Equity in Resiliency Evaluation and Planning:

SCE and Sandia National Labs Final Report on ReNCAT/Social Burden Index Pilot Project

Grid Resiliency and Microgrids Team, Energy Division

November 28, 2023, 9:30am – 11:30 am

California Public
Utilities Commission

WebEx and Call-In Information

Join by Computer:

https://cpuc.webex.com/cpuc/j.php?MTID=m6b225f1422f9e9dd8eab21c8bb0e645c

Join by Phone:

1-855-282-6330 (U.S. Toll Free)

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(Staff recommends using your computer's audio if possible.)

Notes:

- Today's presentations are available in the meeting invite (follow link above) and will be available shortly after the meeting on https://www.cpuc.ca.gov/resiliencyandmicrogrids.
- The presentation portion of this meeting will be recorded and posted on https://www.cpuc.ca.gov/resiliencyandmicrogrids.
- While one or more Commissioners and/or their staff may be present, no decisions will be made at this meeting.
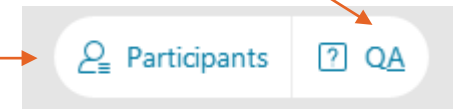
WebEx Logistics

- All attendees are muted on entry by default.
- Questions can be asked verbally during Q&A segments using the "raise hand" function.
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  - If you have another question, please "re-raise your hand" by clicking on the "raise hand" button twice.
- Questions can also be written in the Q&A box and will be answered verbally during Q&A segments.
- Closed Captioning can be turned on by clicking the "cc" button the lower left of your screen.
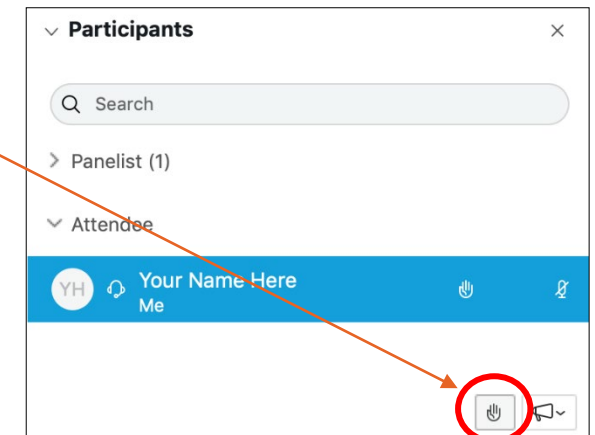
WebEx Tip

Access the written Q&A panel here

1. Click here to access the attendee list to raise and lower your hand.

Participants   ? QA

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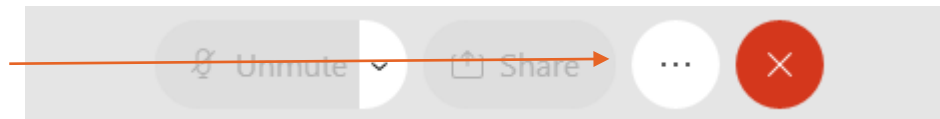
Energy Division Workshop Series on Resiliency

- ✓ **May 10, 2022** - Interruption Cost Estimate (ICE) Calculator/Power Outage Economic Tool (POET)

- ✓ **July 7, 2022** – Sandia National Labs – Resiliency Node Cluster Analysis Tool (ReNCAT) and the Social Burden Index

- ✓ **May 10, 2023** – Lumen Energy Strategy (CEC EPIC funded) – 1st of 3 workshops – Resiliency Standards: Definitions

- ✓ **July 26, 2023** – SCE/Sandia (DOE funded) Kickoff ReNCAT/Social Burden Index Pilot Project (Phase 1)

- ✓ **August 22, 2023** – LBNL (DOE funded) – Final Reporting on Data Schema Pilot project

- ✓ **September 5, 2023** – Lumen Energy Strategy – 2nd of 3 workshops – Resiliency Metrics

- ✓ **October 19, 2023** – SDG&E and Sonoma County Junior College District - Use Case Demonstration of 4-Pillar Methodology

- ✓ **November 8, 2023** – Lumen Energy Strategy (CEC EPIC funded) – 3rd of 3 workshops – Resiliency Methodologies

- ❑ **November 28, 2023** – Final Report: SCE/Sandia (DOE funded) ReNCAT Pilot Project (Phase 1) ← **today's event**

Agenda

I. **Introduction** *(CPUC Staff)*   9:30a – 9:35a

- WebEx logistics, agenda review

II. **Opening Remarks, Commissioner Shiroma**   9:35a – 9:40a

- Background and Context *(CPUC Staff)*   9:40a – 9:50a

III. **Evaluating Social Burden in California: Final Results** *(Sandia National Labs and SCE)*   9:50a – 11:20a

- Q & A

IV. **Closing Remarks, Commissioner Shiroma**   11:20a – 11:30a

- Provide information on upcoming workshops *(CPUC Staff)*

Opening Remarks

Background and Context

4-Pillar Methodology of Equitable Resiliency Evaluation and Planning

I. Baseline Assessment
1) Define geographical area of study
2) Define load tiers or resilience categories (Critical, Priority, Discretionary)
3) Identify minimum resiliency targets within load tiers (e.g. 100% Critical, 30% Priority, 0% Discretionary)
4) Define hazards to consider (All-Hazard assessment, analysis, ranking, weighting)
5) Conduct assessment of current resiliency when disrupted from Hazard 1, Hazard 2, Hazard 3 (according to Hazard assessment)
6) Results of resilience assessment – Identify resiliency deficits and priorities and resiliency metric reporting of baseline levels

II. Mitigation Measure Assessment
1) Identify potential mitigation measure options
2) Assess ability of each mitigation option to reach resiliency targets for Hazard 1, Hazard 2, Hazard 3
3) Compare costs of each mitigation option to reach resiliency targets for Hazard 1, Hazard 2, Hazard 3

III. Resiliency "Scorecard"
1) Resiliency Scorecard is a suggested tool that provides a basic benchmark of achievement but recognizes that more can be done.
2) Scoring reflects resiliency configuration characteristics.
3) Scoring system provides for different areas of improvement (e.g. 100% resilience targets are met, but configuration uses 70% fossil fuel resources to meet those targets, improvement would be to decrease fossil fuel resources while maintaining targets. Would result in a higher "score."

IV. Resiliency Response Assessment (computer modeling or post-disruption approach)
1) Conduct Baseline Assessment (1-6).
2) After implementation of chosen mitigation measure option, conduct annual data collection of Resiliency Metrics,
3) Assess achievement of resiliency targets and any changes in community impacts

4-Pillar Methodology of Equitable Resiliency Evaluation and Planning

I. Baseline Assessment
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2) Define load tiers or resilience categories (Critical, Priority, Discretionary)
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4-Pillar Methodology
I. Baseline Assessment – Detailed Steps

Based on:
- Electrical infrastructure
- City or County Lines
- Project scope
- Local/Tribal Gov't Hazard Mitigation plans

Identify:
- Resource availability/ limitations such as land available, zoning, current generation and/or storage
- Commercial and industrial economy
- Wealth disparities
- Population demographics and needs

Map:
- Critical Facilities, Critical Infrastructure, Essential service assets, C & I, retail, residential

1. Define Geographical Area of Study

2. Define Load Tier Assets: Critical, Priority, Discretionary

Load Tier assets example:
- Critical:
  Critical Facilities, Critical Infrastructure, Medical Baseline, Emergency 1st Responder systems, DAC, VC, Food Banks, Evacuation Centers
- Priority
  Essential services such as gas stations, charging stations, banks, food supply chain: grocery stores, food distribution centers, agricultural centers
- Discretionary
  Commercial/Industrial, Retail stores, residential neighborhoods, recreational centers

- Who defines what is in these Load Tier assets? Collaboration between:
  - ❖ Local Government/Tribes
  - ❖ IOUs
  - ❖ Developers

3. Identify Resiliency Targets in Load Tiers

- Resilience duration required
- Maximum duration of outage to withstand
- # and % of Critical, Priority and Discretionary loads served
  - # of Critical Facilities
  - # of Emergency Services
  - # of Critical Infrastructure
  - # of Community Resource Centers
  - # of Essential Services
  - # of Cumulative Customers without power

4-Pillar Methodology
I. Baseline Assessment – Detailed Steps

- **For defined geographical area:**
- Determine primary disruptive hazards within geographical scope, apply weightings and rankings according to probability, magnitude, geographical impact and economic impact
  - Climate Change hazards such as:
  - Extreme weather,
  - Sea level rise
  - Cybersecurity hazards
  - Physical attack hazards

- Identify impact on Load Tier Assets

- Who conducts all-Hazard assessment?:
  - Cities, Counties, Local Government
    o Hazard Mitigation Plans
    o UNDDR Disaster Resilience Framework for Cities/Counties
  - IOUs
    o RAMP (modified)

4. Conduct All-Hazard Assessment for defined geographical area

5. Conduct current Resiliency Assessment baseline of Load Tiers

For each hazard (in ranking/ weighted order):
- Graph *historical* load not served (CAIDI w/MED) over time for geographical scope
- Graph *projected* load not served (CAIDI w/MED) over time for geographical scope
- Identify impacts on resiliency targets
- Evaluate utility costs of Energy Not Served
- Evaluate public costs of Energy Not Served
  ❖ Interruption Cost Estimator (ICE)*
  ❖ Value of Service estimates *
  * with updated surveys

From results of Baseline Assessment:
- Identify priority resilience deficits
- Identify resilience priorities
- Identify resilience metrics to assessment mitigation impacts

6. Results of Resiliency Baseline Assessment

Evaluating Social Burden in California: Final Results

Value of Resiliency : Economic and Equity Impacts of Large Disruptions – Social Burden Index

Sandia: Olga Hart, Amanda Wachtel, Darryl Melander

SCE: Anna Brockway, Stephen Torres

November 28, 2023

AGENDA

Introductions

Acknowledgements

This project was made possible by a partnership between Sandia National Laboratories, the California Public Utilities Commission, and Southern California Edison.

The following people contributed directly to the work being presented today:

Sandia National Laboratories: Olga Hart, Amanda Wachtel, Darryl Melander

California Public Utilities Commission: Rosanne Ratkiewich, Julian Enis

Southern California Edison: Anna Brockway, Martin Blagaich, Alexandria Chwierut

Project Overview

Project Motivation: Developing an Equity Metric for Energy Resilience Planning in California

- **Sandia National Laboratories (Sandia), Southern California Edison (SCE), and the California Public Utilities Commission (CPUC) investigating how utilities could consider resilience needs within current infrastructure investment planning**

- Sandia, SCE, and CPUC are **investigating the use of Sandia's *Social Burden* metric in California** as a pilot metric reflecting equity considerations for energy resilience planning

Expected outcomes:
- ✓ Identifying use cases for the metric
- ✓ Documenting benefits and drawbacks
- ✓ Understanding use case applications

Potential use cases:
- ✓ Informing IOUs during the grid planning process
- ✓ Informing stakeholders about project prioritization
- ✓ Allowing the CPUC to assess regulatory considerations that include ESJ Action Plan items

Project Overview

In Scope:

✓ This project considers **resilience and equity,** two important considerations within energy planning

✓ *Informing* decision making

Out of Scope:

✕ **Other facets of energy planning**, including but not limited to, reliability, rate affordability and decarbonization

✕ *Making* investment decisions

Project Overview

Phase 1 – Baseline Evaluation	Phase 2—Mitigation Measure Optimization	Phase 3—Options Evaluation
• Collect data • Evaluate the current state of one IOU territory • Educate stakeholders on tools and metrics • Scope data needs for Phase 2	• Collect data • Build optimization model for one IOU territory • Provide analysis of targeted locations for resilience investments	• Refine model for use in evaluating proposed projects • Work with stakeholders to integrate tool into workflow

Background

Electricity outages can have severe consequences

Health and Safety

- Loss of heating/cooling
- Medication spoilage

Daily life

- Communications challenges
- Cooking difficult
- Entertainment unavailable

Productivity

- Damage to equipment
- Loss of perishables
- Lost computing time
- Unsafe work conditions

A **resilient energy system** *supports critical community functions* by preparing for, withstanding, adapting to, and recovering from disruptions

Equity and resilience are interdependent

Resilience is a component of equity

- Cannot have a truly equitable energy system if some communities are more resilient than others

However, equity is also a component of resilience

- Energy system is embedded in communities (social) and within other (physical) infrastructures
  - Embedded social inequalities independent of the energy system also impact equity

- Inequities are vulnerabilities

- Vulnerabilities reduce resilience

- Can escalate events from local concern to national security priority
  - e.g., New Orleans, Puerto Rico

Equity   Resilience

Planning & Prevention   Acute Disruption

Recovery & Adaptation   Chronic Degradation

Community Resilience   WHO   National Resilience
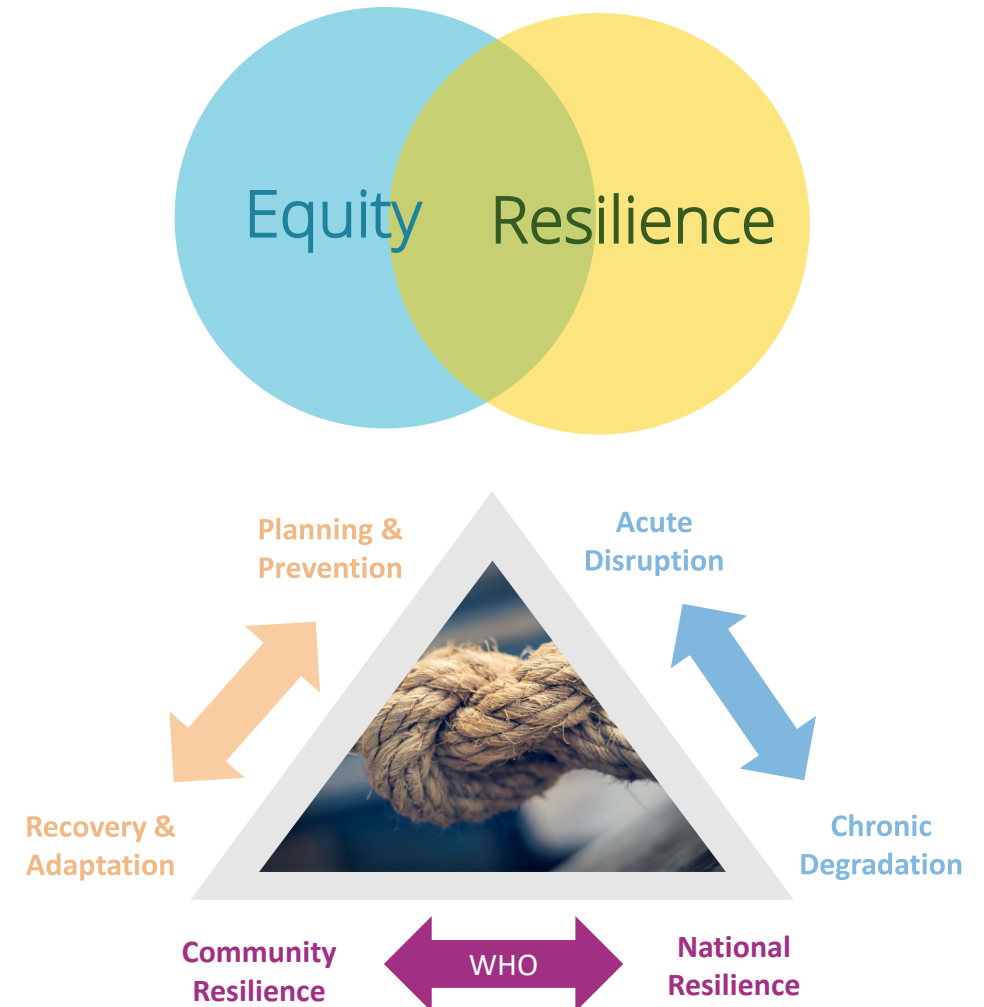
The goal of energy resilience planning

The goal of energy resilience planning is to minimize the **_impact_** of events that can trigger grid outages

Resilience planning aims to:

1. Reduce frequency of outages (**withstand** _the disturbances_)
2. Reduce duration of outages (**_recover rapidly_**)
3. Reduce the impact of outages (**adapt** _physical and social systems_)
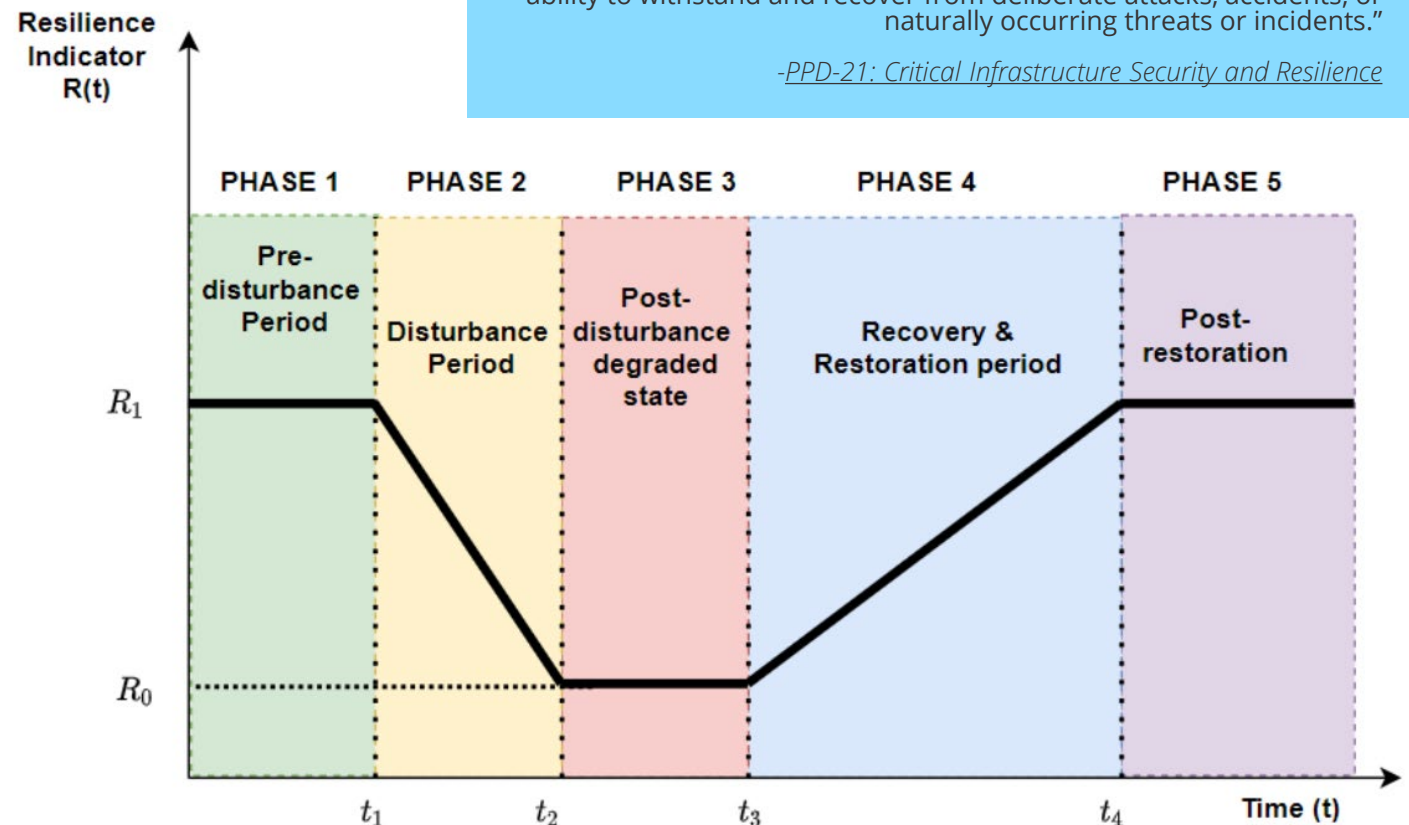
Image source: Panteli, M., Mancarella, P., Trakas, D. N., Kyriakides, E., & Hatziargyriou, N. (2017). Metrics and Quantification of Operational and Infrastructure Resilience in Power Systems. IEEE Transactions on Power Systems. https://doi.org/10.1109/TPWRS.2017.2664141

Reliability and Resilience exist on a continuum

Reliability focuses on the high probability, low-impact events

Resilience focuses on low-probability, high-impact events

Histogram of Customer Minutes Interrupted, Selected Causes

common objective: minimize outage impacts
major challenge: how to address both without "gold plating" infrastructure

The Resilient Node Cluster Analysis Tool (ReNCAT)

one tool x **two** capabilities x **three** applications:

Social Burden Evaluation

What is the Blue-Sky and Black-Sky burden if nothing is done?

