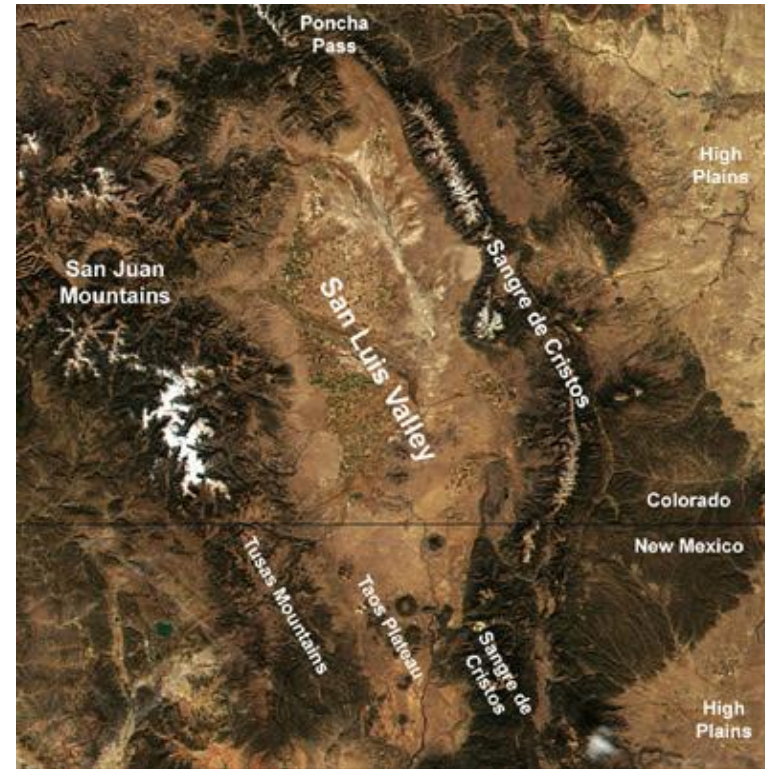


# Exploring Environmental Health Science & Science Fair Mentorship

An initiative of the *SLV Arsenic and Drought Study*

Research reported in this publication was supported by the National Institute of Environmental Health Sciences of the National Institutes of Health (NIH) under Award Number R01ES032612. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

# Water Sampling for Heavy Metals in the San Luis Valley, Colorado



Research reported in this publication was supported by the National Institute of Environmental Health Sciences of the National Institutes of Health (NIH) under Award Number R01ES032612. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

# Research Team



Kathy James, PhD, MSPH, MS  
CU Anschutz Medical Campus



Ryan Smith, PhD  
Colorado State University



Matt Gribble, PhD  
UC San Francisco

# Community Leaders

## Community Leaders:

- Anna Lee Vargas
- Gus Basterrechea
- Chris Canaly
- Shirley Romero Otero
- Hannah Thill

## Community Organizations

- Rio Grande Water Conservation District
- Rio Grande Watershed Conservation & Education Initiative
- San Luis Valley Ecosystem Council
- CSU San Luis Valley Research Center

**Objective: To evaluate the impacts of drought on metals concentrations in groundwater systems used for drinking water**

# Metals in Environmental Systems



- Groundwater systems are the main focus:
  - majority of drinking water sourced from groundwater
  - naturally occurring metals
  - impact that drought has had on the aquifer



# Mining Activity

## Superfund Sites

- Nelson Tunnel

- cadmium, arsenic, zinc, aluminum, lead

- Summitville Mine

- aluminum, arsenic, cadmium chromium, copper, iron, lead, manganese, mercury, nickel, silver, zinc

