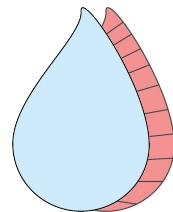


Predicting Hidden Vulnerabilities:

Water quality violations in California

Seigi Karasaki

ER190 talk, 2018





“**Environmental justice** is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.”

“... It will be achieved when everyone enjoys ... the same degree of protection from environmental and health hazards...”

environmental justice

distributive
procedural
restorative
retributive

environmental justice

hazards
exposures
disasters
resources

discriminatory intent?

Failures of the system?

- Environmental Appeals Board
 - Created in 1992
 - hears challenges to permitting decisions
 - Never blocked a decision based on environmental justice
- EJ lawsuits, based on Equal Protection Clause
 - 8 filed; all failed
 - 2001 *Alexander v Sandoval* and discriminatory intent
- Title VI complaints
 - As of 2014: 298 complaints

If...

- 1) The legal system is broken (ineffective);
- 2) IDing polluters is difficult (!)

What can be done? Can ML play a role?

Central Valley, California

Karasaki, working paper.

Predicting hidden vulnerabilities: water quality violations in California

UN Human Right to Drinking Water

“On 28 July 2010, through [Resolution 64/292](#), the United Nations General Assembly explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realisation of all human rights.”

1. **Sufficient** - minimum 50-100 litres of water per person per day;
2. **Safe** - water for domestic/personal use must be free of hazards;
3. **Acceptable** - should be of acceptable color, odor, taste ...;
4. **Accessible** - within 1,000 metres of home, collection time < 30 min;
5. **Affordable** - costs should not exceed 3% of household income.

UN Welcome to the United Nations. It's your world.



News Radio Television Photo Webcast Meetings Coverage Media Accreditation Secretary-General

Africa Americas Asia Pacific Europe Middle East ICYMI

US discriminates on right to safe water and sanitation, says UN expert



Catarina de Albuquerque

4 March 2011 – The United States must do more to eliminate discrimination in access to safe drinking water and sanitation, an independent United Nations expert reported today, citing wide disparities that adversely affect people of colour and Native Americans.

"I am concerned that several laws, policies and practices, while appearing neutral at face value, have a disproportionate impact on the enjoyment of human rights by certain groups," said UN independent expert Catarina de Albuquerque, who is mandated by the UN Human Rights Council to examine human rights obligations for access to safe drinking water and sanitation.

Quoting a study on the racial impact of water pricing and shut-off policies of the Boston Water and Sewer Commission, she noted that for every 1 per cent increase in Boston ward's percentage of people of colour, the number of threatened cut offs increases by 4 per cent.

At the end of her first fact-finding mission to the country, she also highlighted the fact that 13 per cent of Native American households have no access to safe water and/or wastewater disposal, in sharp contrast with 0.6 per cent in non-native households.

Tweet

7 Like

Share

3 Comments

12

Share

Print

4497



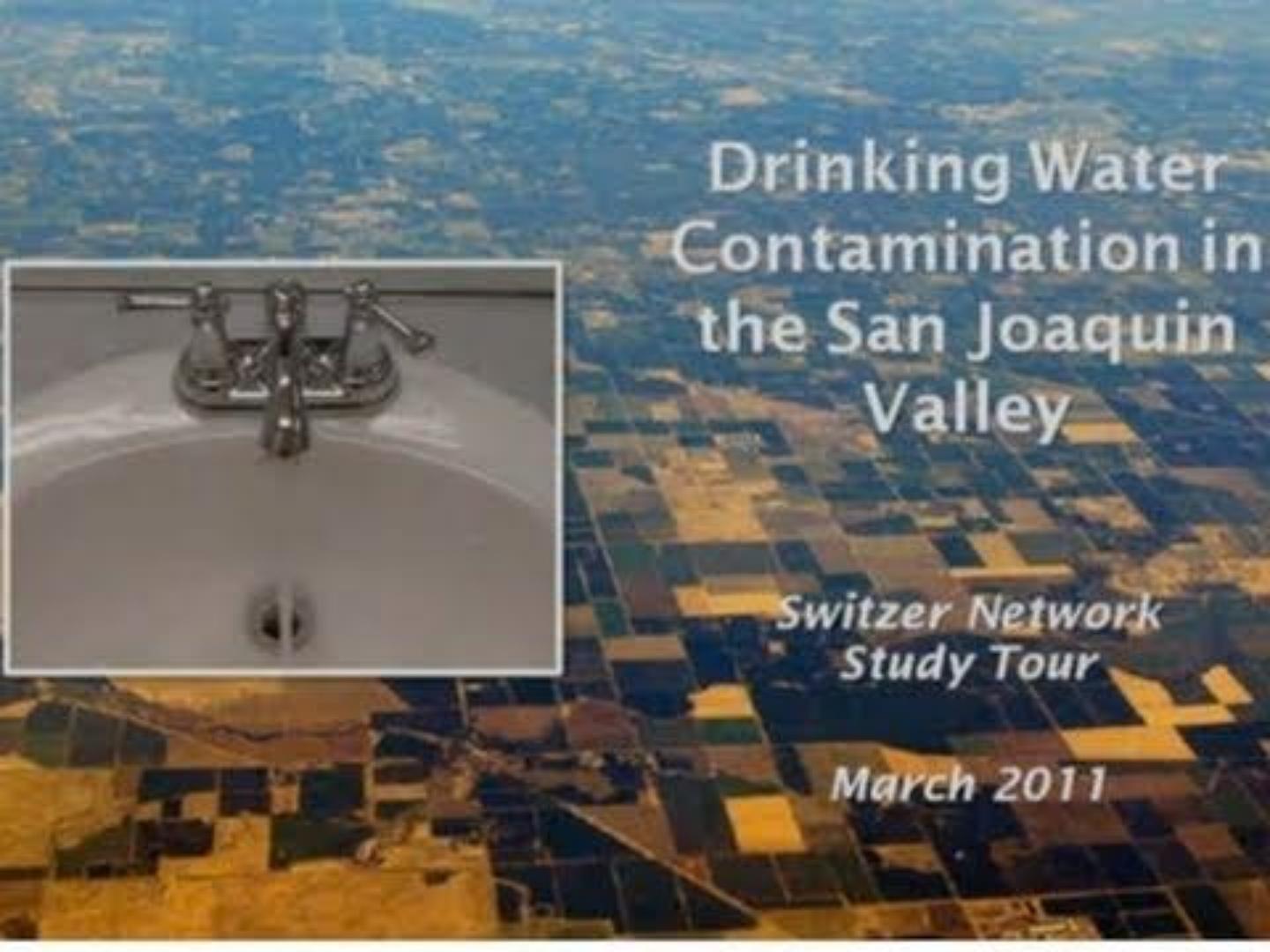
NEWS OPINION VIDEO SHOWS SCHEDULE
SECTIONS U.S. INTERNATIONAL ECONOMY TECHNOLOGY SCIENCE ENVIRONMENT SPORTS
TRENDING ELECTION 2016 IMMIGRATION DRUGS SPECIAL COVERAGE



