Determination of Recovery Bridges through Post-earthquake Corridor Identification

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Objective

Develop simple computational tools to determine which bridges should be designed as recovery bridges on a highway network

- importance measure for bridges
- method to identify corridors
- verifications on the highway network of the Bay Area
- software package development

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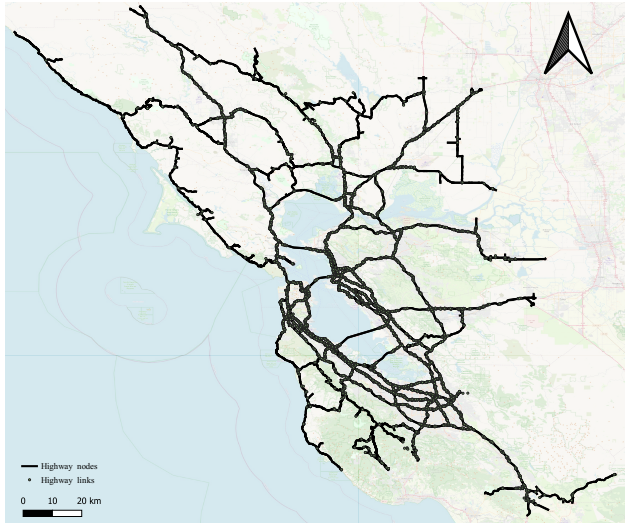
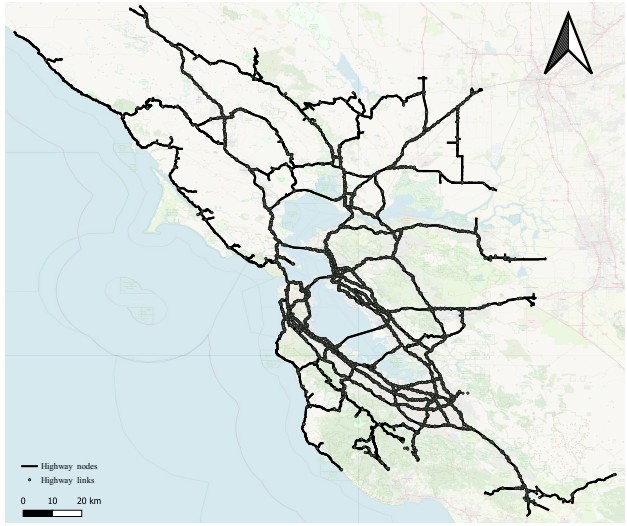


Objective

Develop simple computational tools to determine which bridges should be designed as recovery bridges on a highway network

- importance measure for bridges (done)
- method to identify corridors (done)
- verifications on the highway network of the Bay Area (almost done)
- software package development (on-going)



Importance measure

How to define a critical bridge ?

- vulnerable to earthquakes (component-level)
- important for transportation functionality (network-level)

$$\text{Importance} = \text{Failure Probability} \times \text{System Impact}$$

USGS Earthquake Hazard Toolbox

System impact:

- Percolation – too expensive
- Simulation "free" method
  - model the collective behavior of traffic flows via a statistically average individual performing biased random walks on the traffic network
  - The probability of visiting each bridge is taken as an impact measure

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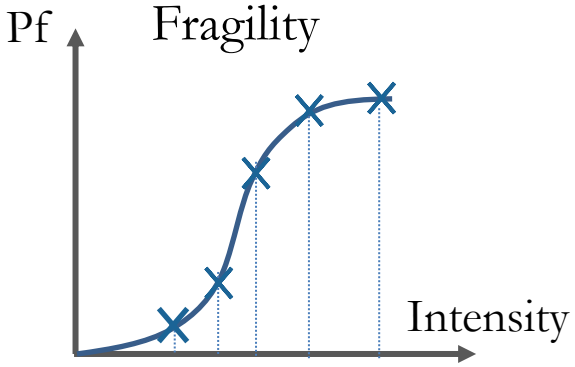

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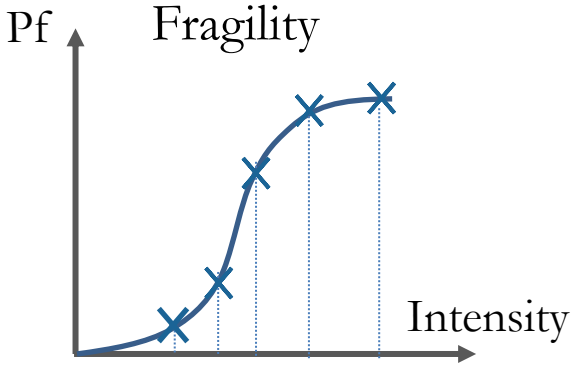

