

Workshop on the Next-Generation Liquefaction Database

September 24, 2018, University of California, Los Angeles

UCLA **Samueli**
School of Engineering

The NGL Database: graphical interface and population status

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September 24, 2018



Engineer Change.

Outline

Introduction

The NGL database graphical interface

Current status of the database

Final remarks and path forward

NGL Database Contributors

- **PIs:** Jonathan Stewart, Steven Kramer, Yosef Bozorgnia
- **Database working group:** Scott Brandenberg (chair), Robb E.S. Moss (Cal Poly), K. Onder Cetin (METU), Kevin Franke (BYU), Paolo Zimmaro (UCLA), and Dong Youp Kwak (Hanyang University)
- **Southwest Research Institute:** John Stamatakos, Miriam Juckett, Bis Dasgupta, Joey Mukherjee, Zackary Murphy, Steven Ybarra
- **Nuclear Regulatory Commission:** Thomas Weaver
- **Caltrans:** Tom Shantz



U.S.NRC



NGL Database Contributors

- ***U. of Utah***: Steve Bartlett, Masoud Hosseinali
- ***Virginia Tech***: Russell Green, Kristin Ulmer
- ***UC Berkeley***: Jonathan Bray, Christine Beyzaei
- ***Tonkin & Taylor***: Sjoerd Van Ballegooey, Mike Liu
- ***BYU***: Heidi Dacayanan, Lila Lasson
- ***METU***: Gizem Can, Makbule Ilgac
- ***UCLA***: Omar Issa, Chris Nicas, Trini Inouye, Arielle Sanghvi, Tristan Buckreis, Naoto Inagaki, Wyatt Iwanaga, Michael Winders, Bryan Ong, Siddhant Jain, Allison Lee, Honor Fisher
- ***Others***: Mike Greenfield, Teruo Nakai, Hideo Sekiguchi, ...



Traditional vs Next-Generation Databases

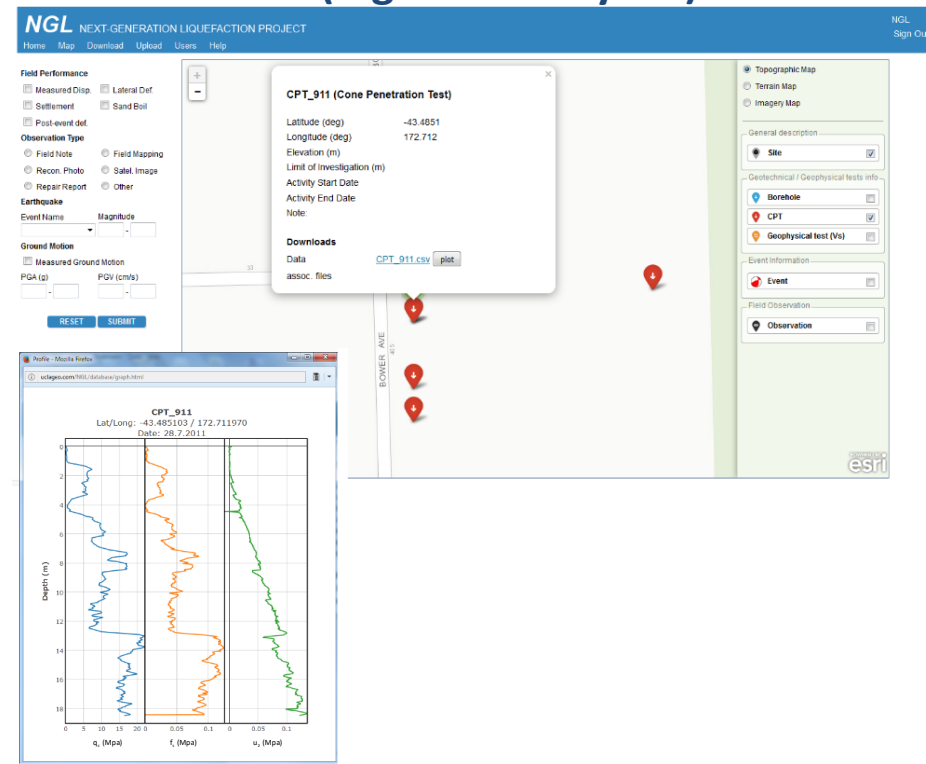
From *spreadsheet*
(Traditional data analysis)



To **relational database**
(big-data analytics)

