DesignSafe: Resources to Support Natural Hazards Research

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Dept. of Civil, Arch., and Env. Engineering
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What is DesignSafe?

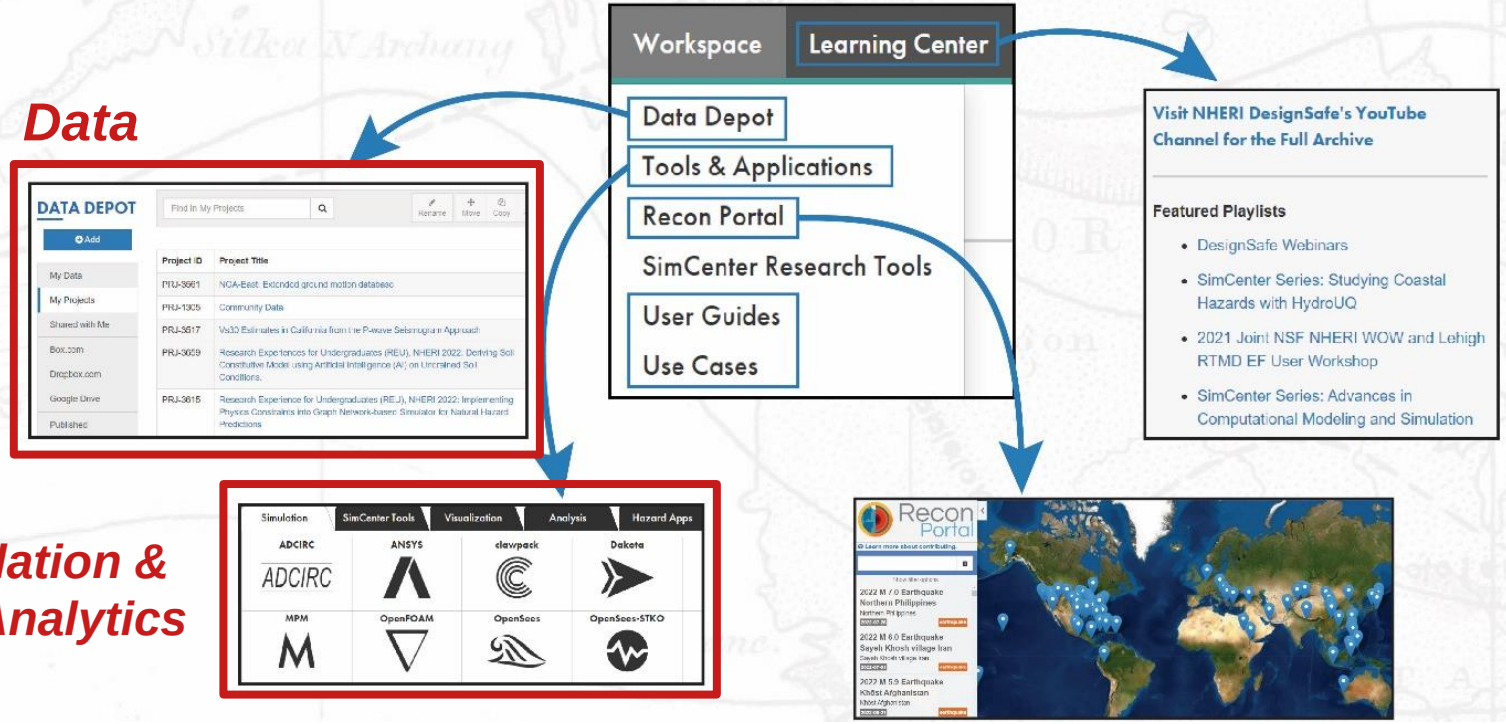
- A web-based research platform that enables transformative research to protect human life/reduce damage during natural hazard events

DesignSafe Vision

- Foster a cultural shift in natural hazards research towards the pervasive use of cyberinfrastructure and the ubiquitous publishing/reuse of data
  - Provide a platform for data sharing/publishing
  - Enable research workflows and access to high performance computing (HPC)
  - Deliver cloud-based tools that support the analysis, visualization, and integration of diverse data types

DesignSafe Components

www.designsafe-ci.org



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NHERI: NATURAL HAZARDS ENGINEERING RESEARCH INFRASTRUCTURE

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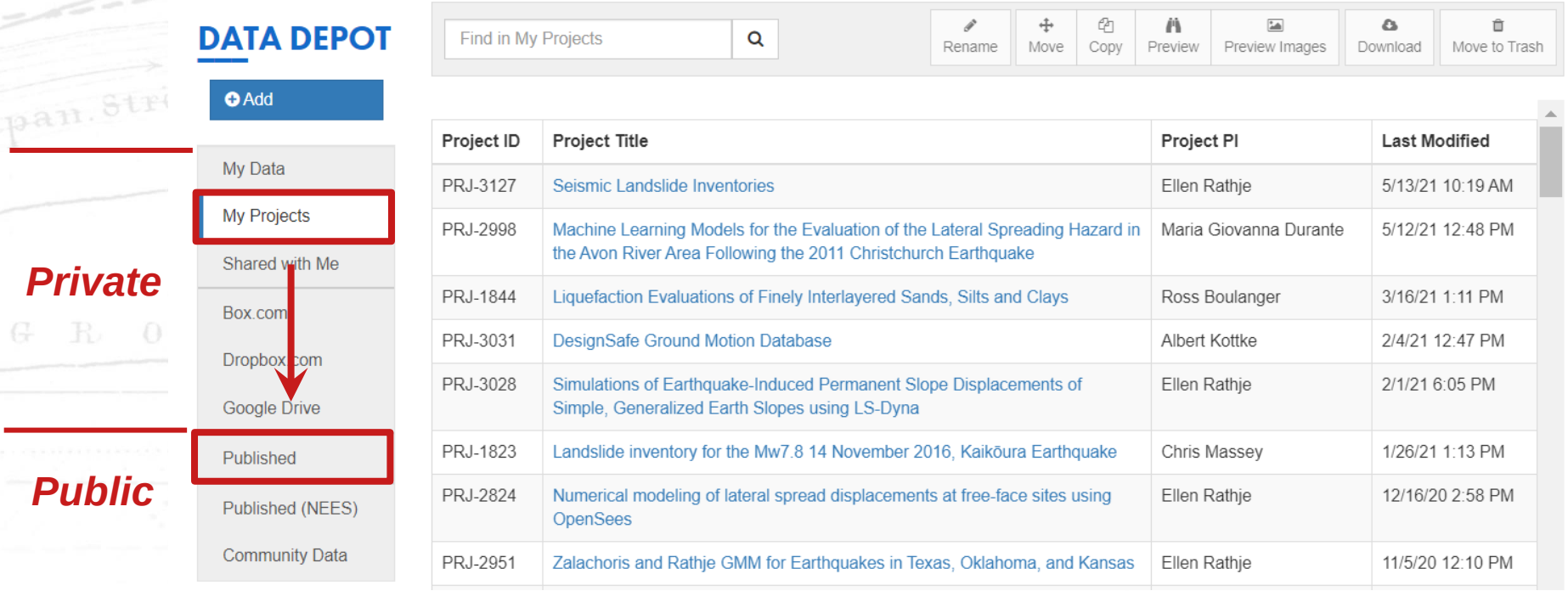
Data Depot