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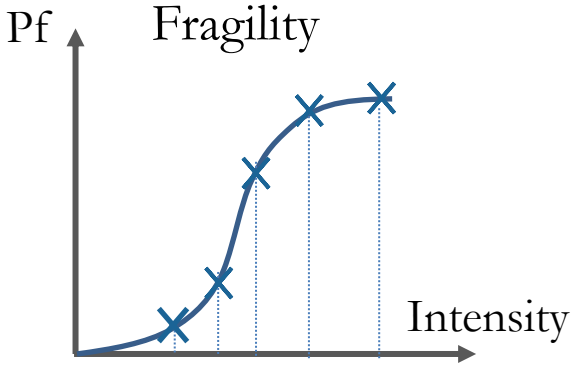

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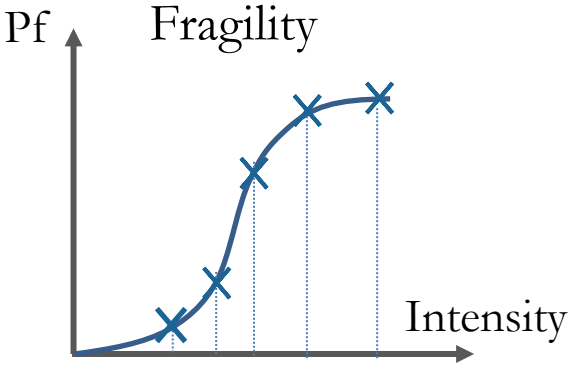

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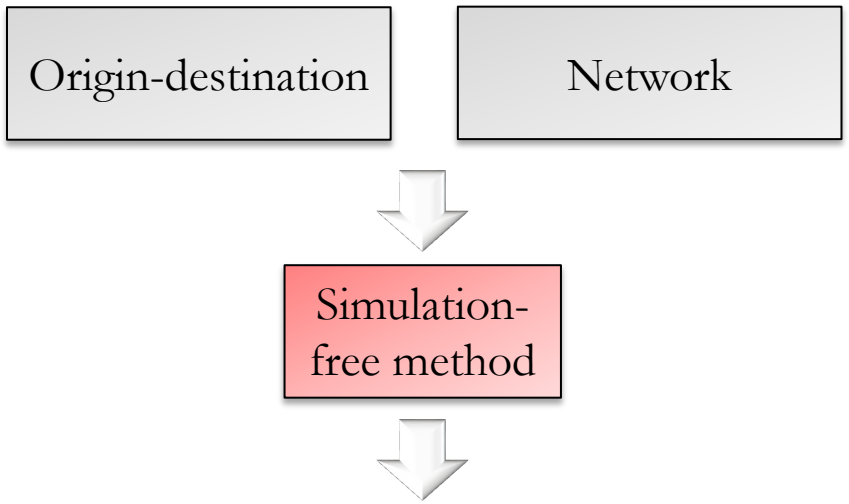

Corridor identification

Two types of corridors are considered

- critical facility access corridor
- high volume corridor

Critical facility access corridor:

- critical facilities as O/Ds and uniform grid points as D/Os
- equity is considered as not weighting by population

High volume corridor:

- daily commute ODs

Critical facilities:

Type A

- Hospitals

Type B

- Fire stations
- Police stations
- Airport/landing zones/Military airports
- Major Sea ports
- Caltrans Maintenance facilities and Traffic Operations Centers/District HQ
- Ferry terminals

