Sensor-Based Earthquake Data for Situational Awareness, Emergency Response and Insurance

Science → **Practice**

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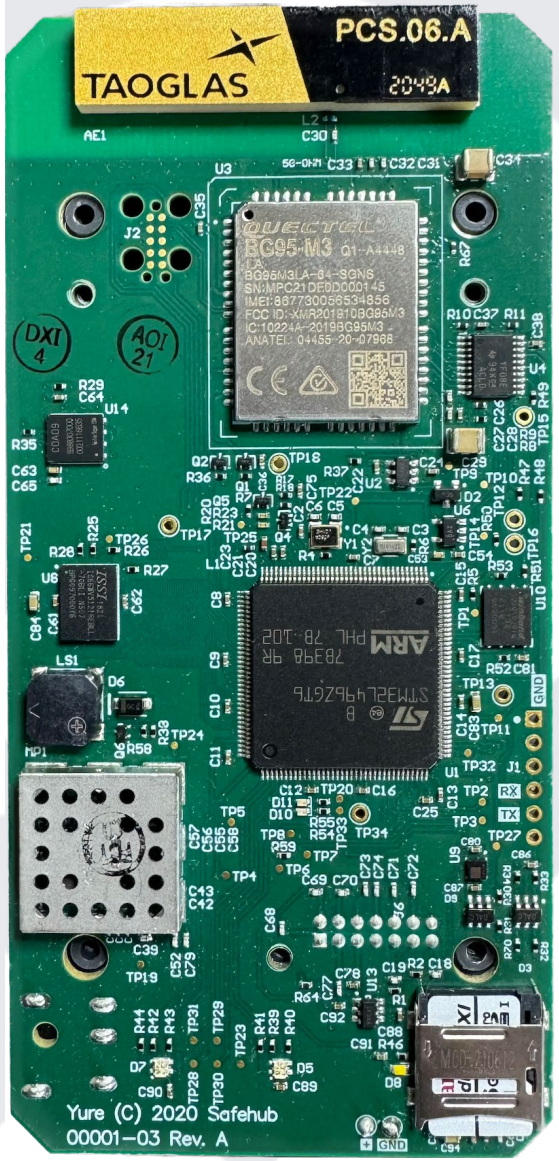
HARDWARE OVERVIEW

- High performance triaxial MEMS accelerometer
- Lithium-Ion battery (2000mAH)
- Proven cellular modem and antenna design
- High-performance, low-power microcontroller
- EMI/RFI shielded power block
- Industrial IoT SD Card



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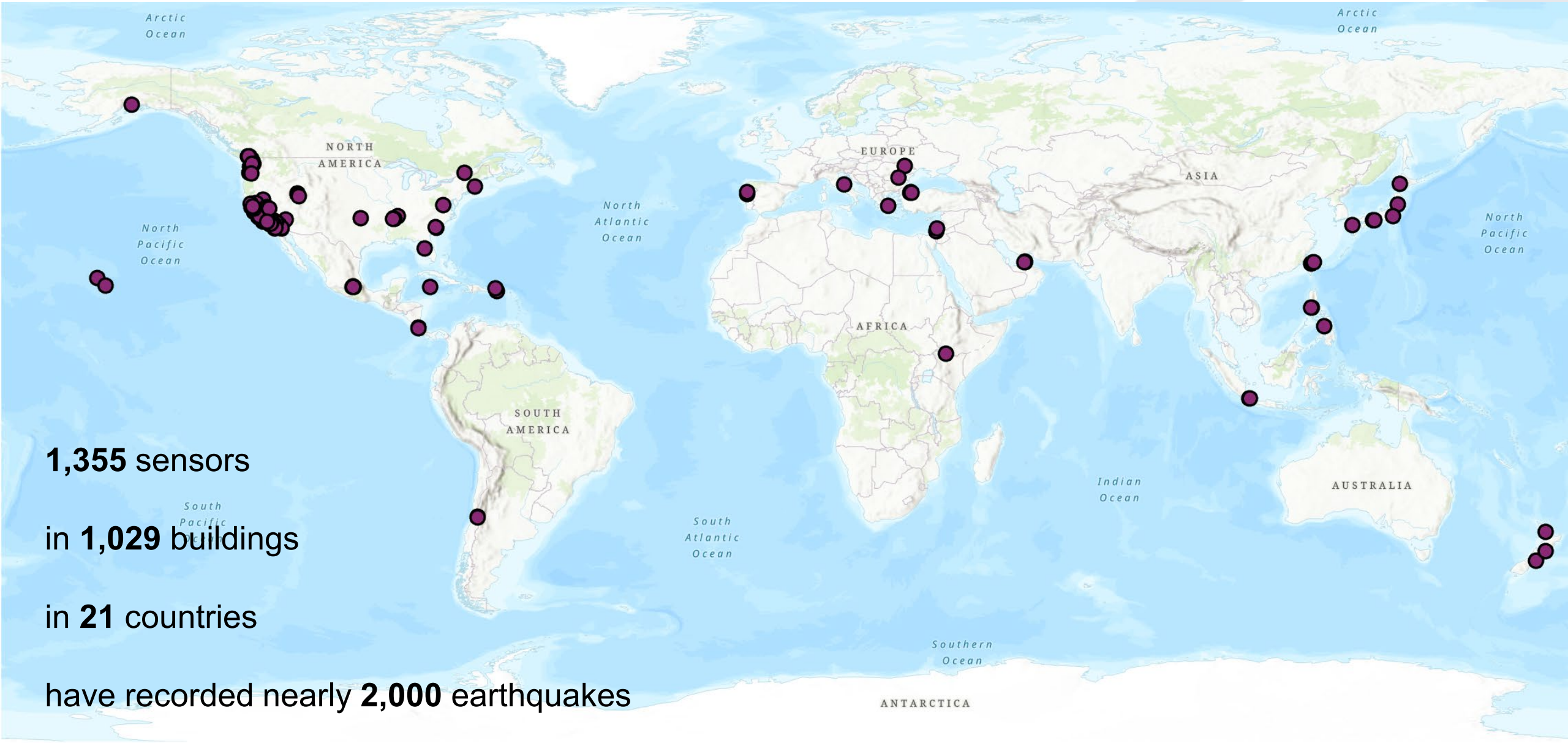
SAFEHUB INSTALLATIONS TO DATE