- Other sites

- arsenic, lead, cadmium, nickel



# Health Impacts of Metals in SLV Environmental Systems

## Arsenic

- Cardiovascular disease, diabetes, and adverse reproductive outcomes in adults

## Manganese

- Cognitive decline and mobility decline and older adults

## Tungsten

- Chronic kidney disease and acute kidney injury

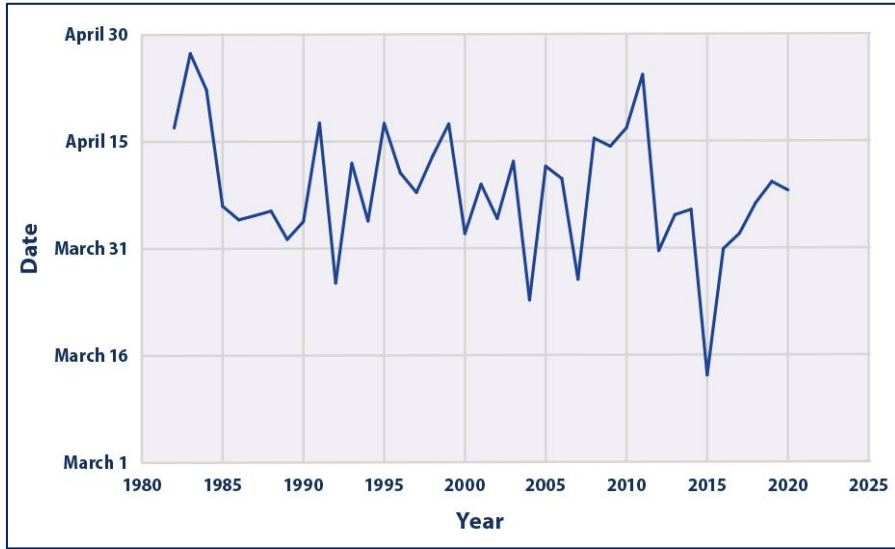
## Antimony

- Cardiovascular disease

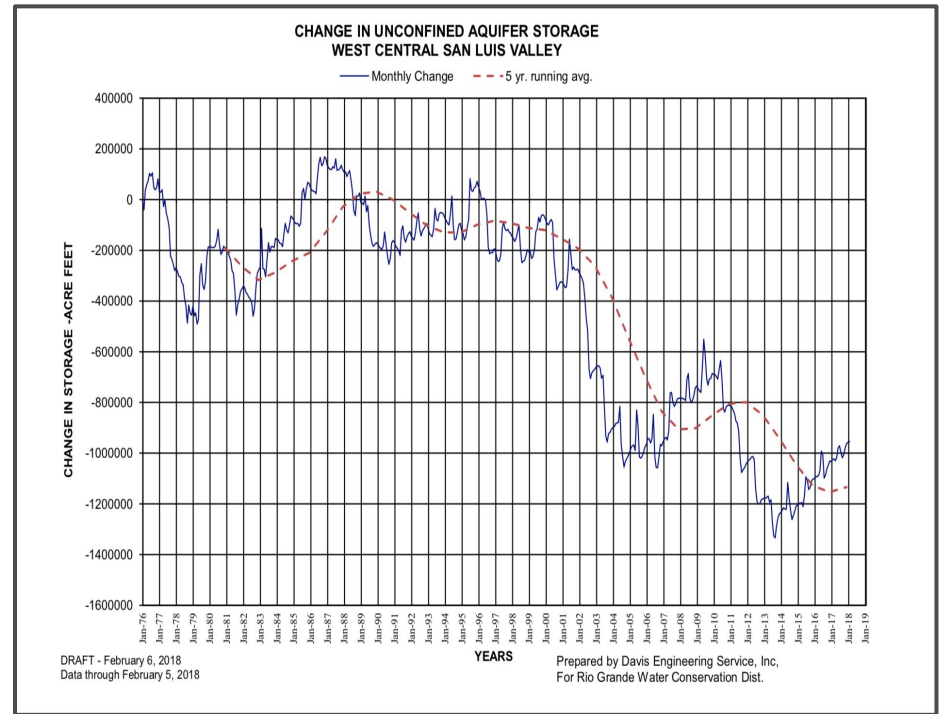
## Cadmium

- Cardiovascular disease, chronic kidney disease

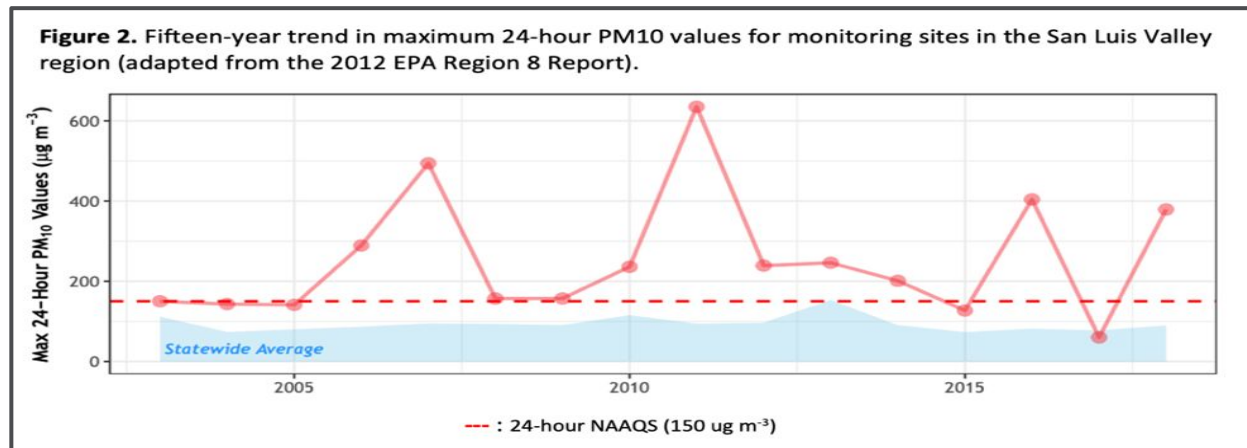
# Mega/Super Drought since 2002



**Figure 3.** Average Date of Peak Snowpack in the Western United States, 1982–2020



DRAFT - February 6, 2018  
