Fresno Understands Environmental Resilience Through Equity (FUERTE):
Bay Area Council's California Resilience Challenge Grant Recipient Final Report

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Executive Summary

The Fresno Understands Environmental Resilience Through Equity (FUERTE) project is a community-engaged vulnerability and adaptation (V&A) needs assessment on climate change and health for Fresno County with the goal to increase community resilience against negative impacts to health and wellbeing from extreme weather events linked to climate change, especially extreme heat, poor air quality, and drought. FUERTE is led by a team of people from public, non-profit, and academic centers shown on the right working together to help Fresno County thrive in a changing climate, where more extreme weather events like extreme heat, wildfires, drought, and flooding are expected in the future.

While climate change is widely understood to impact all communities, we know that people with certain demographic, socioeconomic, and occupational characteristics will be disproportionately impacted. Fresno County (population ~1 million) has a striking combination of people most vulnerable to the detrimental health effects of a changing climate and is greatly affected by excessive heat, drought, and wildfire smoke. Fresno County is 77.2% Latino, Black, native Hawaiian or Alaskan, American Indian, Asian, or two or more races (United States Census Bureau,https://www.census.gov/.). More than 40% speak a language other than English at home, and 20.5% live at or below the poverty line (compared to 9.6% of California). Further, there are an estimated 68,000 undocumented people in Fresno County, of which approximately 60% speak little to no English.

The FUERTE project was modeled on the Centers for Disease Control (CDC) Building Resilience Against Climate Effects (BRACE) framework for climate and health V&A assessments. The approach has five steps: (1) anticipate climate impacts and assess vulnerabilities, (2) project disease burden, (3) assess public health interventions, (4) develop and implement climate and health adaptation plan, and (5) evaluate impact and improve quality of activities. We focused our efforts on the first three steps. Our specific goals were to characterize the likely impacts of climate change in Fresno County, identify who in the county will be most affected, and to understand what is needed for communities in Fresno to thrive in a changing climate, where more extreme weather events are anticipated.

Three working groups carried out the main components of the project. The reports review working group identified, reviewed, and summarized publicly available reports relating to extreme weather preparedness and resilience in Fresno. The epidemiology working group identified communities in Fresno County most at-risk for health harms from climate change-related extreme weather events through the development and use of heat and air quality vulnerability indices. The community engagement working group conducted 8

focus groups, to gather perspectives from communities projected to be at greatest risk, asking about perceptions of health risks, protective actions, and possible adaptive solutions for extreme heat, wildfire smoke, drought, and flooding. All three working groups were advised by a community advisory group composed of leaders from vulnerable communities, environmental justice advocates, and public health and medical professionals in Fresno County.

Finally, the project created a network called Central California Climate Change Clinical Collaborative (C6) to unite stakeholders based on health equity, collaboration, education and training, data-driven action, and community empowerment. C6 is poised to engage with communities, local government, education institutions, and health facilities across Fresno and other central California counties around the findings of the FUERTE project and take action to increase community resilience against health impacts from climate change.

Problem Statement

The intensifying effects of climate change pose a clear threat to the health and well-being of California residents, particularly those living in the Central Valley. For example, projections for Fresno county show an increase in number of extreme heat days (>94.3 F) by 22-30 days per year, and an increase of 8-12,000 acres burned by wildfire over the next 30 years (https://cal-adapt.org/). California's Central Valley also ranks the highest for burden of pollution from multiple sources that are exacerbated by climate change, including PM2.5 and water contamination (https://oehha.ca.gov/). Central Valley communities that already experience health disparities based on race, income, neighborhood, language, immigration status, and other factors are particularly vulnerable to climate-related health threats while also having more limited access to resources necessary to protect themselves from them.

To add additional context on the importance of this project's focus: in addition to long-term trends, during the course of our project (2022- present) our region was affected by multiple NEW challenges, related to health care access (e.g. abrupt closure of a major general hospital in a neighboring county, which added to the burden of health care needs in Fresno county) and multiple environmental "firsts" (winter storms with increased flooding risk and summer heat waves which broke records).

Project Description

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Project Methods and Results

Part 1: Review of previously published reports on climate change and climate disaster preparedness for Fresno County

The FUERTE project strived to make use of and build upon work already done on climate and health in Fresno County. To ensure that our group did not duplicate previous efforts and that our work focused on filling gaps in available data about the impact of climate change on the health and wellbeing of vulnerable communities in Fresno County, the reports review working group of FUERTE identified, reviewed, and summarized publicly available reports relating to extreme weather preparedness and resilience in Fresno.

A. Methodology

We identified 8 reports published between 2011 and 2020 created by a variety of government agencies, consultants, and academic partners. We reviewed and summarized the key findings from each report and assessed how each report could focus the direction of the work of FUERTE.

B. Results

Appendix 1 includes a table with a detailed summary of our review of these reports, including the title and authors of each report, climate or health hazards addressed, the degree to which each report reflected engagement with vulnerable communities in Fresno, and recommendations and future steps for FUERTE based on the information in the report.

In general, we found that the reports included little engagement with vulnerable communities in Fresno. We also found very limited information on health indicators and impacts related to extreme weather events linked to climate change. Finally, we found limited specific information on preparedness for climate disasters in Fresno County.

Overall, findings from our review of these reports supported the need for a health-focused community vulnerability and adaptation (V&A) needs assessment for climate and health in Fresno County and also provided a list of agencies who have done work in this space and who would be important to re-engage to act on findings from our V&A assessment.

C. Barriers encountered

We acknowledge that there may be additional unpublished reports (e.g. internal reports for county government agencies) that we did not review. In addition, this portion of the project was completed early in our process, and there may have additional reports published

by other county agencies in the time since. As we continue to share our findings with government agencies and other community partners, we will conduct another brief search to attempt to identify any additional groups in Fresno doing work in this space who may want to collaborate on climate resilience efforts.

D. Participating stakeholders

This portion of the project was led by Nicky Ranadive, Nour Abou-Fadel, and Joe Prado. Results were shared and discussed with our community advisory group.

Part 2. Development of heat and air quality vulnerability indices to identify Fresno County communities most vulnerable to health impacts from extreme heat and wildfire smoke

This portion of the project focused on understanding Fresno County's vulnerability to extreme heat and air pollution, using indices that combine exposure, sensitivity, and adaptive capacity variables. These indices enable the identification of census tracts that require targeted interventions for climate resilience.

A. Methodology and results

Heat Vulnerability Index (HVI): Comprises 21 variables. Key indicators include land surface temperature, tree canopy coverage, extreme heat days, and socioeconomic factors like poverty and education levels.

Air Quality Vulnerability Index (AQVI): Includes 23 variables focusing on air pollution metrics like PM2.5 levels, diesel particulate matter emissions, and toxic release sites.

Data Sources: Data was gathered from CalEnviroScreen, the Healthy Places Index, the CDC, and the US Census Bureau. Other sources include the US Geological Survey and the EPA. Variables were standardized, scored, and aggregated to determine overall vulnerability rankings. Python and GIS tools were used to map results, visualizing vulnerability across Fresno County.

Exposure to Environmental Hazards

Extreme Heat

Extreme heat is defined as summer temperatures significantly exceeding the local average, with 105°F often used as a threshold in California. The impacts of extreme heat vary across communities due to historical policies like redlining, which have exacerbated vulnerabilities in low-income and racially segregated areas.

Key Variables:

- Land Surface Temperature (LST): This satellite-derived metric captures spatial variability in heat exposure. Data from Landsat-8 imagery (2017–2020) was processed in QGIS to calculate average LST for each census tract.
- Extreme Heat Days: Data from the CDC and National Weather Service highlight the frequency of days exceeding 105°F, reflecting long-term trends (1979–2020).

- Tree Canopy Coverage: Vegetation mitigates heat impacts by providing shade and reducing surface temperatures. Data from the National Land Cover Database reveals significant disparities in tree canopy coverage across census tracts.
- Water Contamination Levels: Poor drinking water quality exacerbates risks during extreme heat events. Data from CalEnviroScreen shows that disadvantaged communities face higher contamination levels.
- Energy Bill-to-Income Ratio: This unique variable reflects financial stress in cooling households during extreme heat. Households spending a high percentage of income on energy are particularly vulnerable.

Air Pollution

Air pollution encompasses harmful substances like PM2.5, diesel particulate matter, and ozone, which pose significant health risks. Fresno County's geography, surrounded by mountains, traps pollutants, exacerbating poor air quality.

