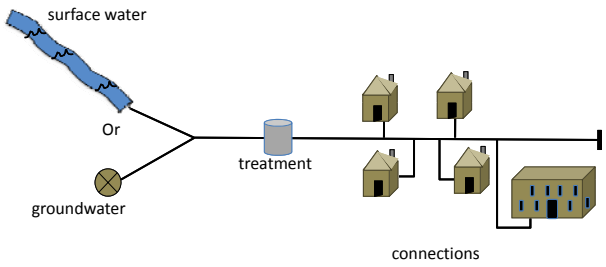
- ~10% of CA's population
- 20% below poverty level (14% in CA)
- Cumulative exposure to multiple contaminants (air, toxic siting, pesticides)
- Drinking water contaminants exacerbate existing exposures and health effects

Why might we expect a relationship?

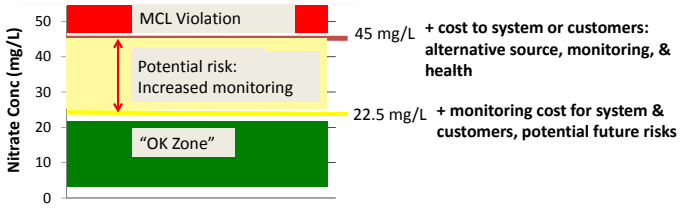
- Potential disparities in exposure may exist because:
  - low income and people of color in closer proximity to agriculture
  - inability to mitigate high nitrate levels b/c of:
    - Lack of economies of scale
    - Resources in community
    - Political clout & representation
- Broader systemic inequalities

Community Water System (CWS)

A public water system that provides water to at least 25 residents or 15 connections and serves water year-round.



Maximum Contaminant Level (MCL) & Monitoring



Study Design

- **Multi-level, longitudinal regression model**
  - Systems→wells→samples
- **Sample selection**:
  - CWS with monitoring samples from 1999-2001
  - source location
  - active sources
  - **n=327** community water systems (36% of CWS)
    - Underrepresentation of small systems

	Active CWS with source location	CWS in Study Sample
# CWS	711	327 (36%)
Population served	3,047,822	2,948,346 (96%)
Incorporated	9%	18%
<200 Connections	74%	48%
Groundwater	89%	91%

Data sources & processing

Water Quality Monitoring Database (CDPH, 2008)
- •Interviews w/CDPH
- •Creation of database
- •Cleaning of data

→ •Nitrate concentration at point of entry

Permits, Inspections, Compliance, Monitoring & Enforcement (PICME)Database (PICME, CDPH 2008)
- •Interviews w/CDPH
- •Creation of database
- •Cleaning of data

→ •CWS Characteristics

GIS & Census Analysis
- •Digitizing CWS
- •Overlay with Census block group (2000)
- • Data & source locations
- •Apply method to 8 counties

→ •CWS demographics
•Environ. factors

3 Variables of Interest

- Average nitrate concentration in system over time
- Nitrate concentration at the point of entry to CWS
- Potentially exposed population (PEP) (Storm 1999)
  - Fraction of population exposed to 3 different nitrate ranges
  - = Pop_i X (# $sources_i$ within nitrate $range_x$/ # $sources_i$ with samples)
  - 3 nitrate ranges:
  - < ½ half MCL (22.5 mg/L)
  - ½ to MCL (22.5- 44.9 mg/L)
  - >=MCL (45 mg/L)

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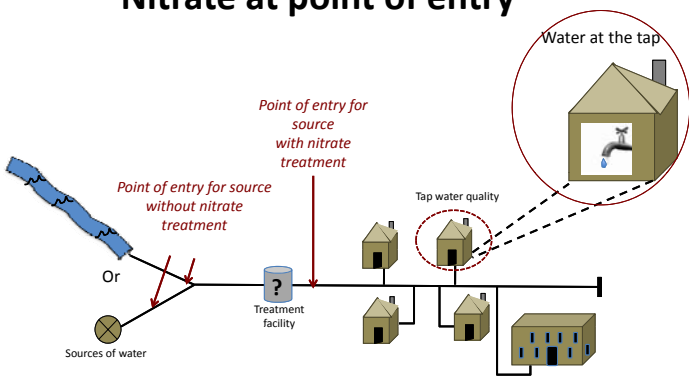
Nitrate at point of entry



