

Assessing Oilfield Produced Water for Crop Irrigation

Timeline: Spring 2017 – Spring 2020

Study Overview

June 22, 2017

Duke
UNIVERSITY



RTI
INTERNATIONAL



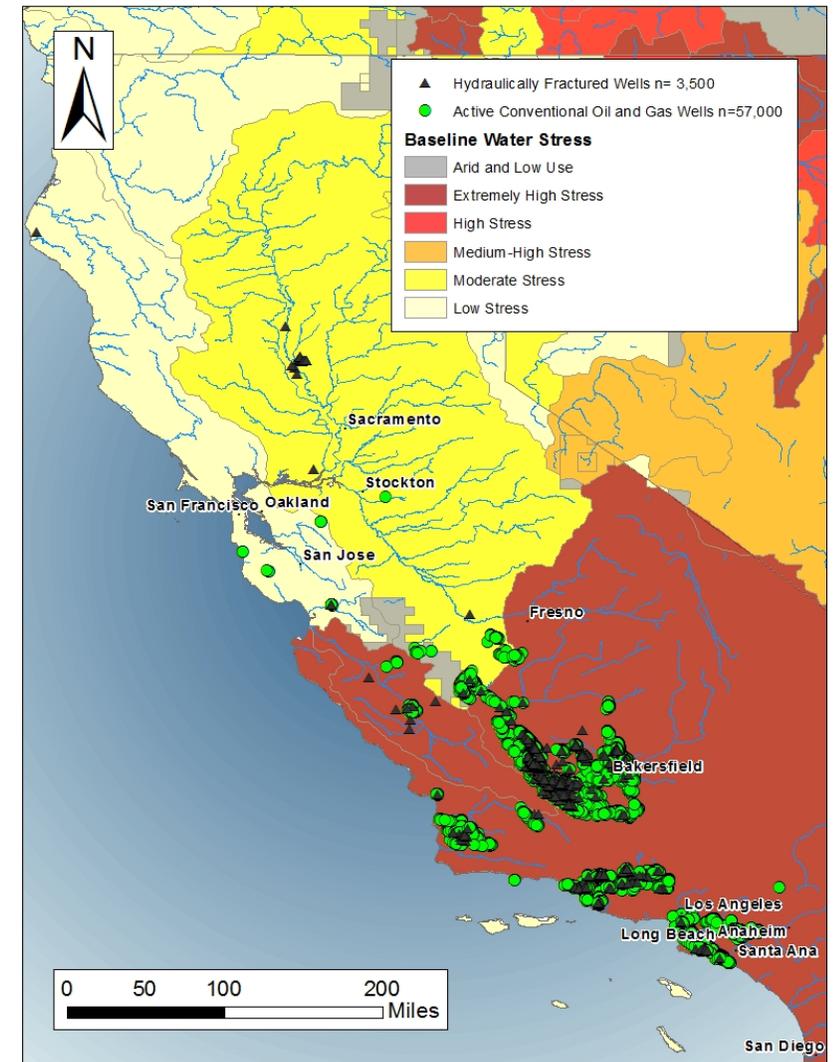
Project Partners and Funder

- California State University, Bakersfield – Dr. Luis Cabrales
- Duke University – Drs. Avner Vengosh and Erika Weinthal
- RTI International – Ms. Jenny Redmon and Dr. Elisabetta Lambertini
- Pacific Institute – Dr. Laura Feinstein
- Funded by US Department of Agriculture (USDA) National Institute for Food and Agriculture (NIFA)
- We are a multidisciplinary study team of scientists, engineers, and policy analysts that understands the importance of both using alternative irrigation water sources and ensuring crop and food safety



Rationale for the Project

- Oilfield produced water (OPW) is a promising source of irrigation water, especially in water-scarce regions.
- The safety of using OPW for irrigation has not been extensively evaluated through **independent and peer-reviewed scientific investigation**.
- Advance **evidence-based decision making and policy development** for OPW for beneficial irrigation uses to proceed and expand safely
- Strengthen stakeholder knowledge and engagement in the process.