	A	B	C	D	E	F
	Record Sequence Number	EQID	Earthquake Name	YEAR	MODY	HRMN
1	1	0001	Helena, Montana-01	1935	1031	1838
2	2	0002	Helena, Montana-02	1935	1031	1918
3	3	0003	Humbolt Bay	1937	0207	0442
4	4	0004	Imperial Valley-01	1938	0606	0242
5	5	0005	Northwest Calif-01	1938	0912	0610
6	6	0006	Imperial Valley-02	1940	0519	0437
7	7	0007	Northwest Calif-02	1941	0209	0945
8	8	0008	Northern Calif-01	1941	1003	1614
9	9	0009	Borrego	1942	1021	1622
10	10	0010	Imperial Valley-03	1951	0124	0717
11	11	0011	Northwest Calif-03	1951	1008	0411
12	12	0012	Kern County	1952	0721	1153
13	13	0012	Kern County	1952	0721	1153
14	14	0012	Kern County	1952	0721	1153
15	15	0012	Kern County	1952	0721	1153
16	16	0012	Kern County	1952	0721	1153

	HZ	IA
1	T7.500S	T8.000S
8151	0.000247	0.000231
8152	0.003331	0.003473
8153	0.000661	0.000639
8154	0.000486	0.000700
8155	0.001060	0.001011
8156	0.001217	0.001057
8157	0.000836	0.000772
8158	0.008571	0.007123
8159	0.011123	0.009935
8160	0.002338	0.001956
8161	0.134076	0.112643
8162	0.298595	0.233477
8163	0.002516	0.002555
8164	0.004065	0.005418
8165	0.004065	0.005418



NGL Database GUI development

Next-Generation Liquefaction Database

Number of Sites



NGL NEXT-GENERATION LIQUEFACTION PROJECT

Home Map Download Upload Users Help

Field Performance

- Measured Disp.
- Lateral Def.
- Settlement
- Sand Boil
- Post-event def.

Observation Type

- Field Note
- Field Mapping
- Recon. Photo
- Satel. Image
- Repair Report
- Other

Earthquake

Type event name

Magnitude

min max

Event Name Magnitude

M6.9 Kobe, Japan

M6.5 Imperial Valley-06

M7.2 El Mayor-Cucapah

M7.7 Nihonkai-Chubu - near the west co

M6.2 Hokkaido

M8.3 Tokachi

M8.9 Oshiro - Hokkaido

Reset Submit

Statistics

Measured Ground Motion

PGA (g) PGV (cm/s)

RESET SUBMIT

Data Statistics	NGL liquef. project
Sites	68
Penetration/Geophysical tests	
Borehole (Boring, SPT)	70
CPT	419
Test pit	0
Geophysical test (Vs)	84
Lab tests	
Sieve	52
Atterberg limit	52
Consolidation	0
Triaxial (monotonic)	0
Triaxial (cyclic)	0
Others	0



General description

- Event
- Site
- Boreholes
- CPT
- Test Pits
- Non-Invasive Geophysical
- Invasive Geophysical
- Water Table
- Stratigraphic Units
- Detailed Soil Description
- Samples
- Other

Field Performance

- Observation (Note)
- Observation (File)

SwRI PEER Caltrans U.S.NRC MPC LTDOT

Ver. Beta_1
(csv + SQL)



Ver. Beta_2
(full SQL)

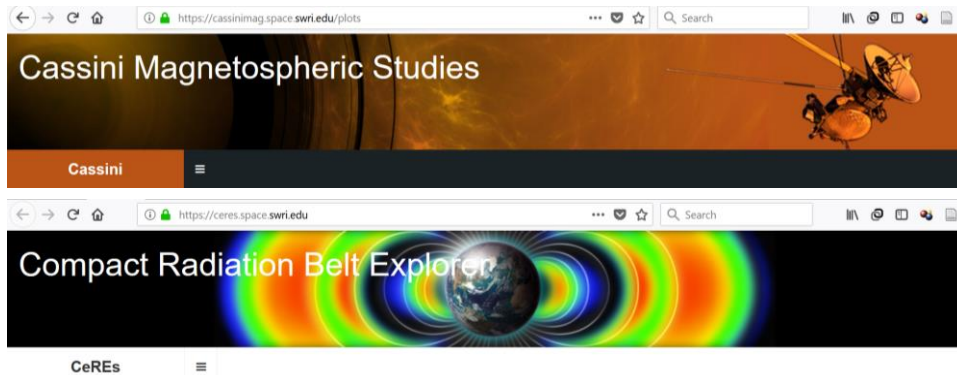


Official release (ver. 2.04)
(full SQL + Review)