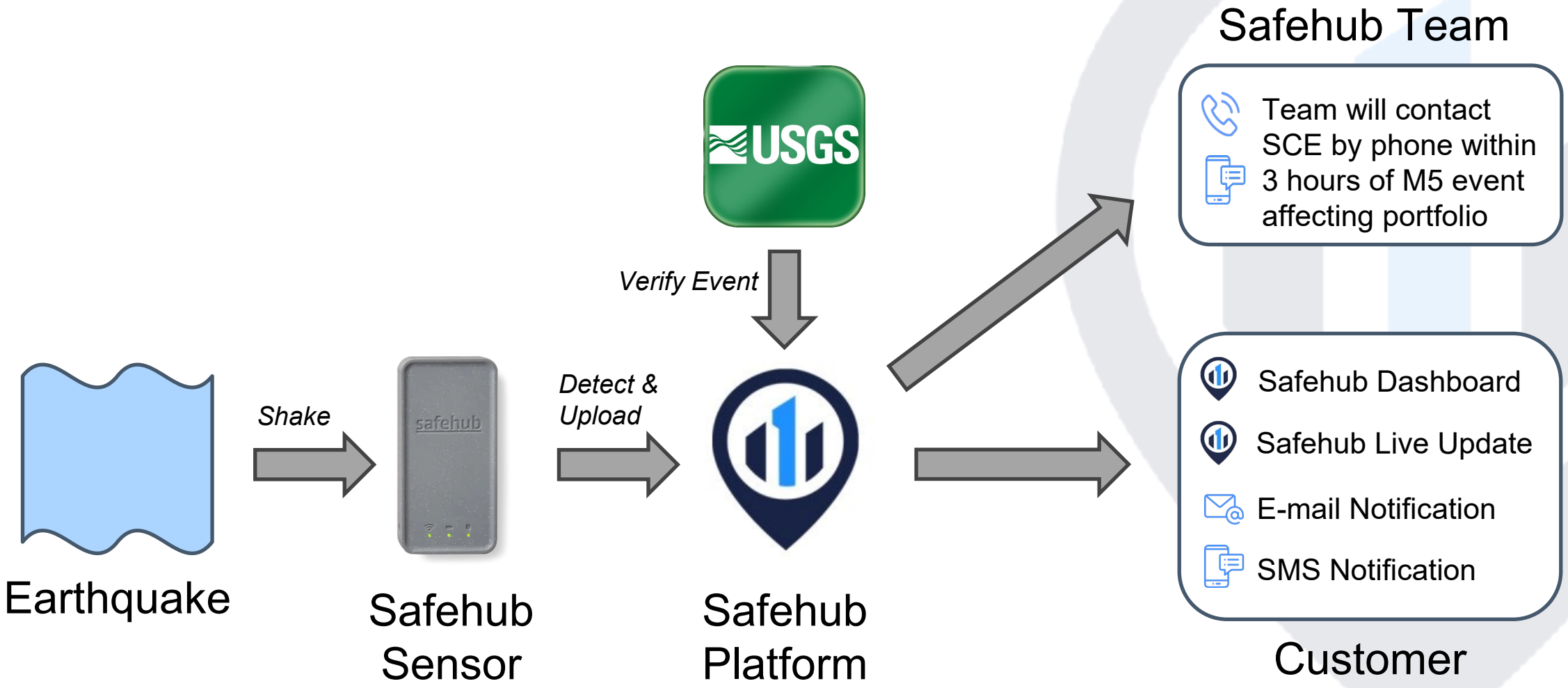
1,355 sensors

in **1,029** buildings

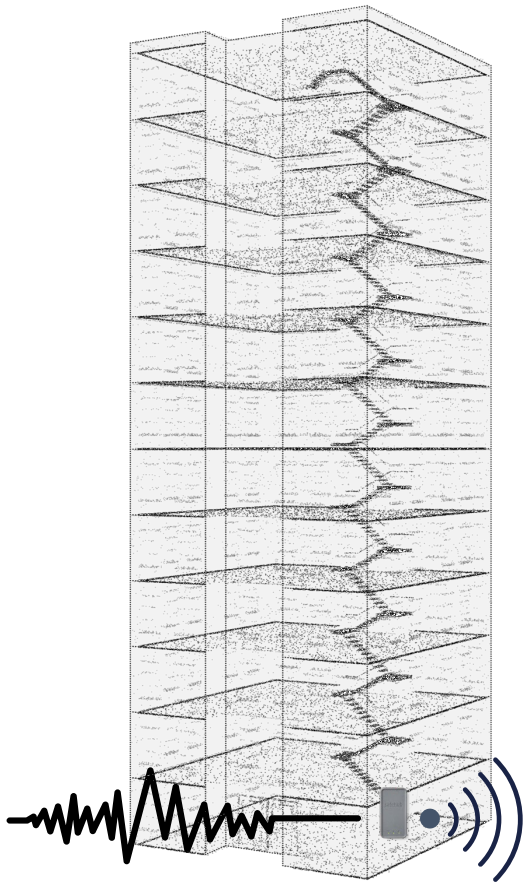
in **21** countries

have recorded nearly **2,000** earthquakes

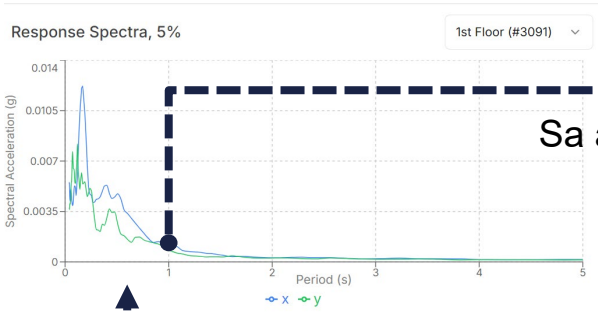
SAFEHUB PLATFORM WORKFLOW



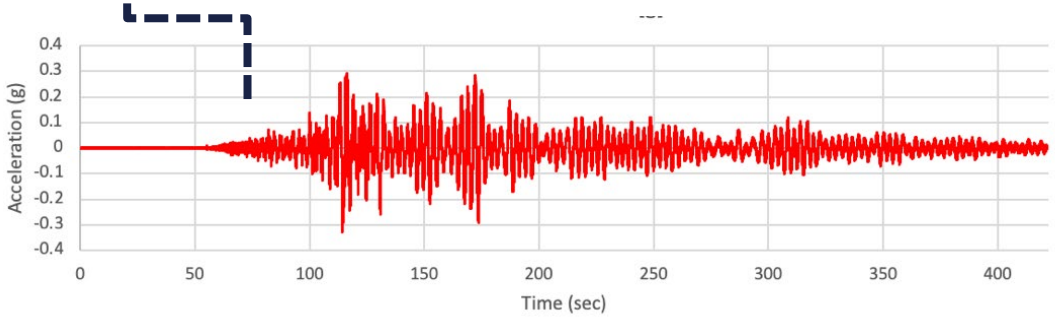
BUILDING-SPECIFIC DATA FOR SITUATIONAL AWARENESS



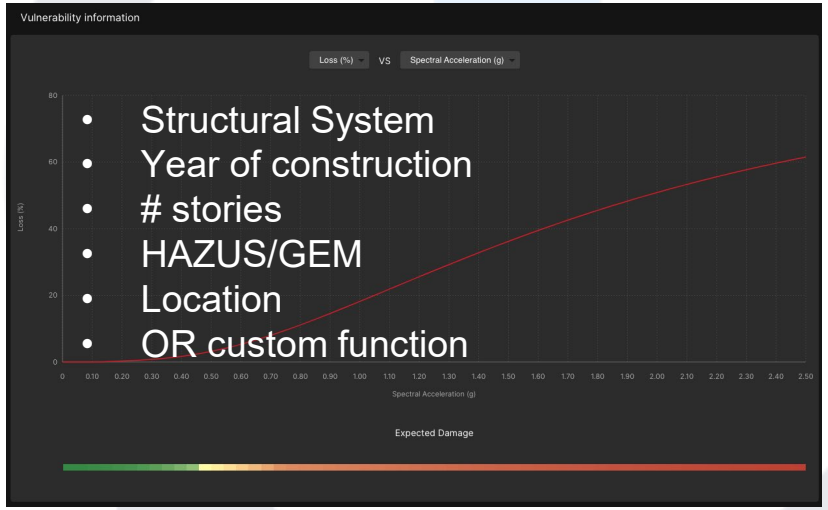
Response Spectra



Sa at 0.3, 0.6 or 1.0 sec



Shaking Data (PGA, PSA)