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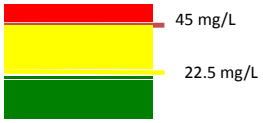
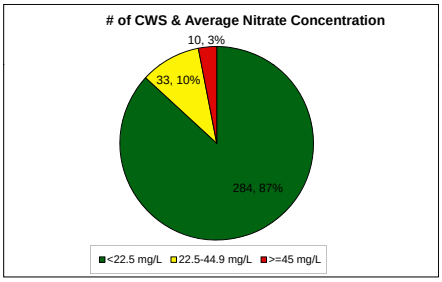
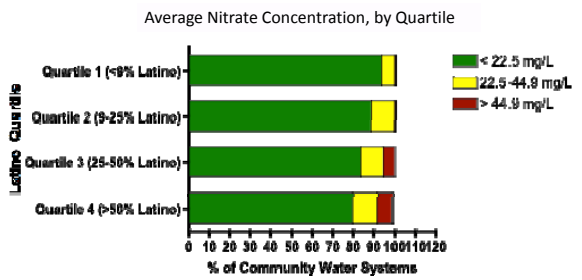


Descriptive Statistics (1): Average nitrate



- Average masks some of higher values
- 9/10 had <200 connections
- 9/10 had 1-2 wells

Descriptive statistics (2):



Model Specification

- **Dependent variable**: nitrate concentration at point of entry
- **Independent variable**: race & class (at water system level), in 2000
  - % Latino
  - % non-Latino people of color
  - % Home Ownership *[wealth/political clout]*
- **Controlling for:**
  - Valley floor (agriculture)
  - Unincorporated
  - Groundwater/surface water
  - Ownership (public/private)
  - # of service connections (<200 connections)
  - *implicitly controlling for # of samples
- **Stratifying by # of connections**
  - < 200 service connections (average population: 3,400, median:75,)

Race and Wealth Associated with Nitrate Levels (mg/L)

Variables of Interest	Unadjusted Model
% Latino (s.e.) [vs % white]	.11 (.03)***
% Non-Lat. POC [vs % white]	-.07 (.13)
% Owner occupancy (s.e.)	-.19 (.05)***

Final model adjusts for: proximity to agriculture, % non-Hispanic POC, incorporated, <200 connections*, # of sources, ground water, ground-water/surface water, unincorporated, season, time**
Outcome: concentration of nitrate (mg/L)
P-values: * .01, ** .05, * .1**

Race and Wealth Associated with Nitrate Levels (mg/L)

Variables of Interest	Unadjusted Model	Adjusted Model
% Latino (s.e.) [vs % white]	.11 (.03)***	.08 (.04)**
% Non-Lat. POC [vs % white]	-.07 (.13)	-.09 (.12)
% Owner occupancy (s.e.)	-.19 (.05)***	-.12 (.06)**

Final model adjusts for: proximity to agriculture, % non-Hispanic POC, incorporated, <200 connections*, # of sources, ground water, ground-water/surface water, unincorporated, season, time**
Outcome: concentration of nitrate (mg/L)
P-values: * .01, ** .05, * .1**

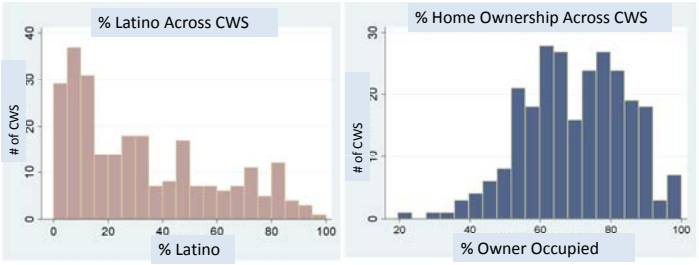
Race and Wealth Associated with Nitrate Levels (mg/L)

Variables of Interest	Unadjusted Model	Adjusted Model	>=200 Conn.	<200 Conn.
% Latino (s.e.) [vs % white]	.11 (.03)***	.08 (.04)**	-0.008 (0.03)	0.23*** (0.08)
% Non-Lat. POC [vs % white]	-.07 (.13)	-.09 (.12)	-0.17* (0.12)	0.005 (0.23)
% Owner occupancy (s.e.)	-.19 (.05)***	-.12 (.06)**	-0.04 (0.06)	-0.20* (0.11)

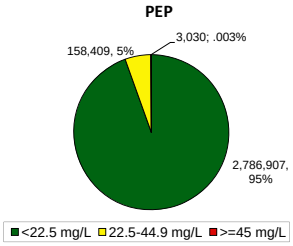
- + 1% in % Latino→ +.2 mg/L
- + 1% in % home ownership→ - .2 mg/L