Data through February 5, 2018  
Prepared by Davis Engineering Service, Inc.  
For Rio Grande Water Conservation Dist.





# Water Sampling, Phase I

- Engage with community members
- Facilitate a regional sampling of private wells (n=1000)
- Provide individual results reports

# Water Sampling, Phase II

- Continue sampling ~40 wells from Phase I
- Evaluate the presence of heavy metals, local weather patterns, and ground subsidence
- Evaluate water age in wells (n=5)

# Phase I – Participants

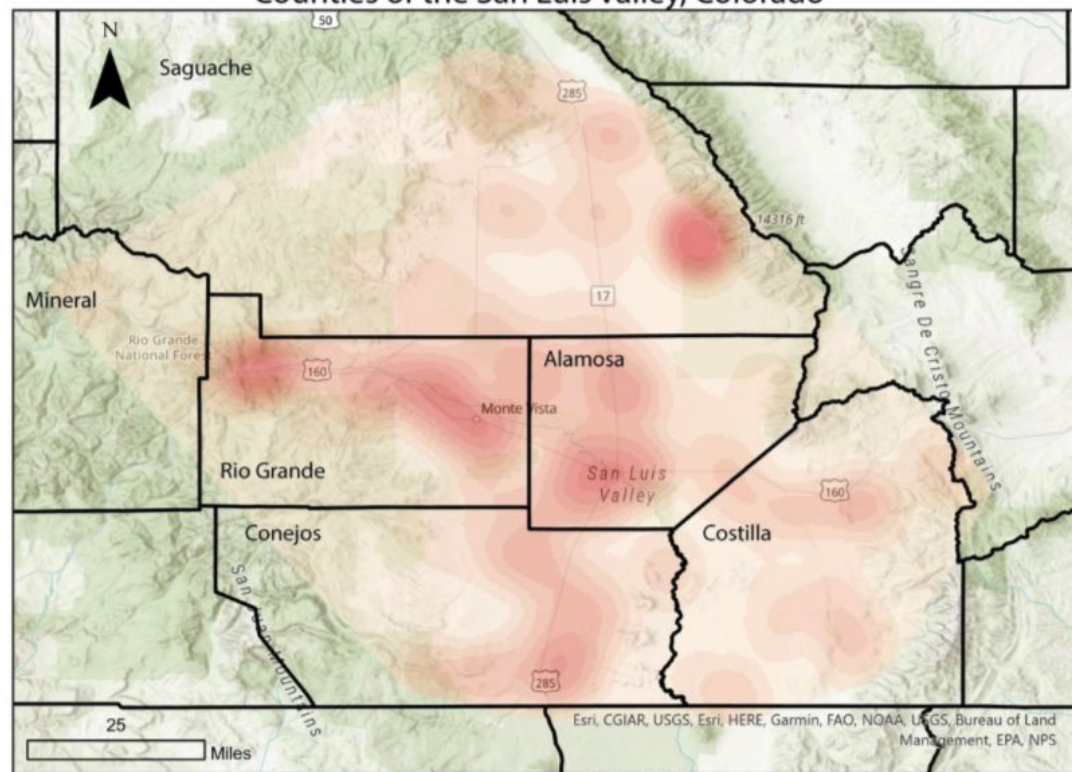
**736** private-well owners in the SLV  
signed-up to have their water tested

