SB 671 In-Person Meeting: Freight Data Workshop

Thursday, February 6, 2023
1:00 pm – 4:00 pm
In-Person Only

East End Complex Auditorium
1616 Capitol Avenue
Sacramento, CA 95814

Agenda

Time	Topic
1:00 - 1:05	Welcome
1:05 - 1:10	Background
1:10 - 1:55	ERDC Presentation & Q+A
1:55 - 2:10	Break and Networking
2:10 - 2:55	LBNL Presentation & Q+A
2:55 - 3:10	Break and Networking
3:10 - 3:20	Clean Freight Corridor Efficiency Assessment
3:20 - 4:00	Open Discussion & Closing

Background

SB671 Zero-Emission Refueling and Climate Vulnerability Results

Presenter: *Dr. Kelsey Stoddard*[1] : kelsey.s.stoddard@usace.army.mil
Presenter / POC: *Dr. Igor Linkov*[1] : igor.linkov@usace.army.mil
Dr. Andrew Strelzoff[2] *, Hannah Walter*[3] *, Sam Dent*[2]

January 9, 2023

ERDC EL[1] *, ERDC ITL*[2] *, CTC*[3]

U.S.ARMY

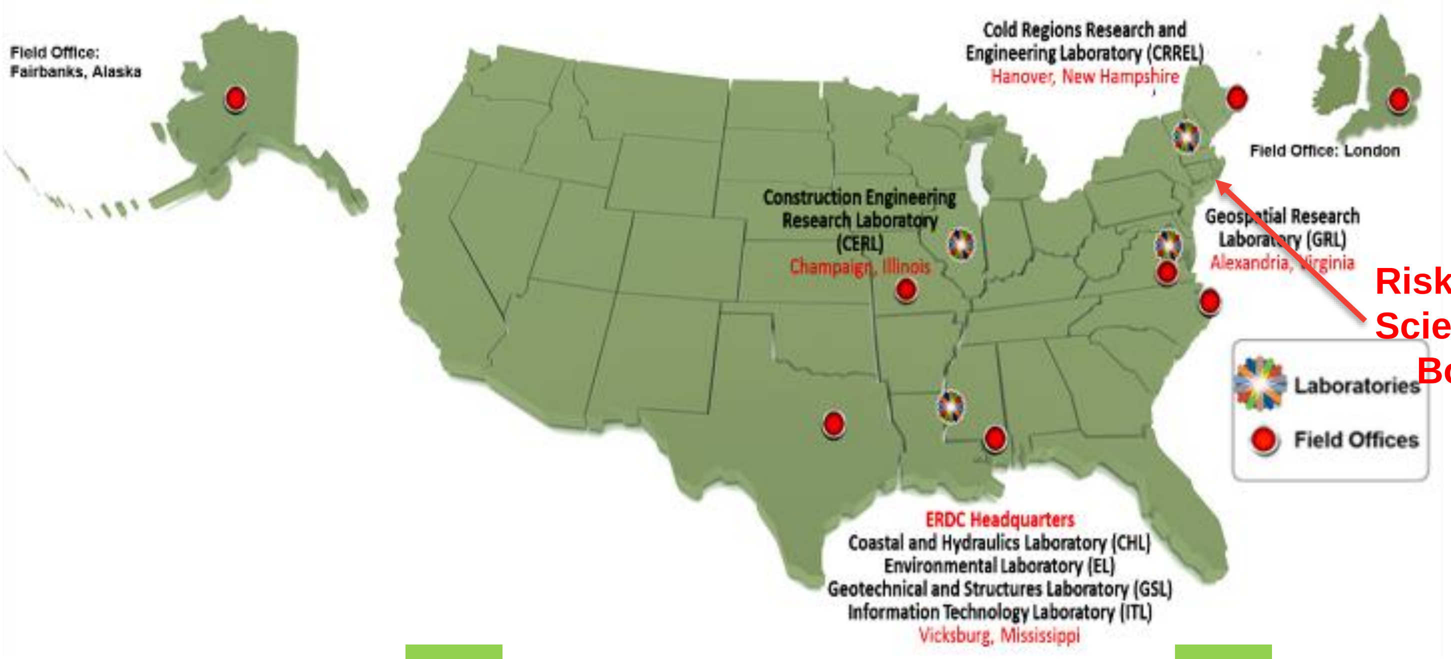
US Army Corps of Engineers

This presentation does not necessarily reflect the views of the United States Government, and is only the view of the author

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

DISCOVER | DEVELOP | DELIVER

About Army Engineer R&D Center



7 Laboratories

Coastal and Hydraulics Laboratory (CHL)
Cold Regions Research and Engineering Laboratory (CRREL)
Construction Engineering Research Laboratory (CERL)
Environmental Laboratory (EL)
Geospatial Research Laboratory (GRL
Geotechnical and Structures Laboratory (GSL)
Information Technology Laboratory (ITL)

Annual Research Program Exceeding
$1.3 Billion

People

2100 Strong
61% E&S
71% of E&S with Advanced Degrees
29% of E&S with PhD

Core Competencies

- Blast and Weapons Effects on Structures and Geo-Materials
- 3-D Mapping and Characterization
- Cold Regions Science and Engineering
- Civil and Military Engineering
- Computational Prototyping of Military Platforms
- Coastal, River, and Environmental Engineering
- Military Installations and Infrastructure

Partners

All DoD Services
Army, Navy, Air Force, NASA, DHS, FEMA, DIA, NGA
Academia
68 EPAs with top engineering schools
Industry
172 CRADAs
International
14 international agreements with 7 countries

Supply chain woes caused US auto sales to fall 8% last year

AP | TOM KRISHER
January 5, 2023, 12:01 PM

Gartner Predicts 95% of Companies Will Have Failed to Enable E2E Resiliency in their Supply Chains by 2026.

02/01/2023 | 04:30am EST

BUSINESS

GULF | MENA | WORLD | BUSINESS | OPINION | CLIMATE | HEALTH | LIFESTYLE | ARTS & CULTURE | TRAVEL | SPORT | PODCASTS | WEEKEND

n | Economy | Energy | Money | Cryptocurrencies | Property | Banking | Technology | Markets | Travel and Tourism | Start-Ups | Future | Comment

Rebuild supply chains with greater resilience and open trade, Davos panellists say

A Resilient Supply Chain Starts With Full Visibility

Forbes Technology Council

Dan Shey Forbes Councils Member
Forbes Technology Council
COUNCIL POST | Membership (Fee-Based)

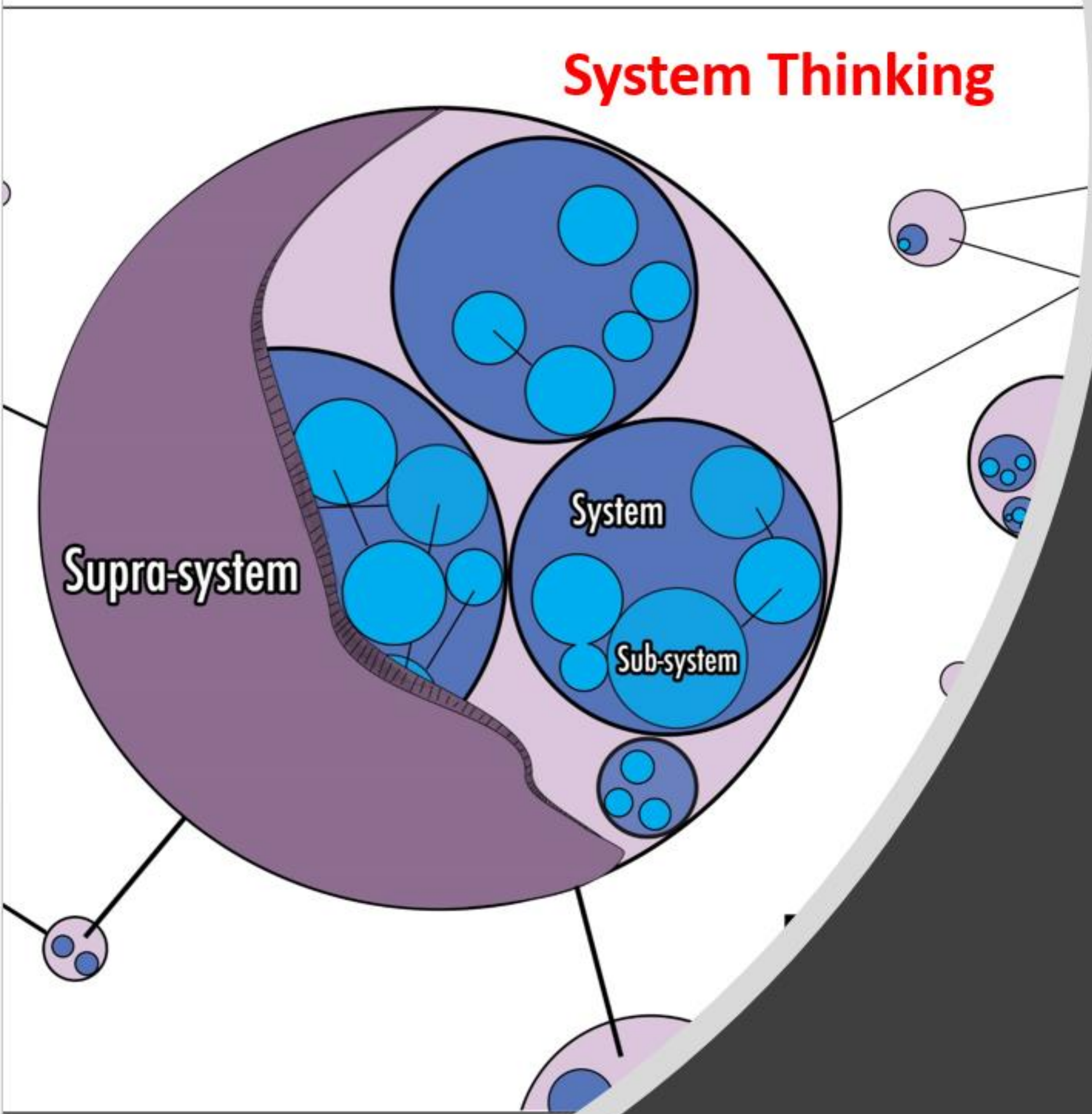
Sep 30, 2022, 09:45am EDT

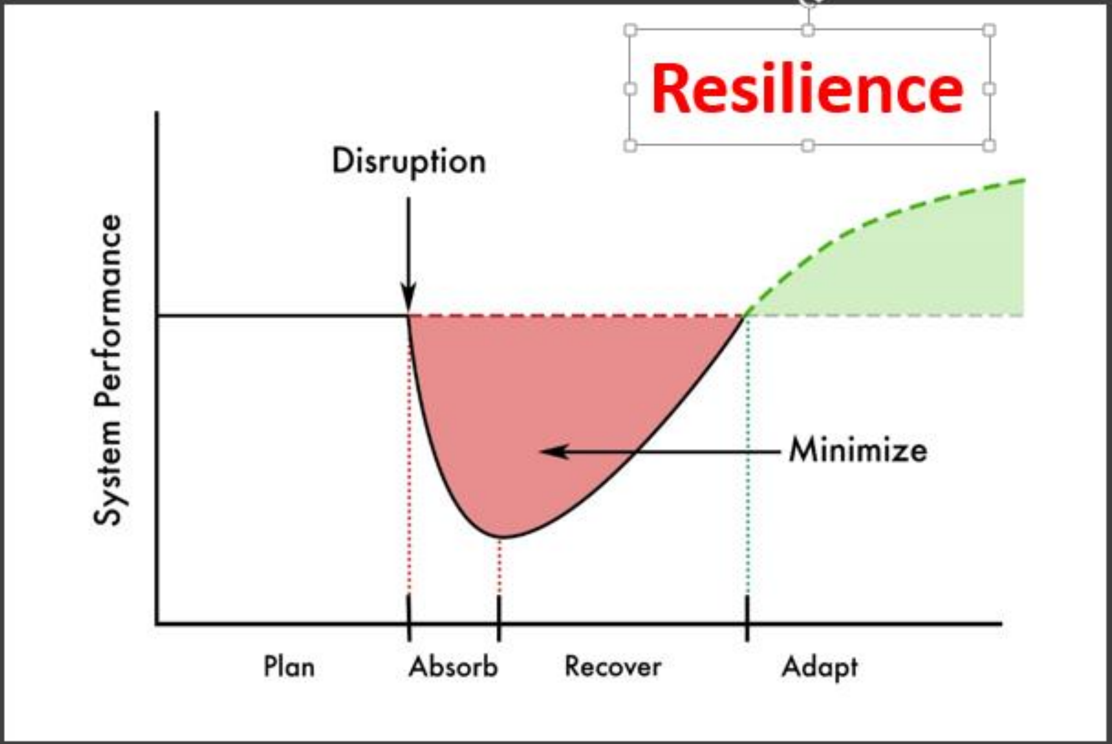
How leveraging connected experiences in logistics can build resilient supply chains

Advances in cloud data storage, artificial intelligence and cellular networks are all collectively driving a more connected experience in transport and logistics

BY BURAK ERTUNA
OCTOBER 1, 2022

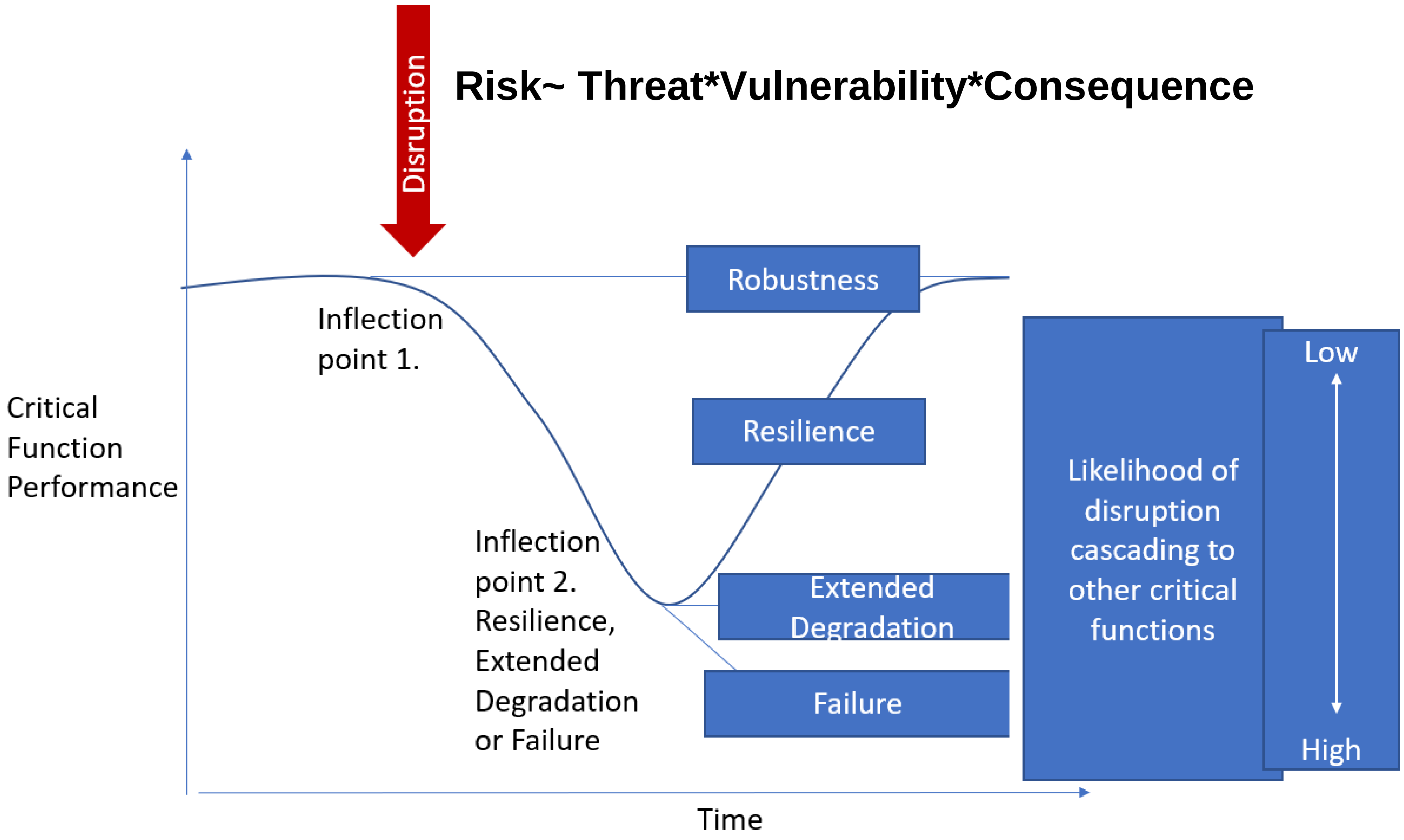
What Makes Complex Systems (Communities) Susceptible to Threat?





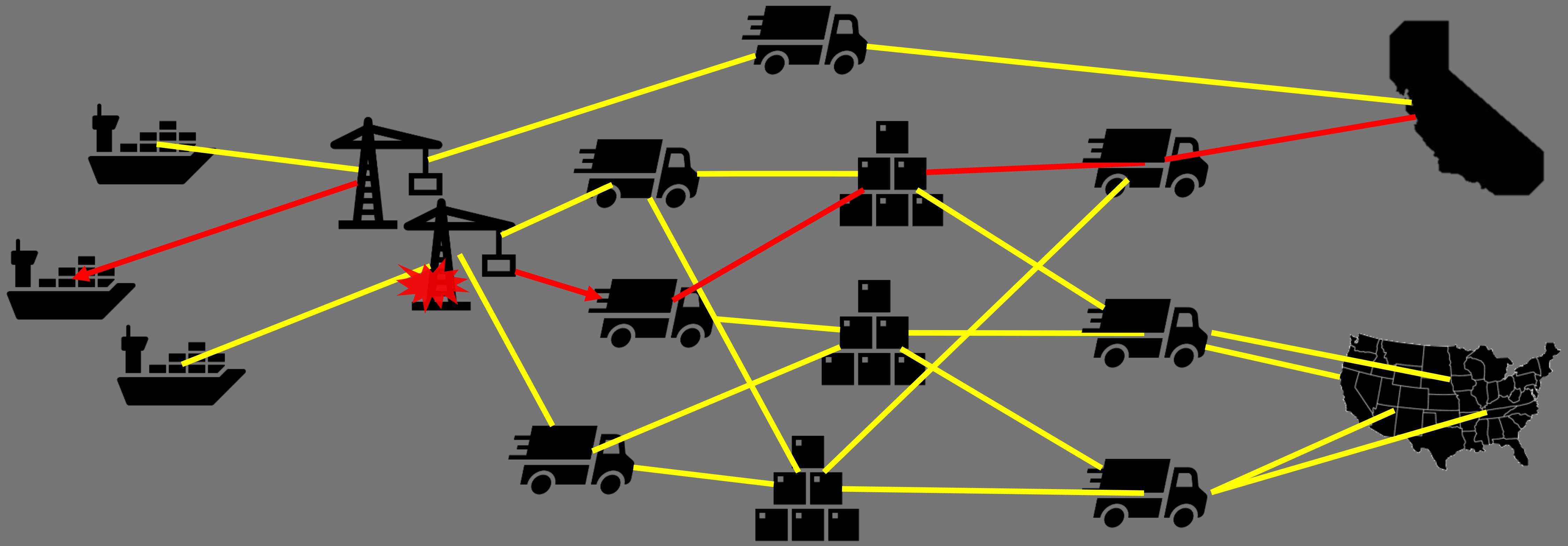
After Linkov and Trump, 2019

Crisis Management, Risk and Resilience



After Galaitsi, Linkov et al, 2022

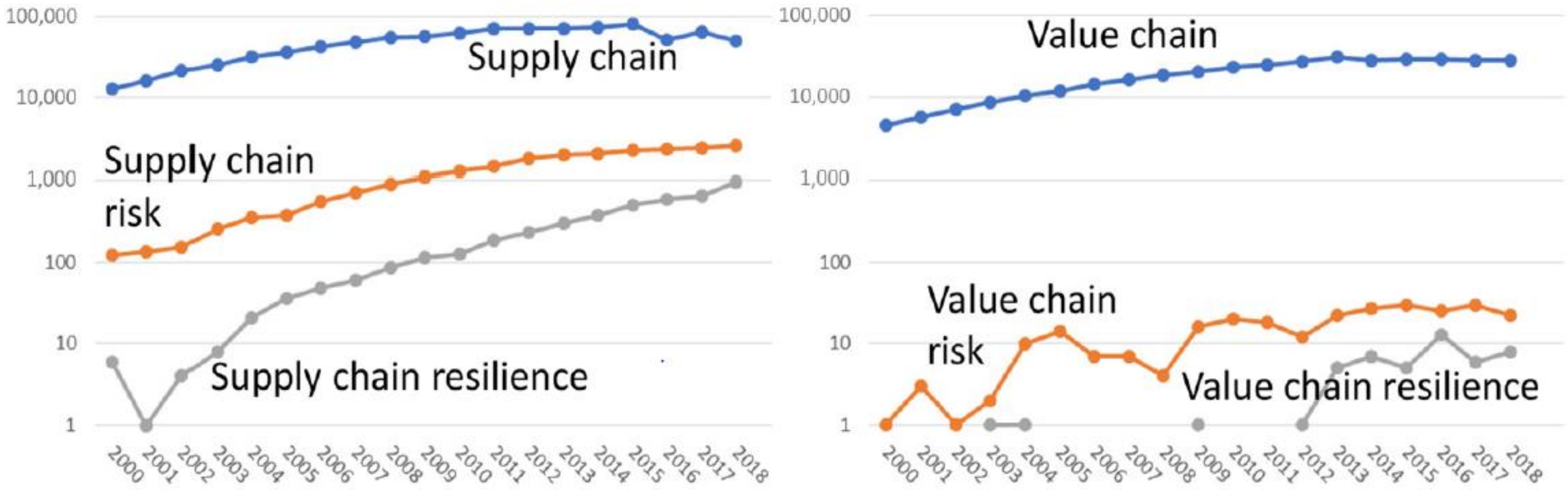
Supply Chain Resilience



ENVIRONMENTAL LABORATORY

Field of Supply Chain Resilience is New

Web of Science Publications

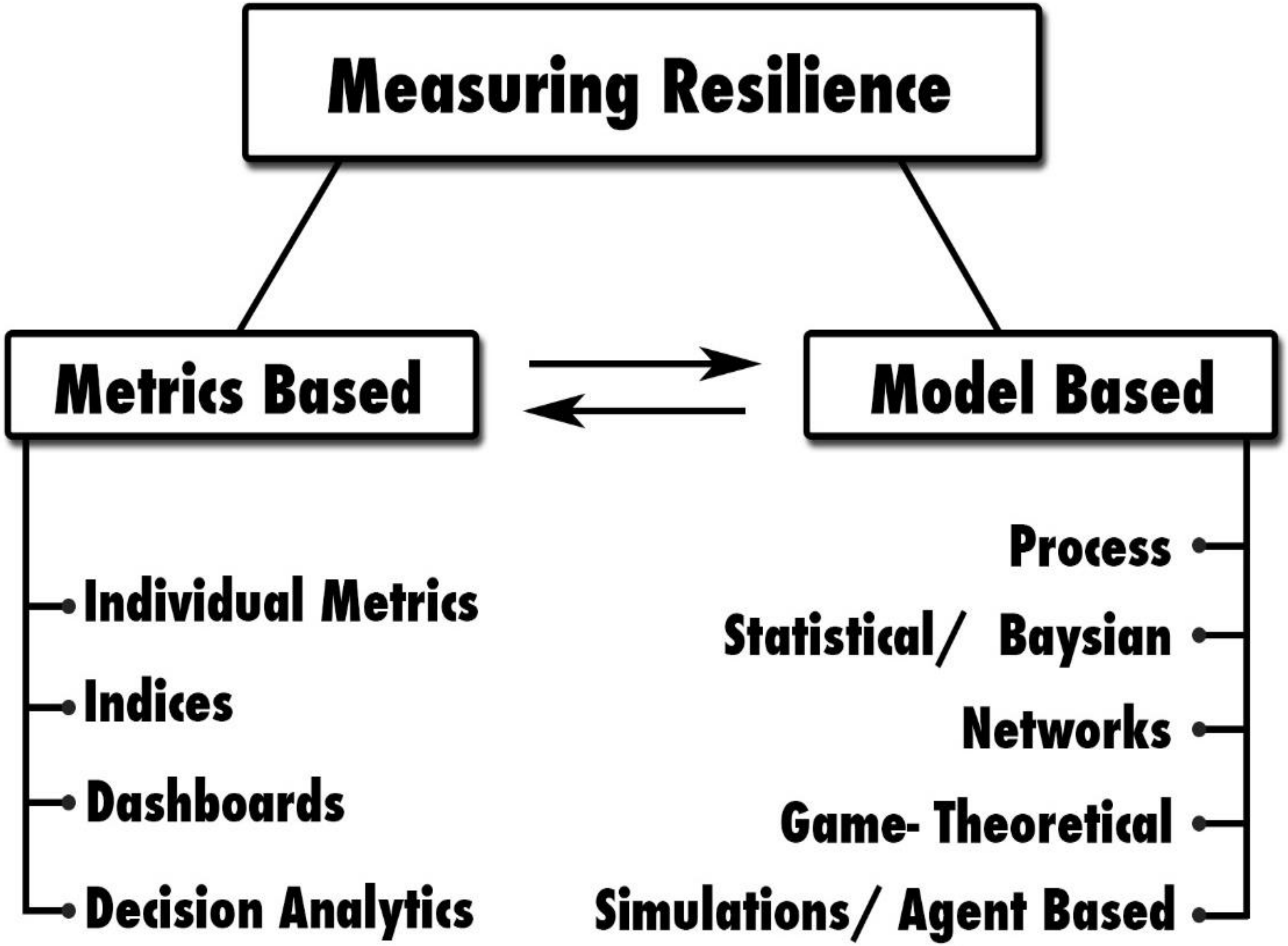


2020

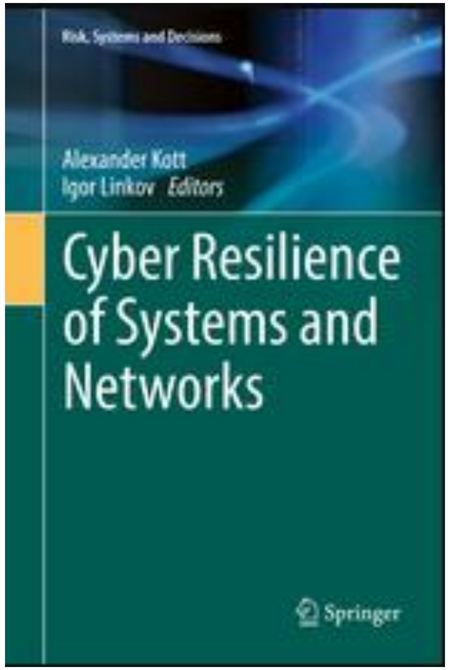
The case for value chain resilience

Igor Linkov, Savina Carluccio, Oliver Pritchard, Áine Ní Bhreasail,
Stephanie Galaitsi, Joseph Sarkis and Jeffrey M. Keisler

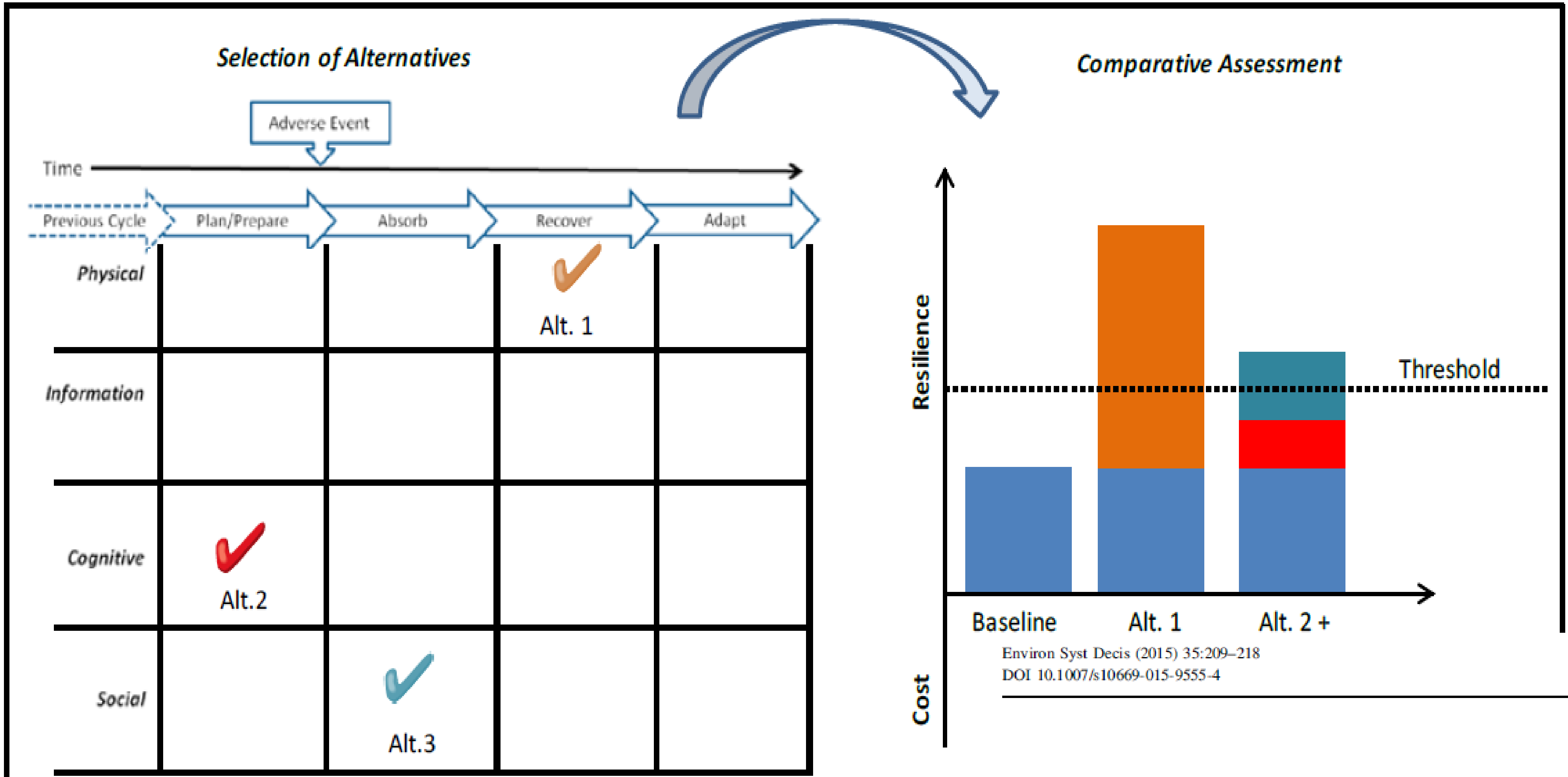
Management Research Review
© Emerald Publishing Limited
2040-8269
DOI 10.1108/MRR-08-2019-0353


Measuring Resilience
Metrics Based
Model Based
Individual Metrics
Indices
Dashboards
Decision Analytics
Process
Statistical/ Baysian
Networks
Game- Theoretical
Simulations/ Agent Based

After
2019


Risk, Systems and Decisions
Alexander Kott
Igor Linkov Editors
Cyber Resilience of Systems and Networks
Springer

Assessment using Resilience Matrix



Use resilience metrics to comparatively assess the costs and benefits of different courses of action

Environ Syst Decis (2015) 35:209–218
DOI 10.1007/s10669-015-9555-4

A matrix approach to community resilience assessment: an illustrative case at Rockaway Peninsula

Cate Fox-Lent[1] · Matthew E. Bates[1] · Igor Linkov[1]

Network-based Resilience Theory?

