DesignSafe: Providing Data and Computational Resources to Advance Research in Natural Hazards Engineering

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Janet S. Cockrell Chair in Engineering
Dept. of Civil, Arch., and Env. Engineering
University of Texas at Austin

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Natural Hazards Research

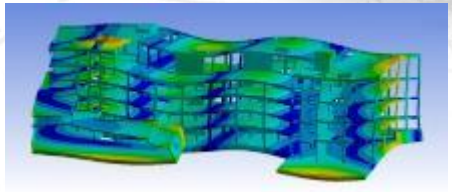
Functional Recovery

Hazard Forecasts

- *Earthquake shaking*
- *Hurricane/tornado wind speeds*
- *Storm surge/tsunami*

Infrastructure/Societal Damage

Infrastructure/Societal Response



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Research Ecosystem

Data

cyberinfrastructure

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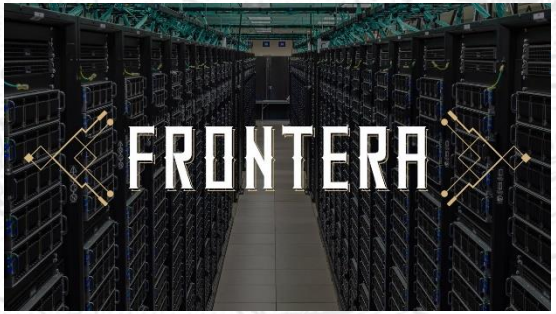
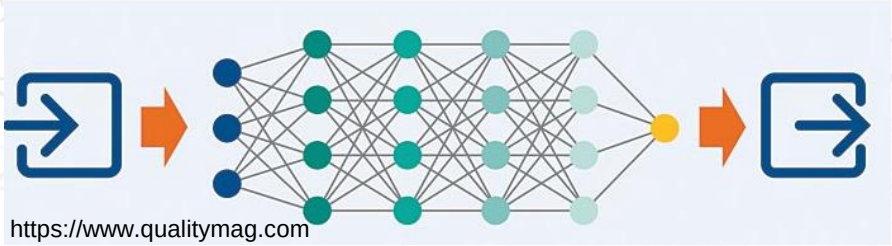
Computational Resources





https://www.quality mag.com

Data analytics / Algorithms / Tools

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Research Ecosystem

Data

cyberinfrastructure

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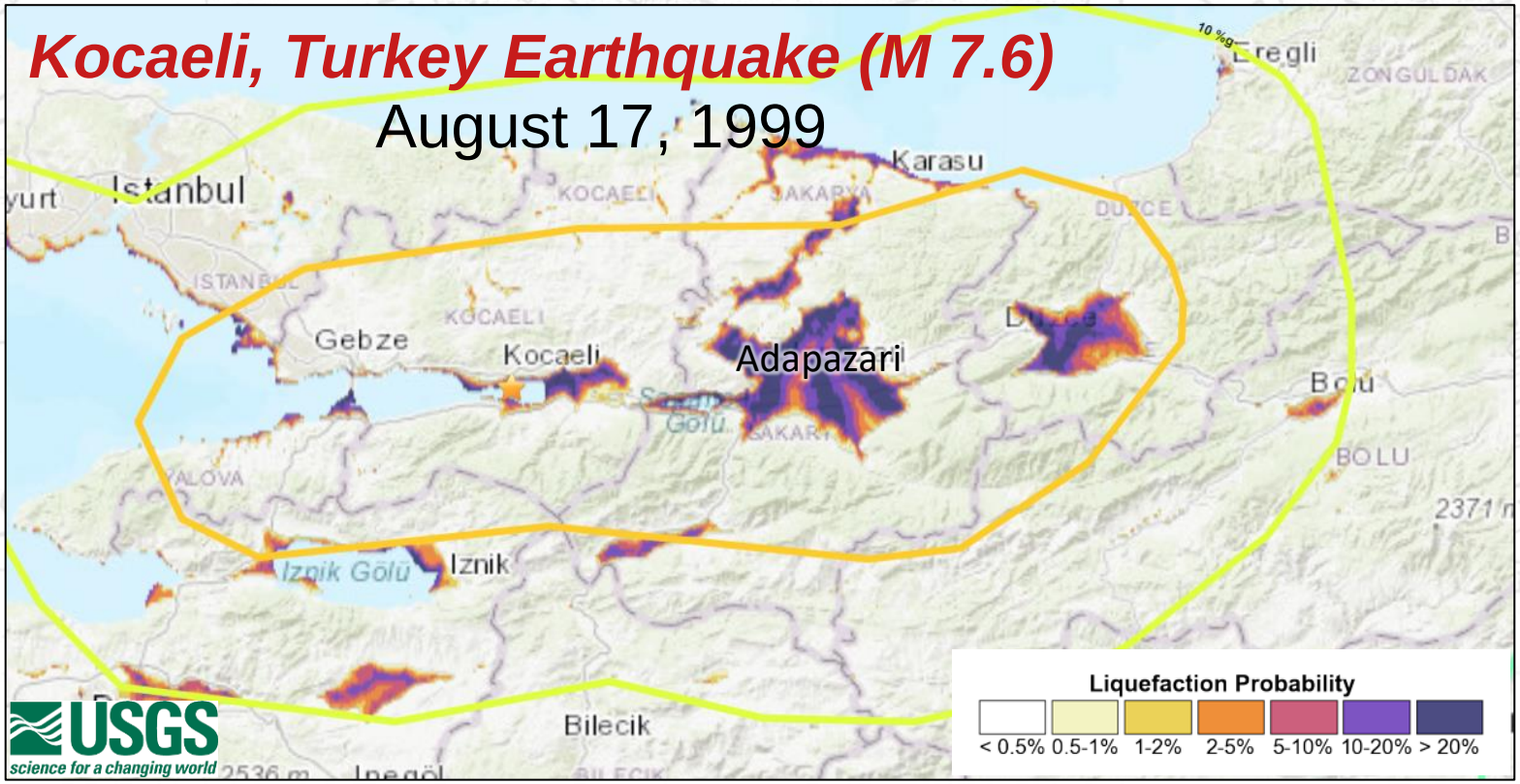
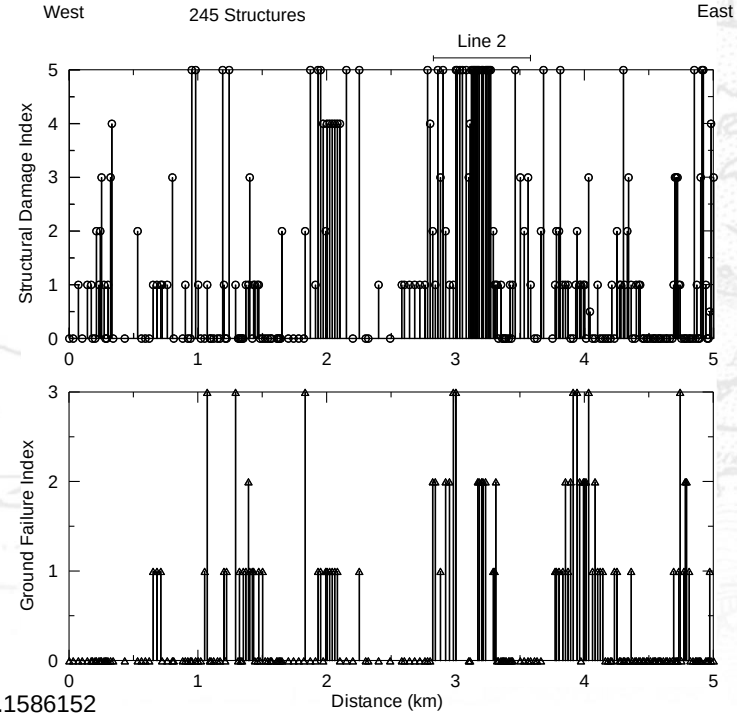

Kocaeli, Turkey Earthquake (M 7.6)
August 17, 1999
Istanbul
Karasu
Eregli
ZONGULDAK
KOCAELI
SAKARYA
DUZCE
Gebze
Kocaeli
Adapazari
Golu
BOLU
Iznik Golu
Iznik
Bilecik
USGS
science for a changing world
Liquefaction Probability
< 0.5% 0.5-1% 1-2% 2-5% 5-10% 10-20% > 20%

Data Collection and Subsequent Research



- Liquefaction of fine-grained soils
- Response of structures on liquefiable ground
- Between 2000-2010, Google Scholar lists 525 papers for “liquefaction” and “Adapazari”

Bray and Stewart (2000): https://doi.org/10.1193/1.1586152

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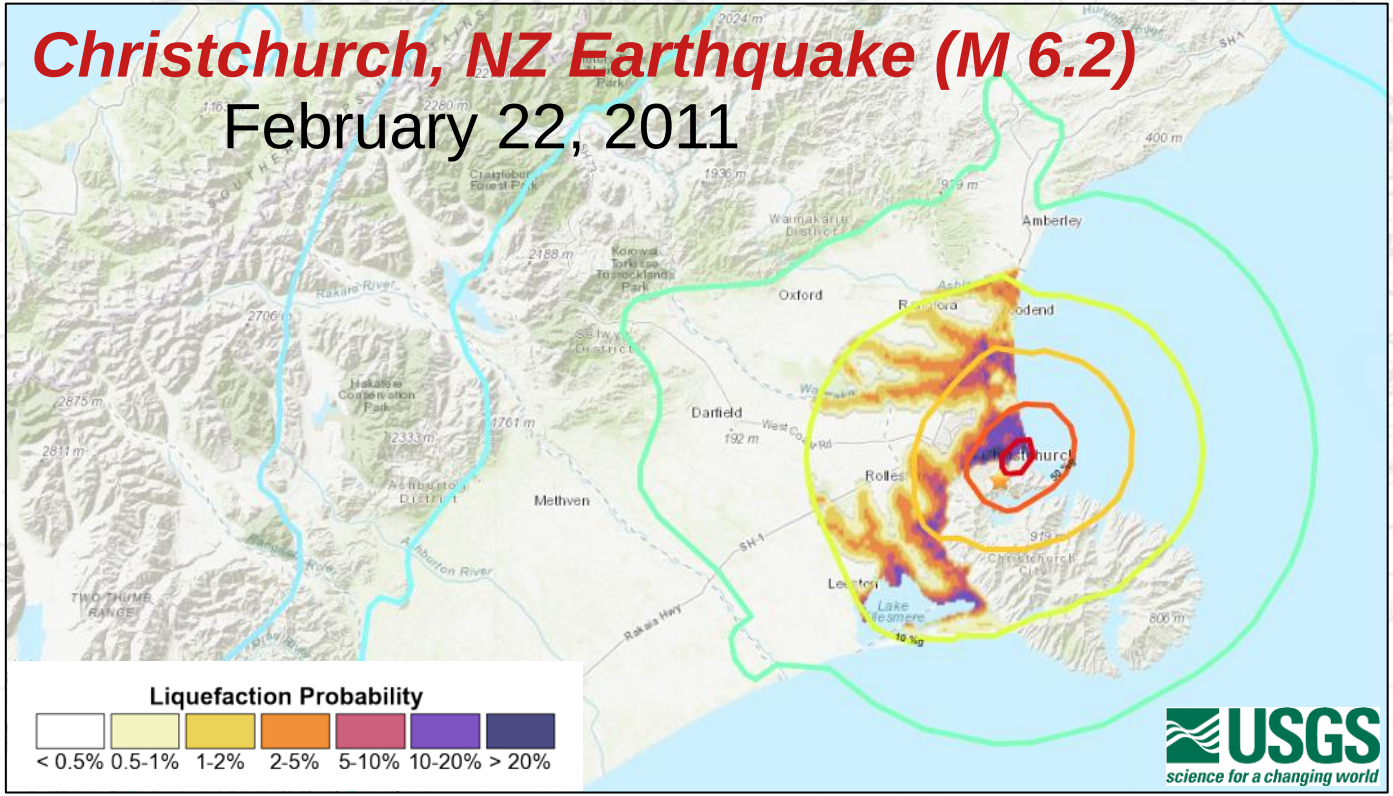
Christchurch, NZ Earthquake (M 6.2)