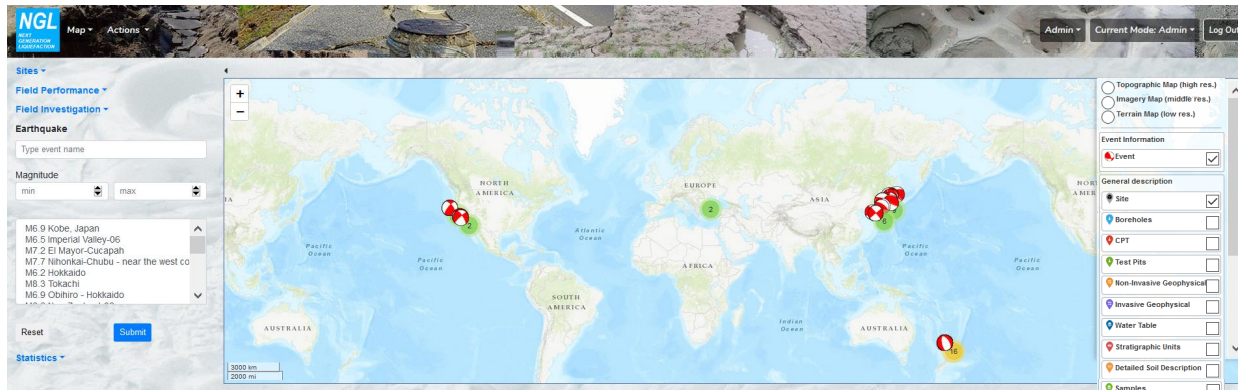
NGL Database GUI development



UCLA-SwRI Collaboration



www.nextgenerationliquefaction.org



U.S. NRC



NGL Database GUI Earthquake Events

Liquefaction analysis (at least):

- Magnitude of the earthquake event
- Estimation of intensity measures at the site
- Ground motion characterization
- Analysis of liquefaction sites with ground motion recordings

Four Tables in the database:

Event information

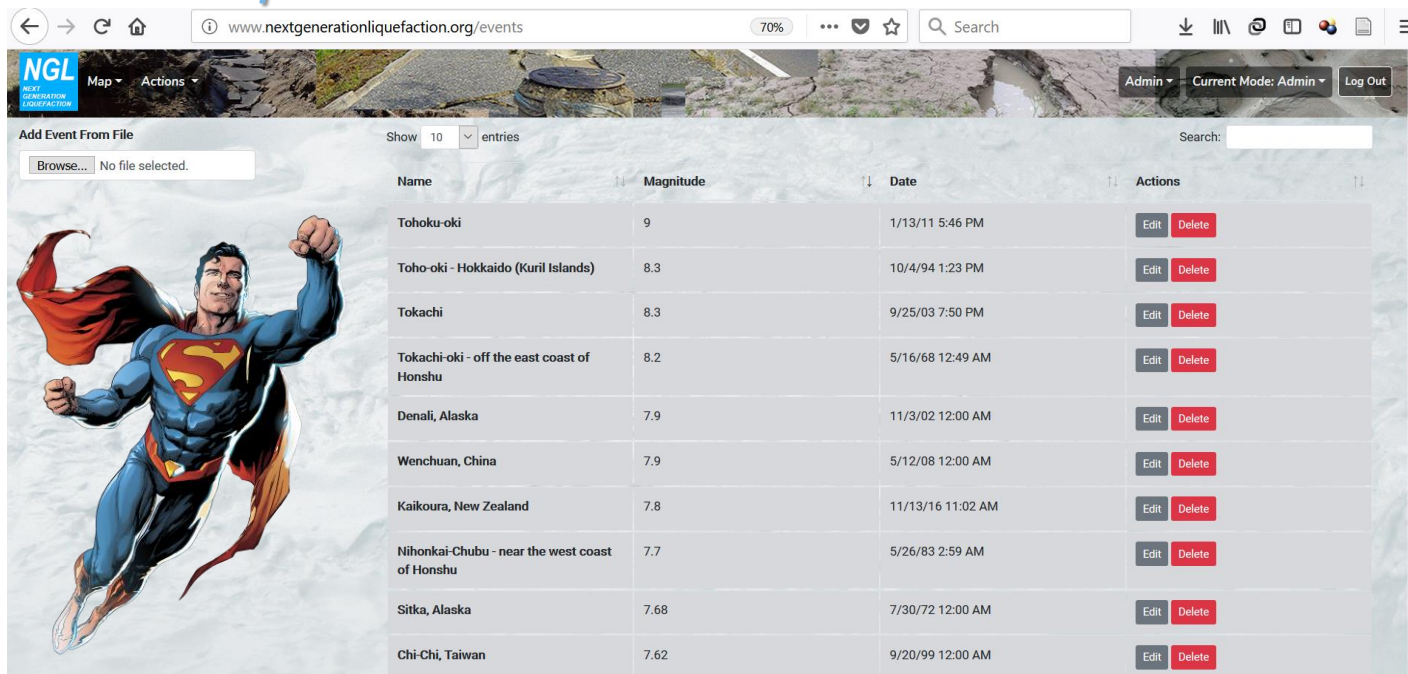
Recording stations

Finite fault models

Ground motion intensity measures

NGL Database GUI Earthquake Events

NGL Event Super-users!



www.nextgenerationliquefaction.org/events

70% Search

Admin Current Mode: Admin Log Out

Add Event From File

Show 10 entries

Browse... No file selected.

