

NHERI GSC

August General Meeting



2024



NHERI GSC 
Graduate Student Council

Agenda

11:00-11:08 Welcome & Announcements

11:08-11:15 Dr. Maggie León-Corwin – NHERI
User Forum Survey

11:15-11:45 Dr. Jinyan Zhao – NHERI
SimCenter Presentation

11:45-11:55 Q & A



Welcome New Members

Buddhi

Joshi

Jonathan Burton

Kate

McNeely

Roshan

Sharma

JUNWEI

Ma

Amma

Agyekum

Javier

Robles Camacho

Brenda

Trejo Rosas

H M

IMRAN

*Reach out to [Daniel Yahya](#) and [Wesam Mohamed](#) to learn how to get involved!



Conference Opportunities!

Conference	Dates	Abstract
NHERI Computational Symposium	February 5-7, 2025	August 30, 2024
AAG: 2025 American Association of Geographers	March 24-25, 2025	October 31, 2024
EMI: ASCE Engineering Mechanics Institute	May 27-30, 2025	December 1, 2024
IWSHM: International Workshop on Structural Health Monitoring	September 2025	February 1, 2025
YCSEC: Young Coastal Scientist and Engineers Conference	April 3-4, 2025	Not Announced
ACWE: 15th Americas Conference for Wind Engineering	May 19-25, 2025	October 1, 2024
ANNSIM: Annual Modeling & Simulation Conference	May 26th-29th, 2025	Not Announced
Geotechnical Frontiers Conference	March 2-5, 2025	Early September



Conference Opportunities!

Conference	Dates	Abstract
AGU24: American Geophysical Union	December 9-13, 2024	Closed
Forensic Engineering Congress	November 4, 2024	Closed
Society of Risk Analysis Conference	December 8-12, 2024	Closed
IMAC	February 10-13, 2025	Closed
American Sociological Association Virtual	January 30-31, 2025	Closed
Association for Public policy Analysis & Management	November 21st- 23rd, 2024	Closed

Abstracts are closed but registration is open.



2024 Annual Report

NHERI GSC

Graduate Student Council



2024 ANNUAL REPORT



NHERI GSC
Graduate Student Council



NHERI GSC Fall Nominations

bit.ly/2024NHERIGSC_FallNominations

- **Officers:** President, Treasurer, Secretary
- **All Chair Positions**
 - Membership
 - Workshops & Mentoring
 - Diversity, Equity, & Inclusion
 - Research
 - Networking & Community Building
 - Social Media & Outreach
- **One Vice Chair Position**
 - Membership
- **Research Subcommittee Representatives (RSRs)**
 - Coastal
 - Earthquake
 - Geotechnical
 - Reconnaissance
 - Simulation/Computational Modeling
 - Social Science
 - Wind



NHERI User Forum Survey



Dr. Maggie León-Corwin
Research Scientist
Oklahoma University and
NHERI User Forum

maggie.leoncorwin@ou.edu



NSF
NHERI
User
Forum
Survey



NHERI GSC 
Graduate Student Council

Speaker Introduction



Dr. Jinyan Zhao
Postdoctoral Scholar at
NHERI SimCenter
Jinyan_zhao@berkeley.edu
u



Introduction to SimCenter tools and using them in your research with a focus on R2D

Jinyan Zhao

Postdoctoral Scholar

NHERI SimCenter, UC Berkeley

SimCenter: computational modeling and simulation research facility for natural hazard engineering

NCO



SimCenter NHERI
Center for Computational Modeling and Simulation

Cloud-enabled research applications
Scalable to run on HPC with emphasis on UQ

SimCenter Tools & Resources

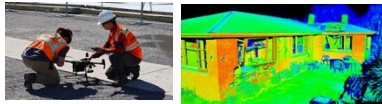
EE_{UQ} WE_{UQ} PBE_{UQ}

Hydro_{UQ} R2D_{UQ}

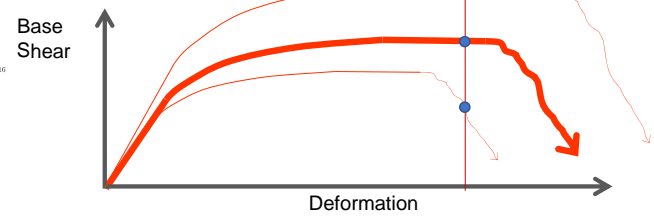
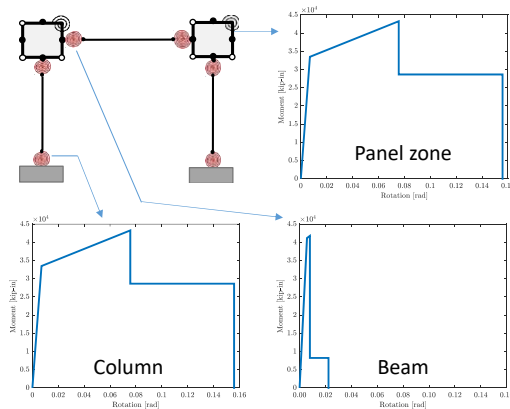
QUO FEM



7 Experimental facilities

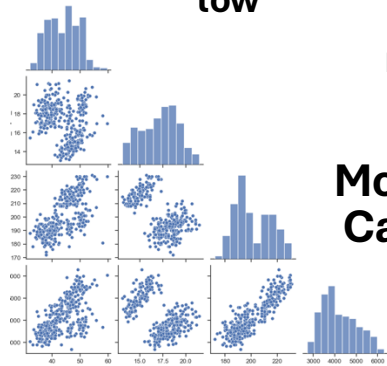
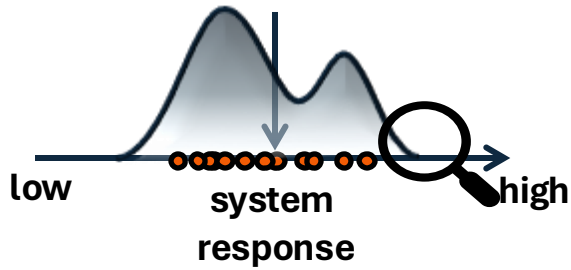


2 Recon facilities

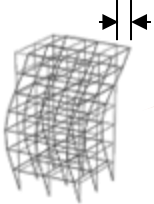


source: SimCenter Teaching Gallery
<https://simcenter.designsafe-ci.org/knowledge-hub/teaching-gallery/>

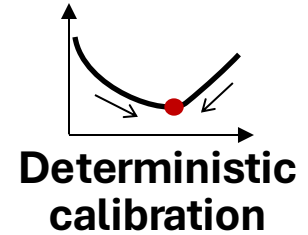
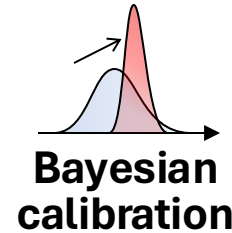
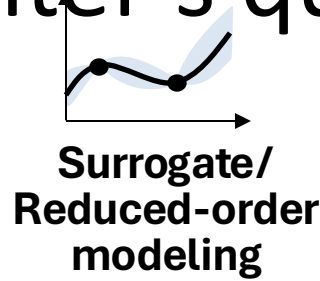
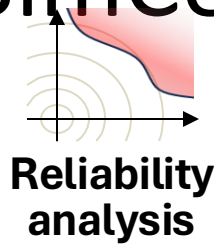
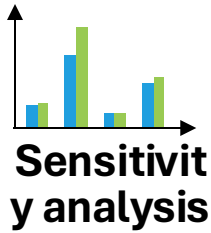
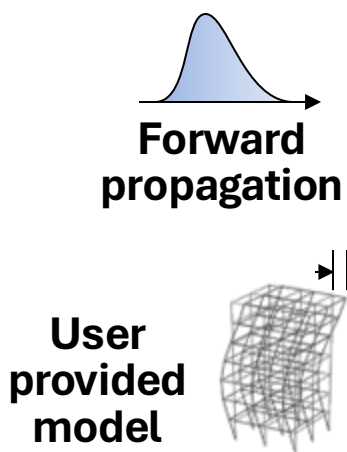
Uncertainty quantification using SimCenter's quoFEM