More than 1 million Californians don't have reliable access to clean water

Agua4All campaign brings clean water to communities that rely on groundwater laced with arsenic

April 6, 2015 5:00AM ET



Drinking Water Contamination in the San Joaquin Valley



*Switzer Network
Study Tour*

March 2011

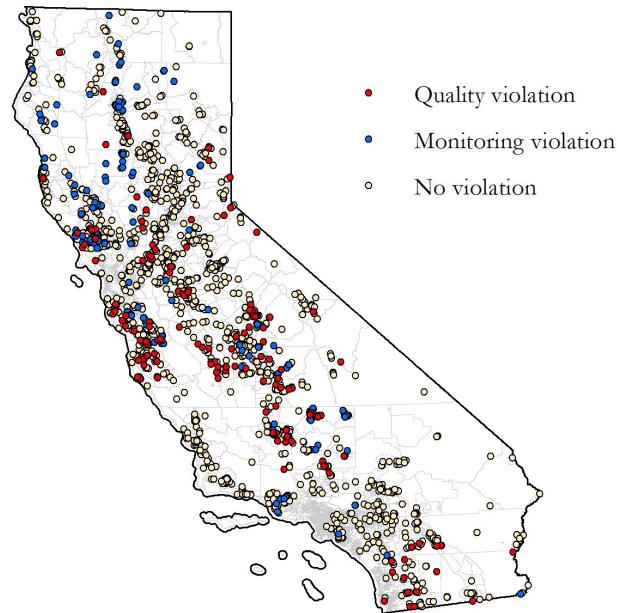
Environmental justice and drinking water

2012:

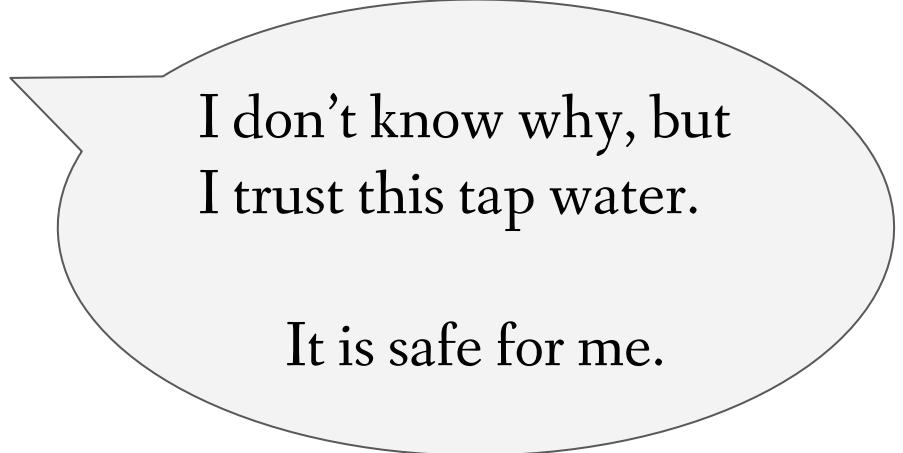
California recognizes a human right to “safe, clean, affordable, and accessible” drinking water (AB685).

2017:

~300 systems across the state lack access to safe drinking water. Disadvantaged communities are disproportionately affected and at risk.



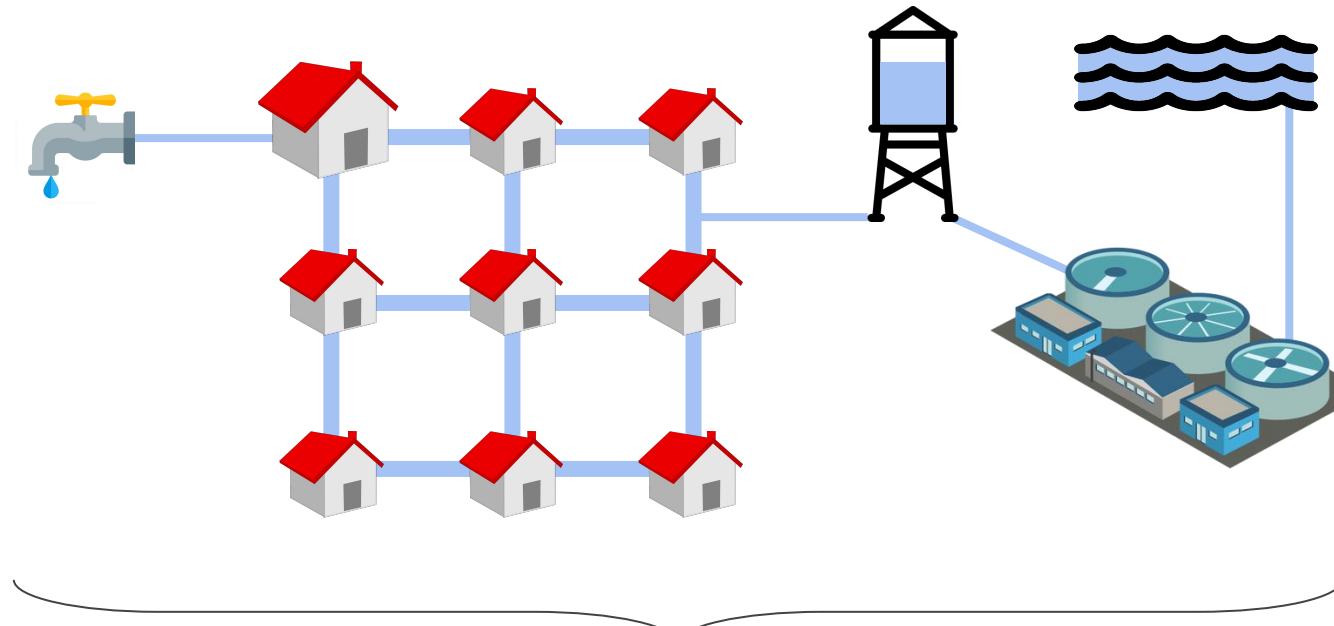
Our relationship with water



I don't know why, but
I trust this tap water.

It is safe for me.