Key Variables:

- PM2.5: Fine particulate matter that penetrates deep into the lungs, causing respiratory and cardiovascular issues. Data from CalEnviroScreen highlights areas with the highest concentrations.
- Diesel Particulate Matter: Emissions from transportation and industry are major contributors. These particles are linked to cancer and respiratory irritation.
- Ozone Concentration: Formed by chemical reactions between nitrogen oxides and volatile organic compounds, ozone exacerbates respiratory conditions.
- Toxic Releases: Data from the EPA's Toxic Release Inventory identifies census tracts near industrial facilities with high emissions.
- Traffic Volume: High vehicle density contributes to localized air pollution.
- Tree Canopy Coverage: Sparse vegetation exacerbates air quality issues.
- Water Contamination Levels: Clean water access is crucial for mitigating heat and pollution-related health risks.

Sensitivity to Extreme Heat and Air Pollution

Sensitivity refers to population characteristics that make individuals more vulnerable to environmental hazards. These include health conditions, age demographics, and occupational factors.

Key Variables:

- Asthma Rates: Fresno County has a 20% asthma prevalence, compared to the state average of 10%. Poor air quality exacerbates asthma symptoms.
- Cardiovascular Disease: Conditions like heart disease and stroke are aggravated by exposure to PM2.5 and extreme heat.
- Low Birth Weight: Infants weighing less than 5.5 lbs are more likely to experience health complications exacerbated by pollution and heat.
- Diabetes: Heat increases the risk of dehydration and complications for individuals with diabetes.
- Outdoor Workers: Prolonged exposure to extreme conditions increases risks for agricultural and construction workers.
- Children Under 5: Younger children are more sensitive to respiratory and heat-related illnesses.
- Elderly Adults: Reduced ability to regulate body temperature and pre-existing health conditions make seniors particularly vulnerable.

Results: Census tract 9.02 in southwest Fresno stands out with high rates of asthma, diabetes, and low birth weight. Additionally, 44% of its workforce comprises outdoor laborers, further amplifying sensitivity.

Adaptive Capacity

Adaptive capacity measures the resources, infrastructure, and social systems available to communities to mitigate environmental impacts.

Key Variables:

- Seniors Living Alone: This demographic faces higher risks due to social isolation during extreme weather events.
- Linguistic Isolation: Households where no adult speaks English proficiently are less likely to access critical resources and emergency information.
- Racial Composition: Research shows non-white populations face systemic barriers that reduce adaptive capacity.
- Educational Attainment: Low education levels correlate with reduced awareness of and response to climate risks.
- Poverty Rates: High poverty limits access to cooling technologies, healthcare, and clean water.
- Insurance Coverage: Uninsured residents are less likely to seek medical care during emergencies.
- Access to Automobiles: Lack of personal vehicles restricts mobility to cooling centers or healthcare facilities.
- Homeownership Rates: Renters often face higher environmental risks due to limited agency in improving living conditions.
- Severe Rent Burden: Households spending over 50% of income on rent have fewer resources for climate adaptation.

Results: Census tract 5.01 in northeast Fresno scores lowest in adaptive capacity. Key drivers include high poverty rates (73% of residents earn below 200% of the federal poverty line), severe rent burden (42% of households), and linguistic isolation (38% of households).

Heat Vulnerability Index (HVI)

- Median Score: 10.63
- Most Vulnerable Tracts: Census tract 9.02 ranks highest with a score of 13.84. Key drivers include high land surface temperatures, low tree canopy coverage, and socioeconomic challenges.
- Least Vulnerable Tracts: Census tract 55.18 scores lowest at 7.33, with high tree canopy coverage (11%) and low heat exposure.

Air Quality Vulnerability Index (AQVI)

- Median Score: 10.40
- Most Vulnerable Tracts: Census tract 25.02 scores highest with poor air quality, high traffic pollution, and limited adaptive capacity. The area's proximity to industrial sites exacerbates exposure.
- Least Vulnerable Tracts: Census tract 55.25 scores lowest at 7.06, reflecting rural conditions with lower pollution levels.

Key Findings

- Overlapping Vulnerabilities: Tracts with high heat and air pollution vulnerability often share characteristics such as low tree canopy coverage, high poverty, and poor health outcomes.
- Geographic Trends: Vulnerable tracts are concentrated in southwest and southeast Fresno, near industrial zones and major highways.
- Disproportionate Impact on Non-white Populations: These areas have higher concentrations of non-white residents, reflecting historical environmental injustices.
- Example: Census tract 9.02 demonstrates extreme vulnerability across indices. It experiences high land surface temperatures, minimal tree canopy coverage, and frequent extreme heat days. Socioeconomic barriers—like a 96% non-white population, high poverty rates, and linguistic isolation—compound risks.

Heat Vulnerability Index Results

After analyzing the variables across the three vulnerability categories, the top 10 census tracts in Fresno County with the highest vulnerability and lowest vulnerability to extreme heat have been identified. The median Heat Vulnerability Index score for all 199 census tracts in Fresno County is 10.6317 (See Heat Vulnerability Sheet. These are the results for the 10 most vulnerable census tracts and their corresponding Heat Vulnerability Index scores:

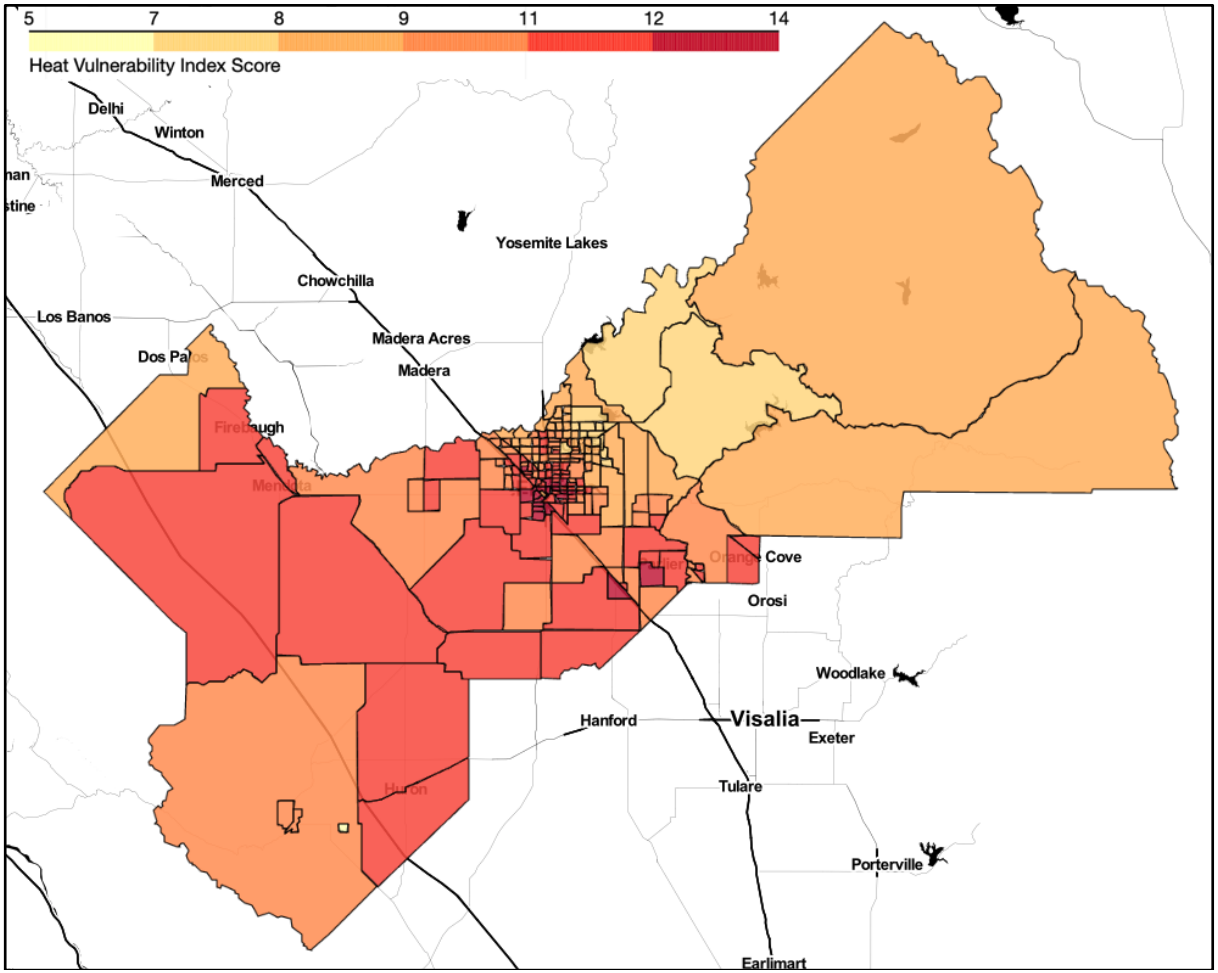
Census Tract	Heat Vulnerability Index Score
9.02	13.84444444
25.02	13.66984127
10	13.53333333
2	13.39047619
11	13.39047619
7	13.36825397
24	13.15238095
6	13.04126984
9.01	13.02539683
28	12.8984127