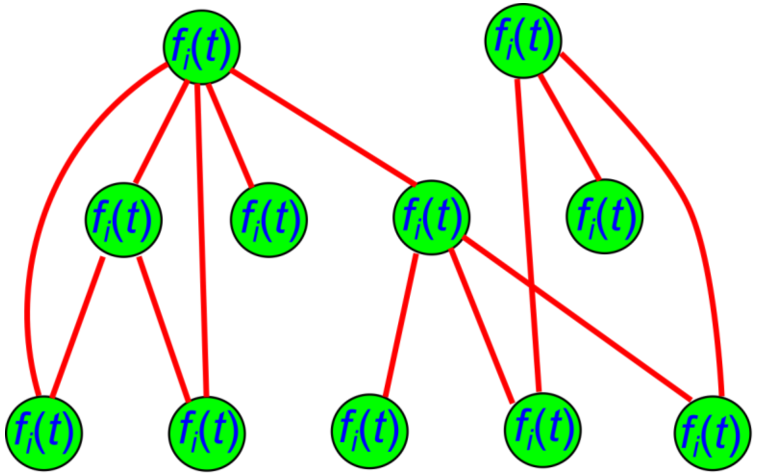
System's *critical functionality* (*K*)

Network topology: *nodes* ($\mathcal{N}$) and *links* ($\mathcal{L}$)

Network *adaptive algorithms* ($\mathcal{C}$) defining how nodes' (links') properties and parameters change with time

A *set of possible damages* stakeholders want the network to be resilient against ($\boldsymbol{E}$)

$$R = f(\mathcal{N}, \mathcal{L}, \mathcal{C}, \boldsymbol{E})$$



After Ganin et al., 2016

Poor Efficiency:

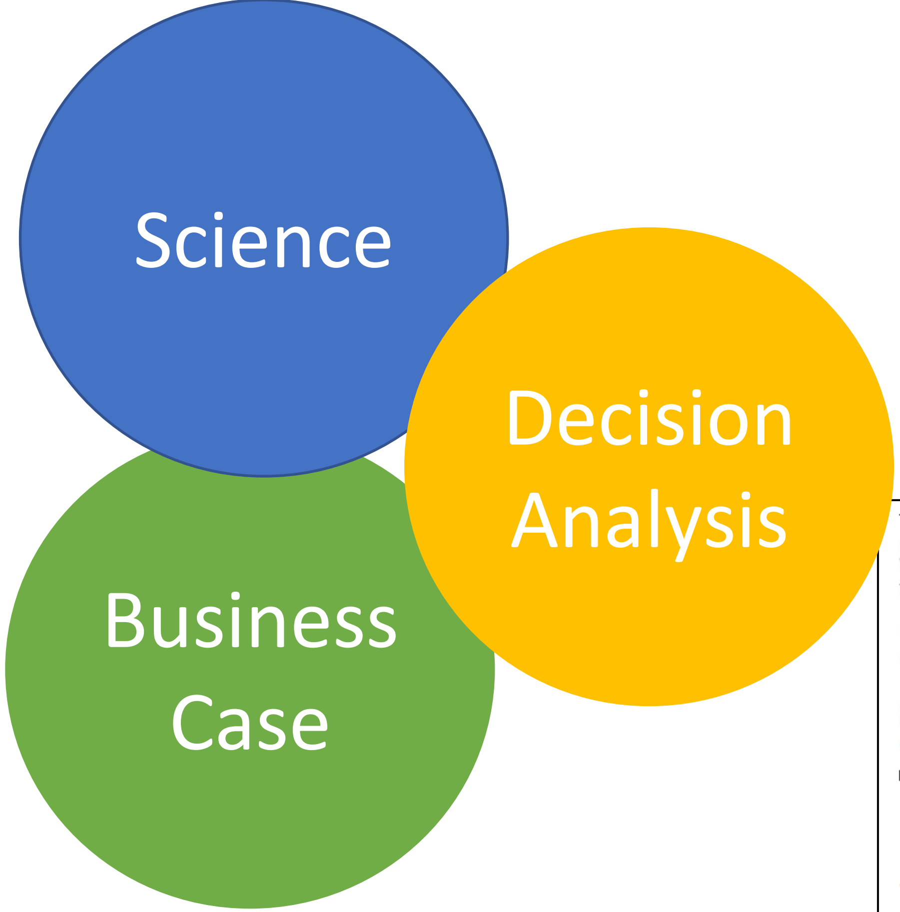
System cannot not accommodate a large volume of commuters driving at the same time.

Traffic congestions are predictable and are typically of moderate level.

Lack of Resilience:

System cannot recover from adverse events
(car accidents, natural disasters)

Traffic disruptions are not predictable and of variable scale.



Transportation Network Model

+

Regional Economic Models, Inc.

Contents lists available at ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

Lack of resilience in transportation networks: Economic implications

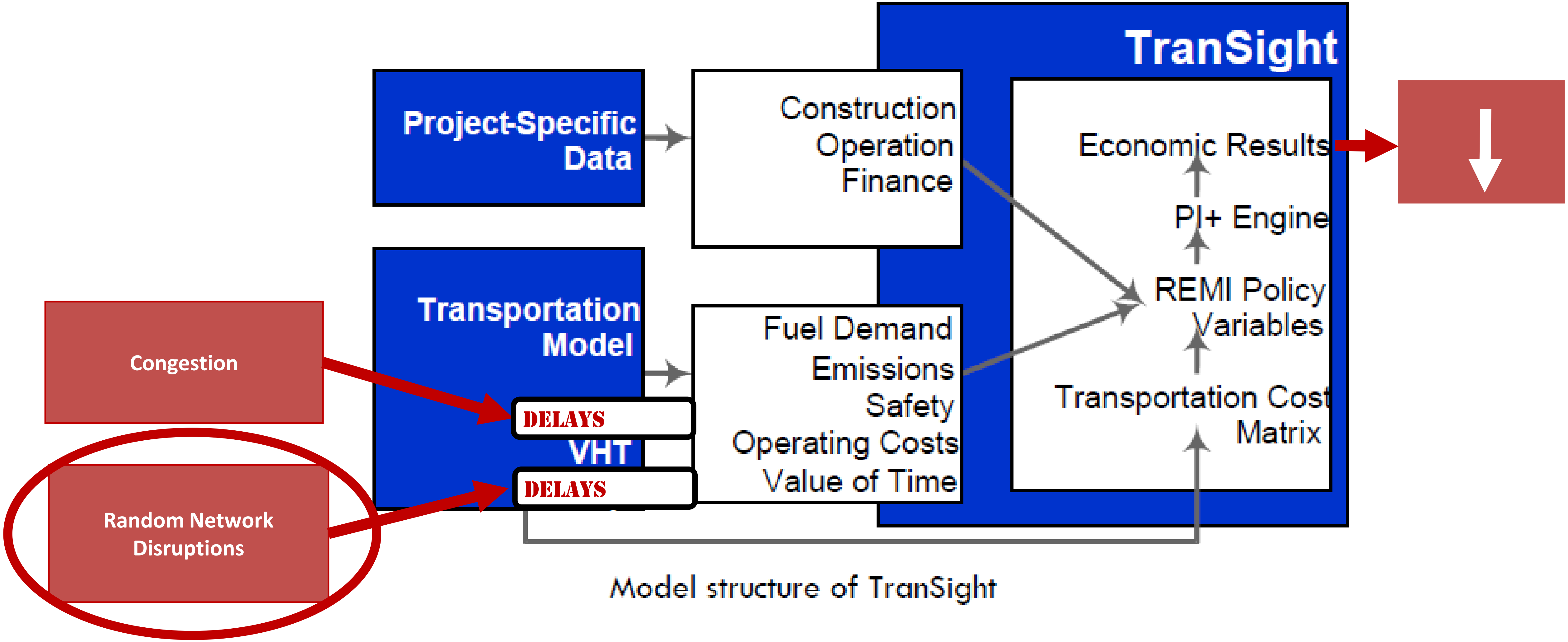
SCIENCE ADVANCES | RESEARCH ARTICLE

NETWORK SCIENCE

Resilience and efficiency in transportation networks

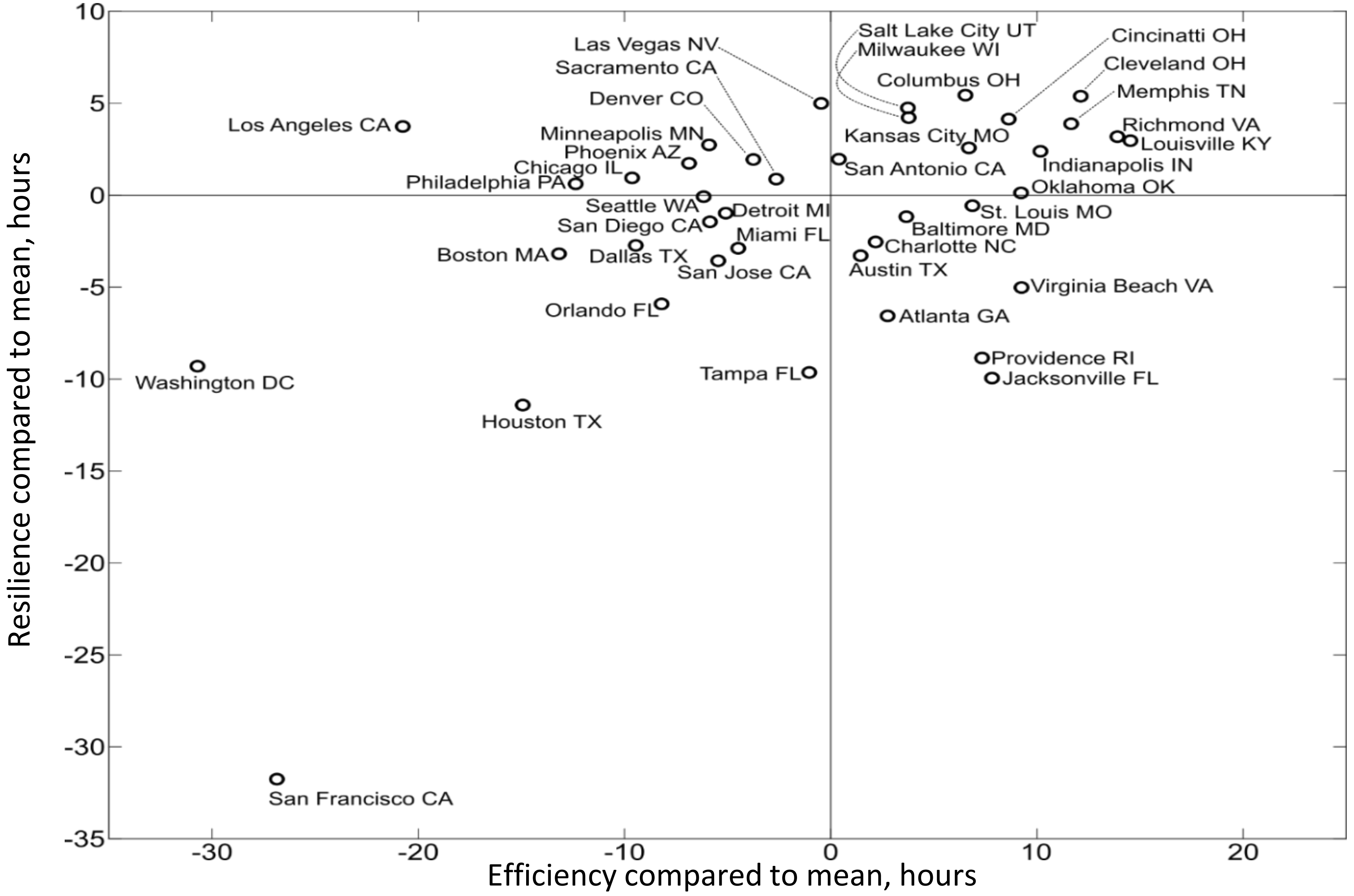
Alexander A. Ganin,[1,2] Maksim Kitsak,[3] Dayton Marchese,[2] Jeffrey M. Keisler,[4] Thomas Seager,[5] Igor Linkov[2]*

Repurpose to Study Economic Implications of Resilience (or lack thereof)

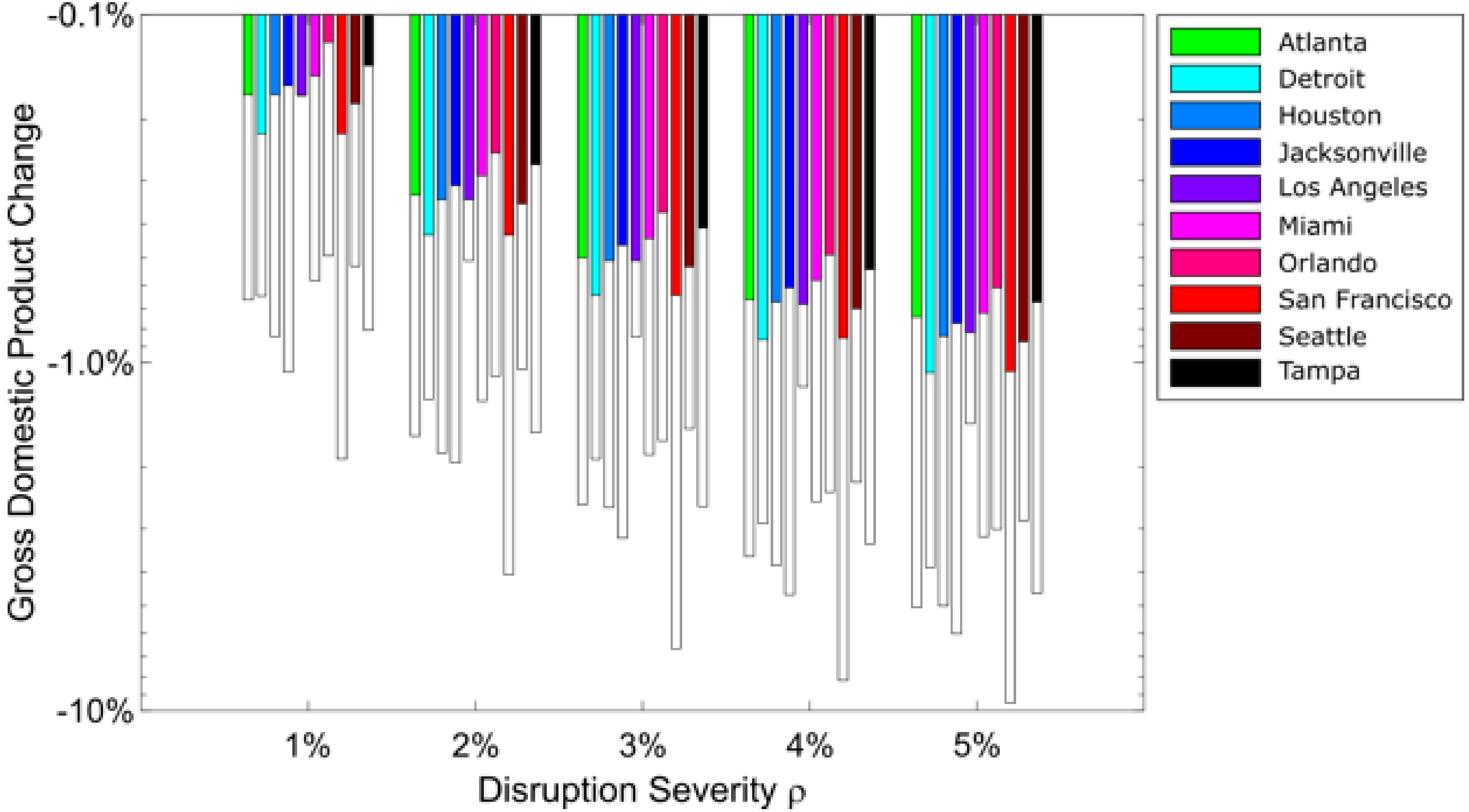


Model structure of TranSight

Resilience vs Efficiency at 5% disruption

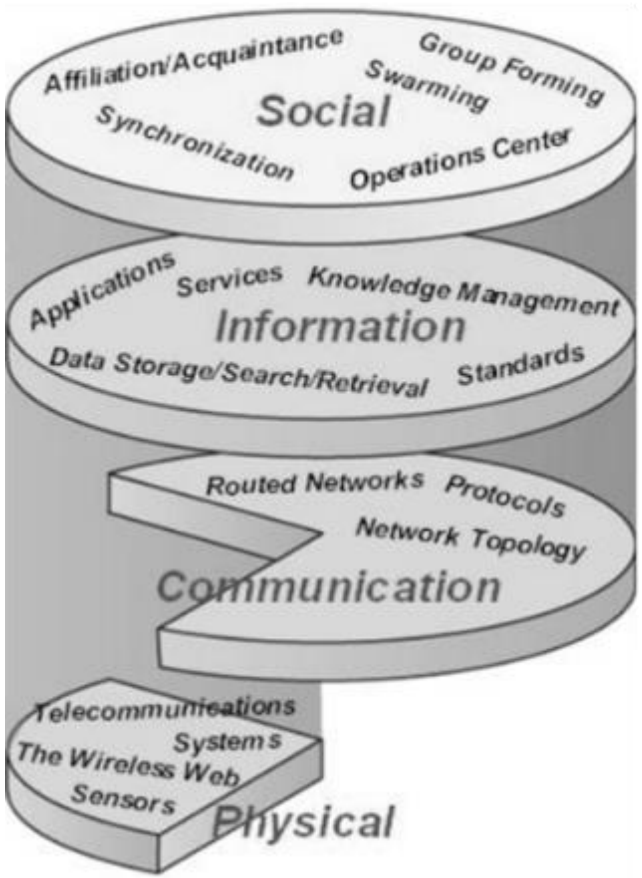


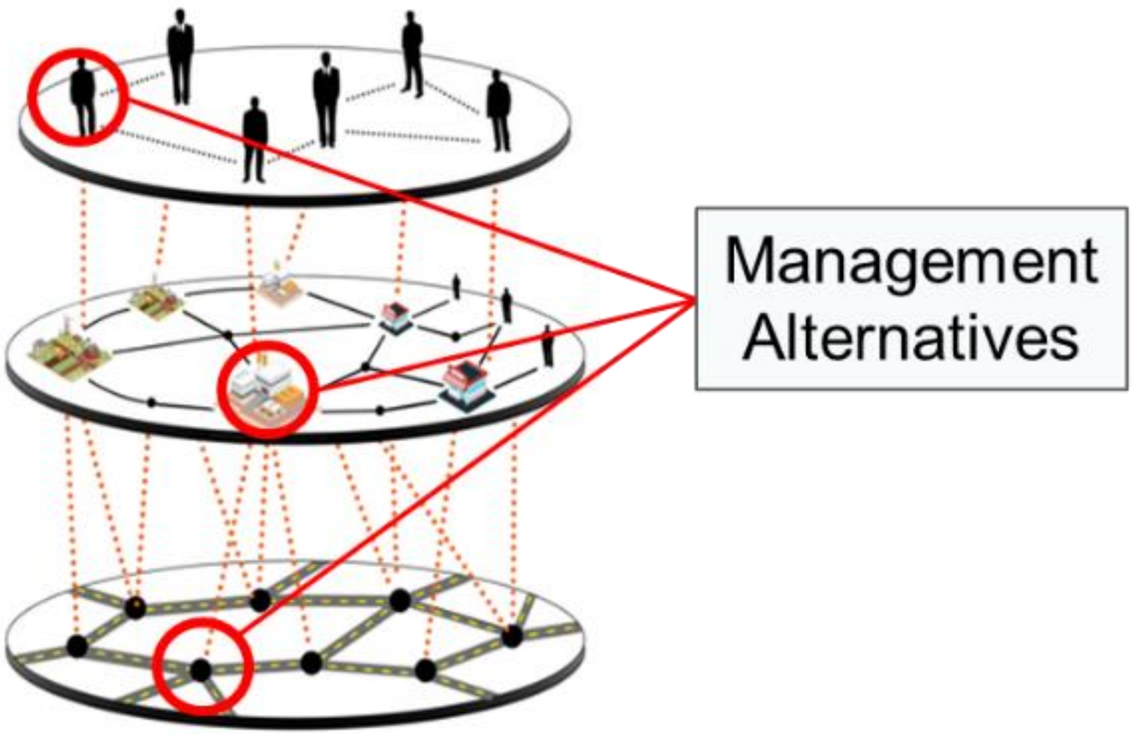
Lack of Resilience: Impact on GDP
Random Disruptions are Much More Consequential



Vision for System Resilience

Real World | Model | Operations





The case for value chain resilience

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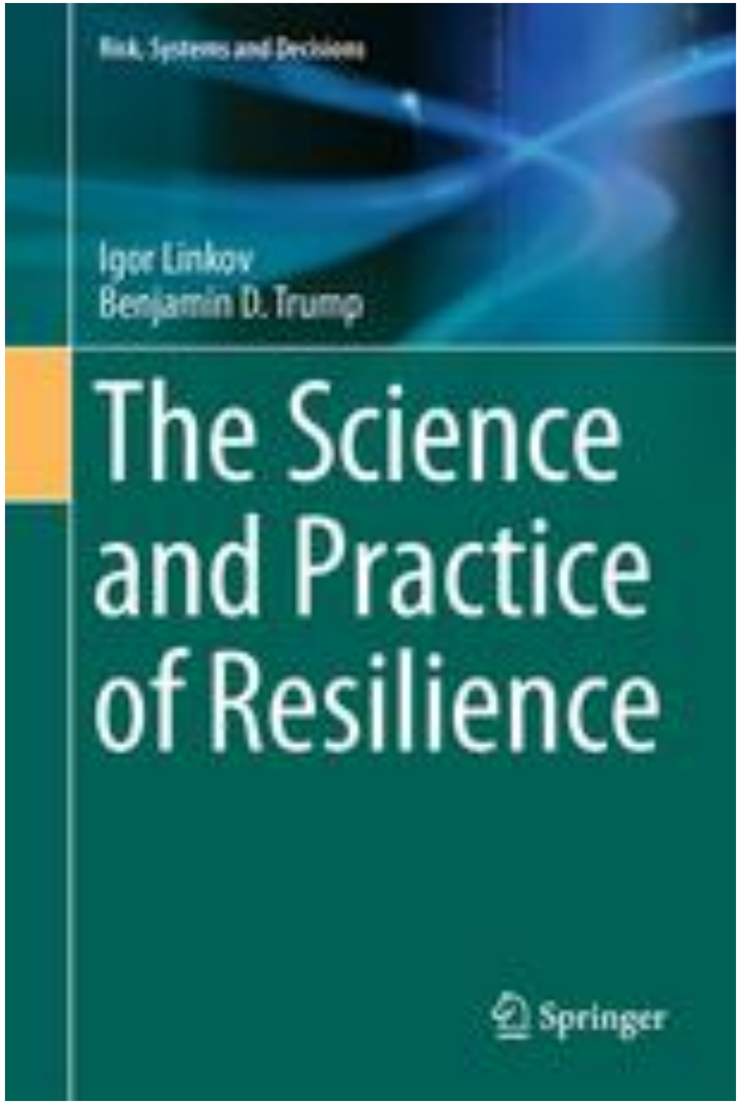
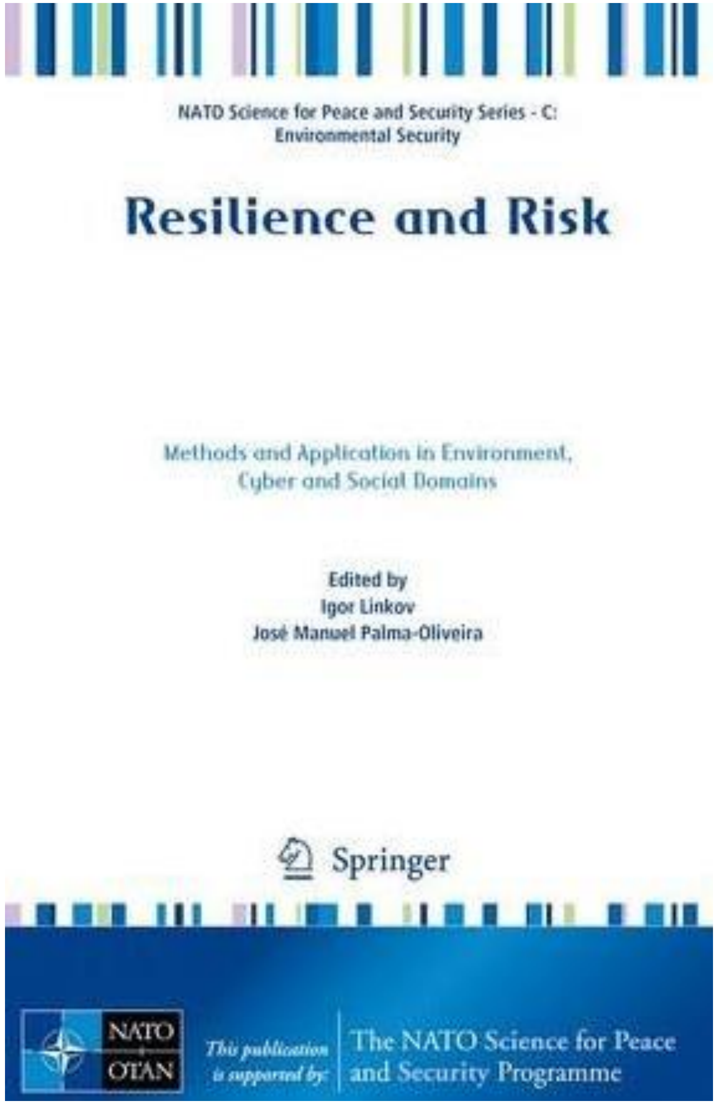
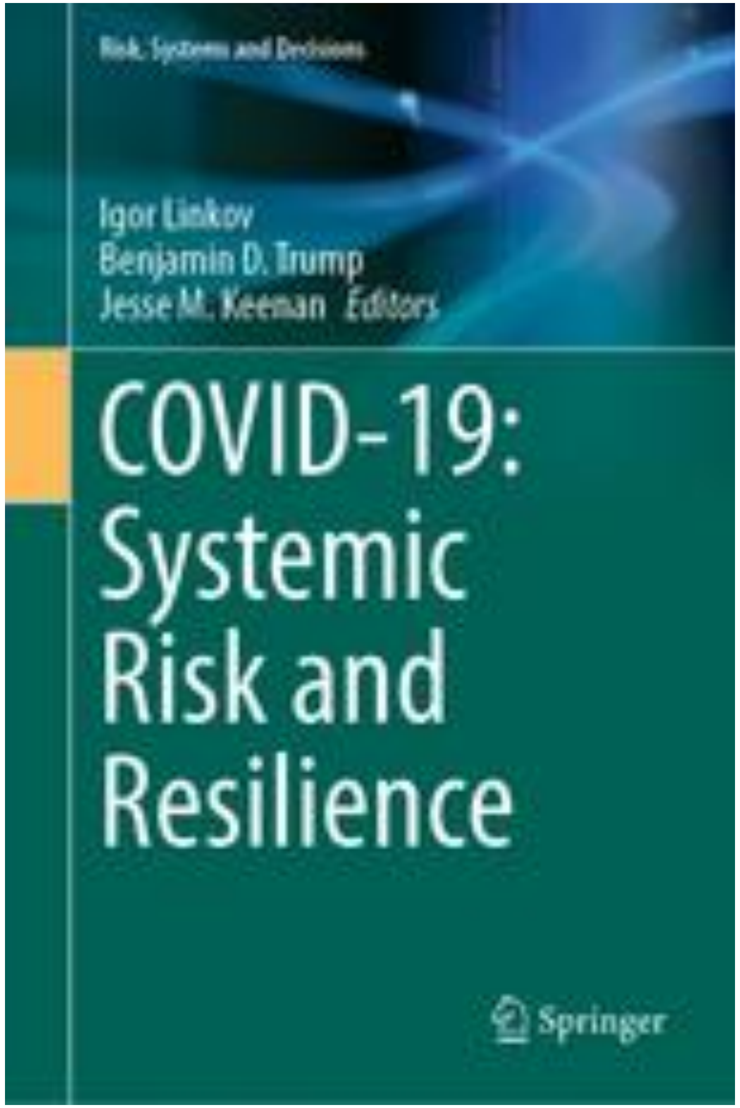