Our relationship with water



Community water system



Source: Sasha Khoka



Source: Community Water Center

Cutler
Tulare County
.25 Ug/L
DBCF over MCL

Arvin
Kern County
12-25 ppb
Arsenic over MCL

Hardwick
Kings County
42-49 pc/L
Uranium over MCL

Porterville
Tulare County
16.98 ppb
Nitrates over MCL

Source: Community Water Center

BOIL WATER NOTICE

Este informe contiene información muy importante sobre su agua potable.
Tradúzcalo o hable con alguien que lo entienda bien.

BOIL YOUR WATER BEFORE USING

Failure to follow this advisory could result in stomach or intestinal illness.

Due to the recent event [e.g., water outage, power outage, flood, fire, earthquake or other emergency situation], the State Water Resources Control Board, Division of Drinking Water in conjunction with the [County Name] County Health Department, and [Water System name] Water System are advising residents of [City, Town, System] to use boiled tap water or bottled water for drinking and cooking purposes as a safety precaution.

DO NOT DRINK THE WATER WITHOUT BOILING IT FIRST. Bring all water to a boil, **let it boil for one (1) minute**, and let it cool before using, or use bottled water. Boiled or bottled water should be used for drinking and food preparation **until further notice**. Boiling kills bacteria and other organisms in the water. [or This is the preferred method to assure that the water is safe to drink.]

Optional alternative to include for prolonged situations where it fits.

- An alternative method of disinfection for residents that are not able to boil their water is to use fresh, unscented, liquid household bleach. To do so, add 8 drops (or 1/8 teaspoon) of bleach per gallon of clear water or 16 drops (or 1/4 teaspoon) per gallon of cloudy water, mix thoroughly, and allow it to stand for 30 minutes before using. A chlorine-like taste and odor will result from this disinfection procedure and is an indication that adequate disinfection has taken place.
- Water disinfection tablets may also be used by following the manufacturer's instructions.
- Optional: Potable water is available at the following locations: [List locations]
Please bring a clean water container (5 gallons maximum capacity).

We will inform you when tests show that water is safe to drink and you no longer need to boil your water. We anticipate resolving the problem within [estimated time frame].

For more information call:

Water Utility contact: [Name, title, phone & address of responsible utility representative].
State Water Resources Control Board – Drinking Water Field Operations Branch- District Office
at [(XXX) XXX-XXXX].

Local Environmental Health Jurisdiction: [XXXXXX County at (XXX) XXX-XXXX].

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

BOIL WATER NOTICE

Este informe contiene información muy importante sobre su agua potable.
Tradúzcalo o hable con alguien que lo entienda bien.

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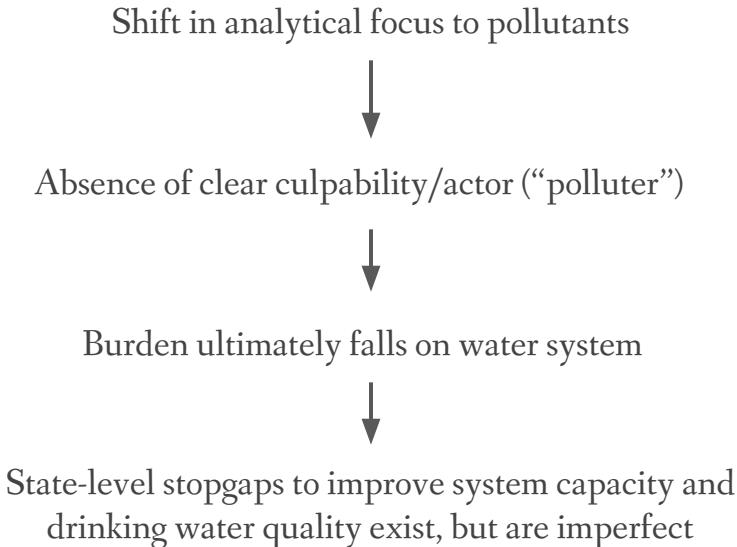
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“This report contains very important information about your drinking water.
Translate it or talk to someone who understands it well.”

*“Public 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.”*

1973 Tulare County General Plan

A Shifting Relationship

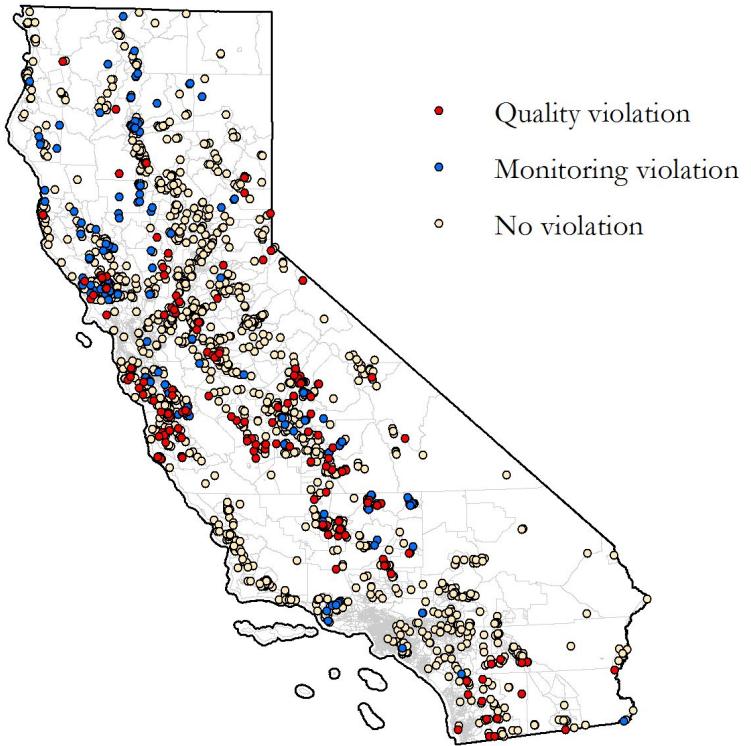


The burden of providing clean water rests with community water systems, but not all systems have the capacity to monitor for, let alone provide, clean and safe drinking water.

These systems are often “hidden” from the state, and are *de facto* excluded from assistance programs.

America's Tap Water: Too Much Contamination, Not Enough Reporting, Study Finds





Research Question

Can we predict water quality violations for small community water systems that have shown lapses of technical and managerial capacity in the last five years?

Approach

1. Describe the relationship between water quality/monitoring violations and system-level demographic data;
2. Predict the likelihood of water quality violations within identified capacity-deficient systems.