- Structural System
- Year of construction
- # stories
- HAZUS/GEM
- Location
- OR custom function

Embedded Vulnerability Curves

- **Heavy** damage expected
- **Moderate** damage expected
- **Minimal** damage expected
- **Unaffected**

Damage Indicators	
Damage	% Loss
Cost	$ Loss
Downtime	Days

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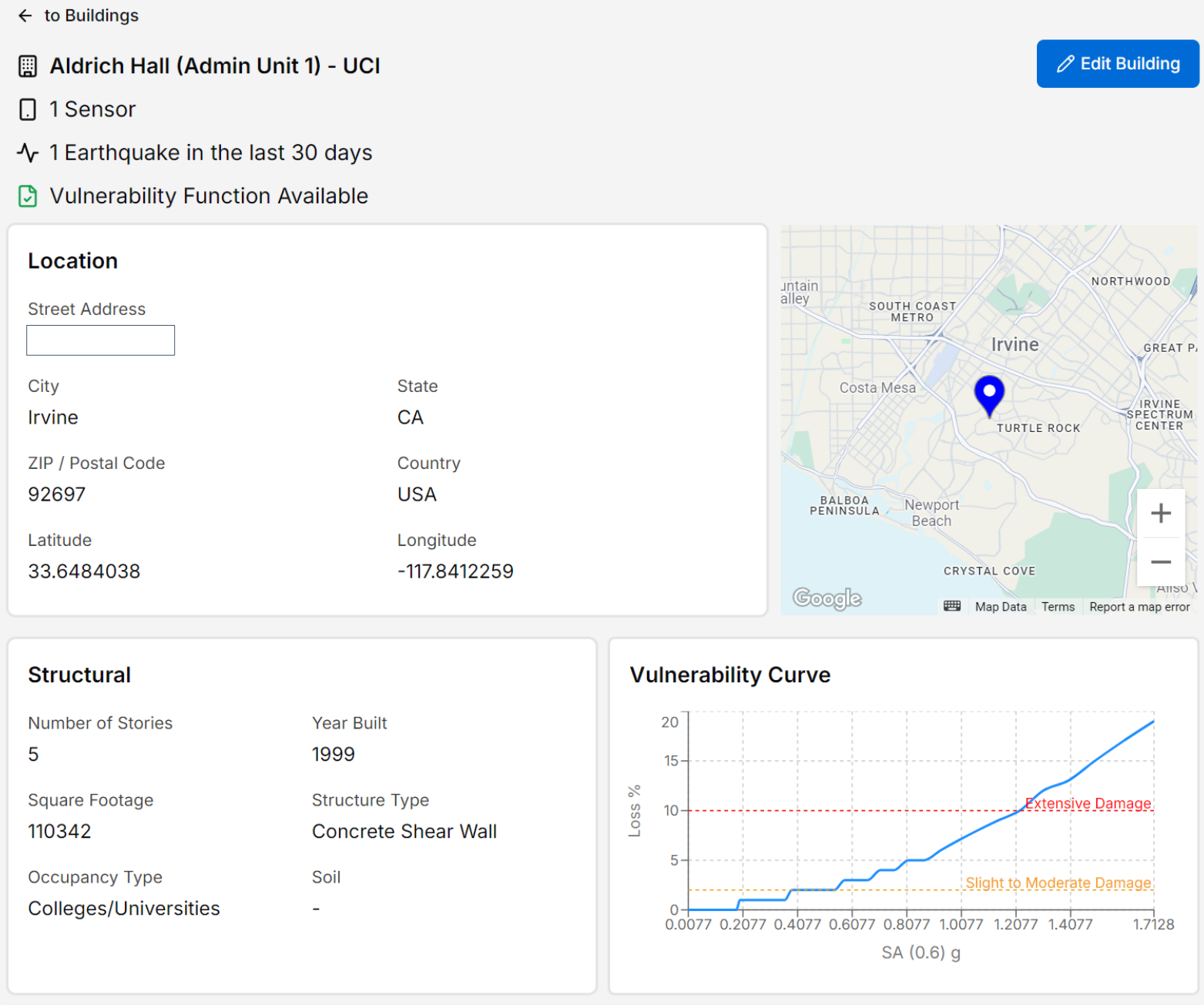
BUILDING-SPECIFIC VULNERABILITY FUNCTIONS TO ESTIMATE DAMAGE

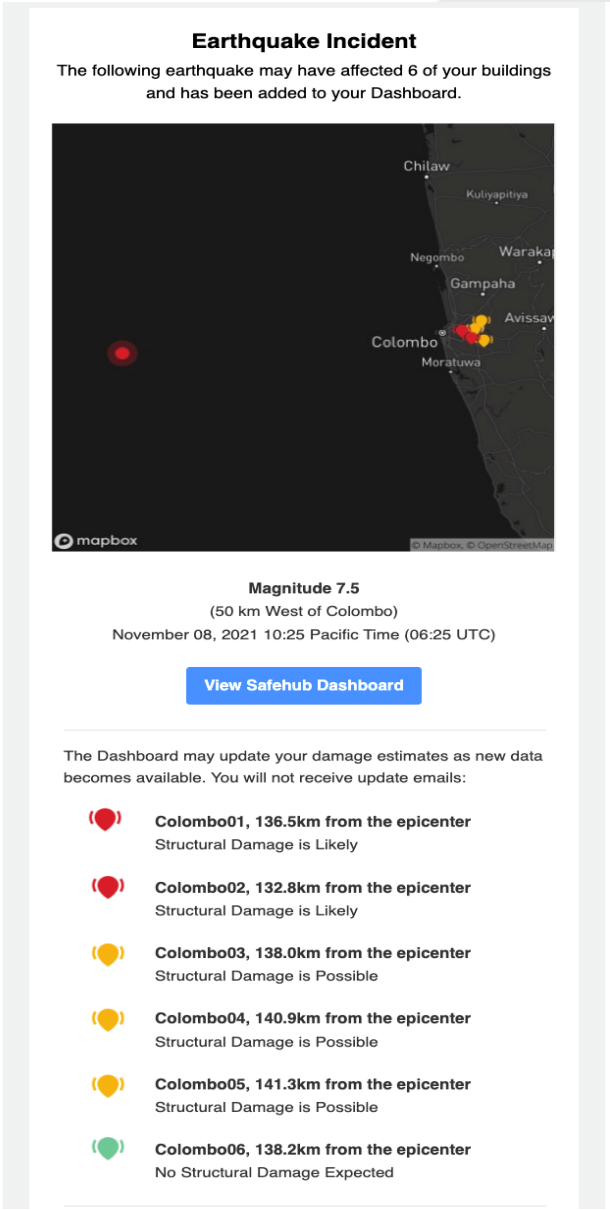
- COPE data
- Global Earthquake Model
- HAZUS
- Building specific analysis



DAMAGE ALERTS

Text, email, and microsite alerts indicating damage estimates:

- **Heavy** damage expected
- **Moderate** damage expected
- **Minimal** damage expected
- **Unaffected**



Earthquake Incident

The following earthquake may have affected 6 of your buildings and has been added to your Dashboard.