User provided model



Uncertainty quantification using SimCenter's quoFEM

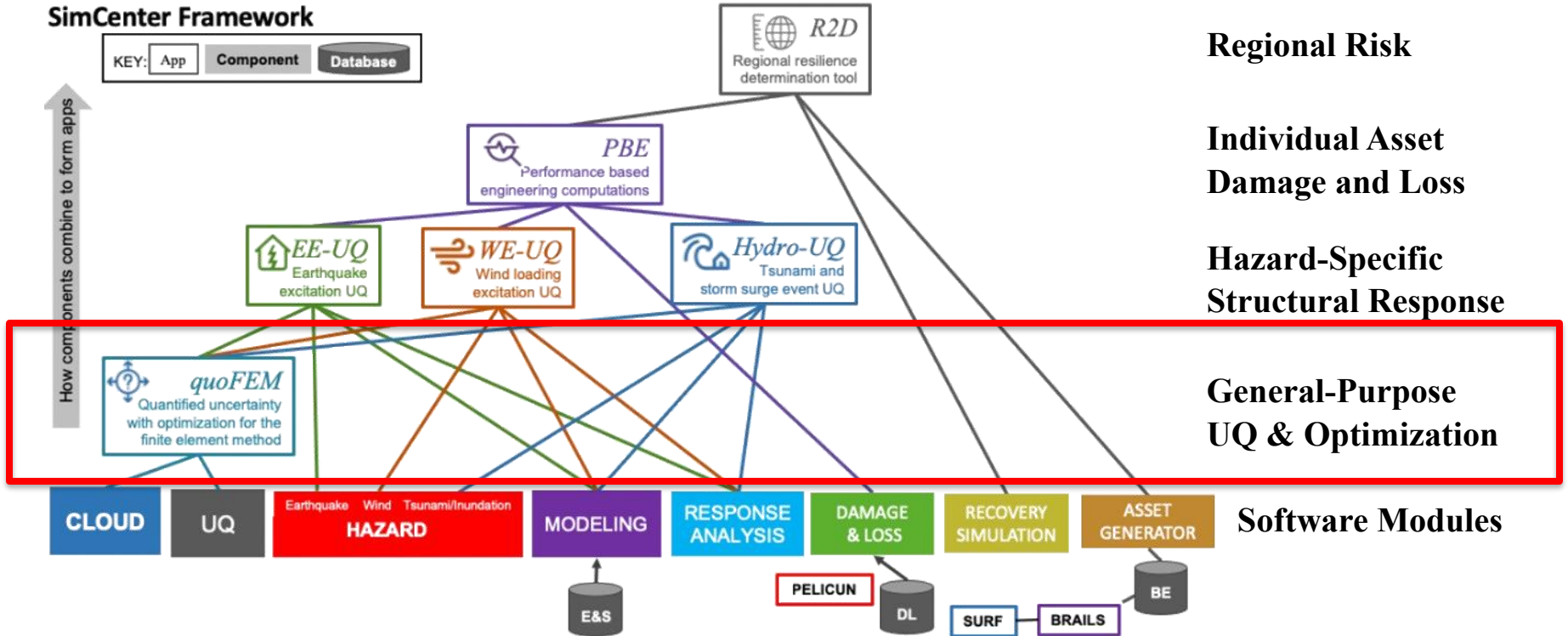


Experimental data



SimCenter – Desktop application portfolio

SimCenter Framework



Regional Risk

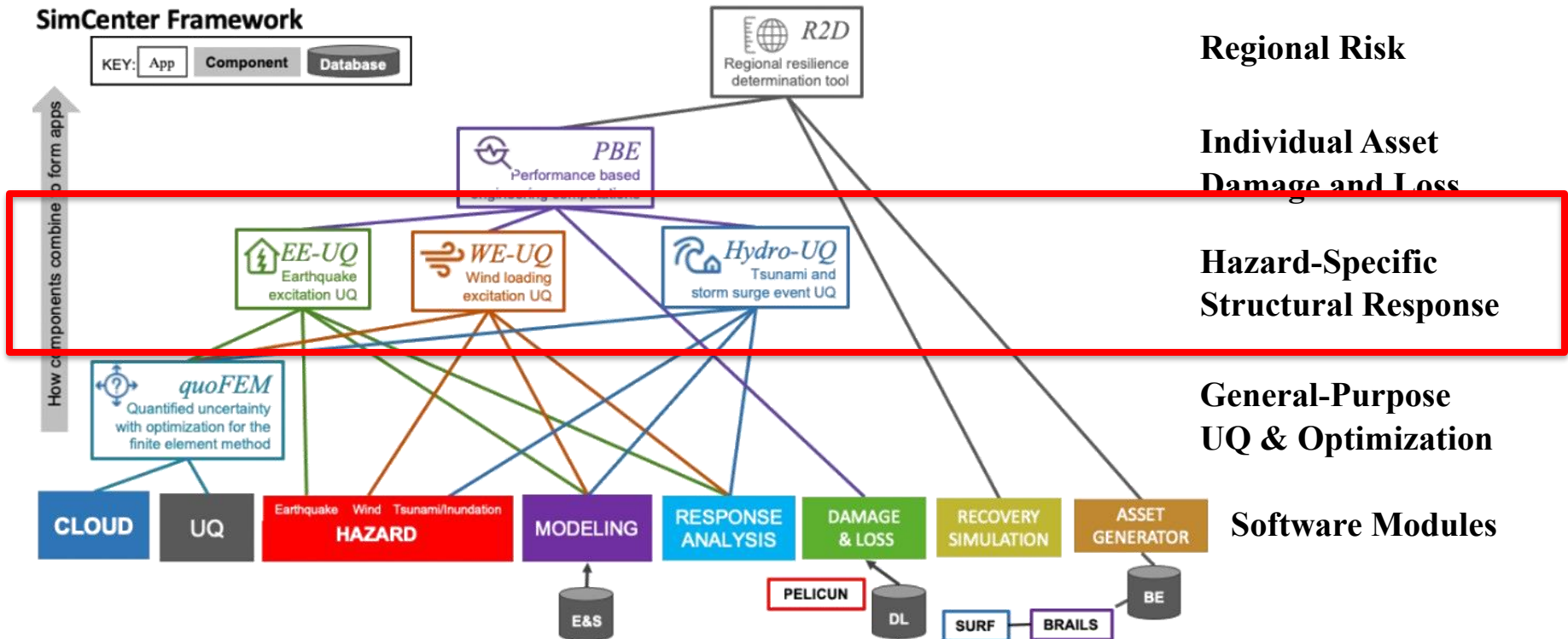
Individual Asset
Damage and Loss

Hazard-Specific
Structural Response

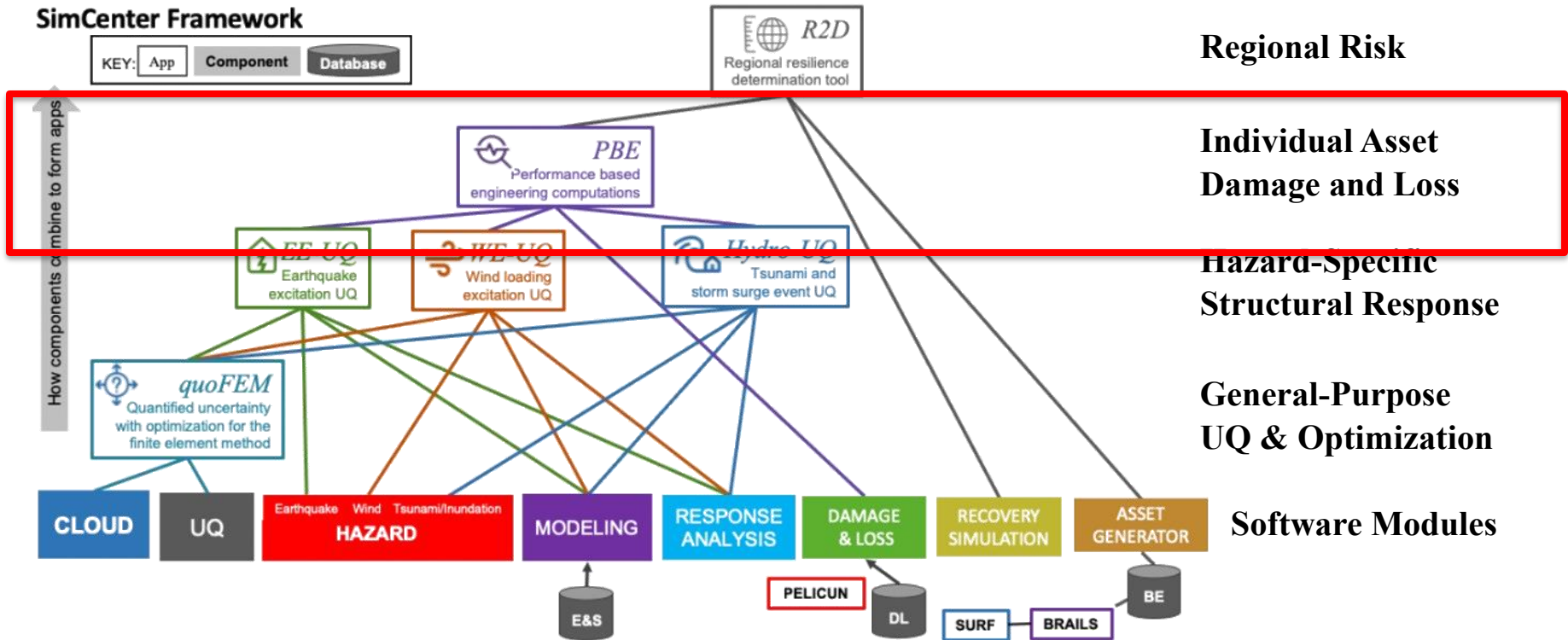
General-Purpose
UQ & Optimization

Software Modules

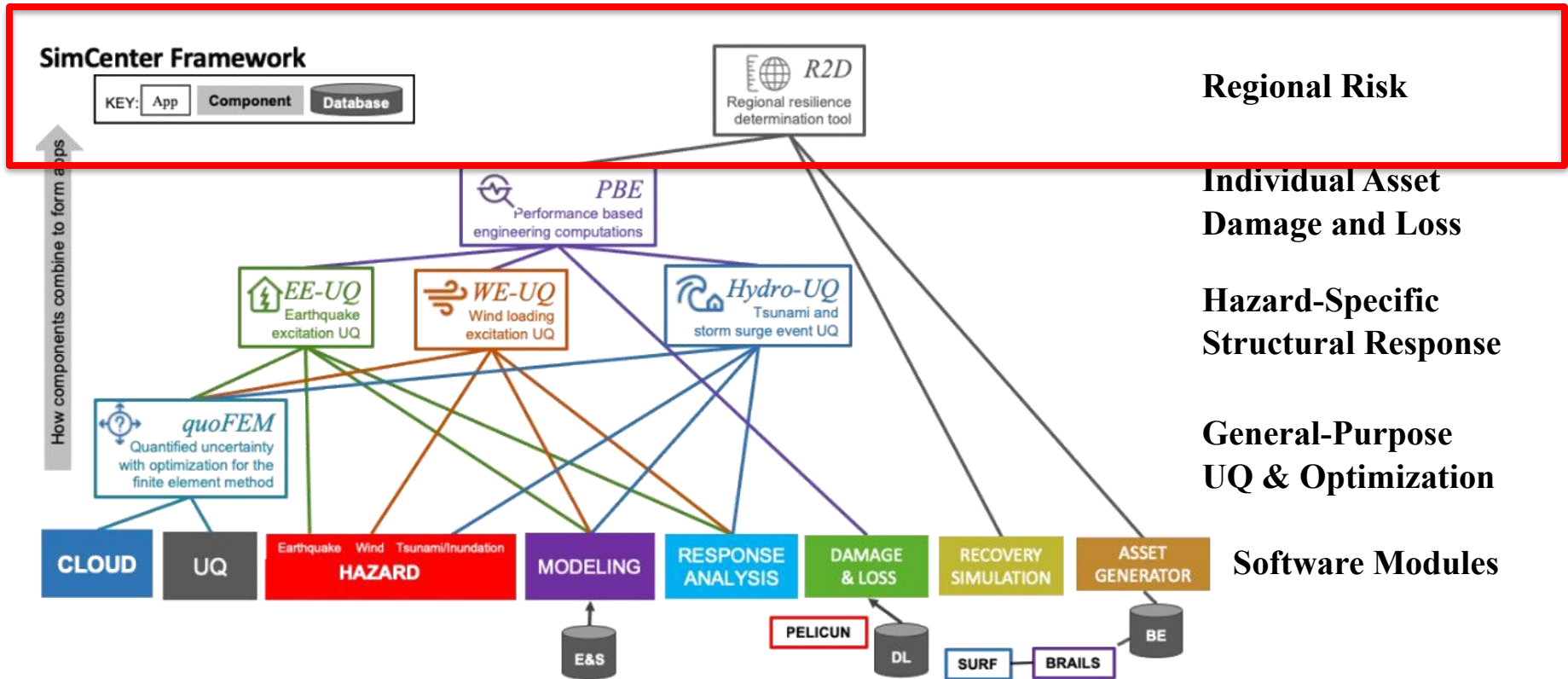
SimCenter – Desktop application portfolio



SimCenter – Desktop application portfolio



SimCenter – Desktop application portfolio



R2D Regional Resilience Determination

Tool (R2D)

Multi-hazards

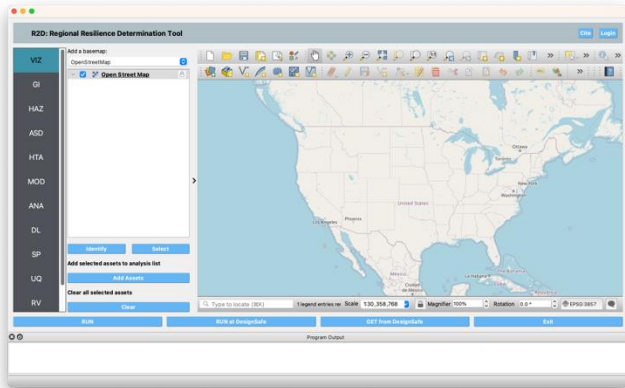


→ Hazards library and event generator

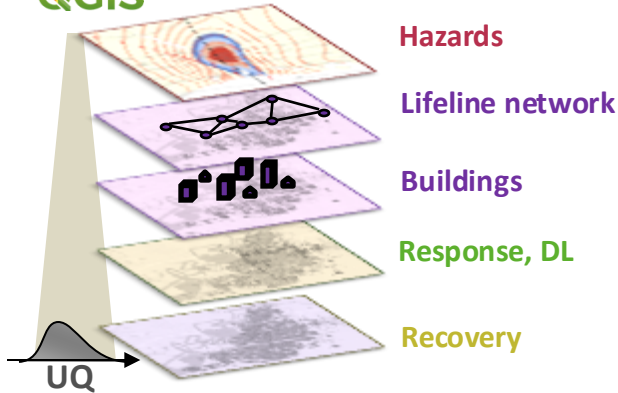
Multiple assets



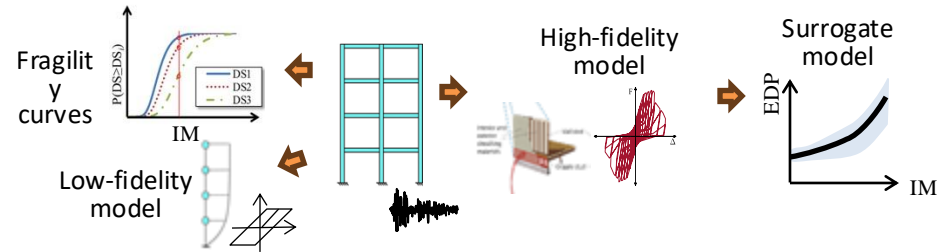
→ Inventory generator **BRAILS**



QGIS



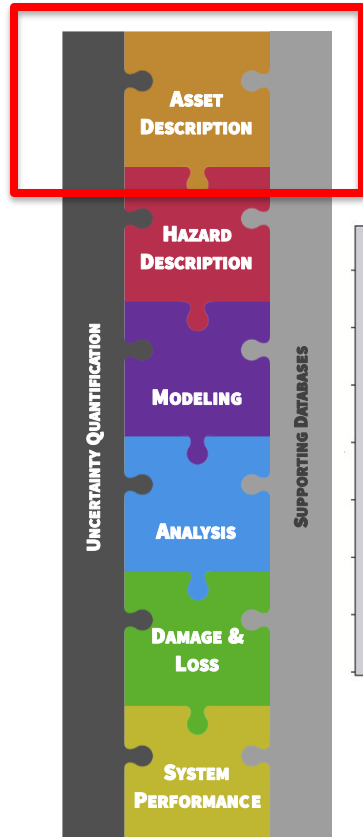
Flexible workflow: Multi-resolution and multi-fidelity



R2D

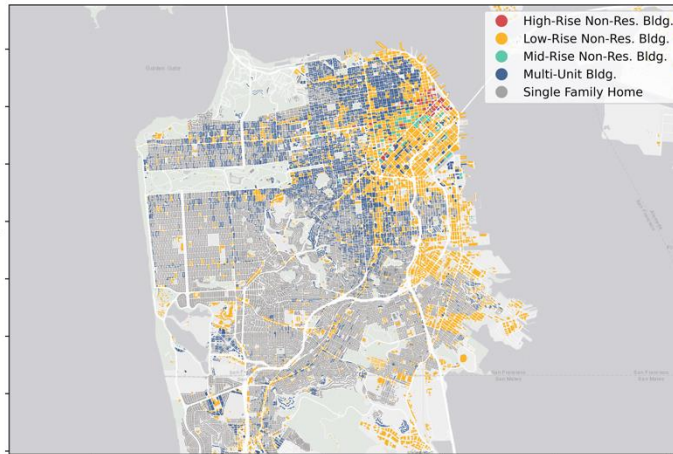


Regional simulation workflow in R2D



Asset

1. User input in GIS formats
2. Retrieve data from public databases or enhance the data using AI



Earthquake building assessment using FEMA's HAZUS fragility curves

- Built year
- Number of stories
- Occupancy type
- Structure type
- Etc.