The size of the correlation matters

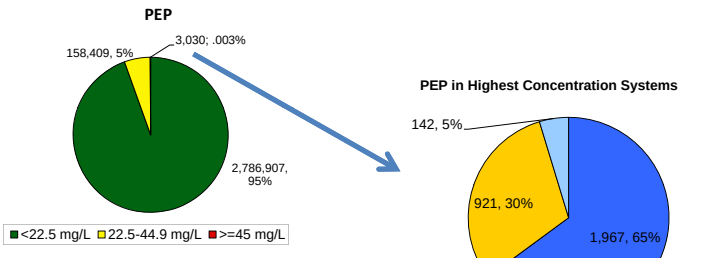
- A system with 90% Latinos → +14 mg/L **vs.** system with 10% Latinos
- A system with 90% owners → -7 mg/L **vs.** system with 40% owners



Potentially Exposed Population

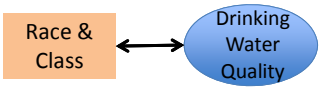


Latinos most vulnerable group in systems with the most degraded water



56% of the population is below or near poverty

Summary of Findings



- Evidence of disproportionate nitrate exposure
  - Scale doesn't explain everything
- Small CWS with + Latinos + renters have + nitrate levels
  - Power & proximity to ag
- "Invisible" middle category
  - 5% of popn.
  - Potential health risk due to lack of monitoring

Implications of Findings

- Potential economic burden when >22.5 mg/L
  - Costs for systems & customers
    - Monitoring
    - Alternative source
    - Two water bills for customers
- Health risks to customers
  - 2 risks to customers
    - Exposure to high levels
    - Unknown exposure
- Vulnerability for systems with 1-2 wells

Policy Implications

- Multi-level solutions needed
  - Water system level:
    - System consolidation, treatment, new sources
    - Targeted resources for most vulnerable communities
    - "Middle category"
  - Groundwater:
    - Groundwater—Drinking water interface
  - Source water protection

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Historical Planning…

Tulare County General Plan (1971)

- "**public resource commitments to communities with little or no authentic future** should **be carefully examined** before final action is initiated. These **non-viable communities** would, as a **consequence of withholding major public facilities such as sewer and water systems**, enter a process of **long term, natural decline** as residents depart for improved opportunities in nearby communities" (Tulare County General Plan, 1971)
- Allensworth, **Alpaugh**, Delft Colony, East-Orosi, Lindcove, Monson, Plainview, Poplar-Cotton Center, Seville, Sultana, Teviston, **Tooleville**, Tonyville, Tract No. 51 and Waukena

Politics of consolidation

Why does the EJ lens matter?

- I have controlled for being in the valley floor, and we still see a differential effect
- The resources available to such communities to address the problem is different
  - E.g. homeowner association in foothills vs. Tooleville

Solutions

CWS-based

- New water source
- Treatment
- Consolidation
- Community organizing/governance

Macro-scale

- Source water protection

Characteristics of Quartiles (Bar charts)

Quartile	% Poverty	% Home Own	% Latino	Avg. Nitrate Conc.
Owner 1		na	50	14
Owner 2		na	41	17
Owner 3		na	25	11
Owner 4		na	13	10
Latino 1	67	81	na	9
Latino 2	72	76	na	12
Latino 3	56	94	na	13
Latino 4	35	59	na	18

Back Up Slides

Model Specification

$$Y_{ijk} = B_0 + B_1\%Latino_i + B_2\%NonLatPOC_i + B_3\%AbovePov_i + B_4\%Owner + B_5Incorporated_i + B_6GW_i + B_5GWSW_i + B_5CountyReg_i + B_5Population_i + B_5Sources_i + B_5\%Ag_i + B_5Time_i$$

- Where:
  i=system
  j=well
  k=time
- 2000 demographics

Statistical Considerations

- Model controls for under-sampling of small systems by upweighting
- Multi-level model
  - Maintains data structure
    - And helps upweight smaller systems that have fewer samples
  - Don't lose variability
  - Can assess the expected mean relationship, as well as inter and intra system variability
- Results may be conservative because:
  - Census undercounts Latinos
  - Under-representation of systems with <200 connections, which is where we see the race/class effect. So the impact may be larger

Why not health outcomes

- Our study does not focus on health outcomes, but instead on health exposures to nitrate, partly because of the difficulty in diagnosing methemoglobinemia and the lack of Valley-wide data.