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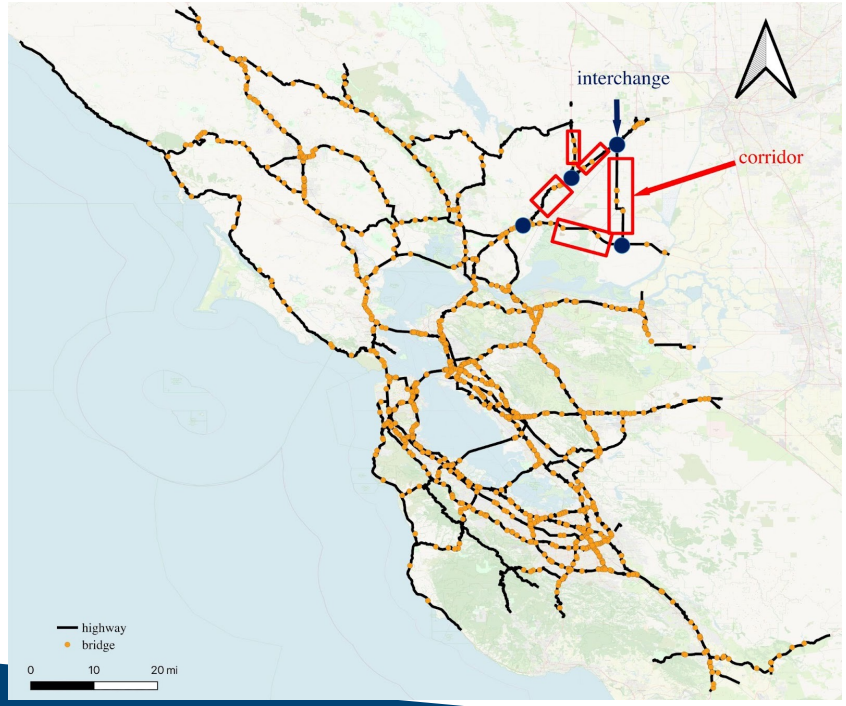
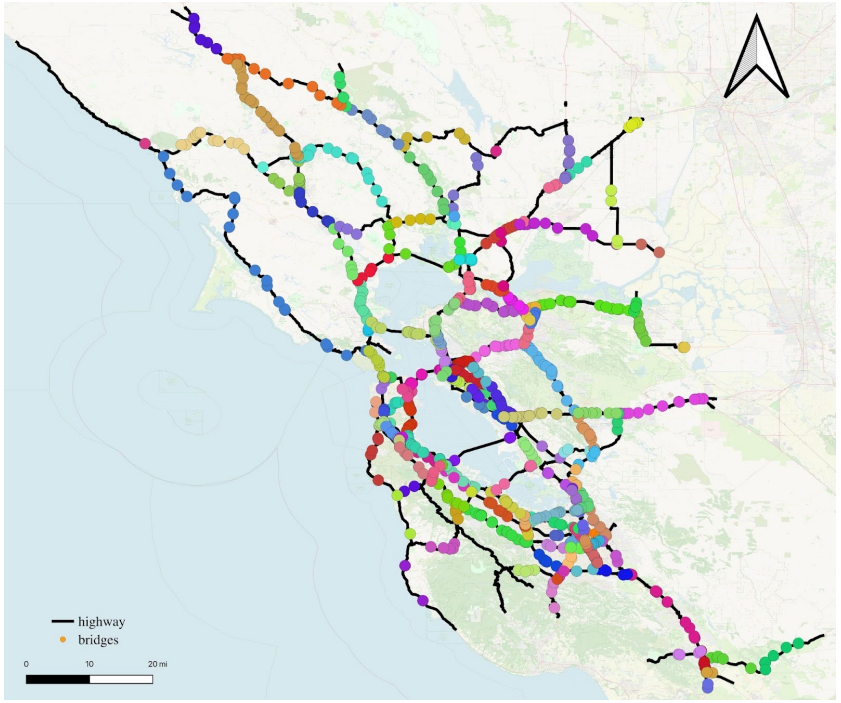
Corridor identification

Partition/Clustering methods

- (Euclidean) distance-based clustering
- Graph-based clustering
- Interchange-based clustering