Earthquake building assessment using multi-degree freedom (MDOF) OpenSees model

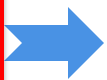
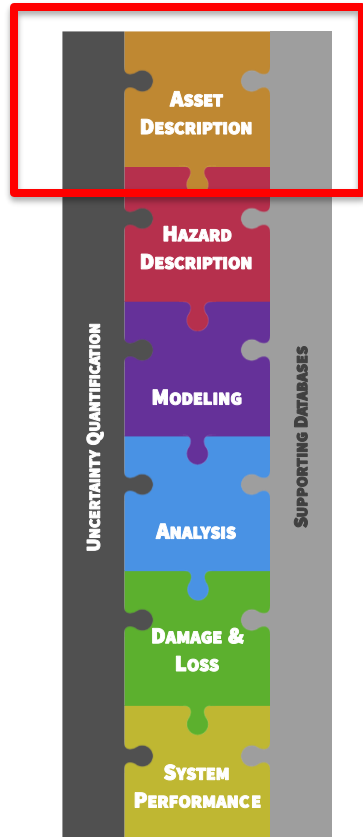
- Story height
- Story stiffness
- Etc

source: SimCenter Testbed
<https://simcenter.designsafe-ci.org/testbeds/>

R2D

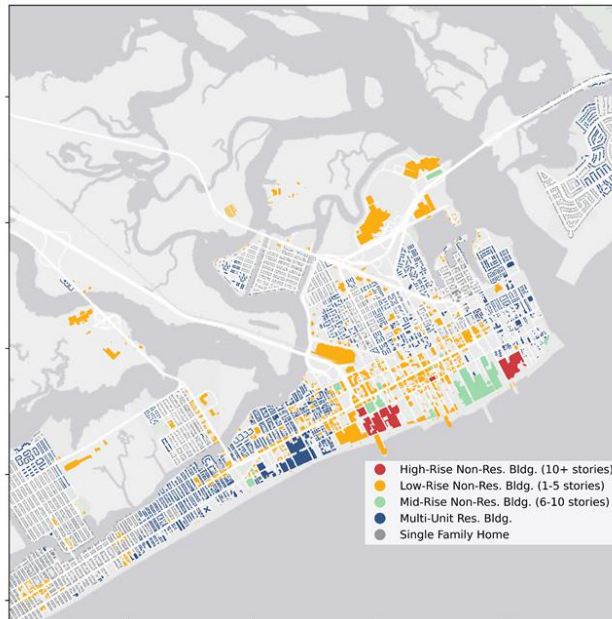


Regional simulation workflow in R2D



Asset

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2. Retrieve data from public databases or enhance the data using AI



Hurricane building assessment using FEMA's HAZUS fragility curves

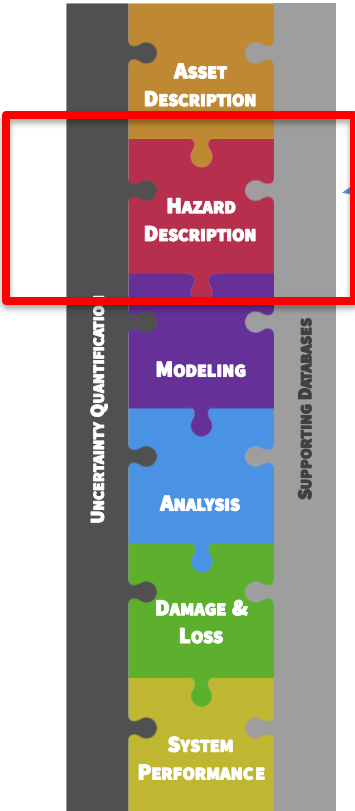
- Roof shape
- First floor elevation
- Occupancy type
- Structure type
- etc

Hurricane building assessment using structural analysis models

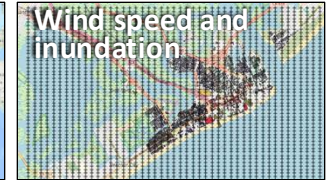
- The attributes needed to build the model

source: SimCenter Testbed
<https://simcenter.designsafe-ci.org/testbeds/>

Regional simulation workflow in R2D



Hazard Description

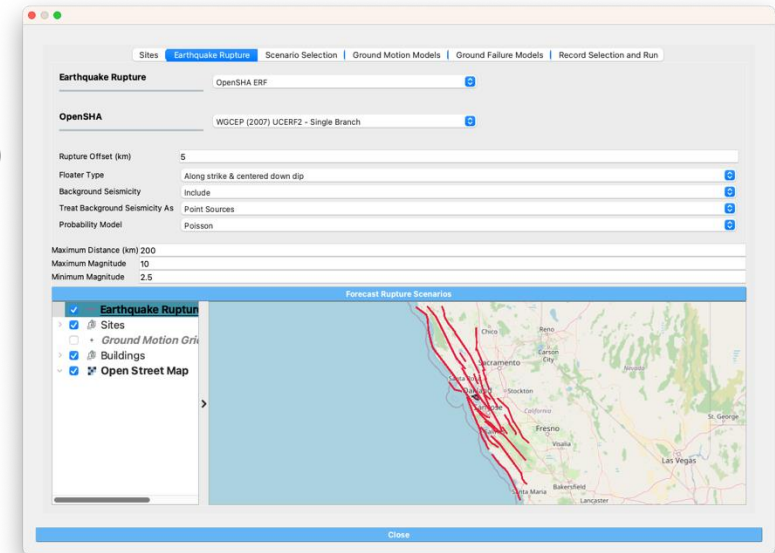


Earthquake building assessment using FEMA's HAZUS fragility curves

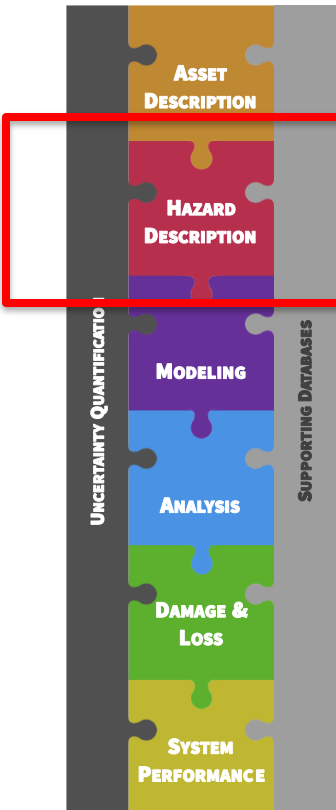
- Ground shaking intensity measures (e.g., PGA)
- Ground failure intensity measures (e.g., PGD)

Earthquake building assessment using MDOF OpenSees model

- Ground shaking records



Regional simulation workflow in R2D



Hazard Description

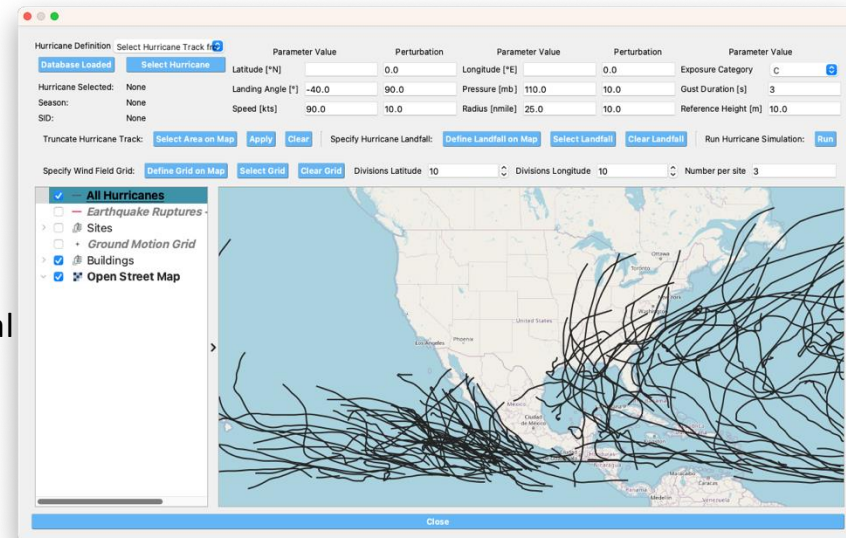


Hurricane building assessment using FEMA's HAZUS fragility curves

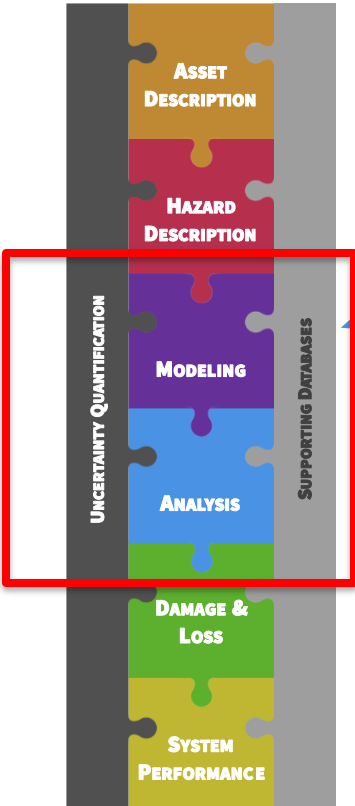
- Peak wind speed

Hurricane building assessment using structural analysis models

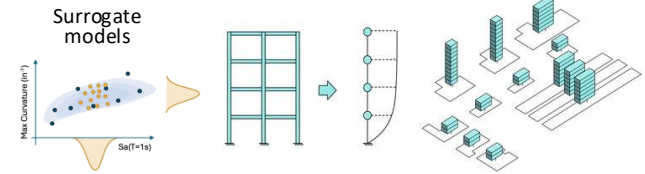
- Wind pressure sequence



Regional simulation workflow in R2D



Modeling & Analysis



Built-in Options

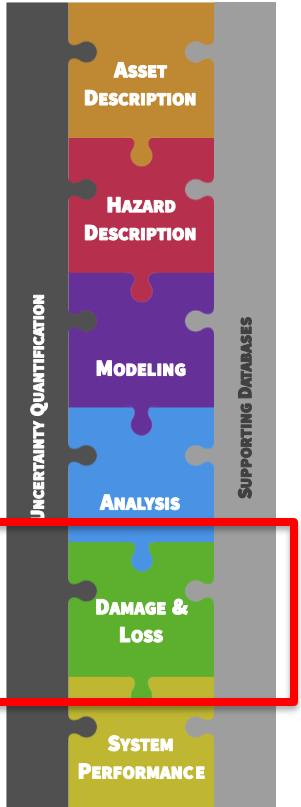
- Multi-Degree of Freedom models
- Intensity Measure as Engineering Demand Parameter (IMasEDP)

User-defined Options

- CustomPy
- Surrogate models



Regional simulation workflow in R2D



Built-in options

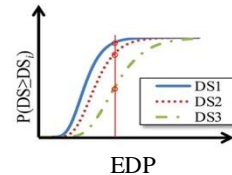
- FEMA's HAZUS fragility curves for Earthquake and Hurricane