Data preparation

1. Basic water system information small community water systems in California (n = 1122)
 - Geospatial data, water source type, connection count, population count, county
 - Small = piped connections < 200 & population served < 10,000
2. Approximated demographic information for each community water system
 - American Community Survey (2012); processed via ArcMap, R
3. Water quality violation data (n = 139)
 - Human Right to Water Portal (State Water Resources Control Board)
4. Water monitoring violation data (n = 90)
 - Manually pulled from 2646 pdf letters (Enforcement actions, State Water Resources Control Board)

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD
DIVISION OF DRINKING WATER

Name of Public Water System: Alameda County Fairgrounds

Water System No: CA0105020

Attention: Beth Wilcox, Maintenance Supervisor & Compliance Specialist

4501 Pleasanton Avenue

Pleasanton, CA 94566-7001

Issued: July 18, 2018

CITATION FOR NONCOMPLIANCE WITH

**CALIFORNIA HEALTH AND SAFETY CODE, SECTION 116555(a)(1) AND
CALIFORNIA CODE OF REGULATIONS, TITLE 22, SECTION 64426.1**

TOTAL COLIFORM MAXIMUM CONTAMINANT LEVEL VIOLATION

JUNE 2018

The California Health and Safety Code (hereinafter "CHSC"), Section 116650 authorizes the State Water Resources Control Board (hereinafter "State Water Board"), to issue a citation to a public water system when the State Water Board determines that the public water system has violated or is violating the California Safe Drinking Water Act (hereinafter "California SDWA"), (CHSC, Division 104, Part 12, Chapter 4, commencing with

Section 116270), or any regulation, standard, permit, or order issued or adopted thereunder.

The State Water Board, acting by and through its Division of Drinking Water (hereinafter "Division") and the Deputy Director for the Division, hereby issues Citation No. 02_04_18C_001 (hereinafter "Citation"), pursuant to Section 116650 of the CHSC to the Alameda County Fairgrounds (hereinafter "ACF"), for violation of CHSC, Section 116555(a)(1) and California Code of Regulations (hereinafter "CCR"), Title 22, Section 64426.1.

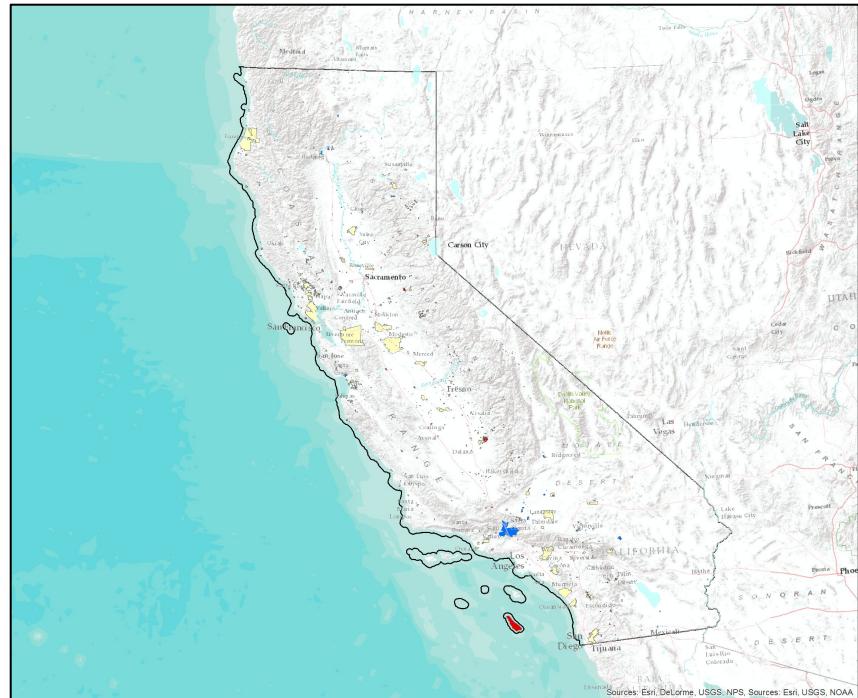
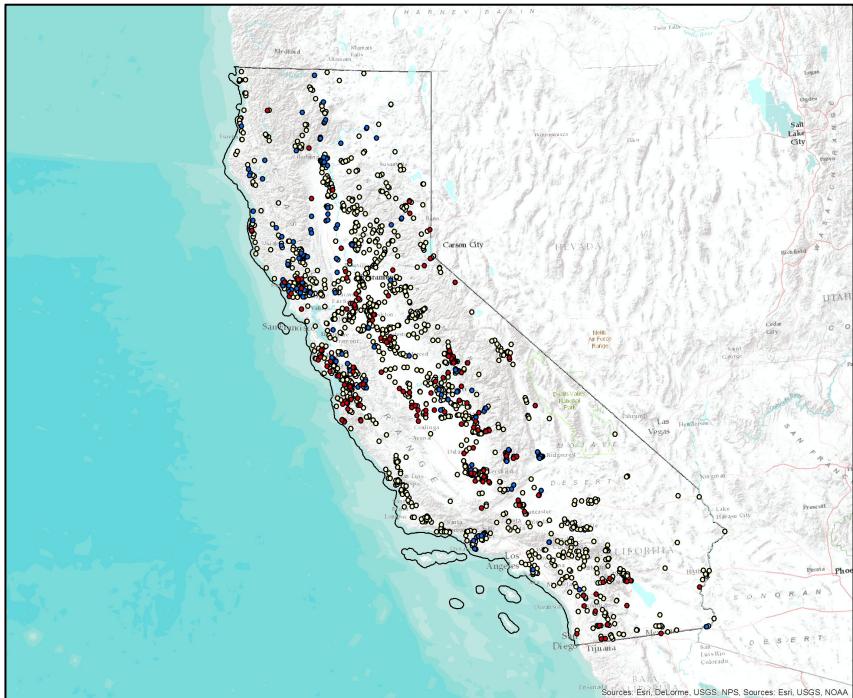
A copy of the applicable statutes and regulations are included in Appendix 1, which is attached hereto and incorporated by reference.

