Session 9: Earthquakes—Interacting and Cascading Hazards

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Session 9 Talks

Cascading hazards

- Hazard from Landslide-Generated **Tsunamis**: Progress and Challenges, Patrick Lynett
- Spatial distributions of **Liquefaction** for seismic risk analysis, Jon Stewart
- Regional Assessments of Earthquake-Induced **Landslides**, Ellen Rathje

Concomitant hazards

- **Pandemic** lessons for earthquake resilience, Lisa Grant Ludwig
- The 2021 Nippes, **Haiti**, Earthquake, Sue Hough

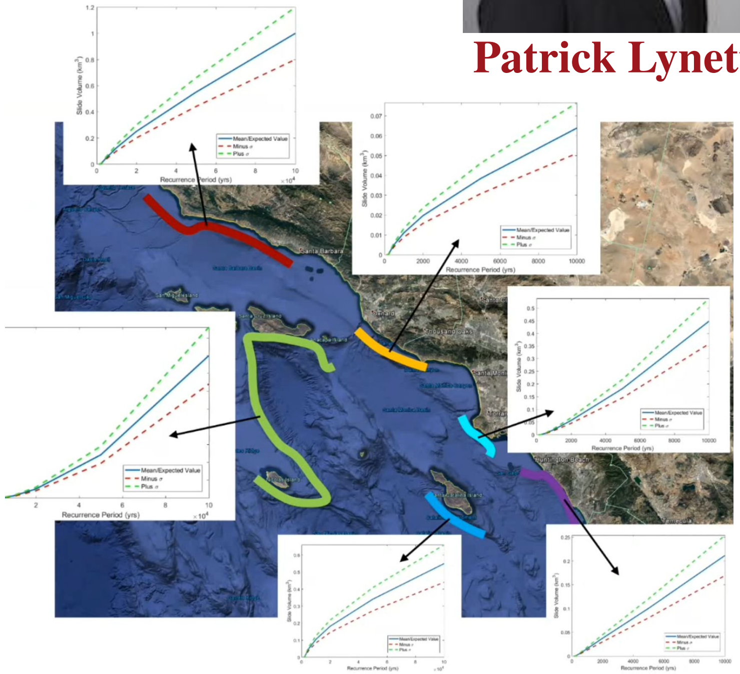
Hazard from Landslide-Generated Tsunamis: Progress and Challenges

Patrick Lynett

Probabilistic Tsunami Hazard Analysis (PTHA) → rate of inundation level (m)

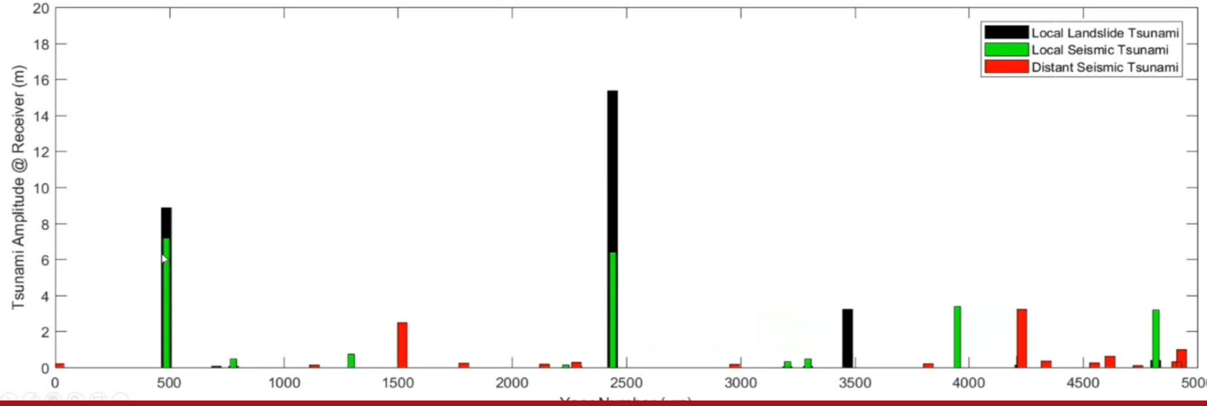
PTHA from distant EQ (routine), local EQ (common, poorly constrained), local landslide (unresolved - focus of talk), ~~distant landslide~~