Risk, Systems and Decisions
Igor Linkov
Benjamin D. Trump
The Science and Practice of Resilience
Springer


NATO Science for Peace and Security Series - C: Environmental Security
Resilience and Risk
Methods and Application in Environment, Cyber and Social Domains
Edited by
Igor Linkov
José Manuel Palma-Oliveira
Springer
NATO OTAN
This publication is supported by:
The NATO Science for Peace and Security Programme

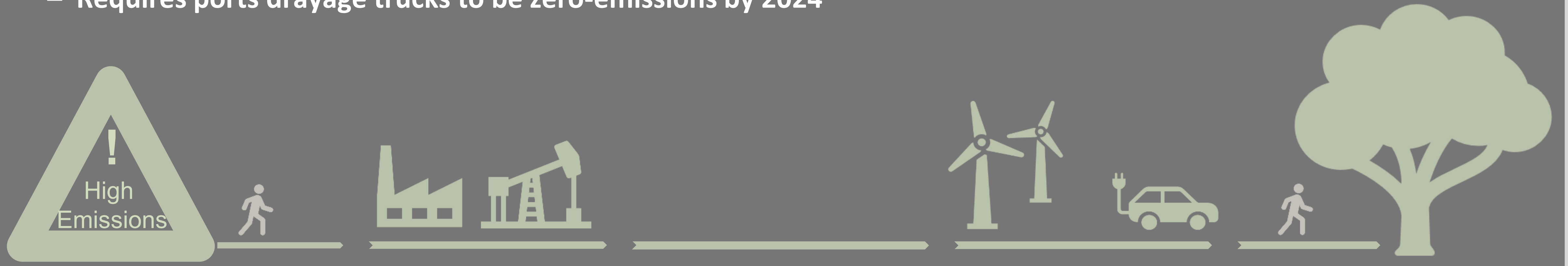

Risk, Systems and Decisions
Igor Linkov
Benjamin D. Trump
Jesse M. Keenan Editors
COVID-19: Systemic Risk and Resilience
Springer

I. Introduction: Optimizing the Location of Medium- & Heavy-Duty Zero-Emission Infrastructure- Legislative Motivation

- **Executive Order N-79-20**
  - **Reach 100% zero-emission sales by 2035:**
    - **passenger vehicles, short-haul trucks, drayage trucks**
  - **Buses and heavy-duty long-haul trucks by 2045**

- **Advanced Clean Trucks Rule**
  - **Requires manufacturers to produce a percent of zero-emission vehicles each year.**
  - **Requires ports drayage trucks to be zero-emissions by 2024**

- Advance Clean Fleets Rule (set to pass in October)
  - Requires commercial fleets to have a percent of zero-emission
  - The percent increases over time



I. Introduction: Zero-Emission Refueling Stations

- **Challenge:**
  Minimize the diversion of freight routes caused by fuel conversion

- **Solution:**
  Identify gas stations that could be converted to dispensing stations:
  - minimize freight displacement
  - scalable

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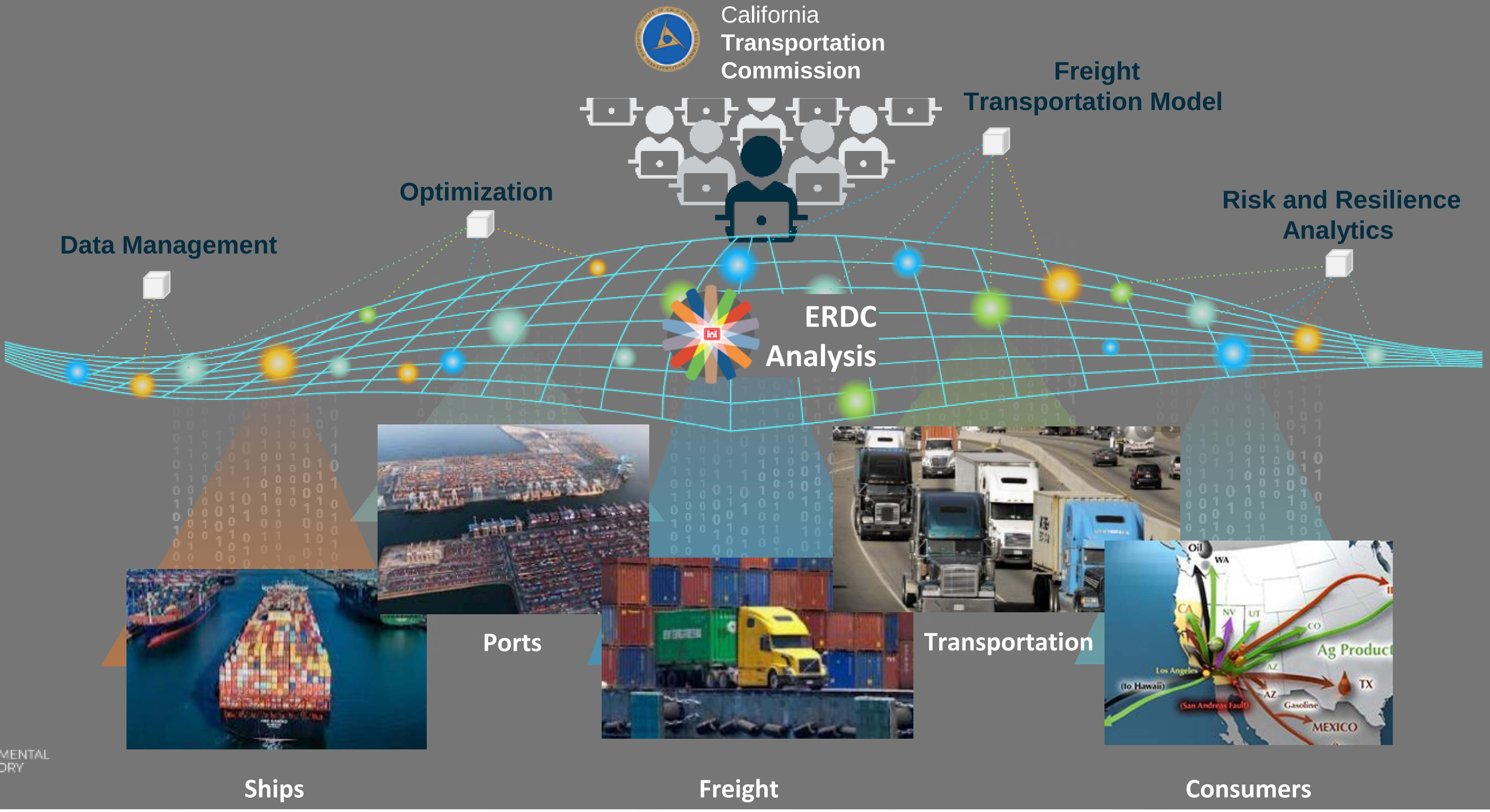
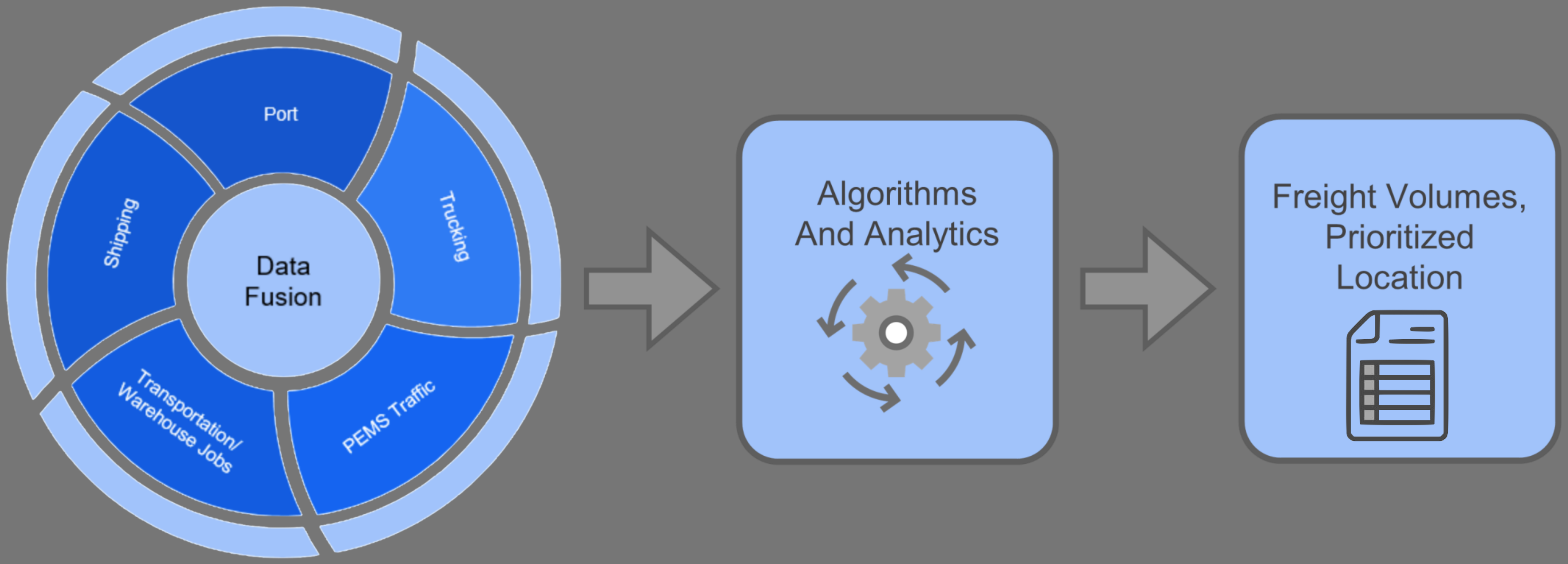
I. Introduction: Project Goal - A System Level Approach Minimizing Freight Disruption

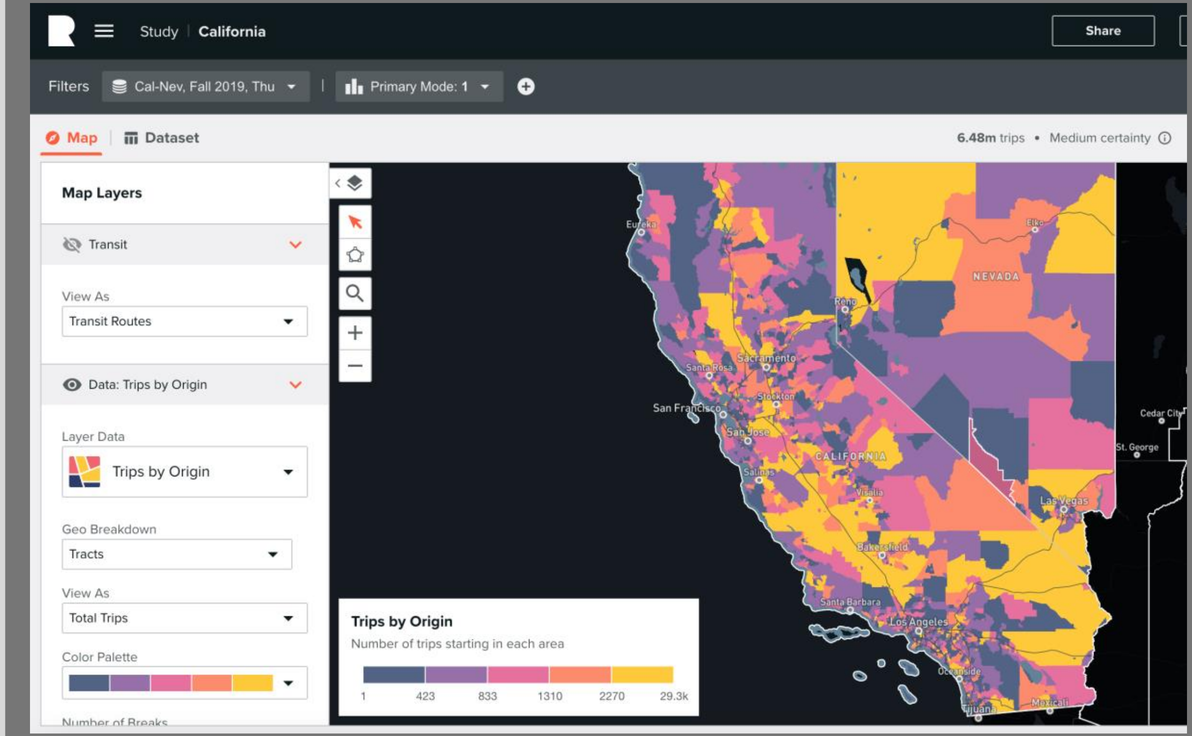


II. Methodology: Data Fusion and Optimization Using AI, Modeling and Resilience Analytics

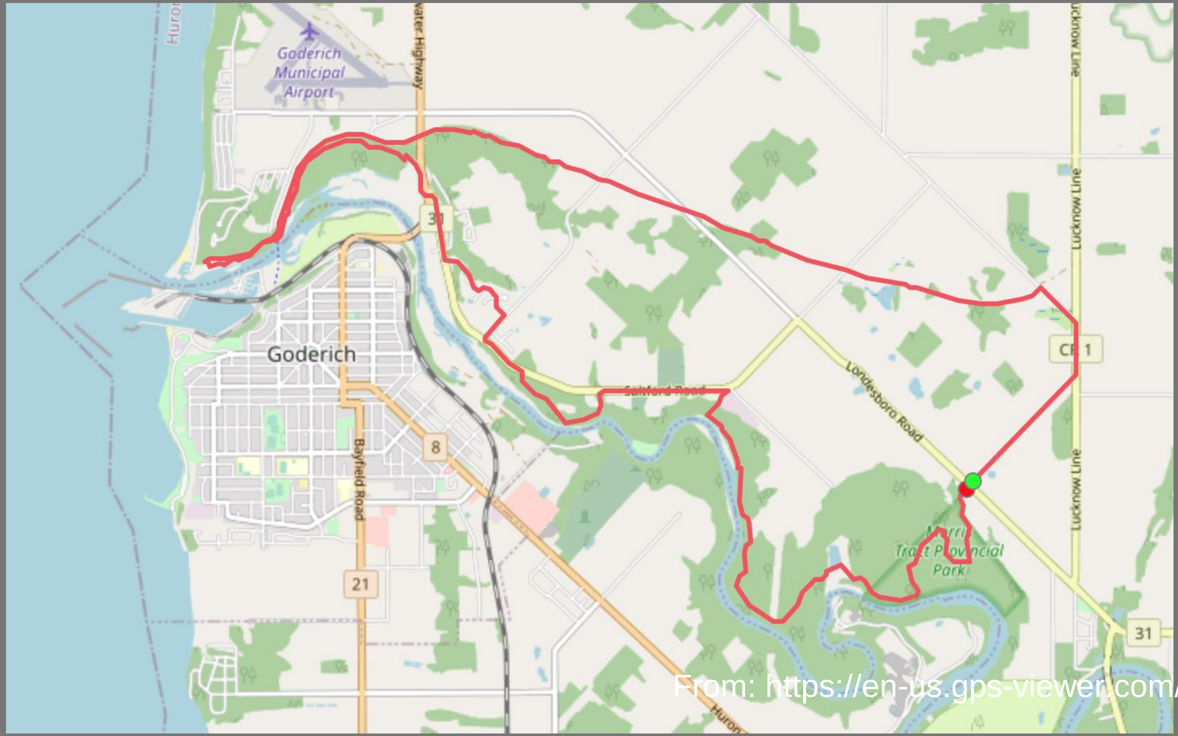


II. Methodology: Replica and GPS Data: Connecting Entry Points, Warehousing and Consumers

Replica - Modeled Trips



GPS - Real Truck Location Data



From: https://en-us.gps-viewer.com/

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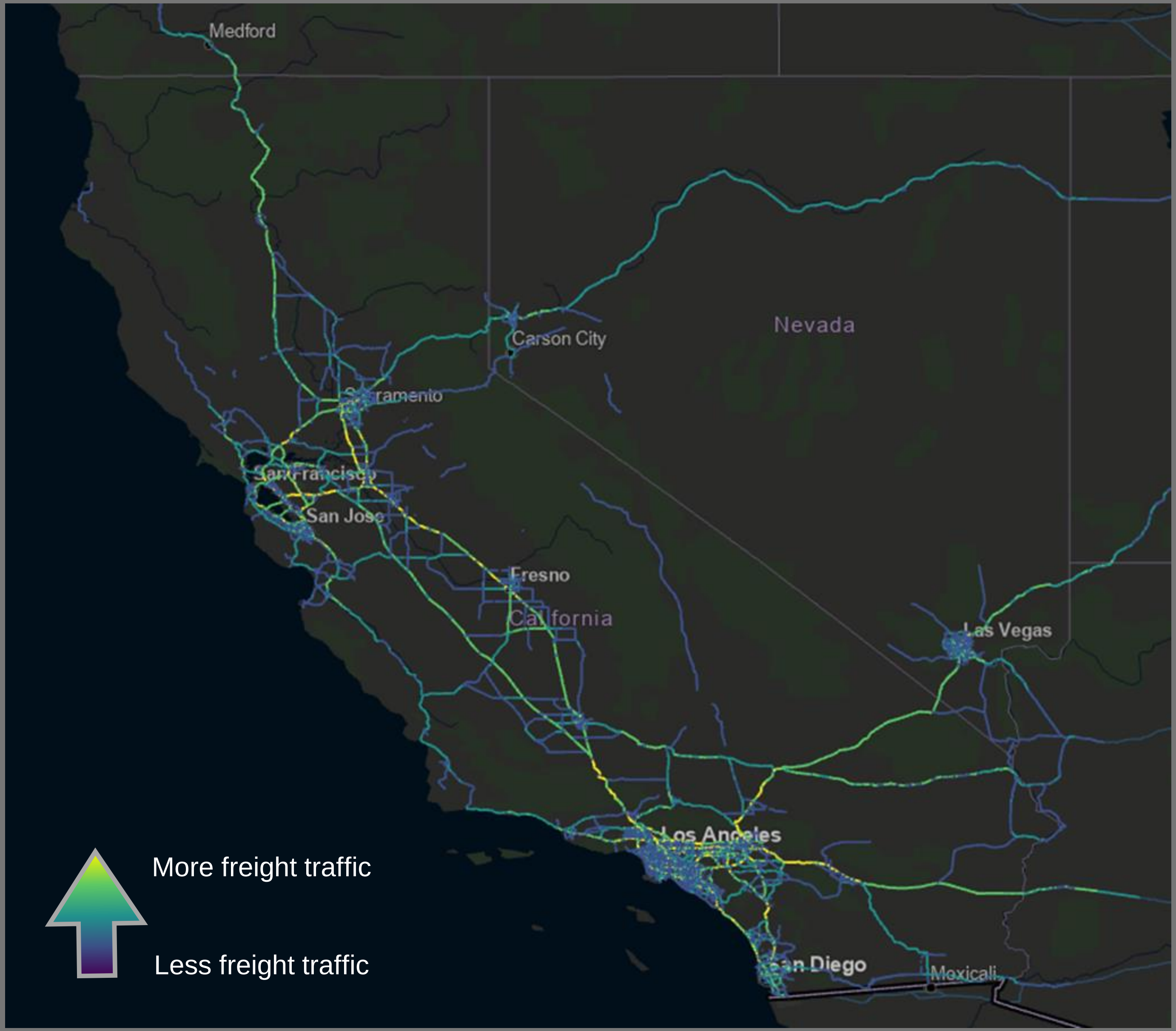
II. Methodology: Replica Freight Volumes

- Aggregate Flows
- Medium vs Heavy Trucks
- Long Haul
- CA External Goods:
  - Ports
  - Airports
  - Land Points of Entry



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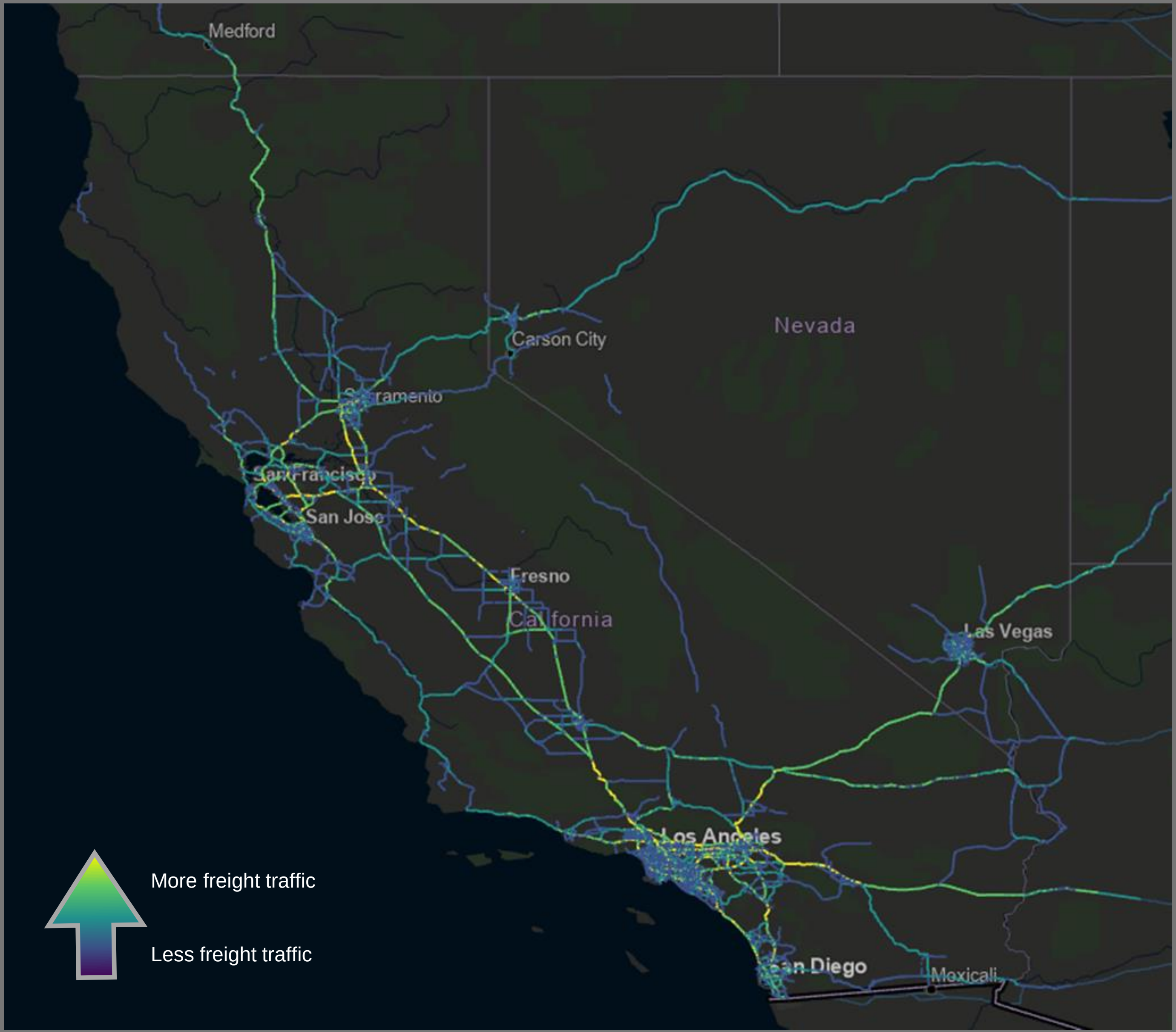