February 22, 2011



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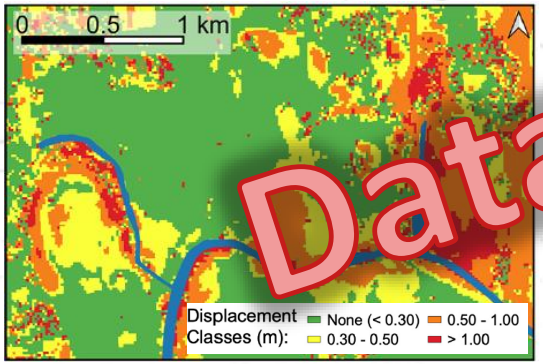
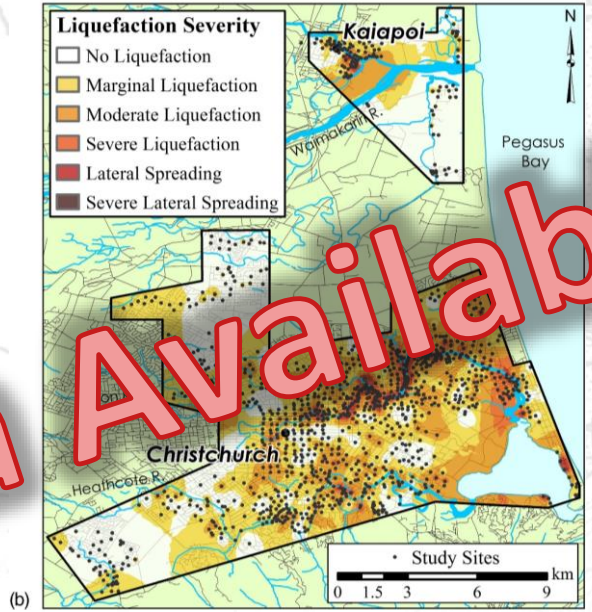
Data Collection and Subsequent Research



Durante and Rathje (2021)
https://doi.org/10.1177/87552930211004613



Maurer et al. (2014)
https://doi.org/10.1061/(ASCE)GT.1943-5606.0001117

- Data available through NZ Geotechnical Database
- Regional scale liquefaction, lateral spreading effects
- Between 2011-2021, Google Scholar lists **6,260** papers for “liquefaction” and “Christchurch”

Data Availability

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All Files > NZ_CHCH_proj

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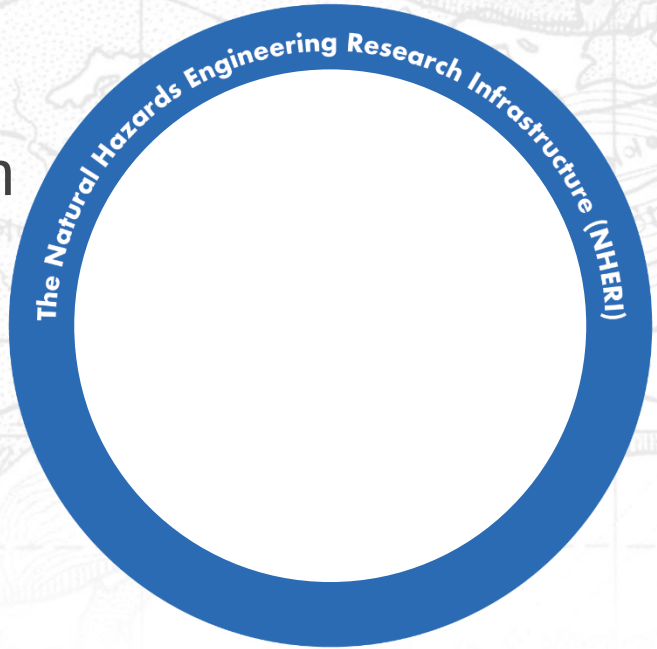
NHERI

Natural Hazards Engineering Research Infrastructure

- Shared use infrastructure for research
  - Network Coordination Office
  - Experimental facilities
  - RAPID reconnaissance facility
  - DesignSafe cyberinfrastructure (CI)
  - SimCenter



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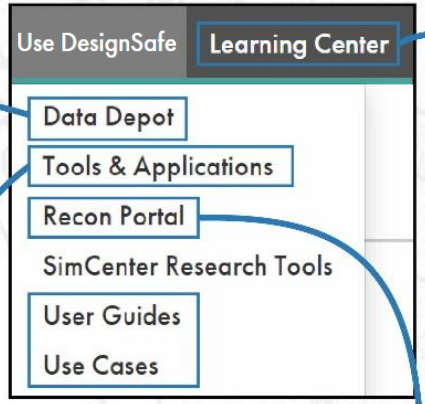
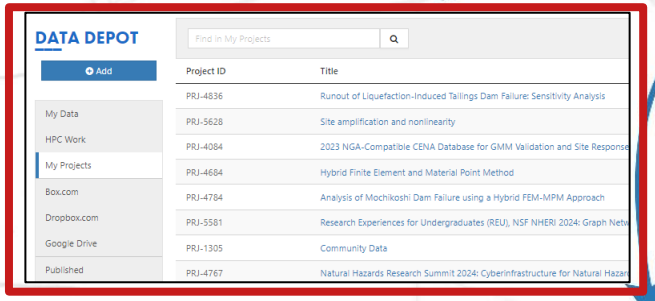
DesignSafe Components

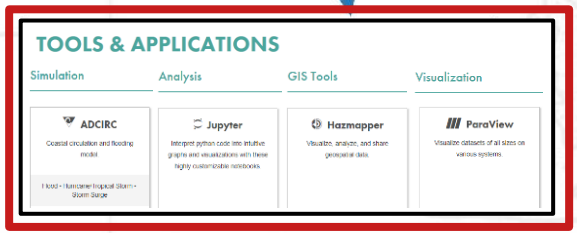
www.designsafe-ci.org



Data



Simulation & Data Analytics



Data

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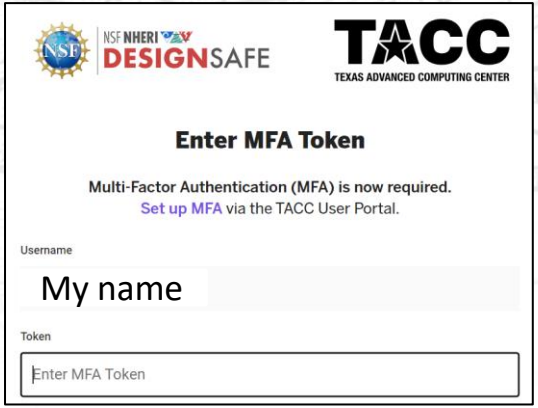
DesignSafe and TACC

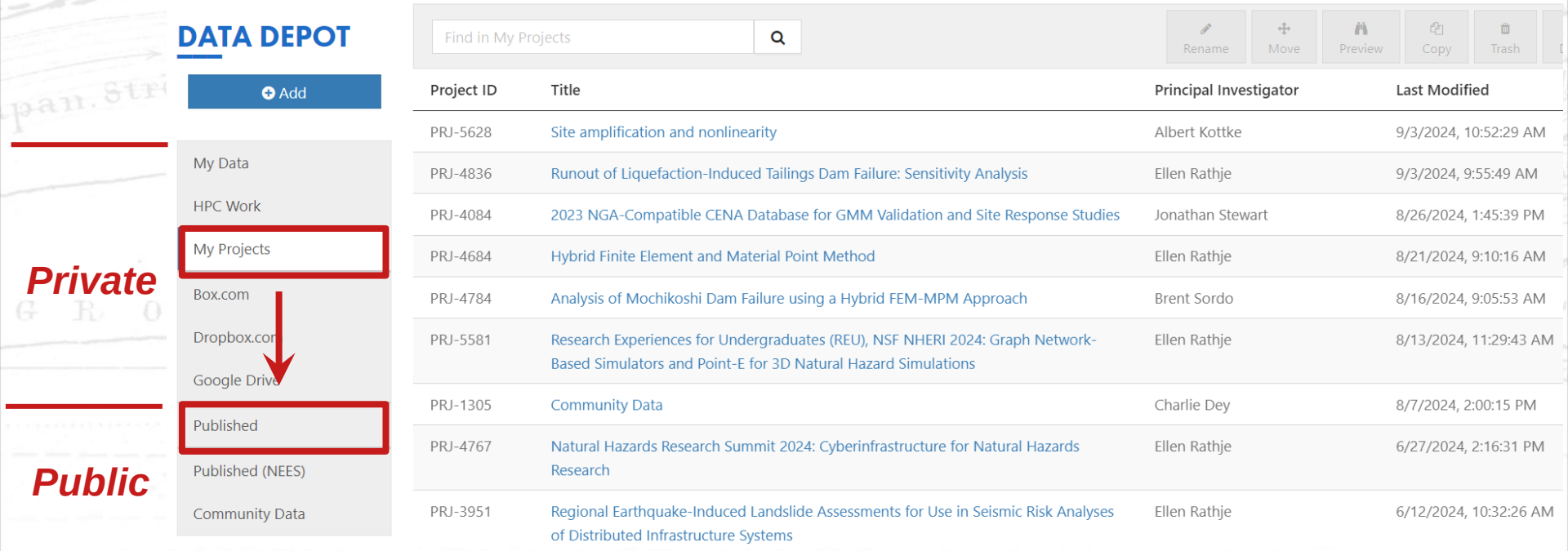
- DesignSafe leverages TACC staff and compute resources
- Tapis is the underlying API for DesignSafe and is developed by TACC (https://tapis-project.org/)
  - Formerly Agave API
  - Tapipy Python package for interacting with Tapis (https://pypi.org/project/tapipy/)
- DesignSafe upgraded to Tapis v3 in August 2024
  - Security enhancements, allocations for individual accounts