User-defined fragility curves

- A .csv spread sheet containing your fragility curve database
- A short Python script mapping each asset to the corresponding fragility curve



Damage & Loss **pelicun**

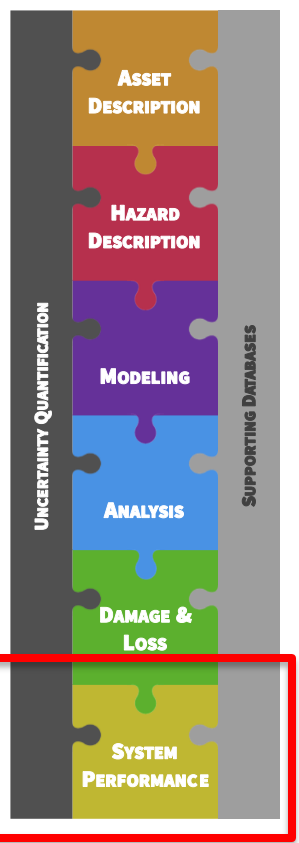


1. A program generates D&L realizations from fragility curves

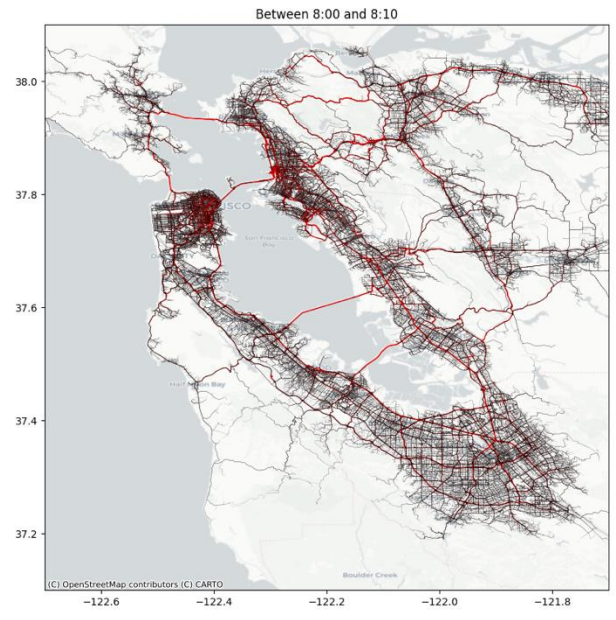
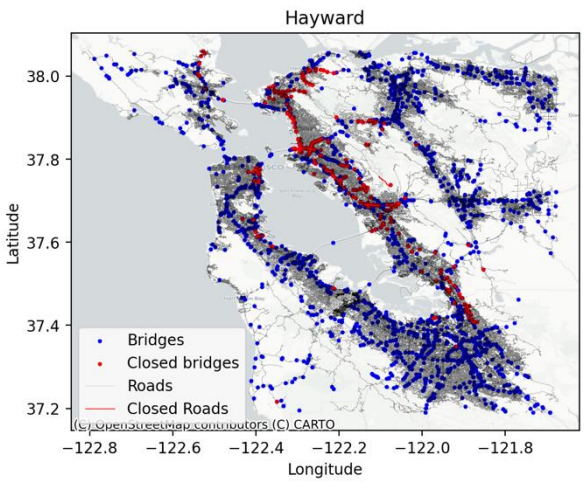
2. Many fragility curves (e.g., HAZUS) are built-in

3. You can also use your own fragility curves

Regional simulation workflow in R2D



1. Traffic flow simulation
 - Dynamic traffic assignment
 - Estimate the travel time of each trip
 - Estimate congestion level of each road



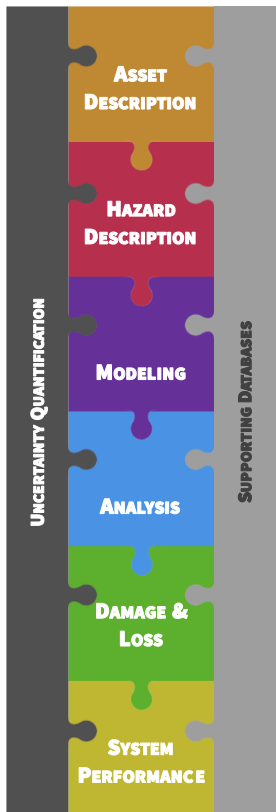
1. Traffic flow simulation
2. Water network hydraulic simulation
3. Community recovery simulation



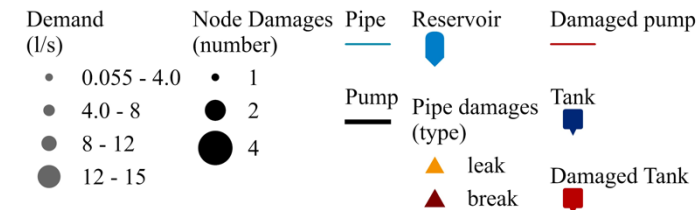
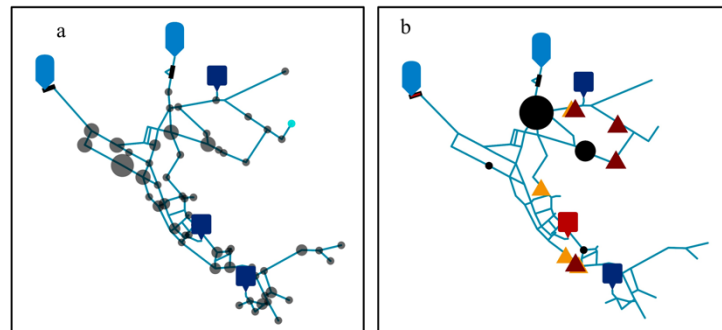
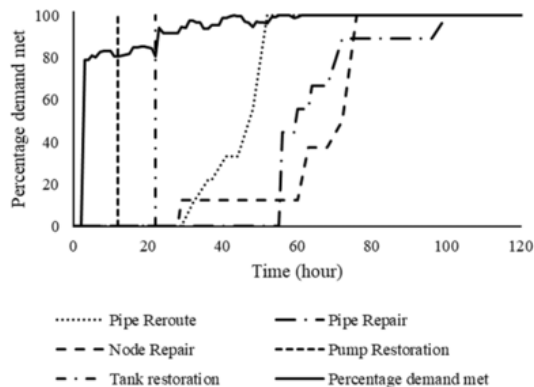
System Performance & Recovery

R2D

Regional simulation workflow in R2D



2. Water network hydraulic simulation
- Simulate hydraulics and water quality
 - Define disruption
 - Define response and mitigation actions



source: Sina Naeimi, Postdoc at SimCenter



System Performance & Recovery

1. Traffic flow simulation
2. Water network hydraulic simulation
3. Community recovery simulation

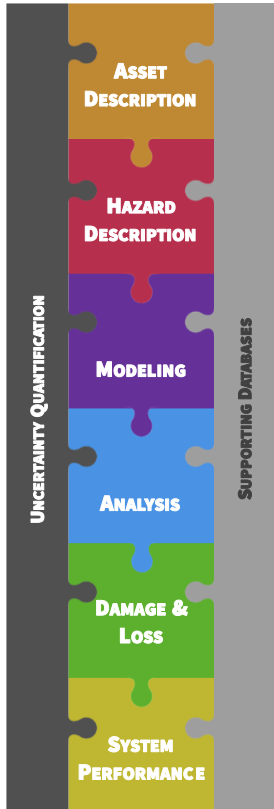


WNTR
Water Network Tool for Resilience

pyrecoodes

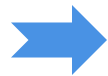
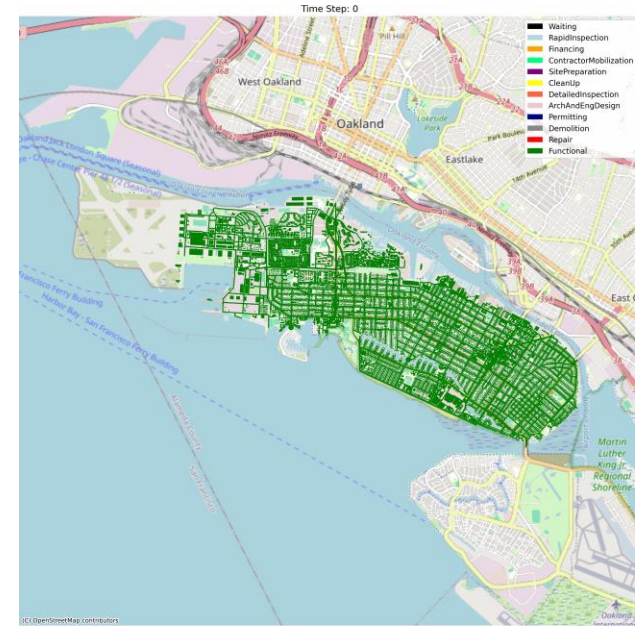
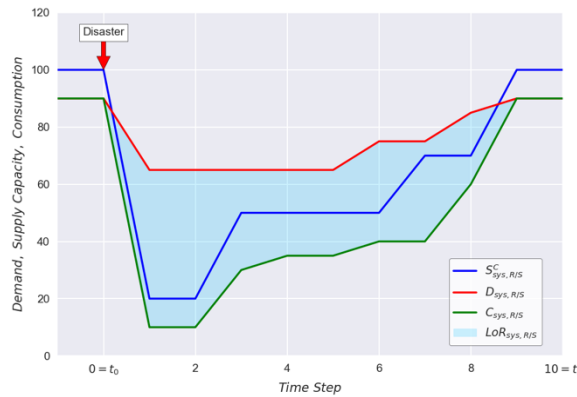


Regional simulation workflow in R2D



3. Community recovery simulation

- Quantify recovery and function resources demand and supply
- Simulate the resource flow among infrastructure
- Estimate recovery time and quantifies resilience

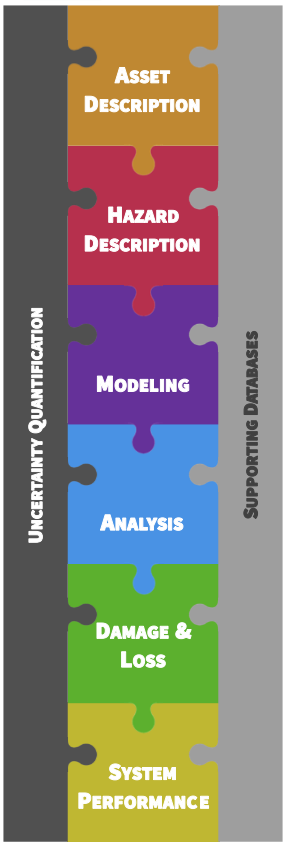


System Performance & Recovery

- Traffic flow simulation
- Water network hydraulic simulation
- Community recovery simulation



Regional simulation workflow in R2D



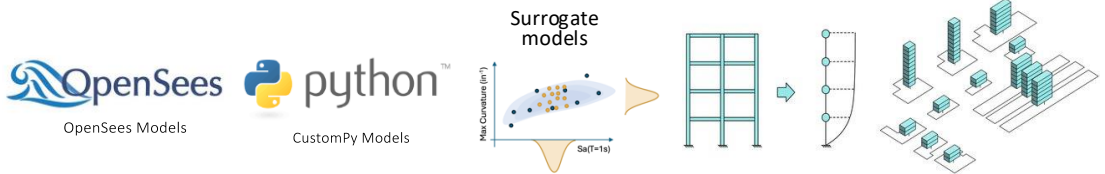
Asset 1. User input in GIS formats
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Hazard

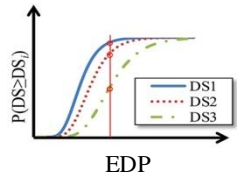


Modeling & Analysis



Damage & Loss

pelicun



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System Performance & Recovery