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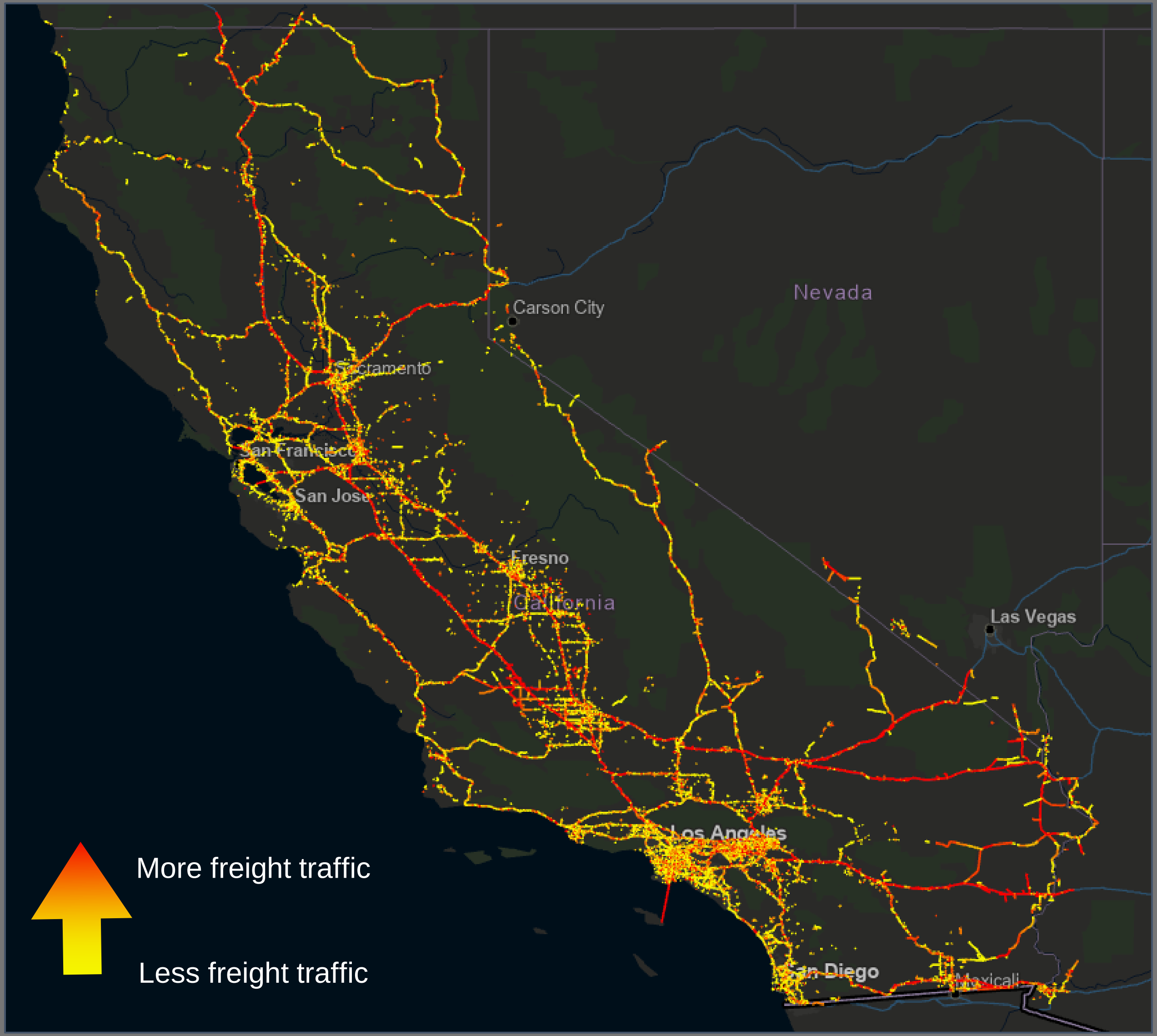
II. Methodology: GPS Freight Volumes

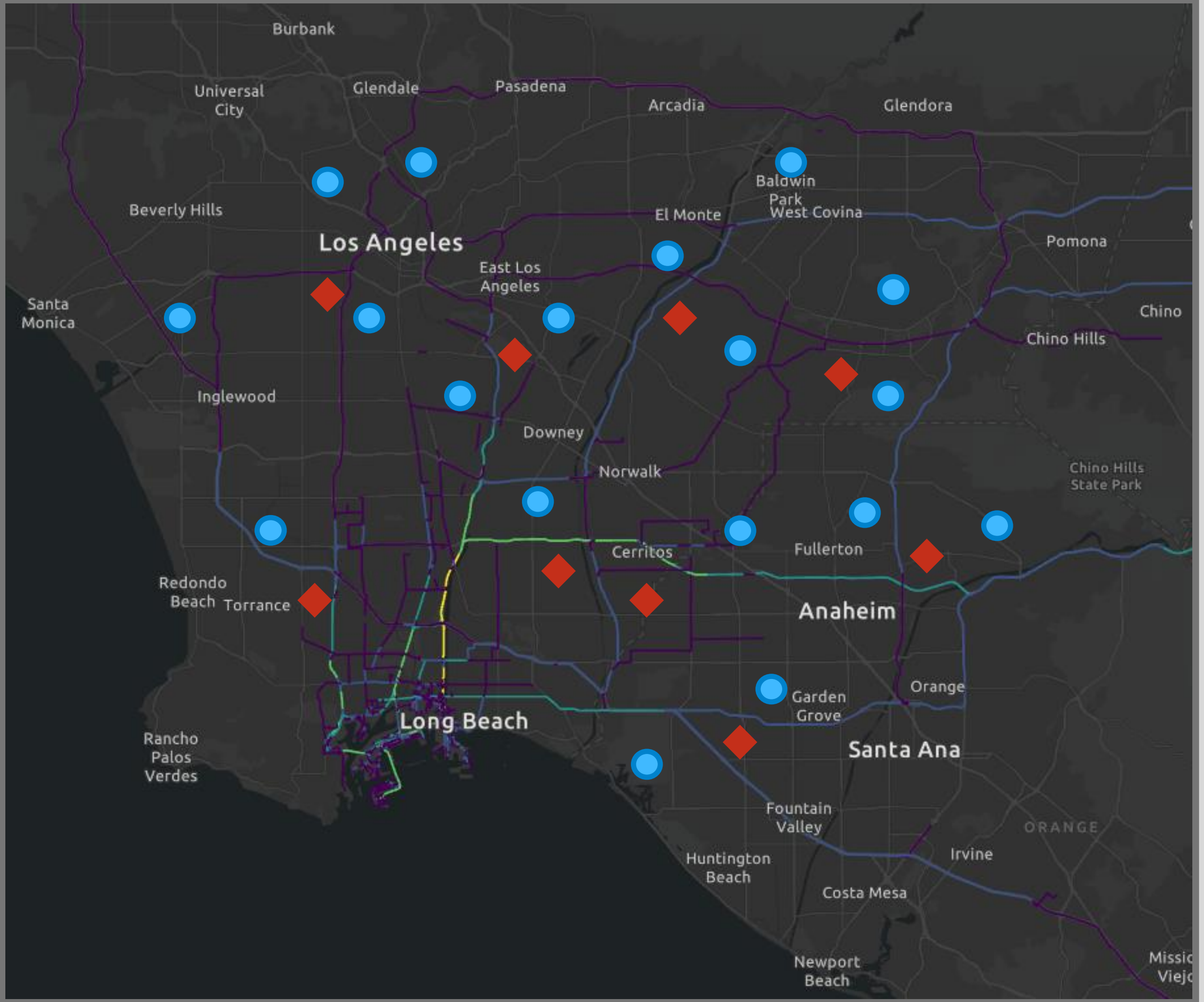
- Aggregate Flows
- Medium vs Heavy Trucks
- Long Haul
- CA External Goods:
  - Ports
  - Airports
  - Land Points of Entry



II. Methodology: Facility Location Problem

- Assigns Demand to Facilities such that an objective is minimized
    - Objective = **Total Travel Time**

- **Need:**
    - Demand Locations
    - Facility Locations
    - Travel Time between Demand and Facilities



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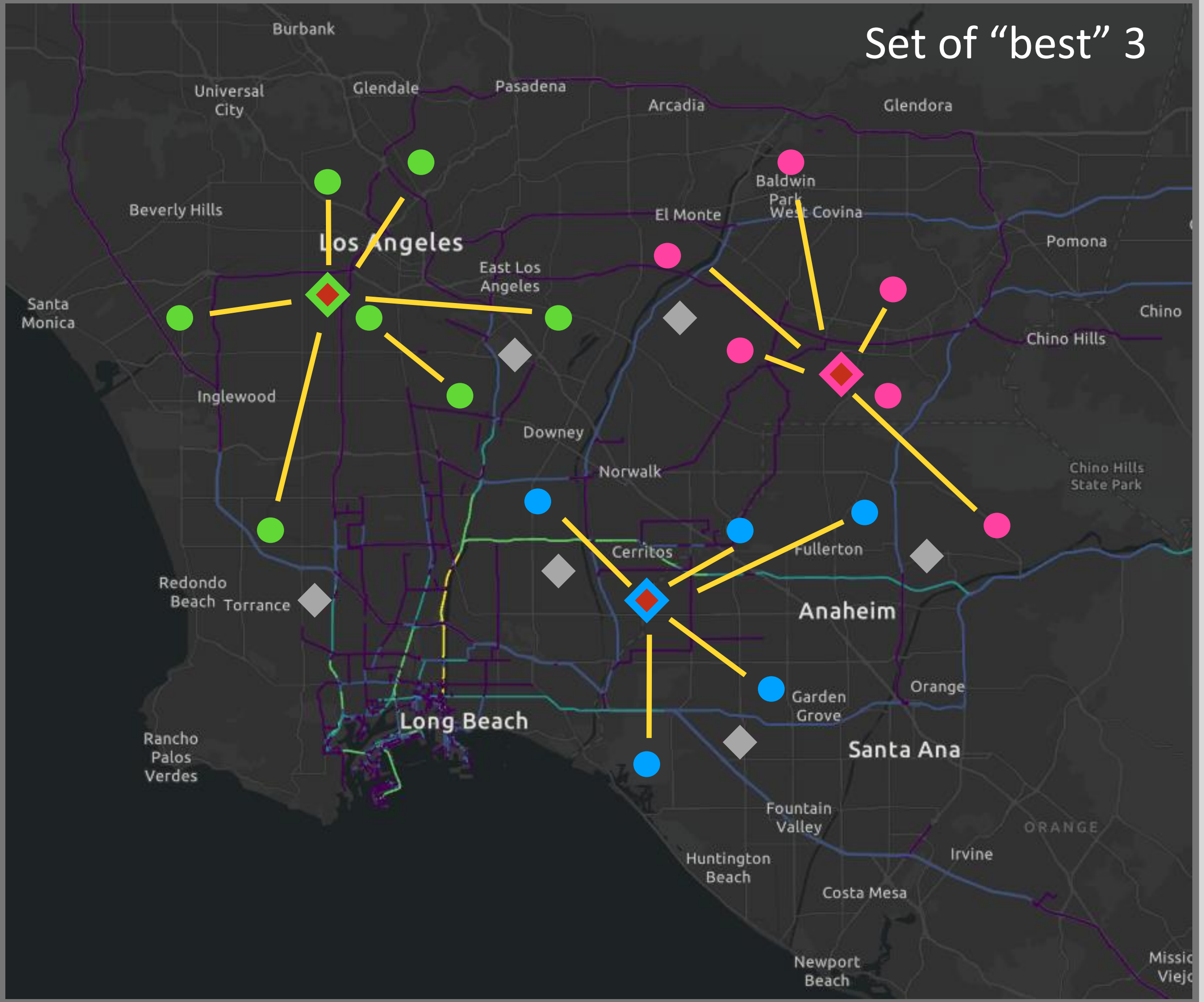

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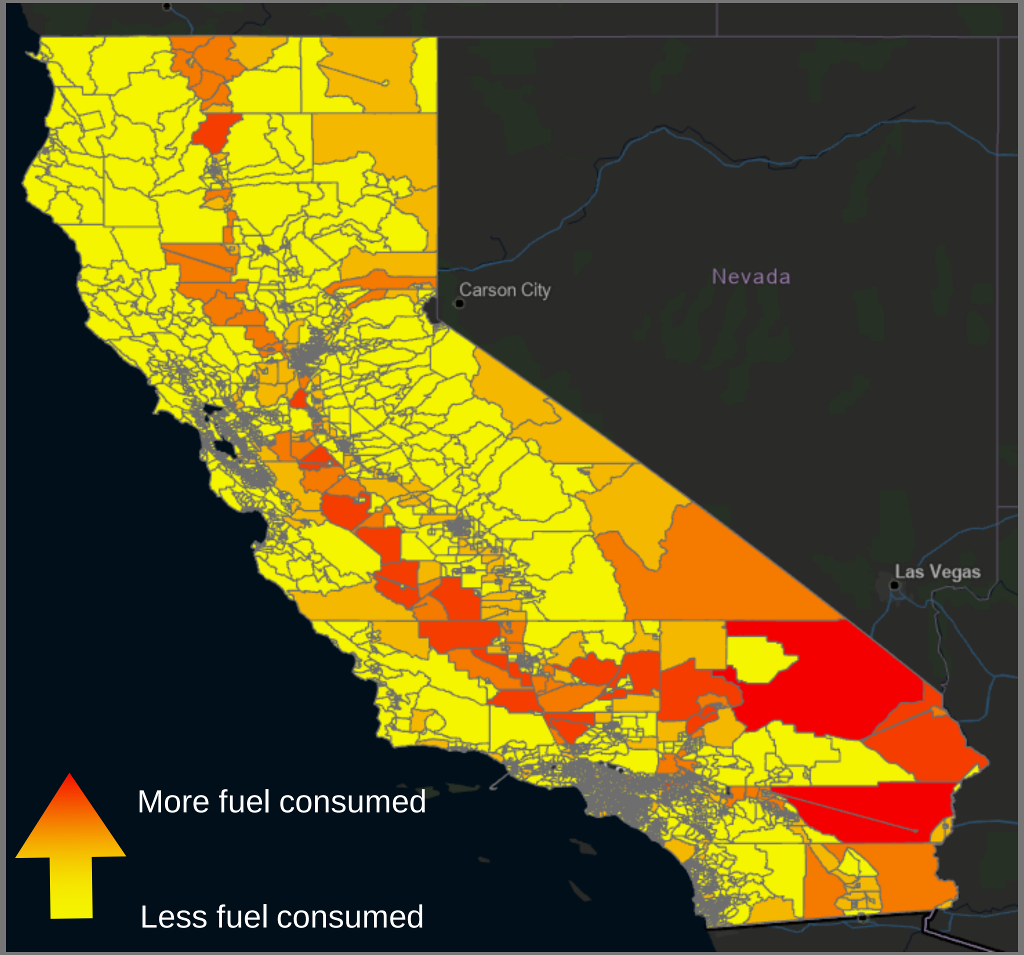
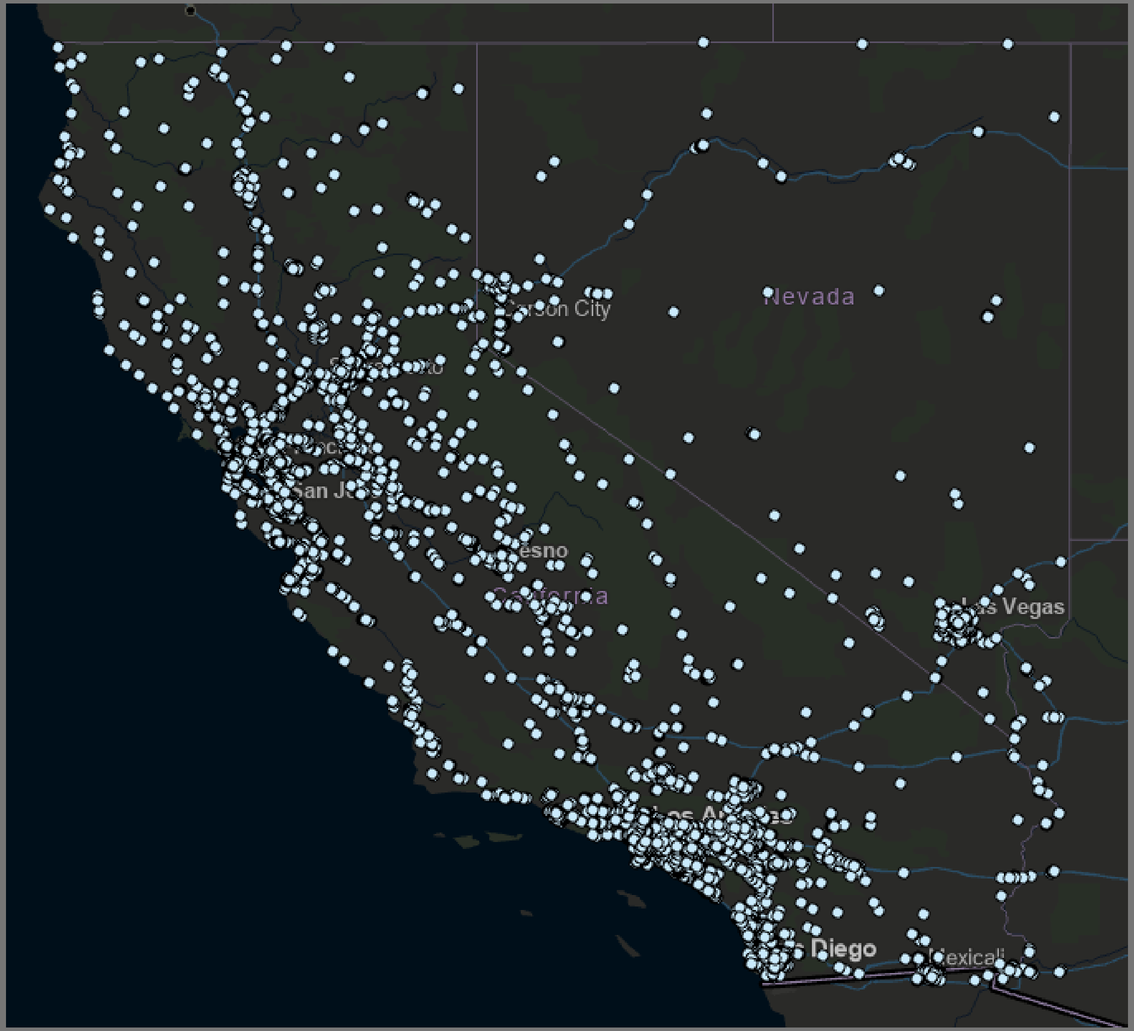
III. Results: Demand



III. Results: Refueling Site Candidates Gas and Service Stations

- **Candidates:**
  Candidates were census block which contained at least one currently existing gas or service station

- **Details:**
  - Tracts were used rather than stations to allow for more flexibility in site location determinations
  - Aggregating to tracts also simplified the optimization

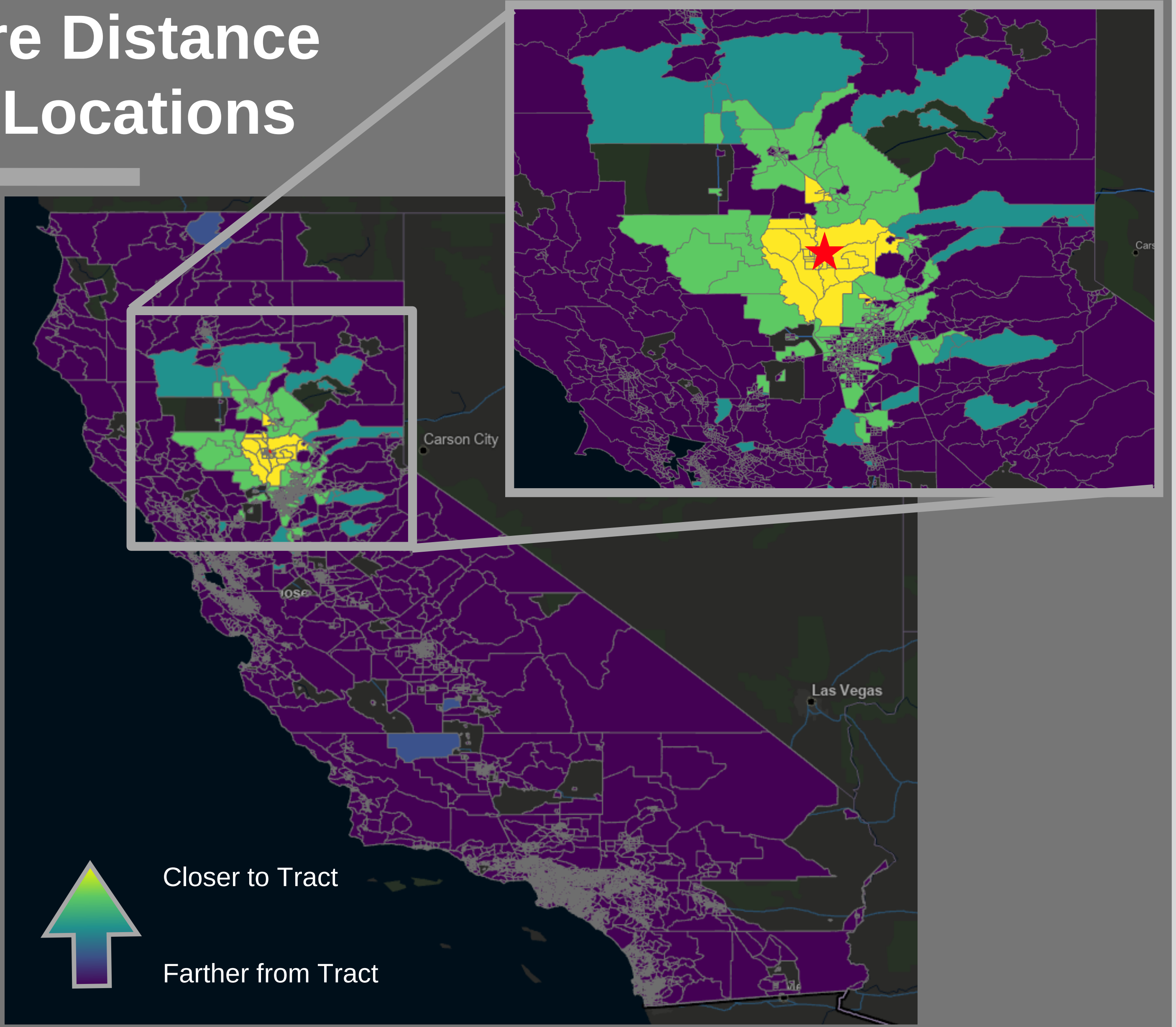


ENVIRONMENTAL LABORATORY

III. Results: Congestion Aware Distance Fuel Demand and Candidate Locations

- **Distances:**
  Mean travel time between tracts from Replica freight trips data

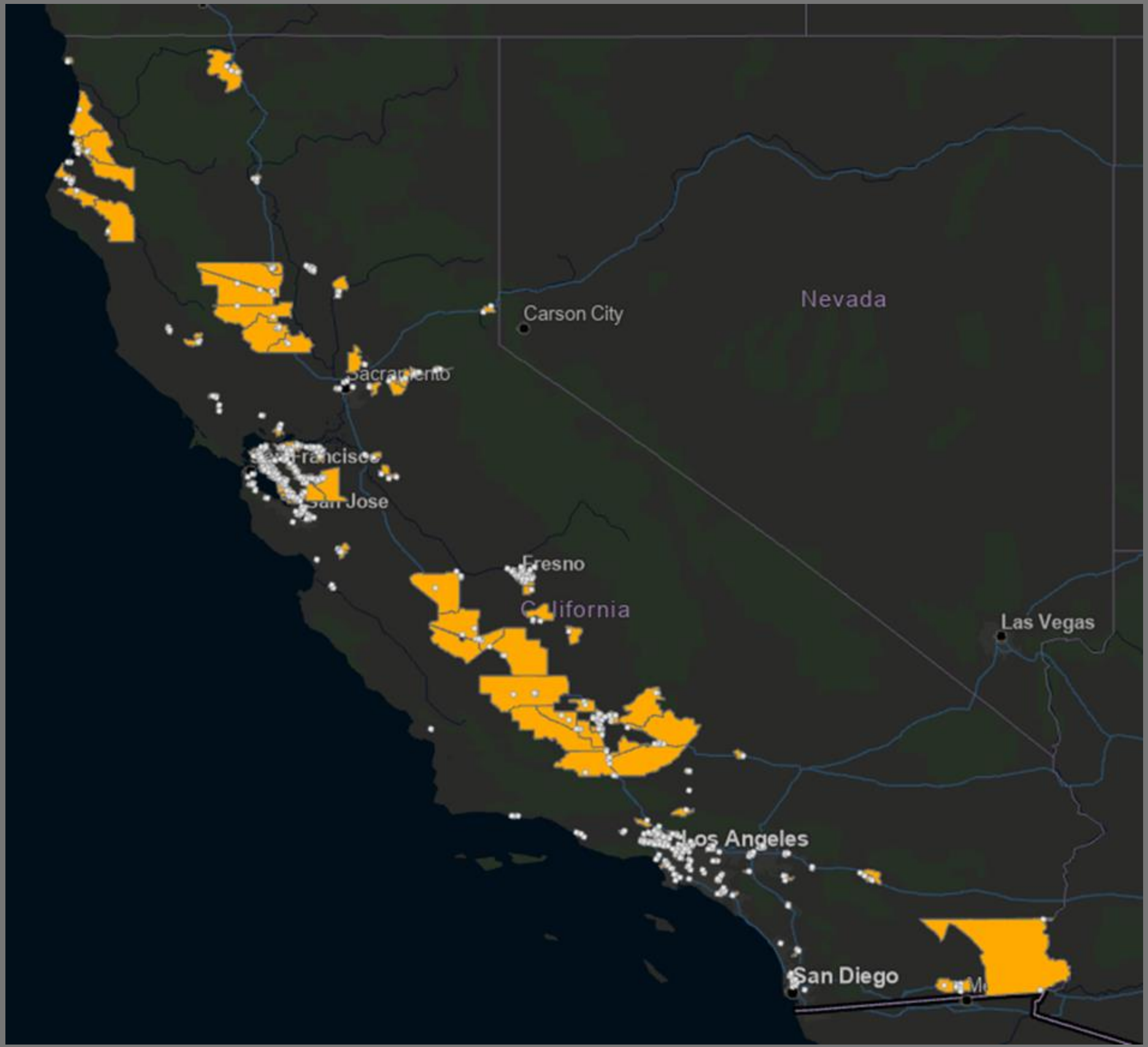
- **Details:**
  - Trip data was used so that travel distances were 'congestion aware'
  - If no trips existed between blocks, travel time was set to 1 day



ENVIRONMENTAL LABORATORY

III. Optimization Results: Candidate Locations

- **Identified:**
  500 Candidate Census block which, together minimize freight diversion
- **Details:**
  - 500 block were identified based on CTC input
  - Gas and Service stations within census blocks were also identified



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III. Results: Hubness
Quantifying Location Scalability

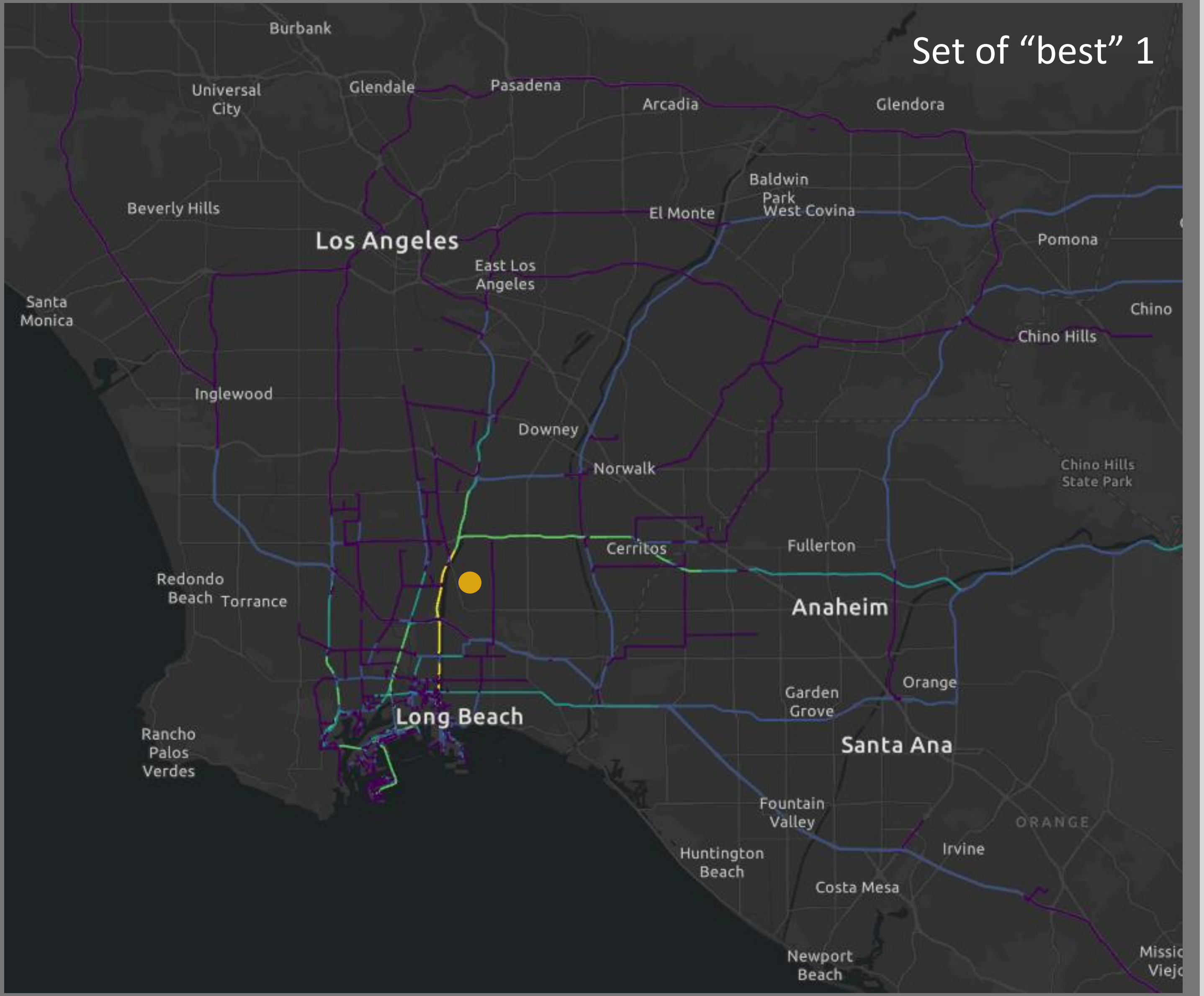
Want: Quantify the Scalability of Locations