Name	Magnitude	Date	Actions
Tohoku-oki	9	1/13/11 5:46 PM	Edit Delete
Toho-oki - Hokkaido (Kuril Islands)	8.3	10/4/94 1:23 PM	Edit Delete
Tokachi	8.3	9/25/03 7:50 PM	Edit Delete
Tokachi-oki - off the east coast of Honshu	8.2	5/16/68 12:49 AM	Edit Delete
Denali, Alaska	7.9	11/3/02 12:00 AM	Edit Delete
Wenchuan, China	7.9	5/12/08 12:00 AM	Edit Delete
Kaikoura, New Zealand	7.8	11/13/16 11:02 AM	Edit Delete
Nihonkai-Chubu - near the west coast of Honshu	7.7	5/26/83 2:59 AM	Edit Delete
Sitka, Alaska	7.68	7/30/72 12:00 AM	Edit Delete
Chi-Chi, Taiwan	7.62	9/20/99 12:00 AM	Edit Delete



PEER Ground Motion Database
Pacific Earthquake Engineering Research Center

NGA West 2 Database
NGA Subduction (soon...)

NGL Database GUI Earthquake Events

NGL Event Super-users!

Additional information (and/or missing events) from:

Open literature

Article Citation:

Brendon A. Bradley (2015) Systematic Ground Motion Observations in the Canterbury Earthquakes And Region-Specific Non-Ergodic Empirical Ground Motion Modeling. Earthquake Spectra: August 2015, Vol. 31, No. 3, pp. 1735-1761.

<https://doi.org/10.1193/053013EQS137M>

Manuscripts

Systematic Ground Motion Observations in the Canterbury Earthquakes And Region-Specific Non-Ergodic Empirical Ground Motion Modeling

Brendon A. Bradley, M.EERI[®]

Local networks

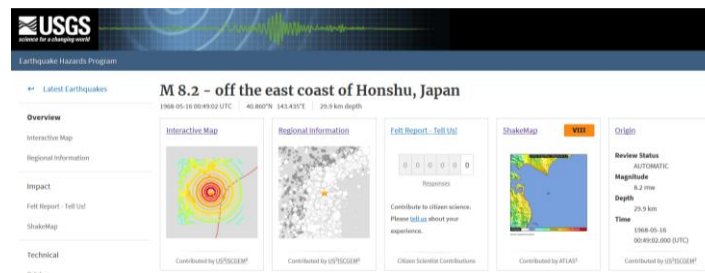


Global CMT catalogue



[Global CMT Web Page](#)

USGS website



NGL Database GUI (Map view)

www.nextgenerationliquefaction.org

NGL NEXT GENERATION LIQUEFACTION

Map Actions Admin Current Mode: Admin Log Out

Sites

Field Performance

Field Investigation

Earthquake

Type event name

Magnitude

min max

M6.9 Kobe, Japan
M6.5 Imperial Valley-06
M7.2 El Mayor-Cucapah
M7.7 Nihonkai-Chubu - near the west co
M6.2 Hokkaido
M8.3 Tokachi
M6.9 Obihiro - Hokkaido

Reset Submit

Statistics

Event

General description

Site

Boreholes

CPT

Test Pits

Non-Invasive Geophysical

Invasive Geophysical

Water Table

Stratigraphic Units

Detailed Soil Description

Samples

Other

3000 km
2000 mi



U.S. NRC



Site – Geotechnical characterization

NGL Database GUI (Map view)

www.nextgenerationliquefaction.org

The screenshot displays the NGL Database GUI in map view. The main area shows a world map with several earthquake events marked by red and white circular icons with numbers. The interface includes a search bar for earthquake events, a list of results, and a sidebar with filters for event information and general descriptions.

Earthquake Search Results:

- Type event name: [Input field]
- Magnitude: min [dropdown] max [dropdown]
- Submit
- Reset

Event Information:

- Event

General description:

- Site
- Boreholes
- CPT
- Test Pits
- Non-Invasive Geophysical
- Invasive Geophysical
- Water Table
- Stratigraphic Units
- Detailed Soil Description
- Samples
- Other

Field Performance:

- Observation (Note)
- Observation (File)

Logos: SwRI, PEER, Caltrans, U.S.NRC, MPC, LTDOT

Earthquake events (that produced observations)

NGL Database GUI (Map view)

www.nextgenerationliquefaction.org



NGL Database GUI (List view and functionalities)

www.nextgenerationliquefaction.org

The screenshot shows a web browser at the URL www.nextgenerationliquefaction.org/sites. The page features a navigation bar with a logo, a search bar, and user controls. Below the navigation bar, there are two main sections: 'Add Site From File' and 'Search and select a site'. The 'Add Site From File' section includes a 'Browse...' button and a message 'No file selected.'. The 'Search and select a site' section has a search input field. Below these sections is a table listing various sites, each with a set of management actions.