DesignSafe Accounts

- DesignSafe Account = TACC Account
- Multi-factor authentication (MFA) required to login
  - Authenticator apps (e.g., Duo, Google Auth, 1Password)
- Initial high-performance computing (HPC) allocations
  - 10,000 SU/yr
  - Larger allocations available by request



DesignSafe: Data Depot



Project ID	Title	Principal Investigator	Last Modified
PRJ-5628	Site amplification and nonlinearity	Albert Kottke	9/3/2024, 10:52:29 AM
PRJ-4836	Runout of Liquefaction-Induced Tailings Dam Failure: Sensitivity Analysis	Ellen Rathje	9/3/2024, 9:55:49 AM
PRJ-4084	2023 NGA-Compatible CENA Database for GMM Validation and Site Response Studies	Jonathan Stewart	8/26/2024, 1:45:39 PM
PRJ-4684	Hybrid Finite Element and Material Point Method	Ellen Rathje	8/21/2024, 9:10:16 AM
PRJ-4784	Analysis of Mochikoshi Dam Failure using a Hybrid FEM-MPM Approach	Brent Sordo	8/16/2024, 9:05:53 AM
PRJ-5581	Research Experiences for Undergraduates (REU), NSF NHERI 2024: Graph Network-Based Simulators and Point-E for 3D Natural Hazard Simulations	Ellen Rathje	8/13/2024, 11:29:43 AM
PRJ-1305	Community Data	Charlie Dey	8/7/2024, 2:00:15 PM
PRJ-4767	Natural Hazards Research Summit 2024: Cyberinfrastructure for Natural Hazards Research	Ellen Rathje	6/27/2024, 2:16:31 PM
PRJ-3951	Regional Earthquake-Induced Landslide Assessments for Use in Seismic Risk Analyses of Distributed Infrastructure Systems	Ellen Rathje	6/12/2024, 10:32:26 AM

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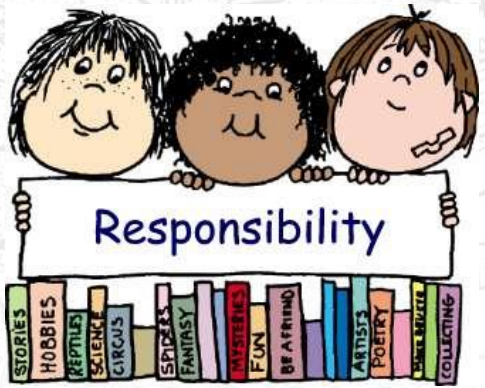
DesignSafe Data Models

Structured, yet ***flexible***, data models for different types of research

- **Experimental Project**
  For physical work, typically done at an experimental facility or in the field.
- **Simulation Project**
  For numerical and/or analytical work, done with software.
- **Hybrid Simulation Project**
  For work using both physical and numerical components.
- **Field Research Project**
  For work done by observation in areas affected by a natural hazard.
- **Other Project**
  For work other than the project types above.



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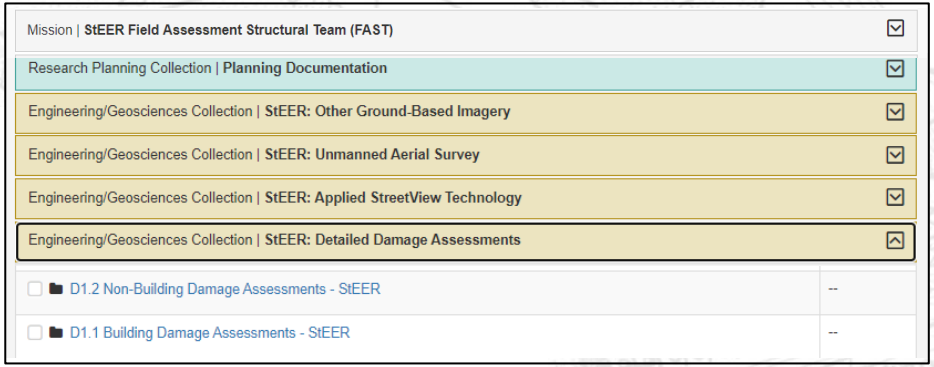
Curation Process



PRJ-3372 | **HazMapper UW Data**

PI	RAPID, NHERI
Project Type	**Field Research** View Overview
Natural Hazard Type	**Other**
Keywords	**Streetview, UAS, Drones, Hazmapper**
Hazmapper Maps	**HazMapper Testing UW Data**

This project is used to house data collected near the University of Washington to test Hazmapper 2.0

Working Directory | Curation Directory | Publication Preview

1 | Add Missions Add Documents 2 | Add Collections 3 | Relate Data

PRJ-3372

HazMapper UW Data -- Select a Collection -- Save	--	1/13/22 6:16 PM
Hazmapper UW Data Guide.xlsx -- Select a Collection -- Save	135.2 kB	1/19/22 2:25 PM
HazMapperTesting-UW.hazmapper -- Select a Collection -- Save	70.0 bytes	1/23/22 11:31 PM

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USER GUIDE

designsafe-ci.org

Search docs

DesignSafe Essentials

- Getting Started
- Account Help

Data Depot

Overview

- Managing Data
- Data Depot Repository
  - About
  - Office Hours
  - Curating & Publication

Data Depot > Overview

DESIGNSAFE DATA DEPOT

DesignSafe Data Depot/Curation

DesignSafe's Data Curator, Dr. Maria Esteva, holds virtual office hours every **Tuesday and Thursday from 1:00pm to 2:00pm CT** (via Zoom) to assist you with your data curation and publication. *Reservations are not required, simply connect to the Zoom feed during this time.*

Connect to Office Hours

Meeting ID: 730 745 593
Passcode: 595633

26 January 2023: DesignSafe Data Depot certified as a Trustworthy Data Repository by the CoreTrustSeal Standards and Certification Board (thru 26 Jan 2026)

- Evaluated on 16 components across 3 themes:
  - Organizational infrastructure
  - Digital object management
  - Technology
- Fewer than 4% of data repositories worldwide have been certified by CTS
  - 115 certified repositories, 3094 registered repositories at re3data.org

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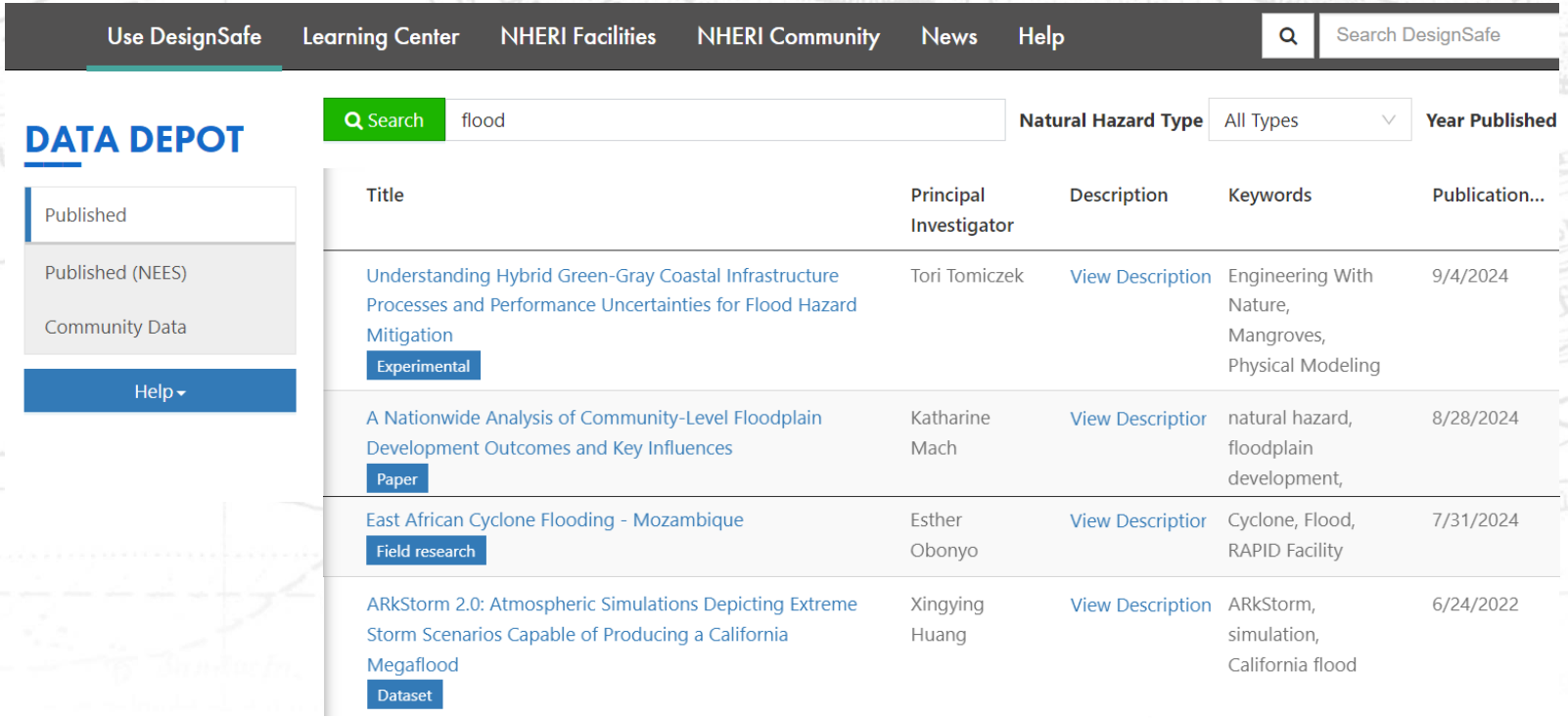
Data Depot: Search



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Published Datasets

DATA DEPOT

Search within Publication

- Published
- Published (NEES)
- Community Data
- Help

PRJ-3499 | ARkStorm 2.0: Atmospheric Simulations Depicting Extreme Storm Scenarios Capable of Producing a California Megaflood

Download Dataset

Cite This Data:
Huang, X., D. Swain (2022). "ARkStorm 2.0: Atmospheric Simulations Depicting Extreme Storm Scenarios Capable of Producing a California Megaflood", in *ARkStorm 2.0: Atmospheric Simulations Depicting Extreme Storm Scenarios Capable of Producing a California Megaflood.* DesignSafe-CI. https://doi.org/10.17603/ds2-mzgn-cy51

Download Citation: DataCite XML | RIS | BibTeX
275 Downloads 1003 Views 1 Citations **Details**

Authors	**Huang, Xingying; Swain, Daniel**
Data Type(s)	**Dataset**
Natural Hazard Type(s)	**Atmospheric River, Flood**
Date of Publication	**2022-06-24**

Description: ARkStorm 2.0 is a cross-disciplinary flood emergency management and clim
scenarios in California in a warming climate. It builds upon previous disaster contingency a
2010. In ARkStorm 2.0, we update and upgrade the methods used in ARkStorm 1.0 in two
based approach to scenario event selection. To do so, we conduct new simulations by emb
Show More

File Name
Analysis Data — Data Used in Analysis
Codes — Analysis Codes

Dataset Metrics [Updated 09/2024]

Aggregated Usage	
Unique Investigations *(views)*	1043
Unique Requests *(downloads)*	277
Total Requests	2292

Quarter 2024	Unique Investigations	Unique Requests	Total Requests
Jan-Mar	32	32	733
Apr-Jun	5	5	15
Jul-Sep	66	8	33
Oct-Dec	--	--	--

These metrics are presented according to the Make Data Count standard.