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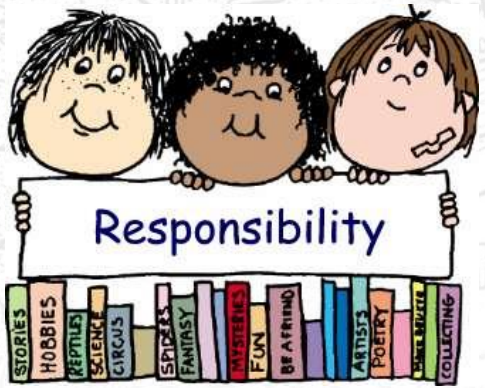
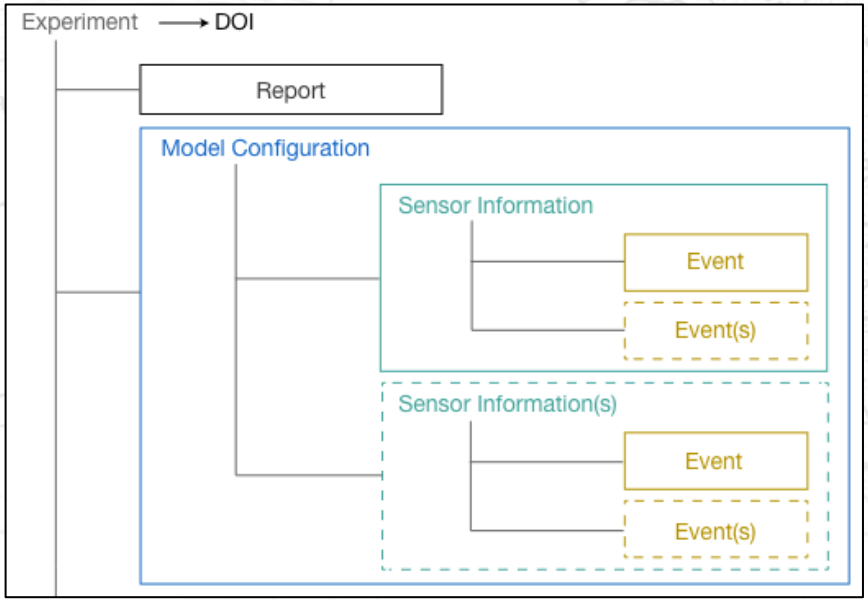
DesignSafe Data Models

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.



Organizing Data



Experimental Data Model

Model Configuration: Files describing the design and layout of what is being tested (some call this a specimen).

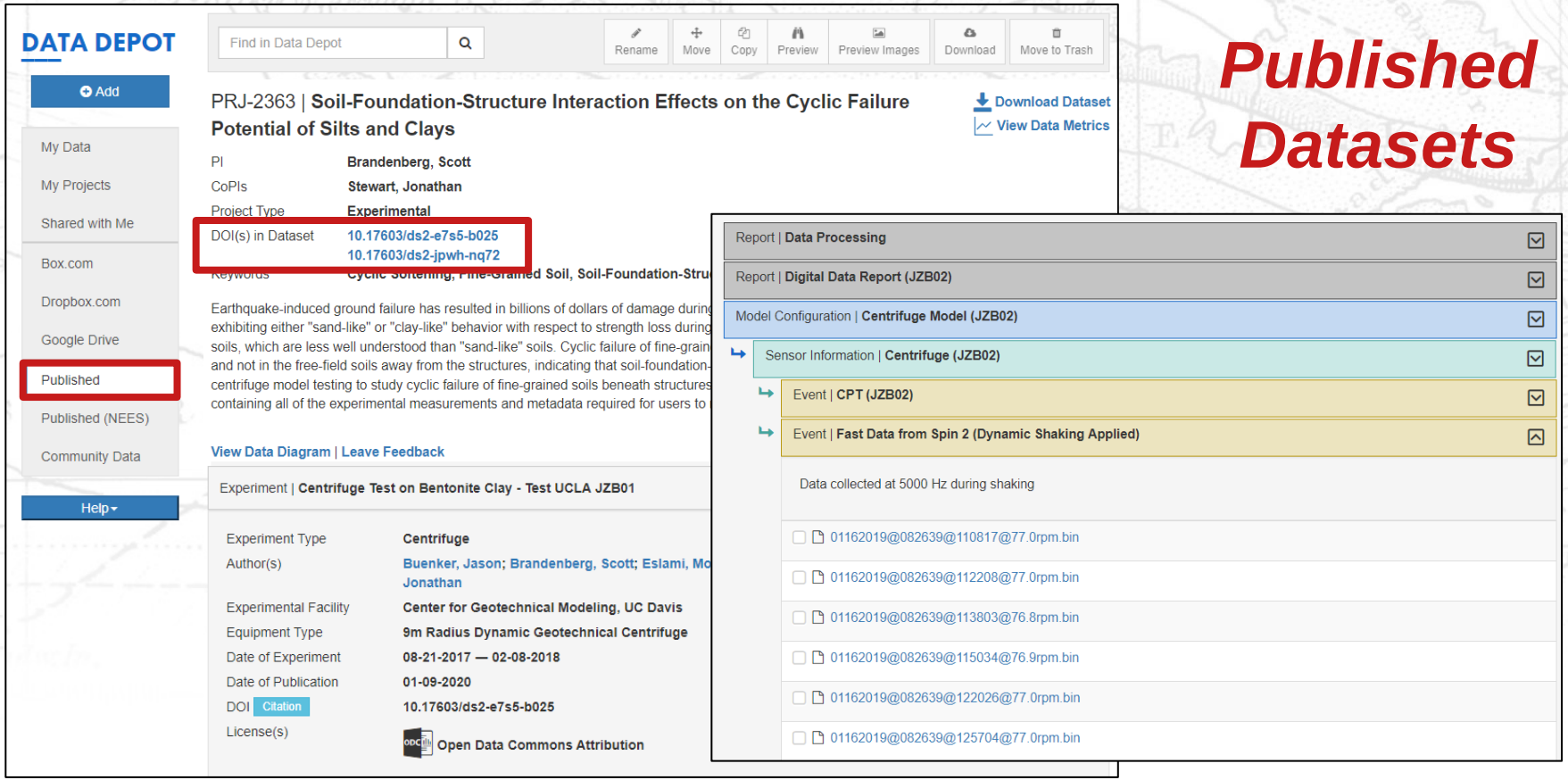
Sensor Information: Files about the sensor instrumentation used in a model configuration to conduct one or more event.

Event: Files from unique occurrences during which data are generated.

Analysis: Tables, graphs, visualizations, Jupyter Notebooks or other representations of the results.

Report: Written accounts made to convey information about the entire project or experiment.

Published Datasets



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Data Depot: Enhancements

Full Dataset Download

PRJ-2828 | **Centrifuge Testing of Liquefaction-Induced Downdrag on Axially Loaded Piles**

Download Dataset

PI	Ziotopoulou, Katerina
Co-PIs	Kutter, Bruce
Project Type	**Experimental**
Natural Hazard Type	**Earthquake**
DOI(s) in Project	10.17603/ds2-d25m-gg48 10.17603/ds2-wjgx-tb78

Awards
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Multi file/folder download

Report | **SKS02: Data Report and Files**

Model Configuration | **SKS02: Model Description**

Sensor Information | **SKS02: Instrumentation Plan & Layout and Event Chronology**

Event | **a) SKS02: PLT1**

Name	Size	Last modified	Open with
07102019@071632.bin ***Slow Data, Raw Data***	-	--	
07102019@071632@101132@64.3rpm.bin ***Fast Data, Raw Data, Pile Load Test***	-	--	
PLT_1 ***Processed Data***	--	--	

Download Project

This download is a ZIP file of the complete project dataset. The size of the ZIP file is **156.4 GB**.

The files are licensed by the following:

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Data Usage Agreement

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Data Depot: Enhancements

PRJ-2828 | **Centrifuge Testing of Liquefaction-Induced Downdrag on Axially Loaded Piles**

Download Data

PI	Ziotopoulou, Katerina
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Project Type	**Experimental**
Natural Hazard Type	**Earthquake**
DOI(s) in Project	10.17603/ds2-d25m-gg48 10.17603/ds2-wjgx-tb78
Awards	**California Department of Transportation under Agreement - 65A0688**
Keywords	**Drag Load, Downdrag, Piles, Centrifuge Testing**

View Data Diagram | View Data Metrics | Leave Feedback

Description | Downdrag loads on pile foundations can be an important design consideration when earthquake-induced liquefaction is expected to c

Data Feedback

Leave Feedback

Full Name
Ellen Rathje

Email
e.rathje@mail.utexas.edu

Feedback
Leave constructive feedback for the author(s) of this publication.