Site Name	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Amagasaki	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Bonds Corner	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Hachirogata	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Higashi-Kobe Bridge	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Hanshin Expressway	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
HKD086	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Brady Farm4	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Edgumbe Pipe Breakages	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Gordon Farm1	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Gordon Farm2	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
James Street Loop	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments

NGL Database GUI (How to upload a case history?) - manually

www.nextgenerationliquefaction.org

The screenshot shows the NGL Database GUI interface. At the top, there is a navigation bar with 'Introduction', 'NGL Database GUI', 'NGL Database Current status', and 'Final remarks'. Below this is a large title 'NGL Database GUI (How to upload a case history?) - manually' and the URL 'www.nextgenerationliquefaction.org'. The browser address bar shows 'www.nextgenerationliquefaction.org/sites'. The main content area is divided into two sections: 'Add Site From File' and 'Add Site Manually'. The 'Add Site From File' section has a 'Browse...' button and the text 'No file selected.'. The 'Add Site Manually' section has a search bar 'Search and select a site' with the placeholder 'Type a site name to search'. Below the search bar is a list of sites, each with a set of action buttons: 'Edit', 'Delete', 'Add Member', 'Field Tests', 'Field Observations', 'Submit for review', 'Add Comment', and 'View Member Comments'. The sites listed are: Amagasaki, Bonds Corner, Hachirogata, Higashi-Kobe Bridge, Hanshin Expressway, HKD086, Brady Farm4, Edgcumbe Pipe Breakages, Gordon Farm1, Gordon Farm2, and James Street Loop. The 'Delete' button for each site is highlighted in red. The background of the page is a grayscale image of a cracked concrete surface.

NGL Database GUI (How to upload a case history?) csv template

www.nextgenerationliquefaction.org

The screenshot shows the NGL Database GUI interface. At the top, there is a navigation bar with 'Introduction', 'NGL Database GUI', 'NGL Database Current status', and 'Final remarks'. The main heading is 'NGL Database GUI (How to upload a case history?) csv template' with the URL 'www.nextgenerationliquefaction.org'. Below the heading is a browser window showing the website's address bar and search bar. The website header includes the NGL logo, 'Map' and 'Actions' dropdowns, and user controls for 'Admin', 'Current Mode: Admin', and 'Log Out'. The main content area is divided into two sections: 'Add Site From File' with a 'Browse...' button and 'Add Site Manually' button, and 'Search and select a site' with a search input field. Below the search field is a table listing sites with their respective management actions.

Site Name	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Amagasaki	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Bonds Corner	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Hachirogata	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Higashi-Kobe Bridge	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Hanshin Expressway	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
HKD086	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Brady Farm4	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Edgecumbe Pipe Breakages	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Gordon Farm1	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Gordon Farm2	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
James Street Loop	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments

NGL Database GUI (How to upload a case history?) csv template

www.nextgenerationliquefaction.org

The screenshot shows the NGL Database GUI interface. At the top, there is a navigation bar with links for 'Introduction', 'NGL Database GUI', 'NGL Database Current status', and 'Final remarks'. The main heading is 'NGL Database GUI (How to upload a case history?) csv template' with the URL 'www.nextgenerationliquefaction.org'. Below the heading is a browser window showing the website's address bar and a search bar. The website header includes a logo, 'Map' and 'Actions' dropdowns, and user controls for 'Admin', 'Current Mode: Admin', and 'Log Out'. A green notification bar indicates 'Data saved.'. The main content area is divided into two sections: 'Add Site From File' with a 'Browse...' button and 'Search and select a site' with a search input field. Below these is a table of sites with management options.

Site Name	Edit	Delete	Add Member	Field Tests	Field Observations	Submit for review	Add Comment	View Member Comments
Amagasaki								
Bonds Corner								
Hachirogata								
Higashi-Kobe Bridge								
Hanshin Expressway								
HKD086								
Brady Farm4								
Edgumbe Pipe Breakages								
Gordon Farm1								
Gordon Farm2								

NGL Database GUI User Experience

Just something
that works(?)



