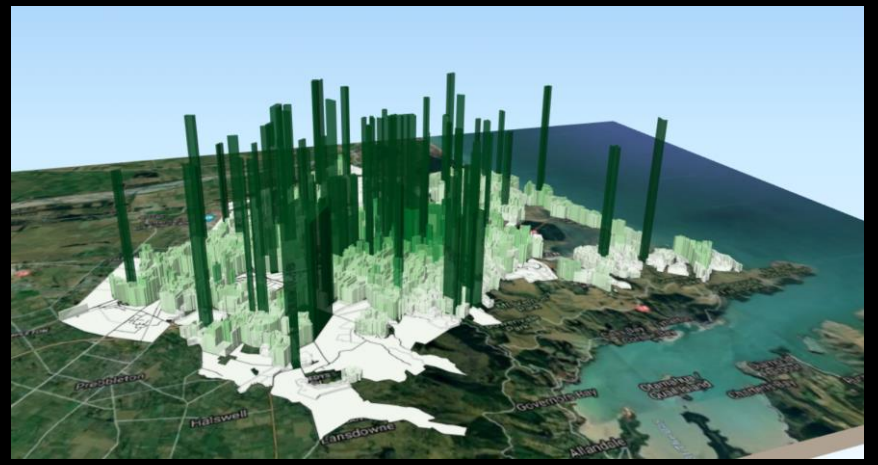
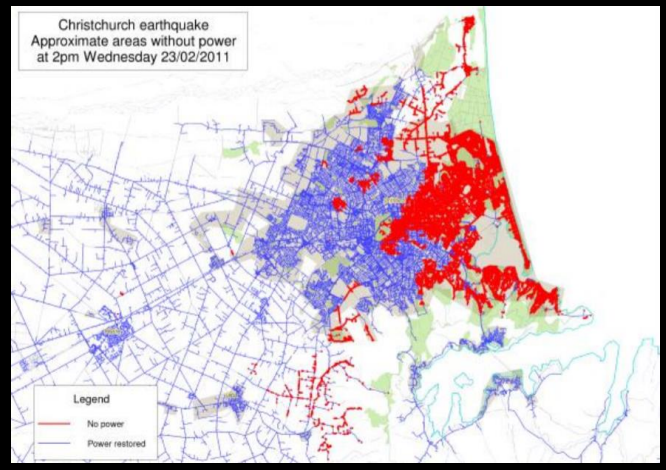
Snapshot of our Cities and Adaptation Research