Difficulty: joint distribution of landslides and seismic events (no paleo data)



Probabilistic approach for local landslide tsunamis:
simulation-based time series analyses (triggered approach)

- Frequency-(slide) volume distribution (VFD ~=MFD)
  - ~~Data driven or~~ triggered (EQ)
  - soCal/borderland: 6 "segments" each with their own VFD
- PSHA → time series of events (UCERF3) and associated ground motions
- Simulate slope failure from triggering (multiple mechanisms in logic trees)
- Obtain slide volume with recurrence interval (i.e., V=f(rate))
- Obtain rate of inundation level (m)

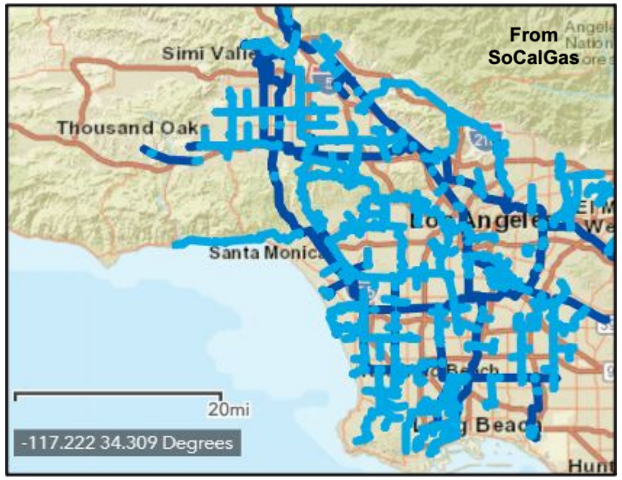


Risk to distributed infrastructure

Goal: regional-scale tools for risk assessment of distributed gas pipelines

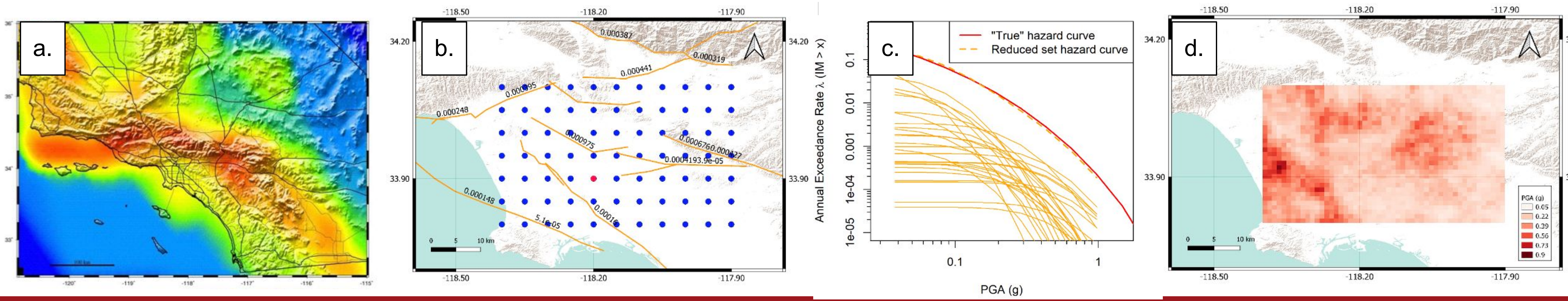
Driver for pipeline damage is displacement of ground around pipes

1. Liquefaction + lateral spreading (Stewart)
2. Landslides (Rathje)



Define ground shaking hazard for the full network→scenario maps

   a. Compute PSHA
   b. Perform disaggregation of PSHA at discretized grid points
   c. Define (manageable) suite of hazard-consistent scenarios
   d. Generate scenarios maps