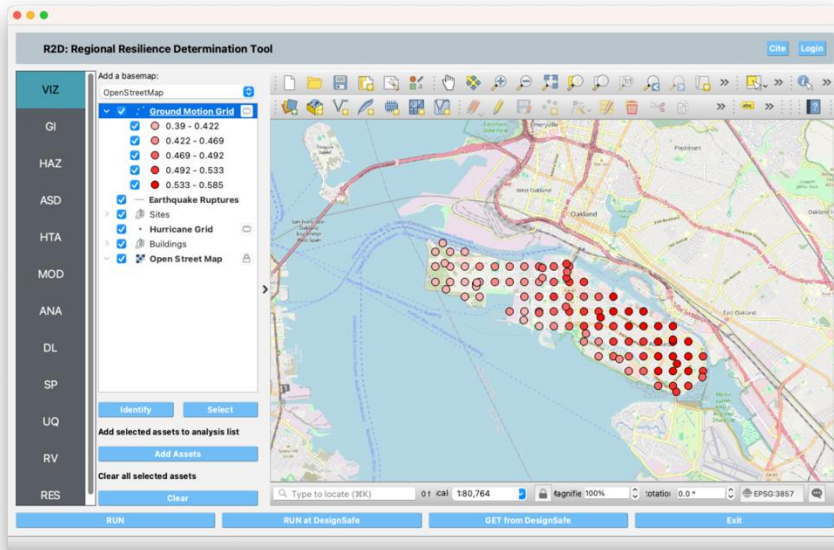
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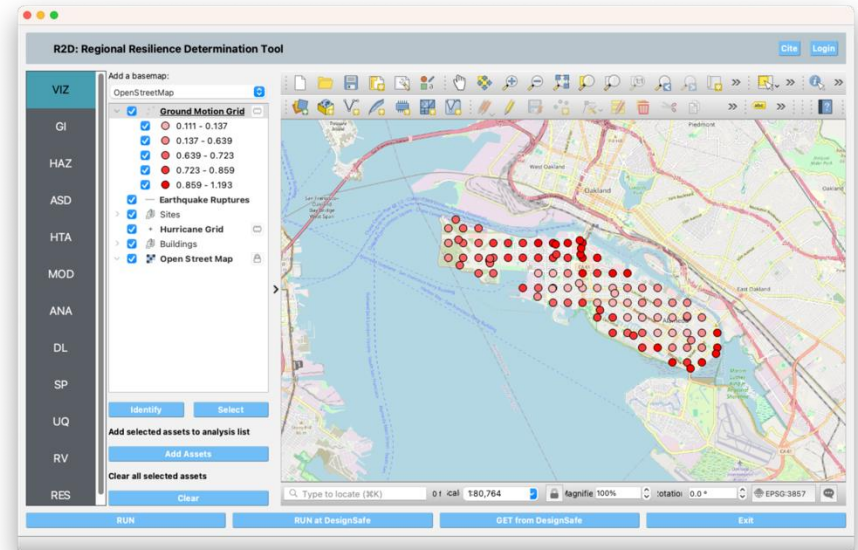


Application examples of R2D

Ex1. Community recovery simulation of Alameda Island, CA, under an Mw 7 earthquake
1. Estimate the ground shaking and liquefaction-induced ground failure



PGA
(g)

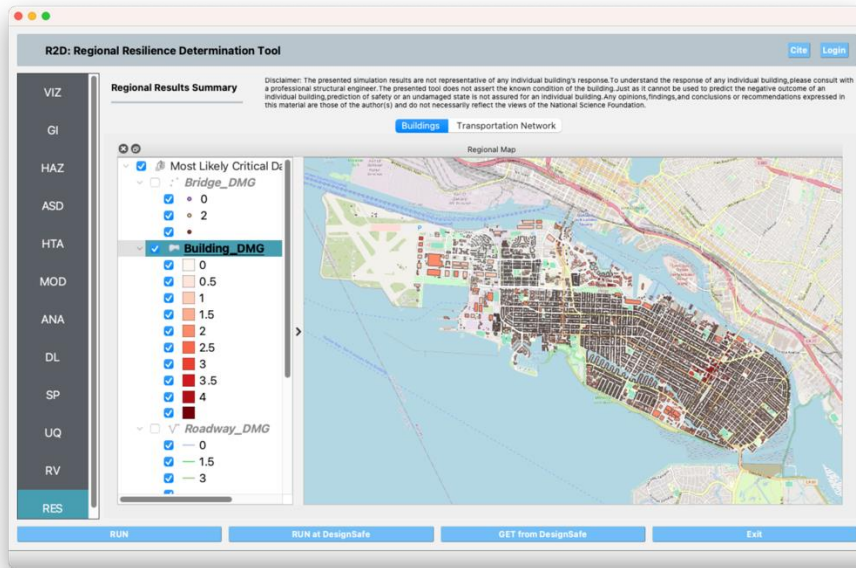


Lateral spreading (m)

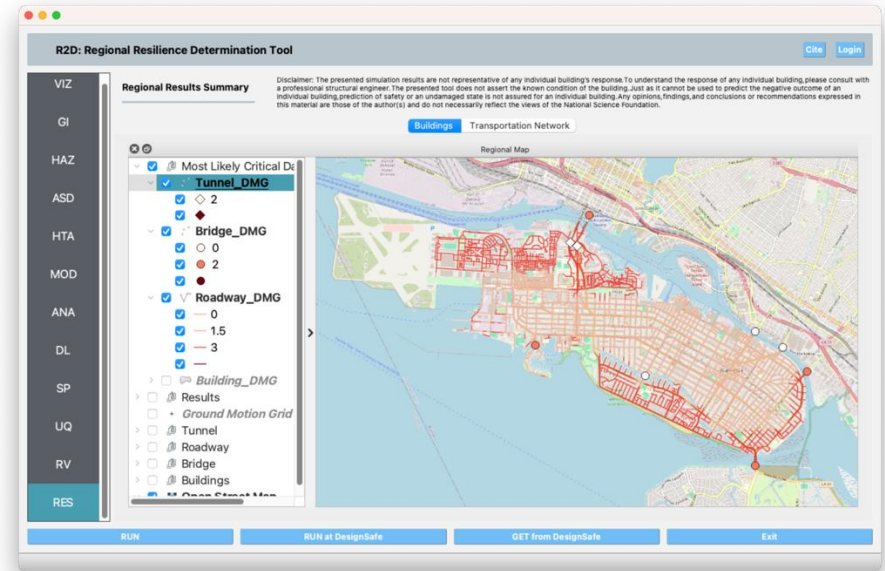


Application examples of R2D

- Ex1. Community recovery simulation of Alameda Island, CA, under an Mw 7 earthquake
2. Estimated building and transportation infrastructure damage with FEMA's Hazus method



Buildings

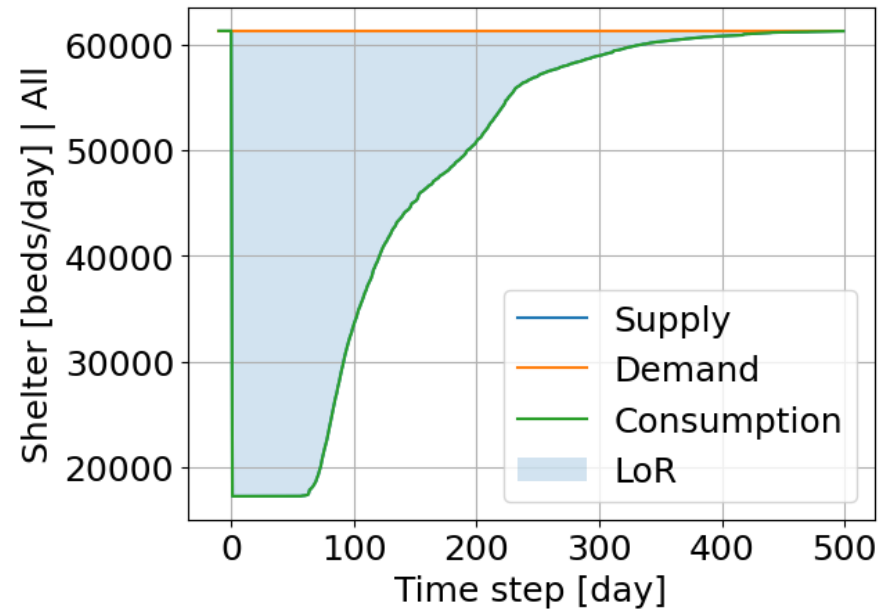
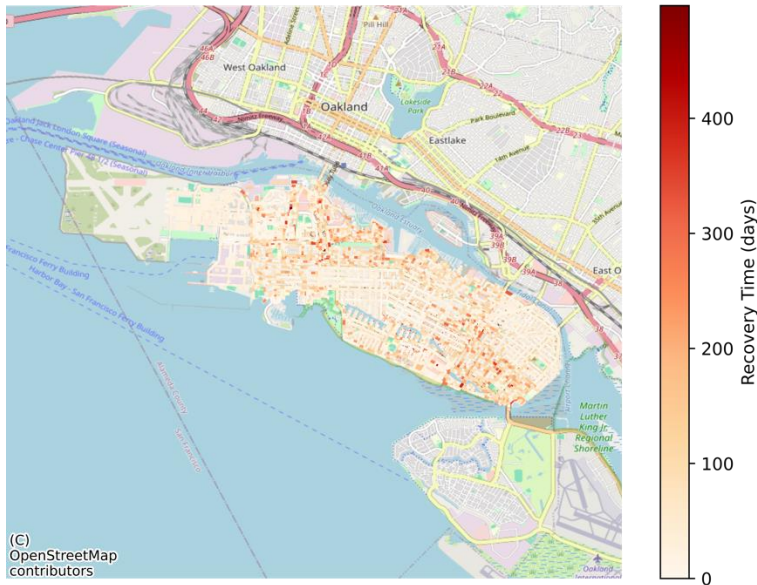


Transportation Infrastructure

Application examples of R2D

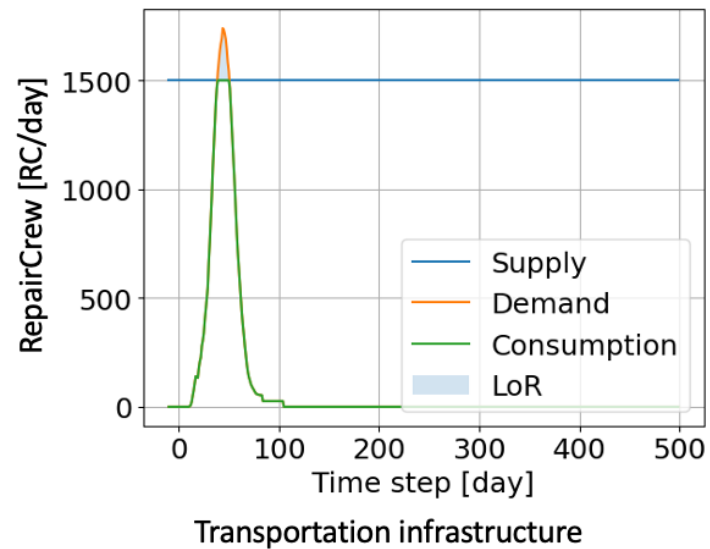
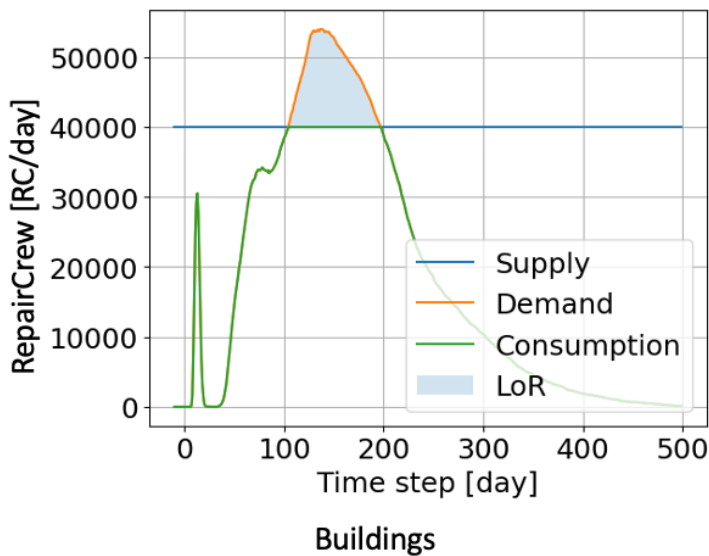
- Ex1. Community recovery simulation of Alameda Island, CA, under an Mw 7 earthquake
- 3. Simulate the recovery of buildings and transportation infrastructure