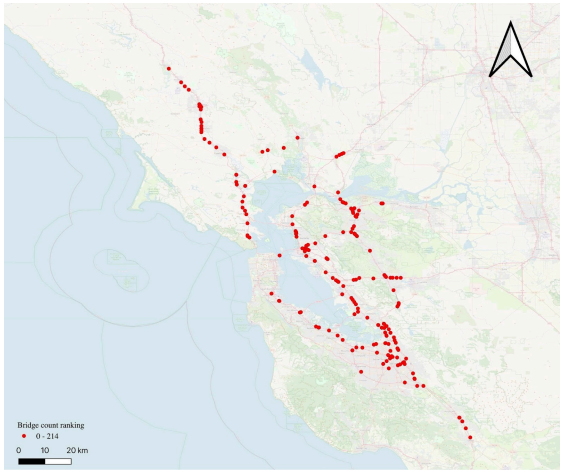




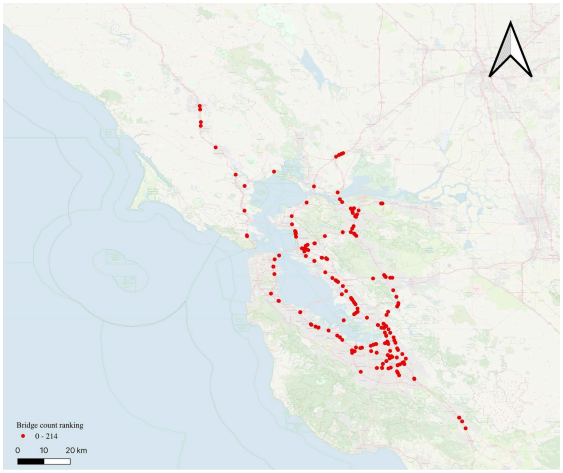
Simulations

Critical (10% high-rank) bridges for the access of hospitals

225-year-return-period earthquake



equity-based weighting



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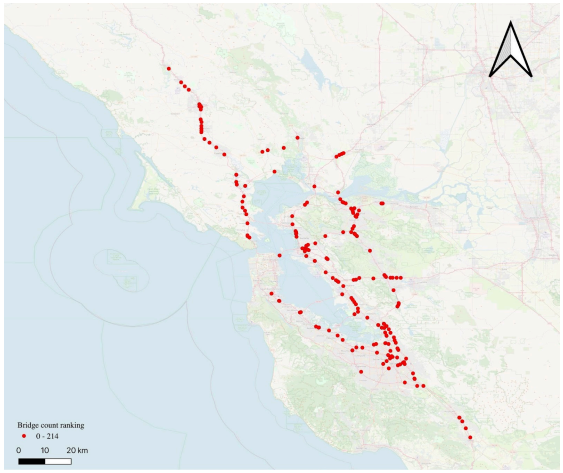

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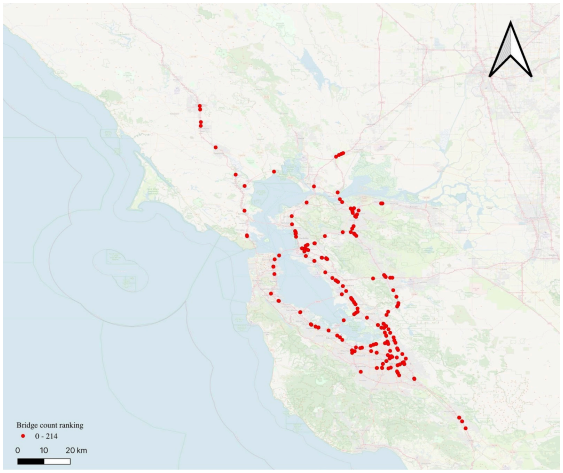
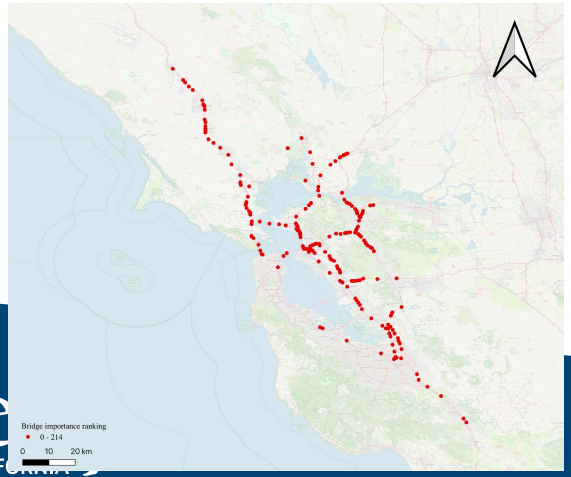
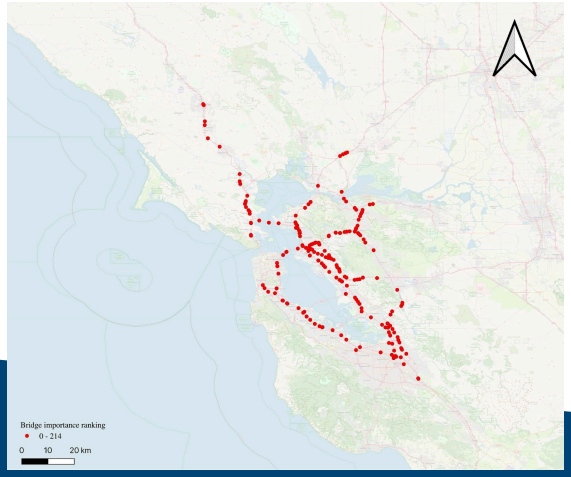


