City-scale Modeling of Traffic and Pipeline Networks Using High-Performance Computer

PEER Transportation Systems Research Program

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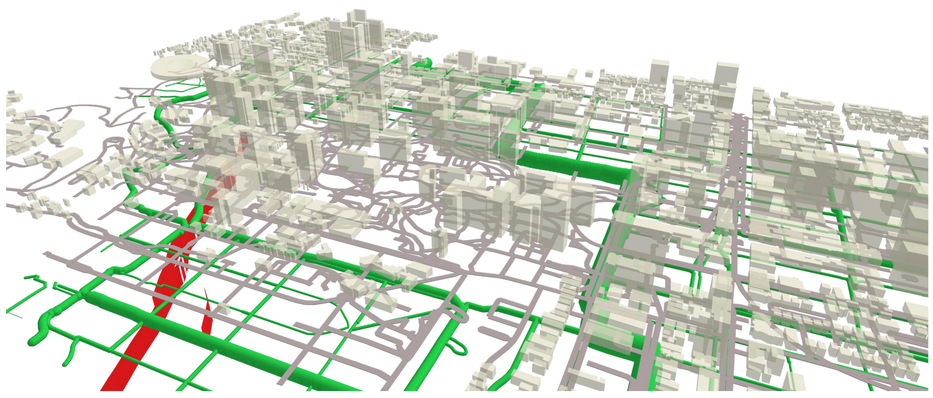
Introduction

Safeguarding urban resilience after natural disasters relies on acute understanding the system formed by multiple critical infrastructures. These infrastructures have complex, layered structures and are deeply intertwined with each other and human activities. The objective of this research is to model the interactions between the traffic and pipeline networks in the Bay Area under earthquake hazards. The population of the study area is over 7 million and high-performance computer is used to model their individual behavior.

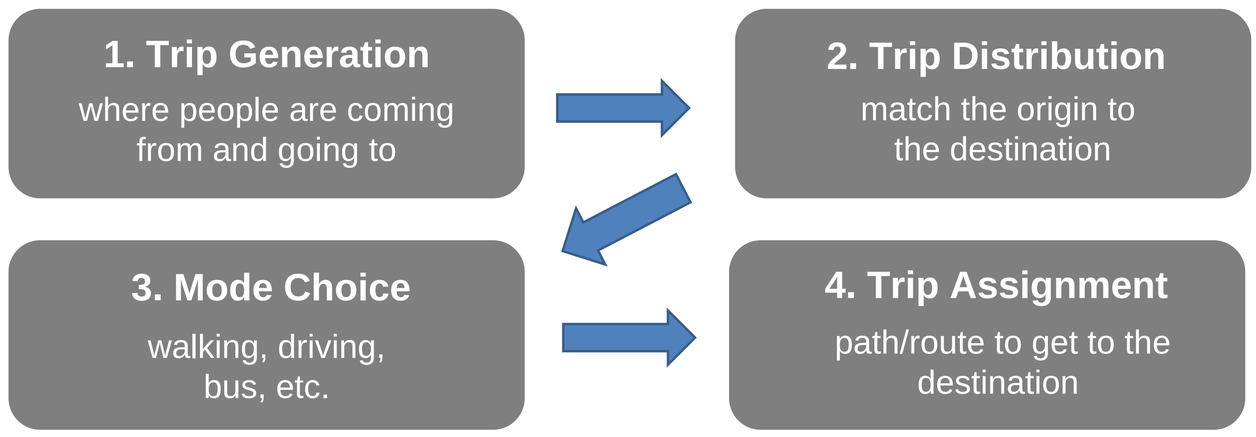


Hayward fault **Water pipelines** **Road network**

Simulation Tool

Agent-based model (ABM) is a powerful tool for simulating complex traffic dynamics: traffic is created by tens or hundreds of thousands of agents traversing a road network. Agents follow the quickest routes to reach their destination and interact with each other through congestion delays.

Four-step travel demand model is the traditional procedure for traffic forecasts.