Microgrid Optimization

How should microgrids be formed to minimize burden & cost

Proposal Evaluation

What impact will existing proposals have on burden?
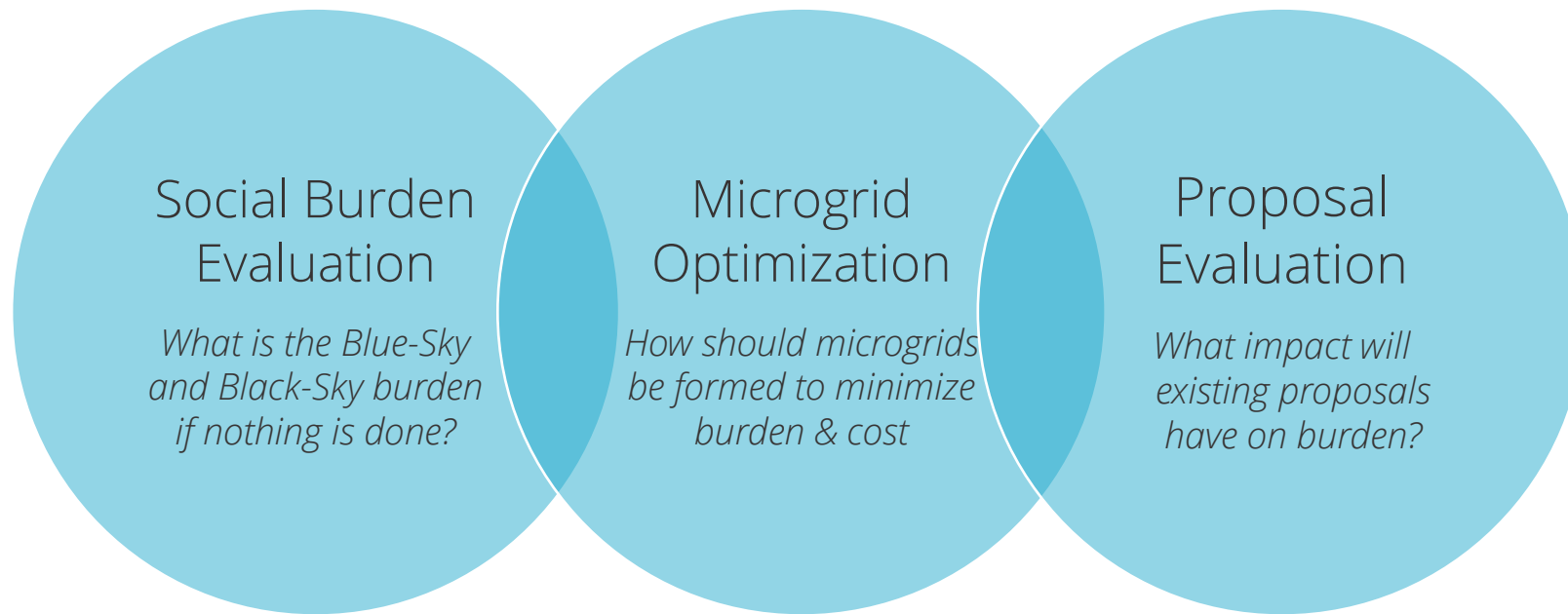
Can be mixed and matched depending on data availability, study questions, and project needs.

What is Social Burden

Social Burden is a measure of: **equity** in service availability vs baseline capacity; **resilience** to disruption in service access

- ✓ Service Availability
- ✓ Accessibility
- ✓ Social Capacity

Social Burden

"Blue-Sky" Scenario: Grid Powered, All Available Facilities "ONLINE"

"Black-Sky" Scenario: Grid Outage, Some /All Facilities "OFFLINE"

SCE's Climate Adaptation and Vulnerability Assessment (CAVA)

- California's first CAVA, filed on May 13, 2022

Analyzed impacts of changing climate patterns...
- Temperature
- Precipitation
- Sea level rise
- Wildfire
- Cascading events

...on SCE's
- Assets
- Operations
- Services

- Developed **equity tools** in consultation with communities to help determine *where* adaptations need to be prioritized and *what* adaptations we would utilize

- Near-term climate adaptation measures are requested in recently-filed 2025-2028 General Rate Case

For CAVA, CPUC directed SCE to:
- Analyze how to promote equity
- Consult Disadvantaged and Vulnerable Communities (DVCs) in determining levels of adaptive capacity
- Allow Community Based Organizations (CBOs) and DVC members to participate in the vulnerability assessment

SCE utilized opportunity to develop unique methods to best meet CAVA goals
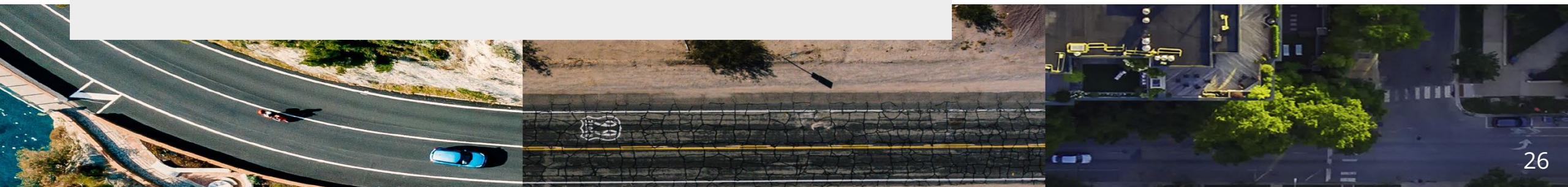
Social Burden Inputs and Assumptions:
Southern California Edison's Community Resilience Metric

Two equity metrics formalized to pilot prioritization and adaptation impacts for communities

Community Resilience Metric (CRM)
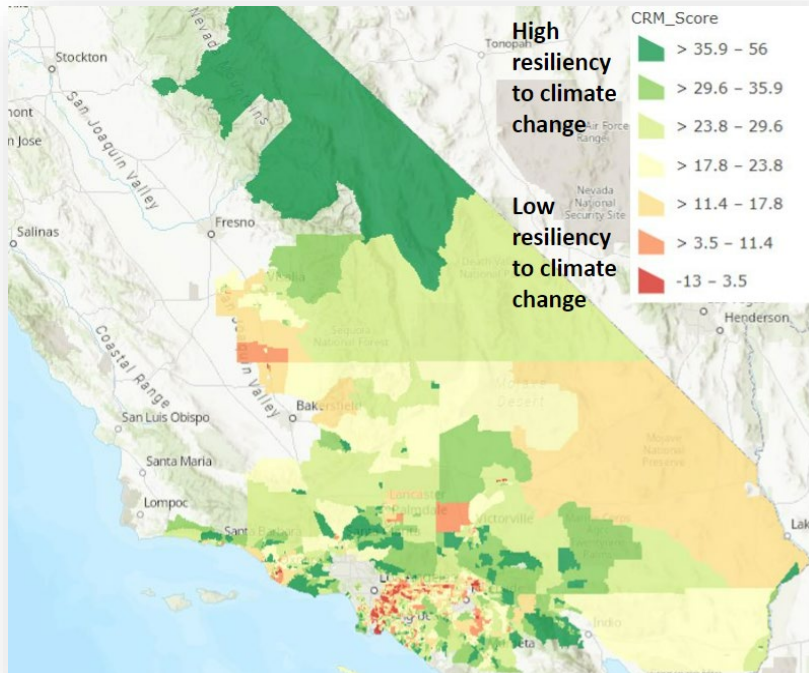
A set of scores measuring the sensitivity and corresponding adaptive capacity of a particular community to potential loss of utility service

Community Impact Metric (CIM)

CIM Metric	Community Burdens	DVC Cost / Benefit Ratio	Interrupted Elec. Service Resolution	Non-Reliability Public Benefit	Local Employment Impact
Adaptation Option 1	🟥	🟩	🟩	🟨	🟩
Adaptation Option 2	🟨	🟩	🟨	🟩	🟩

Set of indicators measuring the positive, negative or neutral effect of an adaptation action on the community it is deployed in

Social Burden Inputs and Assumptions: Southern California Edison's Community Resilience Metric

Community Resilience Metric (CRM):

Where do we build adaptations first?

Prioritizes the timing/order of adaptations based on socioeconomic indicators that approximate a **community's resilience to power outages**

Sensitivity **(negative value)** + Adaptive Capacity **(positive value)** = Community Resilience Score

Sensitivity: The degree to which a community is affected by power outages

Adaptive Capacity: The ability of the community to adjust, moderate damages, and cope with consequences of power outages
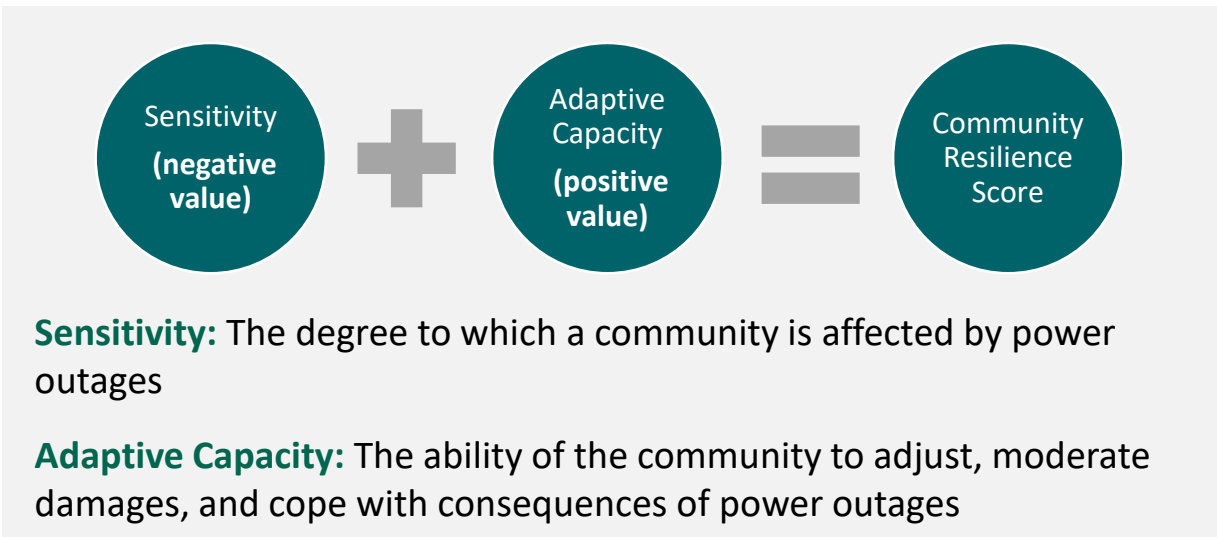
Example:

There is a heat wave in my neighborhood.
I am elderly, however, my community has organized a program to transport residents to Cooling Centers

Sensitivity   Adaptive Capacity

CRM_Score
- > 38.2 - 56
- > 32.5 - 38.2
- > 27.2 - 32.5
- > 22.2 - 27.2
- > 17 - 22.2
- > 11.2 - 17
- > 3.5 - 11.2
- -13 - 3.5

High resiliency
Low resiliency
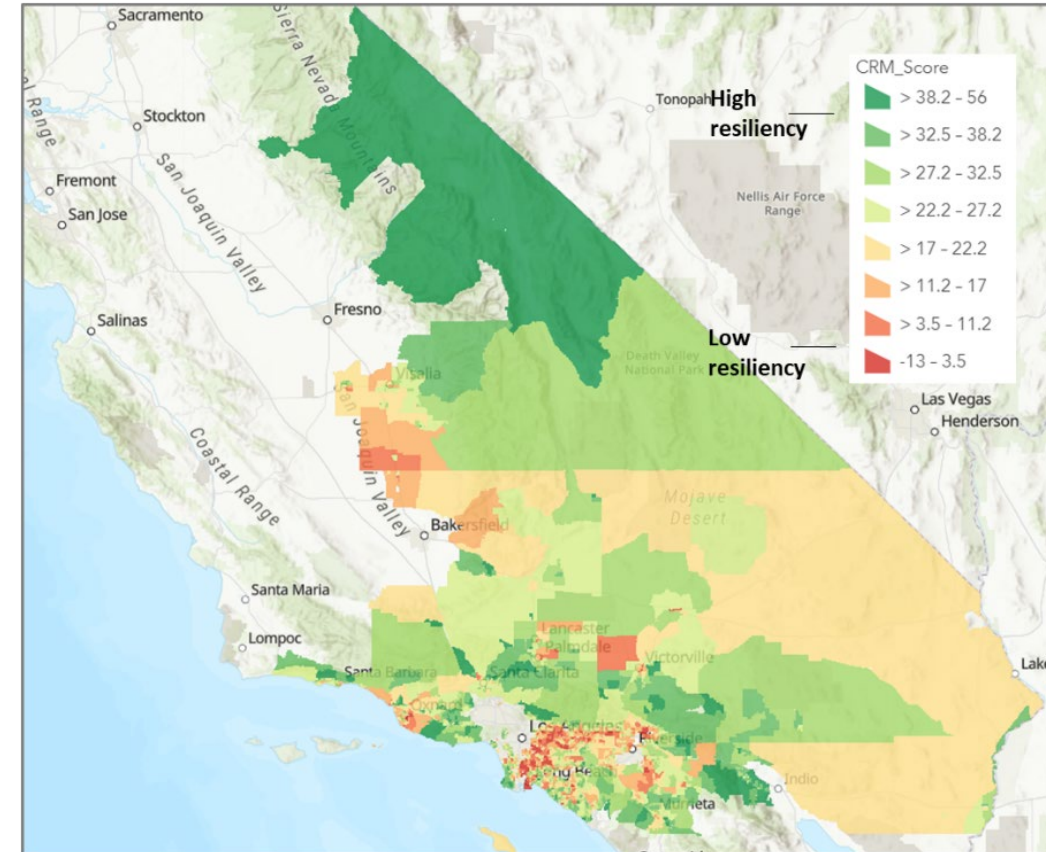
Assigns a score to each census tract based on 12 indicators of Adaptive Capacity and 25 indicators of Sensitivity

Social Burden Inputs and Assumptions:
Southern California Edison's Community Resilience Metric

Community Resilience Metric Methodology

- Indicators are equally weighted within each domain and combined to get final scores
- Data pulled from California's Healthy Places Index, CalEnviroScreen, and the U.S. Census
- Factors, weighting, and results were reviewed with community leadership groups and communities through surveys

Sensitivity Indicators

Built Environment	Health	Housing	Socio-Economic
CalEnviroScreen Pollution Burden*	Asthma	Group Quarters	Educational Attainment
Noise Pollution	Cardiovascular Disease	Housing Burden	Elderly Living Alone
	Children	Housing Quality	Foreign Born
	Diabetes	Mobile Homes	Linguistic Isolation
	Disability	Renters	Outdoor Workers
	Health Insurance		Poverty
	Medical Baseline		Race/Ethnicity
			Rural Communities
			Single Female Head of Household
			Tribal and Indigenous
			Unemployment

Adaptive Capacity Indicators

Community Built Environment	Governance and Services	Individual Built Environment	Transportation
Permeable Surface Cover	Cooling Centers	Air Conditioning	Transit Access
Tree Canopy/ Green Space	Emergency Services/ Responders	Telecommunications Access	Vehicle Access
	Medical Facilities		
	Planning Level		
	Supermarket Access		
	Voters		

Ability score is meant to represent how difficult it is to reach available services and deal with sudden changes in the environment.

The CRM is a useful proxy for ability score as it captures underlying characteristics that represent population wellbeing and dimensions that income alone cannot capture.