Solution: Rank solutions by hubness

Hubness:

1. Re-ran for sets of best (1, 2, …., 500) stations
2. Count of how many sets contain any location

  - High hubness = Scales well as more are added
  - Probably in a good, central location



ENVIRONMENTAL LABORATORY

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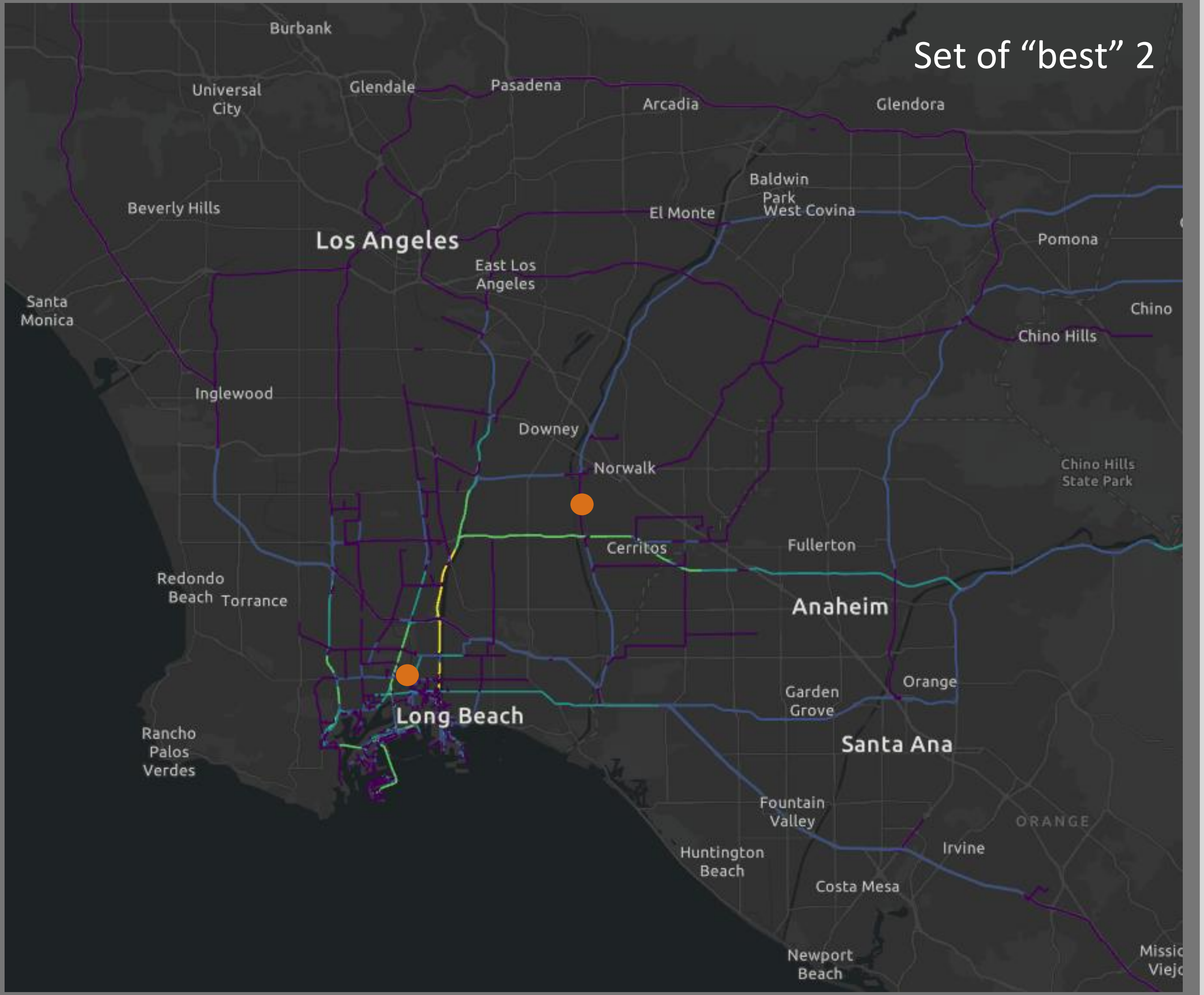

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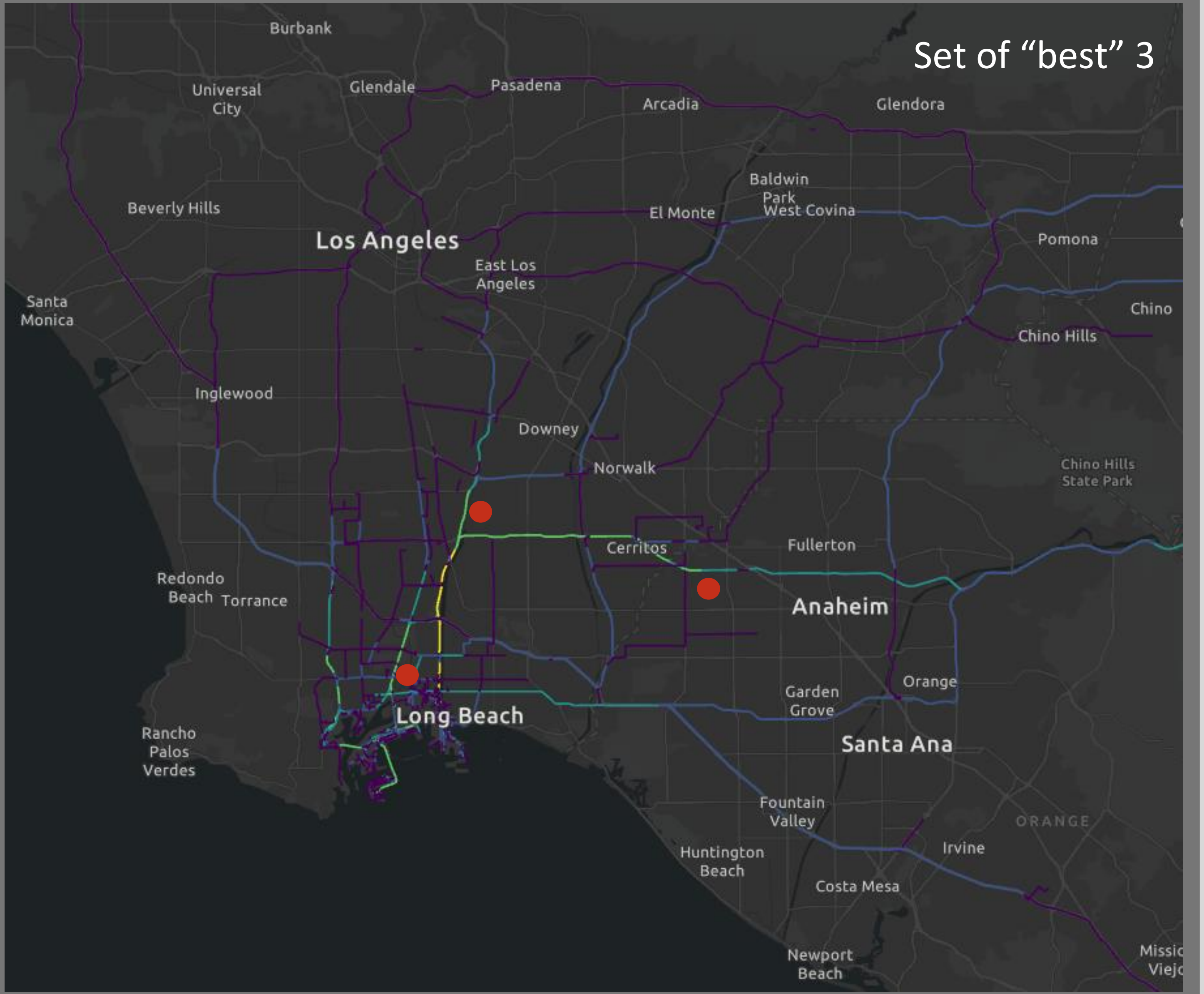

ENVIRONMENTAL LABORATORY

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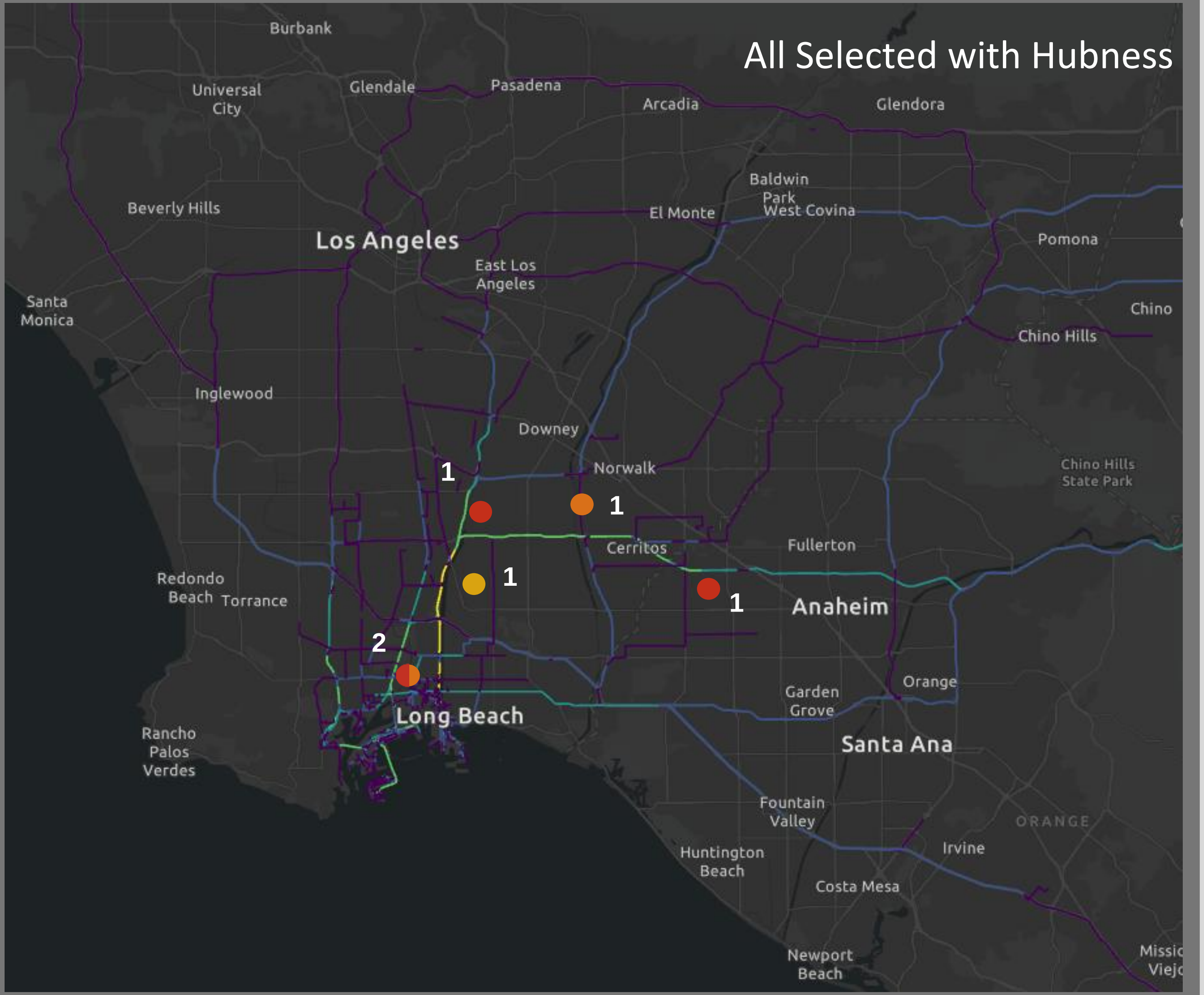

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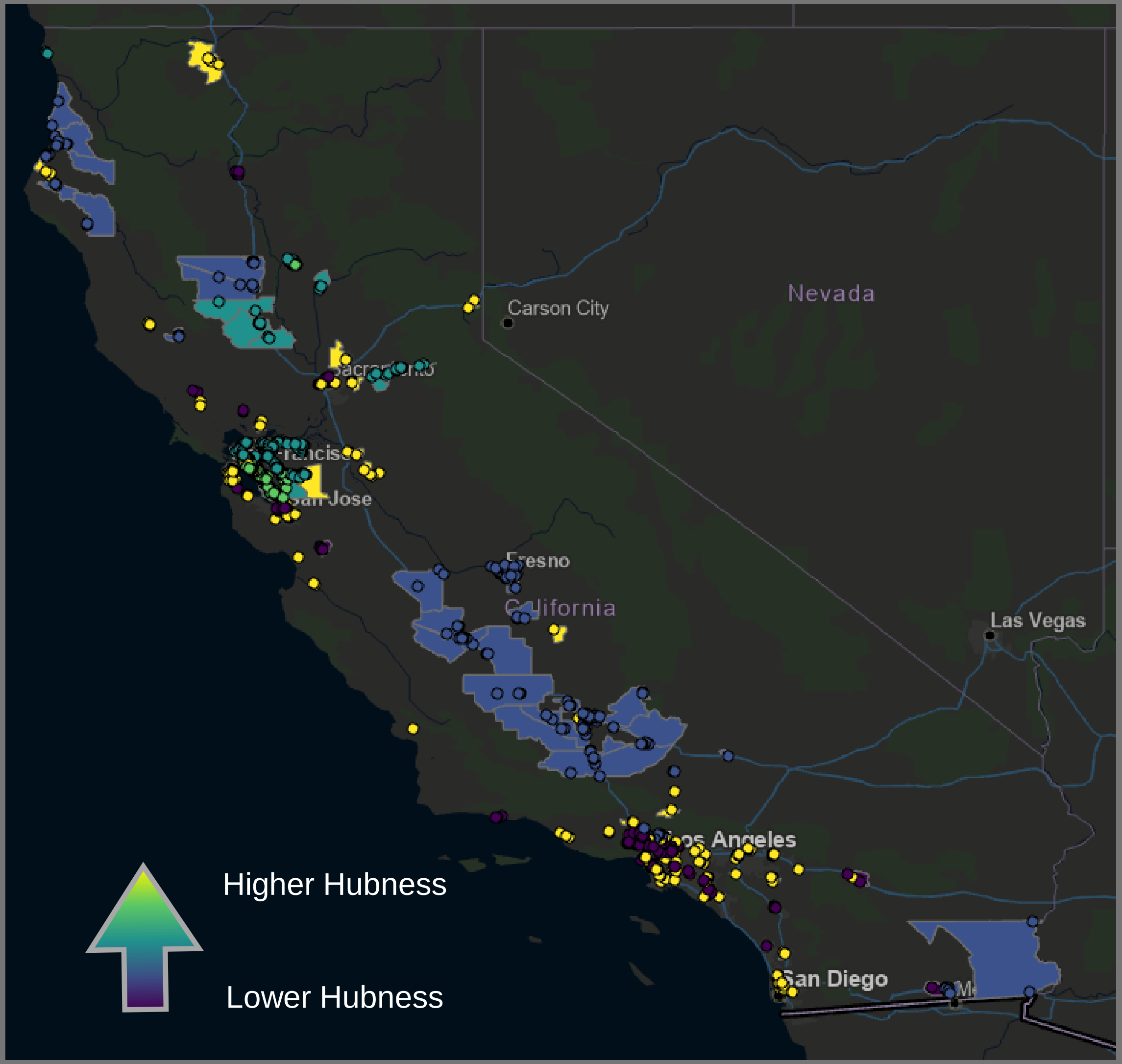


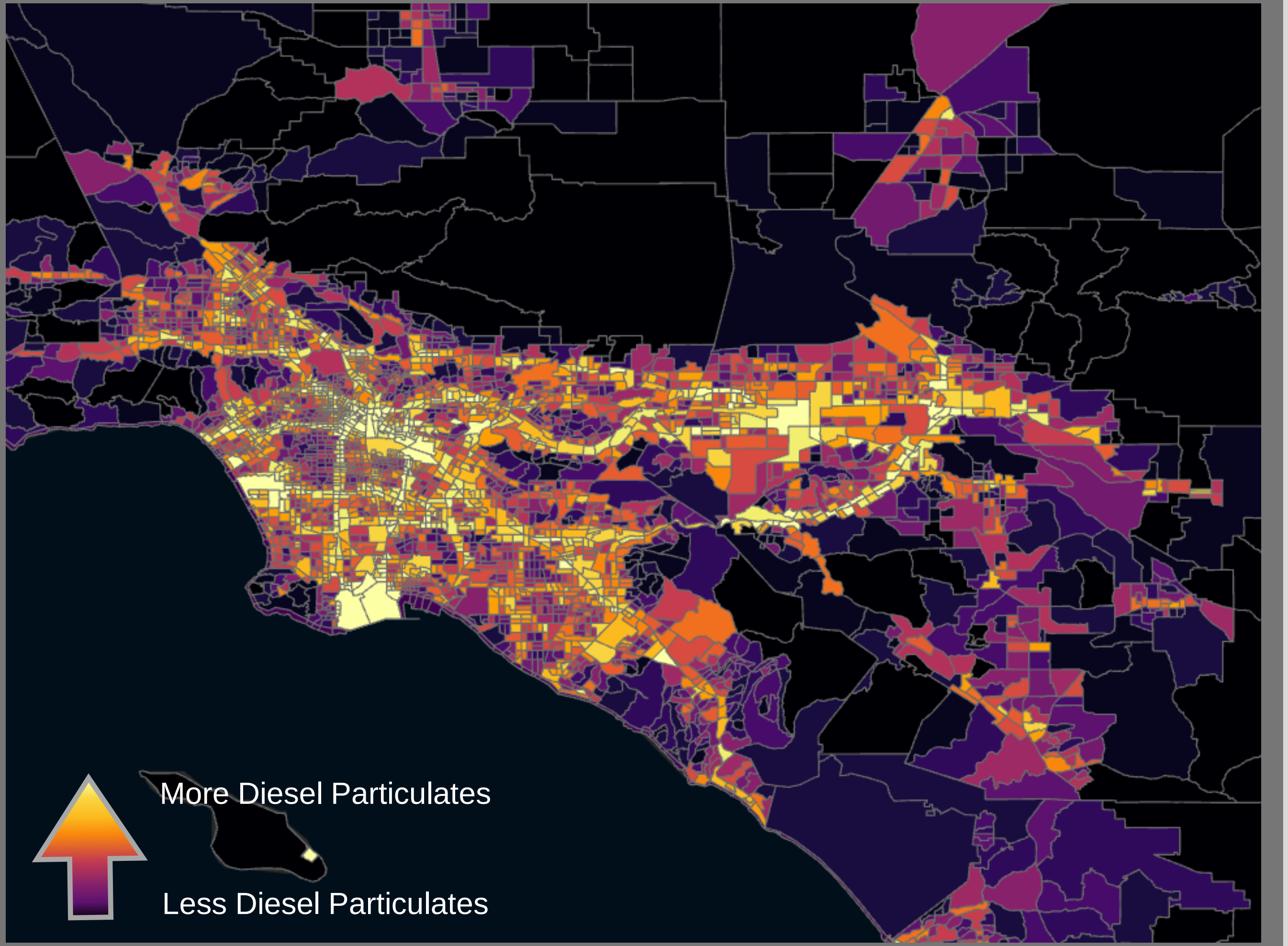
EL ENVIRONMENTAL LABORATORY

IV. Potential Next Steps
Multi-Objective Equity Optimization

- **Examined Concerns:**
  Define a set of equity concerns which can be weighed against each other

- **Solution:**
  Preform Multi-Objective Optimization:

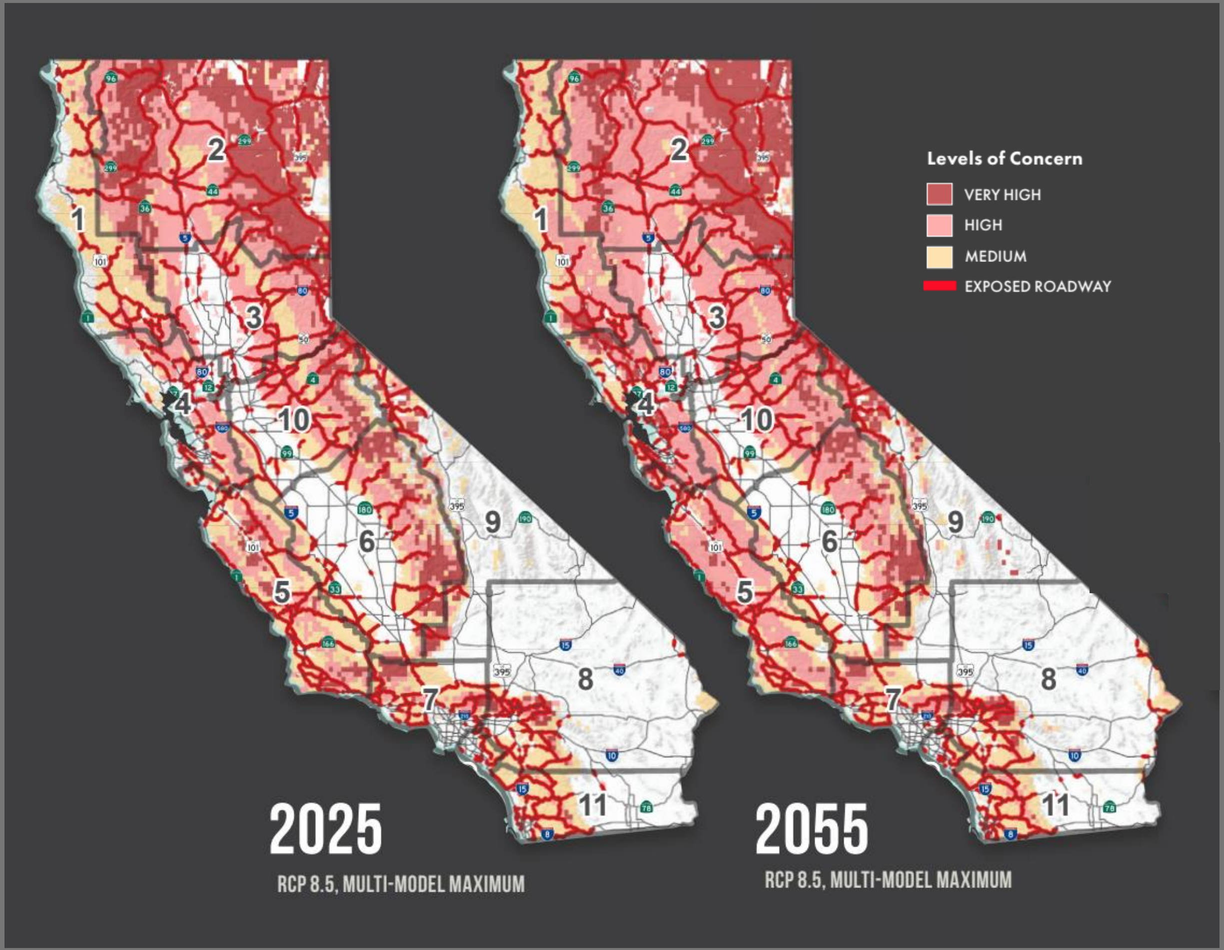
  - Gets you a range of answers so decision makers can weight different options



CalEnviroScreen 4.0
Diesel Particulate Matter - Percentage

IV. Additional Results: Natural Disaster Overlays

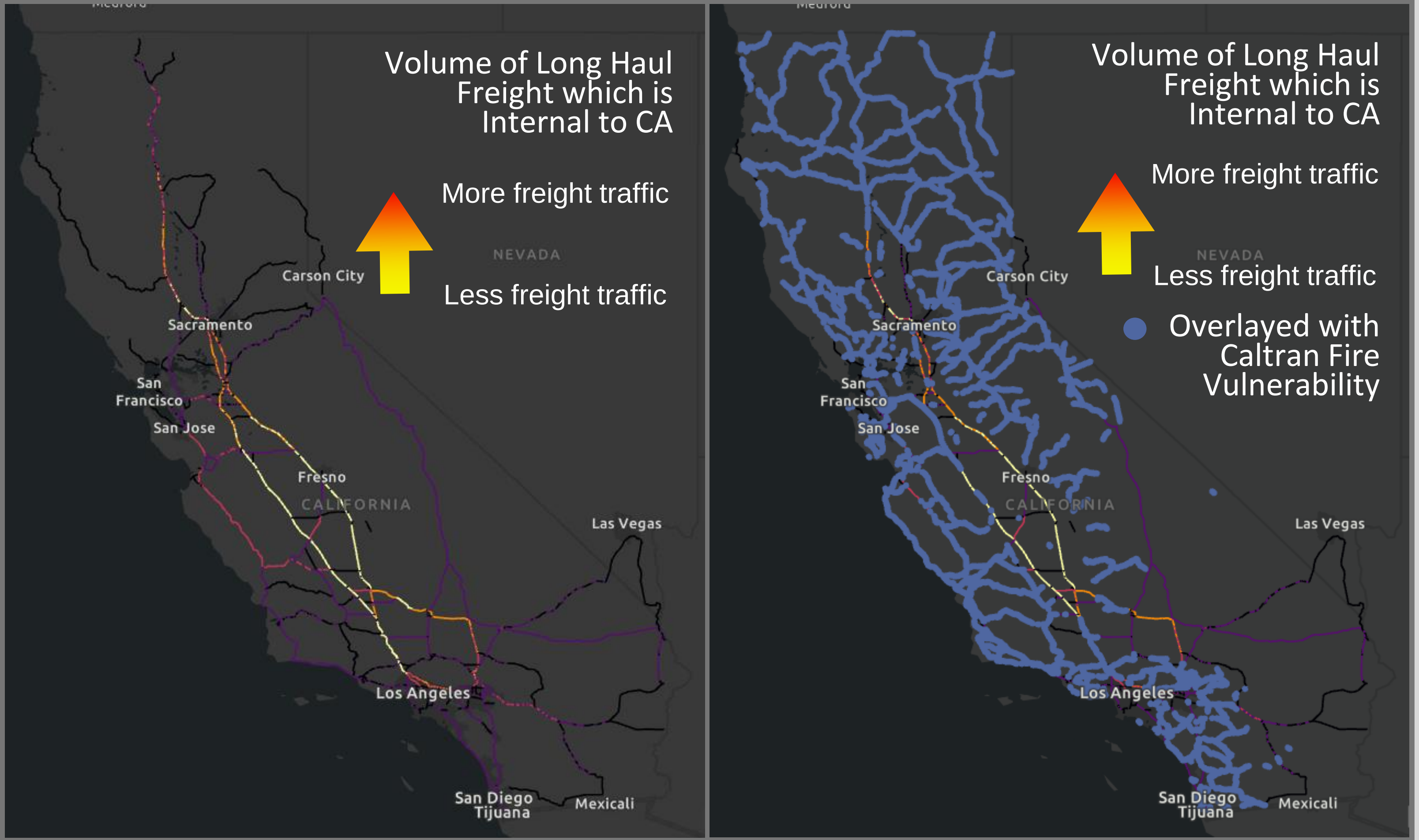
- Overlayed vulnerability assessments:
  - Precipitation
  - Wildfire
  - Sea level rise
  - Storm Surge
  - Cliff Retreat
  - Earthquakes



Changing Level of Wildfire Concern |
Caltrans Climate Change Vulnerability Assessment