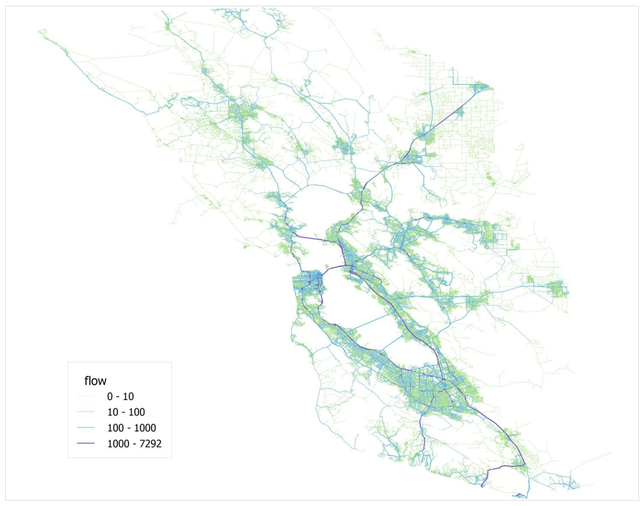
Four-step travel model

High performance computing (HPC) is the use of parallel processing for solving complex and large scale problems. Our simulation is enabled by the Berkeley Savio system. It is a 385-node, 8,040 processor-core Linux cluster.

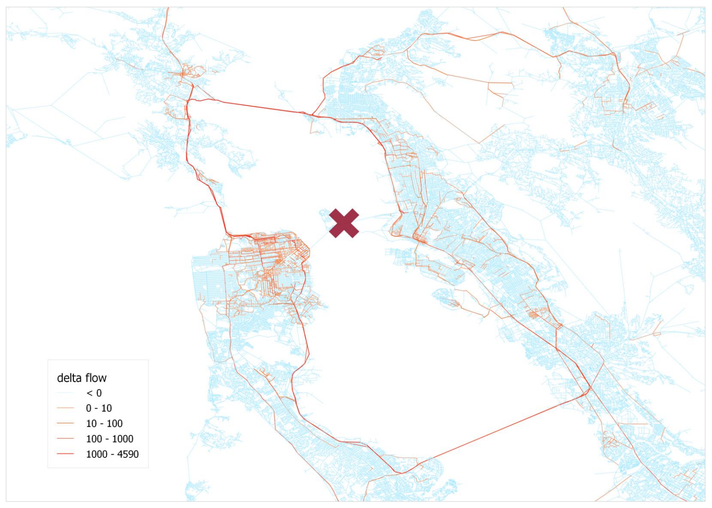
Simulation

The bay area traffic network has 220k nodes and 550k edges. With hourly OD data extrapolated from the California Household Travel Survey (CHTS), traffic for the whole Bay Area can be simulated.

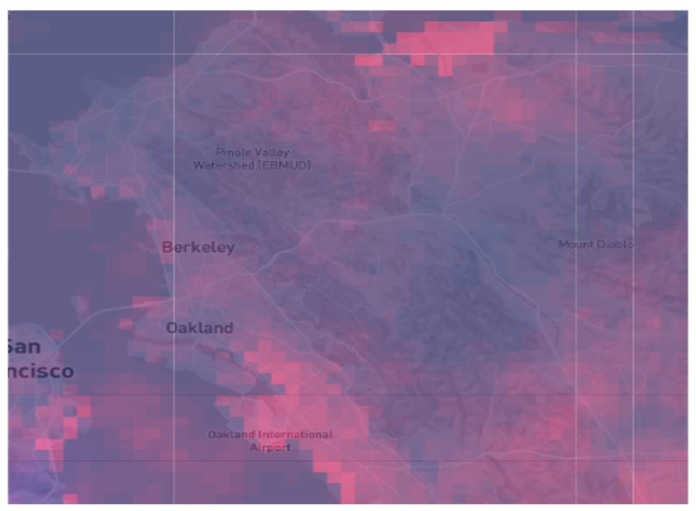
Traffic simulations are conducted with 300k agents (total number of travelers on Thursday 7am) on a undamaged road network (left) and the network where the San Francisco-Oakland Bay Bridge is closed (middle).



Traffic simulation results under undamaged road network



Increased traffic flow during the Bay Bridge closure



Peak ground motion scenario (Prof. Jack Baker, Stanford University)

Summary and Future Plan

So far, bay area scale traffic simulations have been conducted on the undamaged network and the network where the Bay Bridge is closed. As a next step to understand the performance and interactions of the transportation and pipeline networks under earthquake scenarios, the following tasks will be conducted:

- Infrastructure damage calculation: pipe damage and road flooding as a direct result of ground movements under earthquake scenarios.
- Traffic simulation under the damaged network: compare and evaluate the performance loss under different ground motion scenarios.

For more information, please visit our Github page: **github.com/cb-cities/bay_area_abm**

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