*The Built Environment domain under Sensitivity is the only domain for which all indicators are not weighted equally.
The CalEnviroScreen Pollution Burden score is weighted as 12/13 while the Noise Pollution score in weighted as 1/13.
This is due to the fact that the CalEnviroScreen score is weighted value representing 12 relevant pollutants.

$$Social\ Burden =$$

$$\frac{Effort\ to\ Obtain\ Service_{people,services}}{Service\ Levels_{facilities,services} \times Baseline\ Capacity_{people}}$$

Inputs and their proxies must be:
- Quantitative (numeric)
- Available at meaningful spatial scales
- Conceptually congruent

Existing Social Burden Formulation: Common Implementation

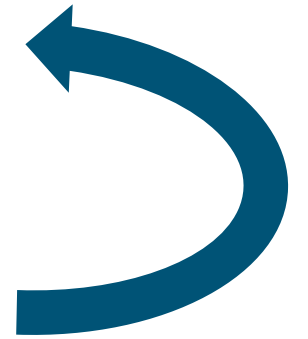Distance from the centroid of census block groups to facilities estimates effort
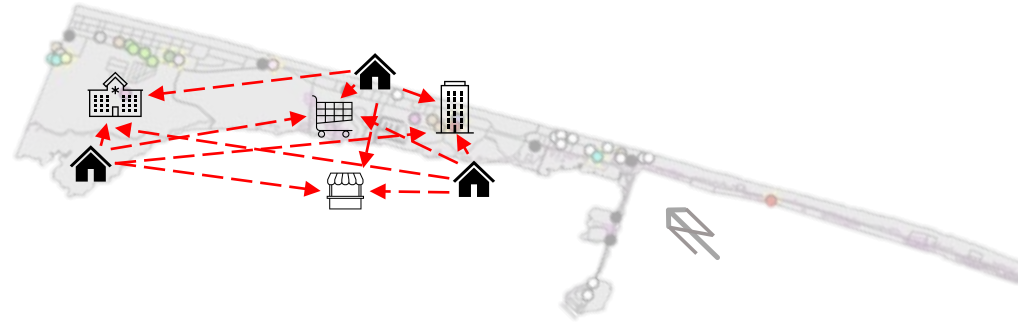
$$SB = \frac{Distances\ to\ Services_{people,services}}{Service\ Levels_{facilities,services} \times Median\ Household\ Income_{people}}$$
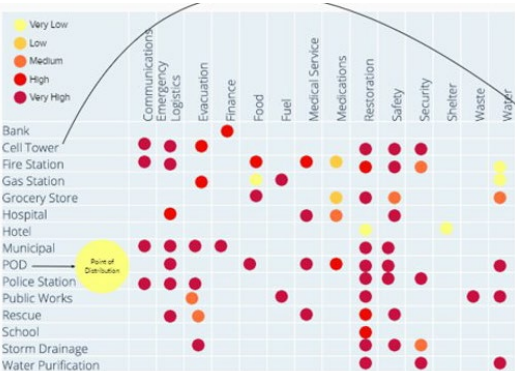
Baseline Capacity frequently approximated using Median Household Income

$172k
$57k
$228k
$43k
…

These proxies can be tailored when needed

Integration of the Community Resilience Metric into Social Burden
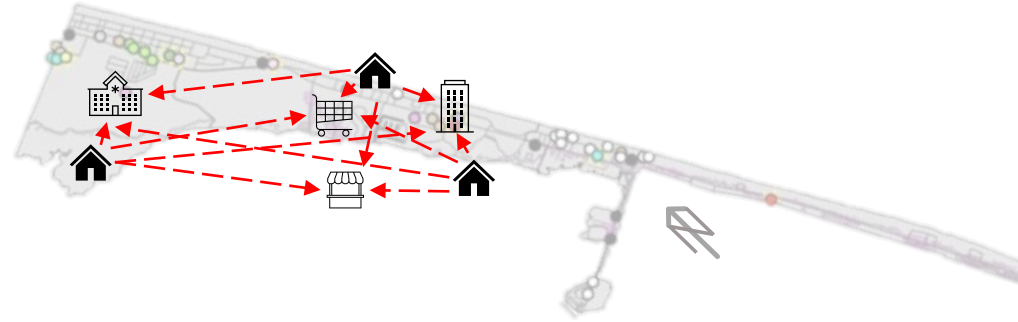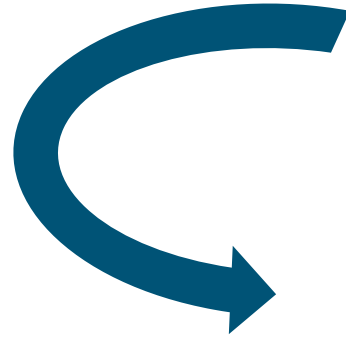
$$SB = \frac{Distances\ to\ Services_{people,services}}{Service\ Levels_{facilities,services} \times CRM}$$

$$\begin{bmatrix} -5.8 \\ 0 \\ +42.7 \\ -1.3 \\ \ldots \end{bmatrix}$$
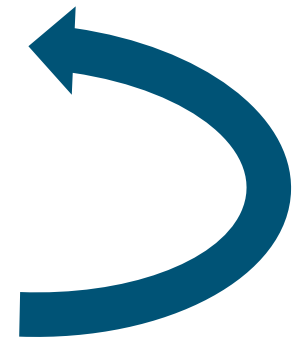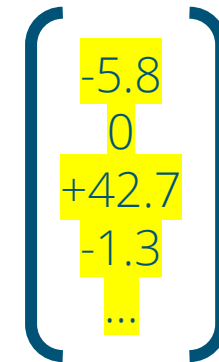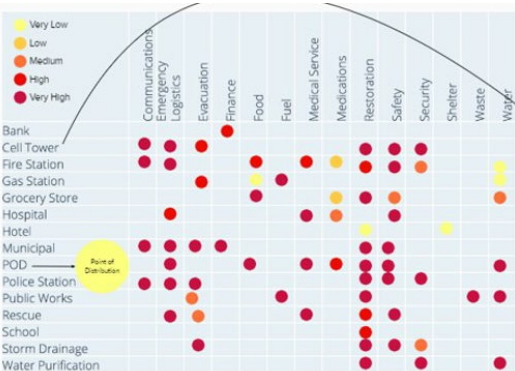
✓ Definition of CRM as a composite of community adaptive capacity and sensitivity paints more complete, multi-faceted picture of baseline capacity; CRM is quantitative and data available at spatial scales that is appropriate with some transformation

Social Burden Inputs and Assumptions

An analysis of Social Burden requires information about how *facilities* are providing *critical services* to *people*.

- Facilities:
  - Locations: open-source datasets
  - Service Levels: Sandia
- Services:
  - List: Sandia
  - Service to Facility Sector Mapping: Sandia, validated with SCE
- People:
  - Spatial Resolution: Census Block Groups
  - Population Counts: US Census
  - Attainment Factors: **SCE Community Resilience Metric as proxy**

Basic Facility Data
- *Location*
- *Sector*

Population Data
- *Census Blocks*
- *Equity Criterion*

Burden Parameters
- *Service levels*
- *Effort parameters*

Power Scenario
- *Which facilities have power?*

Facilities considered for Social Burden analysis are those that provide critical services to people within the study area.

54 types of facilities were considered in this study.

Facilities in Study Area

Air Ambulance	Drinking Water Access Point	Landfill	Public Airport
AM Tower	EMS	Local Law Enforcement	Public Safety Comms
ATM	Emergency Operations Center	Metro Station	Rail O&M Yard
Bank Branch	EV Charging Site	Microwave Tower	Rail Station
Bus Station	Fast Food	Military Airport	Retail Superstore
CalTrans Maintenance Facility	Ferry Terminal	Money Transfer	Service Center
Car Rental	Fire Station	Motel	Sewer Pump
Cellular Tower	FM Tower	Natural Gas Facility	Sewer Treatment Plant
Clinic	Food Bank	Official Shelter	Supermarket
Convenience Store	Gas Station	Oil Refinery	Urgent Care
Cooling Center	Greengrocer	Pharmacy	VA Medical Facilities
Cruiseline Terminal	Grocery	POD	Water Purification
	Hospital	Port	Water Storage Tank
	Hotel	PSAP	Water Tower
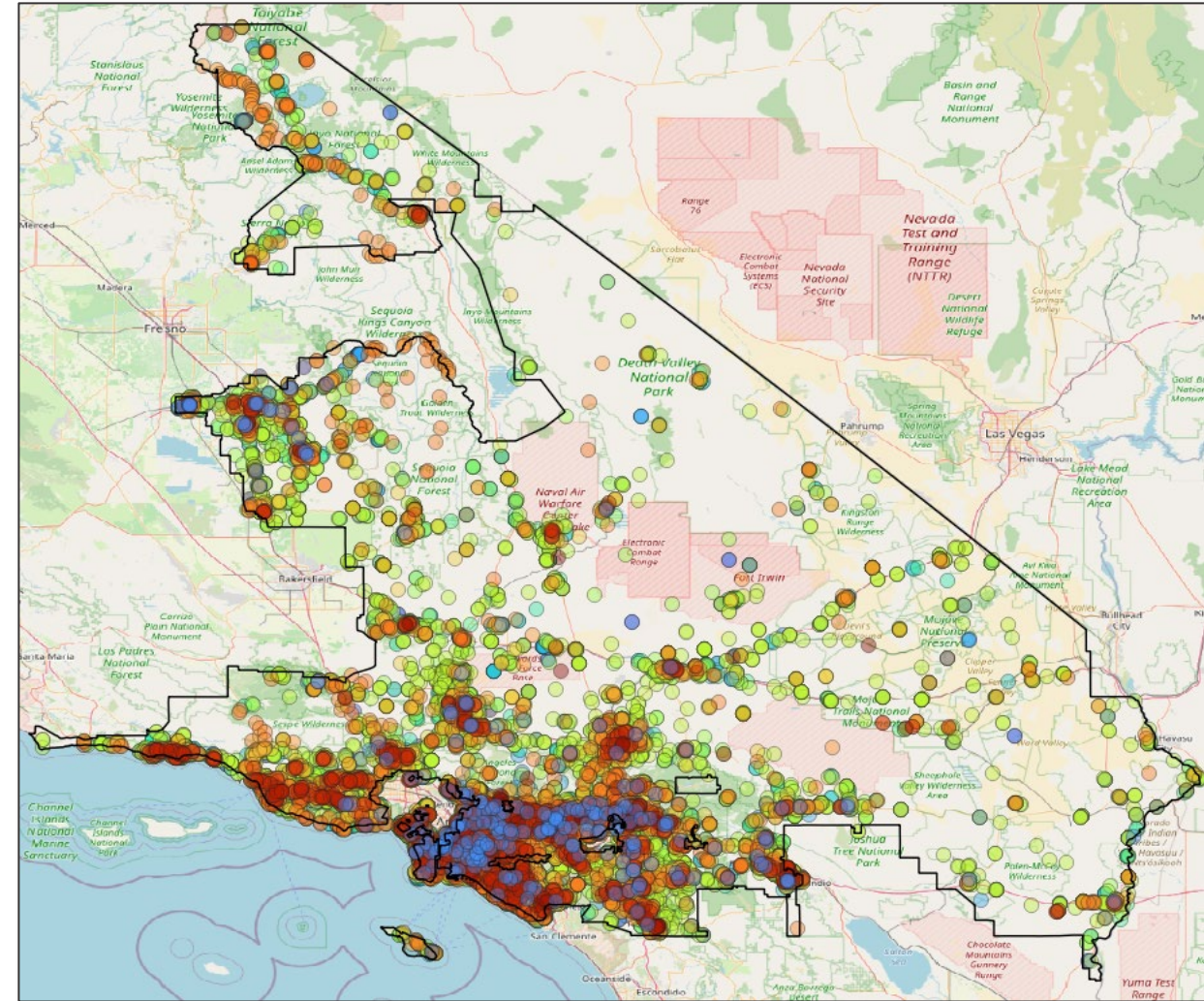
Social Burden Inputs and Assumptions: Facilities

Category	Primary Service	Facility Type
Emergency Services	Evacuation	Emergency Operations Center
	Emergency Logistics	Point of Distribution, Public Safety Answering Point (PSAP), Public Safety Communication Sites
	Medical Services	Hospital, Urgent Care, VA Medical Facility, EMS, Air Ambulance, Clinic
	Security	Local Law Enforcement
	Safety	Fire Station
Basic Needs	Shelter	Official Shelter, Unofficial Shelter, Evacuation Site, Cooling Center, Hotel, Motel
	Food	Food Bank, Convenience Store, Greengrocer, Grocery Store, Supermarket, Retail Superstore, Fast Food
	Water	Water Storage Tank, Water Purification Main Office, Water Tower, Drinking Water Access Points
	Medications	Pharmacy
	Finance	Bank Branch, ATM, Money Transfer

Category	Primary Service	Facility Type
Critical Infrastructure	Communications	AM/FM Transmission Tower, Cellular Tower, Microwave Tower
	Electricity	Service Center
	Waste Management	Landfill, Sewer Pump, Sewer Treatment Plant
Mobility	Transportation	Port, Public Airport, Military Airport, Metro Station, Bus Station, Car Rental, Cruiseline Terminal, EV Charging, Ferry Terminal, Rail Station, CalTrans Maintenance Facilities, Rail Yard
	Fuel	Oil Refinery, Gas Station, Natural Gas Facility

Social Burden Inputs and Assumptions: Services

Critical Services are those services that people need on a recurring basis in their day-to-day life for their health, safety, and well-being.

15 different kinds of critical services were considered in this study.

In alphabetical order:

- Communications
- Emergency Logistics
- Evacuation
- Finance
- Food

- Fuel
- Medical Service
- Medications
- Restoration
- Safety

- Security
- Shelter
- Transportation
- Waste Management
- Water

Social Burden Inputs and Assumptions: People

Social Burden analysis requires 3 pieces of information about **people**:

- Where they are *relative to where facilities and services are*

- How many people there are and *how they are distributed across the study area*

- How some relevant *equity criterion* is distributed across the study area

The **equity criterion** is represented in Social Burden analysis by an *Attainment Factor*.

- The Attainment Factor is a quantitative measure of some proxy variable that accounts for the key aspects of vulnerability and/or capacity, that make obtaining critical services more difficult for some members of the community than others.

In this study, Sandia integrated the Southern California Edison **Community Resilience Metric** as the Social Burden "*Attainment Factor*" (equity criterion).

Project Results

Baseline State ("Blue-Sky")

The Baseline, or "Blue-Sky", scenario represents the state of the world when the power grid is fully operational.

- **All facilities in existence are powered. They are assumed to be providing full service to people.**

During this state, social burden is at its lowest.

The state of the power system is not introducing any *additional* burden beyond that which already exists as a function of the availability and accessibility of critical services in the study area, and people's differing abilities to obtain those services.

"Blue-Sky" Scenario: Grid Powered, All Available Facilities "ONLINE"

Baseline State ("Blue-Sky" per capita Social Burden)

facilities × services

Facilities in Study Area

CRM Percent Rank
- 0th - 20th percentile
- 20th - 40th percentile
- 40th - 60th percentile
- 60th - 80th percentile
- 80th - 100th percentile

people

×

Social Burden Percent Rank
- 0th - 20th percentile
- 20th - 40th percentile
- 40th - 60th percentile
- 60th - 80th percentile
- 80th - 100th percentile
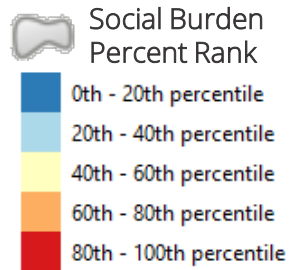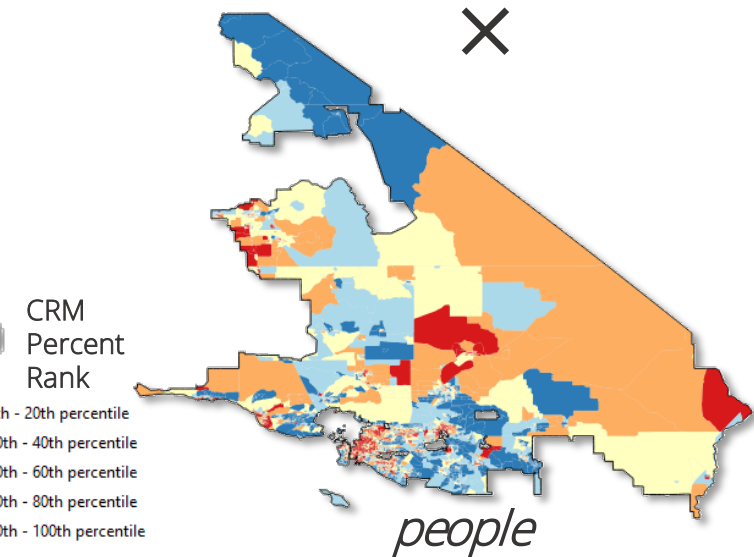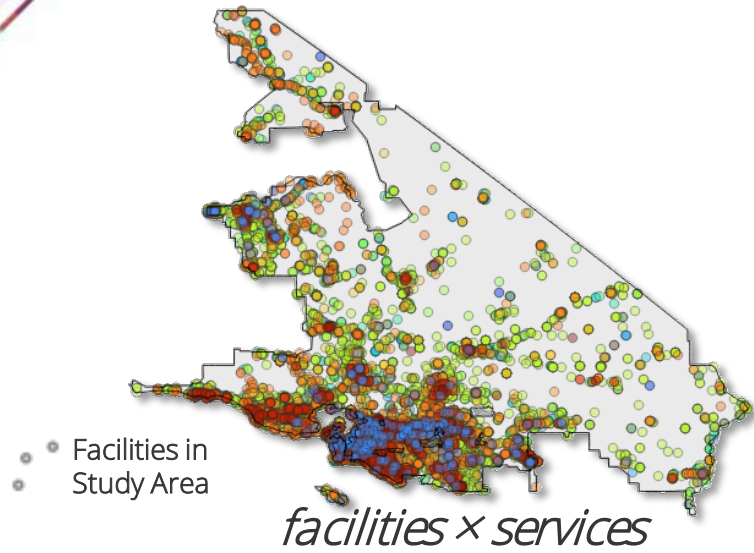
Worse ▮▮▮▮▮ Better

Social Burden

Baseline State ("Blue-Sky" per capita Social Burden)