STATEMENT OF FACTS

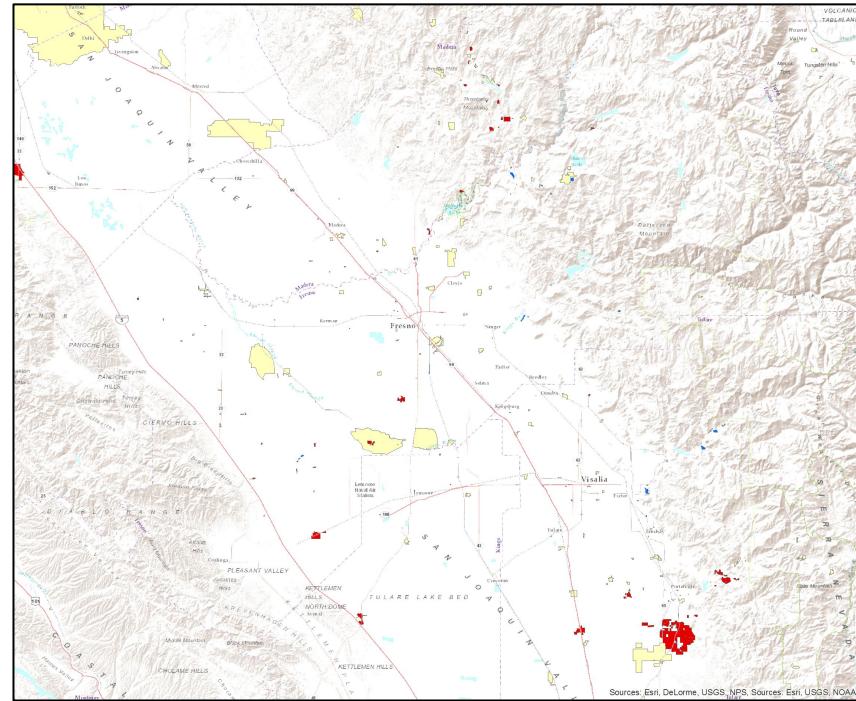
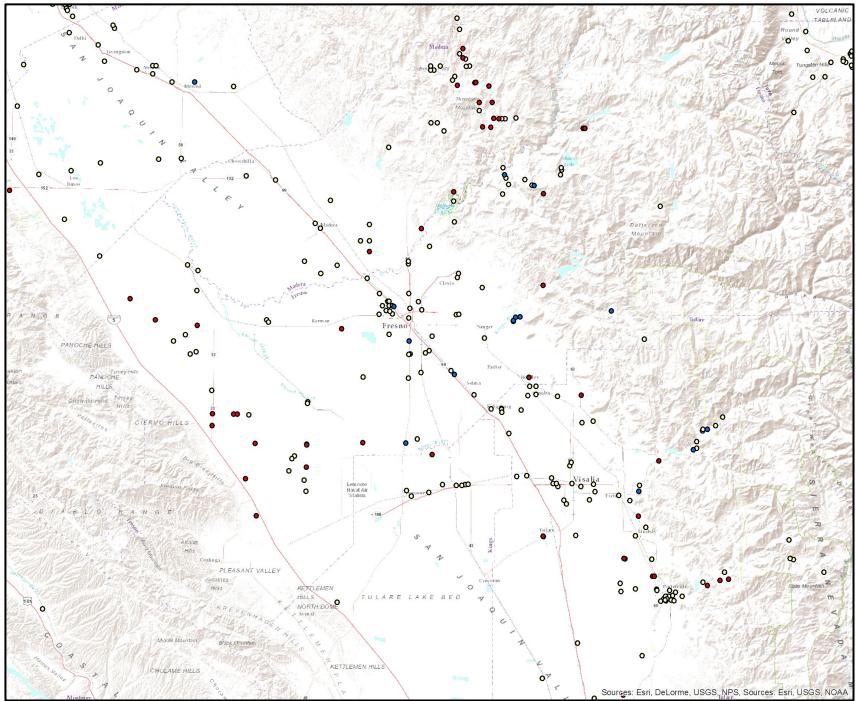
The ACF is classified as a Non-Transient Non-Community public water system with a population of 90 non-transient, 30 transient, and 1 residential, serving 5 unmetered and 2 metered connections. The ACF operates under Domestic Water Supply Permit No. 02-04-99P-0105020 issued by the State Water Board on May 17, 1999.

CHSC, Section 116555(a)(1) requires all public water systems to comply with primary drinking water standards as defined in CHSC, Section 116275(c). Primary drinking water standards include maximum levels of contaminants and the monitoring and reporting requirements as specified in regulations adopted by the State Water Board that pertain to maximum contaminant levels.

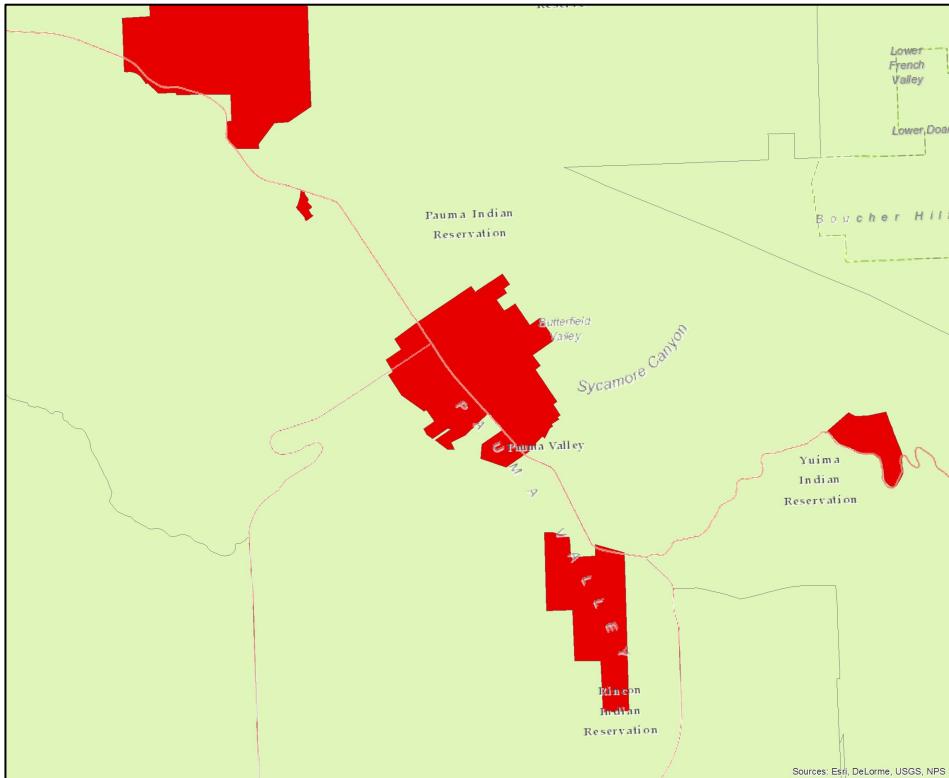
Water systems (point vs. polygon)



Water systems (point vs. polygon)