Some of the primary characteristics of the top 5 heat vulnerability scores for census tracts 9.02, 25.02, 10, 2 and 1 are high levels of extreme heat, contamination, energy bills, asthma, cardiovascular issues, and the presence of historically marginalized populations with low adaptive capacity such as non-white residents and individuals with limited English proficiency. There are also common issues related to low educational attainment, high poverty rates and severe rental burden and low home ownership rates. These commonalities across the highest scores suggest the importance of creating targeted interventions to improve the overall resilience in these communities so they could adapt to extreme heat in Fresno County.

The 5 lowest heat vulnerability scores in the county are:

Census Tract	Heat Vulnerability Index Score
55.2	7.526984127
64.05	7.526984127
55.13	7.415873016
57.02	7.384126984
55.18	7.326984127

A few of the most important similarities among these census tracts and drivers of vulnerability include a lower number of extreme heat days, lower levels of water contamination, and they pay a low percentage of their monthly income in energy bills. In terms of sensitivities, these tracts have lower rates of asthma, cardiovascular issues, and the communities also have low poverty rates. These five tracts generally have better environmental conditions for Fresno County and significantly fewer health challenges compared to the rest of the county. Further, these census tracts show similarities in high educational attainment rates, greater presence of white residents, and higher home ownership rates. These commonalities in the different tracts have created the relatively lower vulnerability and potentially higher overall resilience to extreme heat in Fresno County.



Map 1. Heat Vulnerability Index analysis results mapped on Jupyter Notebook

Air Quality Vulnerability Index Results

After analyzing the three vulnerability categories and creating on overall vulnerability index score, the average Air Quality Vulnerability Index score for all 199 census tracts in Fresno County is 10.3966 (See Air Quality Vulnerability Sheet). The census tracts with greatest vulnerability to Air Quality and their corresponding Index scores are as follows:

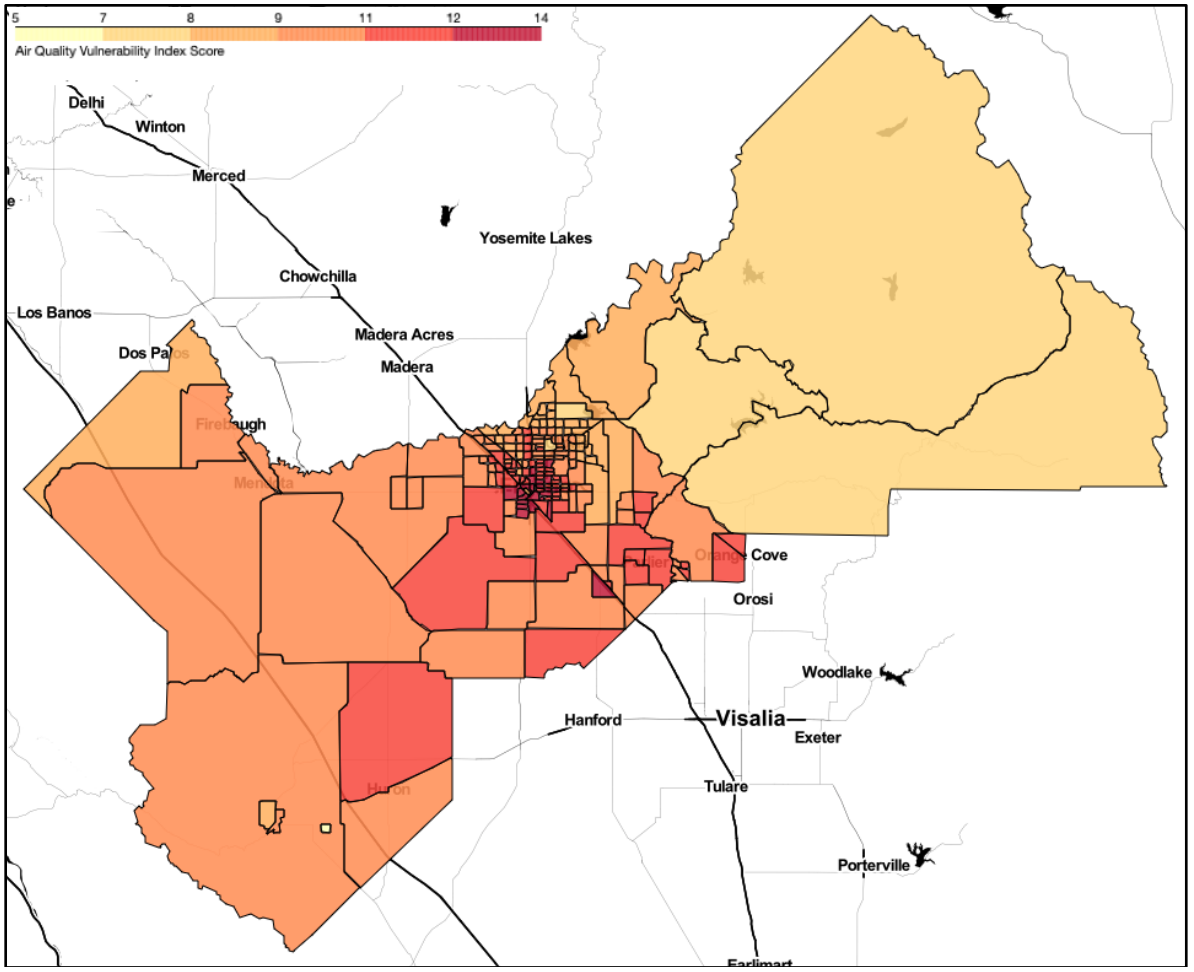
Census Tract	Air Quality Vulnerability Index Score
25.02	13.556
2	13.333
11	13.333
24	13.238
9.02	13.159
10	12.905
28	12.841
6	12.841
5.02	12.825
7	12.683

Some of the important similarities among these census tracts and their primary drivers of vulnerability are the high levels of exposure to PM 2.5, diesel particulate matter, sites with high rates of toxic releases, high traffic density and higher ozone levels. In general, these census tracts have really poor air quality, which can add to the poor health outcomes in the areas. These tracts also have lower tree canopy coverage compared to the rest of the county, which means they do not experience from the potential benefits of natural solutions to improve air quality in their communities. These tracts also have much higher rates of asthma, cardiovascular issues and diabetes than the rest of the county. This suggests they have to deal with respiratory and cardiovascular health problems at a higher rate than the rest of the region. These insights provide an initial understanding of the possible solutions that can support improved vulnerability outcomes for climate health in Fresno County.

To deepen the analysis, these are the five census tracts with the lowest vulnerability scores to air quality in Fresno County:

Census Tract	Air Quality Vulnerability Index Score
57.02	7.984126984
64.03	7.888888889
64.02	7.476190476
64.04	7.333333333
55.25	7.063492063

Among the census tracts that meet the criteria of having at least 15 of the 24 variables, census tract 55.25 obtained the lowest Air Quality Vulnerability Index score of 7.0635. This rural tract is home to 1,041 residents.



Map 2. Air Quality Vulnerability Index analysis results mapped on Jupyter Notebook

These results were presented to various stakeholders, including the Fresno County Department of Public Health. After reviewing our work, they requested to include the FUERTE Vulnerability Indices in their official environmental health priorities map as a new layer to support local decision-making. The FUERTE team will work with County staff in early 2025 to share data and map layers to fully integrate the research to the county tool.

B. Barriers encountered

Our research team encountered minimal barriers in collecting data and identifying sources for the two vulnerability indices. Adhering to best practices for vulnerability assessments, we conducted a comprehensive literature review to identify the most relevant variables for inclusion. However, two data gaps emerged during the process.