Magnitude 7.5
(50 km West of Colombo)
November 08, 2021 10:25 Pacific Time (06:25 UTC)

View Safehub Dashboard

The Dashboard may update your damage estimates as new data becomes available. You will not receive update emails:

Colombo01, 136.5km from the epicenter
Structural Damage is Likely

Colombo02, 132.8km from the epicenter
Structural Damage is Likely

Colombo03, 138.0km from the epicenter
Structural Damage is Possible

Colombo04, 140.9km from the epicenter
Structural Damage is Possible

Colombo05, 141.3km from the epicenter
Structural Damage is Possible

Colombo06, 138.2km from the epicenter
No Structural Damage Expected

Of USGS confirmation

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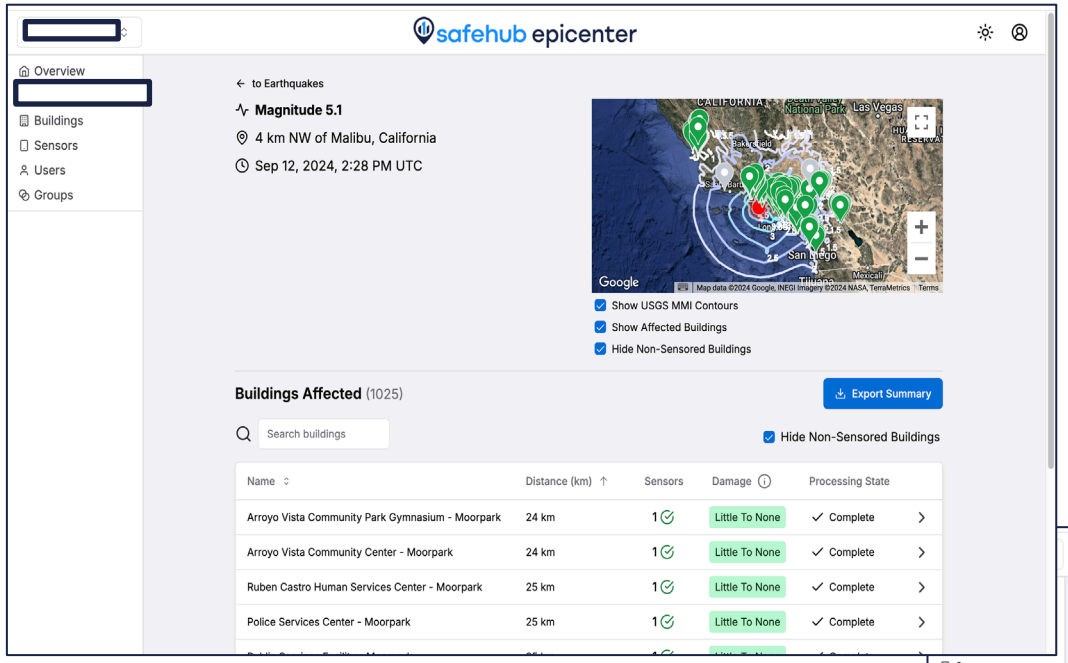
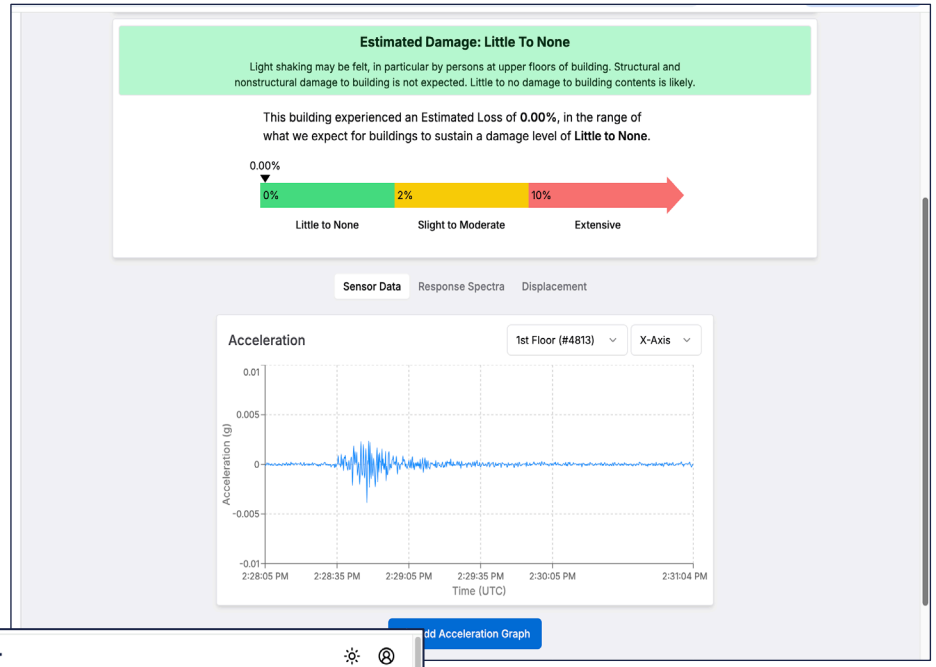
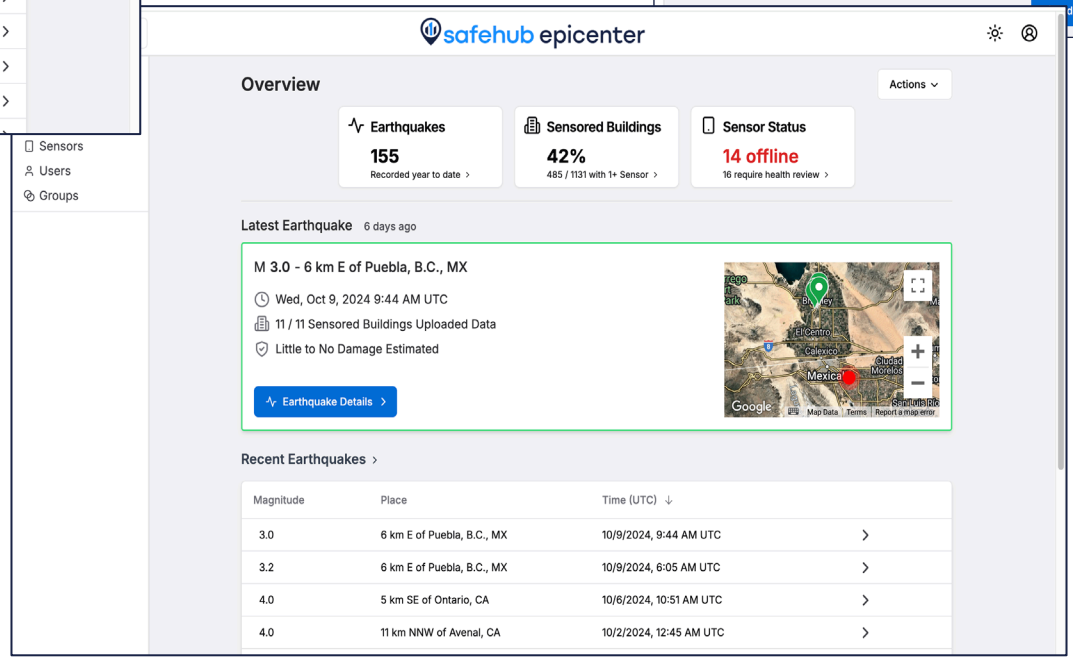
DASHBOARD ANALYTICS