Examples of constructive questions and concerns:

- Questions about the dataset that are not answered in the published metadata and or documentation
- Missing documentation
- Questions about the method/instruments used to generate the data
- Questions about data validation
- Concerns about data organization and or inability to find desired files
- Interest in bibliography about the data/related to the data
- Interest in reusing the data
- Comments about the experience of reusing the data
- Request to access raw data if not published
- Congratulations

Data Diagram

Data Diagram

Experiment | **SKS02: Centrifuge Test of Liquefaction-Induced Downdrag in Uniform Liquefiable Deposit**

- Report: SKS02: Data Report and Files
- Model Config: SKS02: Model Description
- Sensor: SKS02: Instrumentation Plan & Layout and Event Chronology
  - Event: a) SKS02: PLT1
  - Event: b) SKS02: SWM1

Data Metrics

Project Data Metrics (Starting June 2021, updated every month)

Data Reuse Breakdown	
Total Requests	343
Project Downloads	19
File Downloads	115
File Previews	228

Quarterly Reuse	2022
Jan-Mar	98
Apr-Jun	48
Jul-Sep	0
Oct-Dec	0

Make Your Data Count Statistics

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

Unique Request: Any downloads, previews, or copies of files by a user in a one-hour session counts as 1 Unique Request.

Unique Requests (Since January 2022) **43**

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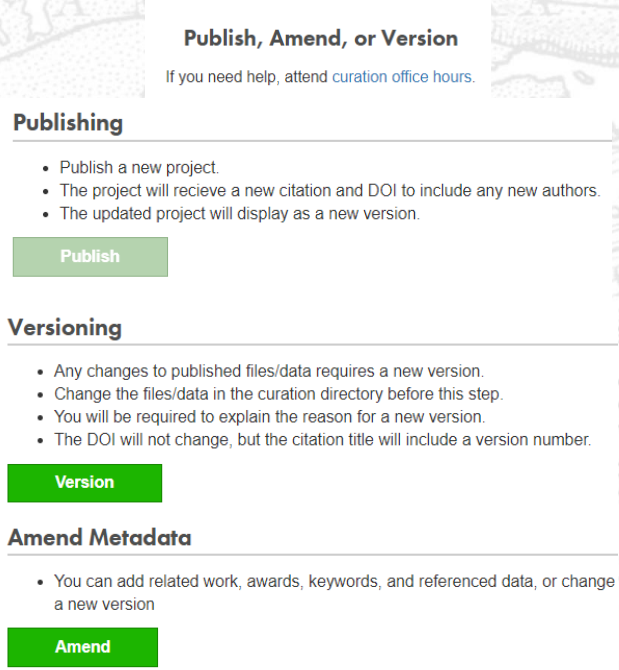
Data Depot: Amends and Versioning

- Amend Metadata
  - Modification to publication metadata (e.g., related works, abstract, keywords)
- Versioning (same DOI)
  - Correct errors, enhance documentation, add data products
  - All versions remain available
- Available for project types “Other” and “Experimental”, “Field Research” coming soon



Make **your** data count!

Make your research re-producible and your data re-usable

- ***Formally publish*** data sets in stable data repositories
  - Include data processing scripts, visualizations, etc.
- Data needs a permanent, ***digital location (DOI)*** not just a URL
  - List curated data sets on your CV, just like papers
- Cite data publication ***in your reference list*** of your paper using DOI, citation language as indicated in DesignSafe

provided here. Additionally, the probabilistic approaches described in this paper are implemented as executable Jupyter notebooks (Saygili 2018a, b). These notebooks can be accessed in the Data

References

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⟩

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Make **your** data count!

MAKE DATA COUNT

PRJ-2769 | **Food Access Impact Survey for Southeast and Harris County, Texas after Hurricane Harvey in 2017**

Download Dataset

PI	**Rosenheim, Nathanael**
Project Type	**Field Research**
Event	**Hurricane Harvey | Southeast Texas | 08-25-2017 — 08-31-2017 | Lat 30.049840 Long -94.077210**
Event Type	**Flood, Hurricane**
DOI(s) in Dataset	10.17603/ds2-aq2k-dy92
Related Work	
Keywords	**Field Research Planning, Food Access, Survey Instruments, Sample Frame**

View Data Diagram

Documents | **Food Retail Survey Instrument**

Author(s)	**Rosenheim, Nathanael; Peacock, Walter; Perez, Maria; Lane, Gina**
Date of Publication	**06-18-2020**
DOI Citation	**10.17603/ds2-aq2k-dy92**
License(s)	**Creative Commons Attribution Share Alike**

This collection archives instruments related to the food retail survey conducted by the Hazard Reduction Recovery Center, as part of a National Science Foundation-funded project. The instrument was designed to gather specific types of information on food retailers affected by Hurricane Harvey. The survey instrument was designed to collect information on: (1) Physical and infrastructure damage, (2) Accessibility problems, (3) Impact on employees and customers, (4) Business interruption, (5) Impact on fresh food availability, and (6) Business characteristics. The survey was designed to be answered by an employee with knowledge about store operations and food availability before and after Hurricane Harvey. The survey was designed to be conducted in-person. This archive documents two versions of the survey. The first version was for use in Jefferson and Orange County, Texas. The second version was for use in Harris County, Texas.

Citation

Rosenheim, N. Peacock, W. Perez, M. Lane, G. (2020) "Food Retail Survey Instrument", in *Food Access Impact Survey for Southeast and Harris County, Texas after Hurricane Harvey in 2017*. DesignSafe-CI. https://doi.org/10.17603/ds2-aq2k-dy92.

Download Citation

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Examples of Citation "Challenges"

DATA AND RESOURCES

The depth to seismic bedrock (V.3.2 ESRI shapefile "Subsurface Structure" layer 30; The Headquarters for Earthquake Research Promotion, 2021), as well as V_{S30} (ESRI shapefile "Site amplification factors," parameter "AVS"; Fujimoto and Midorikawa, 2006; Senna *et al.*, 2013, 2019; Wakamatsu and Matsuoka, 2013, 2020) maps for the kanto basin were downloaded from the J-SHIS web map service available at https://www.j-shis.bosai.go.jp/map/?lang=en (last accessed November 2021). The Bahrampouri *et al.* (2021) strong motion flat file was downloaded from https://www.designsafe-ci.org/data/browser/public/designsafe.storage.published/PRJ-2547 (last accessed November 2021). We used NumPy (Harris *et al.*, 2020) and SciPy (Virtanen *et al.*, 2020). Figures were made with Matplotlib (Hunter, 2007) and Inkscape (Inkscape Project, 2020). Tensorflow (Abadi *et al.*, 2016) was used for deep learning. We used QGis (QGIS Development Team, 2021) for data preparation. Ground-motion models (GMMs) of Zhao, Zhou, *et al.* (2016), Zhao, Liang, *et al.* (2016), and Zhao, Jiang, *et al.*

Google Scholar

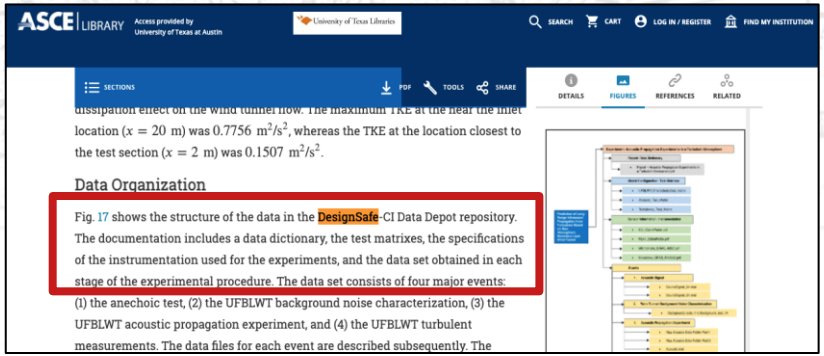
5. Bahrampouri M. Rodriguez-Marek A. Shahi S., and Dawood H. 2021. An updated database for ground motion parameters for KiK-net records, *Earthq. Spectra* **37**, no. 1, 505–522, doi: https://doi-org.ezproxy.lib.utexas.edu/10.1177/8755293020952447.

Google Scholar

6. Blitzstein J. K., and Hwang J. 2014. Introduction to Probability, First Ed., Chapman and Hall/CRC, New York, New York, 385–401, doi: https://doi-org.ezproxy.lib.utexas.edu/10.1201/b17221.