Components Recovery Time



Application examples of R2D

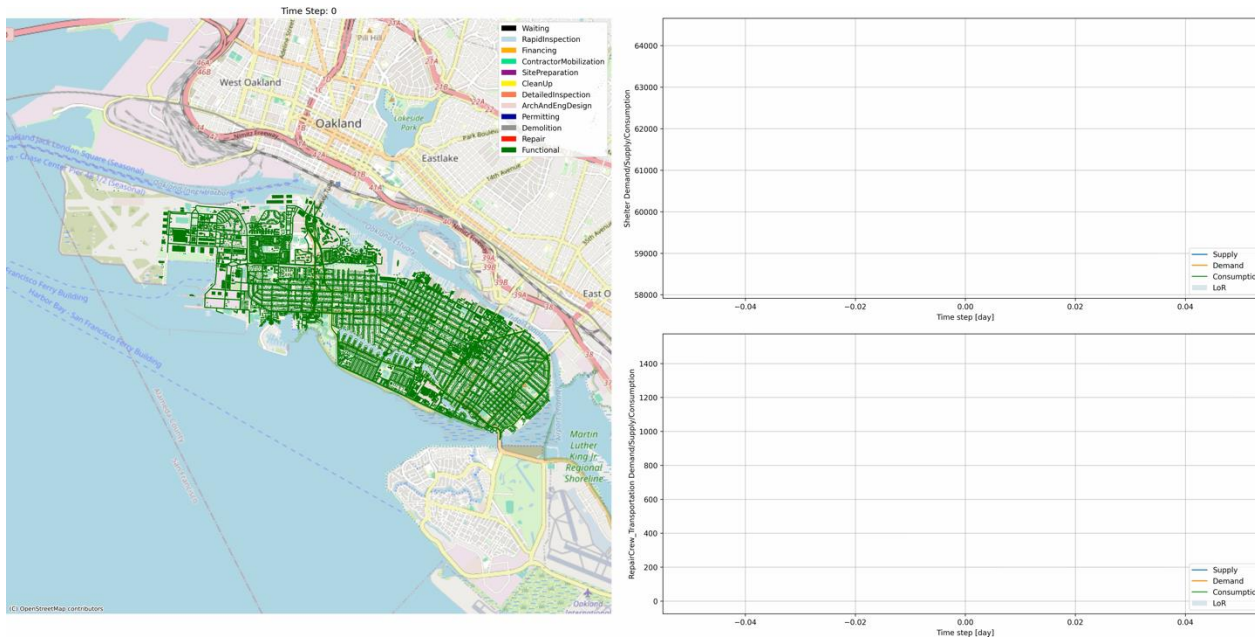
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Application examples of R2D

Ex1. Community recovery simulation of Alameda Island, CA, under an Mw 7 earthquake

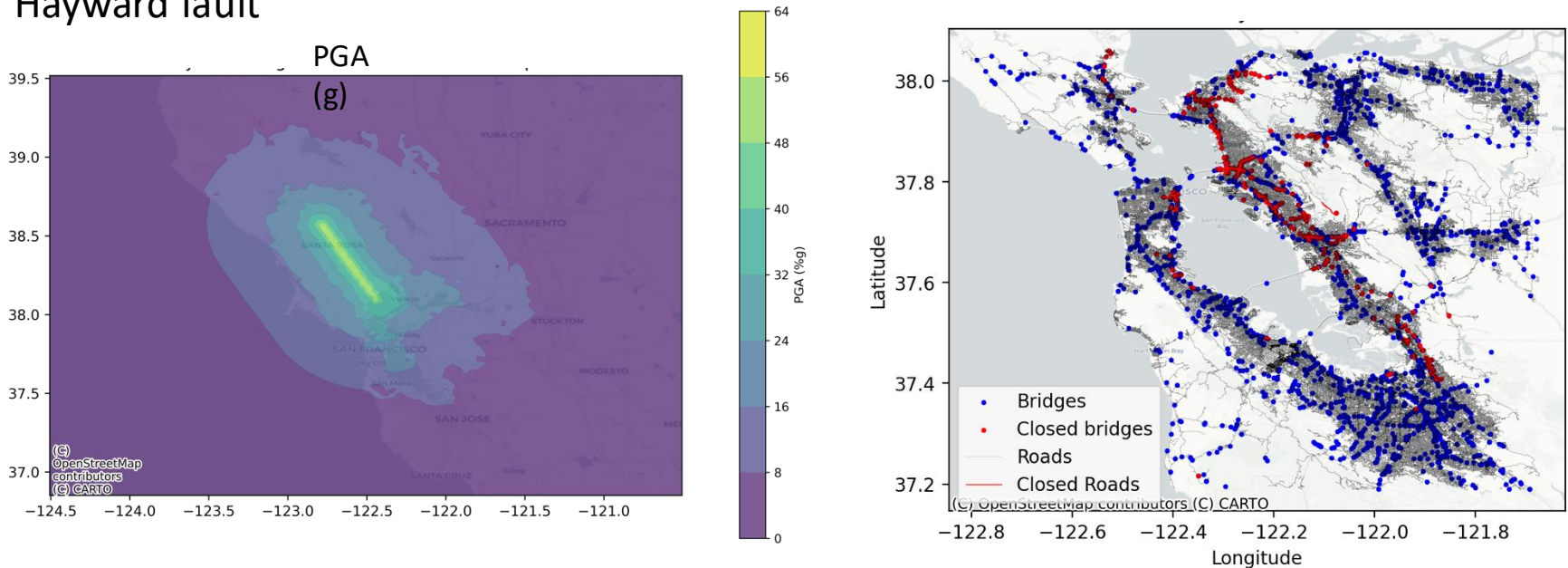
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Application examples of R2D

Ex2. Earthquake disturbance to the SF Bay Area transportation network

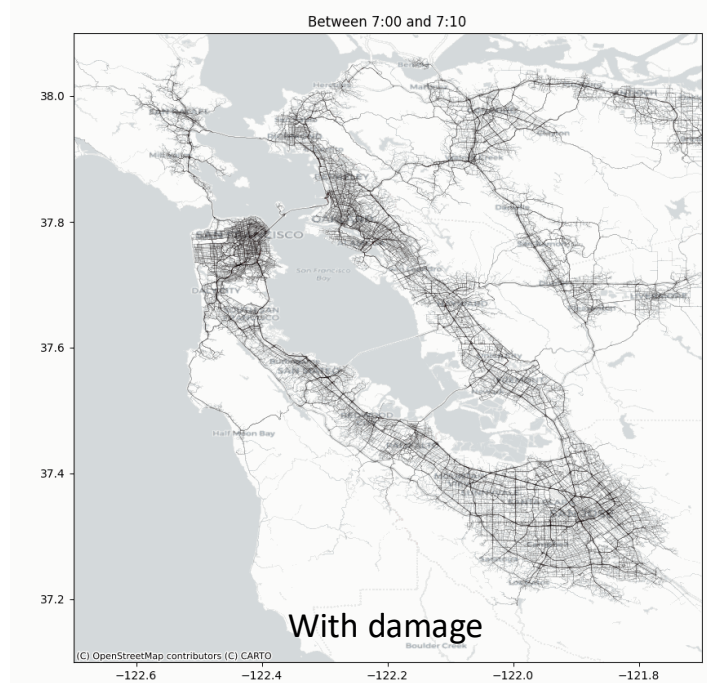
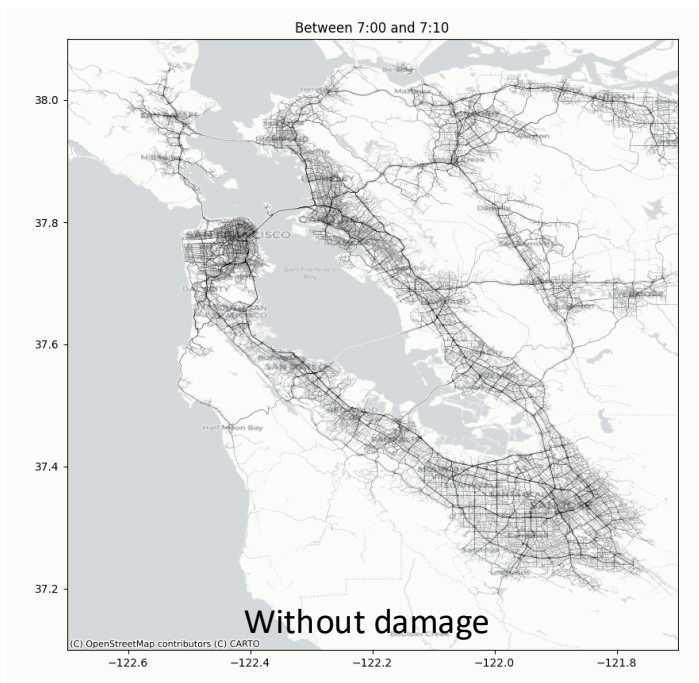
1. Estimate the ground shaking intensity and bridge damages in a Mw 7 EQ on the Hayward fault



Application examples of R2D

Ex2. Earthquake disturbance to the SF Bay Area transportation network

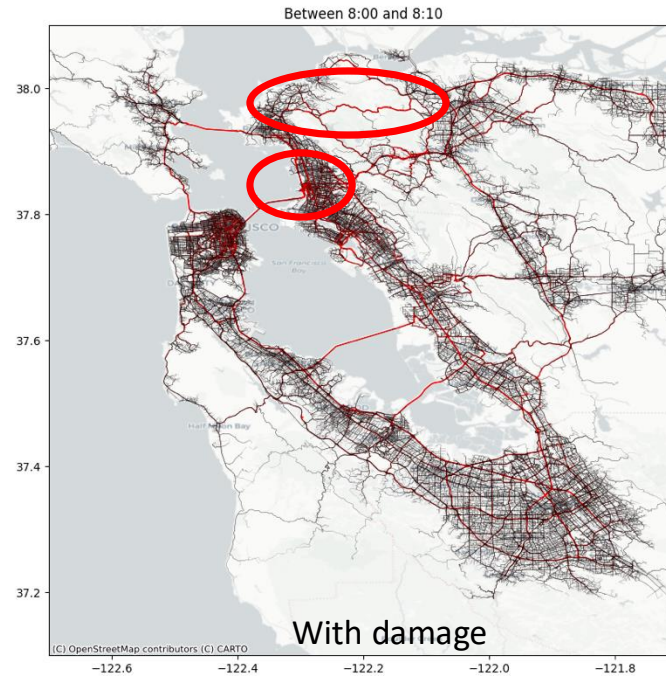
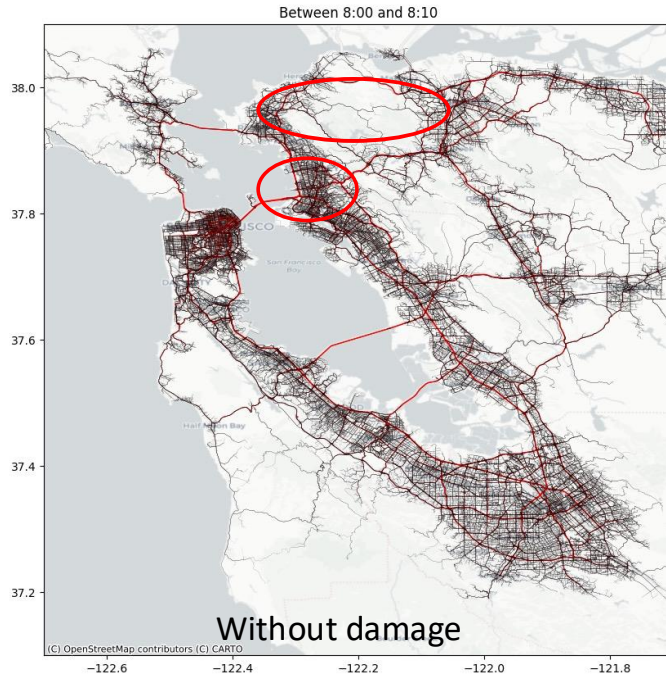
2. Compare the roadway congestion level during the morning rush