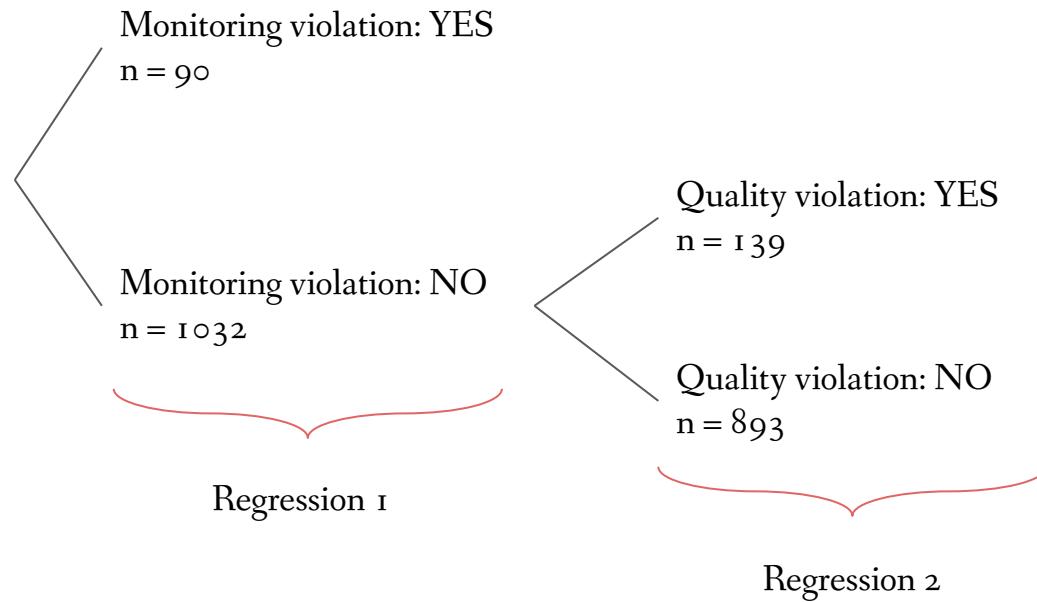
Water systems (weighted census)



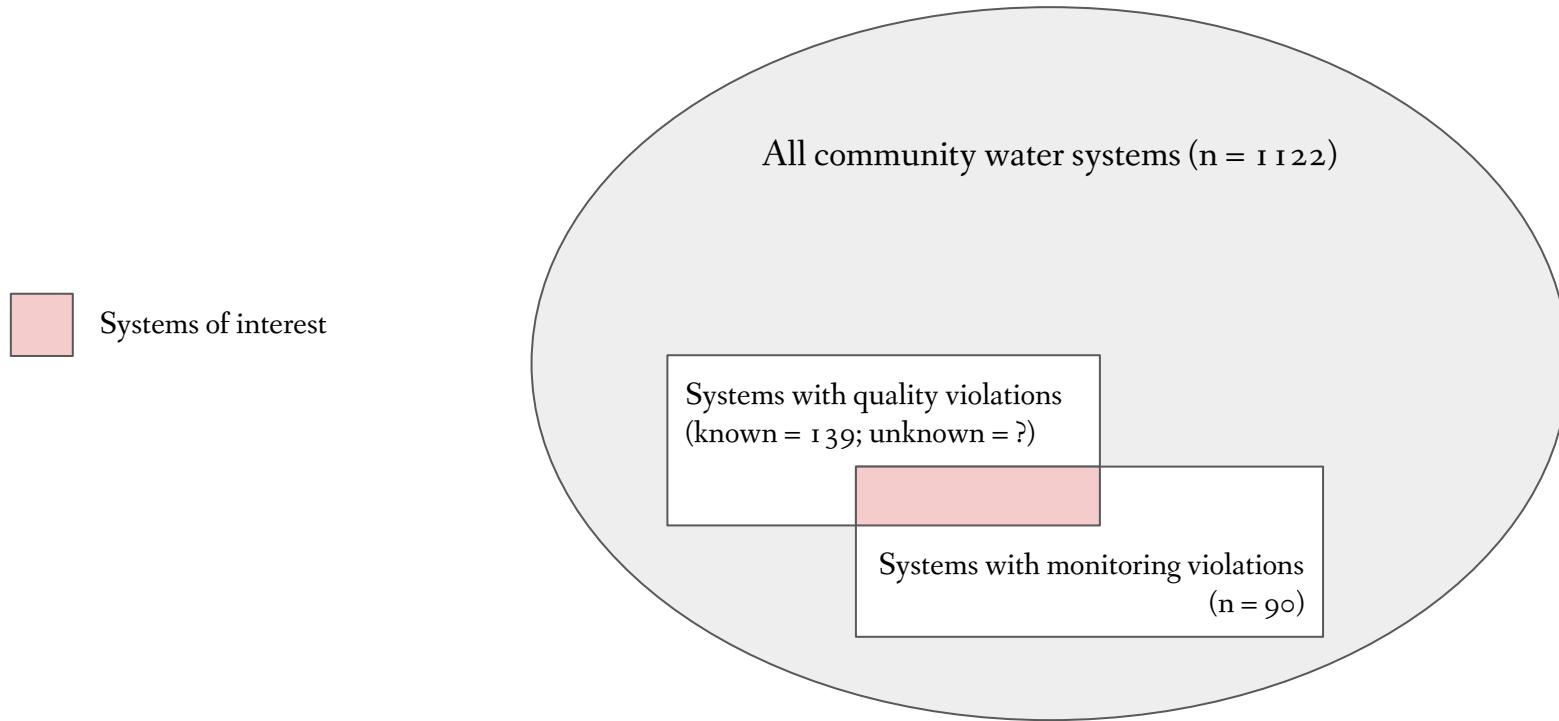
1. Calculate the ratio of water system area to census tract area;
2. Calculate a weighted sum of each census variable by multiplying every term with the area ratio in (1), across all intersecting census tracts.