Google Scholar

7. Derras B. Bard P. Y., and Cotton F. 2014. Towards fully data driven ground-motion prediction models for Europe, *Bull. Earthq. Eng.* **12**, no. 1, 495–516, doi: https://doi-org.ezproxy.lib.utexas.edu/10.1007/s10518-013-9481-0.



DESIGNSAFE

Workspace | Learning Center | NHERI Facilities | NHERI Community | News | Help

USER GUIDES

DATA DEPOT

DesignSafe Marker Paper
Rathje et al. (2017) Natural Hazards Review,
https://doi.org/10.1061/(ASCE)NH.1527-6996.0000246

Managing Data

Data Depot User Guide

Data Transfer Guide

Data Management Plan Gu

Experimental Facility Chec

Maria Esteva
Data Curator

Curating & Publishing Projects

Curation & Publication Guide

Best Practices

Data Depot/Curation Office Hours

Curation & Publication FAQ

Policies

Citing DesignSafe

Virtual Office Hours

DesignSafe Slack

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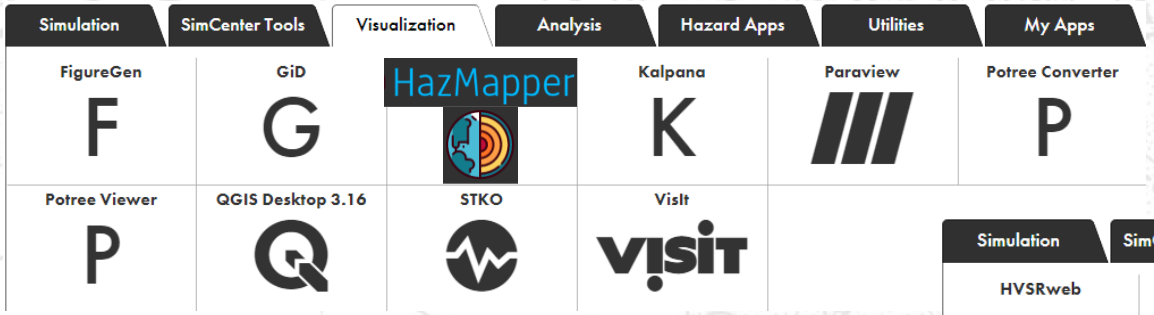
Tools & Apps: Simulation

- HPC-enabled simulation codes (Stampede2, Frontera)
- Available through portal, through TAPIS API, or the Command Line
- Easy access to HPC allocation (CPUs, GPUs) through DesignSafe

Tools & Apps: Data Analysis and Viz

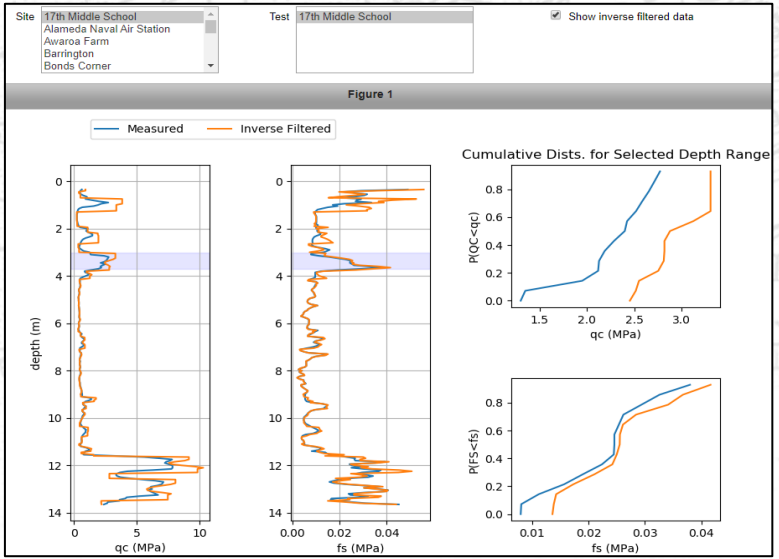


- Cloud-based tools for data analysis and visualization
- Access to files in Data Depot
- Jupyter as workflow engine

Jupyter Notebooks

- Electronic notebooks in Python or R
- JupyterHub 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)

Jupyter Use Cases in DesignSafe

DS Use Case Products

Search docs

- Use Cases Products
- Taggit - Image Tagging
- ML and AI
- NGL Database
- MPM Landslide
- Large-Scale Storm Surge
- Visualizing Surge for Regional Risks
- CFD Analysis of Winds on Structures
- Field Sensing Wind Events
- OpenSees Model Calibration
- Seismic Response of Concrete Walls
- Soil Structure Interaction
  - Background
  - Create OpenSees Model using STKO
  - Setup and submit OpenSees job via Jupyter notebook
  - Post-processing on DesignSafe
- Experimental Shake Table Testing

INTEGRATION OF OPENSEES-STKO-JUPYTER TO SIMULATE SEISMIC RESPONSE OF SOIL-STRUCTURE-INTERACTION

Yu-Wei Hwang and Ellen Rathje - University of Texas at Austin

Setup job description

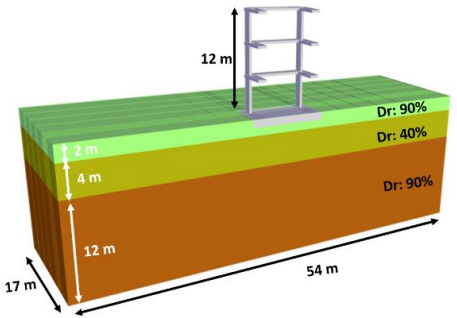
This script demonstrates how to use the agavepy SDK that uses the TAPIS API to setup the job description for the OpenSeesMP (V 3.0) App that is integrated with STKO. More details of using TAPIS API for enabling workflows in Jupyter notebook can be found in the DesignSafe webinar: Leveraging DesignSafe with TAPIS

```
from agavepy.agave import Agave
ag = Agave.restore()
import os

## Running OPENSEESMP (V 3.0)-STKO ver. 3.0.0.6709
app_name = 'OpenSeesMP'
app_id = 'opensees-mp-stko-3.0.0.6709u1'
storage_id = 'designsafe.storage.default'

### One can revise the following job info ####
control_batchQueue = 'normal'
control_jobname = 'SSI_NM_Northridge_0913'
control_nodenumber = '1'
control_processorsnumber = '36'
control_memorypernode = '1'
control_maxRunTime = '24:00:00'
```

Submit and Run job on DesignSafe

The script below submits the job to the HPC system.

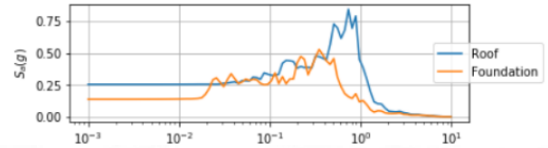
```
job = ag.jobs.submit(body=job_description)
print("Job launched")
```



Example Post-processing Results

This section shows the results from the post-processing scripts performed via the Jupyter notebook. The notebook is broken into segments with explanations of each section of code. Users should edit the code to fit their own needs.