Wrong
design

Something
better



redundant

A well-
designed
product



NGL Database GUI User Experience Design

Extensive Beta-testing from various user types

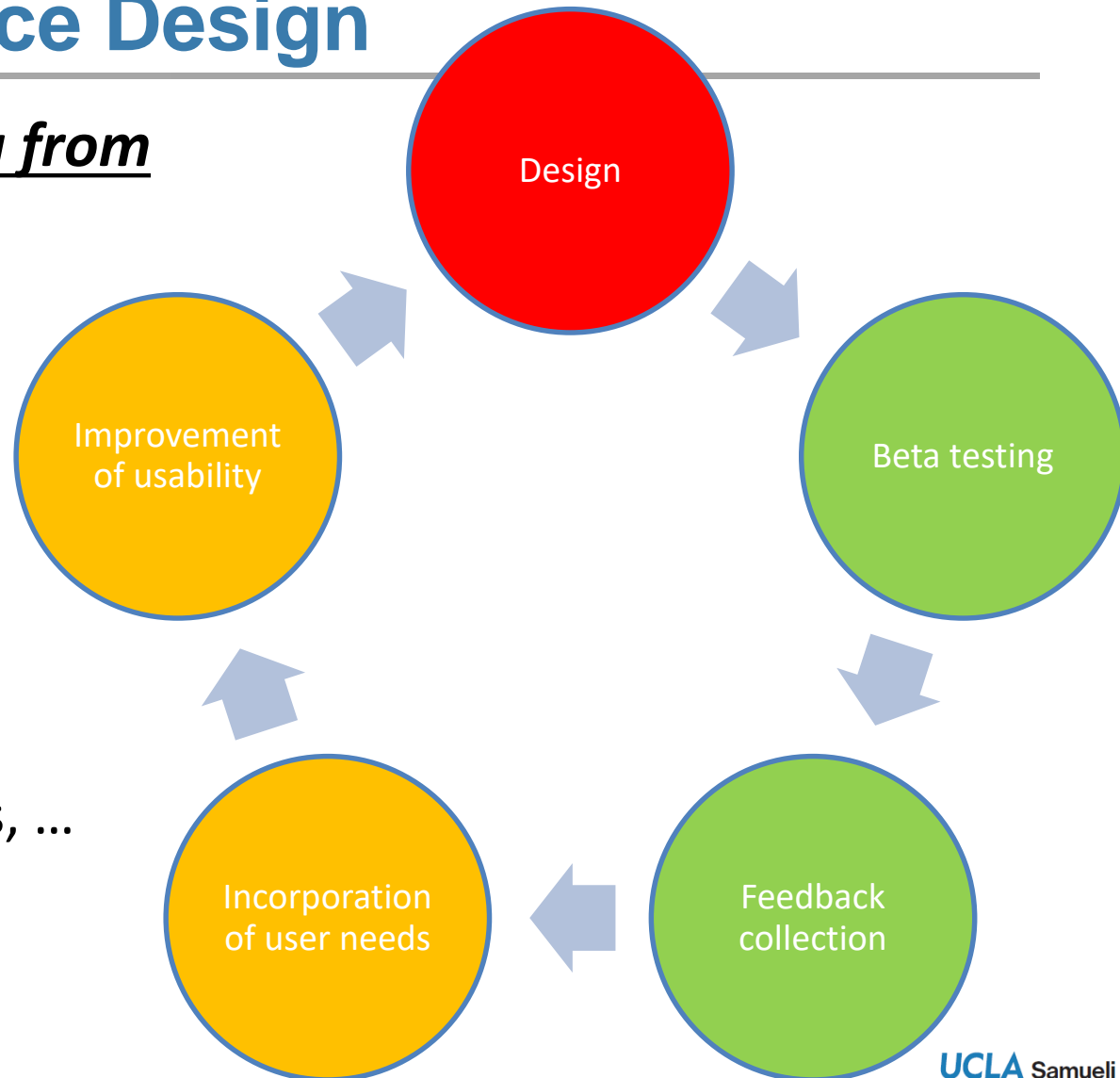
Senior researchers

Practitioners

Junior researchers

Graduate Students

Undergraduate students, ...



Database Current Status

- Legacy case-histories (used in the past for model development) are in the process of being added (~300 case histories)
- Case histories with co-located recording stations
- Recent case histories
 - Christchurch 2010-2011 sequence (New Zealand)
 - Tohoku 2011 **M**9.0 earthquake (Japan)
 - Emilia 2012 **M**5.9 (Italy)
- Total case histories available (and work in progress): ~530
- Stable database GUI officially released on 09/24/2018: **TODAY!**

Database Current Status

Legacy case-histories (used in the past for model development) include:

- 1964 Niigata (Japan)
- 1979 Imperial Valley
- 1987 Superstition Hills
- 1989 Loma Prieta
- 1995 Kobe (Japan)
- 1999 Chi Chi (Taiwan)
- 1999 Kocaeli (Turkey)
- U. Utah + BYU lateral spread sites
- Etc...

Total ~300 case histories (work in progress...)