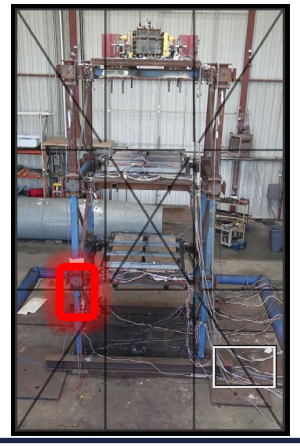


SAFEHUB – UC RESEARCH

UC San Diego and UC Berkeley shake table testing

UC San Diego
JACOBS SCHOOL OF ENGINEERING

Berkeley
UNIVERSITY OF CALIFORNIA



Testing against industry standard instruments

STRUCTURAL SYSTEMS
RESEARCH PROJECT

Report No.
SSRP–24/06

Comparing the Performance of a Compact Wireless Vibration Sensor to Conventional Wired Vibration Sensors in the TallWood Shake Table Test Program

by

Shokrullah Sorosh and Tara Hutchinson
(University of California San Diego)

November 2024

Department of Structural Engineering
University of California San Diego
La Jolla, California 92093-0085

"We found these sensors easy to install and reliable considering repeated measurement scenarios."
– Dr. Tara Hutchinson, UC San Diego

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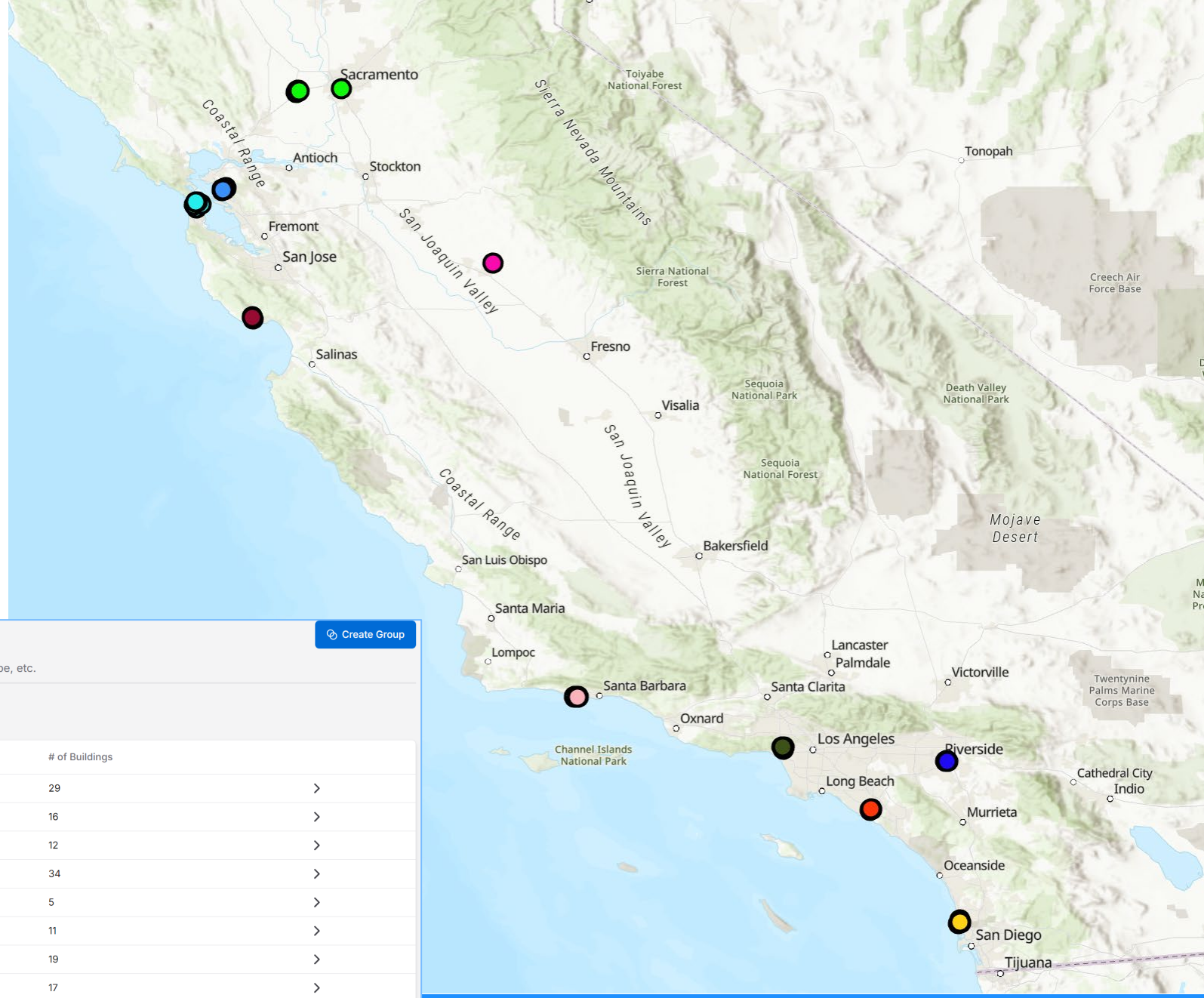
- 10 Campuses + UCOP
- 171 sensored as of today



Groups

Create Group

Organize buildings into groups by region, building type, etc.

Search groups

Name	# of Buildings
UC Berkeley	29
UC Davis	16
UC Irvine	12
UC Los Angeles	34
UC Merced	5
UC Riverside	11
UC San Diego	19
UC San Francisco	17
UC Santa Barbara	14
UC Santa Cruz	7

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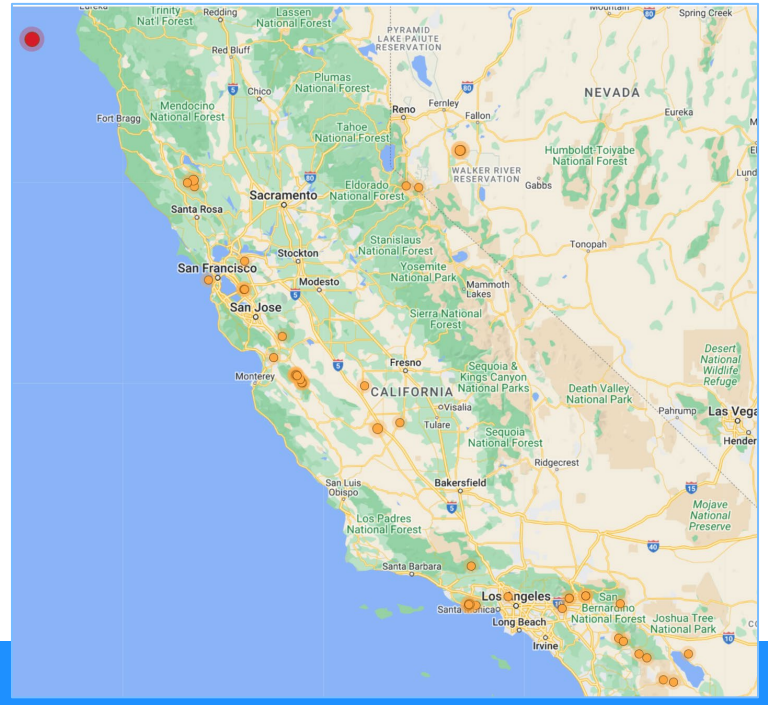
- **62 users receiving alerts**
- **51 earthquakes recorded to date that were captured by UC sensors**



safehub epicenter

Earthquakes

View Map

All Time

51	7.0	2
Earthquakes	Peak Magnitude	Mag. 5.0+ Earthquakes

Search earthquakes

Magnitude	Place	Time (UTC)
3.3	11 km NW of Malibu, CA	3/10/2025, 9:23 AM UTC
4.4	11 km SW of Westlake Village, California	3/9/2025, 8:03 PM UTC
3.9	2 km ESE of North Hollywood, CA	3/3/2025, 6:13 AM UTC
3.3	12 km S of Tres Pinos, CA	2/26/2025, 5:46 AM UTC
3.5	18 km N of Cabazon, CA	2/22/2025, 10:46 PM UTC
3.9	11 km SSW of Tres Pinos, CA	2/22/2025, 10:31 AM UTC
3.0	11 km SSW of Tres Pinos, CA	2/22/2025, 9:25 AM UTC
3.3	12 km SSW of Tres Pinos, CA	2/22/2025, 6:40 AM UTC
3.1	10 km SSW of Tres Pinos, CA	2/22/2025, 5:21 AM UTC
3.0	10 km SSE of Carter Springs, Nevada	2/20/2025, 5:21 PM UTC