First, there was no available dataset on access to cooling in private homes, a variable that could have provided additional insight into heat vulnerability. Second, we lacked clear and comprehensive data on the proximity of census tracts to cooling centers. To address these gaps, we incorporated data on household energy burden as a proxy for access to cooling. This substitution provided valuable insights that strengthened our analysis and allowed us to proceed effectively despite these limitations.

Despite minor data gaps, our team successfully leveraged alternative variables to address critical aspects of the vulnerability indices. The process demonstrates the adaptability and rigor of the data-gathering approach, ensuring that the analysis remained robust and actionable.

C. External factors

Training and Capacity Building

The FUERTE team did not have access to certain GIS tools, which are commonly used for spatial data visualization and analysis. To overcome this limitation, the team used Python and open-source tools to code maps and visualize vulnerability indices. Additionally, the team participated in NASA's *ARSET - Satellite Remote Sensing for Urban Heat Islands* training. This training built capacity in constructing climate vulnerability indices using satellite data and provided valuable methodologies for leveraging remote sensing to assess urban heat impacts. These external resources were instrumental in enhancing the team's technical capabilities despite limited access to proprietary GIS software.

Institutional Context

Accurate data on the health impacts of heat remains a significant challenge due to systemic limitations in data collection and analysis. For example:

- Emergency Room (ER) visits directly associated with heat are difficult to track because healthcare providers often do not document heat exposure as a contributing factor during or after heatwaves.
- Privacy constraints prevent the collection of highly granular health data, making it impossible to pinpoint census tracts with the greatest heat-related health impacts.

Institutionally, there is also a gap in training for emergency physicians, who are not typically equipped to inquire about heat-related symptoms. This limits the overall capacity to gather robust data on heat's health impacts. As a result, the team relied on alternative datasets, such as comorbidities (e.g., asthma, cardiovascular disease), that are known to exacerbate health risks associated with air quality and extreme heat. These alternative data sources helped the team address institutional gaps while maintaining a focus on vulnerable populations.

Stakeholder Input

The research process was strengthened by consistent engagement with stakeholders and experts. A community advisory group reviewed the selected variables and provided critical input to ensure local relevance and applicability. Additionally, public health experts from the Fresno County Health Department contributed their knowledge of regional health challenges. Professor Kirsten Schwarz from the UCLA Fielding School of Public Health provided ongoing guidance to align the methodology with best practices and ensure the use of high-quality data. This collaborative approach ensured the indices reflected both scientific rigor and community priorities.

Quality of Data

The project leveraged data from established sources like CalEnviroScreen and the Healthy Places Index. However, the team prioritized a county-specific analysis by downscaling the data to focus on Fresno County. This approach allowed for the identification of priority communities within the county rather than making state-level comparisons. By refining the spatial granularity, the team was able to pinpoint areas with the greatest vulnerability, ensuring the results were actionable and tailored to local needs.

D. Participating stakeholders

Community Advisory Group

- This group of community members, public health experts, environmental justice advocates, and physicians played a critical role in reviewing the initial results of the indices. Their feedback, based on lived experiences, ensured precision and local relevance, enhancing the overall quality and applicability of the findings.

Fresno County Department of Public Health

- The department supported the project by reviewing the selected variables for the vulnerability indices. Their expertise ensured that the variables aligned with public health priorities and regional challenges.

Public Health Institute

- The Public Health Institute supported the project by providing access to data from the Healthy Places Index. This valuable resource allowed the team to leverage established datasets for understanding health and environmental vulnerability.

UCLA Luskin School of Public Affairs and Fielding School of Public Health

- Professor Kirsten Schwarz: As a faculty advisor to Edgar Reyna from the FUERTE team, Professor Schwarz provided guidance on adhering to best practices for vulnerability assessments and incorporating reliable methodologies.
- Professor Jose Loya: Professor Loya contributed early in the project by offering expertise on quantitative methods for constructing robust indices. His input was instrumental in ensuring the selection of non-redundant data and variables.

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Part 3. Focus group discussions with Fresno communities at increased health risk from climate change

A. Rationale

The objective of this component of the project was to better understand how communities in Fresno County who are known to face increased negative health impacts from climate change due to their occupational, social, or physical characteristics describe their experiences with the local environmental challenges that are expected to worsen with climate change, how they protect themselves, and what additional protections they need and want in order to thrive despite climate change. The results of this project are being used to develop a set of recommendations for local and regional governments, community-based organizations, and industry to improve local adaptive capacity to these hazards. Furthermore, these results will be useful to public health and regional planning agencies in other regions facing similar climate hazards and challenges to building adaptive capacity.

B. Methods

We set out to conduct 11 90-minute focus group discussions (FGDs) with Fresno communities at increased risk for negative health impacts from climate change. We planned to conduct six groups with people residing in one of the top five zip codes in eastern, central (urban), or western Fresno county with the highest Heat and Air Quality Vulnerability Index scores (see section above). We planned to conduct two focus groups in each of the three geographic divisions of the county. We also planned to conduct five groups with Fresno county residents who share certain demographic or occupational characteristics that place them at increased risk of negative health impacts from climate change. These included farm workers, small farmers, older adults (65 years+), outdoor workers in non-agricultural sectors, and persons who have experienced homelessness. We partnered with community organizations to assist in identification of possible focus group participants and logistics of the meeting. Focus groups were conducted in-person or on Zoom and in either English or Spanish. All participants were provided a small gift card incentive, and participants in in-person FGDs were also provided a meal. All participants were adults aged 18 years or older and all provided verbal informed consent to participate.

FGD questions pertained to: (1) observations of the climate changing in Fresno, (2) experiences with extreme heat, wildfire smoke, drought, and flooding in Fresno County, (2) actions people take to cope with these phenomena, (3) interest in and need for resources to help communities cope with these phenomena in the future, and (4) prioritization of resilience efforts against these environmental challenges in the context of other social,environmental, and economic issues impacting Fresno. FGDs were audio recorded and professionally transcribed.

Data were analyzed first using rapid qualitative analysis (Gale, 2019), enabling the analysis team to quickly develop a list of

actionable recommendations for local government and organizations to provide additional support for coping with the environmental hazards addressed in this series of FGDs. Members of the analysis team independently reviewed FGD summaries to identify key themes. A saturation grid adapted from Brod 2009 was used to show the presence of themes across the FGDs to support validity. A reflexive thematic analysis will be conducted at a later stage in Winter-Spring 2025 to generate more nuanced themes as we prepare to further disseminate and act on FGD findings and draft a manuscript for publication in a scientific journal. During each stage of data collection and interpretation, investigators will generate a series of memos in which they will record notes and reflections on their processes and emerging themes, while critically considering the influences the life experiences and positionality the investigators themselves bring to their work and how this may impact data collection and interpretation. The study team met to review emerging themes and will meet several more times in the winter and spring 2025 to collaboratively develop final themes.

C. Outcomes

Eight FGDs were conducted between August 2023 and September 2024. These include two FGDs from high risk (based on HVI and AQVI scores described above) zip codes in western Fresno county, three in central (urban) Fresno County, one in eastern Fresno county, a group with older adults, and a group with farm workers. In Jan 2025, we are planning three final focus groups (small farmers, a second focus group in eastern Fresno county, and a group with food truck workers. We have not been able to find a community partner to assist with recruitment of participants who have previously experienced homelessness. Five groups we conducted were in Spanish and three groups were in English. One group was conducted via zoom, and seven were conducted in-person. Of the remaining three FGDs planned for January 2025, we anticipate all will be conducted virtually and in English.

There were a total of 74 participants across the 8 FGDs. Of these, 74.3% of participants were 25-64 years old, 21.4% were 65+ years old, and 4.1% were under 25 years old. Participants identifying as Latinx/Hispanic comprised 86.5% and 13.5% as African American/Black. Approximately two-thirds (67.6%) of participants identified as women and 32.4% identified as men. Approximately half (52.7%) of participants worked in agriculture. Other participants worked as cooks/in restaurants, in packing houses, for the government, in caregiving, or in community organizing. Some participants were retired or did not work outside the home. Approximately half (54.2%) of participants owned their own home, trailer, or apartment, while 43.1% were renters, and 1.4% lived in a retirement home or other institution. The majority (67.6%) lived in a household with 2-5 other people, while 22.5% lived in a household of 5 or more, and 9.9% lived alone.