Descriptive analysis

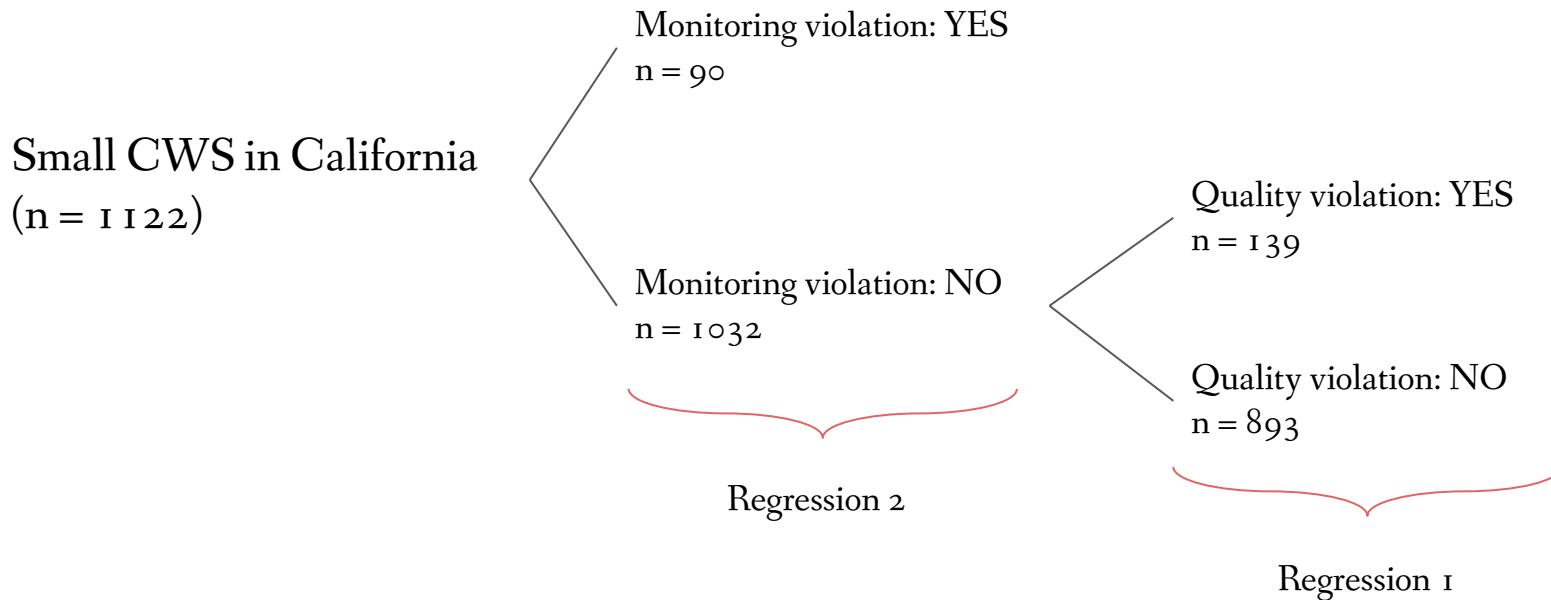
Small CWS in California
(n = 1122)