Response spectra for motions at various locations within the model



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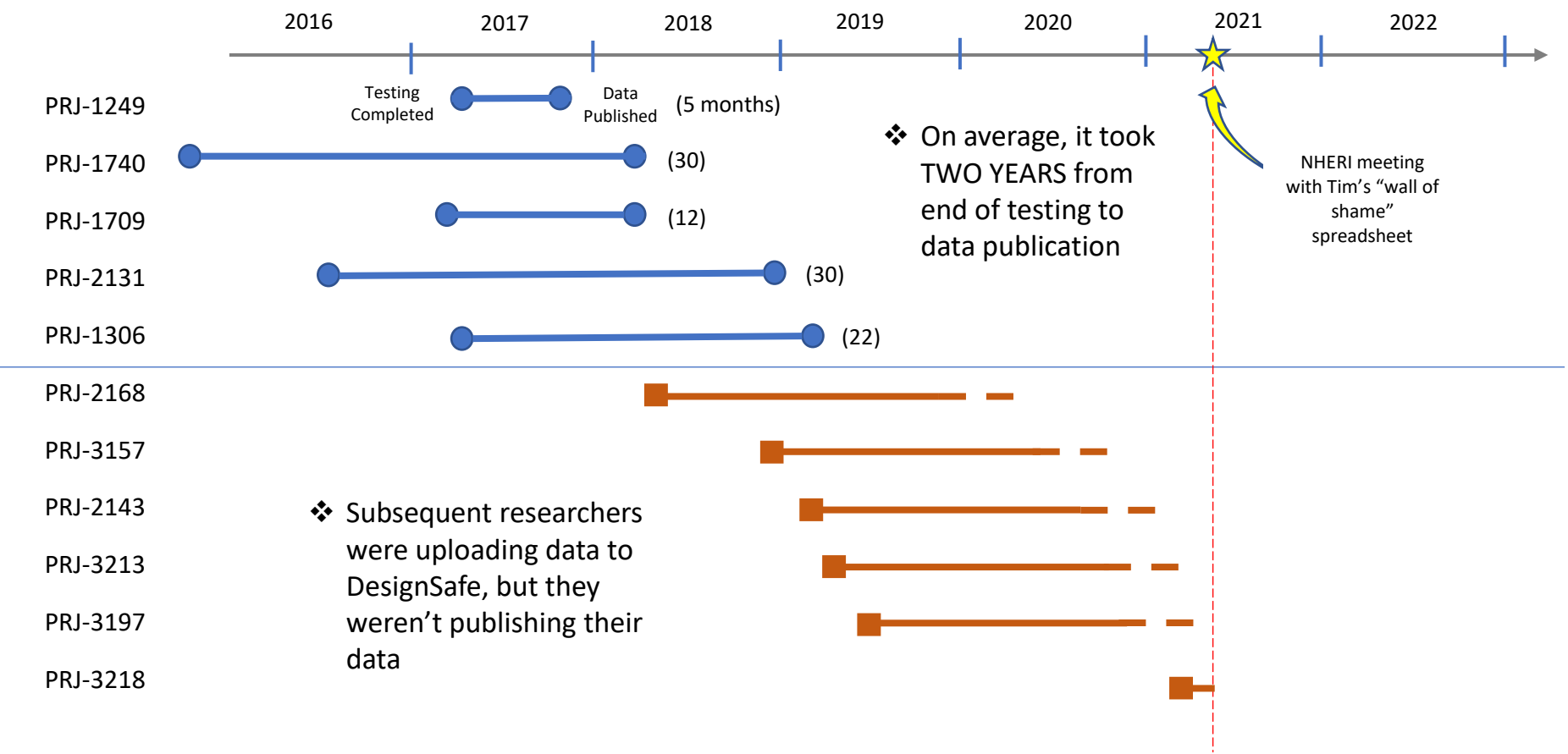
NHERI EF
Data Publishing Experience

Slides from Prof. Dan Cox
Oregon State University

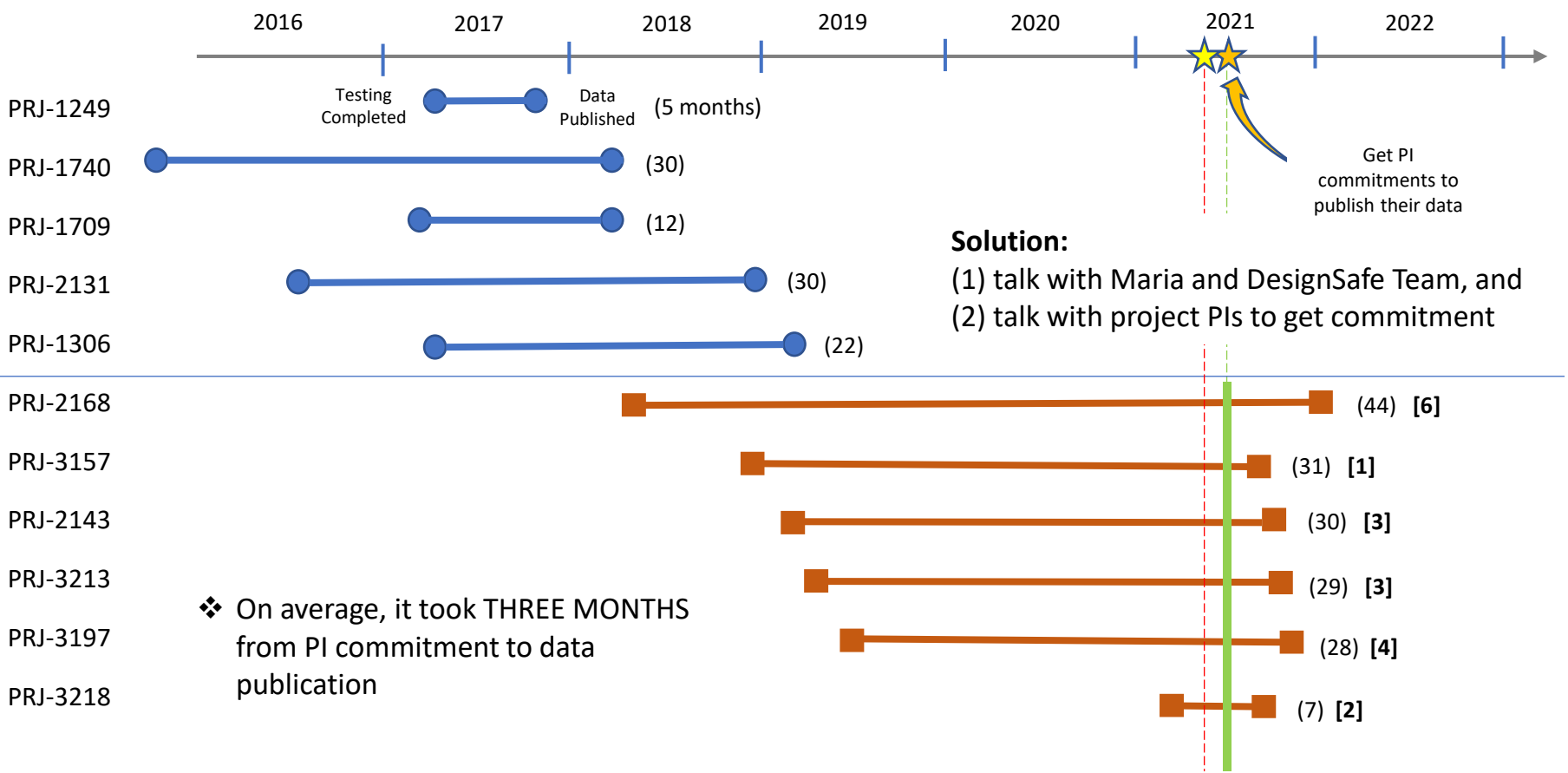
Time from End of Data Collection at EF to Final Data Publication (DOI)

(does not represent all NHERI EF activity)



Time from End of Data Collection at EF to Final Data Publication (DOI)

(does not represent all NHERI EF activity)