Samples submitted:

**150** from Alamosa    **86** from Costilla    **184** from Rio Grande

**119** from Conejos    **8** from Mineral    **158** from Saguache

Counties of the San Luis Valley, Colorado



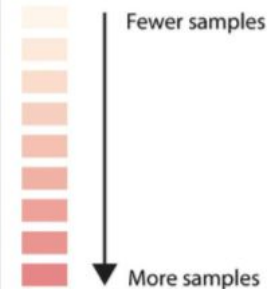
Stanford | Doerr  
School of Sustainability  
Earth System Science



University of Colorado  
Anschutz Medical Campus

Colorado State University

County boundaries



Collection Date: [MMYY]

PIN: [PIN]

Sample Identifier: [MultiSampleIdent]

# Results Report Back

- Results were emailed or post-mailed to all participants
  - Letter describing study
  - Results table with interpretation
  - Exposure mitigation sheets (if applicable)
  - Contact information for questions



Measurement	Your Results (µg/L)	EPA Standard (µg/L)
Arsenic		10
Uranium		30
Aluminum		50-200 <sup>^</sup>
Chromium		100
Cobalt		n/a
Nickel		n/a
Copper		1000 <sup>^</sup>
Zinc		5000 <sup>^</sup>
Strontium		n/a
Molybdenum		n/a
Cadmium		5
Antimony		6
Barium		2000
Tungsten		n/a
Thallium		2
Lead		15
Manganese		50 <sup>^</sup>
Iron		300 <sup>^</sup>

<sup>^</sup>National Secondary Drinking Water Standards

# Metals

## Why are we measuring metals?

This study is evaluating the impacts of drought on water quantity and quality. For this we are evaluating naturally occurring contaminants such as metals and hardness. Changes and fluctuations in naturally occurring metals and hardness can inform us about changes in the geochemistry of the aquifer system that can be induced from drought. Contaminants that are not naturally occurring such as pesticides or PFAS are not included in the analysis because fluctuations in concentrations may not be due to drought.



## Exposure to metals



People can be exposed to metals by breathing air, drinking water, and eating food. The amount of metals in exposed people depends on the level of the groundwater. The United States naturally has elevated metals in some aquifer systems, especially in the west. Common ways people are exposed to metals in groundwater are by drinking, watering crops, mixing baby formula, and cooking food with groundwater. Water can have more metals in it from industries using such as mining and ore smelting.





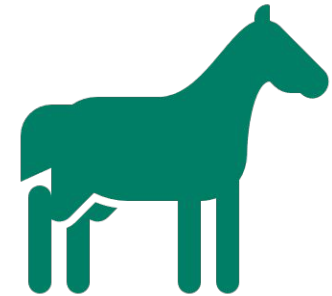
# Questions from Results Reports



Filter



Metals levels  
and health



Health of livestock  
and horses

# Hardness

- Most water in the SLV is considered 'hard' reflecting high levels of calcium and magnesium.
- Health effects due to extremely hard water are notably kidney stones and with long term exposure cardiovascular and kidney disease
- Options to treat are a traditional ion exchange water softening unit


# Community Reports

Center for Health, Work & Environment  
colorado school of public health

NOVEMBER  
2023

## DROUGHT, HEAVY METALS AND WATER QUALITY

SAN LUIS VALLEY, COLORADO



PREPARED BY:  
NICHOLAS STOLL  
KATHERINE A. JAMES

Research reported in this publication was supported by the National Institute of Environmental Health Sciences of the National Institutes of Health (NIH) under Award Number R01ES032612. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Center for Health, Work & Environment  
colorado school of public health