IV. Additional Results: Natural Disaster Overlays

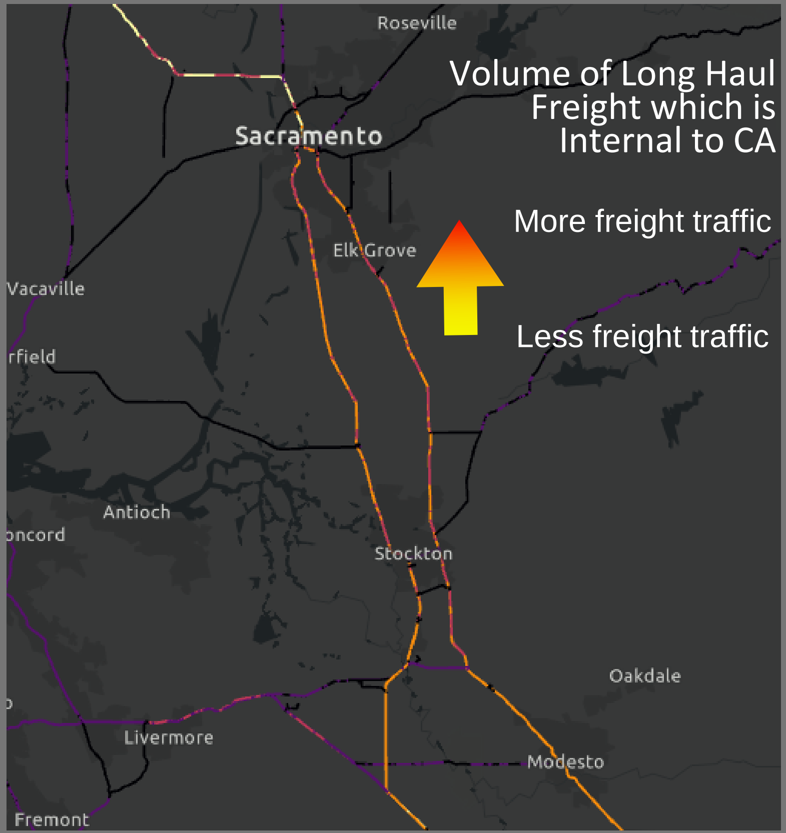
- Overlaying freight volumes with climate change vulnerabilities:
  - Wild Fires - Early 2045
- Result: While routes taken by long haul exiting/entering the state have a lot of fire vulnerability, the internal routes do not

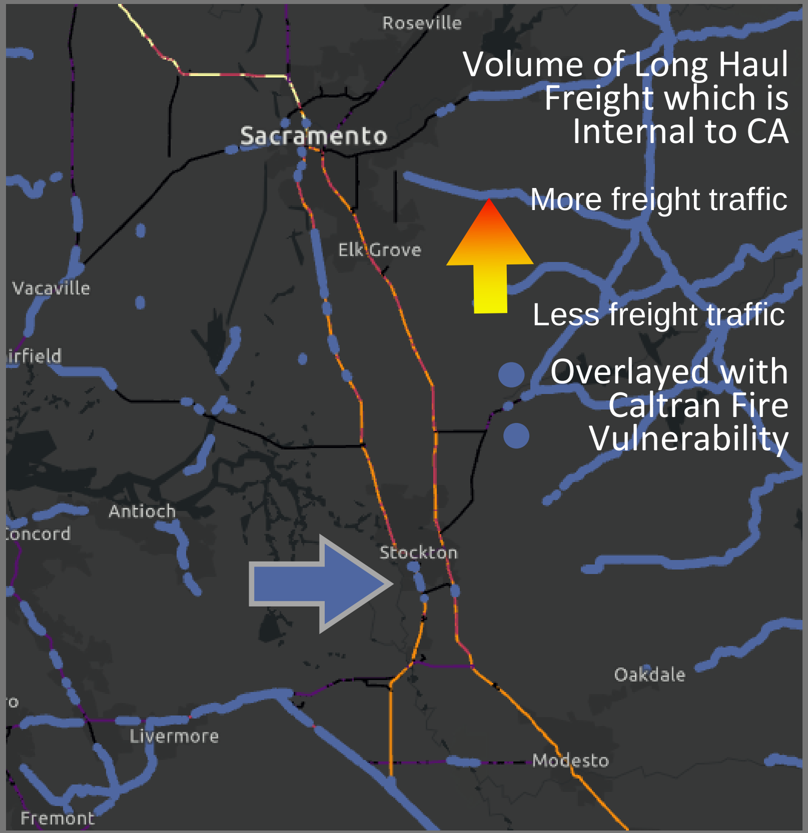


Changing Level of Wildfire Concern | Caltrans Climate Change Vulnerability Assessment

IV. Additional Results: Natural Disaster Overlays

- Overlaying freight volumes with climate change vulnerabilities:
  - Wild Fires - Early 2045
- Result: Near Stockton
  - N/S fright corridors are close
  - Near-term Fire risk

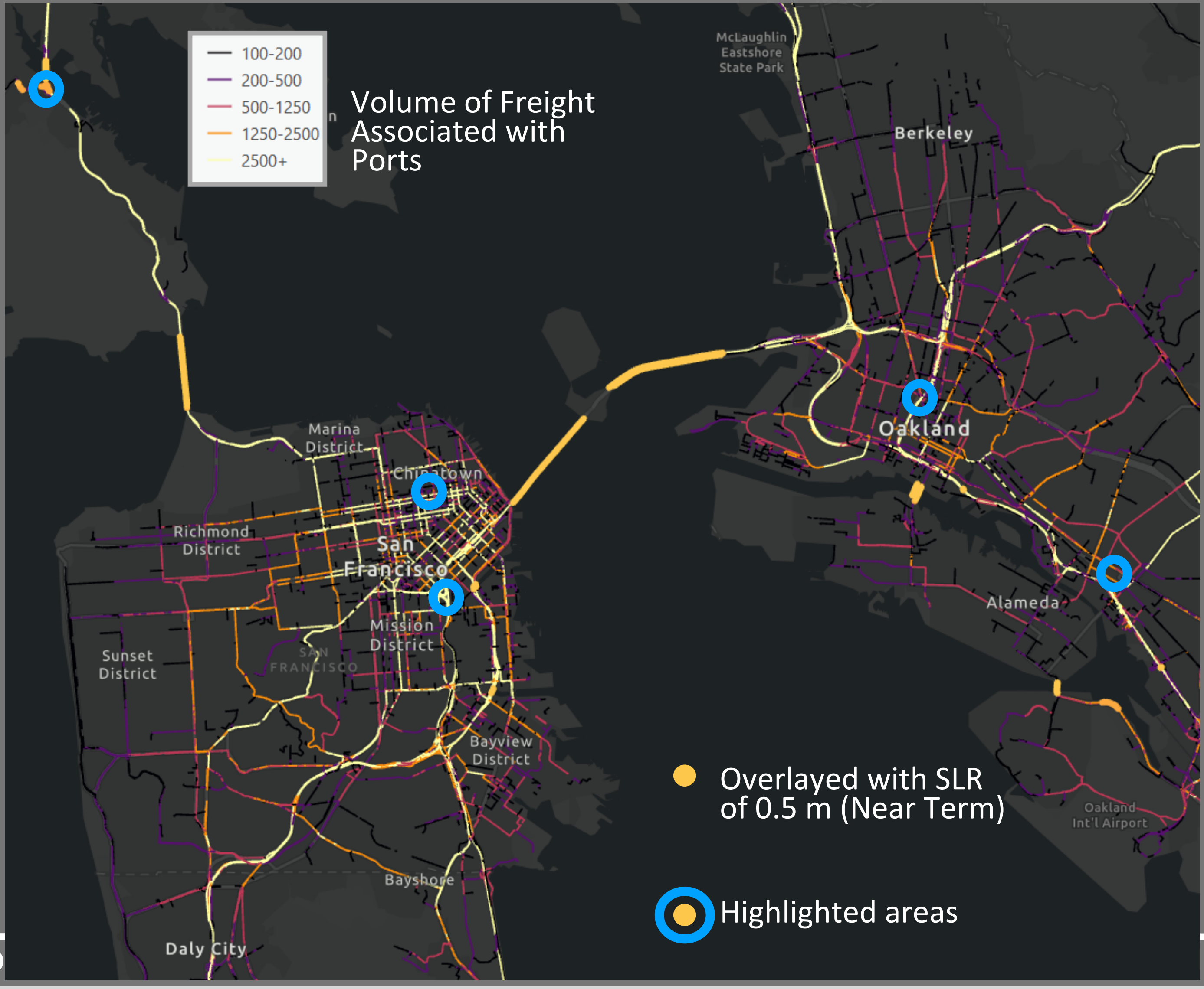




ENVIRONMENTAL LABORATORY

IV. Additional Results: Natural Disaster Overlays

- Overlaying freight volumes with climate change vulnerabilities:
  - Sea Level Rise in the Near Term (0.5 m)
- Result: San Francisco/Oakland
  - Very high freight volumes from ports
  - Risk of Near-term Sea Level Rise



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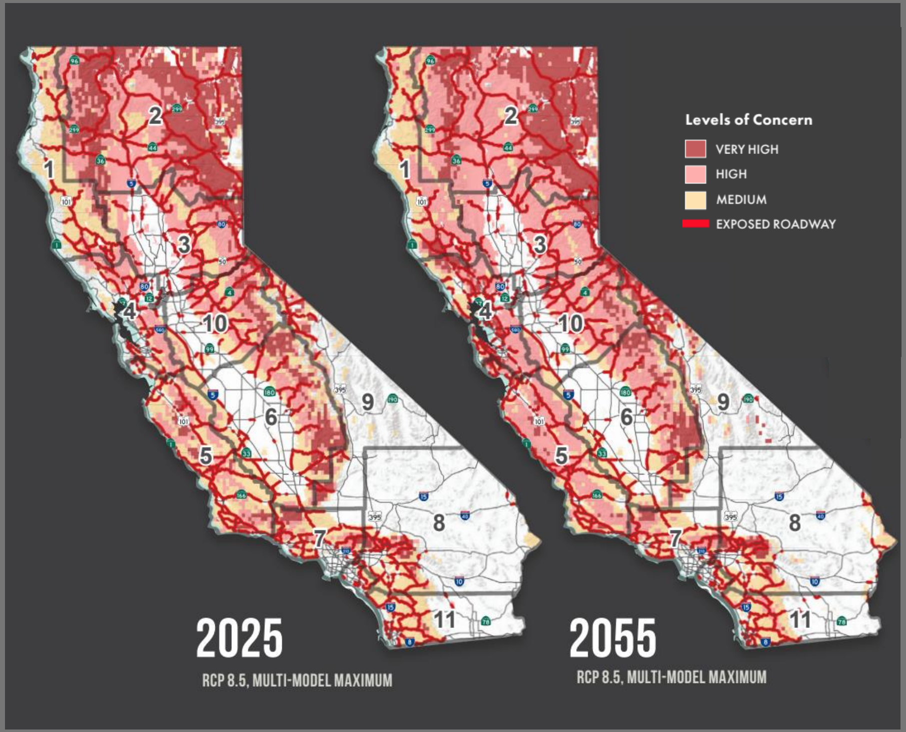
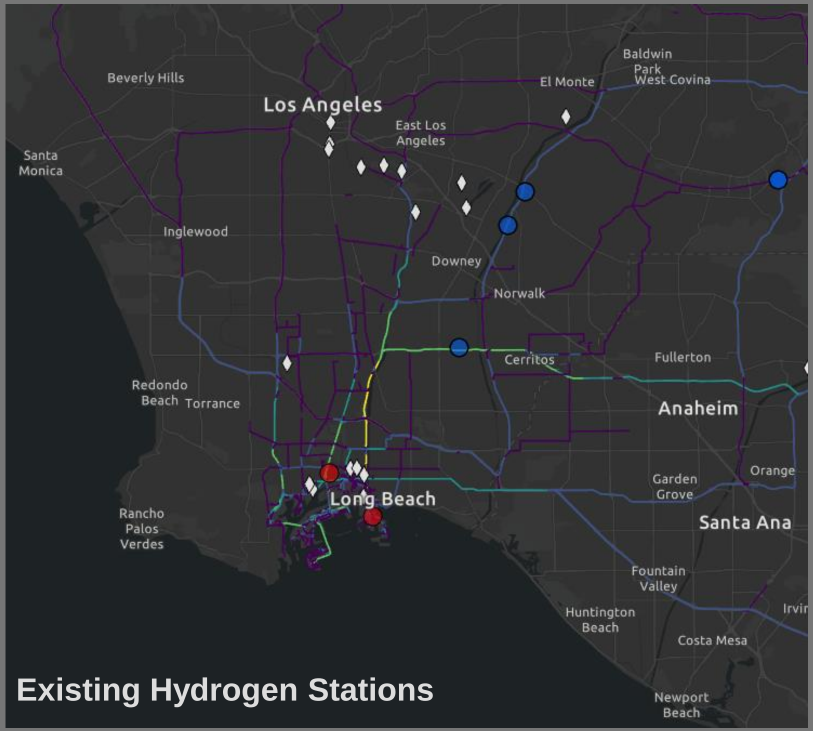
Tools and Applications: Summary

Multi-Treat Natural Disaster Risk



Zero Emission Refueling Station



ENVIRONMENTAL LABORATORY

Approach Summary

Benefits of Approach:

- System-level
- Links Supply Chain/Freight Needs with policies and risks
- State-wide approach
- Data-Driven Approach:
  - Can discover and include non-obvious real-world relationships resulting from unknown behavior

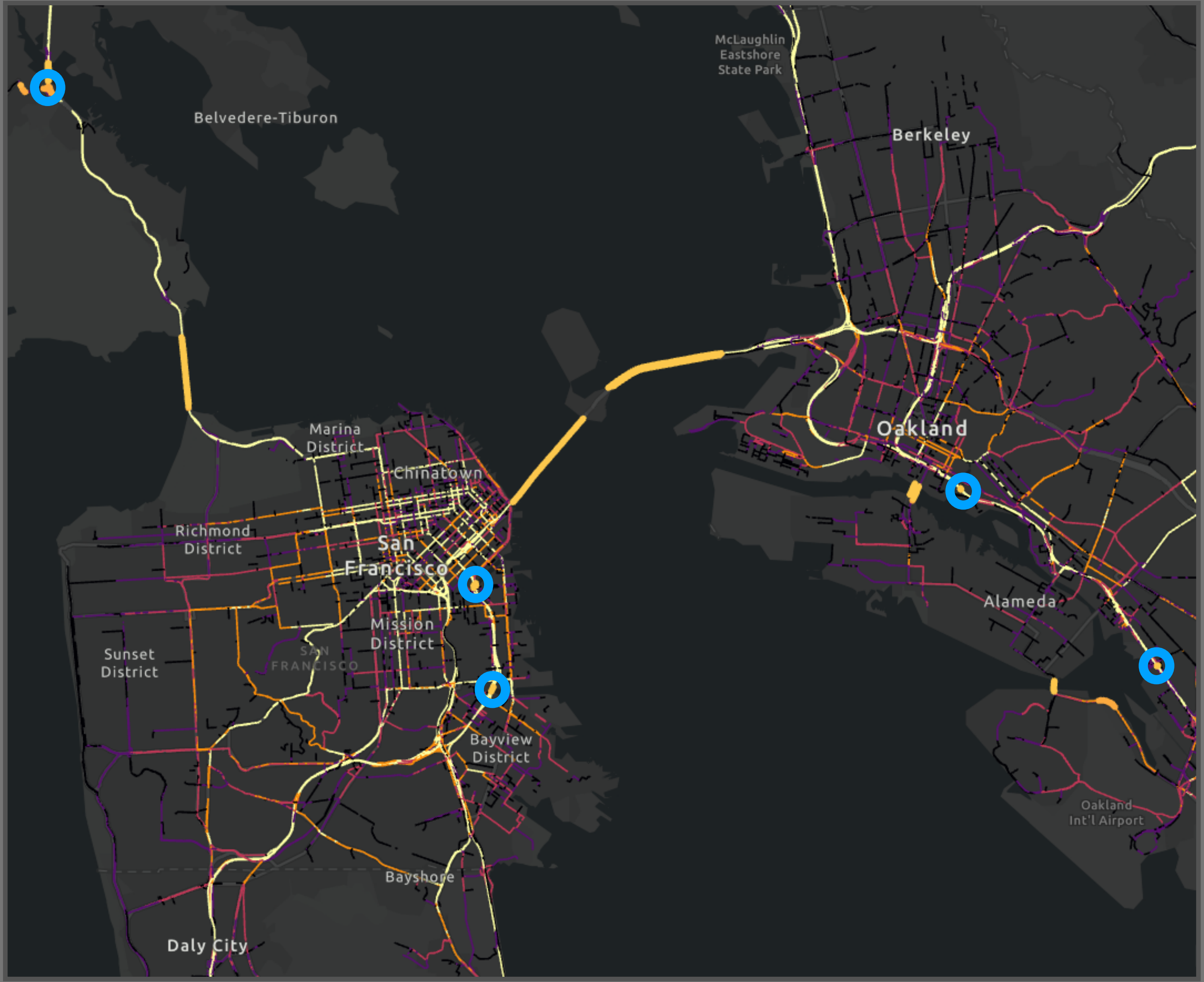
EL ENVIRONMENTAL LABORATORY

California Transportation Commission

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

Questions

Dr. Kelsey Stoddard - kelsey.s.stoddard@usace.army.mil



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Break

Medium and Heavy-Duty Electric Vehicle Infrastructure - Load Operations and Deployment

(HEVI-LOAD)

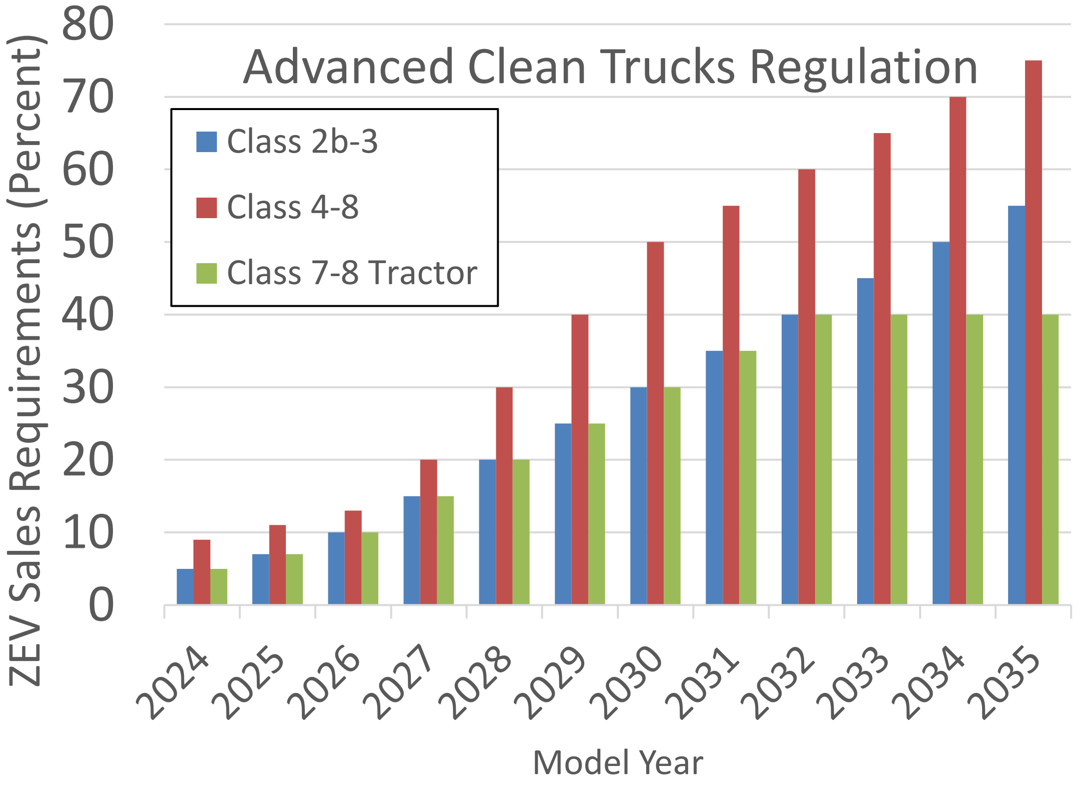
Bin Wang, Ph.D.
Wanshi Hong, Ph.D.
Research Scientist, wangbin@lbl.gov
Lawrence Berkeley National Laboratory

Outline

- HEVI-LOAD Overview
- Modeling Approaches and Assumptions
  - Trip and Travel Demand Forecast
  - Energy Consumption/Charging Demand Quantification
  - Circuit Load and Capacity Analysis
  - Drayage Electrification Case Study
  - Smart/Managed Charging Design
- Discussion and Future Work
  - Challenges
  - Next steps

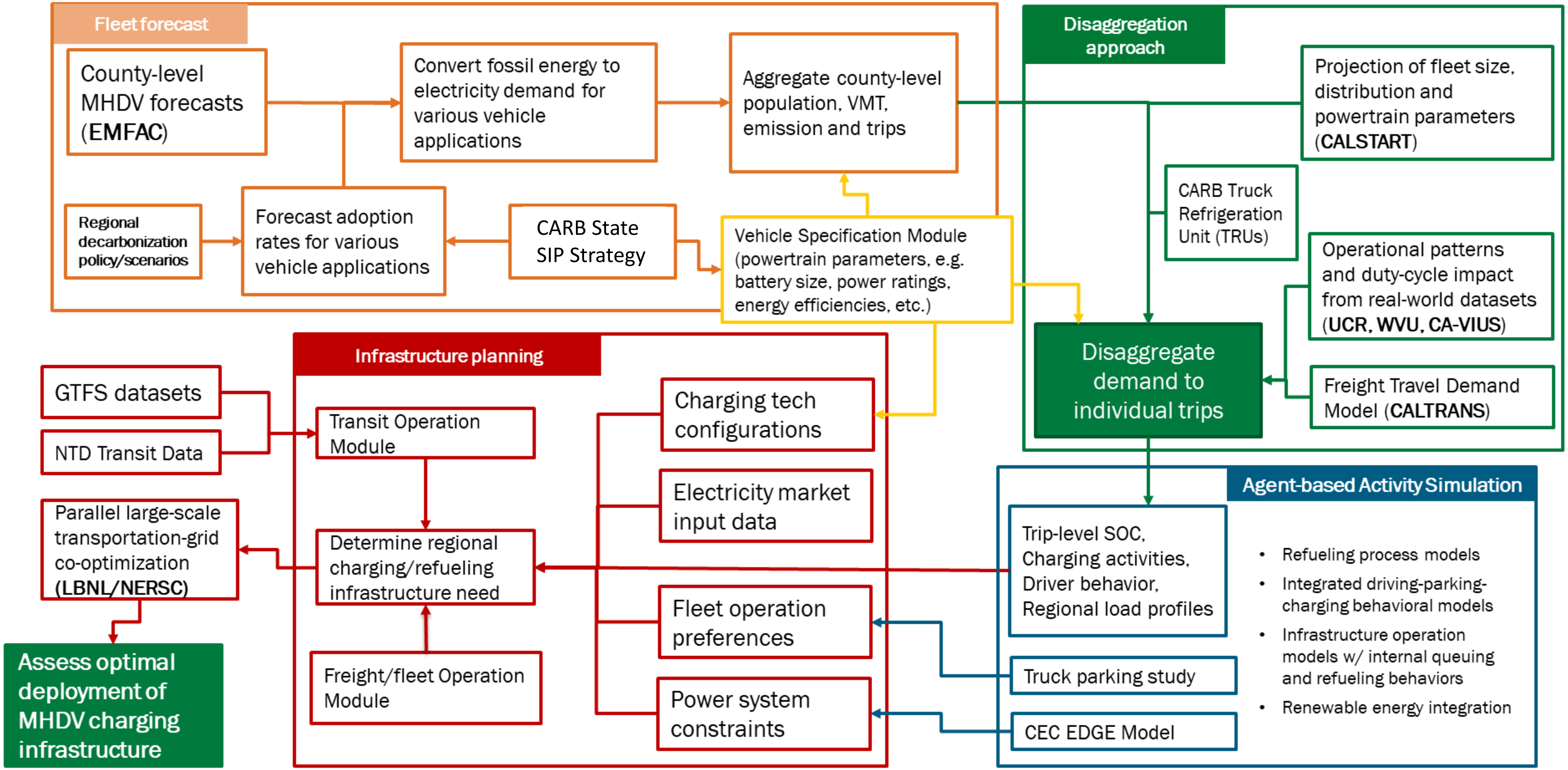
Electrifying Medium and Heavy-Duty Vehicles

- CARB's Advanced Clean Trucks regulation requires an increasing share of trucks sold in California to be zero emission starting in 2024, leading to a full transition to ZEVs by 2045.
- AB 2127 calls for the CEC to project charging infrastructure needed to decarbonize trucking and to reduce the impact of diesel air pollution.
- LBNL is developing HEVI-LOAD in collaboration with the CEC, via applied research funds from the Clean Transportation Program.
- HEVI-LOAD will project infrastructure needs for decarbonizing medium and heavy-duty vehicles (GVWR > 10,000 lbs.).



https://ww2.arb.ca.gov/news/california-takes-bold-step-reduce-truck-pollution
https://ww3.arb.ca.gov/regact/2019/act2019/30dayattb.pdf

HEVI-LOAD Overview



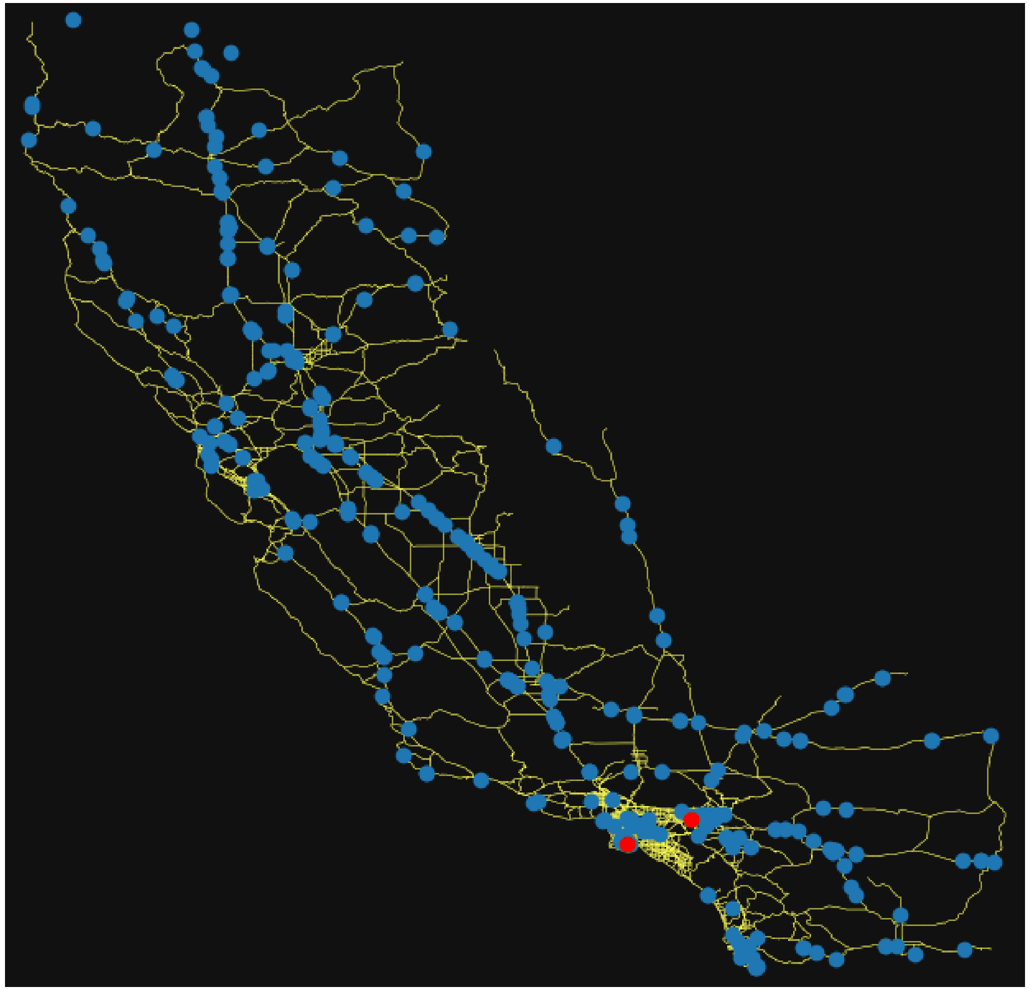
HEVI-LOAD | Metrics

Charging infrastructure need and load profiles for MHDVs

Region	Charging infrastructure		Number of chargers/plugs
	Type of accessibility	Charger type	
Charging infrastructure requirements for **each county**. Aggregate estimates by: **(1) City** **(2) Town** **(3) Rural area** **(4) Interstate/state highway**	**(1) Public (Shared)** **(2) Private (Dedicated)** **(3) Public/Private (Shared / Dedicated)**	Examples include: **(1) 50 kW (DCFC)** **(2) 125 kW** **(3) 250 kW** **(4) 350 kW** **(5) 1 - 4 MW** Charging stations servicing Class 8 heavy-duty trucks should be listed in a separate manner from "normal" charging stations (serving LDVs & MHDVs).	For each type of chargers used for each type of use application, estimates shall be given as **(1) # of plugs** [Alternative metrics could also be given] **(2) # of stations** **(3) # of plugs per station** **(4) # of plugs per 1,000 PEVs**

Site-Level Analysis via Bottom-up Simulations

- **Bottom-up vs Top-down approaches**
  - Bottom-Up approach has more granular geographical resolution, taking into account road networks, critical locations and travel demand model, while the Top-Down approach takes the aggregated vehicle adoption info to project infrastructure needs and load profiles at county-level
  - Bottom-Up approach has the capability to reveal granular vehicle behaviors – driving, routing, parking and charging, etc.
- **Prepare for inputs for the simulation**
  - Road network
  - Travel demand – MD/HD trips with origins, destinations, and trip start times
  - Critical/candidate locations: truck stops, rest areas, etc., using the California Statewide Truck Parking Study
  - Calibrate behaviors using real-world GPS & duty-cycle data
- **Enable decision-making, routing and decision-making capability for each agent (vehicle)**
  - Compute shortest distance/travel time routes
  - Provide flexibility for more customization for future scenarios, e.g., select optimal en-route charging stations

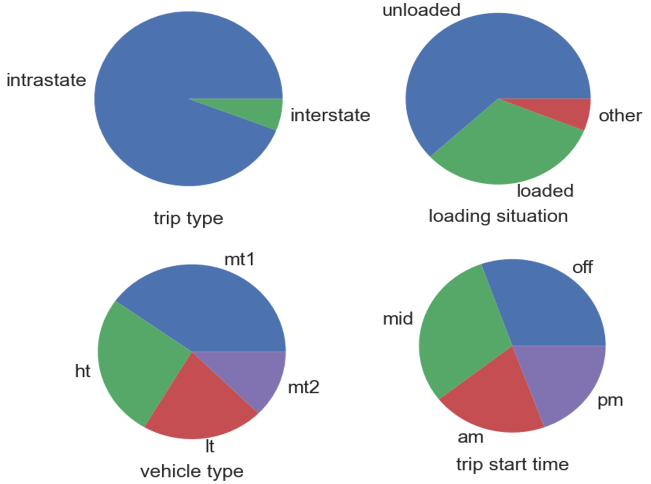


Activity Simulation of selected MDHD vehicle applications: integrated driving-routing-parking-charging scenarios in CA. Red dots: moving MD/HD vehicles being simulated; Blue dots: hwy entry points for the candidate infrastructure deployment locations, such as truck stops, etc.