Worse ▮▮▮▮▮ Better

Social Burden
Percent Rank

- 0th - 20th percentile
- 20th - 40th percentile
- 40th - 60th percentile
- 60th - 80th percentile
- 80th - 100th percentile
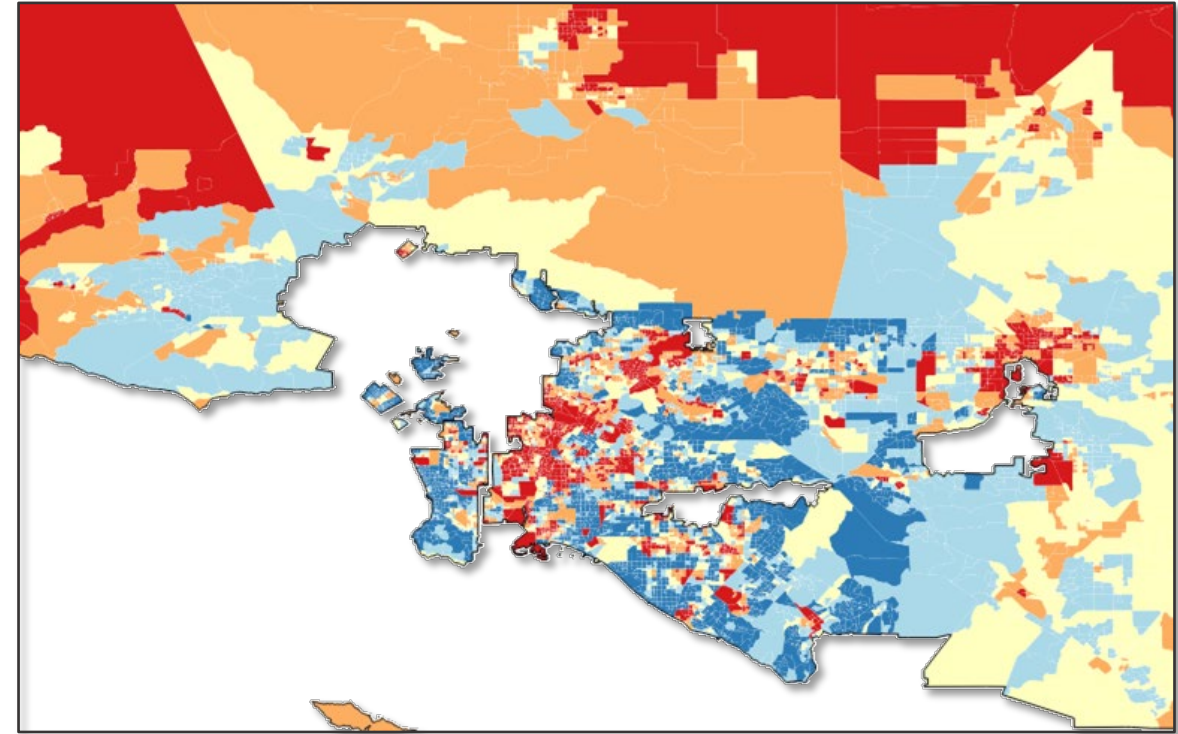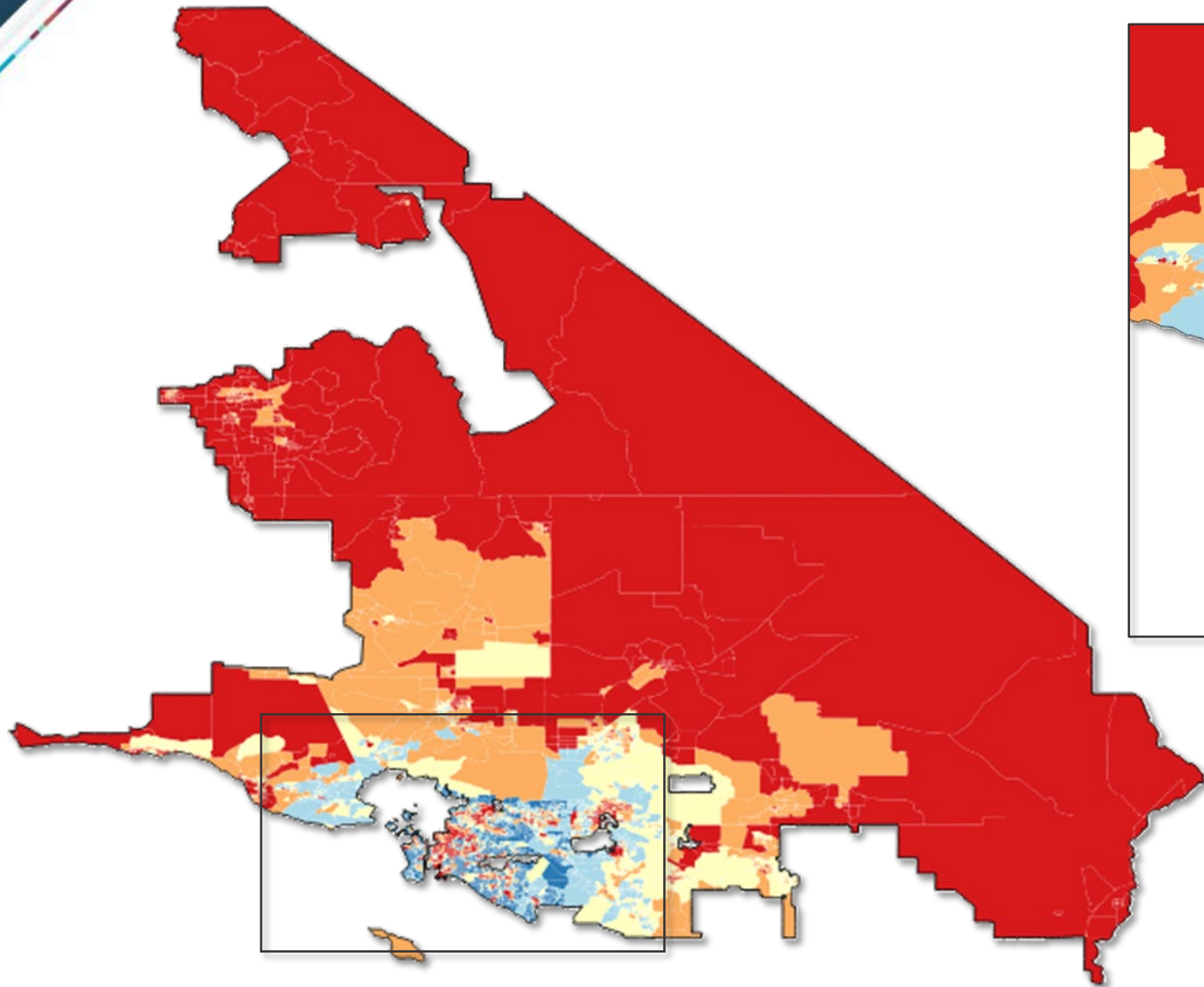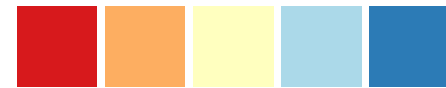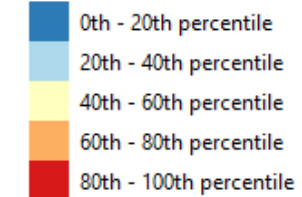
Hypothetical Power Outage Scenario ("Black-Sky")

The hypothetical outage (or "Black-Sky") scenario represents a situation in which certain parts of the study area lose grid power.

- All facilities **within** the outage boundary are no longer powered. They **stop providing services**.

- All facilities **outside** the outage boundary continue to be powered. They **continue to provide services at their baseline levels.**

- **No backup generation resources were modeled.**

A "Black-Sky" scenario in Social Burden analysis can represent any partial or total outage on the grid.

- **In this study**, the outage scenarios were based on Southern California Edison CAVA analysis.

"Black-Sky" Scenario: Grid Outage, Some/All Facilities "OFFLINE"
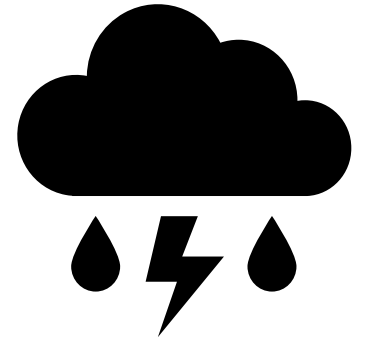
Hypothetical Power Outage Scenario ("Black-Sky")

Accounting for electricity outages in Social Burden analysis

	Baseline state "Blue Sky"	**Hypothetical large outage scenarios** "Black Sky"	**Targeted outage scenarios** Not in Phase 1, potential for Phase 2
Assumption	All facilities and customers have power	Illustrative scenarios meant to test social burden tool response rather than depict expected outage, e.g.: • A climate event causes a blanket outage for a significant number of customers, and normal system redundancies fail to restore many customers	Localized scenarios that SCE would consider deploying adaptation solutions to address, stemming from e.g.: • Equipment failure causes limited outages • Climate event causes larger outage but system redundancies work normally to isolate affected area
Outage assumptions	No outages	Deterministic, customers either have power or not	Deterministic, customers either have power or not
Status	Preliminary results available across SCE's territory	Preliminary results available for a limited set of hypothetical scenarios	Targeted scenarios will need to be developed for specific climate events • Caveat: duration of outage assumptions
Potential Use	Inform further resilience analysis within service territory	Tool testing and uncovering gaps for refinement in following phase(s)	Social Burden benefit comparison of alternative adaptation investments

Hypothetical Power Outage Scenario ("Black-Sky")

Multiple hypothetical large outage scenarios developed to understand tool response and effectiveness of Social Burden application

Goal: several small-scale **hypothetical** outage scenarios in different parts of the territory

- Chosen from scenarios developed for CAVA analysis
- 4 from 13 existing heat outage scenarios
- 4 from 14 existing flood outage scenarios

When selecting, consider range of:

- CRM scores of affected CBGs
- Customer diversity (urban vs rural, reservations)
- Vehicle and road access
- Number of customers without power (accounts)

While not all factors will be utilized in Social Burden calculation, specific scenarios will help guide SCE review of application effectiveness

Hazard	Scenario	County	CRM	Rural	Accounts	IWMS Risk
Temperature	Nelson	Riverside	high	low	medium	medium
Temperature	Peyton	San Bernardino	high	low	medium	medium
Temperature	Rio Hondo	Los Angeles	low	low	high	low
Temperature	Wimbledon	San Bernardino	low	low	low	low
Flood	1	Orange	high	low	medium	high
Flood	3	Ventura	low	low	high	low
Flood	11	Ventura	medium	medium	low	high
Flood	13	Orange	medium	low	medium	low

GIS outline of outage scenarios provided to Sandia

Esri, CGIAR, USGS, City of West Covina, County of Los Angeles, California State Parks, Esri, HERE, Garmin, FAO, NOAA, USGS, Bureau of Land Management, EPA, NPS

*IWMS: Integrated Wildfire Mitigation Strategy defines 3 risk tranches (Severe Risk, High Consequence, and Other) based on wildfire burn, consequence, and road availability. IWMS is included here for its measure of road availability used as a proxy for evacuation ability
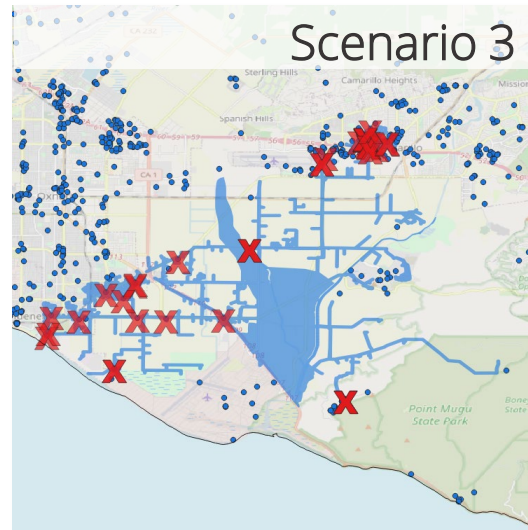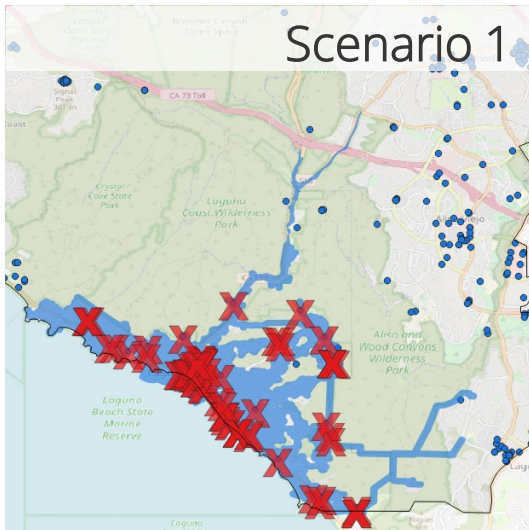
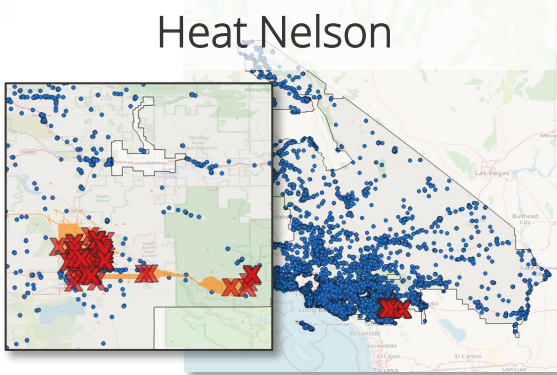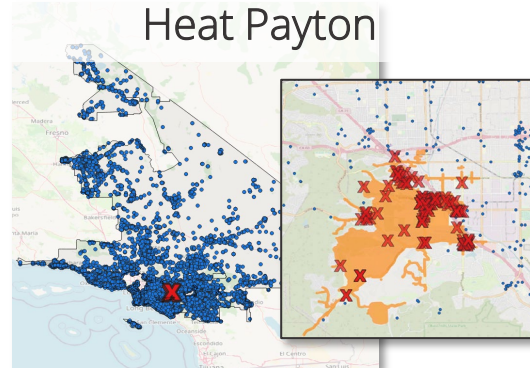# What is lost when the power goes out (facilities × services)
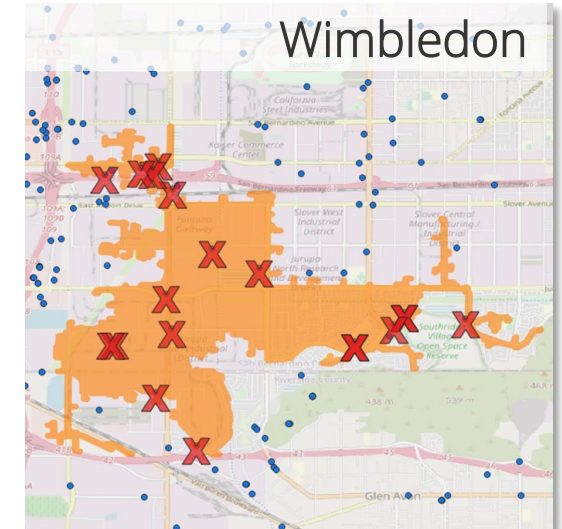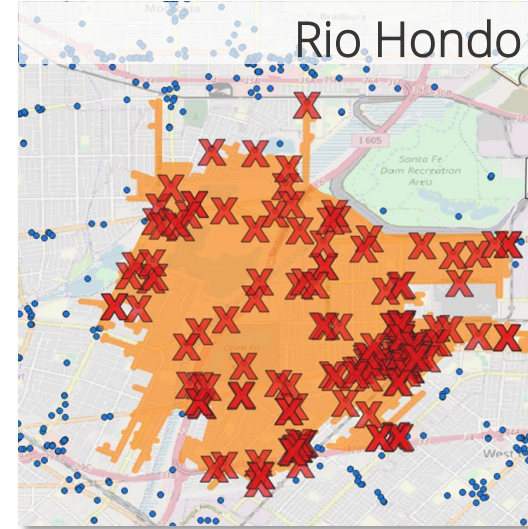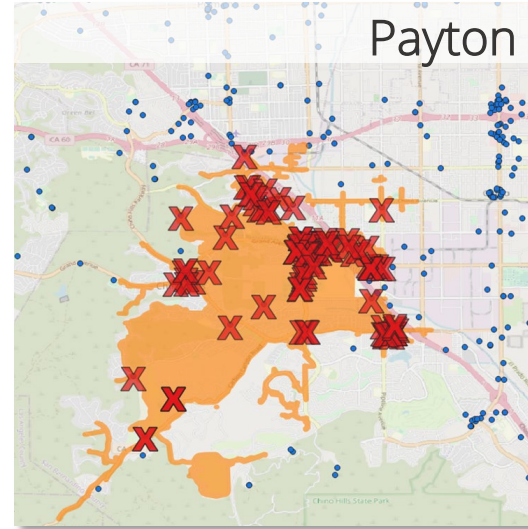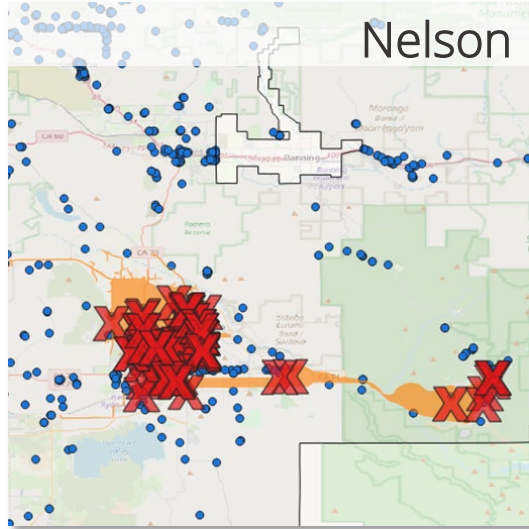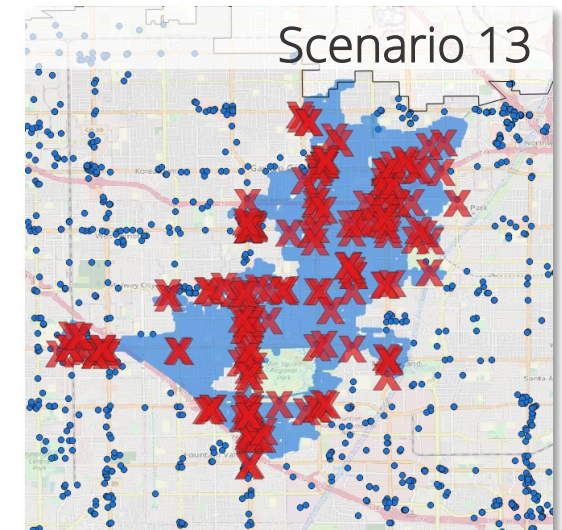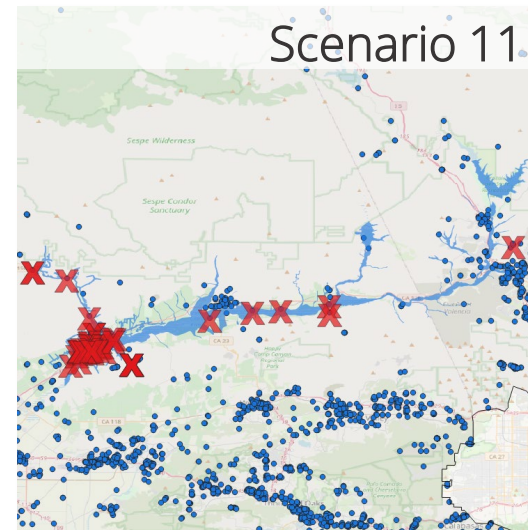
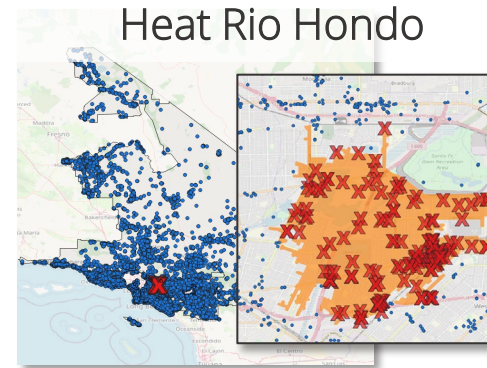# What is lost when the power goes out (facilities × services)