Civil Systems Engineering Team, University of Canterbury



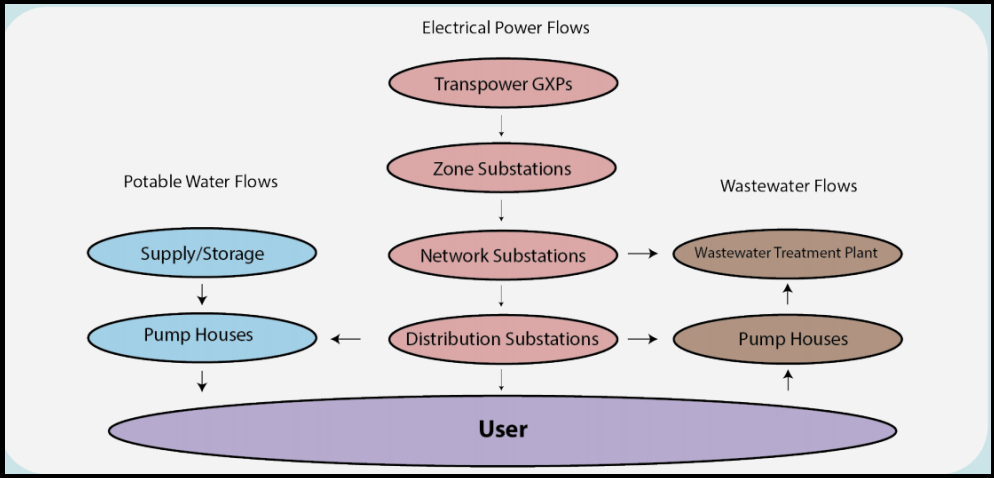


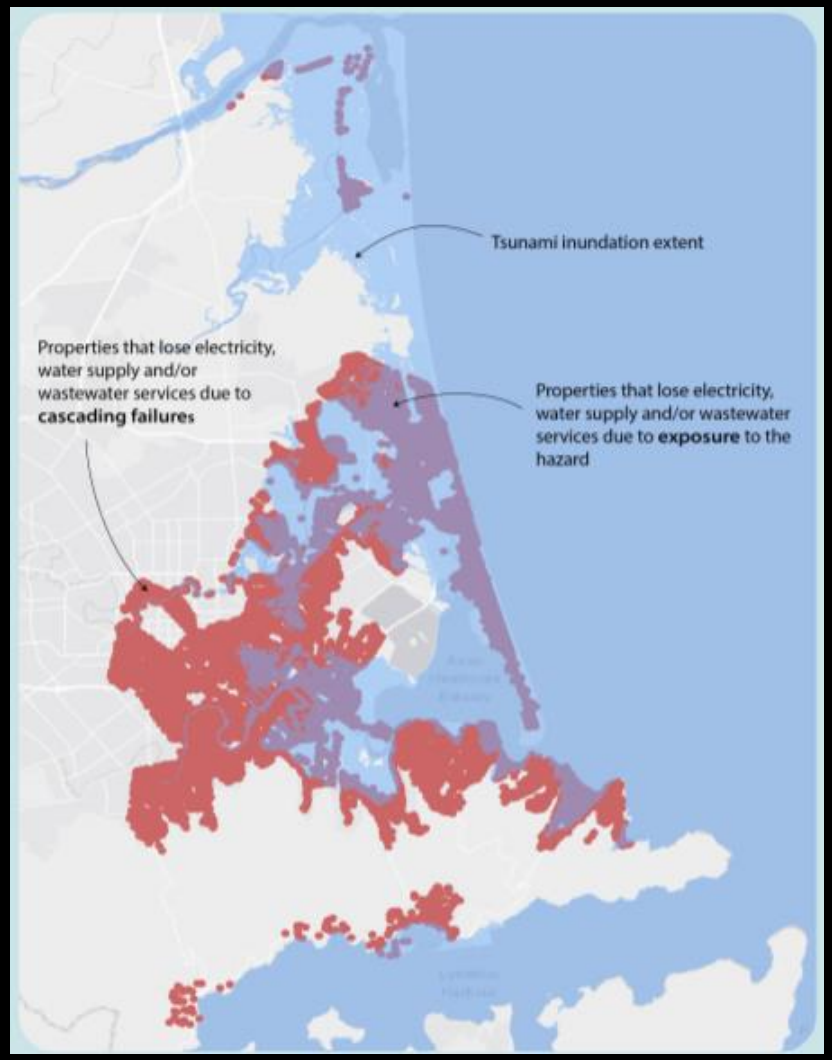
Presentation Overview

1. Overview of projects – Tom
   a. Interdependent infrastructure
   b. Spatial optimization
   c. Adaptation planning
   d. Decision-making under uncertainty
   e. Equitable facility location
2. The resilience of access to urban services - Mitch

Cascading failures in interdependent infrastructure networks

- Ōtautahi Christchurch
- Evaluating how EPN, WSN, WWN dependent and fail due to a hazard event





Mansoor, A. & Logan, T. M. (2021). . *QuakeCoRE USER Conference*.