Themes from topic areas addressed in the FGDs are listed below. For each extreme weather type (e.g. extreme heat, wildfire smoke,

drought, and flooding), we have listed common themes, which were mentioned by participants in two or more focus groups and other notable ideas, which were mentioned in a single focus group by one or more participants. For each extreme weather type, participants were asked how their health and wellbeing was impacted by that type of extreme weather, actions they currently take to protect themselves, barriers to taking protective actions, and proposed solutions to better cope with the extreme weather type.

Ia. Extreme heat: Perception of impact to health and wellbeing	
Common themes (mentioned by participants in 2+ focus groups)	**Other notable ideas mentioned (mentioned by 1+ participants in the same focus group)**
Extreme heat negatively impact participants' mental health. For example, participants reported feeling more irritable, stressed, depressed, anxious, annoyed, and angry during periods of high heat. Some pointed to increased economic pressures from fewer work hours and lower wages and higher expenses (e.g. from air conditioning use) as a major source of anxiety and stress. Others have described social isolation resulting from extreme heat. - "I have children at home and now, with the intense heat, I have to keep the air conditioning on day and night, resulting in electricity bills over $500... sometimes I've had to take on two jobs just to pay these bills and the rent. I end up neglecting my children by working all day and night, or by working extra hours." -- FGD3 participant - "I lie down, and I don't even know what to do. I take my clothes off, take a shower, and then I'm all sweaty. I take another shower, and it's such a frustrating situation because I don't know what to do. The heat makes me lose all patience, and I don't know what to do. I just go and take a shower, then another shower, and I have no idea what to do." -- FGD5 participant - "Sometimes I send pictures to my kids and tell them, 'son don't you want to visit me? It's 90 degrees here in the kitchen.' 'No, mom, thanks.' They don't want to visit me when it's that hot" -- FGD6 participant - "You open the door and that heat just rush in. You have to go outside, you have an appointment or something, by the time you get home from being on that heat, you just messed up the whole day, the rest of the evening, all night--and it is like you just have to start the next day." --FGD8 participant	Experienced disruptions to sleep during very hot days

Participants note a variety of serious physical symptoms and ailments occuring during exposure to extreme heat, including vertigo, headaches, burning sensations, increased fatigue, flu-like symptoms, tunnel vision, and panic sensation. Participants also observe worsening of chronic conditions such as diabetes and chronic kidney disease, either in themselves or someone close to them. Some mentioned feeling that greater impacts from heat as they have grown older. A few participants mention hospitalizations due to heat-related symptoms. - "I've seen some of my coworkers get dehydrated, fainting, and then they can't work anymore." -- FGD5 participant - "The heat now is different from what it was years ago. I've experienced temperatures like 112, 113, even 115 degrees on certain days last year and the years before. And now, at those same temperatures, it feels like the sun is burning the skin even more. That's my perception. I feel as if there's no protection, and it's striking me directly." -- FGD 3 participant - "Working in a crew is very different because the foreman keeps pushing you. They bring in the so-called drivers. If you want to take a little break, they send the driver to hurry you along; they don't let you rest comfortably, drink water as needed, use the bathroom, or find shade because they keep pushing you. The heat really affects you, especially if you're already exhausted and they don't let you take a short break. There are people who have become ill. They've been taken to the hospital because of the heat. Such people never fully recover because even a little heat afterward becomes too much for them to bear." -- FGD 4 participant	
Ib. Extreme heat: Protective actions	
Common themes	**Other notable ideas**
Participants make significant adjustments in their daily rhythms and routines, including: - Cooking early in the day (e.g. 3AM) to avoid turing on the oven/stove when it is hotter indoors - Running errands early or late in the day - Taking children to the playground late in the day, after the equipment has cooled - Stay home more often, forgoing social opportunities, shopping, appointments	Increased use of other methods to cool one's space: - swamp coolers - heavy curtains over windows - aluminum foil over windows

Participants take a variety of actions to directly cool their bodies by: - Seeking various forms of shade (e.g. using umbrellas, wearing a hat, seeking tree cover) - Wearing light, breathable clothing - Bathing more frequently, splashing water on themselves, wrapping themselves in a wet towel, wearing wet clothing - Consuming more water and beverages with electrolytes - "Laying down on a cool floor ("When I arrive, I feel like I am burning and my feet hurt. What I do is I lie down on the floor. It is cool there. The bed is very warm. The floor is very cool. Anyway, I just put a pillow and I stay there. I even fall asleep because the floor is cool. Since the bed has a mattress and a warm blanket; it makes you hotter." --FGD5 participant - "even when you take cold showers, where you get mad is that, you know, by the time you sit on your bed, because I'll-I'll do it where you just wet, but dude, it's so hot, you're just air drying, and then you dry just like-just like, 'Oh, let me go get the water again'" -- FGD8 participant	Seeking outdoor recreation spaces - Parks, especially those with water features - Rivers - Planting more trees
Participants, many of them agricultural workers, report adjustments to their work schedules, either choosing not to go to work or having work hours cut by employers	Making preparations for rolling blackouts
Participants adjust their spending, and allocate a higher fraction of income to electricity bills - "Ending up in the hospital is more expensive; that's what I tell my dad. If we don't turn on the air conditioning and aren't-- I mean, that's why we work; we need to live in decent conditions. If you bear the heat in the trailer, you'll end up in the hospital. That bill will be more expensive, right? So, if it's too hot, we prefer to spend money on that." --FGD6 participant	Applying more sunscreen
Ic. Extreme heat: Barriers to protective actions	
Common themes	**Other notable ideas**
Low wage workers feel economic pressure to continue working, though it places them at significant risk - "Yes. Honestly, when it's so hot, you can't work in peace. When it's really hot, you're taking a risk. If you work under contract, then you're taking quite the risk because it has a negative effect on you. As you heard, some folks have fainted. Imagine you're working and then you collapse, but nobody notices, or they notice it but then are like, 'This guy fainted.' That's quite awful." -- FGD5 participant - "We have to work because here in this country you have to pay rent, the telephone bill, the	A nearby river previously used for recreation was closed due to contamination

electricity bill, buy food and everything else you use at home. If you do not work, there is nowhere to go. Obviously, you have to expose yourself to the sun and heat. You make an effort to work even if things are going poorly at work because there is no help or we have no way to buy what we need." -- FGD4 participant	
Renters feel a limited sense of agency to make their homes more resilient to extreme heat, mentioning: - Not being allowed to plant trees o the property - Limited ability to retrofit facilities with more insulation - Air conditioning in rental homes not working well and being energy inefficient	Ways to finance installation of solar panels
Participants noted a variety of barriers to use of cooling centers, including: - Location of cooling centers far from home - Cooling centers closing during hottest part of the day (~5pm) - Limited number of cooling centers - Shortage of transportation options to cooling centers	Unhoused community members have limited ability to protect themselves from the heat
Some participants felt that their employers were not sufficiently concerned about their wellbeing during periods of extreme heat and did not offer adequate protections and resources to stay cool. Foremen in the fields are incentivized to push workers towards productivity goals irrespective of the heat impact on workers - "you don't really feel the heat until after 1:00 PM. However, from 8:00 AM, we're already soaked in sweat and have to keep going because it's contract work and you're paid by the piece, not by the hour." -- FGD4 participant	Lack of shade in the community
Electricity bills increase substantially when air conditioning is used, leading participants to limit use	
Participants perceive a lack of government support, especially for families and seniors, to offset the economic losses during extreme heat - "The way that our government is, uh, they don't look out for us like they look out for countries way away, and they say we need that, uh, I'm not a soldier, so I don't- I don't know, but they don't help seniors enough to provide for us to be, um, uh, happy, safe, comfortable in our homes." -- FGD8 participant	

Id. Extreme heat: Potential solutions	
Common themes	**Other notable ideas**
Participants, particularly outdoor workers, would like to see some form of wage insurance to preserve their income even on days when they cannot work due to extreme heat	Support with electricity bills, especially during times of year when AC is most needed
Participants want more efficient and effective cooling systems (namely, air conditioning), which some noted was even more important at home -- their place of refuge -- than at work. Participants desired support with electricity bills, especially to afford air conditioning use. - "You have to bear the heat at work, but at least when you get back home, it's cool, and you can rest. If you're working in the heat and at home it's still hot, your body can't rest." -- FGD7 participant	Some had participated in a program by the power company to install more insulating doors and windows and they would like more infrastructure upgrade programs
Participants would like more trees in the community and resources for maintaining those trees	More investment in clean energy, including support for installing solar panels
Participants wanted more fans	Some outdoor workers expressed interest in amenities at work such as longer and more frequent breaks, provision of electrolyte drinks, relaxing the pace of fieldwork in the hot afternoons, more training for foremen and businesses employing outdoor workers, and adjustment to work hours for fieldwork jobs (e.g. 5AM-2:30PM)
	Better water recycling infrastructure
	Lift restrictions against recreating in the river