Heat Nelson

Heat Payton

Heat Rio Hondo

Heat Wimbledon

96 total facilities (-0.29% of total)	105 total facilities (-0.31% of total)	163 total facilities (-0.49% of total)	19 total facilities (-0.06% of total)
16 Microwave Towers (0.2%)	17 Bank Branches (0.7%)	29 Microwave Towers (0.4%)	11 Microwave Towers (0.2%)
15 Gas Stations (0.5%)	13 Fast Food sites (0.5%)	24 Fast Food sites (0.9%)	2 Official Shelters (0.1%)
8 Bank Branches (0.3%)	11 Pharmacies (0.6%)	18 Landfills (2.0%)	2 Fast Food sites (0.07%)
8 Official Shelters (0.4%)	10 Official Shelters (0.5%)	12 Official Shelters (0.6%)	1 Fire Station (0.1%)
6 Fast Food sites (0.2%)	9 Microwave Towers (0.1%)	11 Gas Stations (0.4%)	1 Gas Station (0.03%)
5 EMS sites (0.6%)	8 Gas Stations (0.3%)	10 Convenience Stores (1.5%)	1 Pharmacy (0.05%)
5 Pharmacies (0.3%)	6 EV Charging sites (0.1%)	10 ATMs (3.0%)	1 EMS site (0.1%)
4 POD sites (2.6%)	5 Retail Superstores (1.3%)	10 EV Charging sites (0.2%)	
4 EV Charging sites (0.1%)	5 ATMs (1.5%)	7 Pharmacies (0.4%)	
3 Cooling Centers (1.3%)	4 Convenience Stores (0.6%)	6 Bank Branches (0.3%)	
3 Fire Stations (0.4%)	4 Supermarkets (0.7%)	5 Drinking Water Access Points (0.4%)	
2 Money Transfer sites (13%)	3 Urgent Care sites (1.3%)	3 EMS sites (0.4%)	
2 Public Safety Comms Sites (0.2%)	3 EMS sites (0.4%)	3 Fire Stations (0.4%)	
2 Retail Superstores (0.5%)	2 Fire Stations (0.2%)	3 Retail Superstores (0.7%)	
2 Convenience Stores (0.3%)	2 Cooling Centers (0.8%)	2 Supermarkets (0.4%)	
2 ATMs (0.6%)	1 Car Rental site (1.2%)	2 Public Safety Comms sites (0.2%)	
2 Urgent Care sites (0.4%)	1 Local Law Enforcement (0.4%)	2 AM Towers (2.8%)	
1 AM Tower (1.4%)	1 Public Safety Comms Site (0.1%)	2 Local Law Enforcement (0.7%)	
1 CalTrans Yard (1.1%)		1 PSAP site (0.2%)	
1 Drinking Water Access Point (0.1%)		1 Cooling Center (0.4%)	
1 FM Tower (0.3%)		1 Rail Station (1.4%)	
1 Landfill (0.1%)		1 Hospital (0.5%)	
1 Local Law Enforcement (0.4%)			
1 Supermarket (0.2%)			

*note percentages listed refer to loss per facility category; e.g. 96 total facilities are 0.29% of all facilities; 16 microwave towers are 0.2% of all microwave towers.
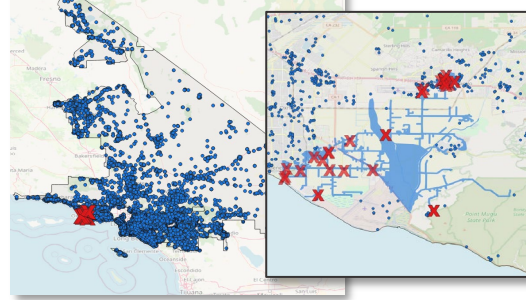
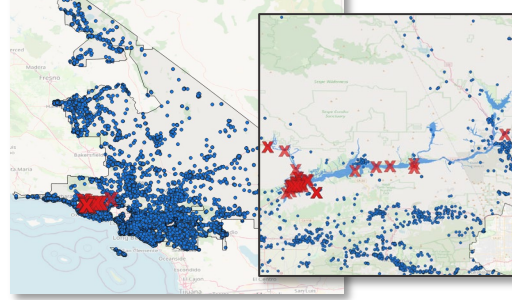# What is lost when the power goes out (facilities × services)
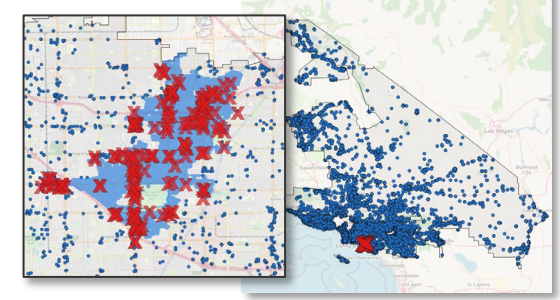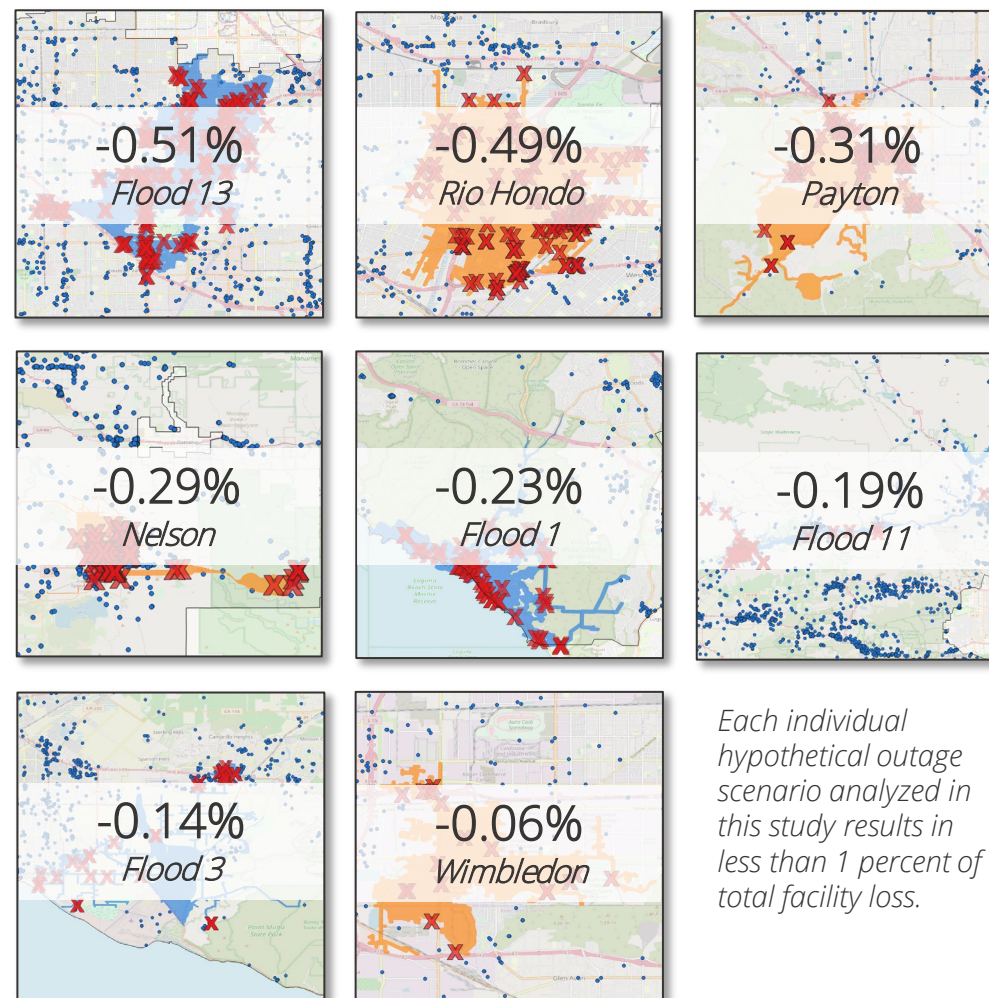
Flood Scenario 1
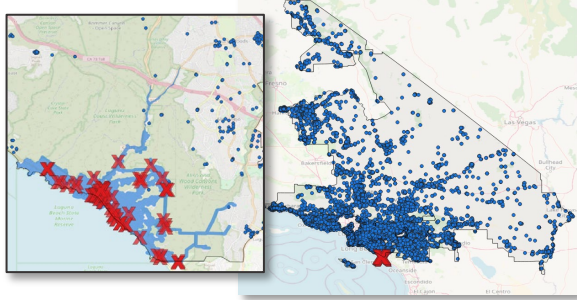
77 total facilities (-0.23% of total)
11 Drinking Water Access (1.4%)
11 EV Charging Sites (0.25%)
7 Bank Branches (0.3%)
5 Gas Stations (0.2%)
6 Fast Food Sites (0.2%)
4 Fire Stations (0.5%)
4 ATMs (1.2% of total)
4 Official Shelters (0.2%)
4 Pharmacies (0.2%)
3 Clinics (1.5%)
3 Hotels (1.5%)
3 Microwave Towers (0.04%)
2 EMS Sites (0.2%)
2 Motels (2.5%)
2 Public Safety Comms (0.2%)
1 EOC (1.2%)
1 FM Tower (0.3%)
1 Grocery (9%)
1 Landfill (0.1%)
1 Local Law Enforcement (0.4%)
1 Urgent Care (0.4%)

Flood Scenario 3

47 total facilities (-0.14% of total)
13 EV Charging Sites (0.3%)
7 Microwave Towers (0.1%)
5 Official Shelters (0.2%)
5 Gas Stations (0.2%)
3 Bank Branches (0.1%)
3 FM Towers (0.9%)
3 Landfills (0.3%)
2 Cellular Towers (0.5%)
2 Convenience Stores (0.3%)
1 ATM (0.3%)
1 EMS Site (0.1%)
1 Fire Station (0.1%)
1 Sewer Treatment Plant (2.6%)

Flood Scenario 11

64 total facilities (-0.19% of total)
18 Microwave Towers (0.2%)
7 Gas Stations (0.2%)
6 Official Shelters (0.3%)
5 Bank Branches (0.2%)
3 EMS Sites (0.4%)
3 Landfills (0.3%)
3 Fire Stations (0.4%)
2 Pharmacies (0.1%)
2 EOC Sites (2.3%)
2 PSAP Sites (0.5%)
2 Urgent Cares (0.9%)
1 AM Tower (1.4%)
1 CalTrans Yard (1.1%)
1 EV Charging Site (0.02%)
1 Hospital (0.5%)
1 Local Law Enforcement (0.4%)
1 Natural Gas Facility (7.7%)
1 POD (0.6%)
1 Public Airport (1.7%)
1 Public Safety Comms Site (0.1%)
1 Rail Station (1.4%)

Flood Scenario 13

181 total facilities (-0.51% of total)
36 Gas Stations (1.2%)
26 Pharmacies (1.4%)
25 Microwave Towers (0.3%)
20 Bank Branches (0.9%)
15 Fast Food Sites (0.6%)
12 EV Charging Sites (0.3%)
10 Official Shelters (0.5%)
8 Convenience Stores (1.2%)
5 Supermarkets (0.9%)
4 Retail Superstores (1.0%)
4 EMS Sites (0.5%)
3 Fire Stations (0.4%)
2 EOC Sites (2.3%)
2 Landfills (0.2%)
2 Local Law Enforcement (0.7%)
1 Hospital (0.5%)
1 ATM (0.3%)
1 Bus Station (2.0%)
1 Money Transfer site (6.7%)
1 PSAP site (0.2%)
1 Urgent Care (0.4%)
1 Cooling Center (0.4%)

*note percentages listed refer to loss per facility category; e.g. 96 total facilities are 0.29% of all facilities; 16 microwave towers are 0.2% of all microwave towers.

What is lost when the power goes out (facilities × services)

Summary:

- Each individual scenario analyzed in this study results in less than 1 percent of total facility loss.

- If all 4 heat and all 4 flood scenarios were aggregated, the resulting facility loss would still be only 2.2% of all facilities in the study area.

Although the outages impact critical services, there are a large number of alternative facilities to serve the population.

-0.51% Flood 13

-0.49% Rio Hondo

-0.31% Payton

-0.29% Nelson

-0.23% Flood 1

-0.19% Flood 11

-0.14% Flood 3

-0.06% Wimbledon

Each individual hypothetical outage scenario analyzed in this study results in less than 1 percent of total facility loss.
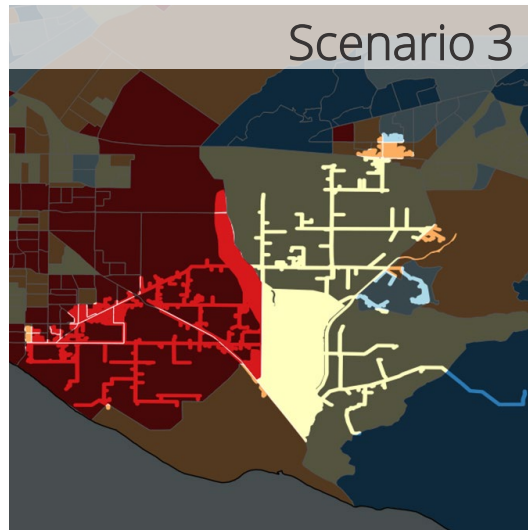
Who is impacted when the power goes out (people)

People living **within or directly-adjacent to the outage** lose some of their *closest* sources of critical services.

They meet their needs from all other remaining sources.

- e.g. the nearest gas station is down, but you have your choice of all other powered gas stations

People living **far away from the outage** lose some of their *further* sources of critical services. They too meet their needs from all other remaining sources.

Because Social Burden analysis measures service *availability* (where people *can* go, not just where people *do* go), **all** people are impacted to some extent when any facility goes offline because the total number of options is reduced.

Who is impacted when the power goes out (people)

Temperature: Nelson, Payton, Rio Hondo, Wimbledon

Flood: Scenario 1, Scenario 3, Scenario 11, Scenario 13

CRM Percent Rank
- 0th - 20th percentile
- 20th - 40th percentile
- 40th - 60th percentile
- 60th - 80th percentile
- 80th - 100th percentile
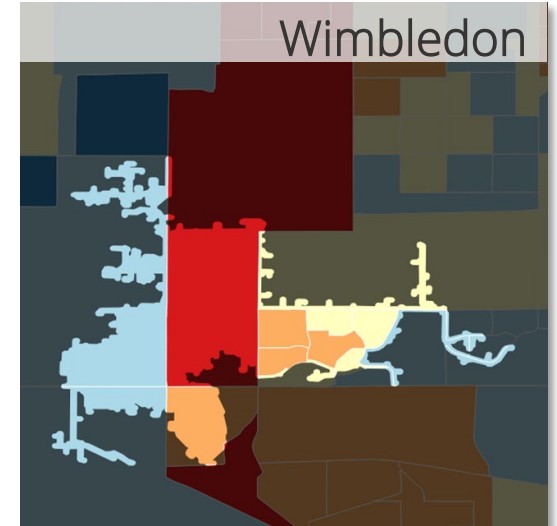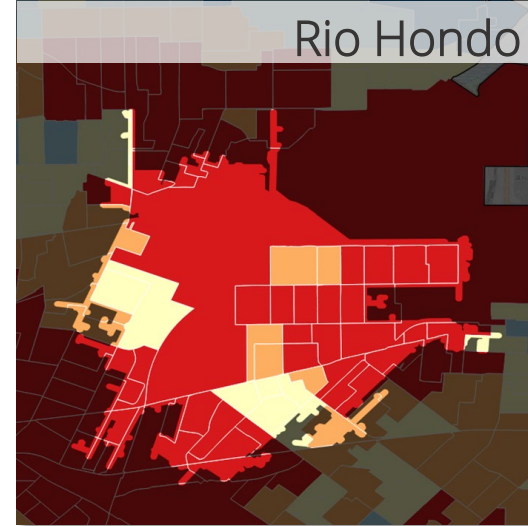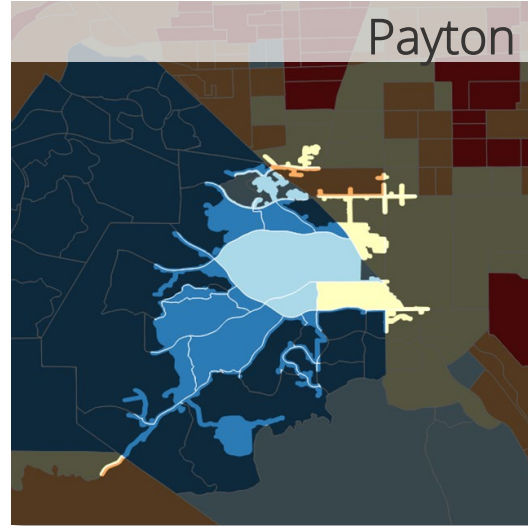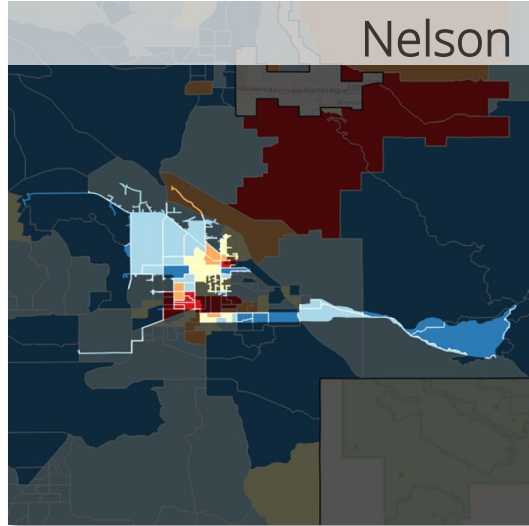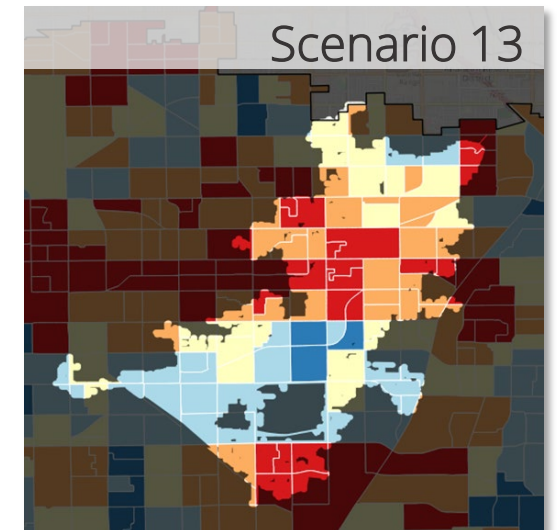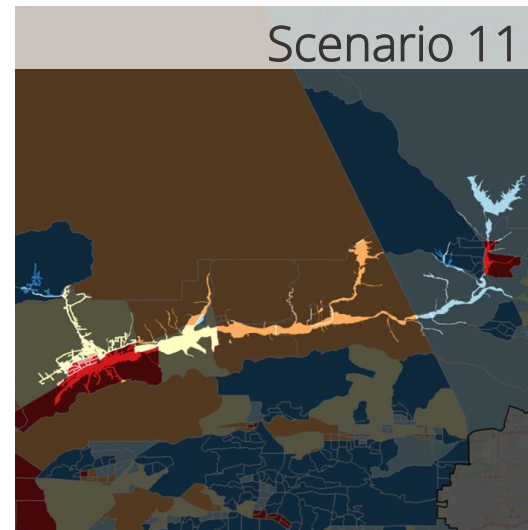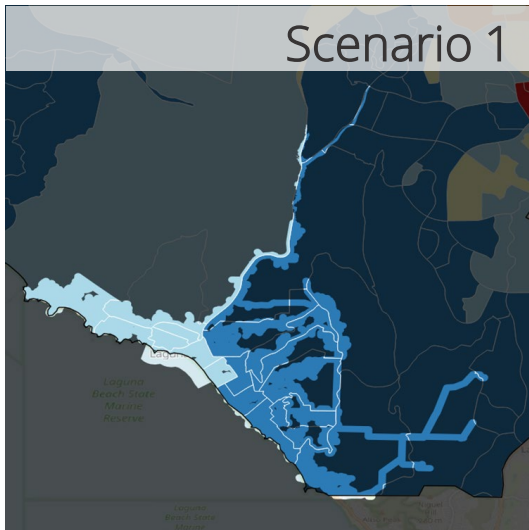
What is the resulting impact? (Blue-Sky vs Black-Sky differential)