Multi-criteria spatial optimization for land-use planning

Tsunami inundation

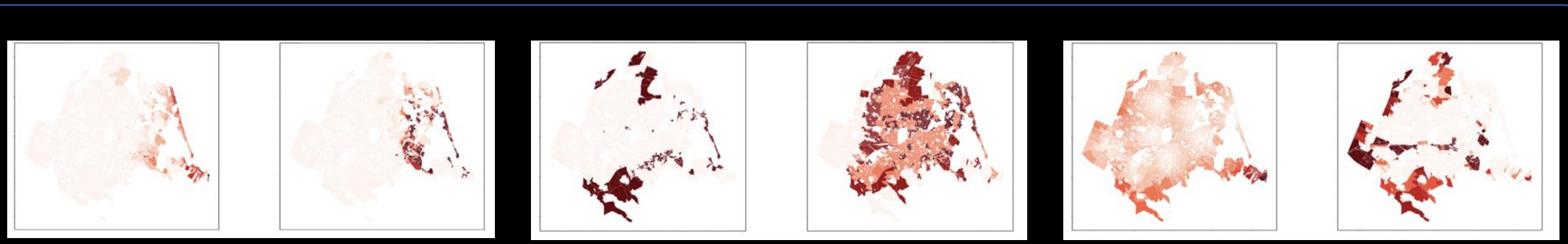
Coastal flooding

River flooding

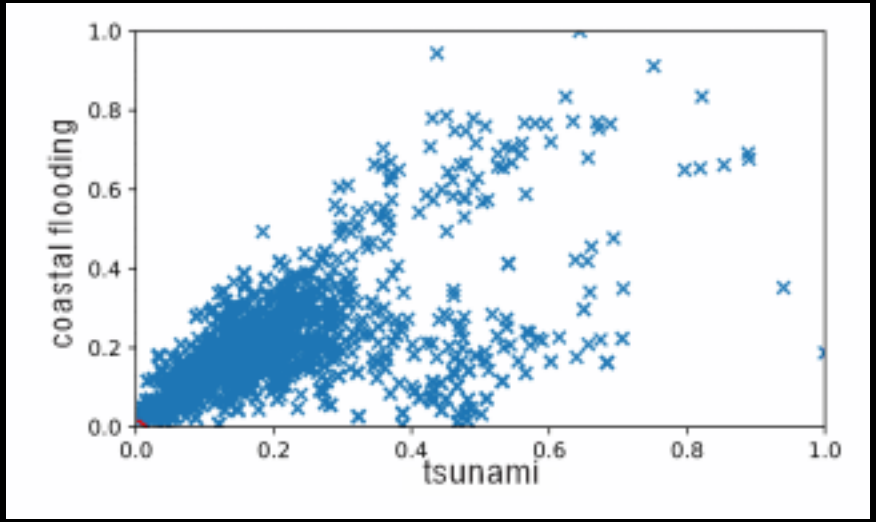
Liquefaction susceptibility

Distance to key activity areas

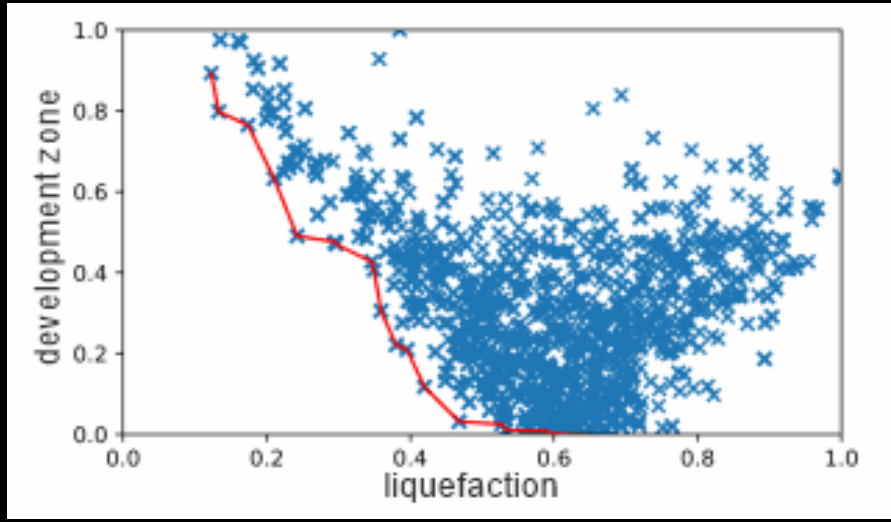
District planning zone



Synergies & Trade-offs



Synergistic relationships exist



Trade-offs are still required

Adaptation Planning

- Review of the state of adaptation planning domestically
- Lessons from international approaches
- Co-funded with UC's Law, Emergencies, and Disasters (LEAD) Institute

Options for decision making under uncertainty

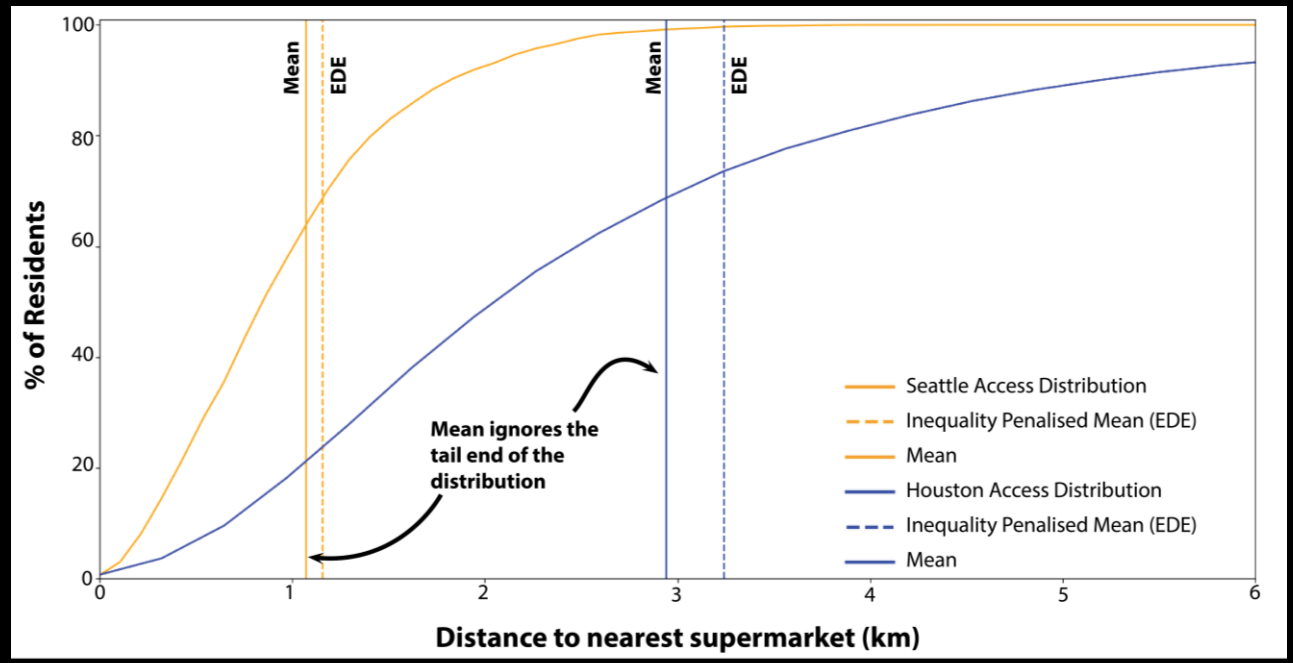
- Review of alternative approaches for decision making under uncertainty for deep uncertainty for local council urban planning
- Co-funded RNC-Urban

Measuring inequality in urban systems

Python:

