Cal-THRIVES: A California Toolkit for Heat Resilience in Underserved Environments

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Research Background and Objectives

EXTREME HEAT:

“Heat now causes more deaths than hurricanes, tornadoes or floods in most years”

The Guardian, June, 2020

“Most costly climate change impact in CA by 2050”

CA 4th Climate Change Assessment, 2018

Research objectives:

– Develop methodology to model heat resilience at neighborhood scale
– Quantify resilience benefits of passive and active measures during extreme heat waves in a disadvantaged community
– Develop a set of toolkit items to help disadvantaged community (DAC) residents better cope with extreme heat
Heat is increasingly brutal in California’s Central Valley, where low incomes, poor air quality, old homes, and high utility bills disadvantage many residents.

California and Fresno are hot... and getting hotter

22 extreme heat days/year by 2040 - 2060
55 extreme heat days/year by 2080 - 2099

Source: Climate Change & Health Vulnerability Indicators for California (CCHVIs)

There are large differences in annual distribution of heat (chronic vs. acute heat): about twice as many “very hot to extremely hot days” in Fresno and Ontario (CA), for example, than in coastal areas, and 50-100 times more days above 100 °F.

<table>
<thead>
<tr>
<th>Location</th>
<th>“Extreme heat day” threshold (°F, red line)</th>
<th>Days/yr.</th>
<th>“Very hot day” (within 5 °F of extreme heat, orange line)</th>
<th>Annual Days above “very hot day” threshold</th>
<th>Annual Days above 100 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresno</td>
<td>106.1; 10</td>
<td>101.1</td>
<td>39</td>
<td>45*</td>
<td></td>
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<tr>
<td>Ontario</td>
<td>103.6; 10</td>
<td>98.6</td>
<td>30</td>
<td>22</td>
<td></td>
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<tr>
<td>Los Angeles</td>
<td>90.5; 5</td>
<td>85.5</td>
<td>17</td>
<td>0.4</td>
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<tr>
<td>Oakland</td>
<td>88.4; 10</td>
<td>83.4</td>
<td>18</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>

*Chronically hot: Fresno days >100 °F have increased by 21% since 1960-90 to an average of 45 days per year.
The good news is that we can implement preventative strategies now to mitigate heat health impacts.

The Cal-THRIVES project has developed a toolkit for local and state stakeholders:

SHORT TERM

- Increase awareness of heat-related vulnerability
- Identify areas that are vulnerable to extreme heat events

NEAR TERM

- Remedy the built environment, such as building retrofits & increases to tree canopy
- Enhance community and home cooling programs
Approach: Our heat-resilience toolkit incorporates both community inputs and science

- Community engagement
- Cooling center optimization
- Neighborhood-scale building modeling
- Outdoor measure modeling

Heat Resilience Toolkit
- Community cooling guide
- Fact sheets
- Modeling outputs
- Heat vulnerability index tool
- Online tutorials (videos, webinars)
- Policy/program recommendations
We find **several key vulnerabilities** for residents in disadvantaged communities (DACs) in south Fresno

- Over 70% are uncomfortably hot at home very often during the summer
- Residents on the top floors and those residents in units that lack air conditioning (about 15%) are especially vulnerable
Window films, roof/ceiling insulation, and cool walls are the among the most effective passive measures overall; **natural ventilation** on top floors is very helpful.

More protection from extreme heat (bigger value)

Less protection from extreme heat (lower value)

(c) King Passive 5-Day SETUDH Relative Reduction Grid Off

*Modeled for worst case historical heat wave conditions across five days*

King & Kirk neighborhoods in Fresno
Policy and program recommendations
Heat-island countermeasures provide failsafe cooling and can be 5-10X more effective indoors than outside.

Cool roofs

Cool walls

Shade trees

We propose more stringent requirements for cool walls and cool roofs when roofs need replacement and when homes need repainting.

R. Levinson - LBNL Heat Island Group Leader
California’s building standards should be upgraded to promote extreme-heat solutions based on human outcomes (death, illness, & misery).

California’s Title 24 energy & green building standards currently focus on energy, carbon, and/or cost savings.

Standards should reward improvements to thermal safety, comfort, & productivity.
We need to **pilot and demonstrate** these promising passive and active cooling measures to determine what works best for residents.

**Examples of high impact measures:**

- Solar-control window films
- Cool walls
- Natural ventilation
- Ceiling fans
- Mini-split AC/heat pumps
To guide California’s future investments, extreme-heat mitigation programs should dedicate resources to monitoring outcomes.

Let’s learn what works by measuring:

- reductions in temperature, heat stress, illness, hospitalizations, deaths
- improvements to health, comfort, productivity, learning
We need more **equitable definitions** of extreme heat and heat waves

Consider fixed-value definitions for extreme heat and/or extreme heat waves, such as “four or more days above 100 °F,” in addition to location-dependent thresholds for extreme heat days.
We need mechanisms/programs to ensure adequate cooling in existing homes, especially in Low Income/DAC areas with older buildings.

- Most of the homes in southwest Fresno are older single-family homes (80% are pre-1980).
- We need to find mechanisms other than new building codes to cool these existing buildings, e.g.:
  - Expanding existing weatherization and low-income assistance programs
  - Requiring adequate cooling on home point-of-sale
  - Requiring cooling equipment inspection during other home inspections
Expanding weatherization audits for energy efficiency (EE) to include climate resilience is recommended for identifying homes most in need of heat resilience upgrades.

- Climate resilience audits expand the scope of existing EE audits and auditors would need additional training and well-defined protocols for privacy and data collection.
- Additional home audit checklist items might include:
  - Age of AC system, type of AC
  - Testing AC system operation
  - Collecting some demographic information about residents such as ages of residents and underlying health conditions
  - Noting risk factors for overheating – top floors, south facing windows, inoperable windows, mobility of residents, transportation options of residents
- These should feed into a ‘heat vulnerability index’ score to identify those most in need for interventions such as home cooling upgrade.
All homes should have a **minimum cooling standard** or equivalently a max indoor temperature allowed

- Our research shows homes without AC get dangerously hot and increasingly so with climate change (95-106 °F, fig. below)
- Minimum cooling standards would avoid dangerous situations and prevent worst case heat exposure to residents
- Some policy options include:
  - New homes: include in Title 24 building code or CAL-GREEN
  - Existing homes: state habitability requirements
  - Existing owner-occupied: require inspection at point of sale, or require inspection during other permitting work
- Specific requirements would be set by a consensus process similar to Title 24 approach

*Modeled for worst case historical heat wave conditions across five days*
All homes without an AC unit in Fresno should get at least one AC or heat pump (HP) unit to safely withstand extreme heat waves.

- Many homes in Fresno without an AC unit and only have swamp coolers, which are inadequate for extreme heat (fig. below)
- Homes without an AC in Fresno and other hot climate areas should be prioritized for upgrades to receive an AC or heat pump unit.
- Increased use of cooling will increase electricity consumption and additional financial assistance may be needed to avoid residents facing higher utility bills.

Modeled for worst case historical heat wave conditions across five days.
More R&D is needed to support resilient, equitable decarbonization

- Non-energy metric development and quantification of impacts to support codes and standards development
- Monitoring of installed measures and their effectiveness
- Development of “comprehensive climate assessments” to consolidate separate audits/assessments
- Decision support tools for larger scale deployment
  - E.g., tool like Home Energy Saver for extreme heat and climate resilient buildings
Thank you

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