Metrics recorded since January 2022.

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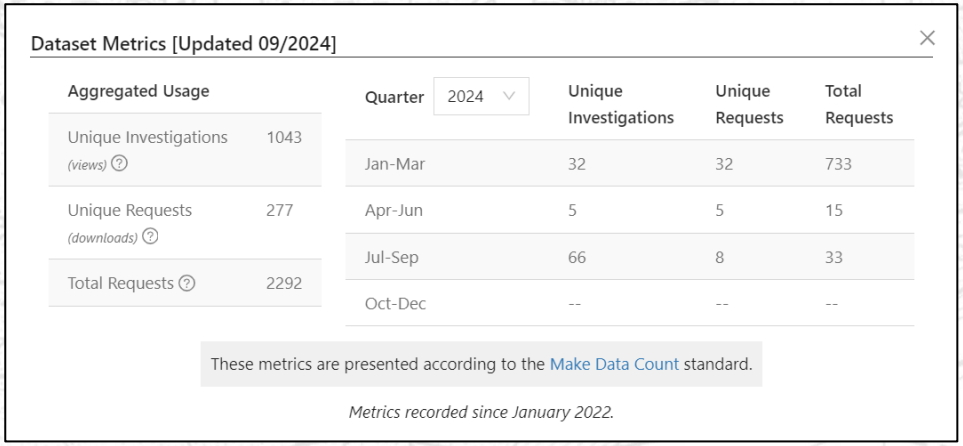
Make Data Count Metrics

Unique Investigation: 1-hour session during which a user viewed metadata or accessed files

Unique Request: 1-hour session during which a user viewed accessed files

Total Requests: Total downloads, previews, and copies of files plus Project Downloads



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Metrics recorded since January 2022.

Since 2022:

Over 45,000 Unique Requests (UR) across all DesignSafe datasets (~1500/month)

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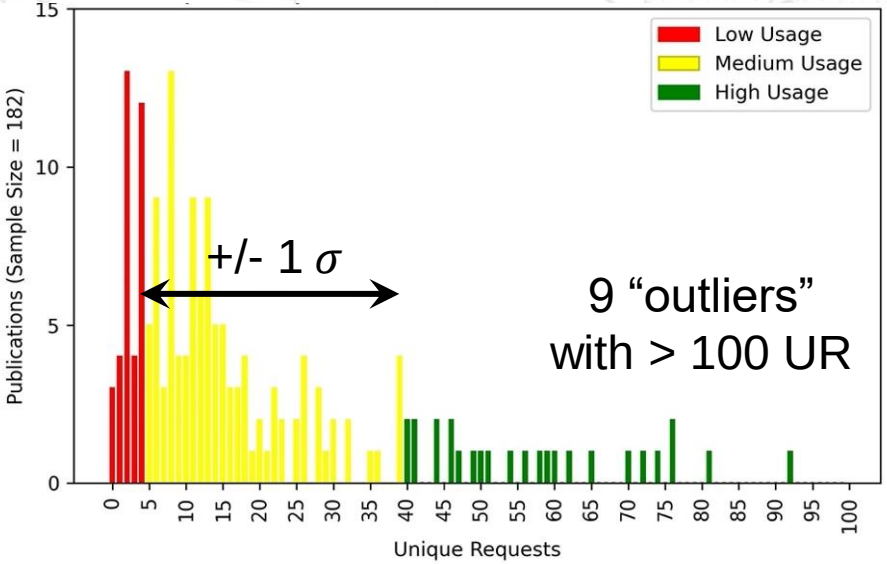
Benchmarking Unique Requests

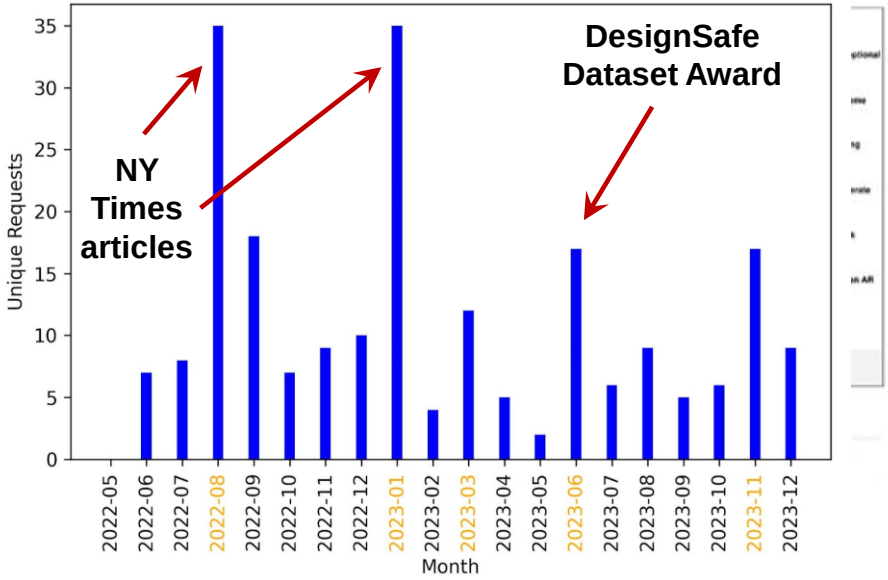
Unique Requests (UR) / Dataset

over 12 months post-publication



Dataset PRJ-3499

ARkStorm 2.0: Atmospheric Simulations Depicting Extreme Storm Scenarios Capable of Producing a California Megaflood



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Data Publication and Citation

Manual Citation Counting

Year	DesignSafe Citation	Primary Data Use	Subsequent Data Reuse	Totals
Q1-3 2024	35	92	147	274
2023	64	142	140	346
2022	65	107	105	277
2021	42	89	60	191
2020	52	74	61	187
2019	21	25	30	76
2018	26	31	13	70

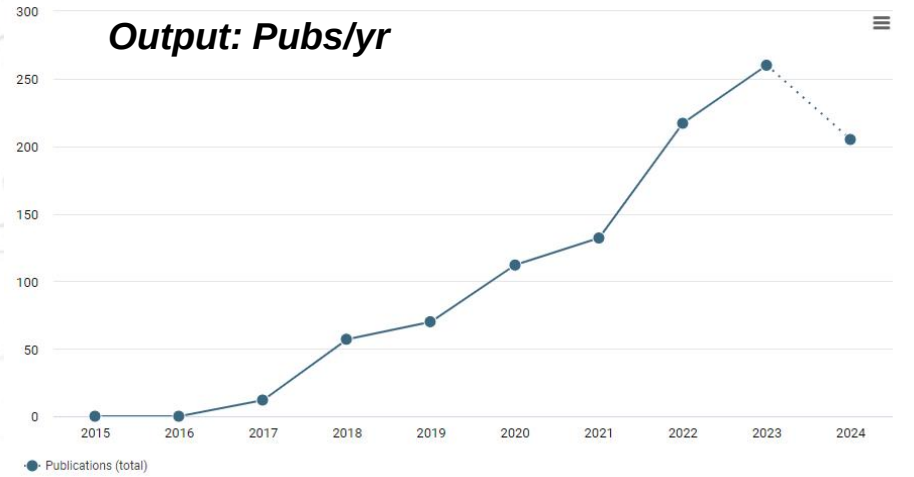
DesignSafe Impact

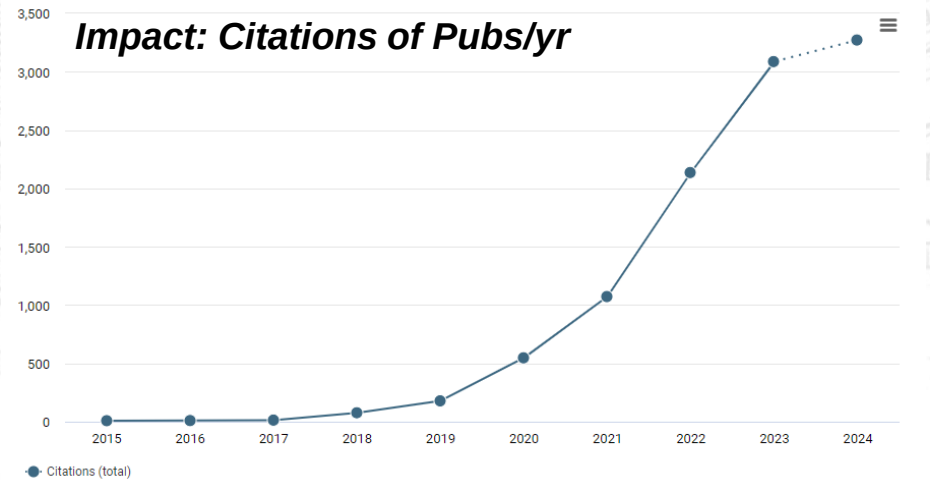
AI Citation Counting

Dimensions

designsafe
Free text in full data

PUBLICATIONS	DATASETS	GRANTS	PATENTS	CLINICAL TRIALS
1,086	90	64	1	0





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How to increase data publishing?