Application examples of R2D

Ex2. Earthquake disturbance to the SF Bay Area transportation network

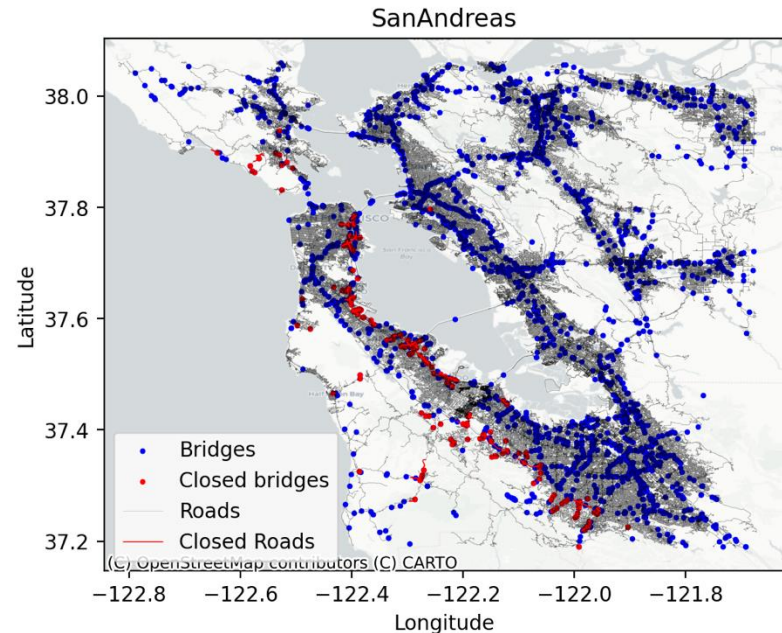
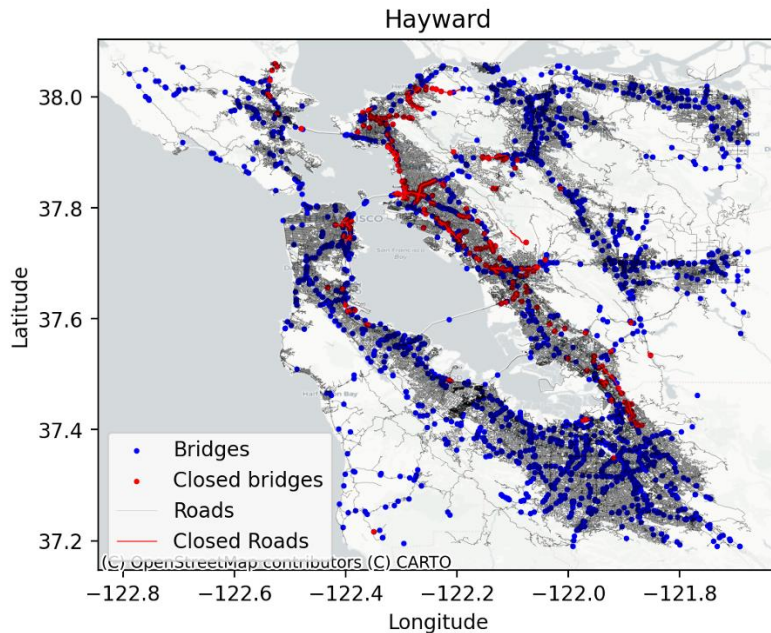
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Application examples of R2D

Ex2. Earthquake disturbance to the SF Bay Area transportation network

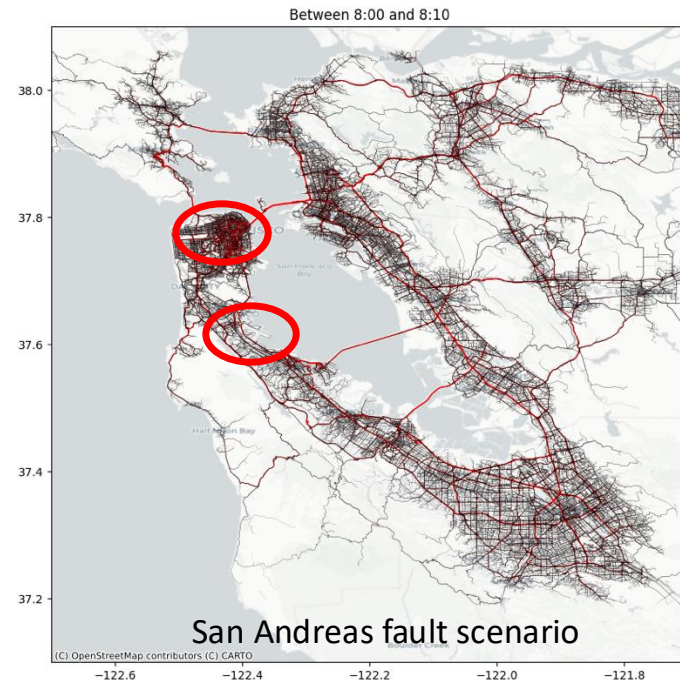
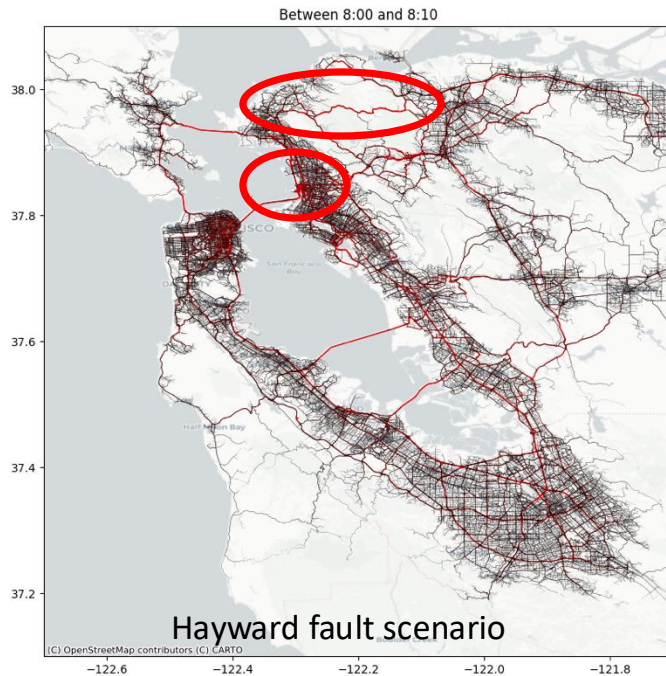
3. Compare the impact of the Mw 7 on the Hayward fault and the San Andreas fault



Application examples of R2D

Earthquake disturbance to the SF Bay Area transportation network

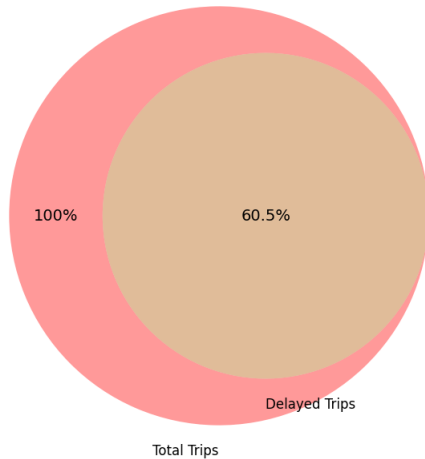
3. Compare the impact of a Mw 7 on the San Andreas fault and the Hayward fault



Application examples of R2D

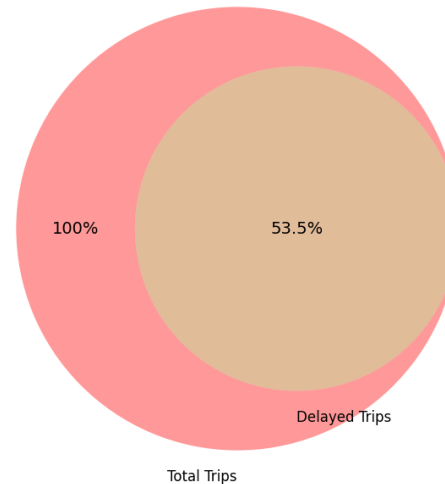
Earthquake disturbance to the SF Bay Area transportation network

3. Compare the impact of a Mw 7 on the San Andreas fault and the Hayward fault



- 60.5% of trips are delayed
- The delay is 21.2 % of normal travel time
- The average travel time increase is 12.3 %

Hayward fault scenario



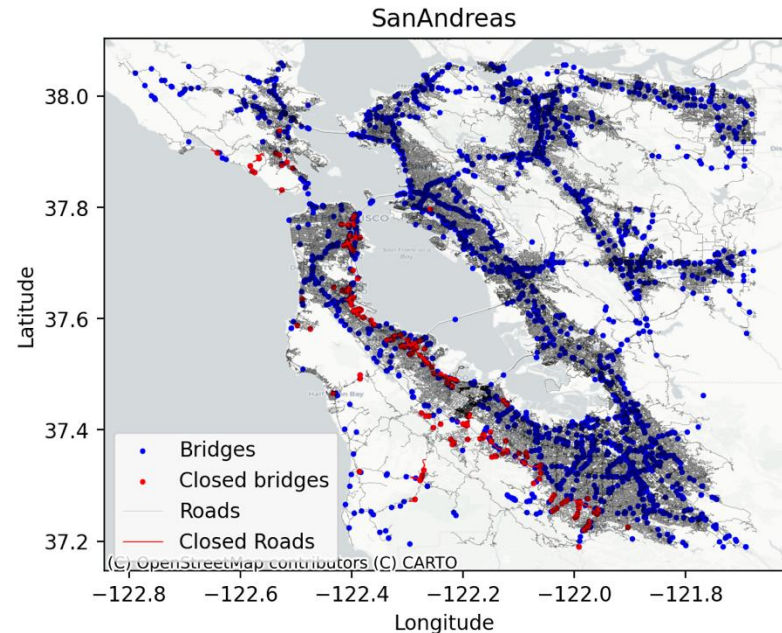
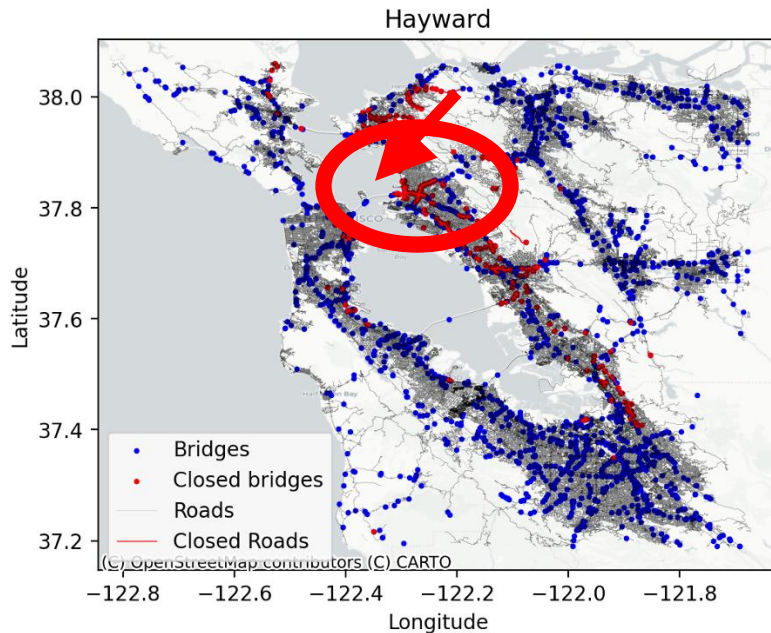
- 53.5% of trips are delayed
- The delay is 9.5 % of normal travel time
- The average travel time increase is 3.6 %

San Andreas fault scenario

Application examples of R2D

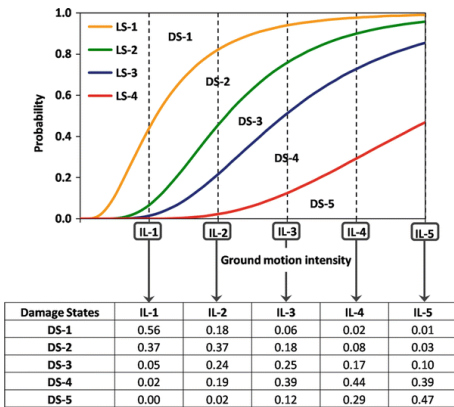
Ex2. Earthquake disturbance to the SF Bay Area transportation network

3. Compare the impact of the Mw 7 on the Hayward fault and the San Andreas fault



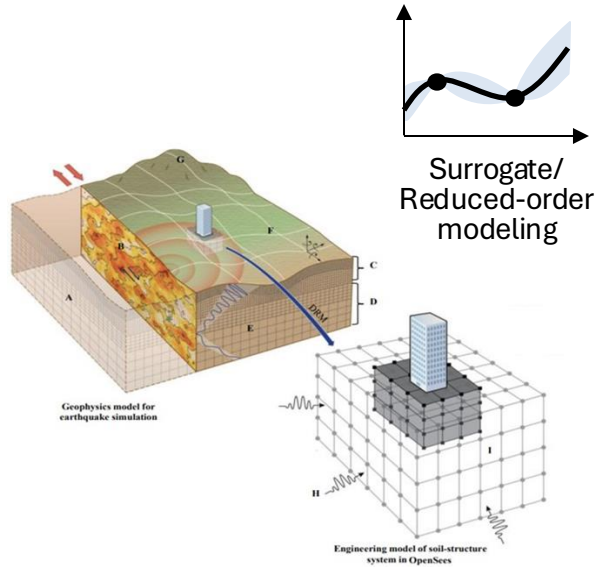
How can R2D help your research?