Rows per page 10 | Page 1 of 6 | Previous | Next

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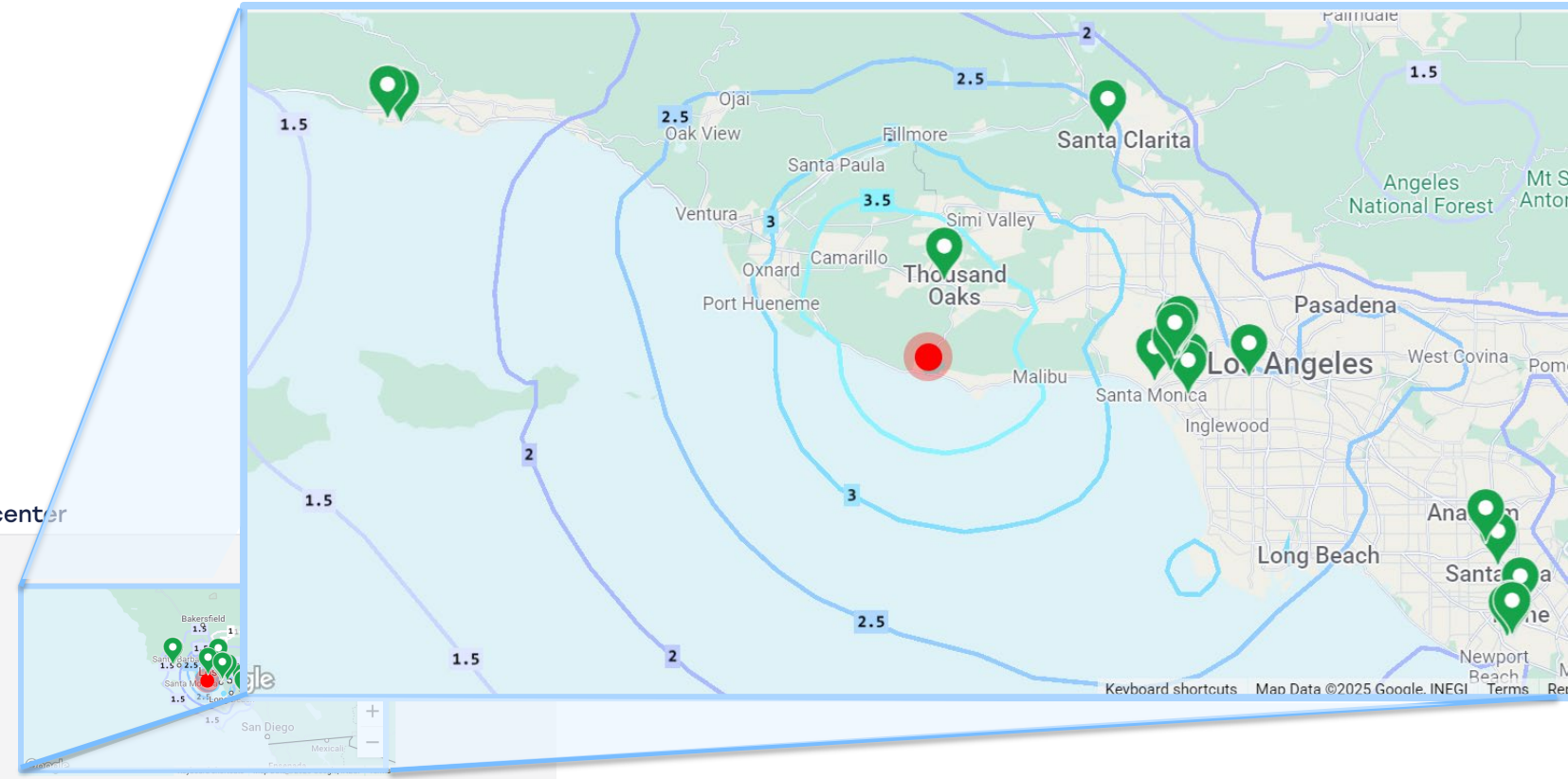
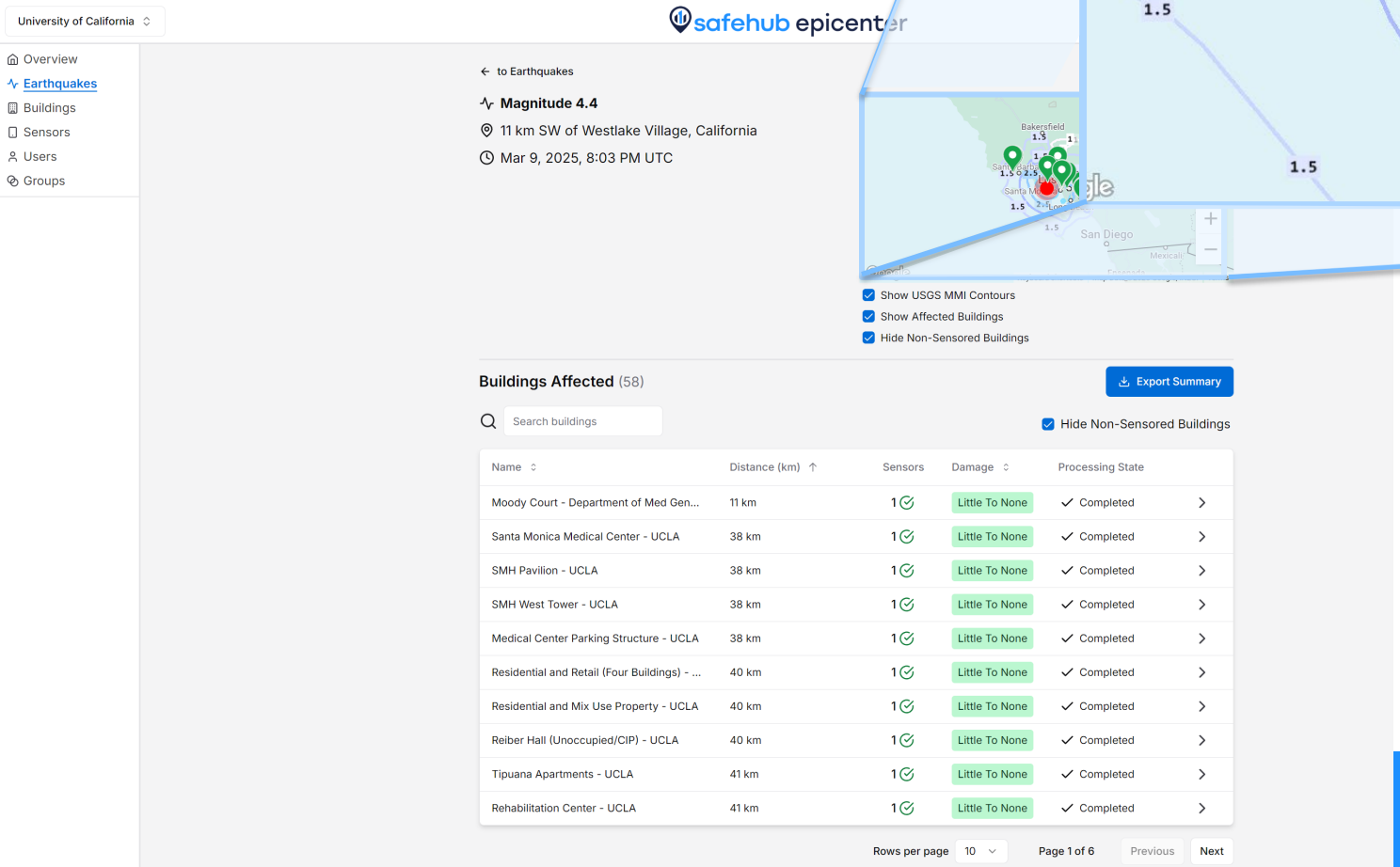
safehub + UNIVERSITY OF CALIFORNIA 1868