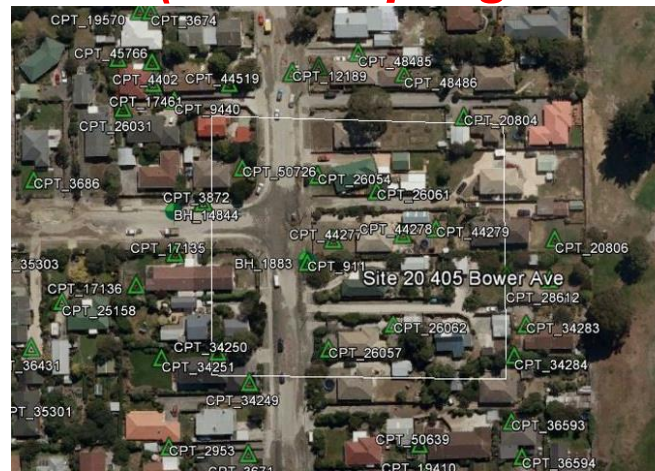
Database Current Status

- Christchurch (New Zealand) 2010-2011 sequence:

Green et al. (2014) case histories (VTech Green and Ulmer)
25 sites, 50 case histories (Complete - under review)

Tonkin + Taylor case histories (Van Ballegooy and Liu)
37 sites, 135 case histories (Complete – will be under review soon)

UC Berkeley sites (Bray and Beyzaei)
10+ sites/case histories (work in progress...)



Database Current Status

- Tohoku (Japan) 2011 **M**9.0 event – Unpublished

Tohoku + Mihama - UCLA

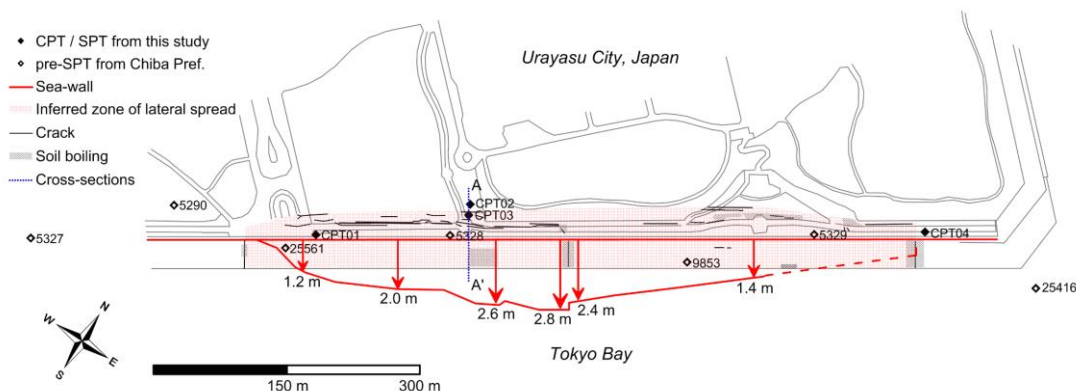
2 sites/case histories (Complete – will be under review soon)

Instrumented levee arrays - UCLA

3 sites/case histories (Complete – will be under review soon)

Additional lateral spread sites – UCLA-BYU

3 sites/case histories (work in progress)



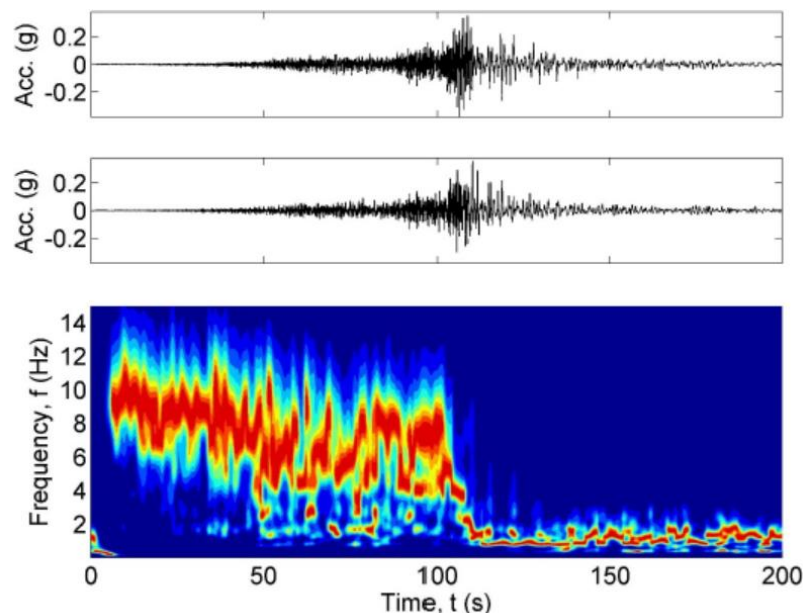
Database Current Status

- Case histories with co-located recording stations (Kramer and Greenfield (U. Washington))

16 sites, 22 case histories (Complete - under review)



Ibaraki, Japan (2011 – Tohoku):
from Kramer et al. (2016) and
M. Greenfield pers. comm.