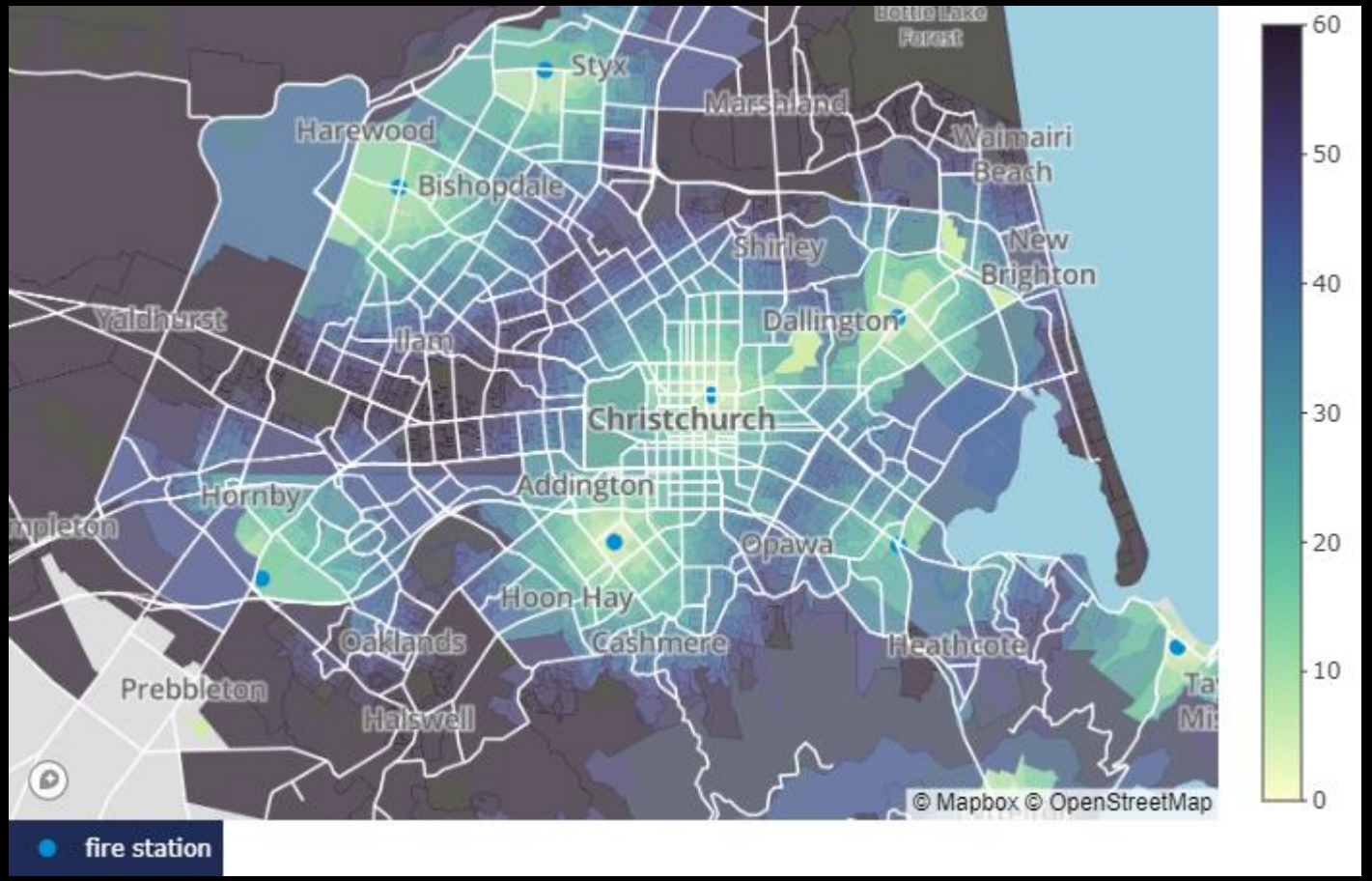
pip import inequalipy

```
>> import inequalipy as ineq
>> ineq.gini(x, weights=w)
>> ineq.kolmpollak.ede(x, weights=w)
```



Logan, T. M., Anderson, M. J., Williams, T. G., & Conrow, L. (2021). Measuring inequalities in urban systems: An approach for evaluating the distribution of amenities and burdens. *Computers, Environment and Urban Systems*, *86*, 101590. https://doi.org/10.1016/j.compenvurbsys.2020.101590

Equitable facility location



The resilience of access to urban services

Mitchell Anderson, PhD Student, Civil Systems Engineering

The resilience of access to urban services

- Identify critical nodes within amenity networks (food resources, health care, etc.), & critical links within the transport network
  - Aid investment prioritization to increase resilience during BAU
- Identify vulnerable geographic areas and demographic groups
  - Aid community engagement and preparedness
- Prioritise post disaster recovery actions to maximise performance and equity within the system using real time data

Anderson, M. J., Logan, T. M., & Kiddle, D. (in progress). Measuring inequalities in urban systems: An approach for evaluating the distribution of amenities and burdens. *Risk Analysis*

ACCESS RESILIENCE

Reliable access is extremely important for urban resilience, especially in the face of a disaster. Use this tool to explore just how resilient your access to essential services is under a hazardous event.