- M4.4 Earthquake 11km SW Westlake Village
- March 09, 2025





➢ **Alerts sent to users within one minute of event**

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- M4.4 Earthquake 11km SW Westlake Village
- March 09, 2025

Earthquake

Magnitude 4.4

11 km SW of Westlake Village, California

Mar 9, 2025, 8:03 PM UTC

Building

Moody Court - Department of Med General and Medi Officies - UCLA

12 km from epicenter

1 sensor

Event Data ✓ Upload Completed

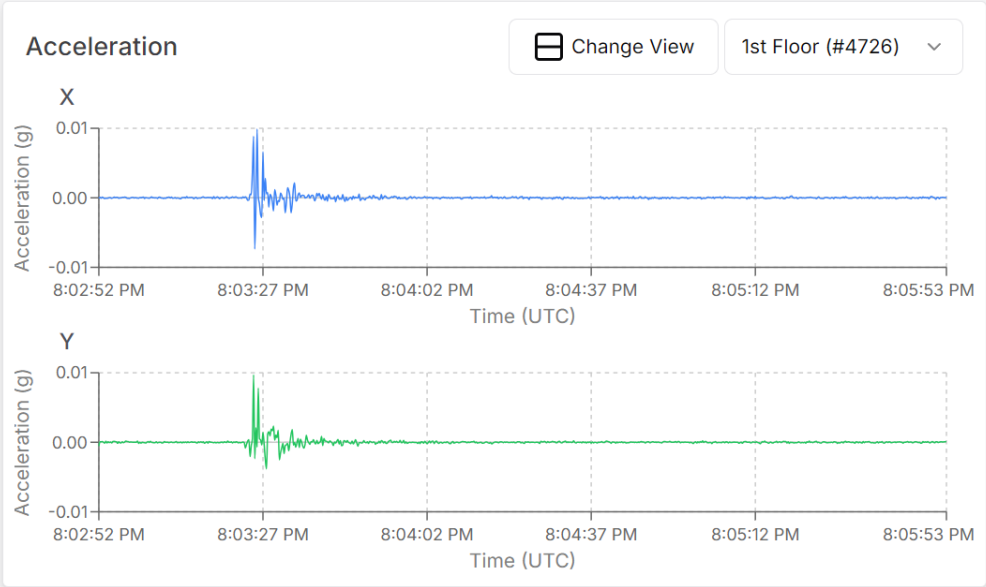
Actions

Peak Ground Acceleration	Spectral Acceleration, 0.3s	Spectral Acceleration, 1s	Peak Ground Velocity
0.0147 g	0.0217 g	0.00210 g	0.491 cm/s

Estimated Damage: Little To None

Light shaking may be felt, in particular by persons at upper floors of building. Structural and nonstructural damage to building is not expected. Little to no damage to building contents is likely.

Sensor Data | Response Spectra | Displacement



- First U.S organization to adopt sensor-triggered earthquake parametric insurance
- Driven by emergency response and recovery
- World's largest sensor-triggered earthquake parametric policy

PARAMETRIC INSURER from Reuters

Index-based solutions and alternative risk transfer

University of California adopts sensor-triggered earthquake cover with LM Re and Safehub

The University of California (UC) has switched carrie for its parametric earthquake insurance program, selecting coverage from Liberty Mutual Re (LM Re) that settles based on measurements from 180 senso *Parametric Insurer* can reveal.

Alliant brokered the transaction, which took place in August. LM Re is the insurer, with additional reinsurance capacity from Munich Re. Howden was also involved in the placement.

The 10-campus university system has over 1,000 buildings representing more than $5(

PARAMETRIC EARTHQUAKE INSURNACE

Earthquake cover that is triggered **not** by physical damage/loss to property from earthquake, but rather, is cover that is triggered by an event that is **strongly correlated** with loss – i.e., "**ground motion**" (e.g. $Sa_{0.3}$).

	Parametric EQ Cover	Traditional EQ Cover
Trigger	Ground Motion	Building Damage from Quake Event
Deductible	Ground motion is ***less*** than the agreed coverage trigger	% of Total Insured Value (usually 5% of value)
Claims Process	Quick & Transparent – average settlement 2-3 weeks	Long & Laborious – can take months/years to settle
Exclusions	"Few"	"Lots"
Territory Covered	Losses Incurred	Scheduled Locations
Eligible Expenses	Any loss associated with event	Building Damage, BI, EE.