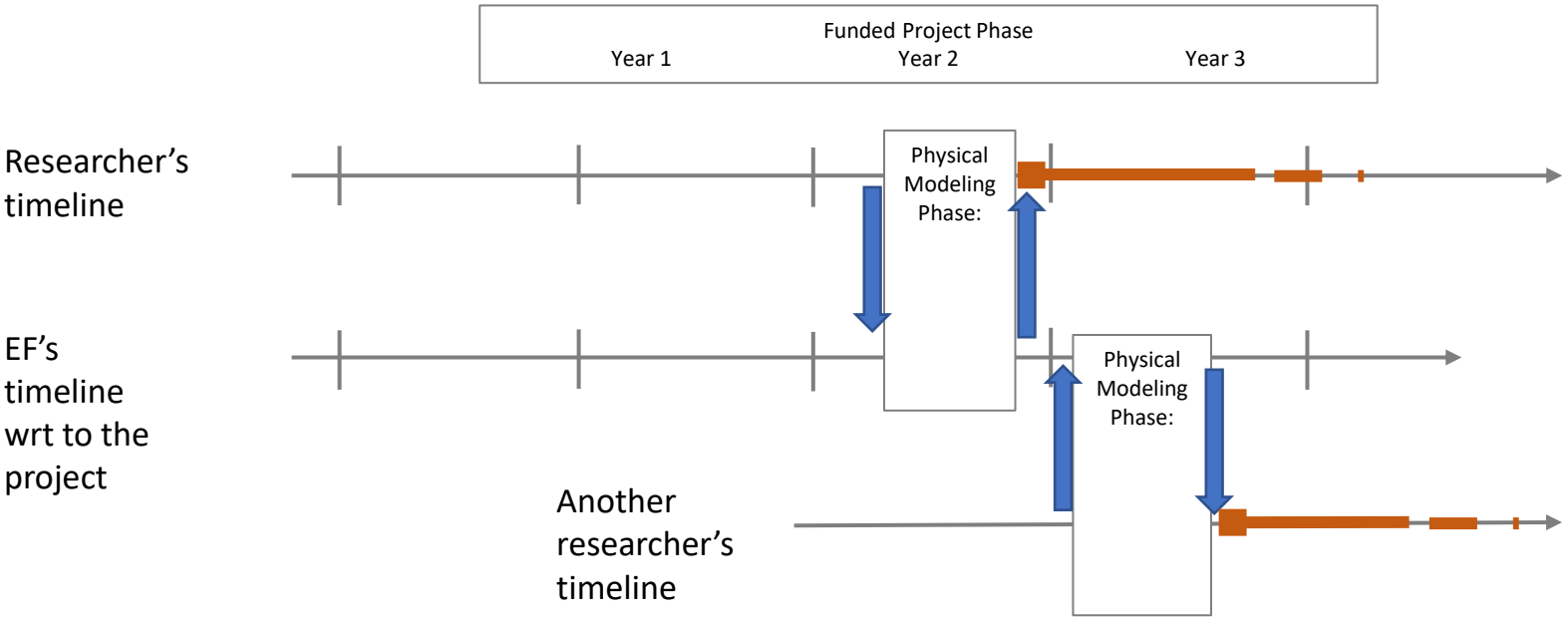
Solution:

(1) talk with Maria and DesignSafe Team, and

(2) talk with project PIs to get commitment

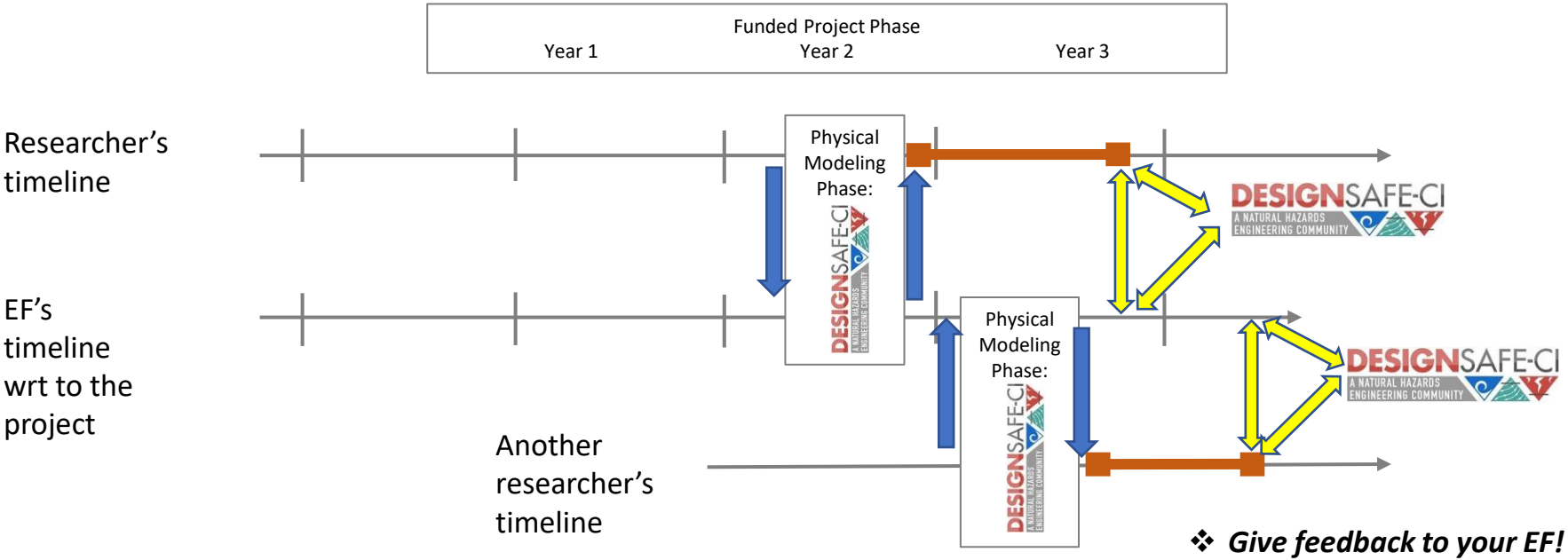
- On average, it took THREE MONTHS from PI commitment to data publication

Long term Solution, Part 1
Re-evaluate our EF workflow



Long term Solution, Part 1
Re-evaluate our EF workflow

- ❖ Get PI "commitment" for data publication
- ❖ Loop in DesignSafe team
- ❖ Check in with PI team
- ❖ Increase awareness of tools
  - Online tutorials
  - Check list
  - Publish Your Data Events



❖ ***Give feedback to your EF!***

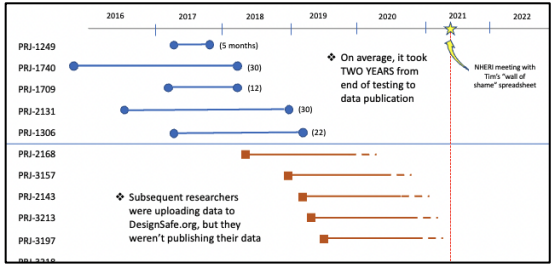
Key Points

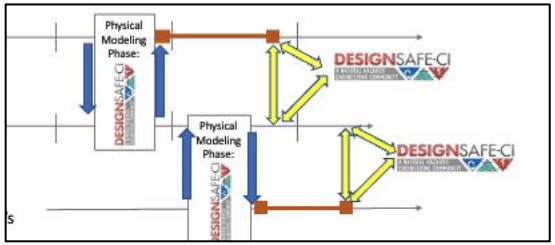
1. Data uploading isn't data publishing

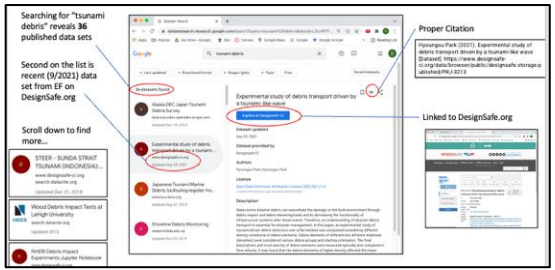
2. Data publishing requires
   - User commitment
   - EF collaboration/intervention
   - DesignSafe team consultation

3. Emphasis on "carrots"
   - Connecting data and papers
   - Google Dataset Search, Google Scholar

Next up: Data reuse!







Why should I publish in DesignSafe?