IIa. Wildfire smoke: Perception of impact to health and wellbeing	
Common themes (mentioned by participants in 2+ focus groups)	**Other notable ideas mentioned (mentioned by 1+ participants in the same focus group)**

Participants mentioned significant respiratory symptoms (e.g. struggling to breathe, coughing) and worsening of chronic respiratory conditions from smoke exposure. They also mention children having to miss more school due to respiratory illnesses made worse by smoke. - “The week only started on Monday, and by Tuesday, my kids were already off because the weather made them sick. They weren’t given a pass. They got one yesterday, but if they miss another day, it won’t be excused—even if it’s asthma, a cold, or whatever. COVID isn’t an excuse anymore.” I’ve noticed this trend among students; many get sick from the heat. Complaints like “My head aches,” or “I have asthma,” are common.” -- FGD2 participant	Felt economic pressure to work in smoky conditions despite the health risks. - “Look, to be honest and direct, we won't make enough to restore our health. As she said, we go to work because we need to get paid, even if our lungs get damaged. Ultimately, what we make won't be enough to cure us.” -- FGD6 participant
Participants noticed a variety of other symptoms connected to wildfire smoke exposure, including headache, sinus pressure, burning sensation in the nose, throat, and eyes. They highlight the particular vulnerability of outdoor workers. - " For those of us working in the fields, the smoke is palpable. It’s as if that distinct smell infiltrates the brain and lungs. You feel a burning sensation in your throat, nose, and your eyes start watering." -- participant, FGD3 - “Sometimes, the environment is so polluted that our eyes turn red and get irritated. I think it’s very hard to know if it’s actually an allergy or if the dust from the almond trees or fields where we work, or the smoke is affecting me. Unfortunately, sometimes when we go to the doctor, the medical services at the healthcare center aren’t as thorough as those of a private service or private insurance. They usually end up prescribing medication for allergies, but even after taking the medicine, you know, it doesn’t go away.” -- FGD6 participant	
Participants in multiple groups noted that, even in the absence of symptoms or disruptions, seeing ash in the air was a visible reminder of damage being done internally that could have long term negative health consequences	
Participants mentioned a variety of negative mental health impacts from wildfire smoke, including feeling sad, stressed, agitated, and powerless. - "Field workers feel its toll, getting agitated. That’s when you can’t help but breathe in the smoke, and that’s when the real panic sets in." -- FGD3 participant	
IIb. Wildfire smoke: Protective actions	
Common themes	**Other notable ideas**

Participants across focus groups mentioned needing to make disruptive changes to their daily rhythms and routines because of wildfire smoke, such as staying indoors or children going without outdoor recess. - "The outside looked hazy, and ash was falling. My kids didn't play outside for about three to four days. I kept them in. Schools also kept children indoors during recess to shield them from that burnt scent; it felt like the fire was right here."-- FGD6 participant	Monitored the Air Quality Index (AQI) on their phone
Some participants made use of personal protective equipment such as mask, though often used surgical masks rather than N95 masks. Some participants wore eye goggles.	Kept windows and doors closed and put towels over the swamp cooler for extra filtration
Some participants mentioned simply enduring the conditions because they did not know what else to do or felt economic pressure to work no matter the risks. - "Well, mostly you bear with it. I'm not sure what else to do." -- FGD3 Participant - "In my case, I had to go to work because if you don't go to work-- If I miss work and don't bring a doctor's note, I get one point. When you reach six points, you're fired. So, it was like, "Let's go; there's no other option." -- FGD6 participant	Installed air purifiers that they purchased or made
IIc. Wildfire smoke: Barriers to protective actions	
Common themes	**Other notable ideas**
Participants from multiple groups felt they lacked information on what to do to protect themselves against wildfire smoke. They thought they should be doing something to prepare or protect themselves but did not know what. Participants expressed a desire for more information about air purifiers in particular. -- "And so what you buy may or may not be the most- give you the most filtering of the air in your home." -- FGD 7 participant	Difficulty fully insulating homes from the smoke given their construction.
	One participant was given a mask by their employer but it was too uncomfortable to work in and they felt they could not breathe in it.
	Felt forced to work in dangerous/smokey conditions to make ends meet.
IId. Wildfire smoke: Potential solutions	
Common themes	**Other notable ideas**

Participants wanted improved indoor ventilation and purification, especially at home and in school environments.	Wanted air conditioners to replace swamp coolers, particularly for older adults
Participants also wanted better personal protective equipment, particularly masks for outdoor workers	
As with extreme heat, numerous participants mentioned a need for wage insurance so they could continue to earn a usual income even if unable to work due to smokey conditions or respiratory illness.	
Participants expressed the need for an emergency plan for the community that would include information about the risks of smoke exposure and what to do, clear guidelines on outdoor play for children as well as breathing centers (similar to cooling centers) where participants could go for refuge during smokey days and transportation to such a place. Some participants wanted text message alerts about the smoke, similar to Amber Alerts for child abduction	
Participants were interested in policies for cancelling outdoor work when particulate matter exceeded a certain threshold.	

IIIa. Drought: Perception of impact to health and wellbeing	
Common themes (mentioned by participants in 2+ focus groups)	**Other notable ideas mentioned (mentioned by 1+ participants in the same focus group)**
Participants, many of them agricultural workers, described being affected by decreased work due to drought. - “It’s affected me deeply, especially those in the fields, as job opportunities decreased a lot. Crops just aren’t the same without water. How are we impacted? Food prices rise, productivity drops, and this touches everyone. Certainly, the lack of water affects us immensely. It’s felt at home when we can’t water. My yard’s grass has dried out and I don’t water it anymore. But it also impacts our jobs severely. One issue just leads to another.” -- FGD 2 participant - "Work opportunities have decreased. We’re getting less produce. It’s been a big blow to us. There was more work available before. It’s reduced quite a bit over the years” - FGD 3 participant	Concern that drought could amplify concentration of pesticides in water or other means of exposure

Participants also mentioned the overall impact of less crop production and a change in foods that can be grown	Another participant who lived in a rural, well-water dependent community mentioned an excess of cancer cases in some rural communities coinciding with onset of drought
Participants noted the increased cost of water adding to their economic concerns	Loss of community due to people moving out of the area on account of drought and its economic impacts - "Yes, folks end up moving. I've seen this in folks who live over there. We're near the dam—I don't know if that's why we have more water. Folks living in remote areas, over there, up the hill, have it tough" -- FGD 5 participant
Participants mentioned negative mental health impacts (particularly stress) due to decreased work, larger bills for water, and having less water to care for their own animals and plans	
Participants depending on well water were concerned about running out of water entirely	
Participants also mentioned wider spread of Valley Fever, a spore-borne fungal infection, due to increased exposure to dirt and dust	
IIIb. Drought: Protective actions	
Common themes	**Other notable ideas**
Participants mentioned multiple ways in which they were attempting to conserve water (e.g.flushing the toilet less often, recycling water used for household purposes to water plants) - "We have a system where we use the water from washing clothes to water the herbs. We can't let them die, right? It's the same with our fruit trees. We use the washing water to water them. Also, my husband uses a hose to direct our bathwater to the plants. We need to find ways." -- FGD 6 participant	Traveled further away (up to several hours) to find other agricultural work
	Stretched their money further by shopping at less expensive stores.

	Joined a program to deliver water to their home while a new well to replace one that had run dry was being dug
	Shared water with their neighbors. - “Also, where I live, some neighbors have had their water dry out. We have shared water whenever we hear that somebody has no water. We say, 'Come to my house. Take a shower, at least. Bring your hose.' That's if it's our neighbor. I’ve had two neighbors run out of water and the church across the street. We joined 750 feet of hose to give the church across the street some water. I don’t believe we have gone to that extreme yet, but I think we will eventually.” -- FGD 5 participant
	Applied for food assistance
	Looked for a different kind of work
IIIc. Drought: Barriers to protective actions	
Common themes	**Other notable ideas**
	Lack of career opportunities in sectors other than agriculture in their communities, which makes finding an alternative source of income for when drought destroys crops and, therefore, career opportunites for many workers in the area.
	Lack of transportation as a barrier for finding similar jobs in agriculture in other communities within driving distance.
	Installed artificial turf in place of grass though noted an unfortunate tradeoff was that the surface would be even hotter during the summer.