Borycz et al. (2023) “Perceived benefits of open data are improving but scientists still lack resources, skills, and rewards”
https://doi.org/10.1057/s41599-023-01831-7

Sticks

- ***Force*** researchers to do it!
- ***Funding agencies*** can require it
- ***Journals*** can require supporting data be published with papers

Carrots

- Make it ***easy***
- Provide ***tools*** and ***resources***
- Provide ***incentives***
- Give researchers ***credit*** for publishing

Saygili, G., Rathje, E., and Wang, Y. (2018a). “Probabilistic seismic hazard analysis for the sliding displacement of rigid sliding masses [Data set].” Designsafe-CI ⟨https://doi.org/10.17603/ds22d6k⟩ (Feb. 7,

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Research Ecosystem

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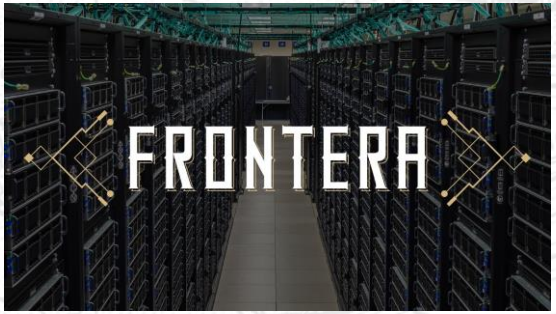
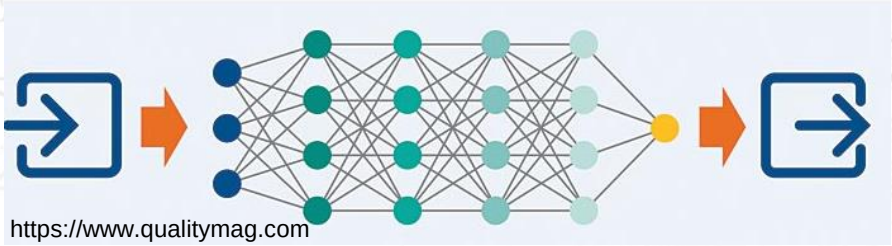
Computational Resources





https://www.quality mag.com

Data analytics / Algorithms / Tools

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Search DesignSafe | Website | Datasets

TOOLS & APPLICATIONS

Simulating the impact of natural hazards requires significant computational power. These tools & applications will give you access to high-performance computing power from the world-class systems at Texas Advanced Computing Center.

New interface: Summer 2024 Release

Simulation

ADCIRC
Coastal circulation and flooding model

Flood • Hurricane/Tropical Storm • Storm Surge

Popular | Open Source

OpenSees
Advanced seismic and structural analysis

Earthquake

Popular | Open Source

Ansys
Model how infrastructure is affected by various hazards.

Licensed

Analysis

Jupyter
Interpret python code into intuitive graphs and visualizations with these highly customizable notebooks.

Popular | Open Source

MATLAB
Analyze data, develop algorithms, and create models.

Popular | Licensed

HVSRweb
Analyze seismic data to assess site amplification.

Earthquake

Open Source

DesignSafe Vision

- Lower the barriers of entry for using simulation tools, high-performance computing (HPC), AI and Machine Learning (ML)
- Tiered approach
  - Portal apps that utilize HPC on the backend (mostly simulation and visualization codes)
  - JupyterLab with access to TACC VM, CPU, or GPU resources, job submission via Tapis API, relevant AI/ML support (e.g., CUDA, PyTorch, TensorFlow)
  - Command line access to TACC resources (Frontera, Lonestar, Stampede)
- Co-location of tools and data through DesignSafe

OPENSEES OVERVIEW

The Open System for Earthquake Engineering Simulation (OpenSees) is a software framework for simulating the static and seismic response of structural and geotechnical systems. It has advanced capabilities for modeling and analyzing the nonlinear response of systems using a wide range of material models, elements, and solution algorithms.

Learn How to Use OpenSees

Read step-by-step instructions on getting started and a detailed breakdown of version differences in the User Guide.

User Guide

Video Tutorials

Running OpenSees on the DesignSafe CyberInfrastructure - Scalability by Design, Nov. 14, 2023

Calibrating an OpenSees Material Model using Experimental Data in quoFEM, Dec. 10, 2021

Fluid-Structure Interaction with OpenFOAM and OpenSees with Hydro-UQ, Nov.19 2021

2021 DSA Hackathon: Automated Model Calibration for Cyclic Tests Using OpenSees & Jupyter Notebooks

WEBINAR - Using OpenSeesPy on DesignSafe, May 22, 2019

WEBINAR - OpenSees & DesignSafe, Oct. 31, 2018

SimCenter | Numerical Simulation of Concentrically Braced Frames using OpenSees, Oct. 10, 2017

Select a Version

Interactive VM for OpenSees — Get Started

Runs OpenSees interactively and responds to errors in real time.

OpenSees-EXPRESS (VM) — Get Started

Runs on a single core with basic computer-resources requirements and is easy to use.

OpenSeesMP — Get Started

Runs all the processors in parallel. Requires understanding of parallel processing and the capabilities to write parallel scripts.

OpenSeesSP — Get Started

Parallel version driven by a single processor. Easy to use even with limited knowledge about parallel computing.

Home > Use DesignSafe > Tools & Applications > Simulation > OpenSees Overview > OpenSeesMP

Job Status

Applications:

- Simulation [18]
  - ADCIRC [3]
  - Ansys
  - EE-UQ [1]
  - Hydro-UQ [1]
  - LS-DYNA [2]
  - MPM
  - OpenFOAM
  - OpenSees [4]

OpenSeesMP

View User Guide

Configuration

Back | Continue

Queue

skx

- icx
- pvc
- skx
- skx-dev
- spr

Node Count

2 Clear

Allocation

- BCS23027
- DesignSafe-Community
- OTH24007
- TACC-ACI

Summary

Submit Job

Inputs

Input Directory	tapis://designsafe.storage.default/erathje/CE 311K

Parameters Edit

Main Script Required

Configuration Edit

Queue	skx
Maximum Job Runtime (minutes)	120
Node Count	2
Allocation	BCS23027

Outputs Edit

Job Name	opensees-mp-s3-3.6.0_2024-09-10T17:41:39
Archive System	designsafe.storage.default

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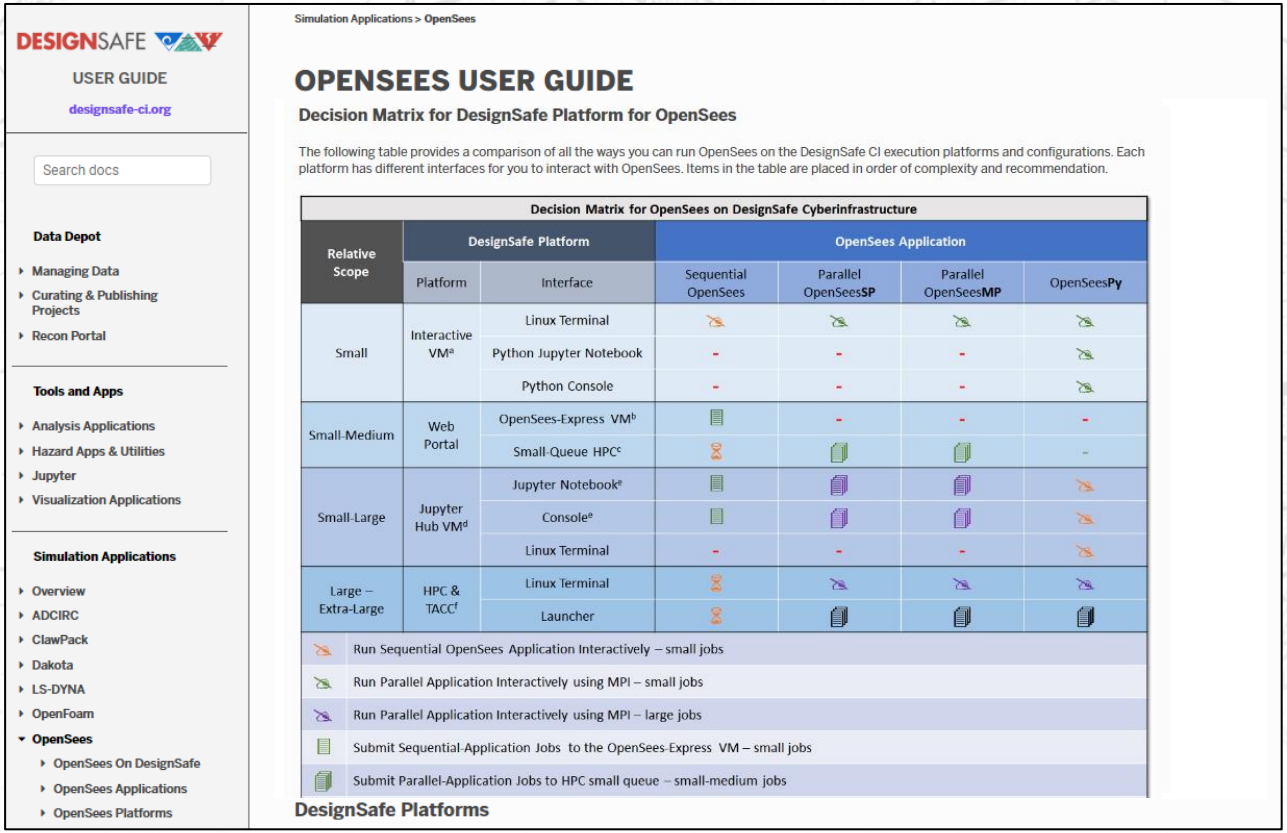

DESIGNSAFE

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Data Depot

- Managing Data
- Curating & Publishing Projects
- Recon Portal

Tools and Apps

- Analysis Applications
- Hazard Apps & Utilities
- Jupyter
- Visualization Applications

Simulation Applications

- Overview
- ADCIRC
- ClawPack
- Dakota
- LS-DYNA
- OpenFoam
- OpenSees
  - OpenSees On DesignSafe
  - OpenSees Applications
  - OpenSees Platforms

Simulation Applications > OpenSees

OPENSEES USER GUIDE

Decision Matrix for DesignSafe Platform for OpenSees

The following table provides a comparison of all the ways you can run OpenSees on the DesignSafe CI execution platforms and configurations. Each platform has different interfaces for you to interact with OpenSees. Items in the table are placed in order of complexity and recommendation.

Decision Matrix for OpenSees on DesignSafe Cyberinfrastructure

Relative Scope	DesignSafe Platform		OpenSees Application			
	Platform	Interface	Sequential OpenSees	Parallel OpenSeesSP	Parallel OpenSeesMP	OpenSeesPy
Small	Interactive VM[a]	Linux Terminal				
		Python Jupyter Notebook	-	-	-	
		Python Console	-	-	-	
Small-Medium	Web Portal	OpenSees-Express VM[b]		-	-	-
		Small-Queue HPC[c]				-
Small-Large	Jupyter Hub VM[d]	Jupyter Notebook[e]				
		Console[e]				
		Linux Terminal	-	-	-	
Large – Extra-Large	HPC & TACC[f]	Linux Terminal				
		Launcher				

- Run Sequential OpenSees Application Interactively – small jobs
- Run Parallel Application Interactively using MPI – small jobs
- Run Parallel Application Interactively using MPI – large jobs
- Submit Sequential-Application Jobs to the OpenSees-Express VM – small jobs
- Submit Parallel-Application Jobs to HPC small queue – small-medium jobs

DesignSafe Platforms

User Guide

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TOOLS & APPLICATIONS

Simulating the impact of natural hazards requires significant computational power. These tools & applications will give you access to high-performance computing power from the world-class systems at Texas Advanced Computing Center.