population-based weighting

975-year-return-period earthquake

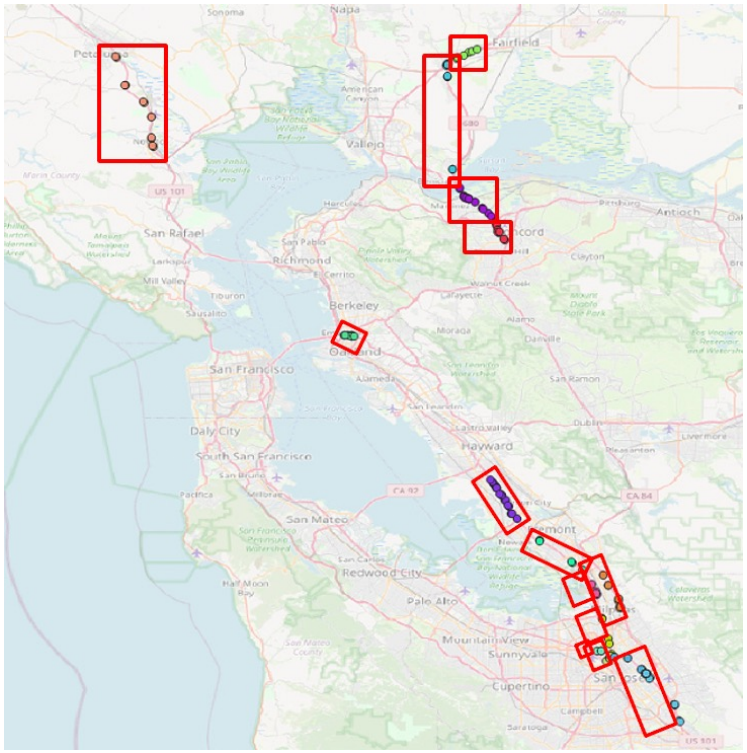




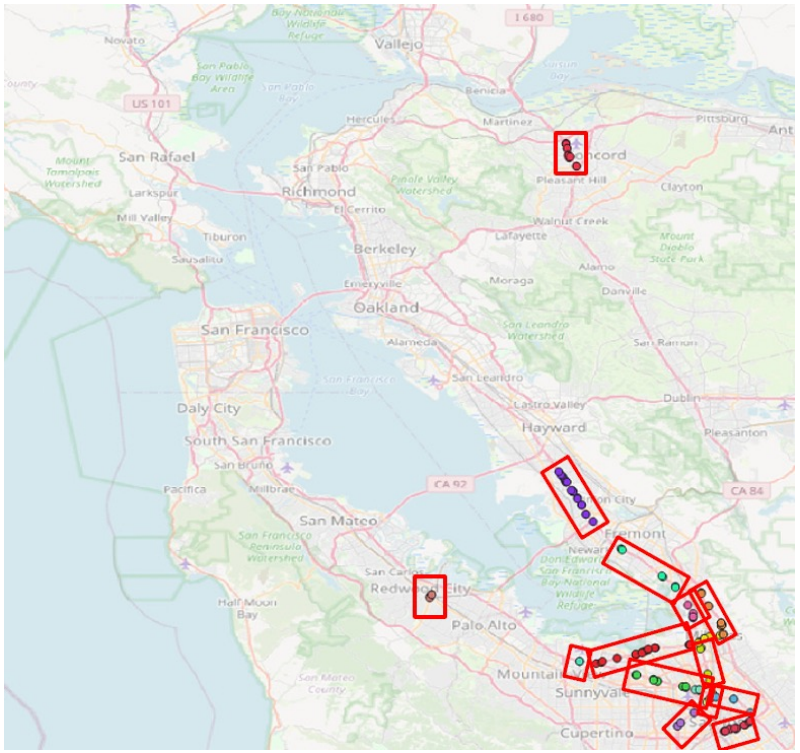
Simulations

Critical (10% high-rank) corridors for the facility access

225-year-return-period earthquake



Hospitals



Other facilities in Type B

Next steps

- More simulations/verifications
- Software package development
- Technical issues:
  - boundary condition: the current OD does not include pass-through ODs or the ODs where either O or D is outside the Bay Area
  - Extensions to local road networks

Thank you!