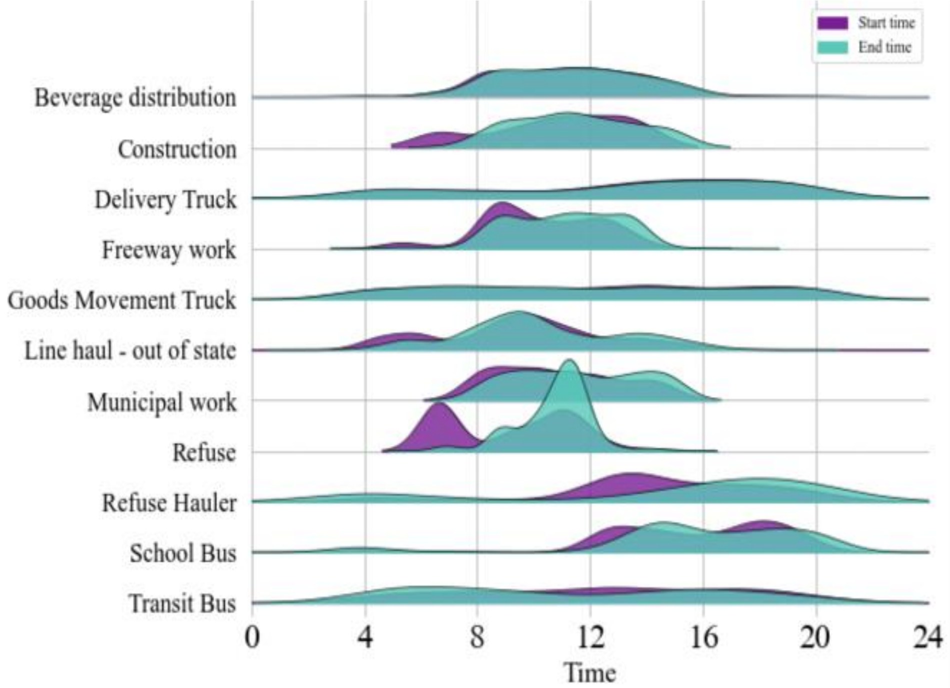
California statewide truck parking study: https://dot.ca.gov/-/media/dot-media/programs/transportation-planning/documents/freight-planning/plan-accordion/catrkpkgstdy-finalreport-a11y.pdf

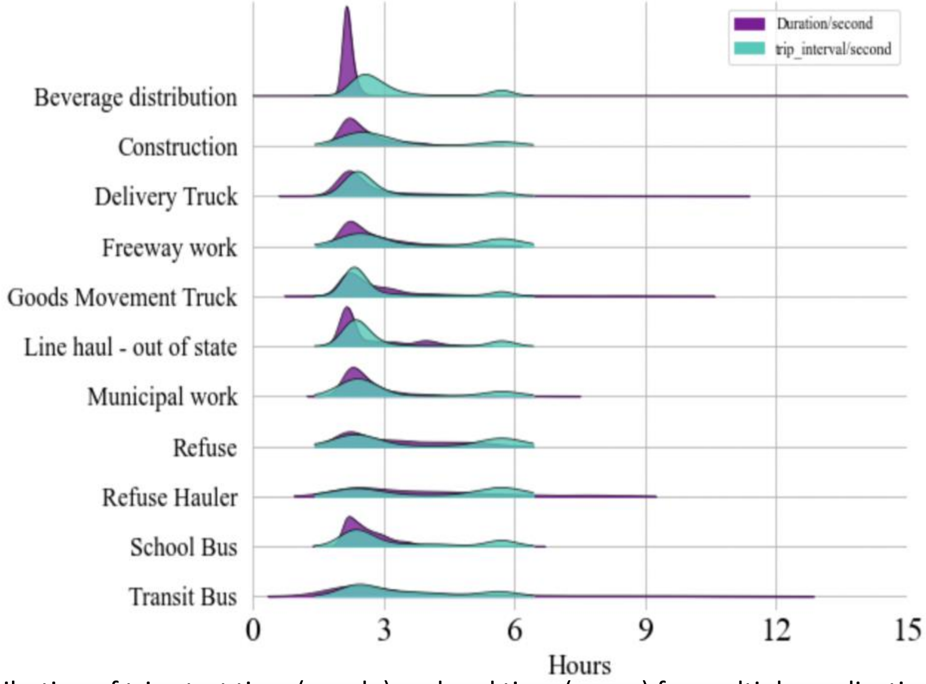
Trip and Travel Demand Forecast

- Extract MD/HD trips from CSTDM/CSFFM
  - ~ 1.3 million trips (LT, MT, HT)
  - Time periods: AM, Mid-day, PM and OFF
- Calibrate the travel demand models as inputs to HEVI-LOAD Simulation
  - Characterize trip behaviors with real-world GPS location datasets
  - Combined with uniform and other distributions for trip start time, etc.



LT, MT, HT, Load/Unload trip percentage in the CSTDM/CSFFM model

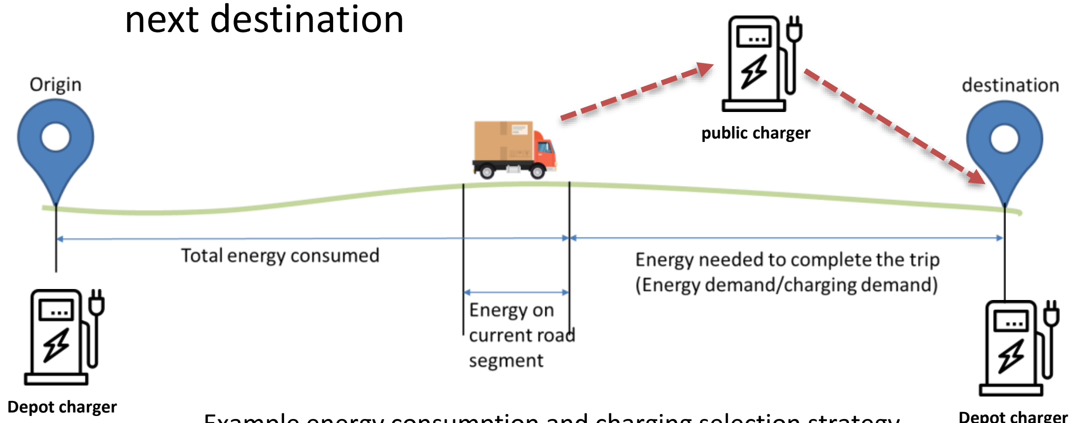




GPS location data (UCR & WVU) to inform the travel demand model, left: statistical distribution of trip start time (purple) and end time (green) for multiple applications, right: statistical distribution of trip duration (purple) and trip interval duration (green)

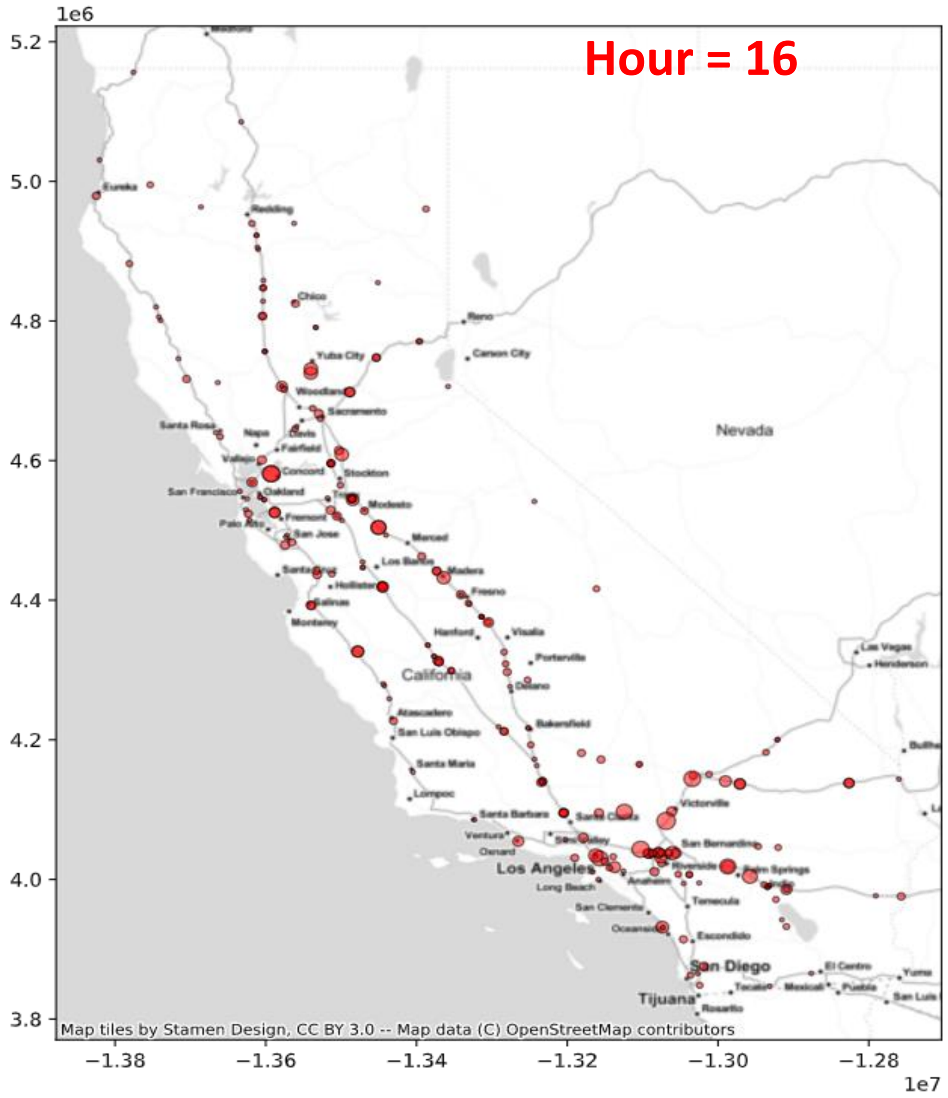
Quantify Charging Demand and Load Profile over Candidate Locations

- Simulate the entire driving-routing-parking-charging behavior chain within HEVI-LOAD
- Compute routes for each trip using the routingkit[1]
- Solve the charging plans for each trip (depot vs. public chargers)
- Develop algorithms to select the enroute charger(s) with the shortest distance/travel time
- Compute the energy consumption over each road segment and estimate the energy needed to reach next destination



Example energy consumption and charging selection strategy

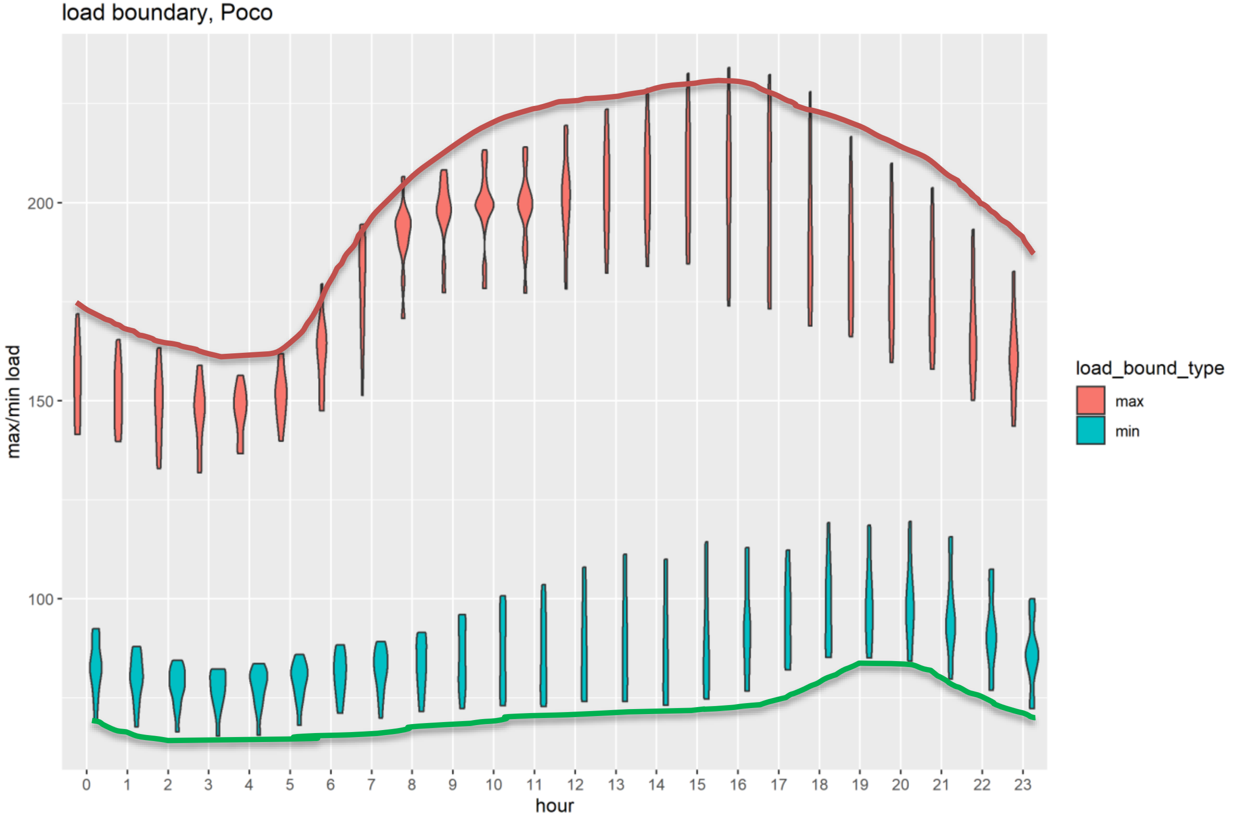
1 - Routingkit:https://github.com/RoutingKit/RoutingKit

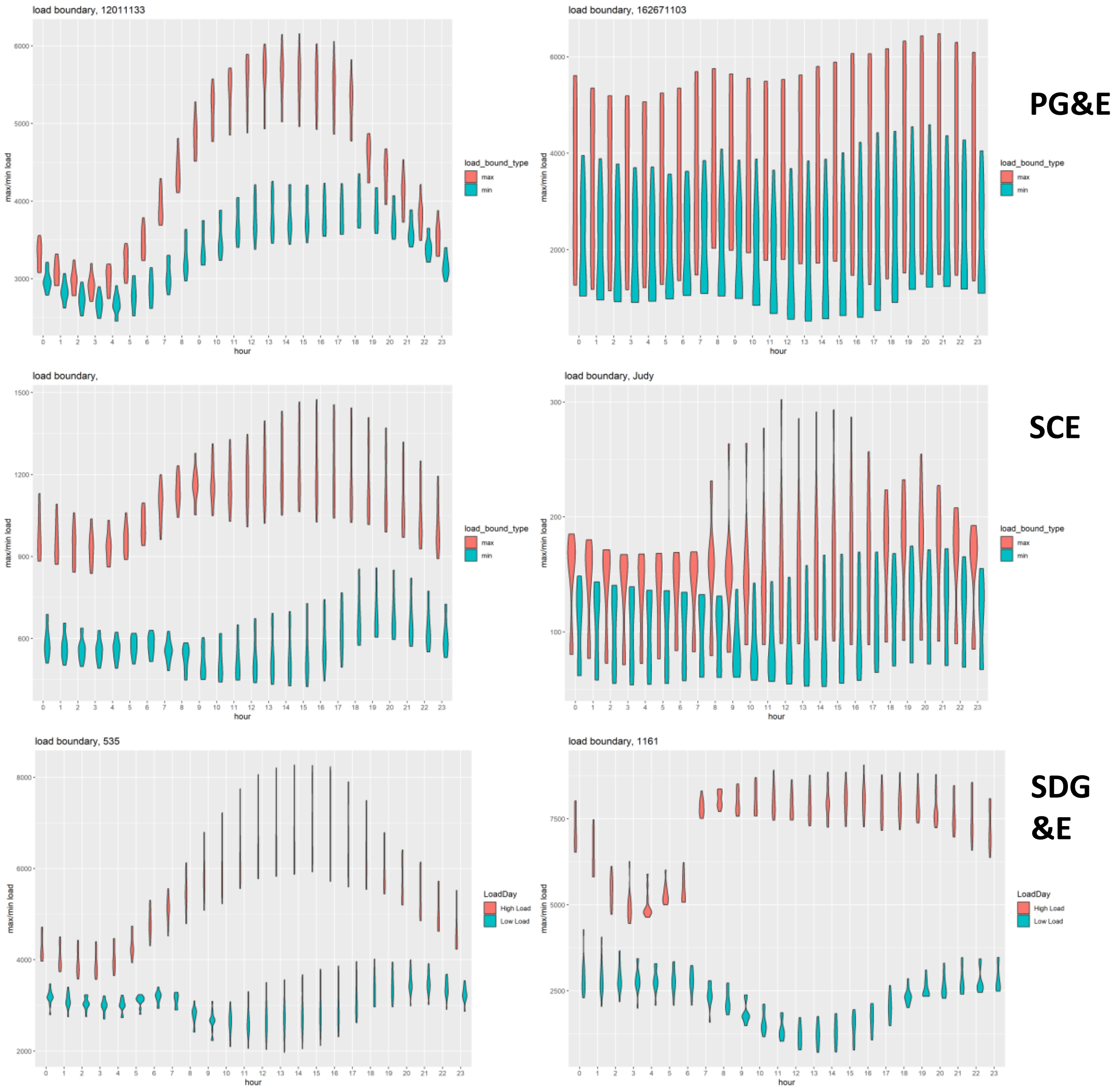


- **Radius of red circles is proportional to the charging demand at each site (truck stops and rest area, etc.)**
- **Aim to assist planning agencies to prioritize infrastructure deployment locations**
- **Can assist to identify freight corridors and critical locations**

Circuit Load and Capacity Analysis

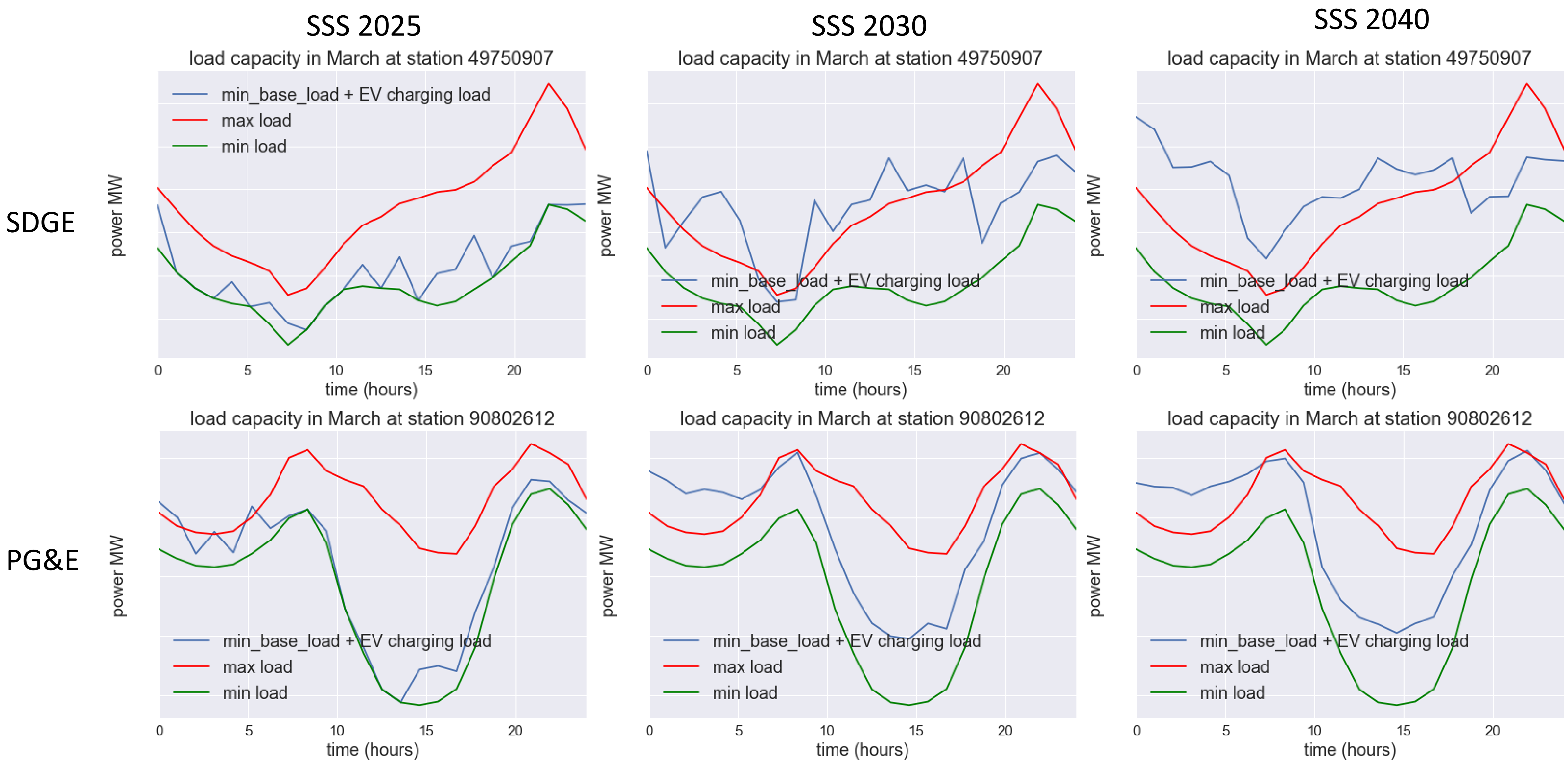
- Quantify the load variation, e.g. the upper and lower boundaries of the circuit baseload
- Prepare the load patterns for circuit capacity analysis with simulated MDHD EV charging load





Example Load Patterns

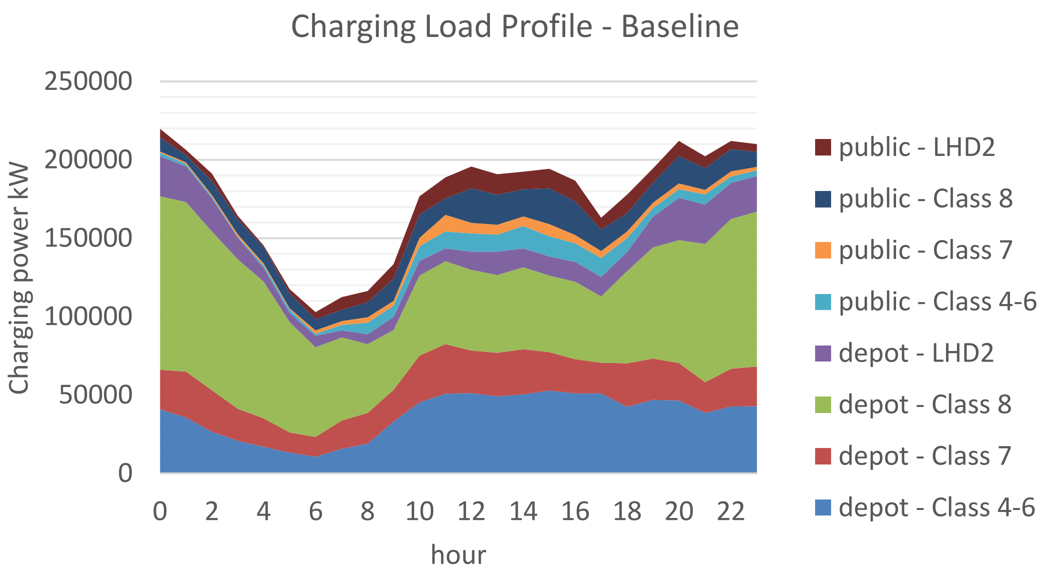
Circuit Capacity Analysis at the Site Level (optimistic)