IIId. Drought: Potential solutions	
Common themes	**Other notable ideas**
Several groups proposed implementing wage insurance for outdoor workers, especially for vulnerable families to guard against loss of income due to lack of work from drought.	Developing industries apart from agriculture in their communities. Participants expressed potential alternatives, which might include work in packing houses, restaurants, housekeeping, sewing, painting, and caregiving.
Multiple groups mentioned wanting strategies for decreasing water storage, perhaps by creating water reservoirs that could also be used for recreation.	Increasing the work hours limit (after which some employers would have to pay overtime) as a way to increase opportunities for work to the community.
	Improving home infrastructure so as to decrease water usage. - "I have to waste that water because I have to flush my pipes and I rarely wash the dishes, like, now I use a power wash tap, so it's just a little bit of water, um, because just myself, there's not a whole lot of dishes and I do s- really simply cooking. So, um, a lot of the technology we're dealing with and-and the way that homes have been built require us to be making, uh, using more water than we should."

IVa. Flooding: Perception of impact to health and wellbeing	
Common themes (mentioned by participants in 2+ focus groups)	**Other notable ideas mentioned (mentioned by 1+ participants in the same focus group)**

Participants from multiple groups describe damage to their homes from flooding, including damage to carpeting, leaking roofs, swelling of wooden doors, and development of a musty/moldy odor. - “Where I live, the drains were clogged and the water started to rise. The water was approaching the house. We started to push the water out to the street with brooms. It was overflowing. I do not know who went to unclog a drain, but the water in the houses was like that, and it tried to get through the doors. With the brooms we began to push water back.” -- FGD1 participant	Increased mosquitos following flooding.
Multiple participants mentioned transportation difficulties due to drought, including loss of personal vehicles, road damage, and increased commute times	Water contamination following flooding.
As with draught, multiple participants described damage to crops, leading to less work and increased food prices.	Sidewalk damage hindering the mobility of community members in wheelchairs.
Participants also described increased stress due to flooding, in part due to fear of damage to their homes and needing to evacuate. - “I just want to express that this situation is affecting me mentally and causing me stress. Costs have risen, I have four children, rent and food prices have increased. The heavy rains have reduced work opportunities, leading to fewer work hours. Nonetheless, we still have to find a way to pay the rents, which have also risen significantly, along with other bills.” -- FGD 4 participant	
IVb. Flooding: Protective actions	
Common themes	**Other notable ideas**
Multiple groups mentioned using sandbags to prevent water intrusion.	Received some financial assistance for damage from flooding, though felt it was insufficient to cover losses
	Prepared for power outages by gathering candles and other supplies
	Remained at home unless absolutely necessary to go out
IVc. Flooding: Barriers to protective actions	
Common themes	**Other notable ideas**

	Multiple participants from one group mentioned that there were insufficient days when large trash was collected in their community, making it more likely for garbage to clog drains during rainy periods.
	Perception that homes and transportation infrastructure are not built to withstand flooding.
	Sandbags provided insufficient water to stop water intrusion.
	Undocumented agricultural workers deprioritized for assistance for loss of income, property from flooding
	Lack of storm drains in the community (water drains directly into a river)
	Feeling that local politicians do not have their interest at heart.
IVd. Flooding: Potential solutions	
Common themes	**Other notable ideas**
Participants expressed a desire for more information about preparing for extreme weather events and wanted there to be an emergency plan developed with and monitored by vulnerable communities. They wanted emergency plans to be tailored to their specific needs.	Better street cleaning services to prevent garbage from clogging drains when it rains
Participants want improved water management infrastructure to prevent flooding and, if possible, collect and store rainwater - “Even if we personally don’t live in a flood-prone area, speaking more generally, I believe the government should, like I mentioned earlier about those reservoirs, also set up pathways. So, when there’s excessive water, it can be directed firstly to the reservoirs and somehow prevent the water from causing floods.” -- FGD2 participant	Distribution of more sandbags during flooding events.
Participants reported needing financial assistance (e.g. for food, rent), particularly to help make ends meet when unable to work due to flooding.	

Of note, across all extreme weather types, common themes were:

(1) Participants were able to easily identify the ways in which extreme weather events linked to climate change were impacting their health and wellbeing.
(2) Working under extreme heat or with significant air pollution carries significant health risks, but workers feel an economic pressure to continue working under these conditions.
(3) Given the financial hardships of not being able to work outdoor jobs as much during periods of extreme heat, wildfire smoke, drought, and flooding, participants commonly proposed implementation of wage insurance programs.
(4) Participants also commonly expressed a desire for more information about what protective actions they can or should take during extreme weather events linked to climate change – something the FUERTE/C6 team should be able to offer to communities in the near future.

C. Barriers encountered

One barrier the team faced in organizing the focus group was connecting with community partners to assist with focus group recruitment and logistics. We used connections at the Fresno County Department of Public Health and with the Central California Environmental Justice Network to try to reach partners, but we still had difficulty finding an interested organization to help us facilitate certain groups (e.g. non-agricultural outdoor workers and persons who have experienced homelessness). We suspect these organizations are busy and may have had limited bandwidth to handle extra requests.

D. External factors

While we had planned to conduct all focus group during warmer months of the year (June-Sept) so experiences with wildfire smoke and extreme heat are freshest, one group was conducted in December, and three more will be conducted in Jan 2025 based on availability of team members and our partner organizations. This has not seemed to have an impact on our results.

E. Participating stakeholders

Our community advisory group reviewed proposed FGD guide questions and participated in a mock focus group to help refine the questions. Our primary community partner for organizing many of the focus groups has been the Central California Environmental Justice Network.

Part 4.Central California Climate Change Clinical Collaborative (C6) Initiation

A. Methods and outcomes

As an outgrowth of FUERTE and in parallel to other climate-resilience work being done in the health care sector, we initiated a network called C6 (Central California Climate Change Clinical Collaborative) to unite stakeholders based on the following principles:

1. Health Equity: Ensuring that all communities, especially vulnerable ones, benefit equally from climate resilience and health solutions.
2. Collaboration: Partnering with local healthcare systems, government agencies, and community organizations to create a coordinated response.
3. Education and Training: Building capacity among healthcare providers and community members on the intersection of climate change and health.
4. Data-Driven Action: Utilizing research and climate-health data to guide decisions and interventions.
5. Community Empowerment: Actively involving local communities in the design and implementation of climate-health solutions.

In November 2024, with the sponsorship of the Fresno Madera Medical Society, the FUERTE team leadership was able to organize a CME event about climate-related health impacts, which also served as a kick-off for C6. Topics covered included interim results from FUERTE, as well as general remarks on emergency response and preparedness, health service delivery, and other issues for medical providers to know about health care impacts of climate-change. We also left time to identify future tasks that need to be performed and recommend responsibilities and timelines for these tasks.

We are currently creating a website for C6 which will serve as a platform to describe the organizations goals, share topic-relevant information, provide information about upcoming meetings and events, and broadcast funding opportunities.

B. External factors and Participating stakeholders:

We envision a broad interdisciplinary network of stakeholders with common goals and overlapping interests in advancing climate resilience in health care sectors of the Central Valley.

C-6 will serve as a catalyst to unite:

Public Health Departments/ Local and Regional Governments
Researchers and practicing clinicians
Community Based and Civic Organizations
Climate health researchers and institutes
Air, water, and climate organizations
Environmental justice and advocacy groups
Law Enforcement, Schools, Business Leaders
Colleges, schools and universities

C. Barriers encountered

Scheduling times for C6 meetings and advertising/announcing formation of the group were the main barriers. In the future, a website and survey-based questionnaires may help bring together stakeholders.

Another barrier is the challenge of bringing more attention to the issue of climate health into the focus of a health care system which, in Central California especially but even nationwide, has many other priorities competing for attention and resource allocation. We developed this brief explanation for our work:

Why is C6 needed?

Central CA is especially vulnerable to health impacts of climate change. As a broad and multidisciplinary network, C6 can foster the clinical and leadership skills to educate ourselves, our staff and future colleagues, and our patients and communities here in central California.

Lessons learned from other communities considering similar projects

The success of this project was rooted in the strong support of local community partners. These partners were instrumental in identifying community groups that could provide insights based on their lived experiences, offering invaluable perspectives that enhanced the precision and relevance of the research. By building trust and fostering open dialogue, community partners ensured that the vulnerability indices reflected not only quantitative data but also the climate realities faced by Fresno County residents. This underscores the importance of establishing and maintaining strong relationships with community-based organizations for research that seeks to address environmental and social inequities.