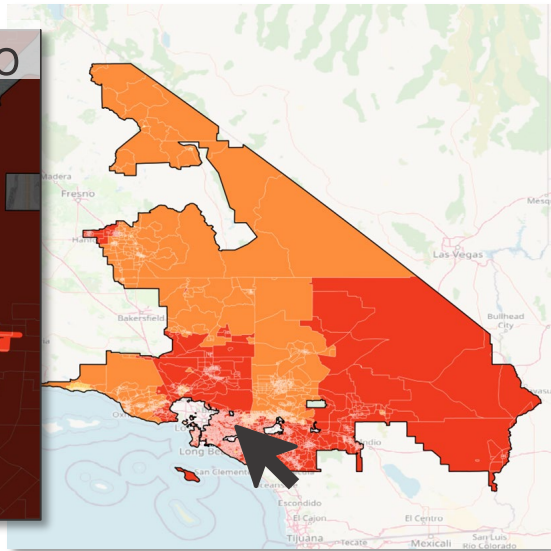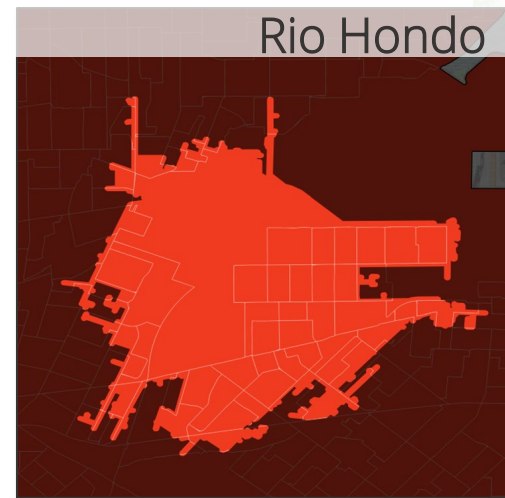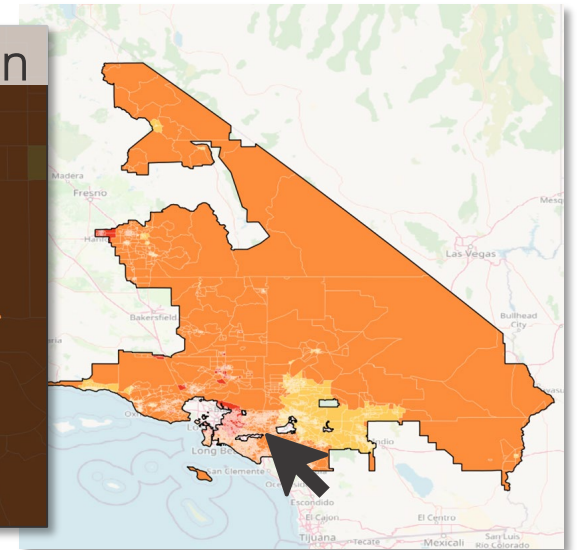**How much of an impact an outage ultimately has on people** is a function of underlying vulnerability and capacity ("*attainment factor*") <u>and</u> *service availability* (the location of infrastructure alternatives and their capacity to provide critical services).
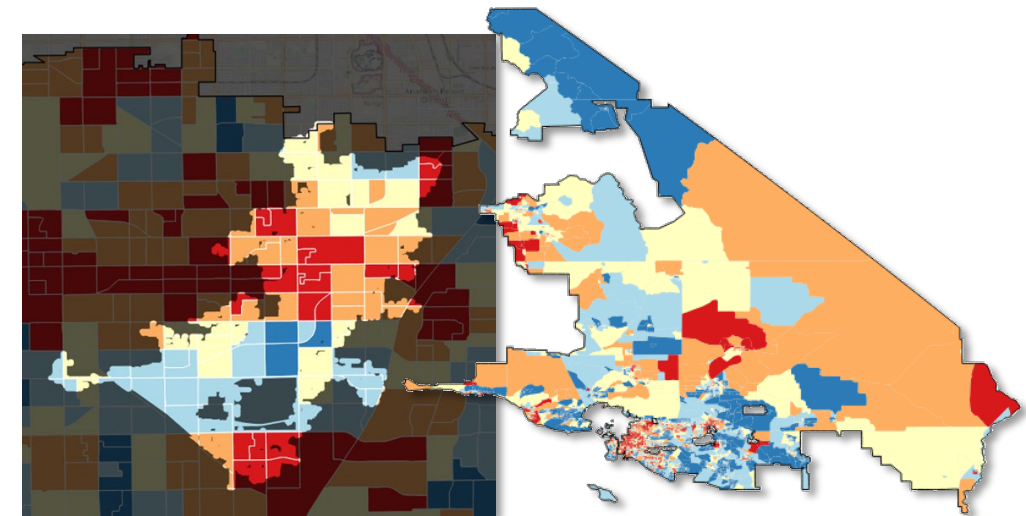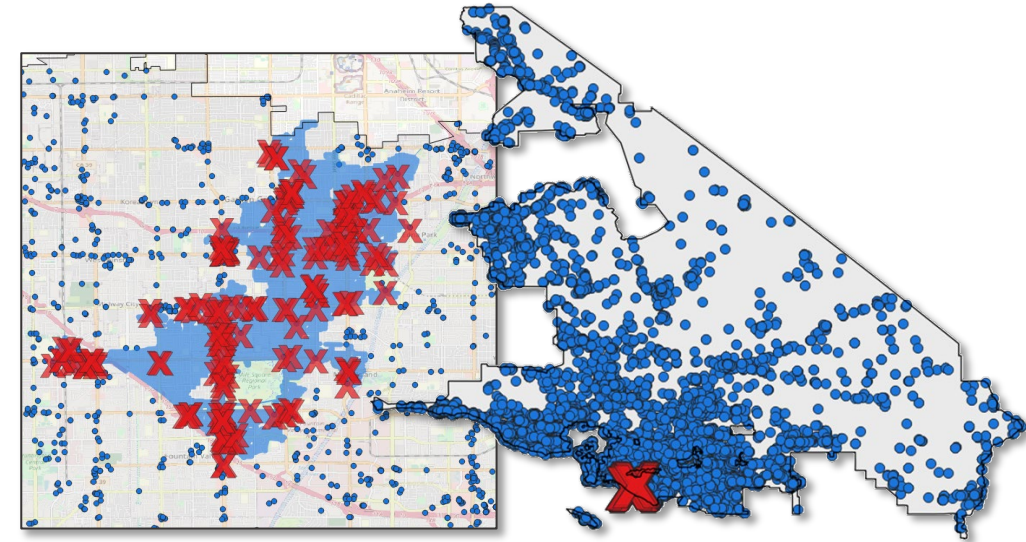
What is the resulting impact? (Blue-Sky vs Black-Sky differential)
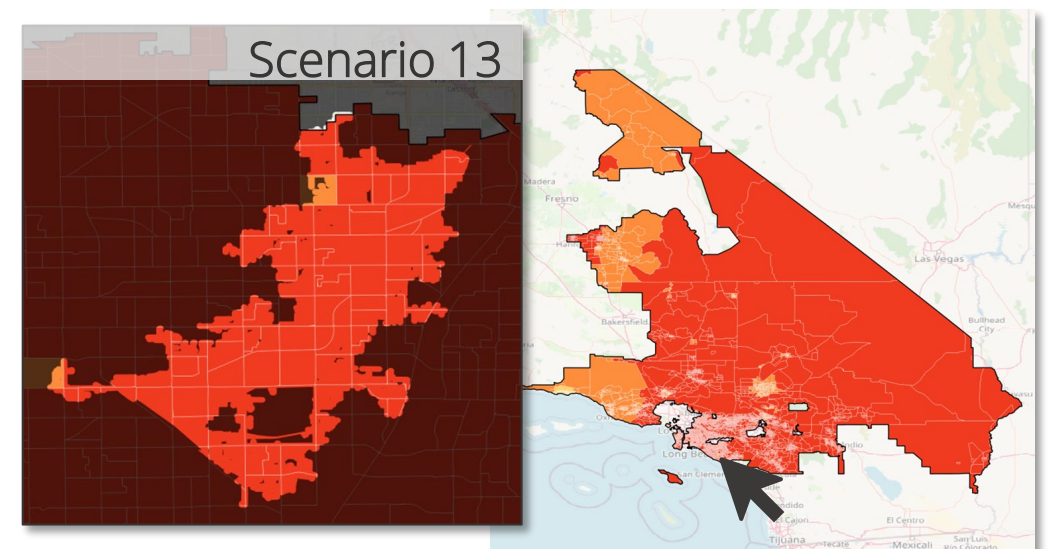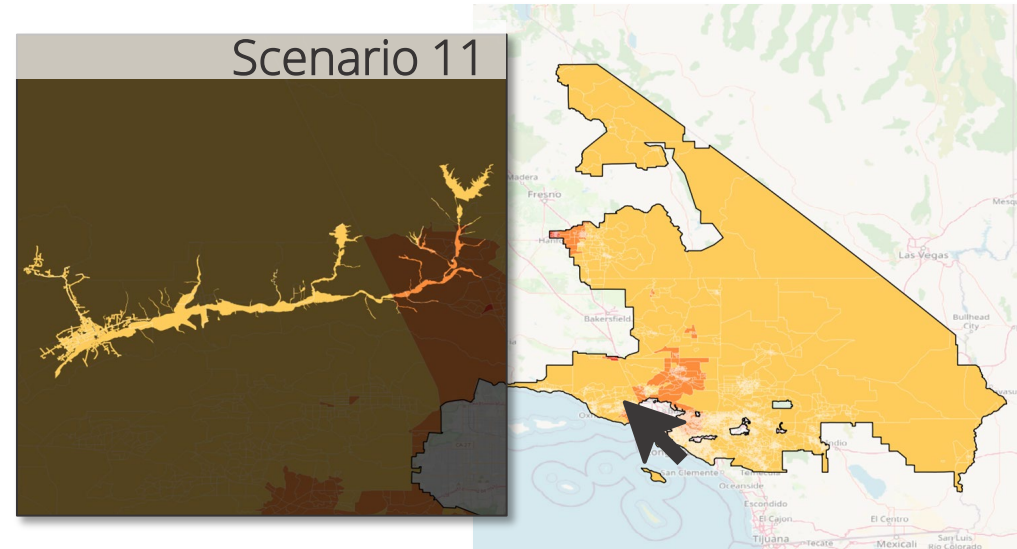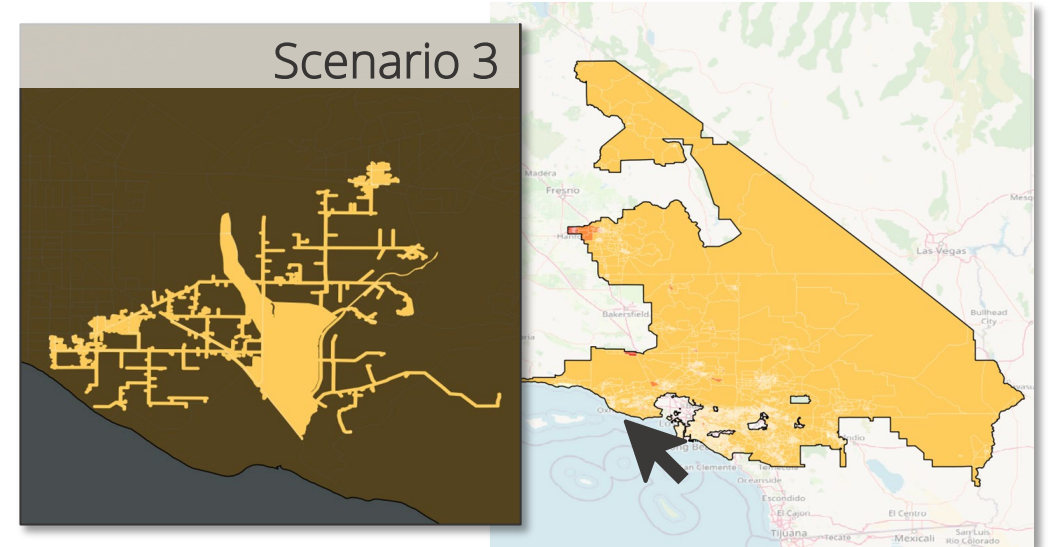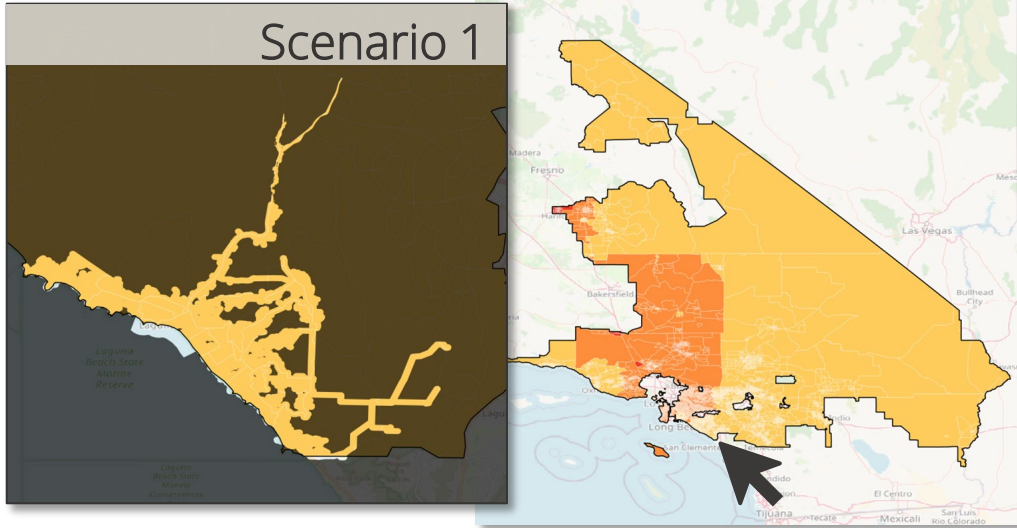

Temperature
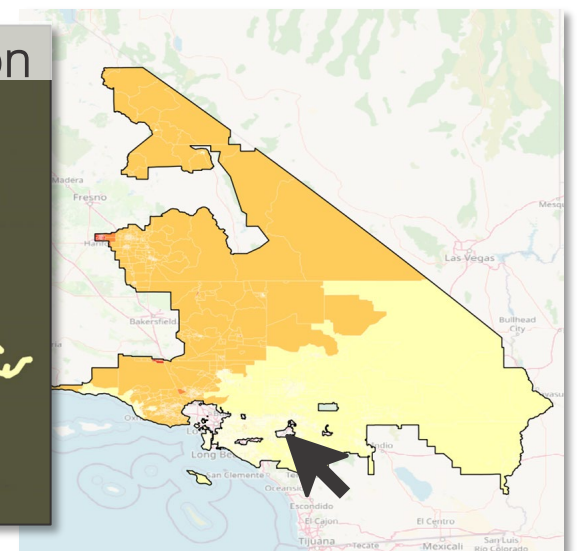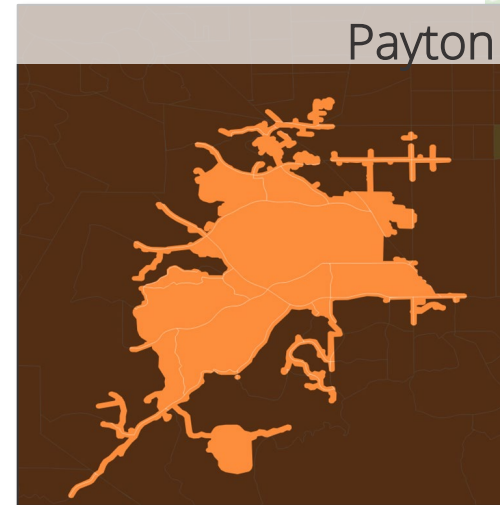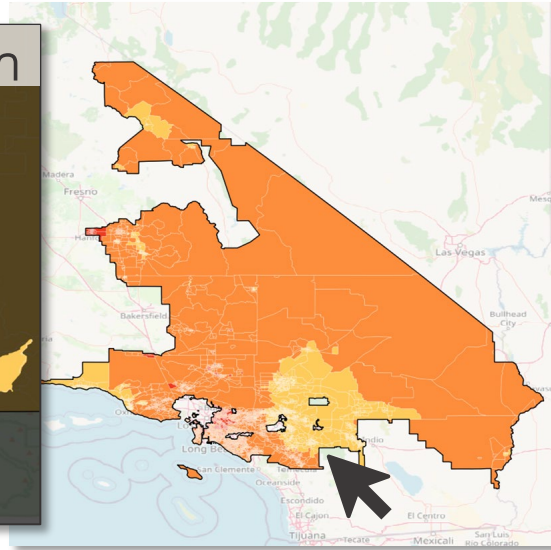
Nelson