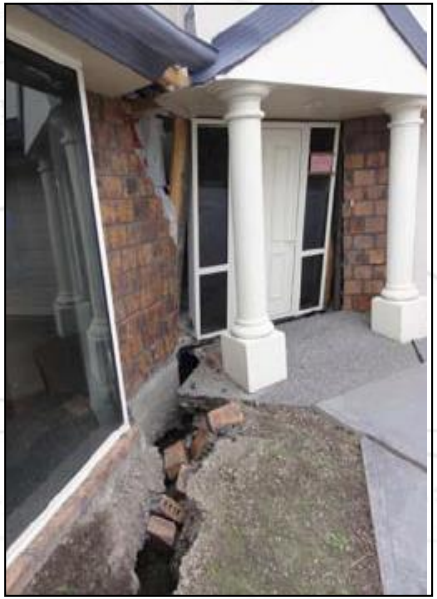
- It's required (duh…)
- Maintains continuity between graduate students
  - Facilitates next student who will utilize data, scripts, etc.
- Enhanced visibility and impact of my research
  - Others can utilize developed approaches, data, etc.
  - Particularly relevant for AI/ML models
  - Cite your data when you publish a paper utilizing your data
- DesignSafe Dataset Awards (nominations due 1/31/23)

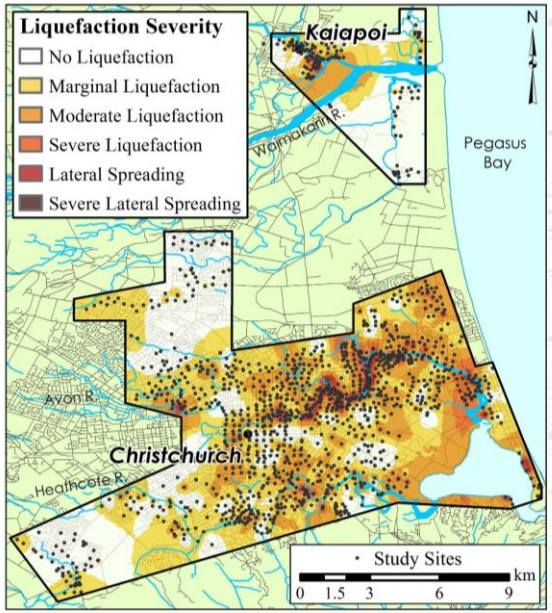
Geotechnical Research Examples

- Liquefaction-induced lateral spreading
  - Predict occurrence of lateral spreading and displacements
  - Machine learning models trained on field data from 2011 Christchurch EQ
- Seismic performance of earth slopes
  - Surrogate models for slope displacement based on finite element simulations
  - Traditional regression and AI models

Liquefaction: Christchurch, NZ (2011)

Severity

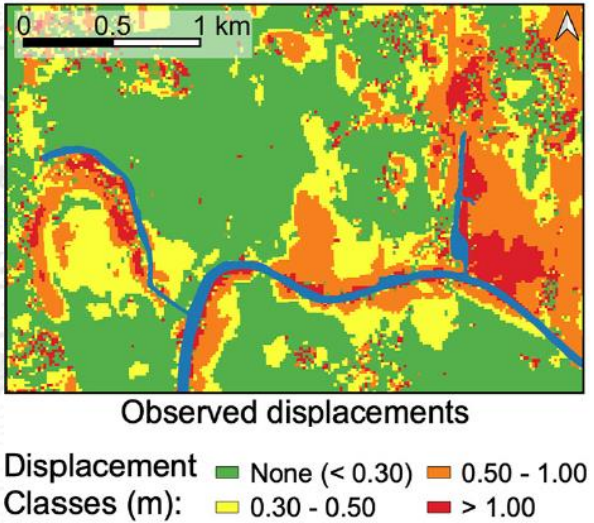




(b)

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

Displacement



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

Published Data Depot Dataset

PRJ-2998 | **Machine Learning Models for the Evaluation of the Lateral Spreading Hazard in the Avon River Area Following the 2011 Christchurch Earthquake**

Download Dataset

Author(s)	Durante, Maria Giovanna; Rathje, Ellen
Data Type	Jupyter Notebook
Natural Hazard Type	Earthquake
Date of Publication	03-12-2021
Awards	Improving our Understanding of Liquefaction-Induced Displacements using Data from the 2010/2011 New Zealand Earthquakes | CMMI-1462855 NHERI Cyberinfrastructure | CMMI-1520817
Related Work	New Zealand Geotechnical Database An exploration of the use of machine learning to predict lateral spreading
Keywords	Machine Learning; Random Forest; Liquefaction; Lateral Spreading; 2011 Christchurch Earthquake.
DOI Citation	10.17603/ds2-3zdj-4937
Version	2 Version Changes
License(s)	GNU General Public License

https://doi.org/10.17603/ds2-3zdj-4937

Name	Size	Last modified
Model Development	--	2/8/21 11:11 AM
Model Usage	--	2/15/21 5:09 AM
ReadMe.pdf	86.8 kB	3/12/21 1:23 PM
Regional Model Assessment	--	3/2/21 6:00 PM

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JUPYTER FAQ

In [1]:
```
#import packages
%matplotlib inline
import math
import numpy as np
import pandas as pd
import numpy as np
import pandas as pd
from pandas.plotting import scatter_matrix
import scipy.stats as stats
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn import model_selection
from sklearn import metrics
from sklearn.metrics import confusion_matrix
from sklearn.utils.multiclass import unique_labels
from sklearn.model_selection import cross_val_score,
from sklearn.preprocessing import MinMaxScaler
from sklearn.metrics import cohen_kappa_score, roc_cu
from statistics import mean

from matplotlib import pyplot
import pickle
```

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In [12]:
```
#define function to find best parameter combination based on Cohen's kappa co
def rfr_model(X, y):
# Perform Grid-Search
    kappa_scorer = make_scorer(cohen_kappa_score)
    gsc = GridSearchCV(
        estimator=RandomForestClassifier(),
        param_grid={
            'max_depth': range(2,10),
            'n_estimators': (5,10, 50, 100, 1000),
            'max_features': ('auto','sqrt','log2'),
            'criterion': ('gini','entropy'),
        },
        cv=10, verbose=0, n_jobs=-1,scoring=kappa_scorer)

    grid_result = gsc.fit(X, y)
    best_params = grid_result.best_params_

    rfr = RandomForestClassifier(max_depth=best_params["max_depth"],
                                 n_estimators=best_params["n_estimators"],
                                 max_features=best_params["max_features"], cr
    # Perform K-Fold CV
    scores = cross_val_score(rfr, X, y, cv=10)
    predictions = cross_val_predict(rfr, X, y, cv=10)
    optimised_random_forest = gsc.best_estimator_
```

Scikit-learn, Keras, Tensorflow, PyTorch

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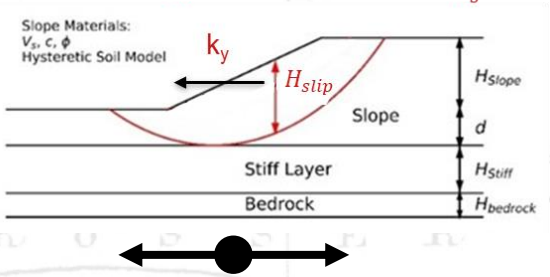
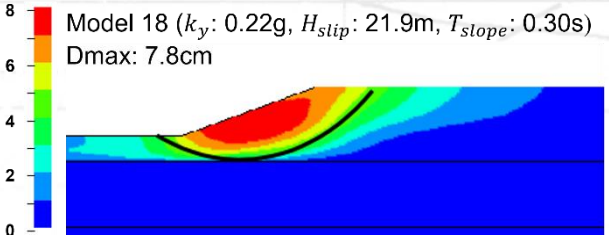
TEXAS The University of Texas at Austin UCLA TACC RICE Florida Tech

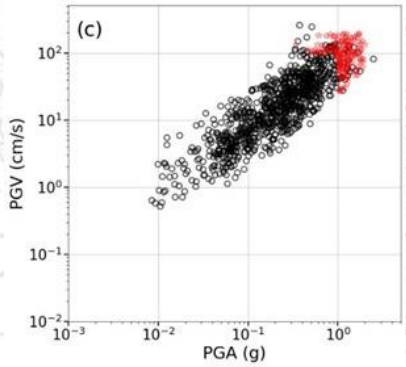
Seismic Displacement of Earth Slopes

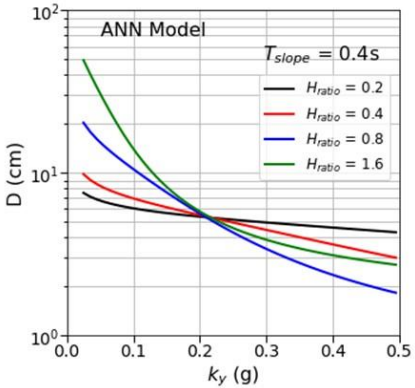
Surrogate models from 50 slopes x 1,000 earthquake motions

$$T_{slip} = \frac{4 \cdot H_{slip}}{V_s} \qquad T_{slope} = \frac{4 \cdot H_{slope}}{V_s}$$