## San Luis Valley Water Quality Report

---

# Arsenic

PREPARED BY: NICHOLAS STOLL  
KATHERINE A. JAMES

Research reported in this publication was supported by the National Institute of Environmental Health Sciences of the National Institutes of Health (NIH) under Award Number R01ES032612. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

# Other Studies under James Climate Lab

Community Voices Volume 1

Climate Stressors Report: Perceptions and Experiences of Mountain West Climate-Health Engagement Hub Advisory Board Members

May 2024

Prepared by:

Cerise Hunt, PhD, MSW  
Gabrielle Cooper, MPH  
Nicholas Stoll, MPH  
Kelsey Phinney, MPH

## A Total Worker Health Approach to Ag Worker Health



San Luis Valley

Photo credit: Kathy James

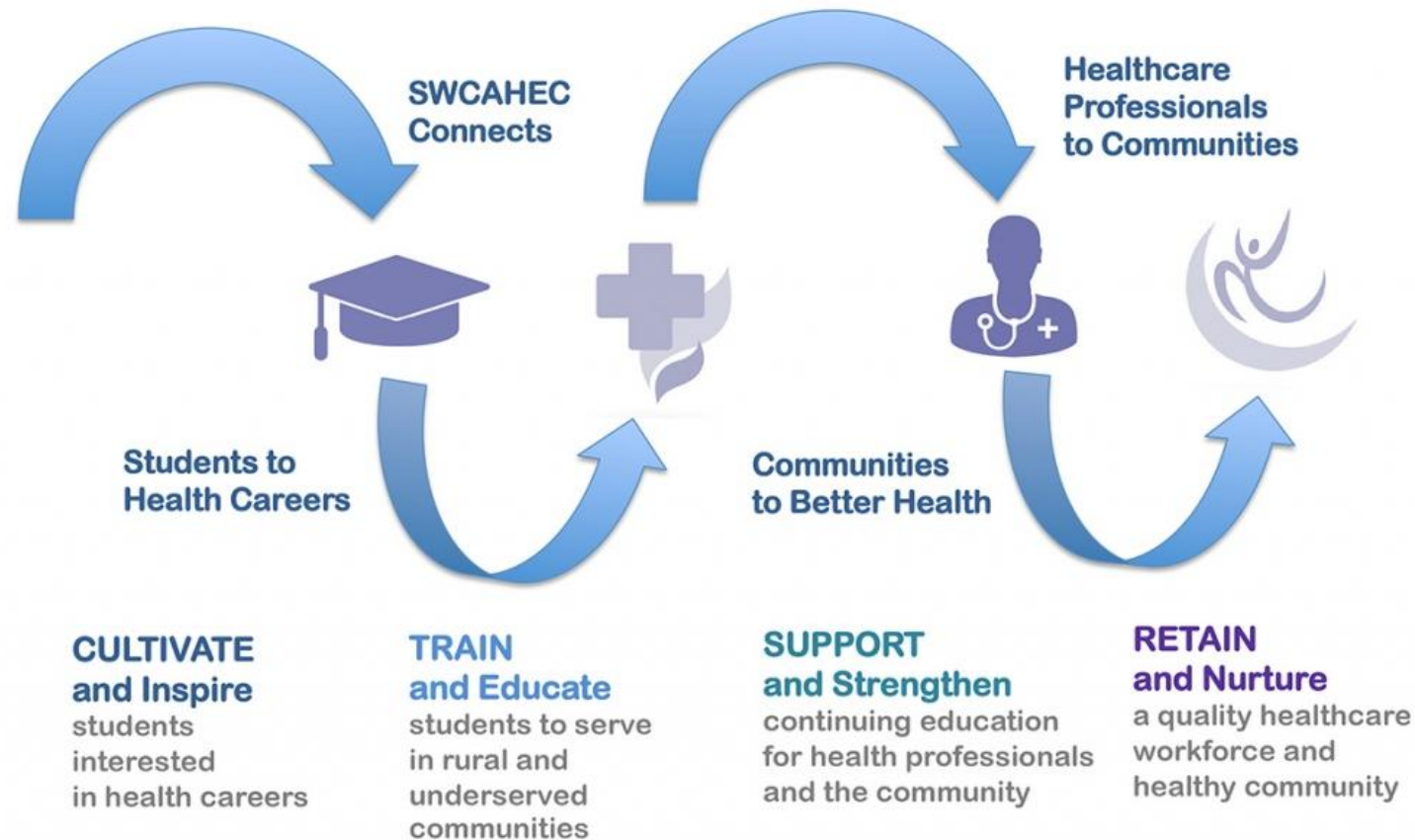


West Denver

Photo credit: Anthony Villalobos



# Community Engagement



# A Guide for Exploring Environmental Health Science



[https://www.nih.gov/news-events/pastirg/2021/eamhh\\_2021](https://www.nih.gov/news-events/pastirg/2021/eamhh_2021)

Prepared by: Nicholas Stoll

Naomi Perlman

Katherine A. James

Development of this document was supported by the National Institutes of Health (NIH) under Award Numbers R01ES032612 and OT2HL158287. This content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

## Table of Contents

Section 1: What is environmental health science? .....	3
Defining Environmental Health Science .....	3
Environmental Justice .....	4
Pollution and Human Health.....	5
Climate Change.....	6
Section 2: Designing an Experiment.....	8
The Scientific Method .....	8
Introduction to Experimental Design.....	8
Data to Justify Experimental Claims (Examples).....	9
Section 3: Science with secondary data sources.....	11
Primary and Secondary Data .....	11
Using Secondary Data .....	11
Examples of Secondary Data Sources.....	12
Section 4: Mentorship and current research in the San Luis Valley .....	14
What is mentorship? .....	14
How to find a mentor.....	14
Section 5: Do it yourself!.....	16
Research Question .....	16
Hypothesis.....	16
Independent variable(s).....	16
Dependent variable(s).....	17
Needed materials/support .....	17
Procedure .....	17