SELECT CITY

CHRISTCHURCH, NEW ZEALAND

SELECT HAZARD

TSUNAMI

SELECT AMENITY

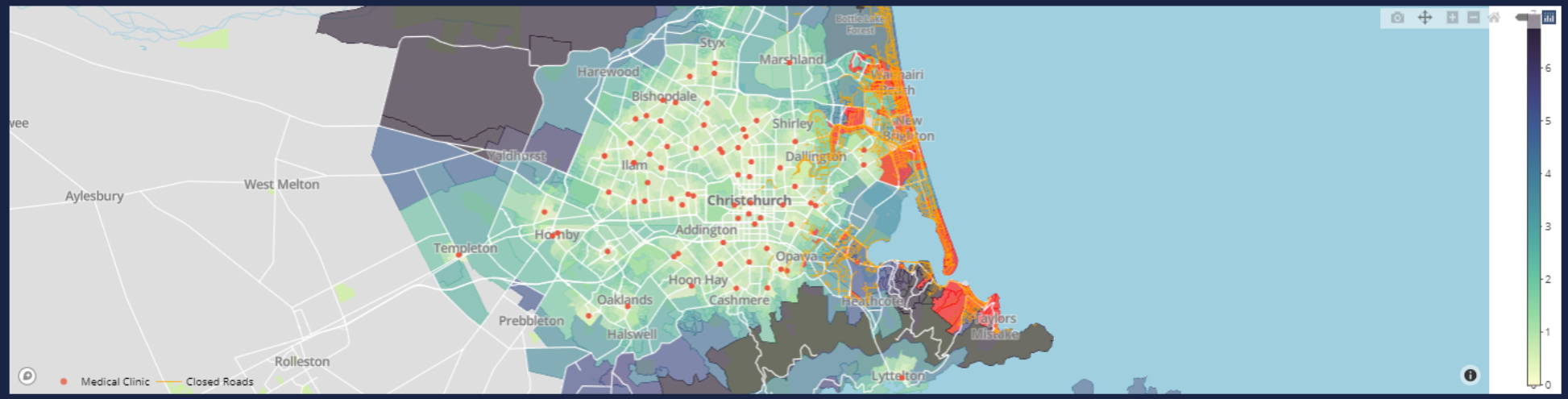
MEDICAL CLINIC

COMPARE DEMOGRAPHICS

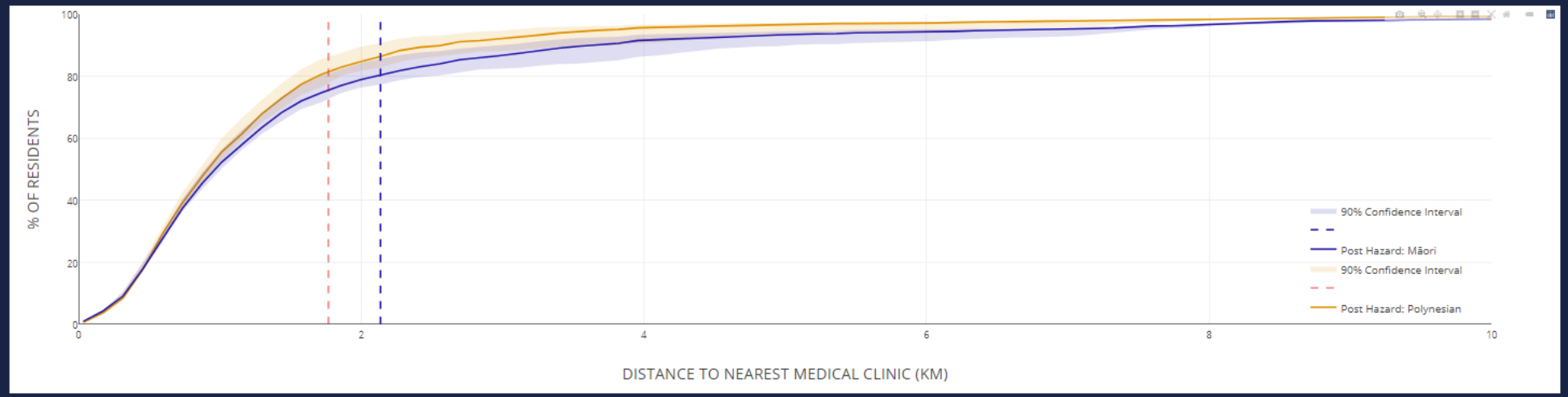
POLYNESIAN | MĀORI

RUN HAZARD EVENT | RESET HAZARD

EXPLORE HOW FAR PEOPLE NEED TO TRAVEL



SELECT A DISTANCE RANGE



Thank you to the developers of Dash and Plotly, whose work made this app possib

The importance of access

Thousands of Indonesian children still do not have access to education 2 years after 2018 earthquake

Hurricane Katrina leaves long standing access issues throughout New Orleans

The Approach

1: Overlay

Transport Network

Essential Services

Demographic data

2: Baseline Access

Use Python + OSRM to evaluate the baseline access distribution

3: Simulate Hazard

Simulate a hazard and categorize each road segment and amenity.

[Operable / Non-Operable]

4: Hazard Access

Remodel the road and service network based on step 3.

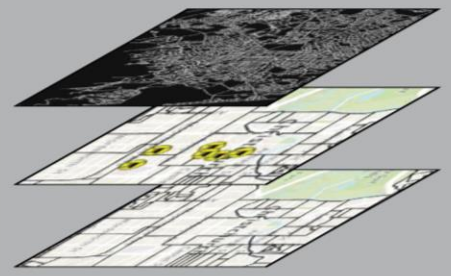
Evaluate new access distribution

5: Calculate Equity & Visualise

Evaluate the equity, mean, and uncertainty within the simulation results.

Map and graph the results.