Oil wells and water stress in California



Study Goals

- **Perform baseline testing** to identify what is present in water, soil, and crops with and without the use of OPW.
- **Develop a risk assessment framework** to quantify perceived human health concerns.
- Use risk results to identify **optimal management and policy options** for OPW irrigation, considering food safety and agricultural sustainability.
- **Involve stakeholders in recommendations** to develop usable proposals for optimizing OPW use.



Study Area & Timeline

- California's Central Valley
 - Oilfield Produced Water (OPW) is used for crop irrigation
 - Incomplete data and understanding of this practice hinder full public confidence
 - Area was selected to reflect a wide range of OPW use and crop types
- Project will take 3 years to complete
Spring 2017 – Spring 2020



Study Objectives

- **Research:**
 - **Objective 1:** OPW Risk Screening Analysis Leveraging Existing Datasets
 - **Objective 2:** Baseline Field Survey of Blended OPW Used for Irrigation, Soil, and Crops
 - **Objective 3:** Multimedia Human Health Risk Assessment Modeling
 - **Objective 4:** Policy Scenario Analysis
- **Extension:**
 - **Objective 5:** Stakeholder Engagement
 - **Objective 6:** Outreach and Dissemination of Study Results
- **Education:**
 - **Objective 7:** Develop university curriculum on irrigation water quality and the Water-Food-Energy Nexus based on the project case study

Project Objectives, Tasks, and Outputs

| Objectives | Research Objective 1: OPW Database and Risk Screening | Research Objective 2: Field Sampling and Exploratory Risk Factor Analysis | Research Objective 3: Probabilistic Quantitative Health Risk Modeling | Research Objective 4: Policy Scenario Analysis | Education Objective 7: Curriculum Development and Offering | Extension Objectives 5-6: Stakeholder Engagement, Dissemination of Results |
|------------|--|--|--|---|---|---|
| Subtasks | Data QC and Curating OPW Dataset | Stakeholder Engagement and Risk Factor Survey | Modeling Inputs | Literature Review | Assessing Training Needs | Stakeholder Forums Before & After Field Survey |
| | Deterministic Risk Screening | Field Sample Collection at Participating Farms | Conduct Probabilistic Modeling | Stakeholder Analysis | Coursework Development | Dissemination of Study Findings via Web and Articles |
| | | Laboratory Analysis | Results Analysis | Policy Analysis | Coursework Offering | Stakeholder Outreach Workshops |
| | | Exploratory Risk Factor Analysis | Documenting Findings, Creating Risk Scenarios | | | Add OPW Quality to Ongoing Extension Plans |
| Outputs | Risk Screening Results Manuscript, Database | Field Survey Manuscripts, Metal Level Dataset, Farm Survey Results | Risk Modeling Manuscript; Risk Scenarios | Policy Manuscript, Results of Policy Analysis | Educational Coursework, Class Materials | Stakeholder Forums, Outreach Workshop, Training Materials |



Study Expertise

Dr. Vengosh and colleagues at Duke

- Analysis of OPW for salts, metals, and NORMs; working with USGS to assemble the most extensive dataset on OPW quality to-date (Obj. 1).
- Expertise in water, soil, and plant sampling and has access to state-of-the-art analytical facilities to measure a wide spectrum of inorganic elements, NORMs, and strontium isotopes tracers (Obj. 2).

Ms. Redmon and Dr. Lambertini at RTI

- Modeling fate and transport of contaminants in the environment, food safety, and quantitative human health risk assessment (Obj. 1 and 3).

Dr. Feinstein at the Pacific Institute and Dr. Weinthal at Duke

- Environmental policy analysis, stakeholder engagement and mediation, and governance of natural resources (Obj. 4).

Dr. Cabrales and colleagues at California State University at Bakersfield (CSUB)

- Irrigation water treatment and agricultural engineering; regional network of stakeholders including produce growers, oil companies, water districts, and extension agents (Obj. 5 and 6).



Objective 1 - OPW Risk Screening Analysis Leveraging Existing Datasets

- Preliminary risk screening using existing datasets on OPW in Central California from
 - USGS-Duke project
 - Covers inorganic constituents (salts, metals, radionuclides) and total organic carbon (TOC)
 - Publicly available sources
 - Data collected from contacts
- Outputs will include a comparison of available data to current regulatory limits and benchmarks.