Payton

Rio Hondo

Wimbledon

Social Burden % Increase During Power Outage

| 0 - 0.1% | 0.1 - 0.5% | 0.5 - 1% | 1 - 5% | 5 - 10% |

What is the resulting impact? (Blue-Sky vs Black-Sky differential)

Flood

Scenario 1

Scenario 3

Scenario 11

Scenario 13

Social Burden % Increase During Power Outage — 0 - 0.1% — 0.1 - 0.5% — 0.5 - 1% — 1 - 5% — 5 - 10%

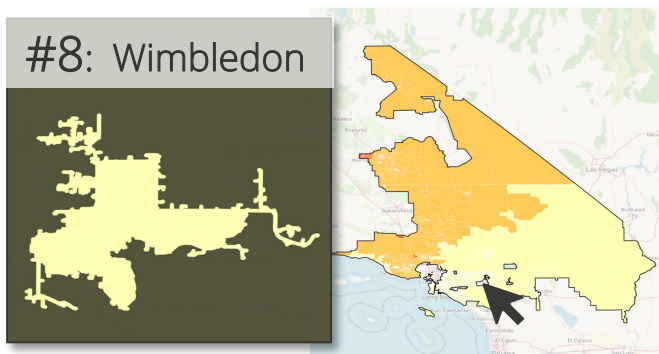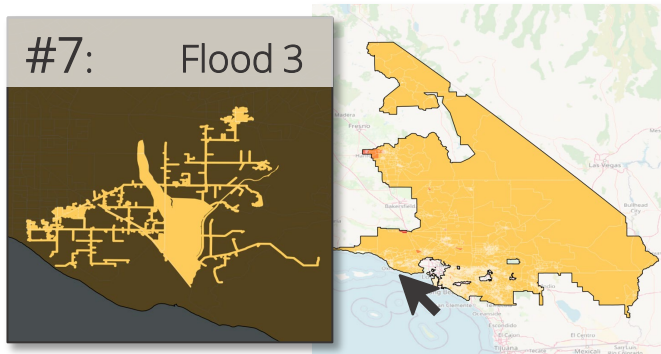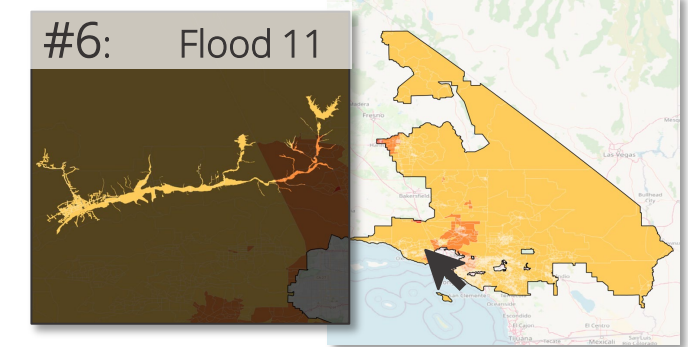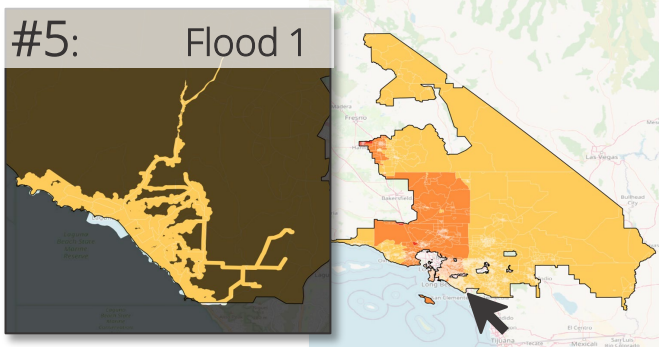# What is the resulting impact? (Blue-Sky vs Black-Sky differential)

#1: Flood 13

#2: Rio Hondo

#3: Payton

#4: Nelson

#5: Flood 1

#6: Flood 11

#7: Flood 3

#8: Wimbledon
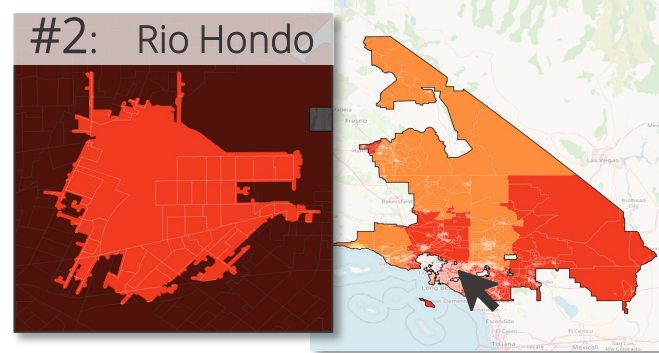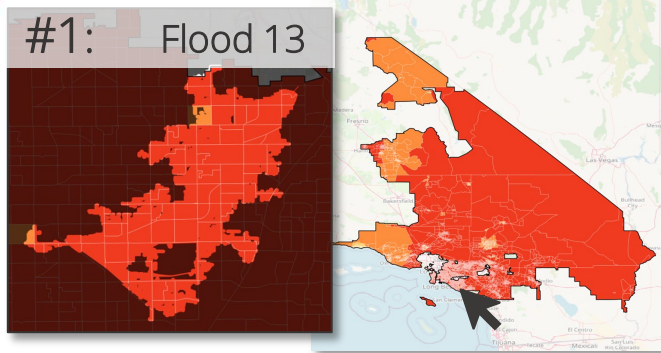
Hypothetical outage scenarios can be ranked from most to least burdensome based on the Social Burden impact of each outage on people both within and outside the outage footprint
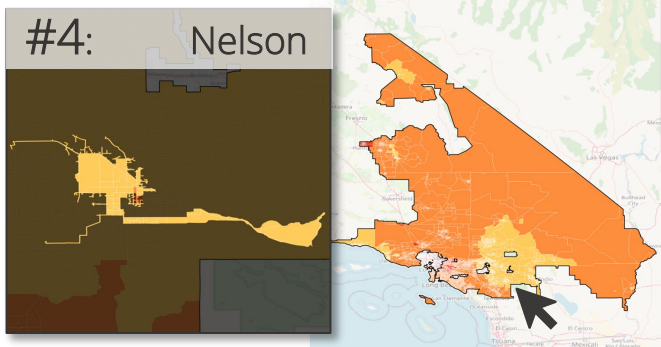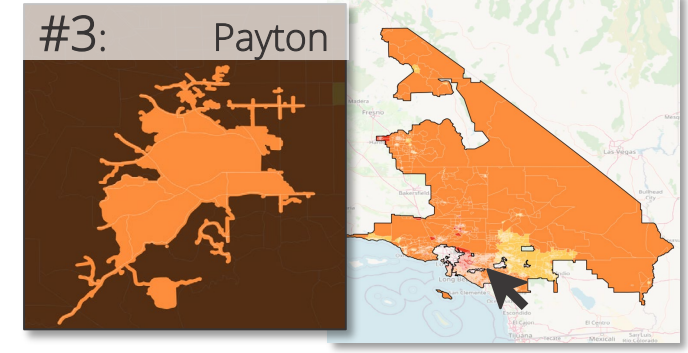
Social Burden % Increase During Power Outage   0 – 0.1%   0.1 – 0.5%   0.5 – 1%   1 – 5%   5 – 10%
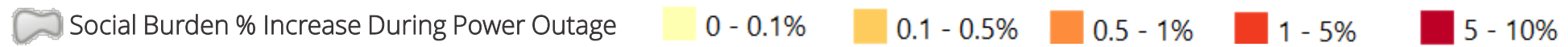
Interpreting the Results

What do the Blue-Sky Social Burden results mean?

- Blue Sky Social Burden measures baseline disparities in service access relative to an equity criterion (in this study, the SCE Community Resilience Metric)

What contributed to differences in Social Burden across the study area?

- The Social Burden results are a combination of differences in CRM scores and the availability of services across the study area (both during blue- & black-sky)

What is the meaning of the differential between Blue- and Black-Sky Social Burden analyses?

- The differential between Blue- & Black-Sky Social Burden is a measure of impact of selected (modeled) threats.

- Overall, although the 8 selected outage scenarios impacted critical facilities, there was enough redundancy across the study area that Social Burden did not increase by more than 10% in any one census block group within the study area

Service Availability

	High	Avg	Low
High	Least Impact		
Avg			
Low			Most Impact

Attainment Factor (~CRM)

Interpreting the Results

facilities × services

Facilities in Study Area

people

CRM Percent Rank

- 0th - 20th percentile
- 20th - 40th percentile
- 40th - 60th percentile
- 60th - 80th percentile
- 80th - 100th percentile

[A]
[B]
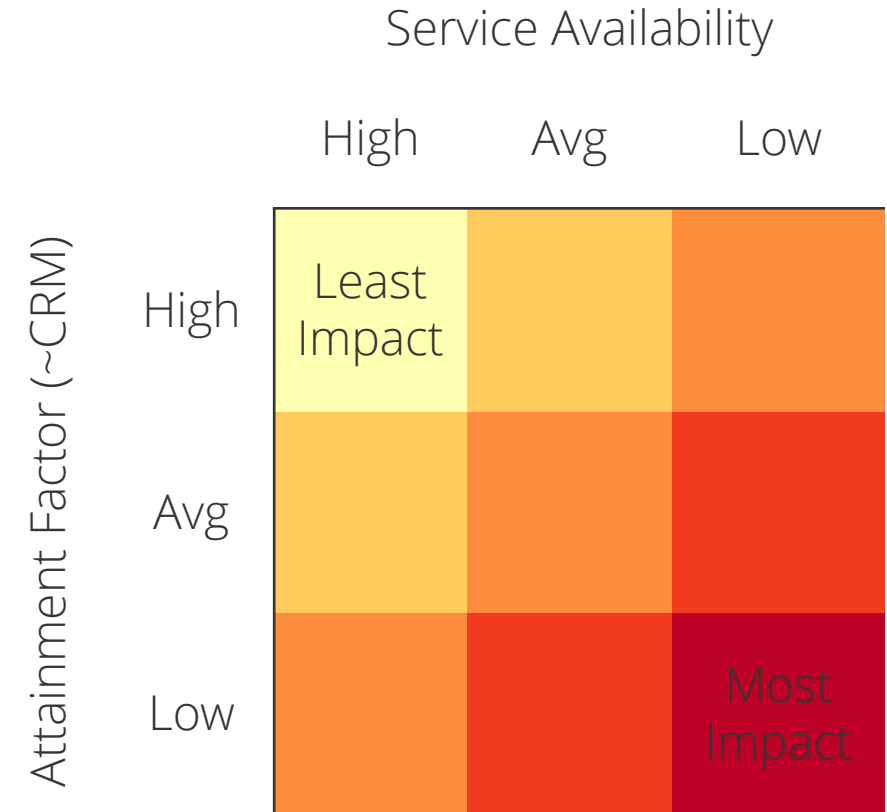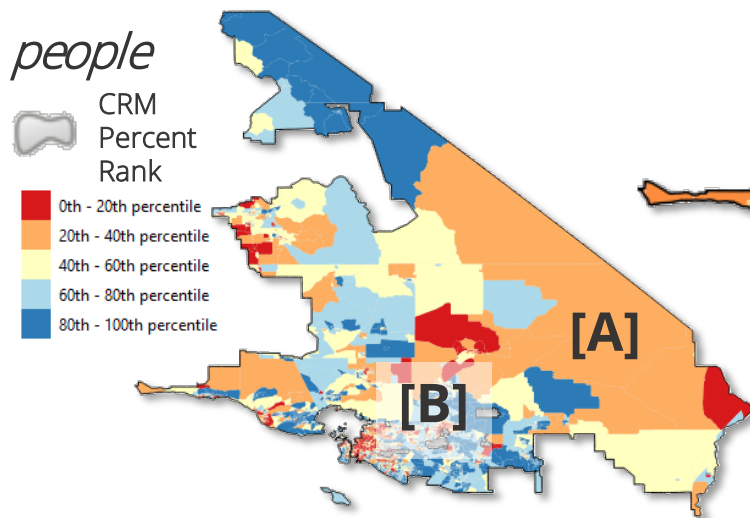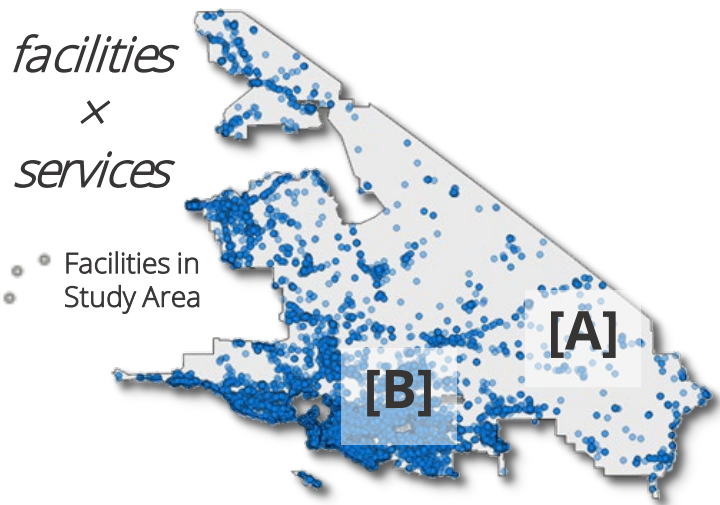
Social Burden impact of example power outage

Rio Hondo

[A]

[B]

Social Burden % Increase During Power Outage

- 0 - 0.1%
- 0.1 - 0.5%
- 0.5 - 1%
- 1 - 5%
- 5 - 10%
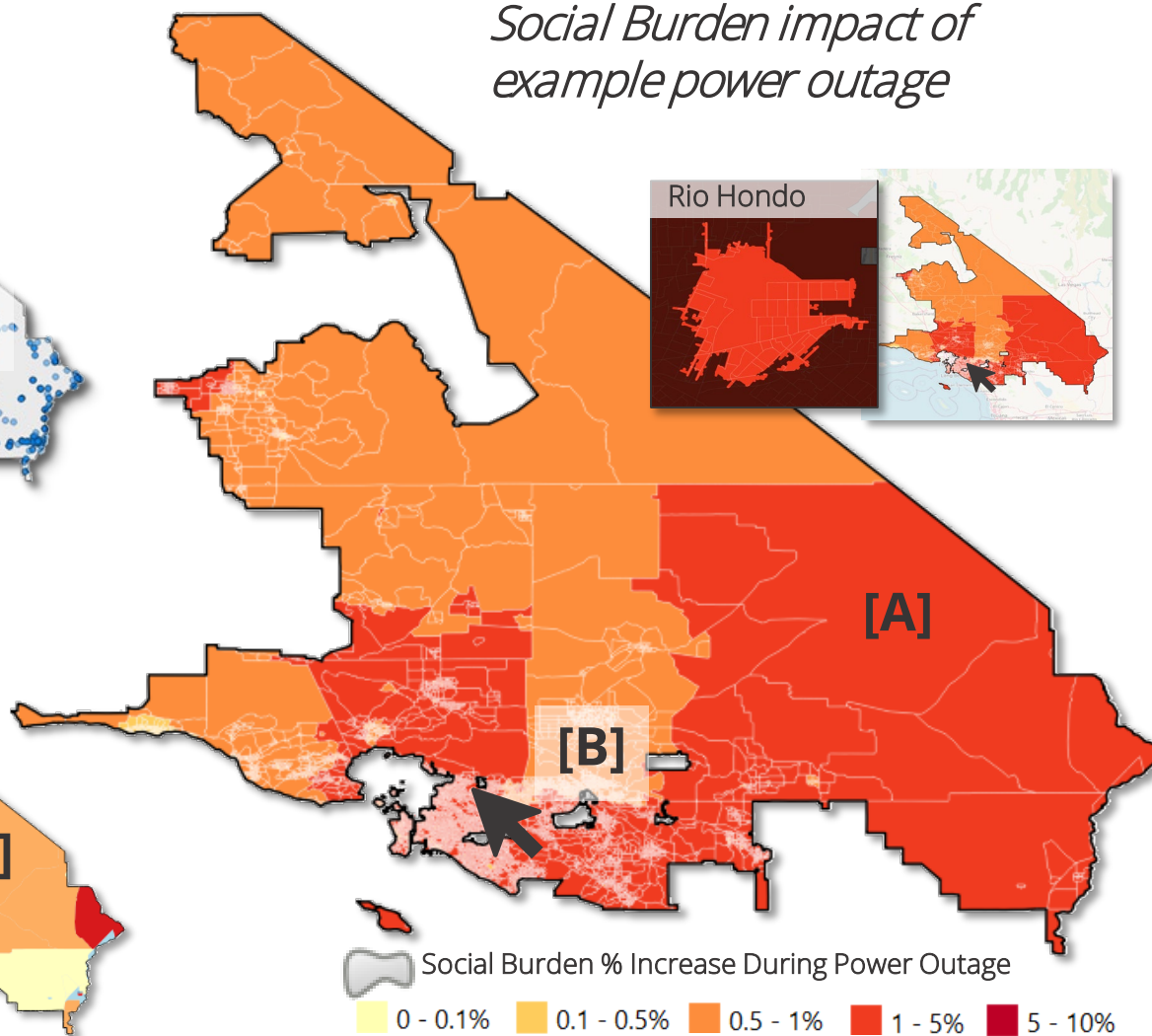
People (population), people's social capacity (CRM), facilities, and services are not distributed evenly in space across the SCE service territory.

Areas [**A**] with lower underlying social capacity (lower CRM) **and** less service availability see greater increase in Social Burden in response to outages – even if they are located further away.

Areas [**B**] with higher underlying social capacity (higher CRM) **and** much higher service availability see less of an increase in Social Burden in response to outages – even if they are much closer to the outage areas.

Closing:
Application of Phase 1 Results and Next Steps

What can be done with the results

- The Social Burden results are useful for ranking and/or prioritizing areas within the broader service territory to target for equity and resiliency-based projects.

- Driving down blue-sky Social Burden is not within the jurisdiction of the utility.
  - However, these results be used by other planning authorities to determine infrastructure siting and the prioritization of critical service access.

- The utility can use information about the distribution of the differential between the Blue- and Black-Sky Social Burden results to prioritize and site resilience investments.

- Social Burden is a key input to Sandia's Resilient Node Cluster Analysis Tool (ReNCAT), an optimization software that can be used as a decision support tool to identify load shedding, backup generation purchases, microgrid formation, and line hardening investments that can reduce Social Burden at least cost.