Collaboration with other groups working on related projects is essential to enhance the quality of data collection, and generate actionable outcomes. For example, the City of Fresno is currently developing an adaptation plan, and partnering with them from the beginning could have streamlined data gathering for both teams. We are also aware of other groups such as Transforming Climate Communities (TCC) Fresno that has been working on climate resilience efforts in the region. A coordinated approach could have strengthened both projects and yielded more precise policy recommendations to address local adaptation needs and we plan to engage with these groups as we act on the findings of the FUERTE projet via C6.

In addition, collaboration with community groups goes beyond logistical support—it's about empowering those involved. While providing stipends and meals to participants during data collection is a step forward in participatory research, it is equally important to foster community ownership of research projects. When communities feel ownership over the data and findings, it can build long-term adaptive capacity to climate change. For instance, many community members expressed the need for follow-up after sharing their insights. Researchers have a responsibility to ensure that the voices of community members are communicated as authoritative sources to policymakers, and it is critical for decision-makers to recognize the expertise and lived experiences of these communities. Community members must be treated as equal partners in shaping climate adaptation strategies. This shift in approach is critical for creating long-term sustainable and equitable solutions.

Next steps

We have developed this tentative 10-Step Plan to help address climate resilience and health care preparedness in central California, building on the FUERTE project and framing the development of C6 (Central California Climate Change Clinical Collaborative):

Step 1: Needs Assessment and Stakeholder Mapping
Conduct a comprehensive needs assessment across Central California to understand the specific climate change health impacts on local communities. Map key stakeholders including healthcare providers, local government, non-profits, environmental organizations, and community leaders to form a foundational network of support. THE FUERTE PROJECT ADDRESSES ALMOST ALL COMPONENTS OF THIS CRITICAL FIRST STEP.

Step 2: Formulate Organizational Structure
Define the structure and governance model of the C6 collaborative. Establish a steering committee consisting of healthcare professionals, climate scientists, community leaders, and policymakers to guide the initiative. Determine staffing needs, roles, and responsibilities.

Step 3: Secure Support and Resources
Apply for grants from government, philanthropic organizations, and corporate sponsors. Seek support from funding programs such as the California Resilience Challenge and other relevant climate-change health funding initiatives. Additionally, explore partnerships with local universities and research institutions, health care organizations, regional medical societies such as FMMS to leverage resources.

Step 4: Develop a Mission, Vision, and Core Values
Create a clear mission and vision statement for the Collaborative that emphasizes health equity, resilience, and collaboration. Establish core values that will guide the work of the organization, ensuring that all interventions are community-centered, sustainable, and science-based.

Step 5: Establish Collaborative Partnerships
Form formal partnerships with regional healthcare systems, public health departments, academic institutions, environmental advocacy

organizations, and community-based groups. Develop Memoranda of Understanding (MOUs) to solidify collaboration and ensure alignment on goals and expectations.

Step 6: Design Educational Programs
Develop training programs aimed at healthcare providers, climate scientists, and community leaders on climate change health impacts and resilience strategies. These programs should focus on building awareness, developing climate-related healthcare strategies, and training professionals to assess and address climate risks.

Step 7: Create a Data Hub and Monitoring System
Establish a centralized data system to collect, analyze, and disseminate climate-health data in Central California. Collaborate with academic partners and the Fresno County Department of Pubic Health Epidemiology division to generate region-specific data on climate change health impacts. Use this data to inform policy, practice, and future interventions.

Step 8: Develop Community Engagement Strategies
Continue to engage with our region's diverse communities through town halls, workshops, and advisory councils to ensure that their needs and concerns are addressed. Create climate-health resilience plans that are locally tailored and participatory, empowering communities to take action in climate adaptation and mitigation.

Step 9: Pilot Programs and Interventions
Implement pilot programs in select communities to test climate-health interventions, such as heat health action plans, climate-sensitive healthcare strategies, or disaster preparedness initiatives. Measure the effectiveness of these interventions and gather feedback from participants to refine future strategies.

Step 10: Advocate for Policy Change and Sustainability
Work with Central California policymakers to advocate for systemic changes that prioritize climate-resilient health infrastructure, especially for vulnerable populations. Push for funding, regulation changes, and the integration of climate change into public health planning. Ensure the long-term sustainability of the C6 Collaborative by diversifying funding sources and integrating climate-health resilience into local government planning processes.

Appendix 1. Summary of published reports pertaining to climate change and extreme weather preparedness in Fresno County

Report title	Year	Authors	Climate or Health Hazards Addressed	Engagement of vulnerable communities	Recommendations/ Future Steps
Fresno County Heat Emergency Plan	2017	Fresno County Department of Public Health	Heat/ heat related emergencies/ goal to reduce heat related morbidity and mortality	No - plan to identify vulnerable communities	Any concrete plans developed since release (2017)? How much of the guidelines/procedures have been implemented by local agencies?
Fresno Cooling Centers	2020?	City of Fresno	Heat / providing list of available cooling centers	No	Finding out how residents are notified of the cooling centers location?Transportation to center? Have any additional centers been opened since? Restrictions?
Toward a vibrant, prosperous and sustainable Fresno County	2012	Susanne Moser Research & Consulting, Julia Ekstrom (UC Berkeley) - prepared for California Energy Commision	Climate change projections and impact on public health, agriculture, community services, infrastructure, and emergency preparedness. The report looked at vulnerable communities impacted by climate change effects.	No - project identified vulnerable communities through census tracts and demographics but did not directly engage with the communities.	Helpful to provide background information and vulnerability assessment maps- but lacks community engagement
Impact of the Drought in the San Joaquin Valley of California	2015	CSU Fresno; Lynnette Zelenzky (PI), Xuanning Fu (Co-PI), and multiple additional researchers including Samendra Sherchan (FCDPH)	Drought/ drought implications focused on agricultural revenue loss, economic impact on disadvantaged communities.	No - project examines how drought implications impact disadvantaged communities in areas of unemployment, migration and low median income.	Study refers to disadvantaged communities and low income households but would be helpful to see in follow up studies how low income households have been affected by drought since 2015.
Integrated Strategies for a Vibrant and Sustainable Fresno County	2011	Geos Institute- Marni E. Koopman; Local Government Commission - Kate Meis, Judy Corbett	Climate change adaptations in Fresno County, looking at temperature, precipitation, vegetation change, wildfires. The report proposes a recommended strategy for various climate change impacts.	No	These materials are more geared towards SJV and drought planning in general but may be out of date. The stakeholder recommendations are helpful when looking at strategies for adaptation but would require further detailed/ focused more on vulnerable communities. Would be helpful to see how these strategies would be updated now and if any of these strategies have been implemented

Fresno County Health Needs Assessment	2020	Fresno County Community Health Needs Assessment Workgroup	Assessment to reach vulnerable populations and identify the causes of community health needs	Yes - many focus groups and relevant stakeholders: place-based, population based, key informant interviews and stakeholder focus groups to identify priority needs.	Helpful to see how these interviews and focus group meetings were conducted and if their priority health needs have been changed since the report. Questionnaires also provided helpful to conducting focus group interviews.
Fresno County Local Hazard Mitigation Plans	2018	County of Fresno - Dept. Public Health	Coordinate mitigation responses and reduce the cost of disaster impacts on communities such as flooding, earthquakes, landslide, erosion, fires, etc. Includes examining and updating data such as past occurrences for each hazard and natural resources available, and maps including vulnerabilities to hazards, and identify what facilities and populations are at risk.	No	Plan does not directly address any health impacts/indicators. Maps for the county and city provide a comprehensive picture of existing dams, rivers, roadways and areas at risk which would be useful when describing the vulnerability of Fresno County.
California Heat & Health Project	2016	Four Twenty Seven - Aleka Seville, Nik Steinberg,Robert Dickinson, Neil Maizlish, Claire Quiner, Linda Rudolph,Emilie Mazzacurati	Identifying how to support public health and extreme heat impact/ interviews with key informants and stakeholders/ address heat planning process and how policies across California manage extreme heat response plans, alerts, and interventions	No - interviews with key informants and stakeholders, but not vulnerable communities	Report is generalized to CA, no specific information relating to Fresno. Health impacts are not described in detail, the report focuses more on heat emergency preparedness and alert systems. Online survey questions provided to the key informants in that would be helpful for focus group interviews.