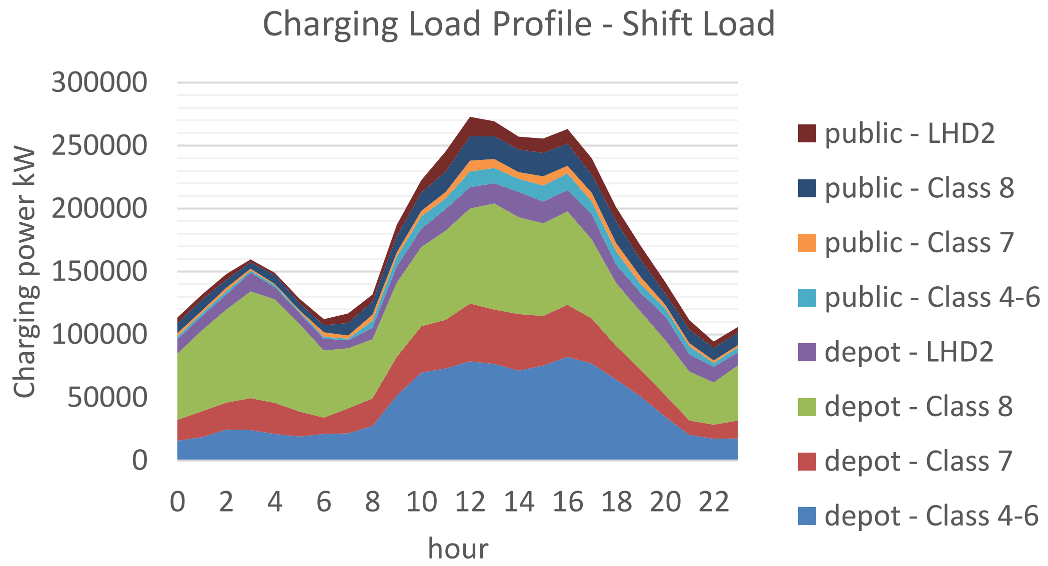


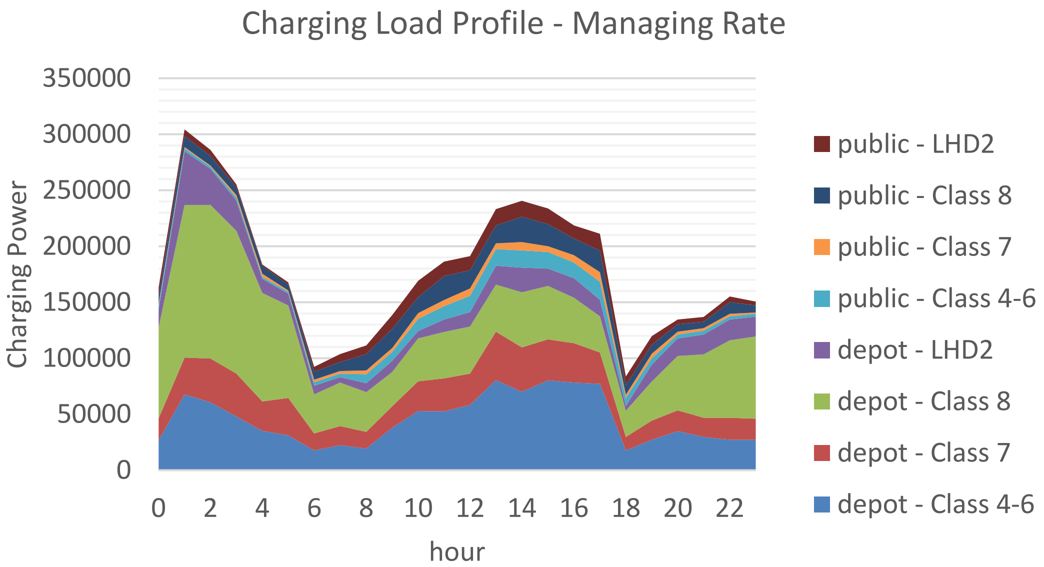
Scenario definition

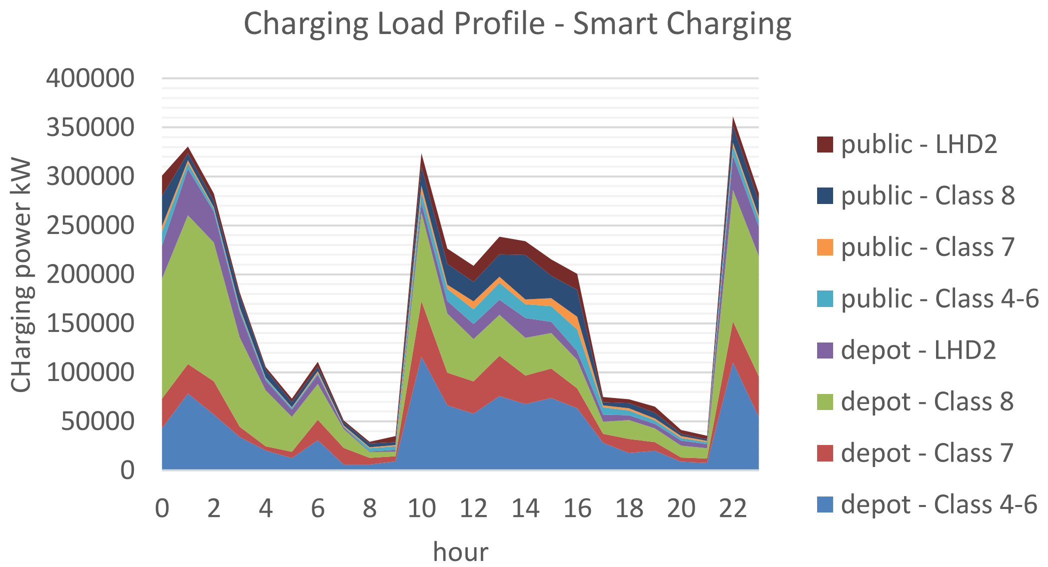
	Baseline Scenario	Load Shifting	Manage Charging Rate	Smart Charging
Battery Capacity Level	B1: low (~200kWh), B2: medium (~400 kWh), B3: high (~600kWh)			
EV Adoption Scenario	ACT+ACF, AATE3	AATE3 2025	AATE3 2025	AATE3 2025
Charging Rate	C (20 – 1500 kW)	Low charge rate at 18:00 – 23:00	C = [low_rate(18:00-24:00), mid_rate(6:00-12:00), high_rate(0:00-6:00, 12:00-18:00)] (20 – 1500 kW)	C_1 (20 - 1500 kW)
Charger Placement	Charger level (kW) = [20, 50, 100, 200, 350, 500, 700, 1000, 1500]	Charger level (kW) = [20, 50, 100, 200, 350, 500, 700, 1000, 1500]	Charger level (kW) = [20, 50, 100, 200, 350, 500, 700, 1000, 1500]	Charger level (kW) = [20, 50, 100, 200, 350, 500, 700, 1000, 1500]
Charging Mode	Uncontrolled charging	Load shifting	Pre-assigned charging rate	Smart charging rate
Energy Pricing	PG&E BEV	PG&E BEV	PG&E-BEV	PG&E BEV

Charging Load Profile (Preliminary)



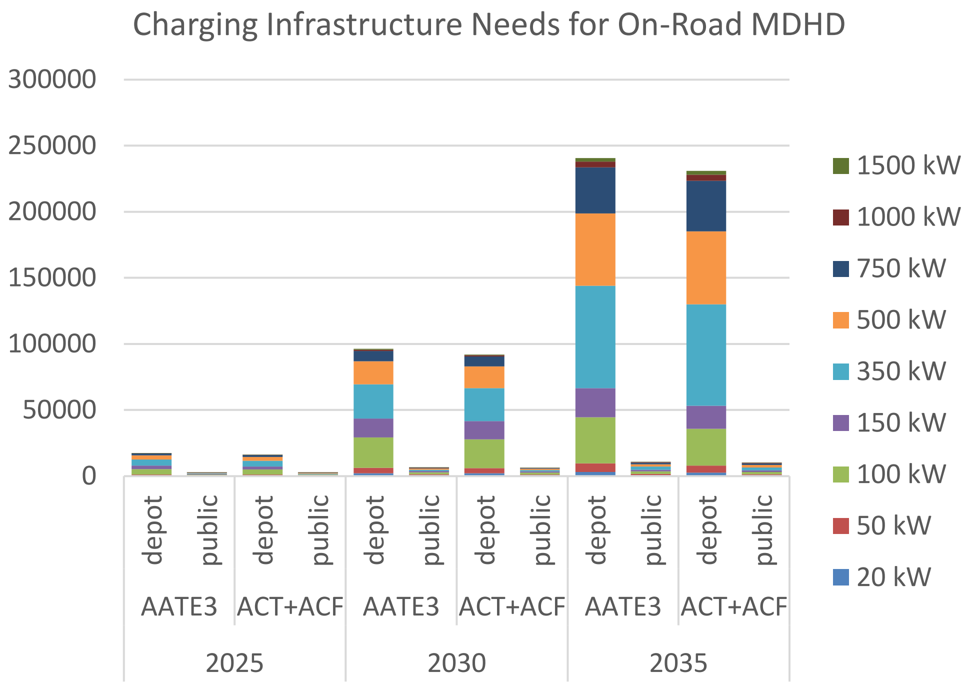


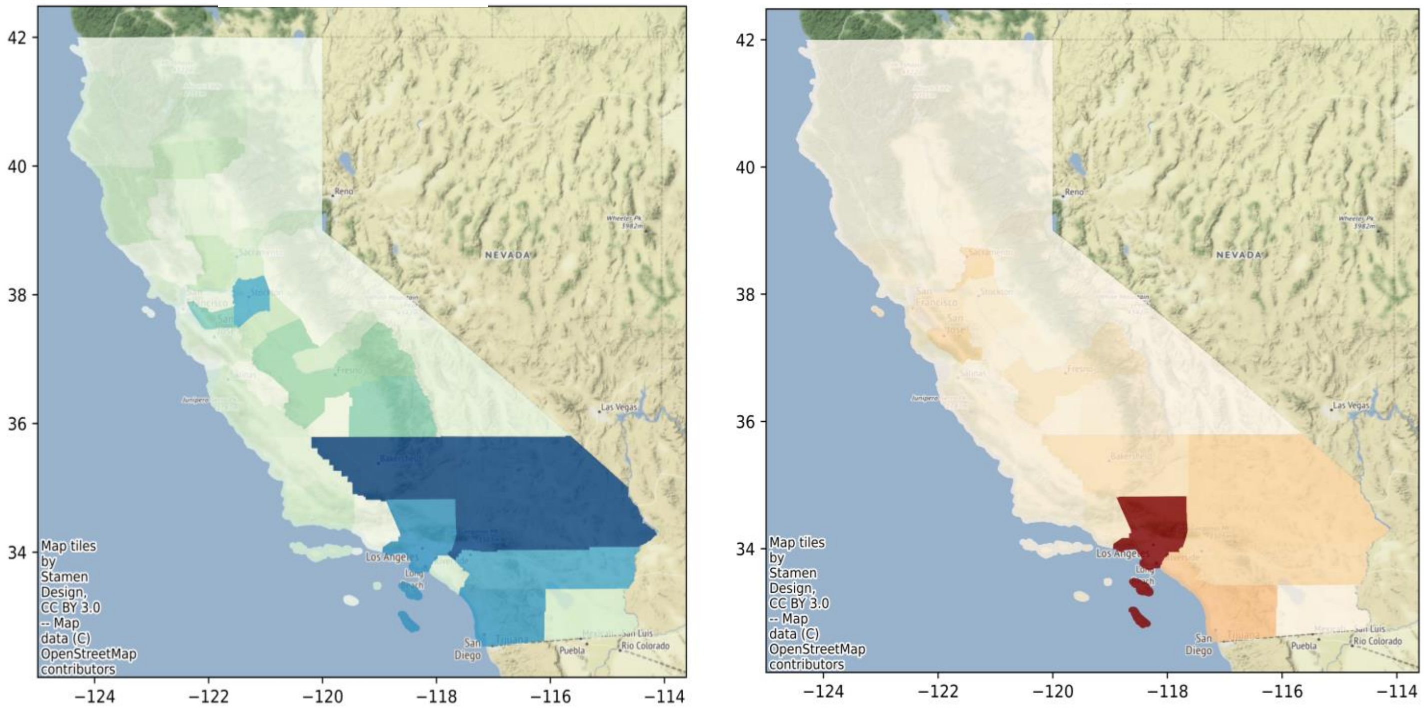




Charger Counts (Preliminary)

- Projected the charging infrastructure needs by region based on MDHD travel demands (from CSTDM data)
- For public charger, the charger utilization continues to increase by year as charger quantity increases

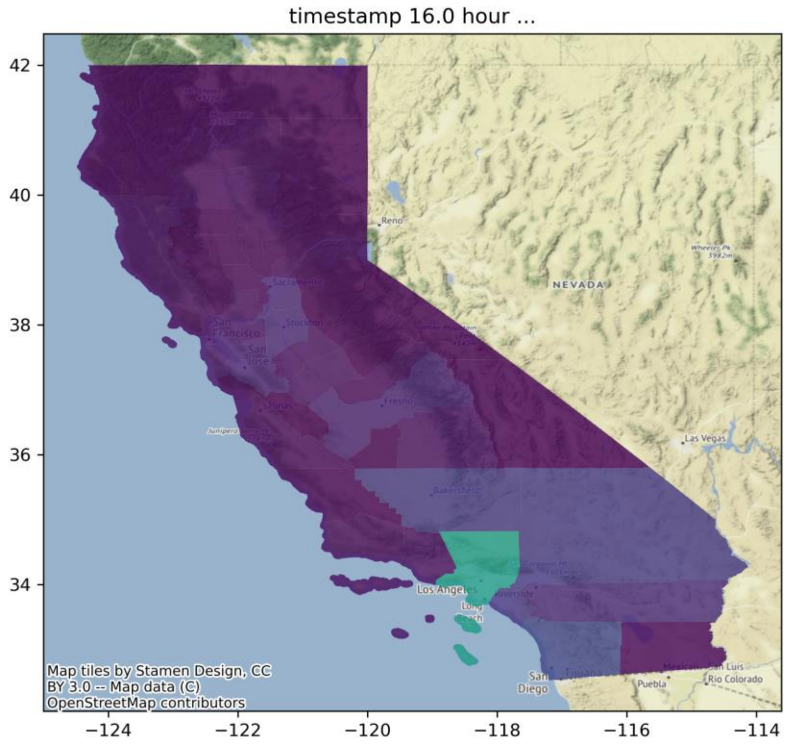




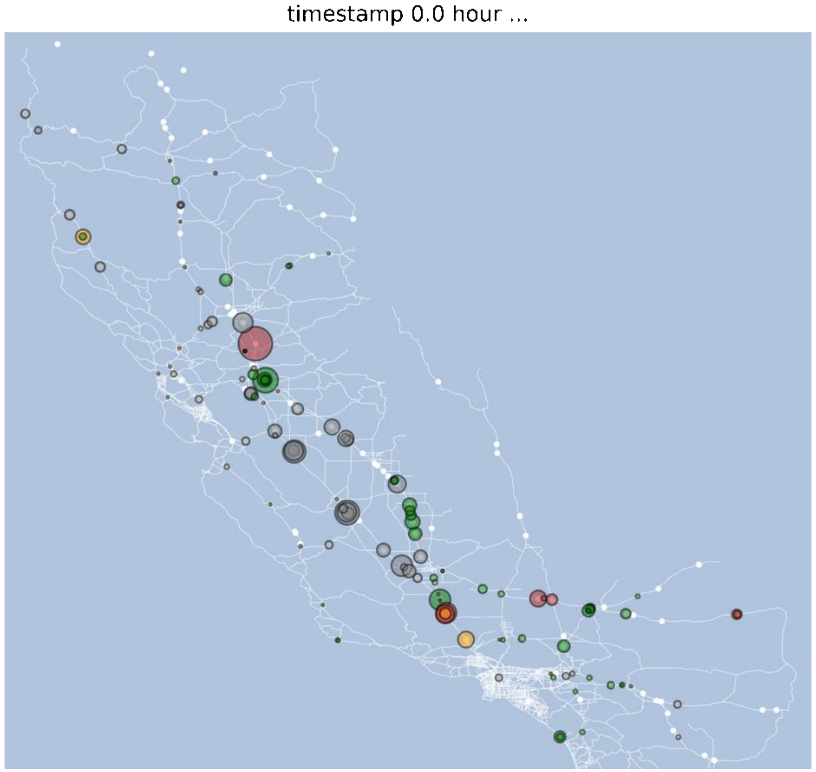
Charger distribution by county 2030 AATE3

Charging Demand Results (Preliminary)

- Radius of the circle proportional to the charging demand at the candidate locations
- Color of the circle shows the percentage loading (current load/ load capacity)
  - green: K = 0% - 50%, yellow: K = 50% - 100%, red: K > 100%, gray: circuit capacity data not available



Overall charging demand by county



Public charging demand by candidate parking lots

Challenges and Future Work

- Challenges
  - Data needed to
    - Characterize the MD/HD fleets penetration, business-as-usual duty-cycles and tour-based travel demand
    - Candidate locations for future infrastructure deployment, beyond truck stops, rest areas, critical warehouses/distribution centers, and existing refueling stations, etc.
    - Validate the assumptions in the simulation models
  - Model and simulation validation
    - Calibrate the simulated scenario with real-world deployment practices
- Current and future work
  - Fully integrated scenario analysis
  - Work with utility to validate the circuit capacity analysis
  - Incorporate hydrogen refueling infrastructure into the simulation and analysis
  - Finalize the results into AB 2127 reports

Thanks!

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Micah Wofford, CEC, Program Manager, micah.wofford@energy.ca.gov

Break

Clean Freight Corridor Efficiency Assessment Update

Disclaimer

AS OF 01/27/2023 **PRELIMINARY – FOR DISCUSSION**

The purpose of this document is to present the analysis and results of select elements of Task 1-3 of the Clean Freight Corridor Efficiency Assessment in an initial draft on February 9, 2023.

This document was created at the request of the California Transportation Commission as part of the Clean Freight Corridor Efficiency Assessment. Sources include material from CTC-provided documents and the RFP and other department teams.

The approaches and considerations included in this document are preliminary and may be further developed based on additional inputs from the CTC team and other departments.

Source: CTC Working Group

Today's update will address the approach to identify proposed priority freight corridors and their emissions and pollution impact

A four-step process was used to identify potential priority freight corridors

1. **Goods Movement:** Use the estimated commodity flows anticipated into, out of, and through CA to determine expected trip types, vehicle class used, and potential powertrain adoption
2. **Vehicle Trips:** Define freight corridors >50 miles in length with the highest concentration of goods movement and related daily truck traffic / VMT
3. **Freight Corridors:** Determine the natural break point for potential corridors by triangulating data and analysis across FAF, USACE, and CalTrans/LBNL
4. **Emissions and Pollution Impacts:** Evaluate the potential priority corridors for emissions and near-source pollution exposure effects

Source: CTC Working Group

Potential priority freight corridors were identified by commodity flows, trip type, and likely vehicle used (by class and powertrain)

AS OF 01/27/2023 **PRELIMINARY – FOR DISCUSSION**

By layering multiple inputs on top of Federal state traffic data, freight flows can be cut by the following factors:

1 Commodities[1]

Agriculture & food

Chemicals, rubber & plastic products

Construction & wood materials

Consumer goods

Fossil Fuels

Metals, metal products & hardware

2 Trip type[2]

Urban

Regional

Long-haul

3 Vehicle class[3]

MDT: Class 4-6

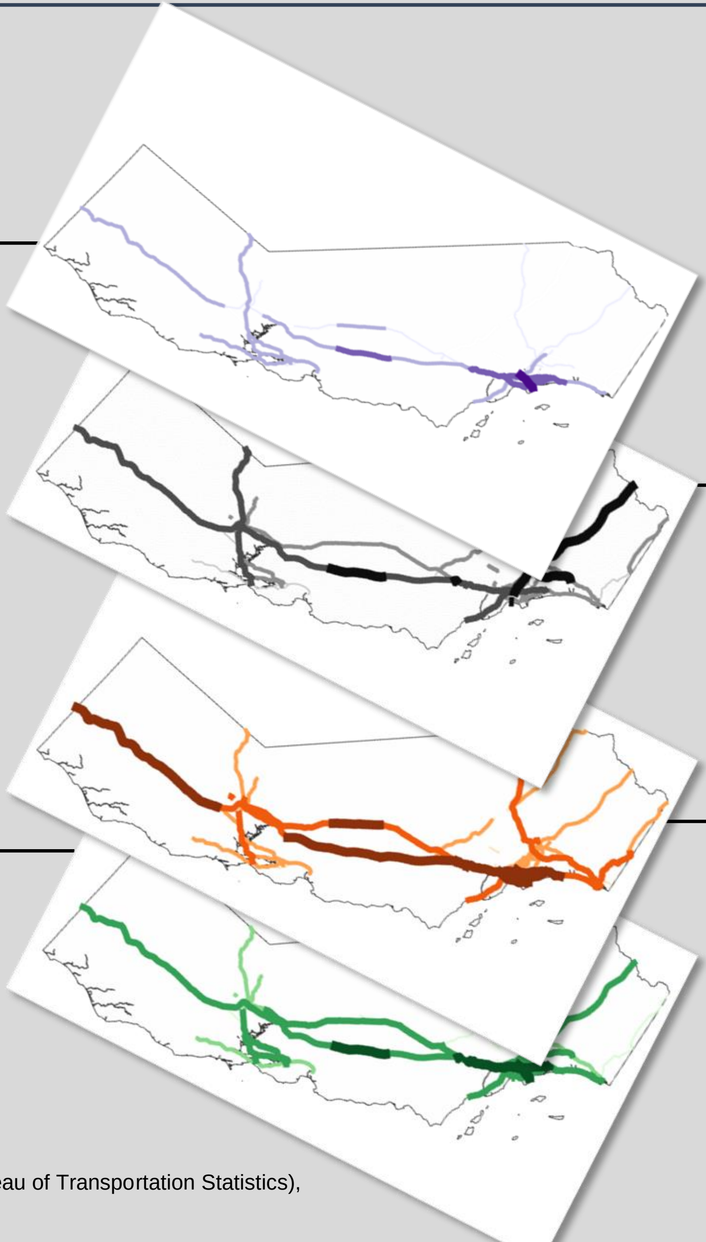
HDT: Class 7-8

4 Projected powertrain mix[4]

Combustion engine

Battery electric vehicle

Fuel cell electric vehicle



1. FAF counts of trips by commodity
2. National trip type percentages applied to FAF corridor traffic
3. FAF counts of heavy and medium duty trucks (MDT and HDT)
4. National powertrain percentages applied to FAF corridor traffic counts

Source: Highway Performance Monitoring System (Federal Highway Administration), Freight Analysis Framework (Bureau of Transportation Statistics), powertrain and vehicle class production and technology insights (2022)

Six proposed priority corridors represent >60% of daily truck vehicle miles travelled

AS OF 02/02/2023 **PRELIMINARY – FOR DISCUSSION**

Priority corridors for consideration *(Ordered by VMT[1] – 2022 projected)*	**Daily VMT on high-volume FAF links by corridor,** *Millions*
I-5 from the south border to north border (Oregon)[2]	4.5
I-15 from LA to southeast border (Nevada)	1.6
Route 99 from Stockton to Bakersfield	1.3
I-10 from LA to southeast border (Arizona)[3]	1.2
I-40 from intersection with I-15 to southeast border (Arizona)	0.7
I-80 from San Francisco to northeast border (Nevada)[4]	0.7
Other	6.4
Total	16.5

>10M or >60% of statewide vehicle miles travelled

Source: Highway Performance Monitoring System (Federal Highway Administration), Freight Analysis Framework (Bureau of Transportation Statistics)

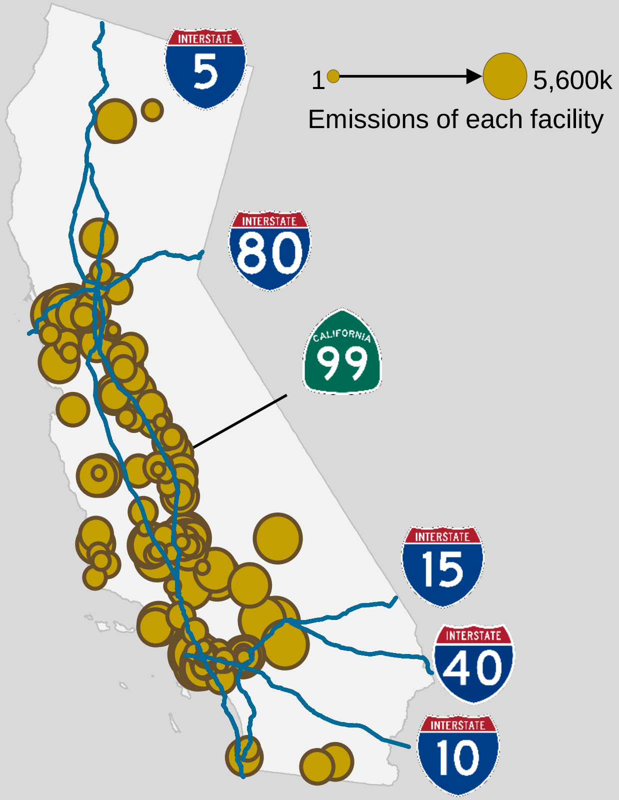
Further consideration of high truck vehicle volume but low VMT or <50-mile corridors may be necessary to complete charging and/or refueling infrastructure

1. Vehicle miles travelled
2. The I-5 corridor includes the I-710 where it connects I-5 to the ports of Los Angeles and Long Beach, and the segments of I-405 and Highway 1 that connects I-10 and I-710 near the San Pedro Bay Ports. This corridor also includes the local roads that connect the I-5 to the Port of San Diego and to the US/Mexico border.
3. The I-10 corridor includes the short segment of SR-47 that connects I-10 to the Port of Los Angeles, and the segments of I-405 and Highway 1 that connects I-10 and I-710 near the San Pedro Bay Ports.
4. The I-80 corridor includes the short segments of I-580 and I-880 that connect I-80 to the Port of Oakland.

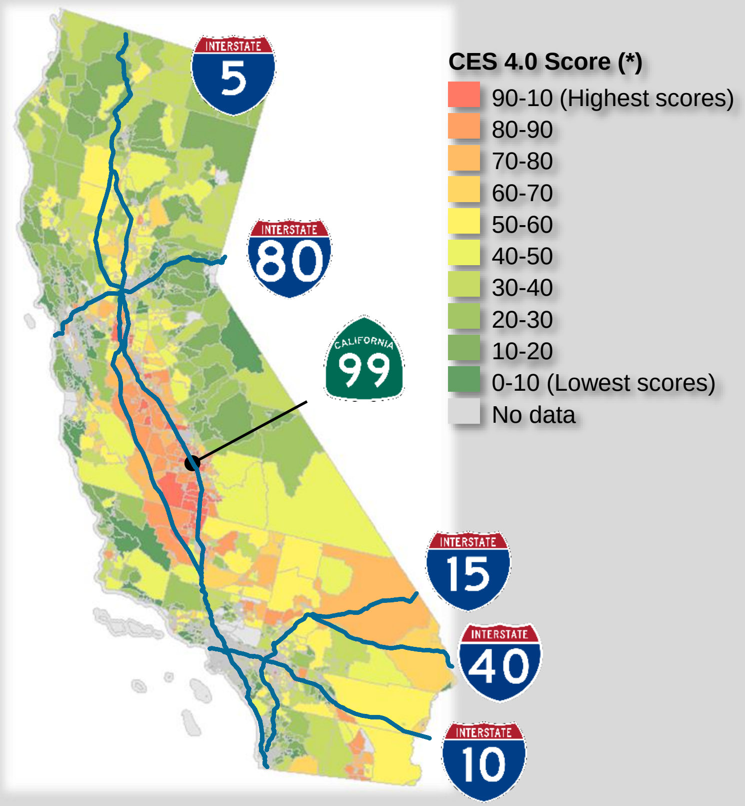
Proposed 6 priority corridors also overlap with emissions from industrial sources and areas with the highest pollution burden

AS OF 01/27/2023 **PRELIMINARY – FOR DISCUSSION**

CARB Pollution Emitting Facility Locations and Emission Magnitude[1]



CalEnvironScreen 4.0 Pollution Burden Score[2]



1 The Pollution mapping tool includes location of large facilities and associated GHG emissions and criteria pollutant emissions; the latter are not included in this map. Facilities include the following industrial classification: cement plant, cogeneration, electricity generation, hydrogen plant, oil and gas production, other combusting source and refineries. The map includes industrial facilities and covered facilities

2 The mapping is made up by considering "cumulative impacts means exposures, public health or environmental effects from the combined emissions and discharges, in a geographic area, including environmental pollution from all sources, whether single or multi-media, routinely, accidentally, or otherwise released. Impacts will take into account sensitive populations and socioeconomic factors“

(*) CES 4.0 Score explanation and all indicators included in the pollution burden score can be found at the Report “CalEnviroScreen 4.0. October 2021”. Source: California Office of Environmental Health Hazard Assessment (Link)

Source: California Office of Environmental Health Hazard Assessment - CalEnviroScreen 4.0 (Link), California Resources Board – CARB Pollution Mapping Tool (Link); Data pulled as of 01/25/2023

Open Discussion

Questions to think about:

- How is freight data important to your organization?
- What effect does freight data have on your work?
- How might this work inform work you are doing?
- Is there any information that you have that may help inform these efforts?

Closing Remarks

Thank you!