Glossary .....	19
References .....	21

# Section 1: What is environmental health science?

## Defining Environmental Health Science

“Environmental health science is a field that focuses on how the environment affects human health.”<sup>1</sup> This is done by assessing environmental exposures and determining if they harm health. This may result in public policies or legislation to prevent further injury or disease, or education to help citizens in adapting to environmental effects that are unavoidable.

The field of environmental health science includes professionals with backgrounds in atmospheric science, ecology, chemistry, geology, hydrology, geography, anthropology, and much more.

### Check-out these videos describing environmental health:

- [How does the environment affect our health?](#)
- [Environment, Health, You](#)





## Examples in the San Luis Valley

### Summitville Mine

The Summitville Mine is located approximately 20 miles southwest of Del Norte in Rio Grande County. Abandoned in 1992, this open pit mine has been a significant source of heavy metal pollution (copper, cadmium, manganese, zinc, lead, nickel, aluminum, iron) to the Alamosa River. While these metals are naturally occurring, the additional contamination eradicated local aquatic life and negatively influenced agriculture operations relying on the Alamosa River for irrigation.<sup>2,3</sup> While the scientific evidence on some metals is less robust, we know that elevated exposure to lead can result in a wide range of health effects including impaired neurologic and cognitive development for children, and cardiovascular disease.<sup>4</sup> Manganese is a micronutrient and needed by our bodies in small quantities – however, excess exposure can result in impaired cognitive functioning and motor skills (especially in children).<sup>5,6</sup>



## Examples of Secondary Data Sources

1. [Colorado Health Information Dataset \(CoHID\)](#)

CoHID provides access to state and local-level data and resources compiled by the Colorado Department of Public Health and Environment and its partners to help understand health and related issues affecting people in Colorado.