- Emilia (Italy) 2012 **M5.8** earthquake – UCLA

4 sites/4 case histories (Complete - will be under review soon)

Review/Vetting Process

Database working group. After review, data is marked as reviewed.

Purpose: to verify that required fields are present and the inputs match source materials.

The screenshot displays the NGL Database GUI interface. At the top, there is a navigation bar with links for 'Introduction', 'NGL Database GUI', 'NGL Database Current status', and 'Final remarks'. The main header area features a large title 'Review/Vetting Process' and a sub-header 'Database working group'. Below this, a paragraph explains the purpose: 'Purpose: to verify that required fields are present and the inputs match source materials.'

The interface includes a search bar with the URL 'www.nextgenerationliquefaction.org' and a search button. A sidebar on the left contains navigation options: 'Map', 'Actions', 'Sites', 'Field Performance', 'Field Investigation', and 'Earthquake'. The 'Earthquake' section is active, showing a search box for 'Type event name', a 'Magnitude' filter with 'min' and 'max' dropdowns, and a list of recent events including 'M6.5 Imperial Valley-06', 'M5.9 Westmorland', 'M6.6 New Zealand-02', 'M6.2 Superstition Hills-01', 'M6.5 Superstition Hills-02', 'M6.9 Loma Prieta', and 'M6.9 Kobe, Japan'. A 'Submit' button is located below the list.

The central part of the interface is a world map showing earthquake locations. Markers are placed on the map, with some labeled with numbers like '2' and '9'. The map includes a scale bar (3000 km / 2000 mi) and a zoom control. On the right side, there are map style options: 'Topographic Map (high res.)', 'Imagery Map (middle res.)', and 'Terrain Map (low res.)'. Below these are input fields for 'General description', 'Site', 'Event', 'Observation (Note)', and 'Observation (File)', each with a corresponding checkbox.

At the bottom of the page, there are logos for partner organizations: SwRI, PEER, Caltrans, U.S. NRC, MPC (Mountain Plains Consortium), and LTDOT (Keeping Utah Moving).

Vision for Community Access

(to cloud or not to cloud?)

- Due to **large amount of data**, downloading data and processing them on a laptop is inefficient and undesirable (though still possible).
- The database is mirrored onto **DesignSafe** (www.designsafe-ci.org). Users will be able to process data on the cloud using SQL queries in Jupyter notebook Python scripts (*off-the-shelf* libraries).



A screenshot of the DesignSafe-CI web interface. The header includes the 'DESIGNSAFE-CI' logo and the text 'NHRI: A NATURAL HAZARDS ENGINEERING RESEARCH INFRASTRUCTURE'. A navigation menu contains 'Research Workbench', 'Learning Center', 'NHRI Facilities', 'NHRI Community', 'About', and 'Help'. A search bar is on the right. Below the menu is a toolbar with icons for 'Tag', 'Rename', 'Move', 'Copy', 'Preview', 'Preview Images', 'Download', 'Share', and 'Move to Trash'. A 'Projects' section is visible, showing a project titled 'PRJ-2032: NEXT-GENERATION LIQUEFACTION (NGL) CASE HISTORY DATABASE'. A user profile 'Welcome, Paolo!' is in the top right corner.

Final Remarks

- Today's milestone: Release of Stable database GUI: ***nextgenerationliquefaction.org***
- The NGL relational database (being populated): capabilities for big data analytics
- Vetted database (NGL working group)
- NGL-NGA interaction – earthquake events
- The NGL database is mirrored onto DesignSafe – Cloud-based analytics

Thank you!

Questions?

Relevant References

- Brandenberg S.J., Kwak D.Y., Zimmaro P., Bozorgnia Y., Kramer S.L., Stewart J.P. (2018). Next-Generation Liquefaction (NGL) Case History Database Structure. Fifth decennial Geotechnical Earthquake Engineering and Soil Dynamics Conference, Earthquake Engineering and Soil Dynamics Committee of the Geo-Institute. Austin, TX (USA), June 10-13.
- Zimmaro P., Kwak D.Y., Brandenberg S.J., Stewart J.P. (2018). NGL: An Open Source Global Database for Next-Generation of Liquefaction Assessment. SSA-LACSC scientific conference - Seismology of the Americas. Miami, FL (USA), May 14-17.
- Stewart J.P., Kramer S.L., Kwak D.Y., Greenfield M.W., Kayen R.E., Tokimatsu K., Bray J.D., Beyzaei C.Z., Cubrinovski M., Sekiguchi T., Nakai S., Bozorgnia Y. (2016). PEER-NGL project: Open source global database and model development for the next-generation of liquefaction assessment procedures. Soil Dyn. Earthquake Eng., 91, 317–328.



Project homepage:

<https://uclageo.com/NGL/>

Database:

<http://nextgenerationliquefaction.org>