Obj. 2 - Baseline Field Survey of Blended OPW Used for Irrigation, Soil, and Crops

- Collect samples from farmland (Duke/CSU Bakersfield)
 - Contact farmers to arrange visits
 - Sign confidentiality agreements
 - Conduct interview on irrigation and growing practices
 - Perform sample collection, and ship samples to Duke University
 - Laboratory analysis of irrigation water, soil, and edible crops
 - Test for metals, salts, and NORM tracers in fields that irrigated with OPW for at least two consecutive years.



Obj. 2 - Baseline Field Survey of Blended OPW Used for Irrigation, Soil, and Crops

- Water quality testing
 - Compare just-extracted OPW at the oilfield and at the point of delivery.
- Compare metal levels in
 - soil and crops
 - different crops irrigated with OPW
 - farms never irrigated with OPW and farms irrigated with (blended) OPW for more than 5 years
 - different soil management and irrigation techniques
- Strontium isotopes measurements in irrigation water, soil, and crops to understand metals uptake in crops



Obj. 3 - Multimedia Human Health Risk Assessment Modeling

- RTI will conduct a probabilistic multi-pathway, multimedia assessment to quantify risk from potential human exposure to chemicals present in OPW used for crop irrigation.
- RTI's current models have withstood several rounds of intense scrutiny by peer reviewers, US Office of Management and Budget, and public and private stakeholders; served as the basis for final federal regulations.
- The model will consider the concentrations of chemicals and type of irrigation used on crops in the study setting.
- Outputs will include human non-cancer and cancer risk estimates for constituents of concern.



Obj. 4 - Policy Scenario Analysis

- Duke will lead efforts to evaluate potential scenarios for beneficial reuse of OPW for irrigation
 - Evaluate management, engineering and policy options
- Develop generalizable criteria to use to evaluate practice



Obj. 5 - Stakeholder Engagement and Obj. 6 – Dissemination of Study Results

- Foster a regional stakeholder platform to advance shared governance and decision making on agricultural water quality management
- Identify needs and constraints faced by growers and irrigation water districts via stakeholder forums.
- Communicate with stakeholders (growers, irrigation water managers, state and regional agencies, consumer groups, etc.) to ensure transparency and usefulness.
- Fact-sheets, presentations, and stakeholder workshops will be developed (in English, and Spanish when possible).



Objective 7: Develop University Curriculum

- **University course material on irrigation water quality and the Water-Food-Energy Nexus based on the project case study**
- Developing highly trained agricultural professionals who understand the interactions between irrigation water quality, soil quality, and food, in the context of environmental, water scarcity, and regulatory constraints, and
 - (1) Foster systems-based and multidisciplinary thinking with curriculum that combine issues and students from agriculture, engineering, environmental sciences, economics, policy, public health, and community development.



Expected Outputs

- Risk assessment of crop quality and irrigation water safety;
- Source-specific guidelines to select the right water for the right application (e.g. considering risk difference for different crops, and different exposure pathways);
- Tracking pathways of metals and salts from irrigation water to soil and crops by using isotope tracers;
- Recommending policies that integrate the systemic interconnection between energy production, water quality and quantity, and food safety/public health;
- Enlisting stakeholder engagement in benefit/risk assessment;
- Case-based interdisciplinary education using real-world scenarios.



Study Limitations and Opportunities

- Due to resource constraints and current data availability, the proposed project focuses on human exposure to metals associated with irrigation OPW in Central California. In the future, the study could be extended to include organic contaminants, additional crops, and a wider geographical and geological coverage of the U.S., including OPW from both conventional and unconventional oil and gas development, as well as treated industrial wastewaters.

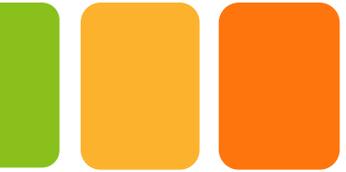
Partnering with Lawrence Berkley National Laboratory for data sharing with their organic constituent analysis would improve the quality and quantity of the data in this study

- We need farmer access to collect multimedia samples at farms with and without OPW use and conduct farmer surveys. Individual farms will be deidentified and results will be combined for analysis at a larger scale.

We would like to partner with stakeholders that have ideal areas for inclusion in this study.

Thank you for your time.

Questions?



For more information, comments, or questions about entering our study, please contact lfeinstein@pacinst.org