2. [National Environmental Public Health Tracking Network](#)

The National Environmental Public Health Tracking Network brings together health data and environmental data from national, state, and city sources and provides supporting information to make the data easier to understand. The

# List of Mentors

First Name	Last Name	Education/Degrees	Position	Expertise	Affiliation
Kathy	James	PhD - Epidemiology MS - Civil Engineering MS - Epidemiology	Associate Professor	Climate health, heavy metal toxicology, epidemiology, rural health, worker exposure assessment	CU Anschutz Colorado School of Public Health
Nicholas (Example)	Stoll	BS - Psychology MPH - Environmental & Occupational Health	Project Coordinator	Community engaged research, DEI	CU Anschutz Colorado School of Public Health
Naomi (Example)	Perlman	BS - Environmental Science MPH - Epidemiology, Global Health	Research Assistant	Climate change, infectious disease, data analysis	CU Anschutz Colorado School of Public Health
Francesca (Example)	Macaluso	BS - Environmental Science MPH - Environmental Science DrPH - Environmental & Occupational health	Instructor	Tobacco use, cannabis use, heavy metals, data analysis, heavy metals exposure	CU Anschutz Colorado School of Public Health

# List of existing projects- Existing data or opportunity to collect

Name of Project	Project Status	Opportunity to collect data?	Geographic focus area	Description of Project	Example research questions
The Attitudes and Behavior Survey (TABS)	Active Project	Maybe	Colorado	Launched in 2001, TABS on Health is a population-level survey of Colorado adults to identify and understand influential factors that public health programs can address to improve the health of our state. Every 3-4 years, TABS	Does rural vs urban status influence health behaviors? (tobacco, alcohol, cannabis) Who engages more in risky health-behaviors? (occupation, demographic, geolocation)
Metals and Metals Mixtures, Cognitive Aging, Remediation and Exposure Sources (MEMcare)	Active Project	No	San Luis Valley, CO	MEMcare-SLV is a sub-research group from the Health	Is soil or water more influential on the level of heavy metals in urine? Does the level of heavy metals in urine change after birth?
The San Luis Valley Diabetes Study	Existing Dataset	No	San Luis Valley, CO	The SLVDS is a study conducted in the 1980s-1990	Which groups of people experience more diabetes/CVD/cancer, etc.? Does health behaviors (e.g. smoking, activity level) influence health status? Are there differences in health status by county?
Total Worker Health for Agriculture Workers	Existing Dataset	No	San Luis Valley, CO	This project leveraged local community knowledge	How does drought influence mental health? Which group of workers experiences more stress? Do agriculture workers have more chronic health conditions?
Drought and Water Quality	Existing Dataset	Maybe	San Luis Valley, CO	In this regional effort to quantify groundwater qua	Do the deeper wells have high levels of heavy metals? Which heavy metals are more common in different counties? Are there differences in heavy metals between the confined and unconfined aquifer systems?



# We want your feedback!

- General Thoughts?
- How/when do you see it being used?
- Any concerns with mentorship facilitation?
- What barriers to you see for students?



# Follow up Survey

Additional feedback:

- We will send an link to the emails collected
- You get \$75 for filling out the survey

# Stay Connected!

Kathy James

- [Kathy.James@cuanschutz.edu](mailto:Kathy.James@cuanschutz.edu)
  - 303-724-8169

Hannah Thill

- hannah@rgwcei.org
  - 719-315-1214

First Name	Last Name	Education/Degrees	Position	Expertise	Affiliation
Kathy	James	PhD - Epidemiology MS - Civil Engineering MS - Epidemiology	Associate Professor	Climate health, heavy metal toxicology, epidemiology, rural health, worker exposure assessment	CU Anschutz Colorado School of Public Health
Nicholas	Stoll	BS - Psychology MPH - Environmental & Occupational Health	Project Coordinator	Community engaged research, DEI	CU Anschutz Colorado School of Public Health
Naomi	Perlman	BS - Environmental Science MPH - Epidemiology, Global Health	Research Assistant	Climate change, infectious disease, data analysis	CU Anschutz Colorado School of Public Health
Francesca	Macaluso	BS - Environmental Science MPH - Environmental Science DrPH - Environmental & Occupational health	Instructor	Tobacco use, cannabis use, heavy metals, data analysis, heavy metals exposure	CU Anschutz Colorado School of Public Health

<https://coloradosph.cuanschutz.edu/resources/directory/directory-profile/James-Katherine-UCD11025>