Simulation

ADCIRC
Coastal circulation and flooding model.

Flood • Hurricane/Tropical Storm • Storm Surge

Popular — Open Source

OpenSees
Advanced seismic and structural analysis.

Earthquake

Popular — Open Source

EE-UQ
Determine the response of a structure to an earthquake.

Earthquake

SimCenter — Open Source

Analysis

Jupyter
Interpret python code into intuitive graphs and visualizations with these highly customizable notebooks.

Popular — Open Source

MATLAB
Analyze data, develop algorithms, and create models.

Popular — Licensed

HVSRweb
Analyze seismic data to assess site amplification.

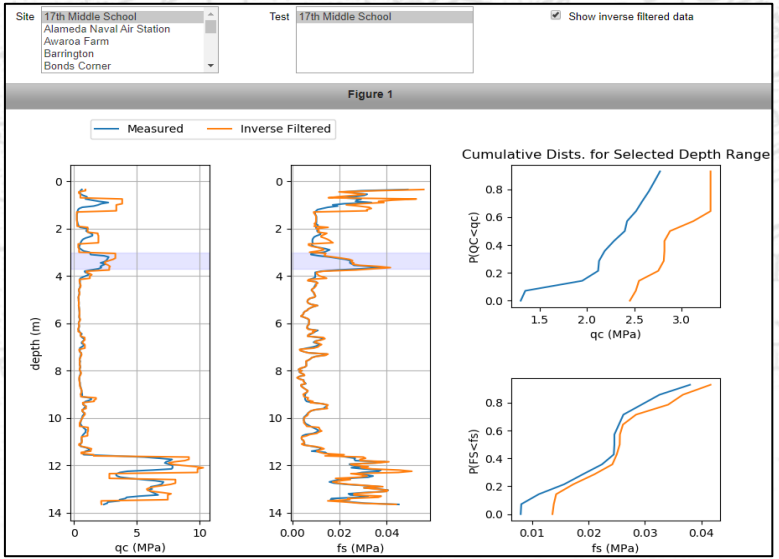
Earthquake

Open Source

Jupyter

- JupyterHub/Lab in DesignSafe
  - Access to Data Depot files
  - HPC Jupyter
- Interactive data viewer
- Scripts for data processing, AI / ML
- Publish for use by others
- Accelerates data reuse, adoption of approaches into practice

Next Generation Liquefaction



From Scott Brandenberg (UCLA)

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JUPYTER OVERVIEW

The Jupyter Notebook is a web application that allows you to create and share documents that contain live code, equations, visualizations and explanatory text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, machine learning and much more.

Learn How to Use Jupyter

Read step-by-step instructions on getting started and a detailed breakdown of version differences in the User Guide.

User Guide

Video Tutorials

WEBINAR - Unleashing Python and Jupyter in DesignSafe, March 1, 2017

WEBINAR | PART 1 - Jupyter, Python, and the Scientific Workflow, Oct. 26, 2016

WEBINAR | PART 2 - Jupyter, Python, and the Scientific Workflow, Oct. 26, 2016

A Jupyter/Tapis workflow for processing, visualization, & analysis of experimental & field wind data

WEBINAR - Launching numerical simulations using Jupyter, March 28, 2018

Select a Version

Jupyter Hub — Get Started

Access the Jupyter ecosystem.

Jupyter Lab HPC (CPU) — Get Started

Launch an interactive Jupyter instance running on a Frontera compute node. Community Data, Publications, and your HPC Work directory will be available within the session.

Jupyter Lab HPC (GPU) — Get Started

Launch an interactive Jupyter instance running on a Frontera RTX node with CUDA enabled. Community Data, Publications, and your HPC Work directory will be available within the session.

Spawner Options

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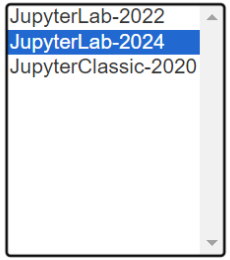
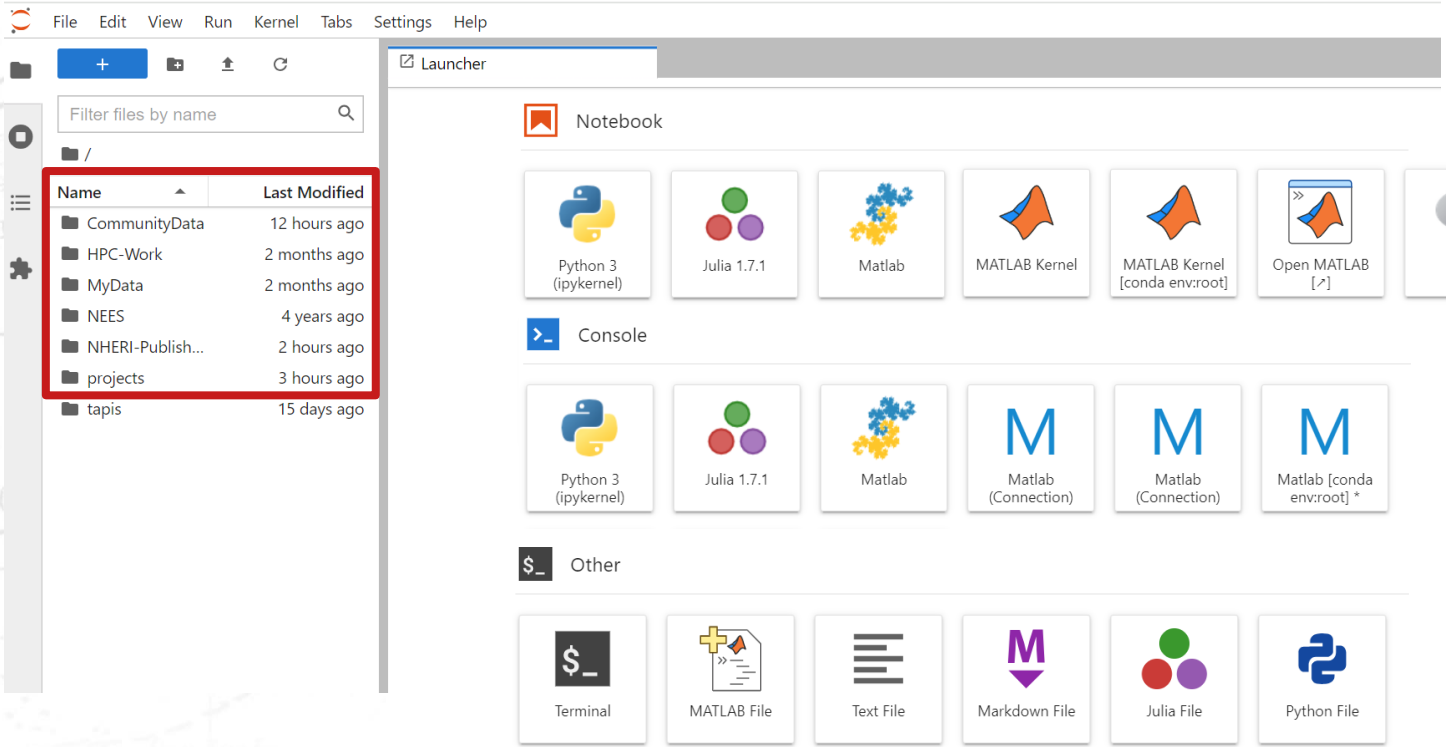
Available Jupyter Images



https://jupyter.designsafe-ci.org

JupyterLab-2024 (released August 2024) is the recommended default image. This JupyterLab interface supplies Python 3.9 as its default Python interpreter. The image provides fewer pre-installed APT and Python packages to allow it to remain light and flexible. Temporary package installations can be performed using pip or conda. Persistent installations can be created and shared between users using the kernelutility Python package.


File Edit View Run Kernel Tabs Settings Help
Launcher
Filter files by name
/
Name
Last Modified
CommunityData 12 hours ago
HPC-Work 2 months ago
MyData 2 months ago
NEES 4 years ago
NHERI-Publish... 2 hours ago
projects 3 hours ago
tapis 15 days ago
Notebook
Python 3 (ipykernel)
Julia 1.7.1
Matlab
MATLAB Kernel
MATLAB Kernel [conda env:root]
Open MATLAB [↗]
R
Console
Python 3 (ipykernel)
Julia 1.7.1
Matlab
Matlab (Connection)
Matlab (Connection)
Matlab [conda env:root] *
Other
Terminal
MATLAB File
Text File
Markdown File
Julia File
Python File

HPC Jupyter

- Jupyter images deployed directly on HPC resources
- Jupyter Lab HPC (CPU)
  - CPU compute nodes on Stampede3, provides more memory and speed
  - Well-suited for data processing and parallel computing using 56 cores
- Jupyter Lab HPC (GPU)
  - NVIDIA RTX GPU nodes on Frontera
  - Commonly used Python AI packages (e.g., TensorFlow and PyTorch) are pre-installed
  - Well-suited for AI/ML applications

Use Cases

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- **Use Cases**
- Overview
- Data Analytics
  - Basic Image Browsing and Mapping
  - Grouping and Tagging Image Files
  - Multi-Data Set Image Analysis in Taggit
  - ML and AI
  - Application Programming Interfaces
  - Visualization of spatially distributed data
- GeoHazard
- Seismic
- Wind and Storm Surge

Use Cases > **Overview**

DESIGNSAFE USE CASES

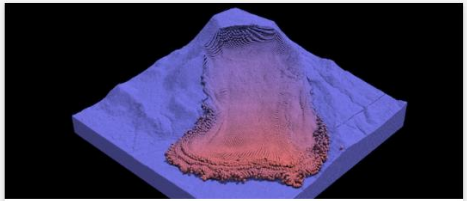
DesignSafe provides a wide variety of resources that allow researchers to effectively share, find, analyze, and publish data; perform numerical simulations and utilize high performance computing (HPC); and integrate diverse datasets.

To help users fully embrace DesignSafe functionalities, we have developed a suite of Use Cases that demonstrate how DesignSafe is being used to advance natural hazards research. Practical products, examples, and scripts developed as part of these Use Cases are provided for each Use Case. The different simulation codes, tools, and DesignSafe resources used in each Use Case are also indicated.