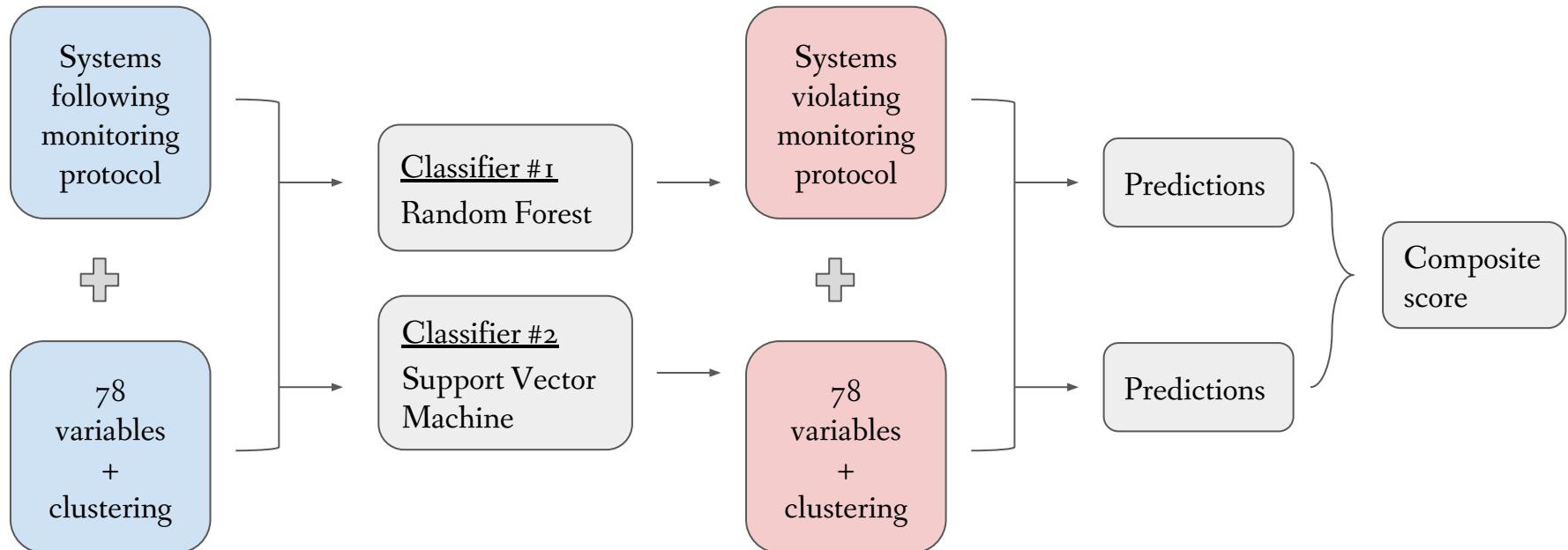
Identifying “hidden” systems



Predictive analysis

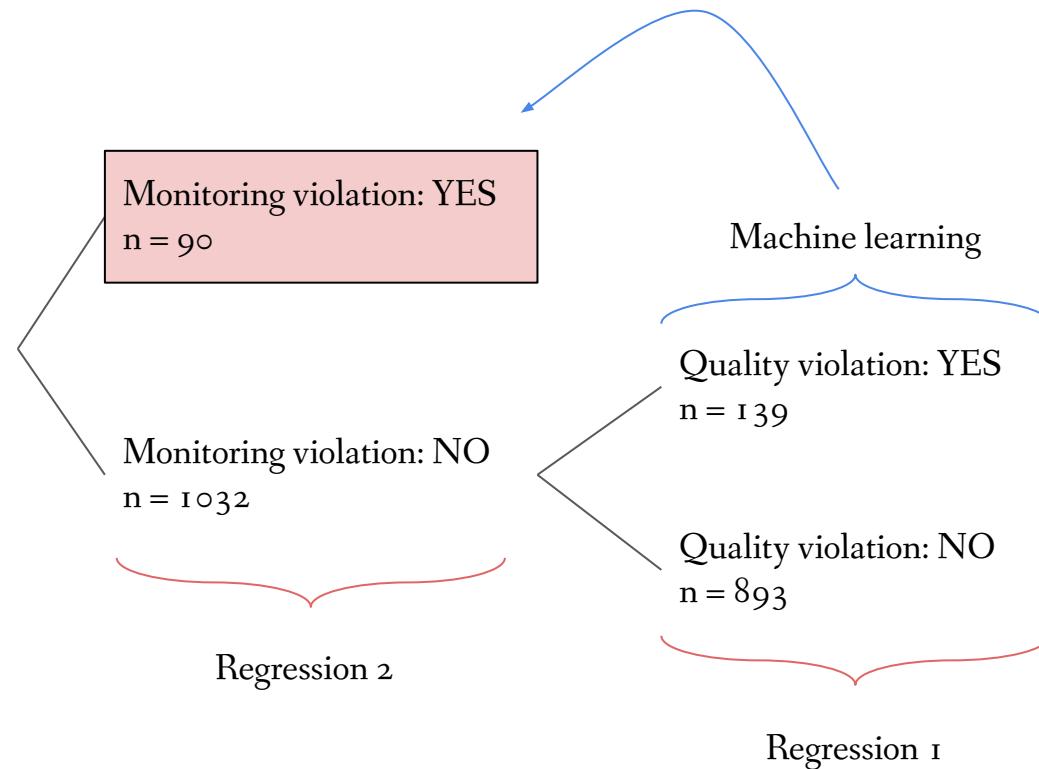


Predicting water quality violations

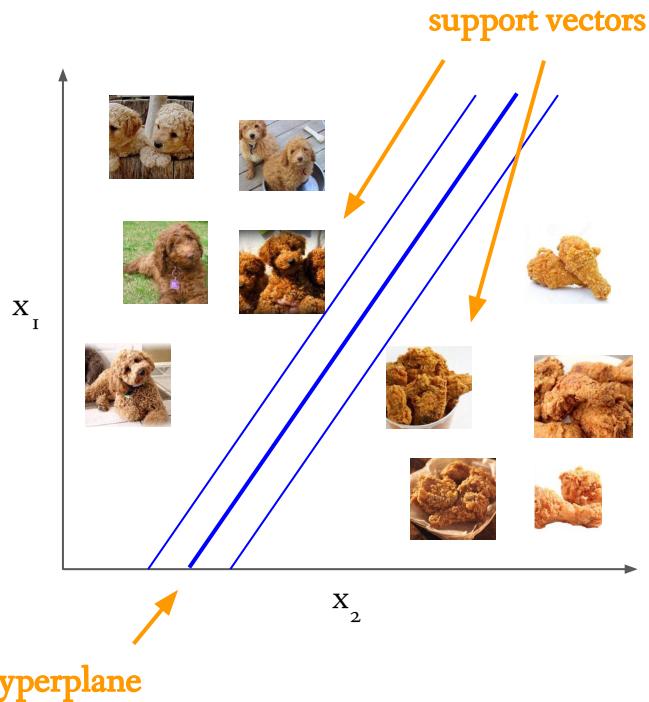


Predictive analysis

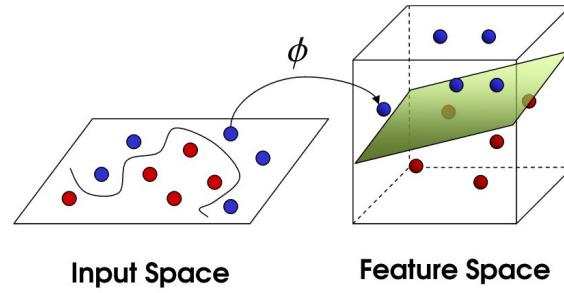
Small CWS in California
(n = 1122)



Quick pause: Support Vector Machines (SVM)



- Optimized by minimizing loss (error) function using gradient descent
- Also works with linearly-nonseparable datasets



Spatial distribution of quality vs. monitoring violations



All water systems,
2017



Water quality violations,
2017



Water monitoring violations,
2012-2017

Spatial distribution of “hidden” violations



Predicting water quality violations
for capacity-deficient systems

PWSID	NAME	SCORE	COUNTY
CA1000019	EL PORVENIR	1	FRESNO
CA1000021	WILDWOOD ISLAND	1	FRESNO
CA1000247	SHERWOOD FOREST MHP	1	FRESNO
CA1000359	CANTUA CREEK	2	FRESNO
CA1000546	FIVE POINTS	2	FRESNO
CA1300009	WINTERHAVEN COUNTY WATER DISTRICT	1	IMPERIAL
CA1500405	AERIAL ACRES WATER COMPANY, INC.	2	KERN
CA1500571	LUCKY 18 ON ROSAMOND, LLC	1	KERN
CA1500578	LONG CANYON WATER COMPANY CORP.	2	KERN
CA3301528	OAK HAVEN ASSOCIATION	1	RIVERSIDE
CA3500006	STONEGATE WS	1	SAN BENITO
CA4300630	FOOTHILL MUTUAL WATER	1	SANTA CLARA
CA4900603	RIEBLI MUTUAL WATER COMPANY	1	SONOMA
CA4900901	SOBRE VISTA WATER COMPANY	1	SONOMA
CA5400710	BADGER HILL ESTATES	1	TULARE

Outputs

Identification of systems lacking in technical and managerial capacity that

- a. have a high likelihood of violating water quality standards;
- b. we would expect to violate water quality standards, but do not.

Immediate policy relevance

- E.g., AB-560: project financing for severely disadvantaged communities (2017)

Important: ground-truthing is necessary.

Limitations



Limitations

1. Algorithms are only as good as the data you put in
2. Machine learning is not inherently ‘just’
3. Borders are violent; someone always loses
4. Those most in need are often not represented by the data
5. Tension of scale: “big” data v.s. “small” n
6. Numbers have historically struggled to gain traction in the courts

THIS IS YOUR MACHINE LEARNING SYSTEM?

YUP! YOU POUR THE DATA INTO THIS BIG
PILE OF LINEAR ALGEBRA, THEN COLLECT
THE ANSWERS ON THE OTHER SIDE.

WHAT IF THE ANSWERS ARE WRONG?

JUST STIR THE PILE UNTIL
THEY START LOOKING RIGHT.



Definitions

“Public water system” means a system for the provision of water for **human consumption** through pipes or other constructed conveyances that has 15 or more **service connections** or regularly serves at least 25 individuals daily at least 60 days out of the year. A public water system includes the following:

1. Any collection, treatment, storage, and distribution facilities under control of the operator of the system that are used primarily in connection with the system.
2. Any collection or pretreatment storage facilities not under the control of the operator that are used primarily in connection with the system.
3. Any water system that treats water on behalf of one or more public water systems for the purpose of rendering it safe for human consumption.

“Service connection” means the point of connection between the customer’s piping or constructed conveyance, and the water system’s meter, service pipe, or constructed conveyance. A connection to a system that delivers water by a constructed conveyance other than a pipe shall not be considered a connection in determining if the system is a public water system if any of the following apply:

1. The water is used exclusively for purposes other than residential uses, consisting of drinking, bathing, and cooking or other similar uses.
2. The department determines that alternative water to achieve the equivalent level of public health protection provided by the applicable primary drinking water regulation is provided for residential or similar uses for drinking and cooking.
3. The department determines that the water provided for residential or similar uses for drinking, cooking, and bathing is centrally treated or treated at the point of entry by the provider, a pass through entity, or the user to achieve the equivalent level of protection provided by the applicable primary drinking water regulations.