Surrogate models

- Predict Disp = fxn (k_y, T_s, ground shaking)

Cho and Rathje (2022) https://doi.org/10.1016/j.soildyn.2021.107024

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Published Data Depot Dataset

PRJ-3028 | **Simulations of Earthquake-Induced Permanent Displacements of Generic Earth Slopes using LS-Dyna**

Download Dataset

PI	**Rathje, Ellen**
Project Type	**Simulation**
Natural Hazard Type	**Earthquake**
DOI(s) in Project	10.17603/ds2-jysn-dt71
Keywords	**Seismic Slope Displacement, Predictive Model, LS-Dyna, Earthquake**

https://doi.org/10.17603/ds2-jysn-dt71

View Data Diagram | View Data Metrics | Leave Feedback

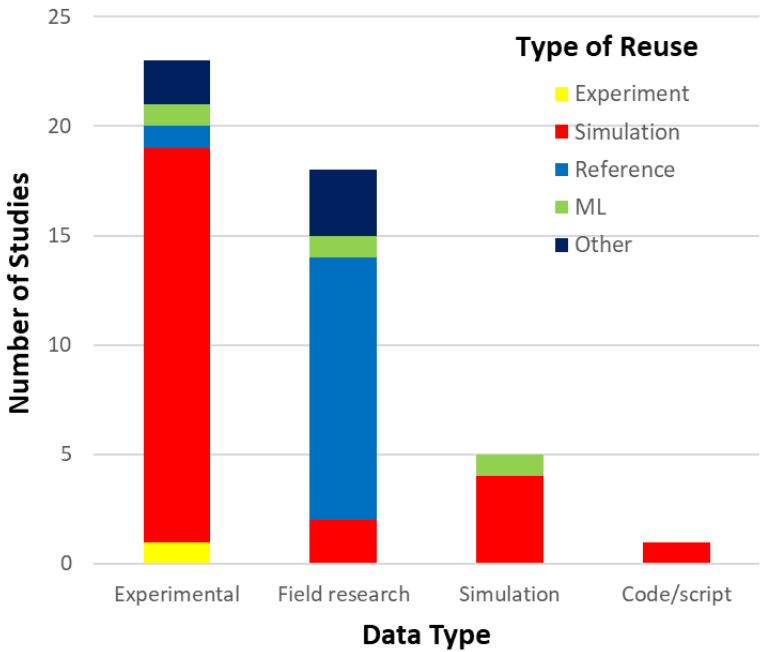
Description | This DesignSafe published dataset is associated with research aimed at developing simulation-based predictive models of earthquake-induced slope displacements through classical regression and artificial neural network (ANN) approaches. Towards this end, finite element modeling was used to build a displacement database associated with different slope geometries, soil properties, and ground motion characteristics. A total of 49 slope geometries were analyzed, with each subjected to 1,051 earthquake motions. The maximum resultant displacements on the slope surface are collecte…

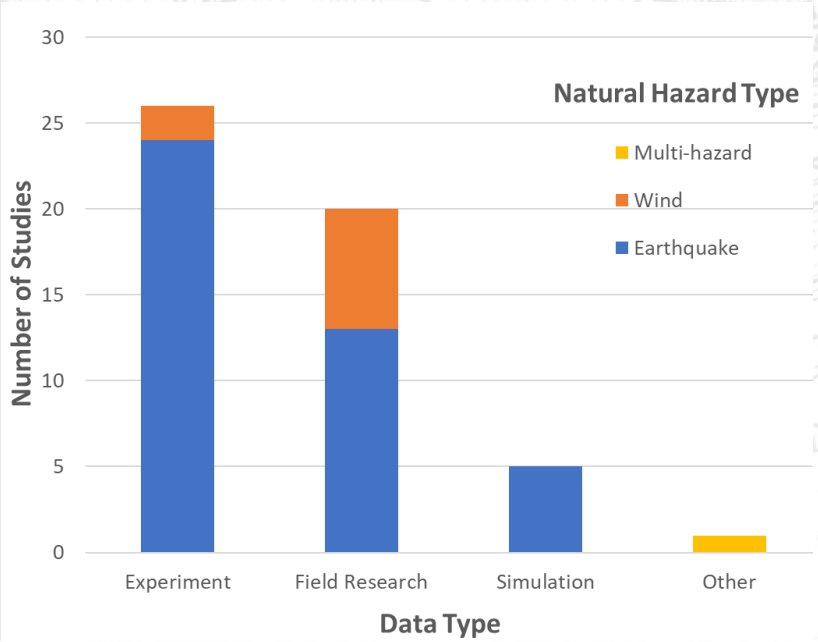
- Simulation | **Slope Models in Finite Element Mesh Subjected to Numerous Earthquake Records**
  - Report | **Description on dataset and method of simulations**
  - Simulation Model | **LS-Dyna Simulations for Seismic Slope Displacements**
    - Simulation Input | **Slope Models and Earthquake Records**
      - Simulation Output | **Compiled Output from Simulations**
  - Analysis | **Predictive Models of Seismic Slope Displacement**

Data Citation Analysis (M. Esteva)

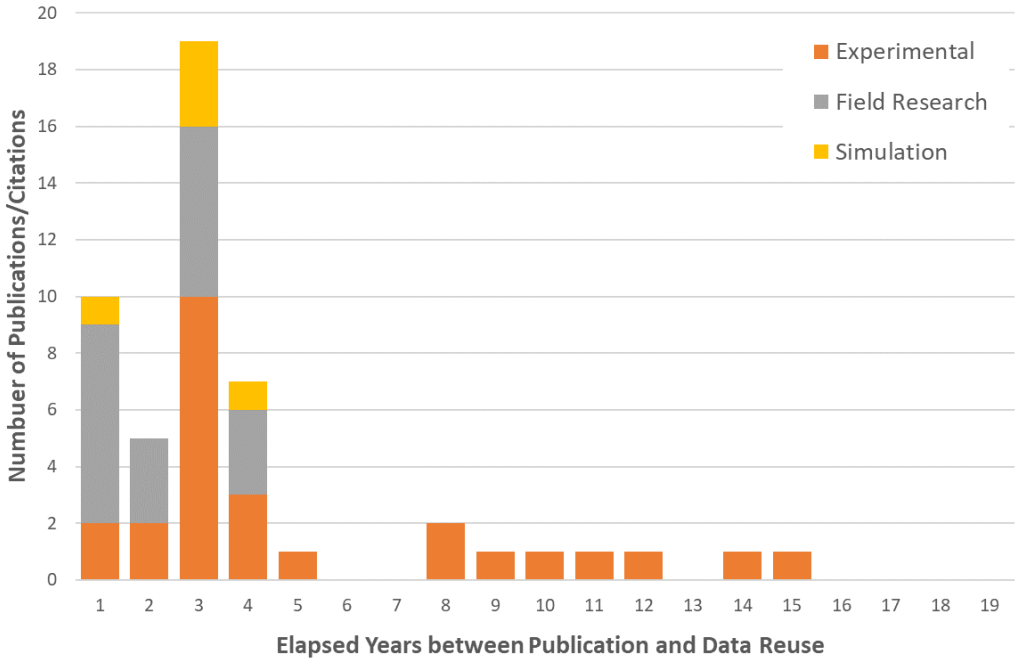
- Gold standard: reuse by others (not the original authors)
  - 15 month time frame (Jan 2021-March 2022)
  - 46 papers that reused one or more datasets
- In-depth analysis
  - How, when, for what natural hazard data is reused
- Understand NH community data reuse trends and needs
  - Inform new developments, track through time

Reuse: Type of Reuse and NH Type





Data cited in 2021 was published when?



- Long tail of reuse from NEES experimental data (8-15 yrs)
  - Long-lasting value of experimental data
- Reuse is accelerating
  - More reuse of recent data (due to more data available…change in culture…)
  - Still takes 2-3 yrs for reuse
- Significant reuse of field research data

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slack

Please share your feedback, ideas, experiences!

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