Make sure you are logged into DesignSafe so that you can access the Use-Case products.

Data Analytics

Analyze data from multiple datasets, with A.I. and Machine Learning, or via APIs or visualization.



GeoHazard

Geological hazard use cases like liquefaction and landslide modeling.

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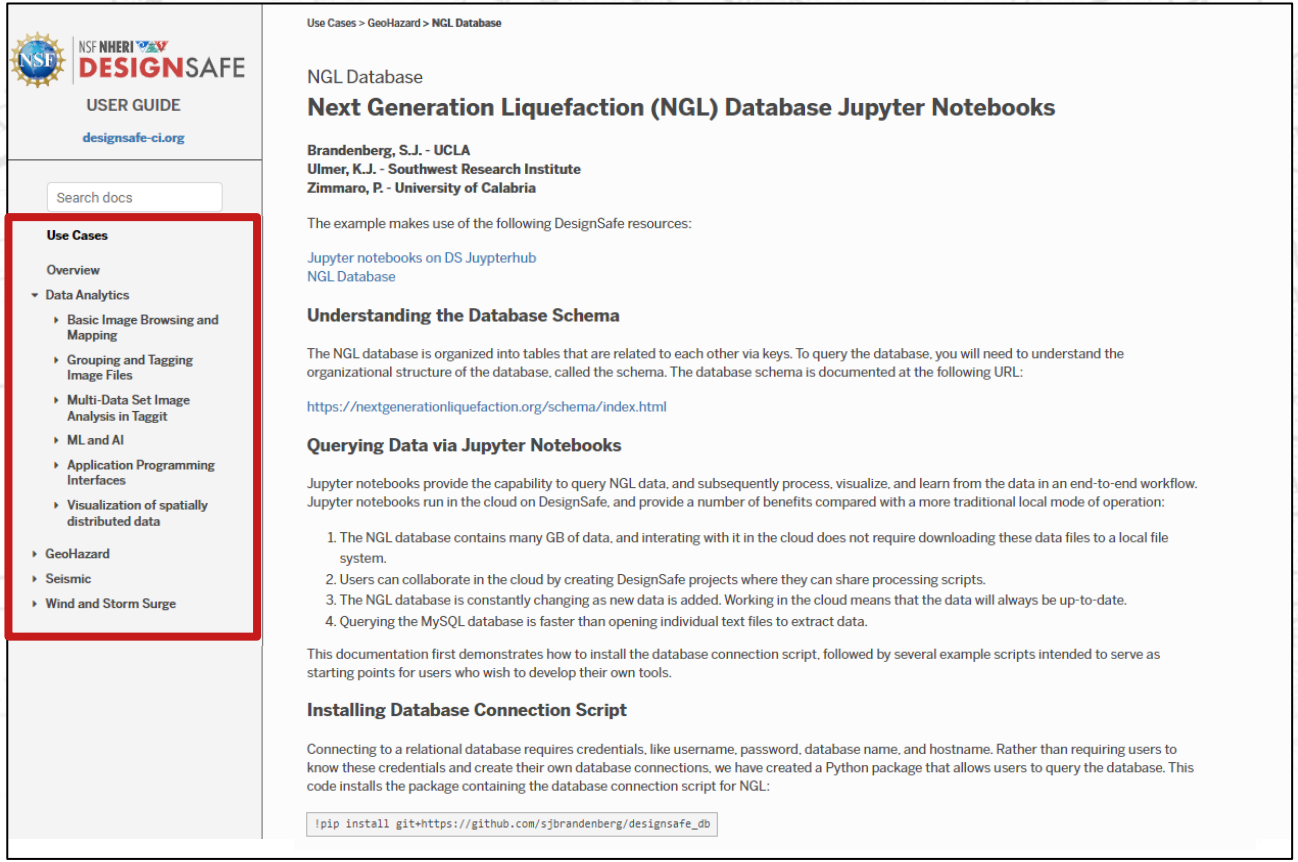
Use Cases



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Use Cases

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- Visualization of spatially distributed data

GeoHazard

Seismic

Wind and Storm Surge

Use Cases > GeoHazard > NGL Database

NGL Database

Next Generation Liquefaction (NGL) Database Jupyter Notebooks

Brandenberg, S.J. - UCLA
Ulmer, K.J. - Southwest Research Institute
Zimmaro, P. - University of Calabria

The example makes use of the following DesignSafe resources:

Jupyter notebooks on DS Juypterhub
NGL Database

Understanding the Database Schema

The NGL database is organized into tables that are related to each other via keys. To query the database, you will need to understand the organizational structure of the database, called the schema. The database schema is documented at the following URL:

https://nextgenerationliquefaction.org/schema/index.html

Querying Data via Jupyter Notebooks

Jupyter notebooks provide the capability to query NGL data, and subsequently process, visualize, and learn from the data in an end-to-end workflow. Jupyter notebooks run in the cloud on DesignSafe, and provide a number of benefits compared with a more traditional local mode of operation:

1. The NGL database contains many GB of data, and interating with it in the cloud does not require downloading these data files to a local file system.
2. Users can collaborate in the cloud by creating DesignSafe projects where they can share processing scripts.
3. The NGL database is constantly changing as new data is added. Working in the cloud means that the data will always be up-to-date.
4. Querying the MySQL database is faster than opening individual text files to extract data.

This documentation first demonstrates how to install the database connection script, followed by several example scripts intended to serve as starting points for users who wish to develop their own tools.

Installing Database Connection Script

Connecting to a relational database requires credentials, like username, password, database name, and hostname. Rather than requiring users to know these credentials and create their own database connections, we have created a Python package that allows users to query the database. This code installs the package containing the database connection script for NGL:

```
!pip install git+https://github.com/sjbrandenberg/designsafe_db
```

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Use Case Incorporating Jupyter

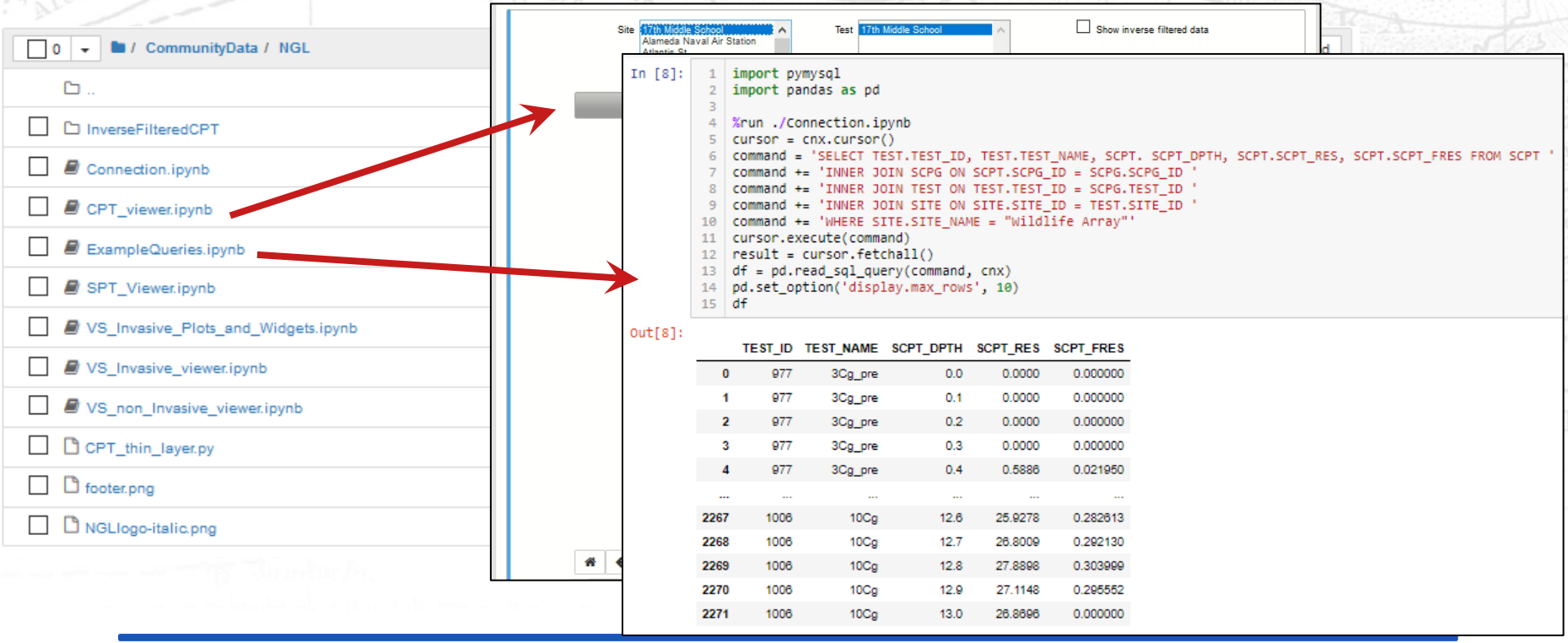
NGL: Community database of liquefaction case histories

Next Generation Liquefaction (NGL)

- Data housed in SQL database
  - http://nextgenerationliquefaction.org/schema/index.html
- Database replicated to DesignSafe daily
- Jupyter notebooks to access data available in DesignSafe

From P. Zimmaro, UCLA

NGL Jupyter Notebooks



	TEST_ID	TEST_NAME	SCPT_DPTH	SCPT_RES	SCPT_FRES
0	977	3Cg_pre	0.0	0.0000	0.000000
1	977	3Cg_pre	0.1	0.0000	0.000000
2	977	3Cg_pre	0.2	0.0000	0.000000
3	977	3Cg_pre	0.3	0.0000	0.000000
4	977	3Cg_pre	0.4	0.5886	0.021950
...	...	...	...	...	...
2267	1006	10Cg	12.6	25.9278	0.282613
2268	1006	10Cg	12.7	26.8009	0.292130
2269	1006	10Cg	12.8	27.8898	0.303999
2270	1006	10Cg	12.9	27.1148	0.295552
2271	1006	10Cg	13.0	26.8696	0.000000