1. Scale up your models to a regional scale.



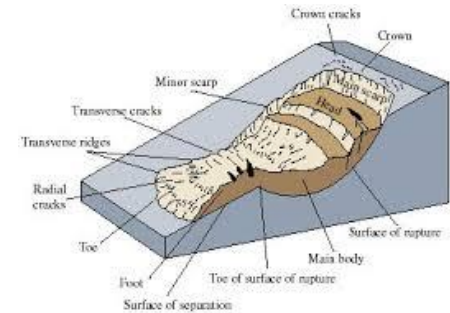
- New fragility curves

source: Erberik (2015)



- Advanced numerical models and surrogate models

source: Pedro Arduino (2023)



- New hazard models

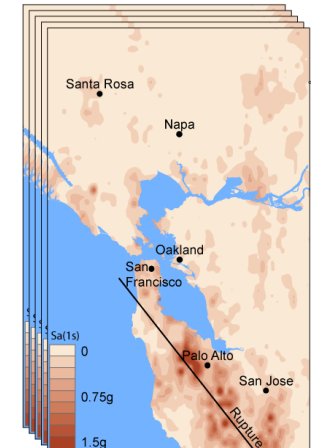
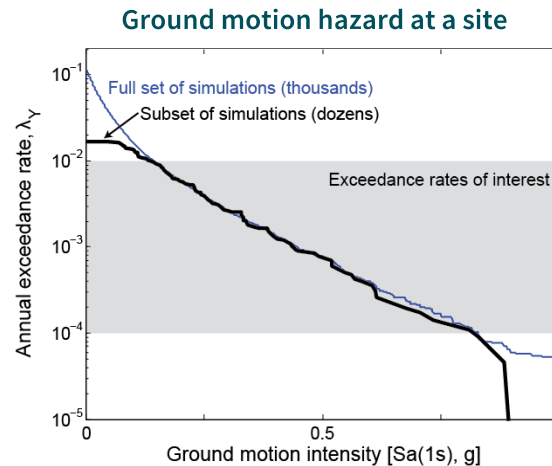
source: NOAA and USGS

Can R2D help your research?

2. Generate data to supplement, proof of concept, validate your models and algorithms



- Computer vision model to generate inventory



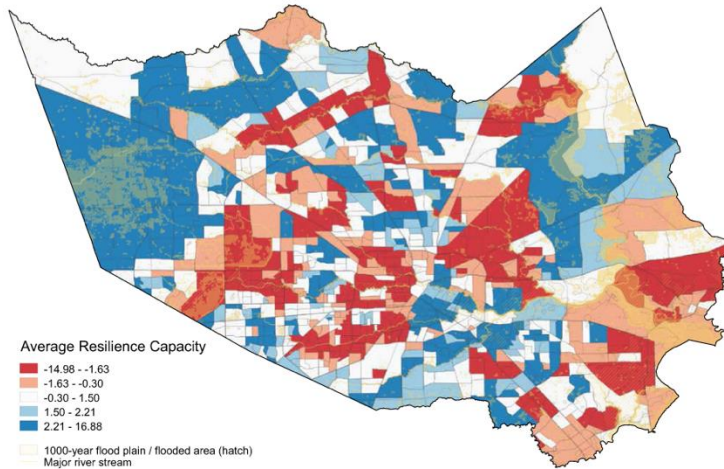
- Efficient algorithms to quantify uncertainties

source: SimCenter BRAILS
<https://simcenter.designsafe-ci.org/backend-components/brails/>

source: Jack Baker (2023)

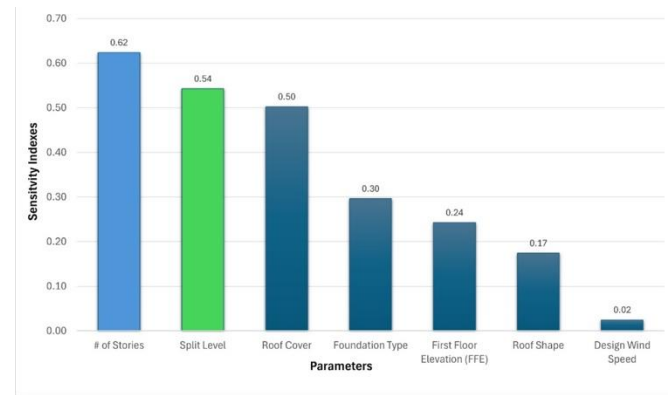
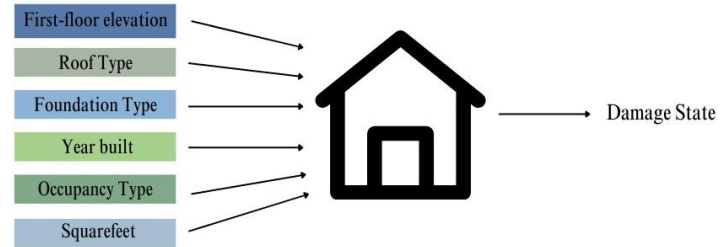
Can R2D help your research?

3. Understand the natural of natural hazards and community resilience



- Measure community resilience and social equality

source: *Hong et al. (2021)*
Measuring inequality in community resilience to natural disasters using large-scale mobility data. *Nature communications*, 12(1), 1870.



- Sensitivity of building safety to modeling parameters *Arudi (2024)*

R2D does not meet your needs? Extend it!



- Source codes are publicly available on GitHub.
- Most of the code is in Python and can be easily extended.
- Documentation available.

Popular repositories

- pelicun** (Public): Probabilistic Estimation of Losses, Injuries, and Community resilience Under Natural hazard events. Languages: Python (49 stars, 29 forks).
- BRILS** (Public): DL-based Building Information Modeling (BIM). Languages: Jupyter Notebook (48 stars, 33 forks).
- TurbulenceInflowTool** (Public): Adds input definition for turbulent inflow model to OpenFOAM files. Languages: C (44 stars, 26 forks).
- quoFEM** (Public): code for NHERI SimCenter quoFEM application. A desktop application to add UQ and Optimization routines to FEM applications. Languages: C++ (22 stars, 44 forks).
- rWHALE** (Public): Framework for Regional Earthquake Simulation. Languages: C++ (28 stars, 24 forks).
- PileGroupTool** (Public): An Application for Understanding Behaviour of Laterally Loaded Piles. Languages: C++ (20 stars, 20 forks).

Top discussions this past month

Discussions are for sharing announcements, creating conversation in your community, answering questions, and more.

[Start a new discussion](#)

People

This organization has no public members. You must be a member to see who's a part of this organization.

Top languages

- Python
- C++
- Jupyter Notebook
- HTML
- C

REGIONAL RESILIENCE DETERMINATION (R2D) TOOL (LATEST VERSION 3.0.0)

The Regional Resilience Determination Tool (R2D) is a graphical user interface for the SimCenter application framework designed to simulate the regional impact of hurricanes and earthquakes. R2D advances the capabilities of the natural hazards engineering community by facilitating the high-resolution assessment of disaster impact and risk on a regional scale. Researchers can investigate disaster scenarios or perform a probabilistic assessment by considering a diverse set of plausible events and propagate the uncertainty in the hazard and the characteristics of the built environment through the simulations.

The user interface of the R2D Tool facilitates reporting and querying input data that describes the regional hazard and the built environment and helps researchers with setting up and running the simulations either on their local computer or at the HPC clusters available at DesignSafe. Once the simulations are completed, the main results are visualized in the tool and detailed results are also available for post processing.

Be sure to update to this new version as older versions will not run at DesignSafe due to changes in the backend.

Several examples are provided to demonstrate the application's versatility when it comes to assembling simulation workflows of various levels of complexity:

- E1 - Basic HAZUS
- E2 - MDOF Building Response
- E3 - Physics-based Ground Motions
- E4 - OpenSeesPy FEM
- E5 - Ground Shaking + Liquefaction
- E6 - ShakeMap San Andreas Scenario
- E7 - Hurricane Wind + Water
- E8 - Hurricane Wind
- E9 - Tsunami
- E10 - Site Response Analysis

See the Tool's Documentation for details on these examples.

R2D is built on the SimCenter's Application Framework, which presents opportunities for community development and contributions to enhance simulation capabilities and tackle complex scientific questions in natural hazards research. To help expand the workflow capabilities with your contributions, contact NHERI-SimCenter@berkeley.edu or join the Forum conversation.

[Read the R2D Application Summary \(V3.0.0\).](#)

Examples:

- 4.8. E9 - Tsunami
- 4.8. E7 - Hurricane Wind + Water
- 4.9. E10 - Regional Site Response

Software Insights:

- Current Capabilities
- Recent Updates
- Future Plans

How to cite:

Faheh Motterna, Steven Gericoli, Adam Zarnitsky, Kuansh Zheng, Wael Elhaddad, & Pedro Arias. (2023). NHERI-SimCenter/R2DTool: Version 3.0.0 (V3.0.0). Zenodo. <https://doi.org/10.5281/zenodo.7946803>

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Michael Motley
Michael Shields
Kenichi Soga
Seymour Spence
Ertugrul Taciroglu
Alexandros Taflanidis
Stella Yu

SimCenter - website

<https://simcenter.designsafe-ci.org/>

The screenshot shows the SimCenter website interface. At the top, there are logos for NHERI SimCenter and DESIGNSAFE-CI. Below the logos is a navigation menu with items: About, Research Tools, Learning Tools, Testbeds, Backend Components, Knowledge Hub, and Collaborate. The main content area is titled "REGIONAL RESILIENCE DETERMINATION (R2D) TOOL (LATEST VERSION 3.0.0)". It contains a detailed description of the tool, its user interface, and a list of examples. On the right side of the page, there are three red arrows pointing to buttons: "Download App", "Documentation", and "Join the User Forum Conversation". Below these buttons is a video player showing a presentation slide titled "REGIONAL RESILIENCE DETERMINATION TOOL (R2D) TOOL WORKSHOP FOR SOCIAL SCIENTISTS AND RECOVER RESEARCHERS".

- Download
- Documentation
- SimCenter Forum



A row of social media icons for LinkedIn, X, and Facebook, followed by a red icon representing a group of people. To the right of the icons is a text box that says "Subscribe to the SimCenter Newsletter".

Thank you!

Let's connect 😊
jinyan_zhao@berkeley.edu

LinkedIn



SimCenter

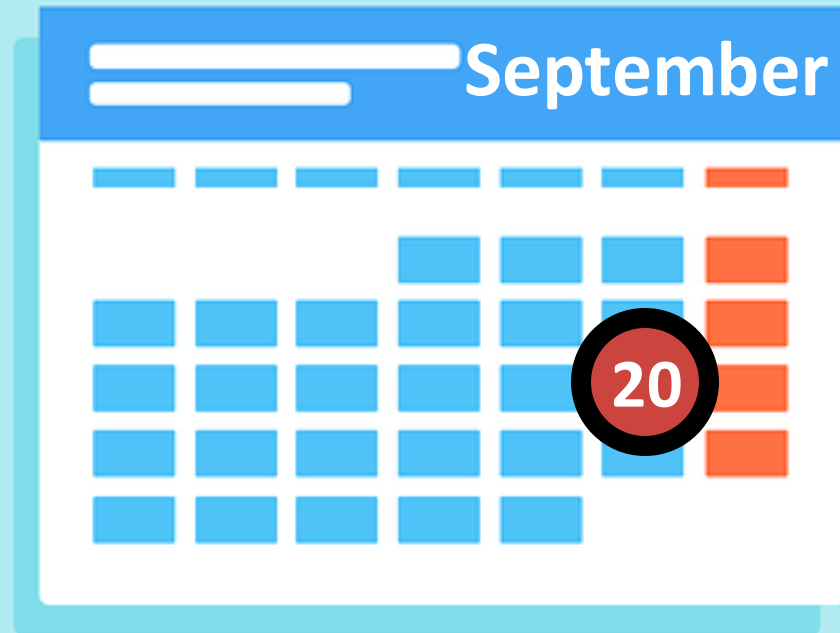


SimCenter Github



Future Meeting Date

3rd Friday of
every month
at 11:00am
CST





National Science Foundation

The NHERI Network Coordination Office is supported by the National Science Foundation award [CMMI 2129782](#). Any statements in this material are those of the presenter(s) and do not necessarily reflect the views of the National Science Foundation.