Insights from Phase 1 Social Burden Analysis

Hazard	Scenario	County	CRM	Social Burden Differential[a]
Temperature	Nelson	Riverside	High	+0.72%
Temperature	Peyton	San Bernardino	High	+0.78%
Temperature	Rio Hondo	Los Angeles	Low	+1.12%
Temperature	Wimbledon	San Bernardino	Low	+0.10%
Flood	1	Orange	High	+0.55%
Flood	3	Ventura	Low	+0.29%
Flood	11	Ventura	Medium	+0.44%
Flood	13	Orange	Medium	+1.23%

Note:
[a]Social Burden differential refers to the increase in Social Burden as a result of service loss during an outage scenario relative to the Blue Sky baseline. Reported here summarized across the entire population; individual population groups may rank higher or lower.

Lessons Learned and Future Research

Lessons Learned

- The CRM provides a richer, more nuanced look at differences in community attainment factors

- Quantifying Social Burden at the scale of a large utility is a non-trivial task, but open-source data and computational tools make the task possible

- Social Burden can be useful for prioritizing within a portfolio of equitable resilience investments, to pick which should go first and address the most impactful/most needed

Process Refinement & Future Research

- In Phase 1, Social Burden analysis considered each outage as a steady state problem
  - Future research can explore how outage duration impacts Social Burden

- In Phase 1, backup generation resources were not considered in the analysis

- Future research can explore how non-resilience or equity-focused investments contribute to grid resilience

Next Steps: Project Partnership and Social Burden Research

As we close out phase 1 of this project, Sandia, CPUC, and SCE are collectively working to define and refine the next phase of the project partnership.

Phases 2 and 3 are expected to continue research and testing of the application of social burden to determine optimal locations for resilience investments using ReNCAT, and the training, technology transfer, and broader exploration of how social burden and ReNCAT can be integrated into California planning processes.

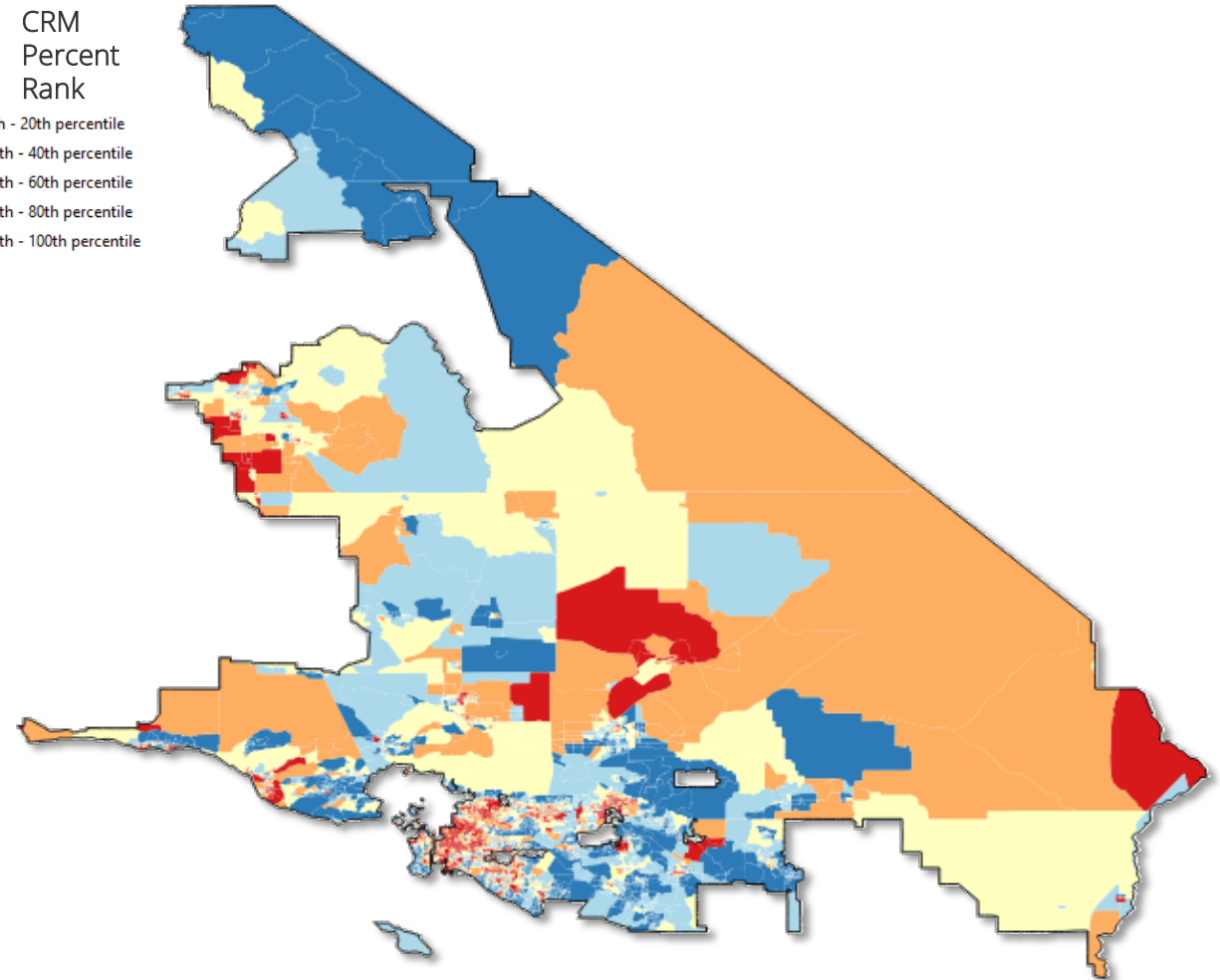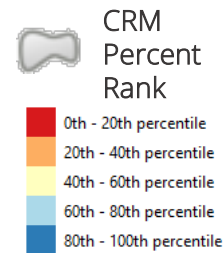| Phase 1 – Baseline Evaluation	Phase 2—Mitigation Measure Comparison	Phase 3—Options Evaluation
• Collect data • Evaluate the current state of one IOU territory • Educate stakeholders on tools and metrics • Scope data needs for Phase 2	• Collect data • Build ReNCAT optimization model of IOU territory • Provide analysis of targeted locations for resilience investments	• Refine model for use in evaluating proposed projects • Work with stakeholders to integrate tool into workflow

Next Steps: Social Burden for Climate-Driven Resilience Investments

Prior to this project:
Community Resilience Metric (CRM)

- **CRM developed in CAVA with input from Community-Based Orgs (CBOs)**

- **CRM proposed in SCE's 2025 GRC filing as one mechanism to prioritize timing of climate-driven resilience investments**
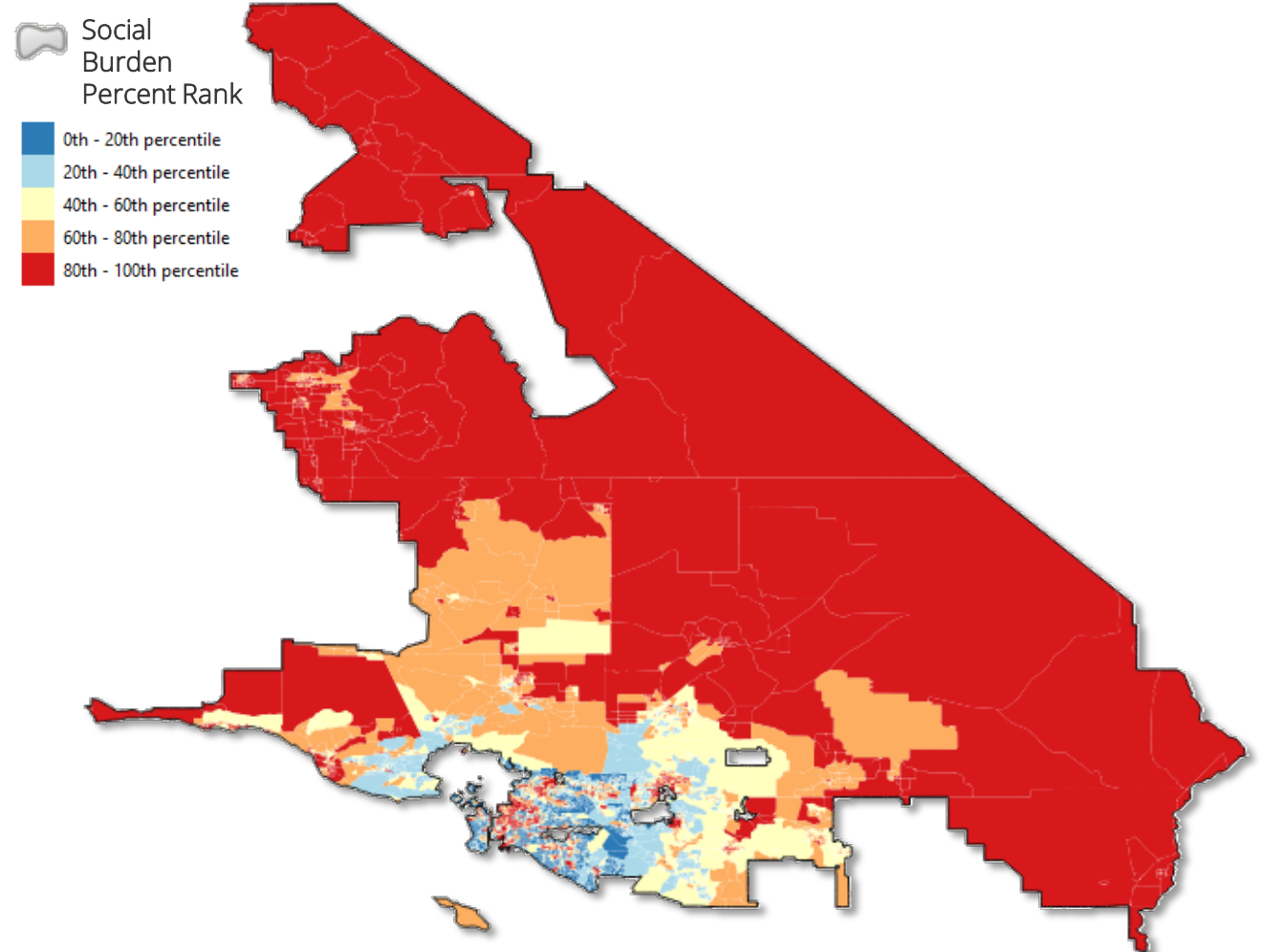

CRM Percent Rank
- 0th - 20th percentile
- 20th - 40th percentile
- 40th - 60th percentile
- 60th - 80th percentile
- 80th - 100th percentile

Next Steps: Social Burden for Climate-Driven Resilience Investments

Prior to this project:
Community Resilience Metric (CRM)

Available now:
Blue Sky Social Burden

- **Blue Sky Social Burden incorporates CRM and additional dimensions of burden (physical distance to services)**

- **Could be used as spatial tool to depict underlying burden to inform follow-on resilience analyses across the territory**

    - **Should it be used instead of or alongside CRM?**

Social Burden Percent Rank

- 0th - 20th percentile
- 20th - 40th percentile
- 40th - 60th percentile
- 60th - 80th percentile
- 80th - 100th percentile

Next Steps: Social Burden for Climate-Driven Resilience Investments

Prior to this project:
Community Resilience Metric (CRM)

| Available now: |
|---|
| **Blue Sky Social Burden** |

Potential for Phase 2:
Delta from Blue Sky to Black Sky for Targeted Investments

- **Social Burden increase of a specific, targeted outage scenario could be used as metric for equity impact of outage**

- **Social Burden improvement from proposed resilience investment in a targeted area can be used to compare equity impacts of adaptations**

  - **Metric enables project-specific assessments, application to broader planning is less clear**

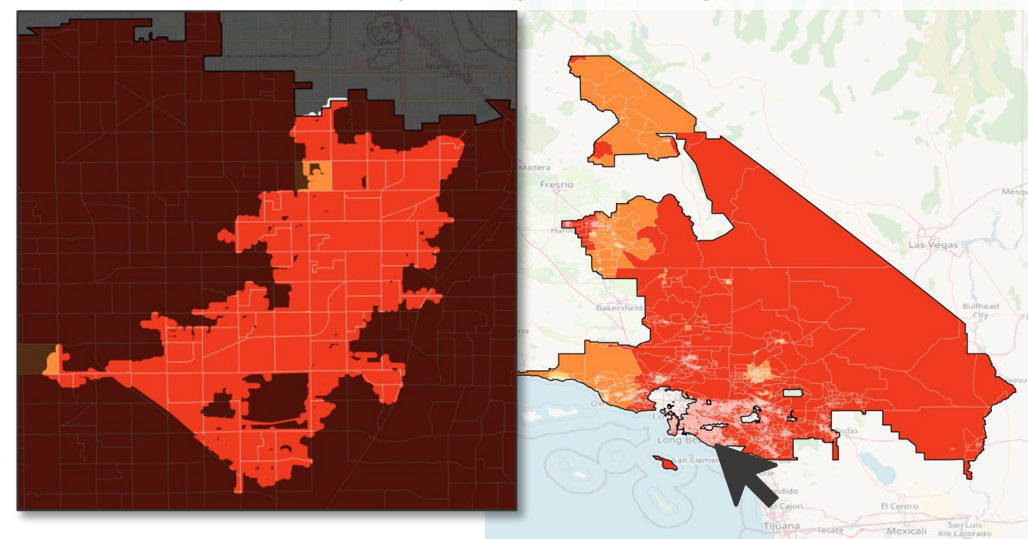 - **How to define appropriate distance cutoffs for social burden impacts?**

Social Burden
% Increase
During Power
Outage

- 0 - 0.1%
- 0.1 - 0.5%
- 0.5 - 1%
- 1 - 5%
- 5 - 10%
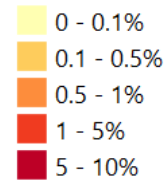
Social Burden impact of power outage scenario A
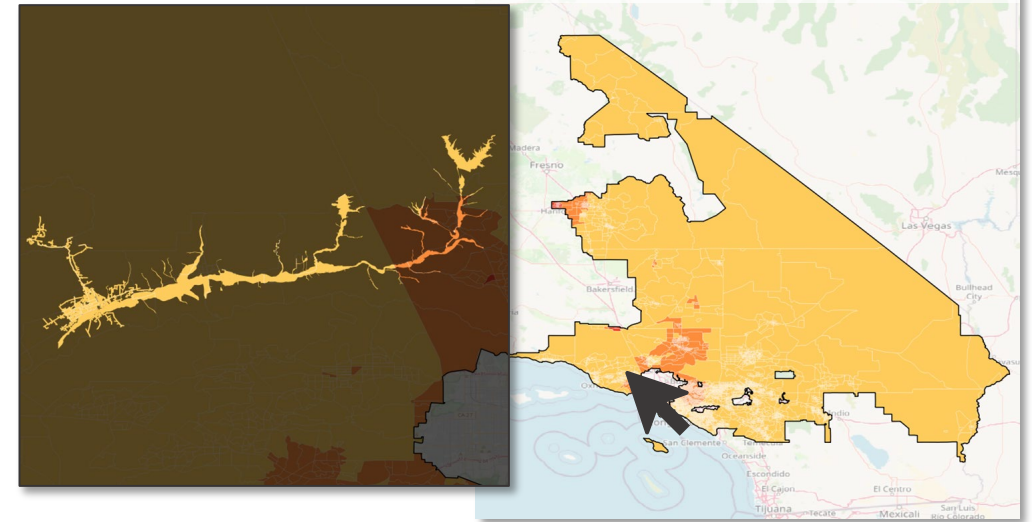
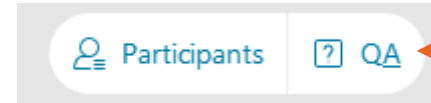*Social Burden impact of power outage scenario B*

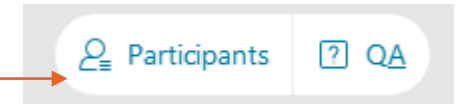# Discussion and Questions

Discussion and Q&A

WebEx Tip

Option 1:

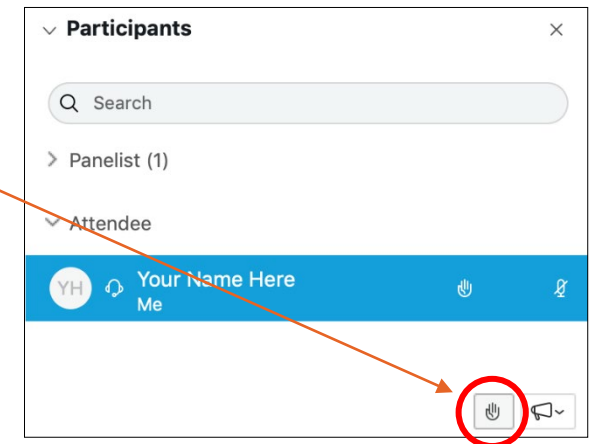**Access the written Q&A panel here**

Option 2:

1. Click here to access the attendee list to raise and lower your hand.

2. Raise your hand by clicking the hand icon.

3. Lower it by clicking again.

Sandia National Laboratories

Evaluating Social Burden in California: Final Results

Value of Resiliency : Economic and Equity Impacts of Large Disruptions – Social Burden Index

Sandia: Olga Hart, Amanda Wachtel, Darryl Melander

SCE: Anna Brockway, Stephen Torres

November 28, 2023

EDISON INTERNATIONAL®

Energy Division Workshop Series on Resiliency

Dates	Workshop	Presenters	Description
05/10/2022	Interruption Cost Estimate (ICE) Calculator / Power Outage Economic Tool (POET)	Lawrence Berkeley National Labs	Top-down econometric reflection of the value of lost load
07/22/2022, 07/26/2023, 11/28/2023	Resiliency Node Cluster Analysis Tool (ReNCAT) and the Social Burden Index (SBI); Pilot Partnership Project	Sandia National Labs and Southern California Edison (SCE)	Bottom-up reflection of social burden and impacts of large-scale electrical system disruption
08/22/2023	The Value of Sharing and Consolidating Critical Community, Electricity, and Natural Hazard Information	Lawrence Berkeley National Labs	Translating hazard mitigation plans into geospatial layers to enable greater coordination of resilience planning between local authorities and utilities
10/19/2023	Use Case Demonstrations of the 4-Pillar Methodology of Resiliency Planning and Evaluation	San Diego Gas & Electric (SDG&E) and Sonoma County Junior College District	4 Pillar Methodology applied to small scale and medium scale applications of resilience planning
05/10/2023, 09/05/2023 11/08/2023	Resiliency Standards: Definitions, Metrics and Methodologies	Lumen Energy Strategy	Discussion of resiliency definitions and metrics as standards for applications using grid planning scale use case

Closing Remarks

Commissioner Shiroma

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Julian.Enis@cpuc.ca.gov

https://www.cpuc.ca.gov/resiliencyandmicrogrids/