Name of Project	Project Status	Opportunity to collect data?	Geographic focus area	Description of Project	Website	Example research questions
The Attitudes and Behavior Survey (TABS)	Active Project	Maybe	Colorado	Launched in 2001, TABS on Health is a population level survey of Colorado adults to identify and understand influential factors that public health programs can address to improve the health of our state. Every 3-4 years, TABS interviews 12,000 - 18,000 randomly selected adults. The surveys collect behavioral and attitudinal information about blood lipids, high blood pressure, diabetes, weight and physical activity, and other health-related issues such as tobacco use, cannabis use, mental health statuses, and chronic diseases. The most recent survey wave has included information on occupational industry.	<a href="https://coloradosph.uanschultz.edu/research-and-practice/centers-programs/cepeg/survey-research/tabs">https://coloradosph.uanschultz.edu/research-and-practice/centers-programs/cepeg/survey-research/tabs</a>	Does rural vs urban status influence health behaviors? (tobacco, alcohol, cannabis) Who engages more in risky health-behaviors? (occupation, demographic, geolocation)
Metals and Metals Mixtures, Cognitive Aging, Remediation and Exposure Sources (MEMcare)	Active Project	No	San Luis Valley, CO	MEMcare-SLV is a sub-research group from the Harvard Superfund Center. The mission of the Superfund center is to understand and mitigate the effects of exposure, particularly early life exposure, to metals and metal mixtures on late life cognitive health. The SLV research group has enrolled pregnant persons living near regional superfund sites to participate in the study. Participants have completed a comprehensive exposure assessment survey; provided pre-natal water, soil, and urine (parent) samples; and provided post-natal water, soil, urine (parent), and nail (infant) samples. These samples have been analysed for trace heavy metals.	<a href="https://memcare.sph.harvard.edu/home">https://memcare.sph.harvard.edu/home</a>	Is soil or water more influential on the level of heavy metals in urine? Does the level of heavy metals in urine change after birth?



The San Luis Valley Diabetes Study	Existing Dataset	No	San Luis Valley, CO	The SLVDS is a study conducted in the 1980s-1990s focused on researching the prevalence of diabetes in the local population residing in counties of Alamosa and Conejos. This dataset contains information on demographics, diabetes status, cardiovascular disease, cancer diagnosis, height/weight/BMI, activity levels, tobacco use, alcohol use, dietary habits, cause of death, and more.		Which groups of people experience more diabetes/CVD/cancer, etc.? Does health behaviors (e.g. smoking, activity level) influence health status? Are there differences in health status by county?
Total Worker Health for Agriculture Workers	Existing Dataset	No	San Luis Valley, CO	This project leveraged local community knowledge and networks to survey agriculture workers in the San Luis Valley. The objective of this survey was to assess the mental health status of workers, identify sources of stress, and identify ways to promote worker wellbeing. Participants in this survey either identified as a non-agriculture worker (community member), owner/operators, or field worker. Mental health variables include general stress, anxiety, depression, life satisfaction, fatigue from work, job engagement, chronic health conditions, general poor mental health, general poor physical health, tobacco use, cannabis use, alcohol use, work-related injuries, and size of social-support network.	<a href="https://coloradosph.cuanschutz.edu/research-and-practice/centers-programs/chwe/research/mental-health-in-farming-populations">https://coloradosph.cuanschutz.edu/research-and-practice/centers-programs/chwe/research/mental-health-in-farming-populations</a>	How does drought influence mental health? Which group of workers experiences more stress? Do agriculture workers have more chronic health conditions?
Drought and Water Quality	Existing Dataset	Maybe	San Luis Valley, CO	In this regional effort to quantify groundwater quality, over 800 private well owners were engaged and successfully collected more than 739 groundwater samples. These samples were analyzed for a panel of metal and ion elements (arsenic, antimony, barium, chromium, cadmium, calcium, cobalt, copper, iron, lead, manganese, molybdenum, manganese, nickel, potassium, sodium, strontium, sulfur, thallium, tungsten, uranium) by the research team. Samples have been match to latitude and longitude coordinates, and well depth (when available).		Do the deeper wells have high levels of heavy metals? Which heavy metals are more common in different counties? Are there differences in heavy metals between the confined and unconfined aquifer systems?