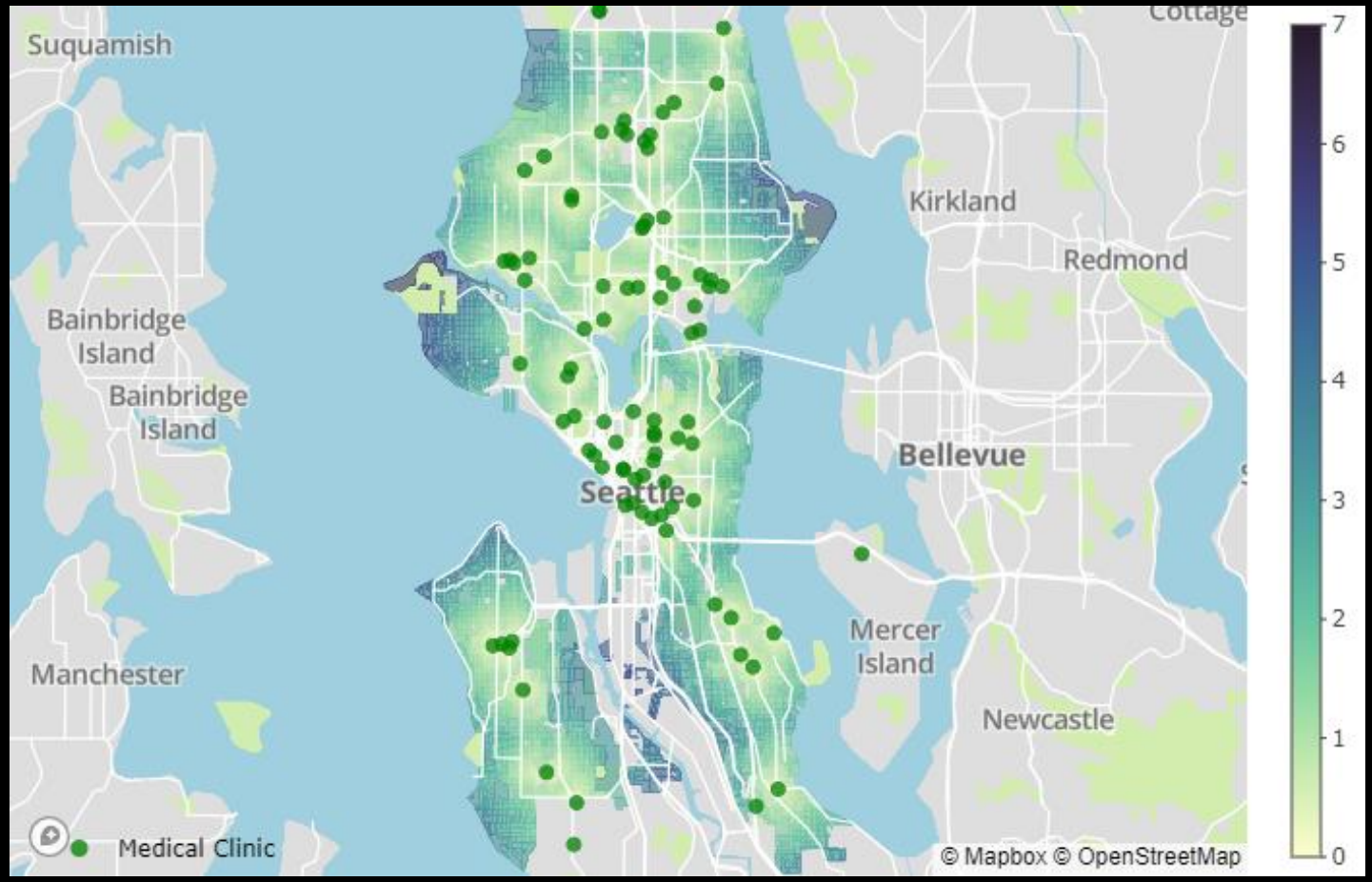
Monte Carlo Hazard Simulation Repeat x1000