INCREASING SPEED, REDUCING BASIS RISK

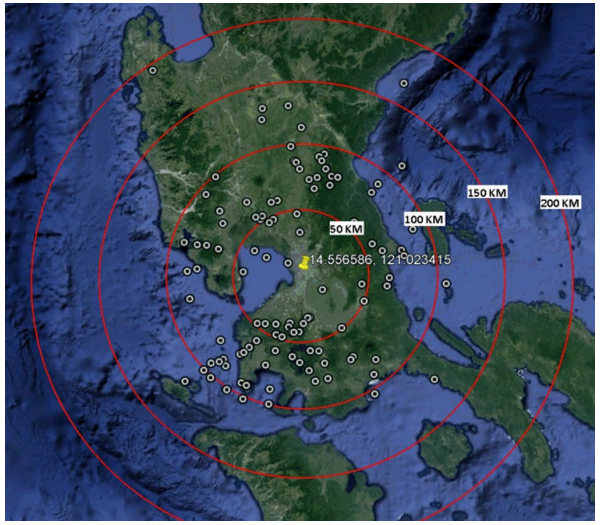
INDEMNITY INSURANCE

PARAMETRIC INSURANCE

TRADITIONAL POLICY

Speed

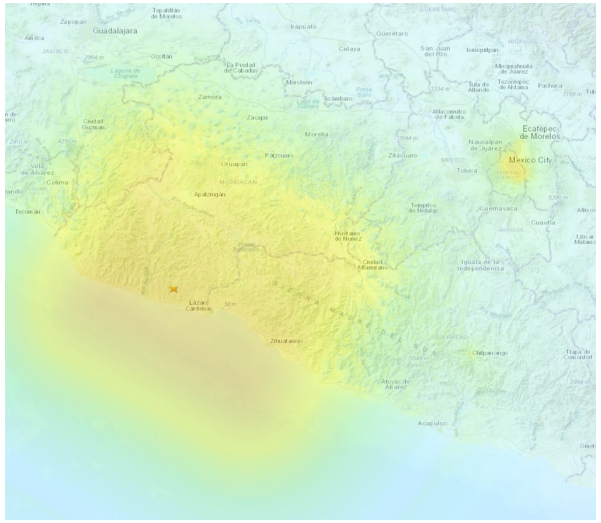
Basis Risk



CAT IN A CIRCLE

Speed

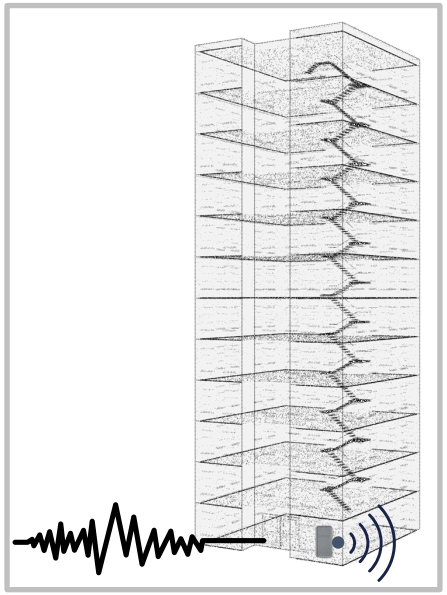
Basis Risk



USGS SHAKEMAP

Speed

Basis Risk



SITE SPECIFIC SENSORS

Speed

Basis Risk

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HOW IS COVERAGE TRIGGERED, AND CLAIMS ADJUSTED?

- Earthquake occurs (epicenter can be *anywhere)* and is reported by the USGS.
- Safehub sensors report maximum Peak Spectral Acceleration registered at sensored buildings and damage estimates provided
- Maximum PSA is used to calculate Payout %
- Insured has one year (or as agreed) to report how funds provided have been, or will be used

Safehub recorded peak spectral acceleration

0.60 g

Payout Table	
PSA (g)	**Payout***
0.45	0
0.50	20%
▶ 0.60	40%
0.75	60%
0.90	80%
1.15	100%

*As % of policy limit or building sublimit

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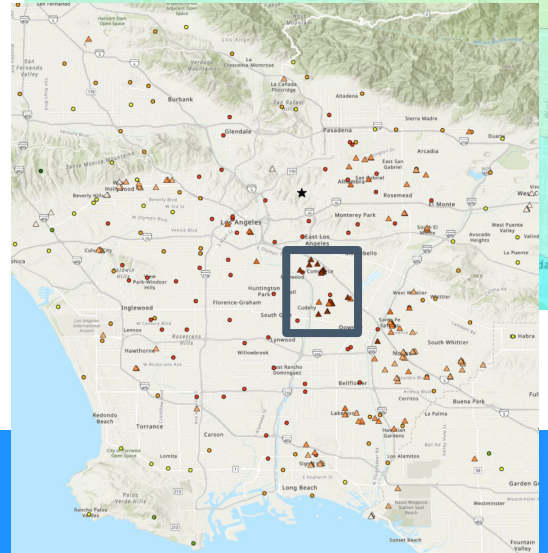
IMPROVING MAPS WITH DENSER SENSOR NETWORKS

Peak Spectral Acceleration contours measured at 0.3 second period

USGS Shake Map
(3 ANSS stations)

Safehub ShakeNet
(22 Safehub sensors+3 ANSS stations)

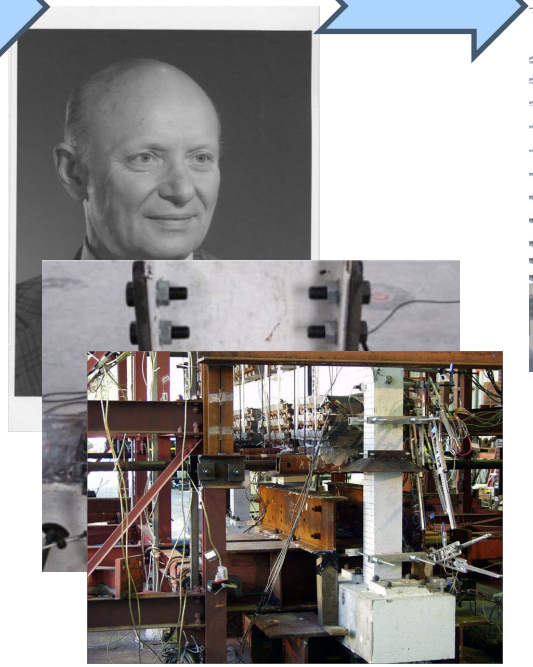
ShakeMap and ShakeNet values at the corner of Bandini and S Eastern Aves., City of Commerce, CA



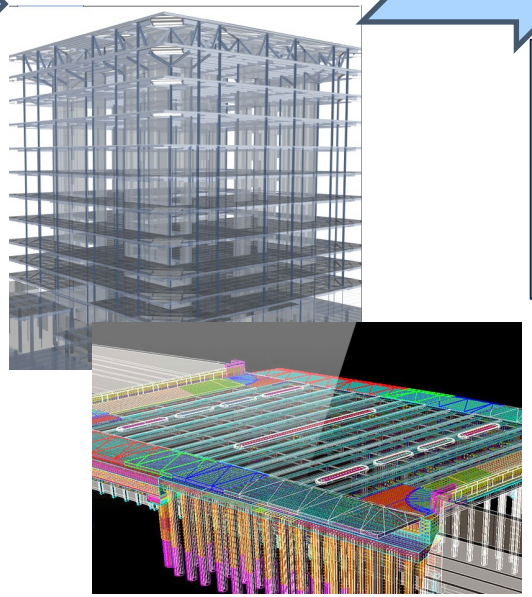
WHAT'S NEXT IN DRIVING CHANGE?

Empirical evidence

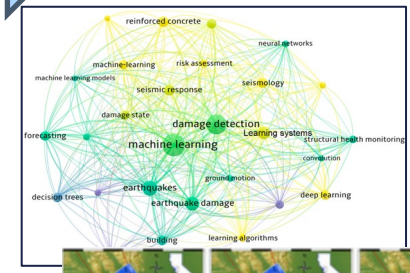
Laboratory testing

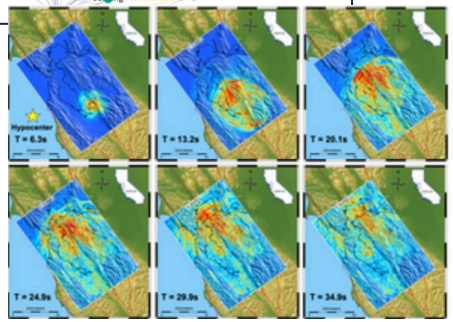


Computer modeling

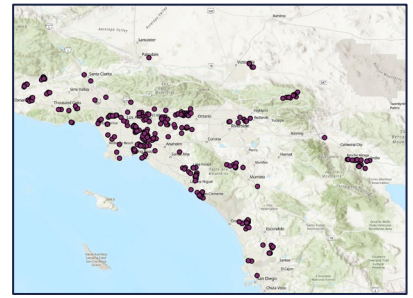


Simulation (ML)





Empirical evidence 2.0?



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THE FUTURE OF CATASTROPHE RISK MANAGEMENT.