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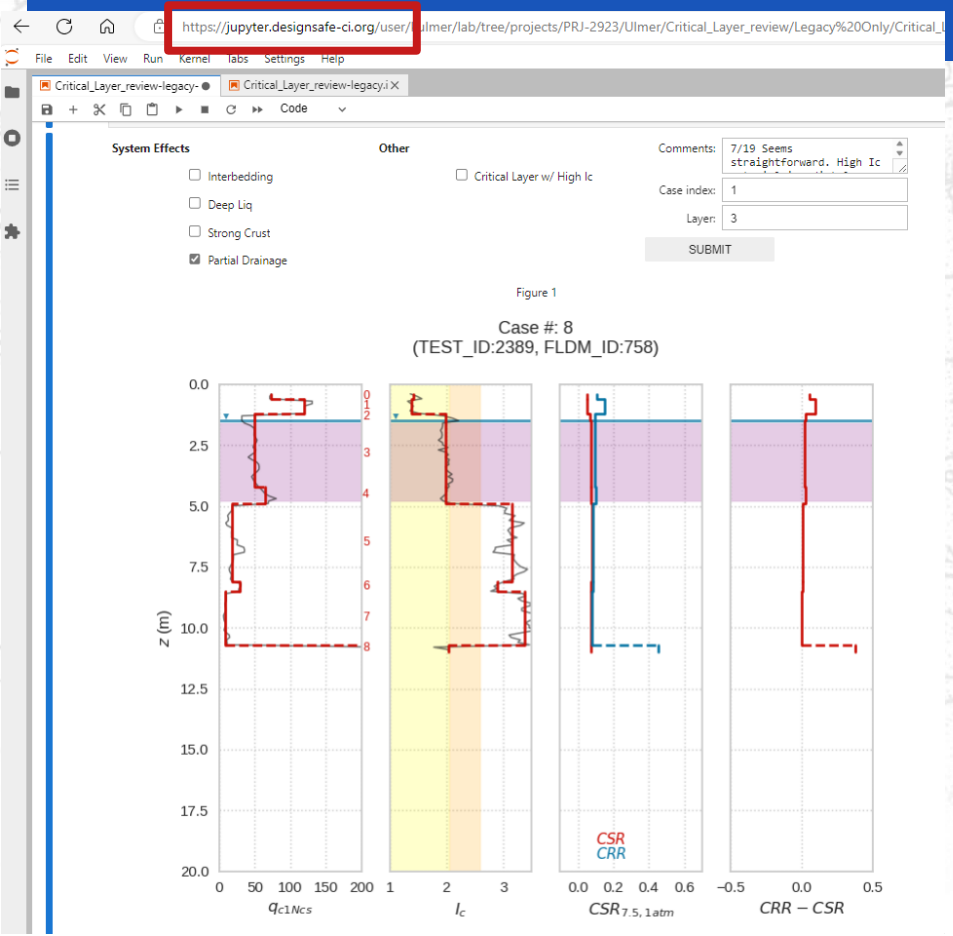
Use of DesignSafe by NGL Team

- Current NGL database
  - 450+ sites
  - 1000+ CPT, 1000+ boreholes
  - 200+ Vs profiles
  - 10,000+ lab tests (FC, PI, grain size, triaxial, simple shear)
- Data interpretation and analysis taking place in DesignSafe Jupyter
- Always working with the most up to date dataset

From Kristin Ulmer (SWRI) and Scott Brandenberg (UCLA)

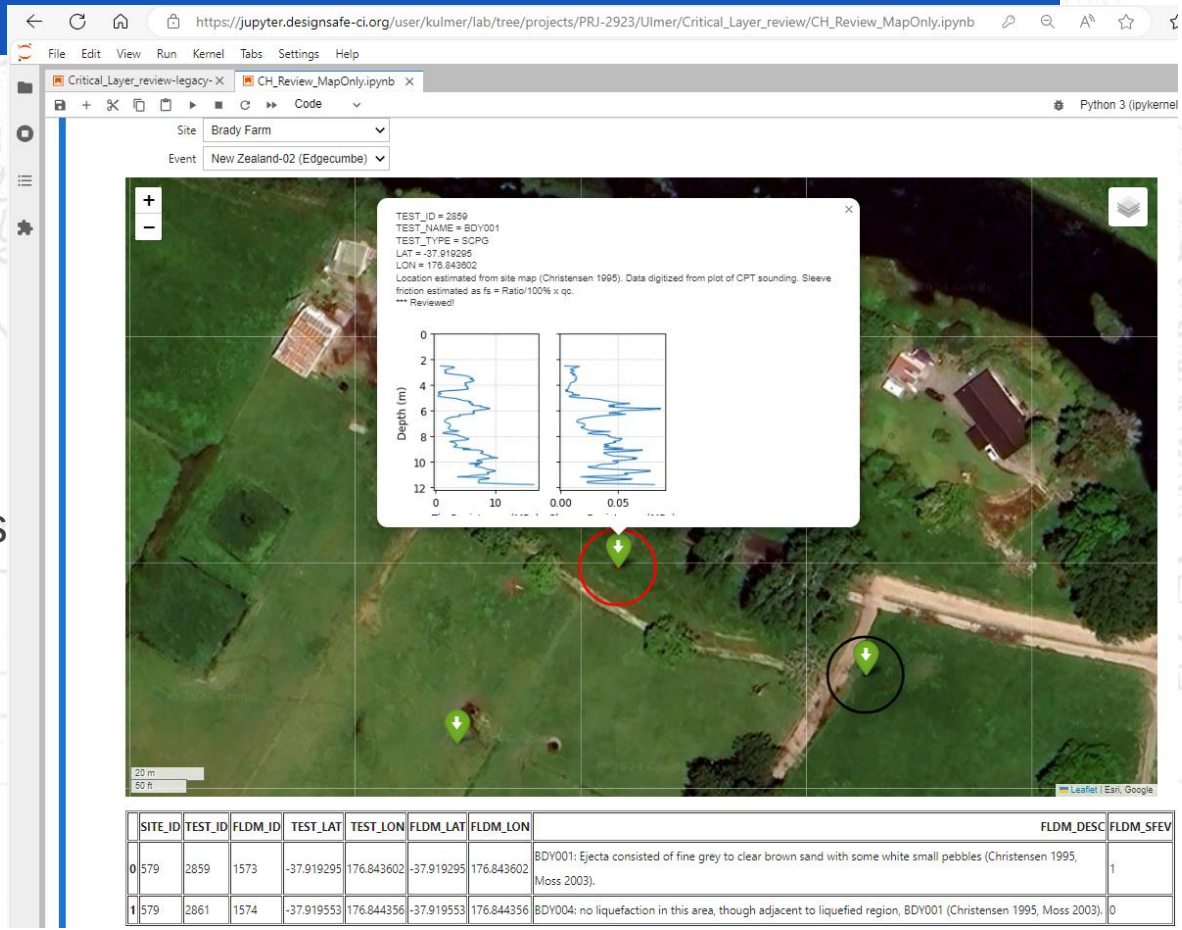


Critical Layer Evaluation

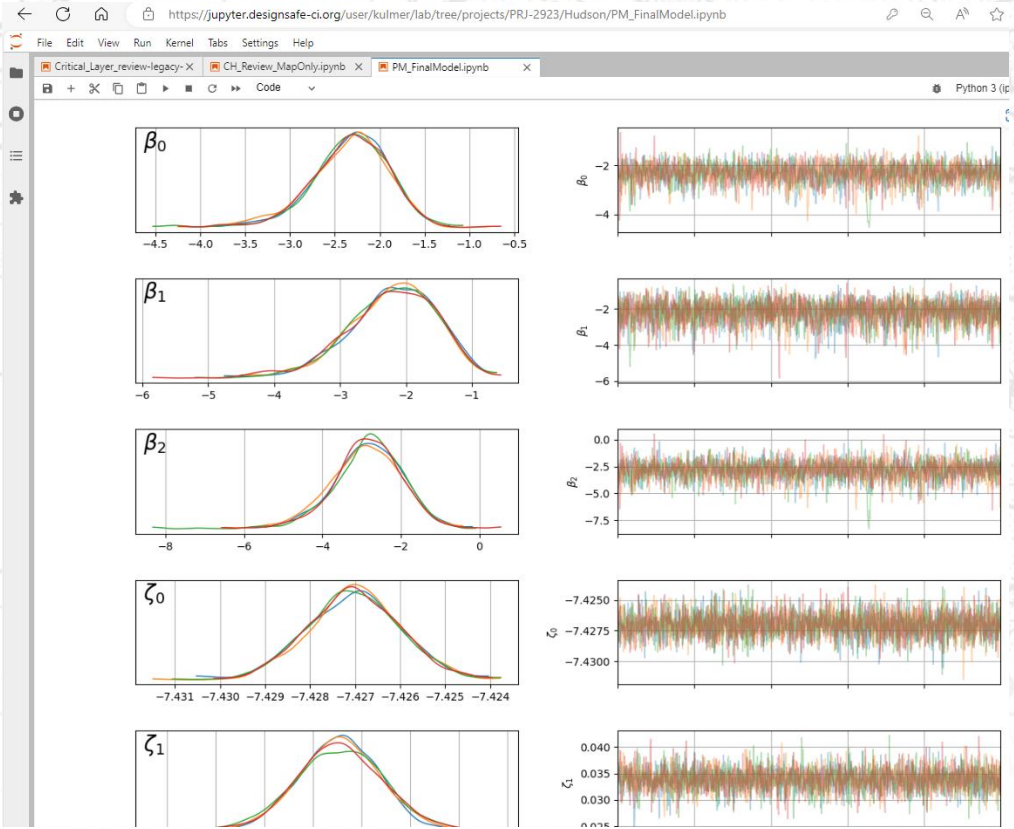
- Liquefaction analysis of surface profiles to identify “critical layer”

Data Integration

- Liquefaction site with:
  - Field liquefaction observations
  - CPT/borehole locations
  - CPT/borehole results
  - Lab test results



	SITE_ID	TEST_ID	FLDM_ID	TEST_LAT	TEST_LON	FLDM_LAT	FLDM_LON	FLDM_DESC	FLDM_SFEV
0	579	2859	1573	-37.919295	176.843602	-37.919295	176.843602	BDY001: Ejecta consisted of fine grey to clear brown sand with some white small pebbles (Christensen 1995, Moss 2003).	1
1	579	2861	1574	-37.919553	176.844356	-37.919553	176.844356	BDY004: no liquefaction in this area, though adjacent to liquefied region, BDY001 (Christensen 1995, Moss 2003).	0



Data Analysis

- Bayesian liquefaction triggering model derived using pyMC witinh DesignSafe JupyterHub

Community Impact

A snapshot of our community impact dating back to July 2015:

- > 9,000 user accounts
- 304 marker paper citations https://doi.org/10.1061/(ASCE)NH.1527-6996.0000246
- 100 training events, > 5,000 attendees
- > 200 outreach events
- ~350,000 web hits online training/documentation
- ~1,000 published datasets
- > 330,000 Slack posts

Concluding Remarks

- Data, tools, and computational resources have always been critical in natural hazards research
- Research advancements are facilitated by formal electronic publishing of data, scripts, tools, workflows, etc.
- DesignSafe links the pieces together
  - Co-location of data, tools, and computational resources
  - Lowers the barriers of entry for new researchers
  - Facilitates computational workflows that enable surrogate modeling, AI and ML, uncertainty quantification, model calibration, etc.