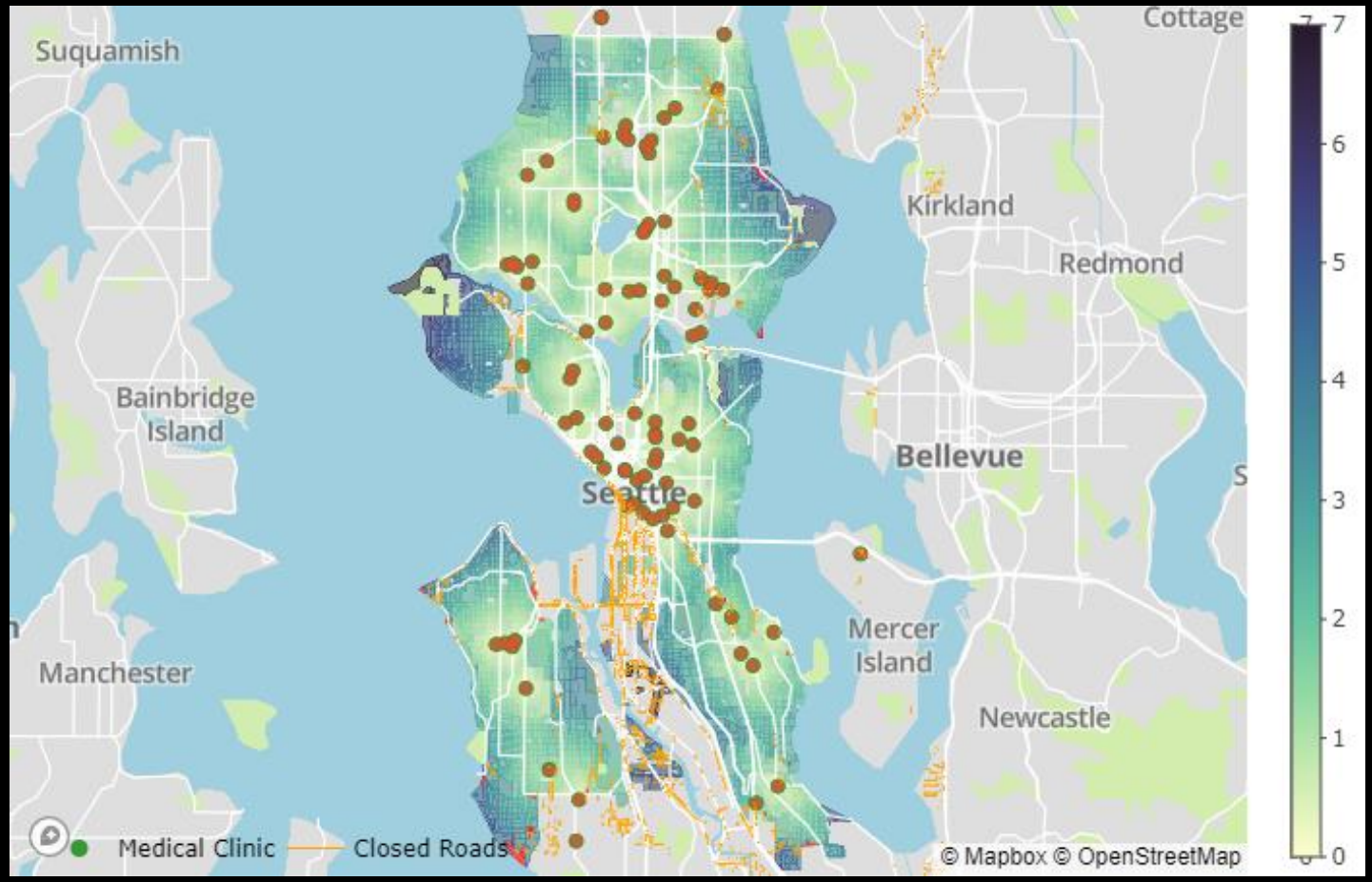
Case Studies

Road networks of Christchurch, Seattle and Houston

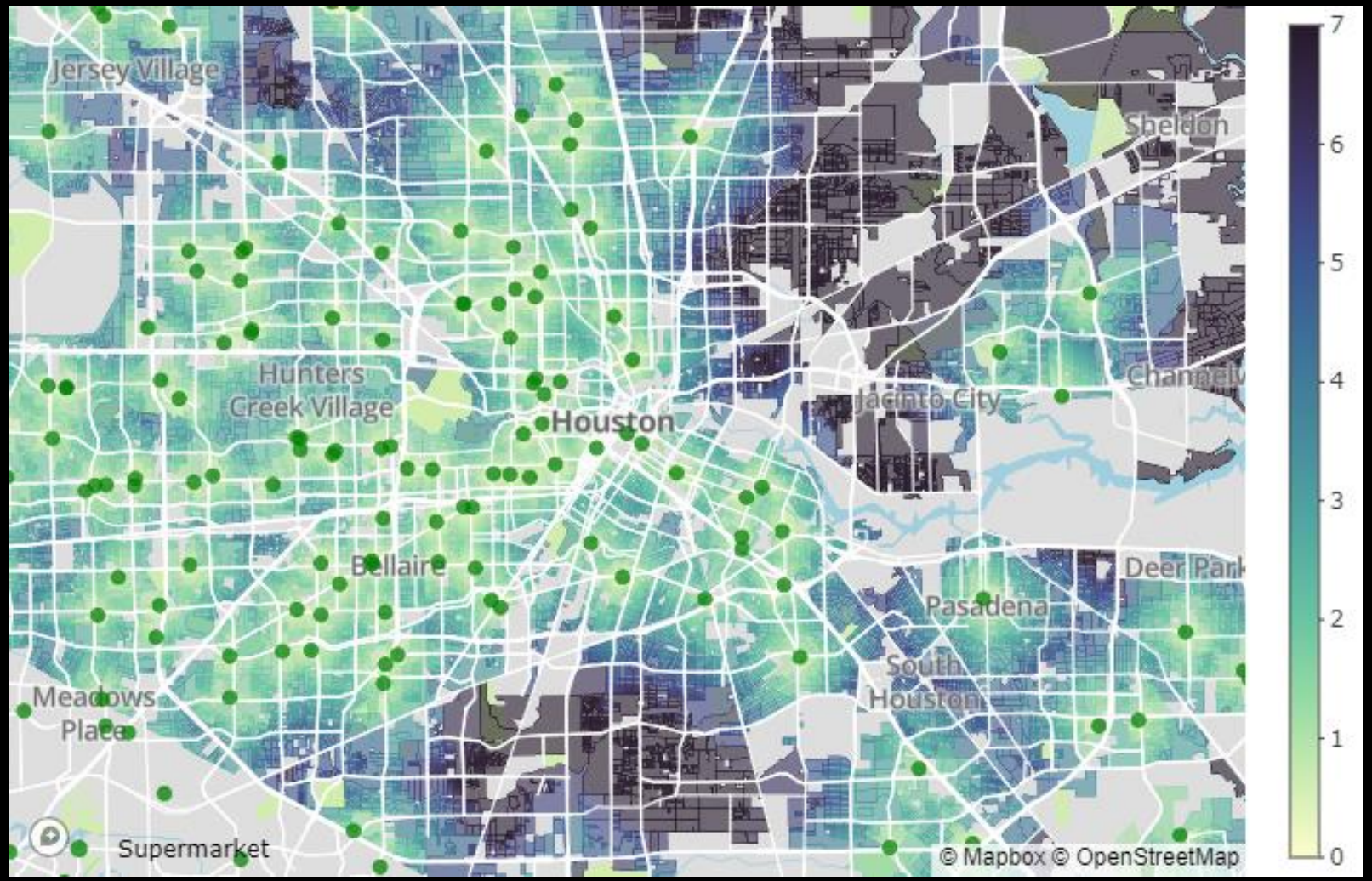
Seattle – Base Access



Seattle – Access post Liquefaction



Houston – Base Access



Houston – Access post Hurricane

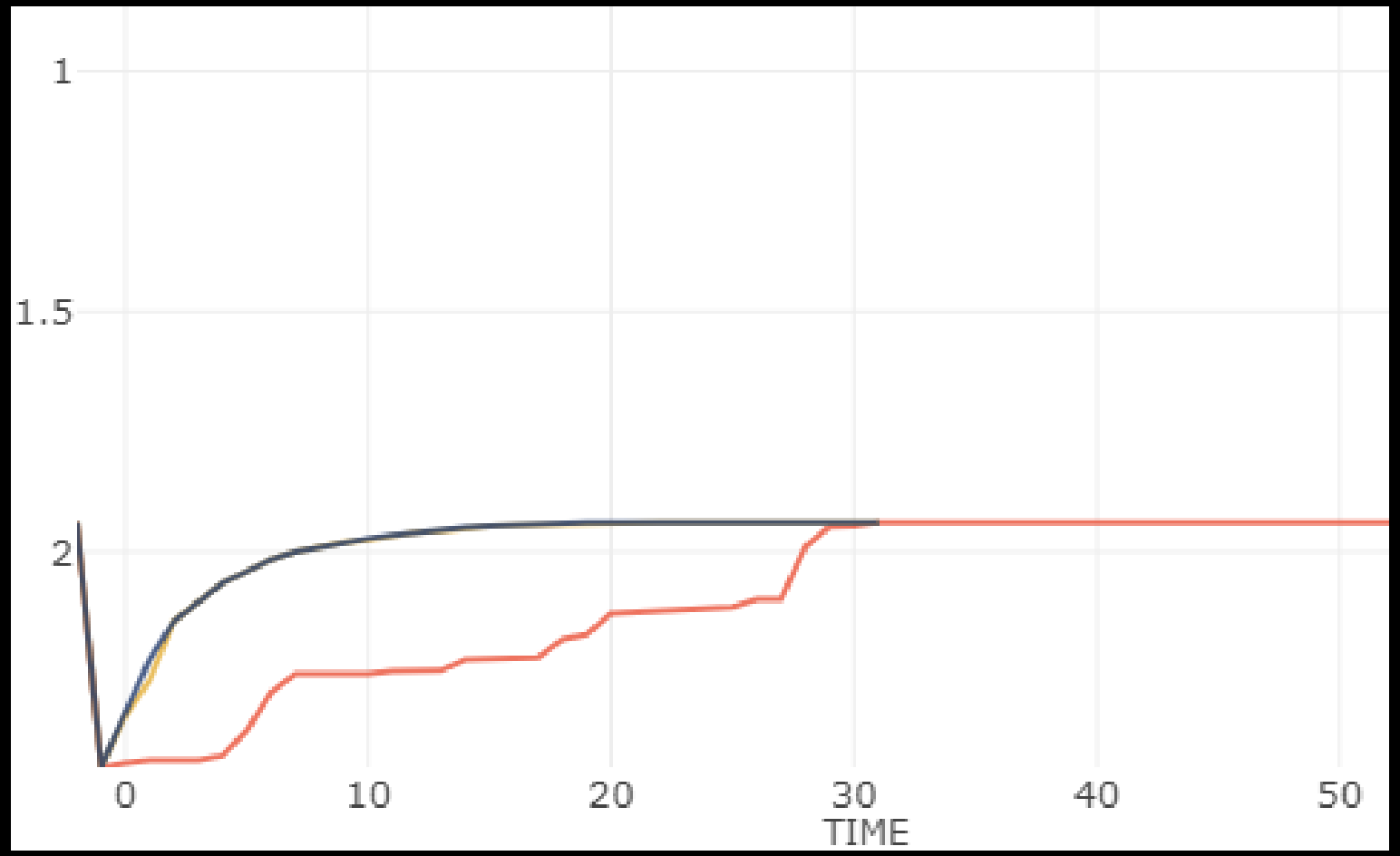
Future Opportunities

EQUITABLE RECOVERY OPTIMIZATION

INTERDEPENDENT INFRASTRUCTURE

COMMUNITY ENGAGEMENT AND PREPARATION

Optimizing Recovery



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