Spatial distributions of liquefaction for seismic risk analysis

Jon Stewart

1. Liquefaction

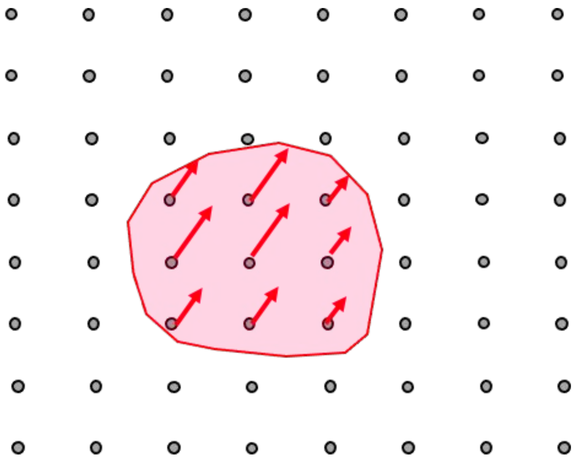
Perform regional liquefaction analysis for each scenario map (uncertainties in logic tree)

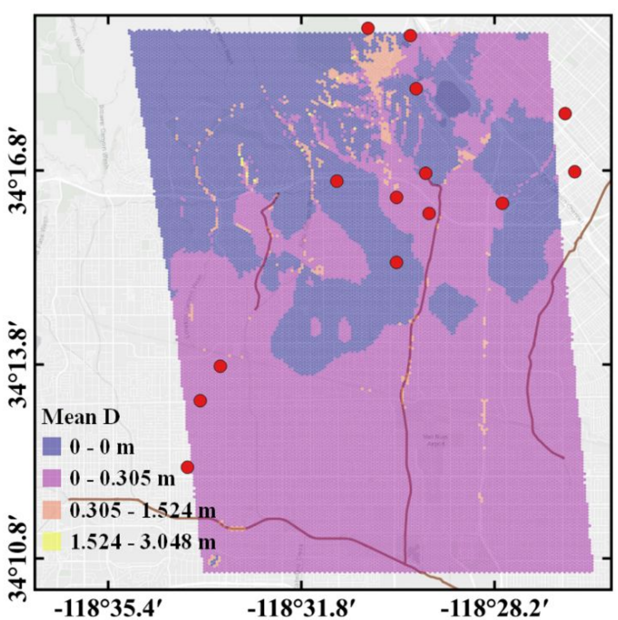
Scenario shaking maps (M, ground motions)

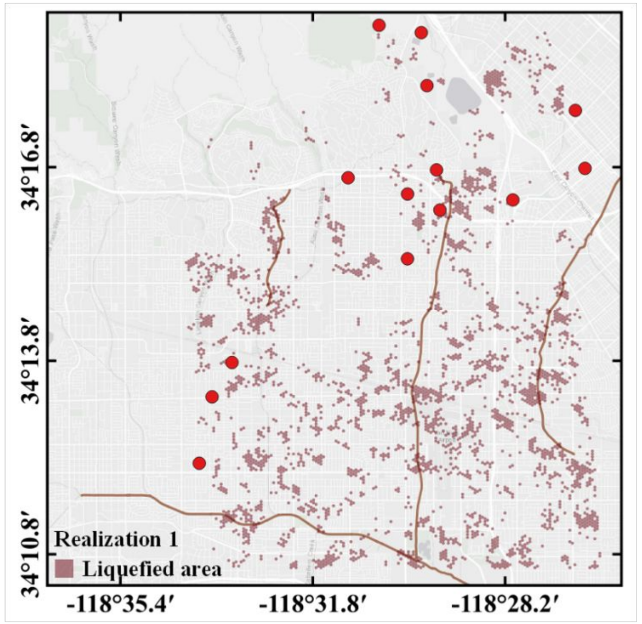
Geologic map

DEM

Water table map







Zach Bullock

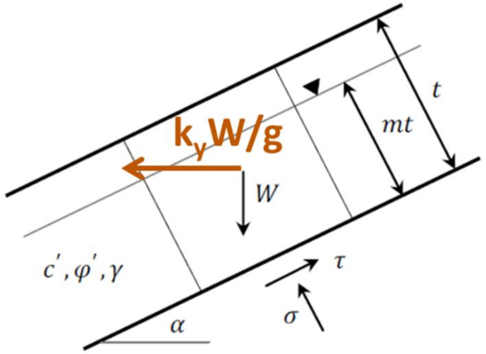
Regional Assessments of Earthquake-Induced Landslides

Ellen Rathje

2. Landslides

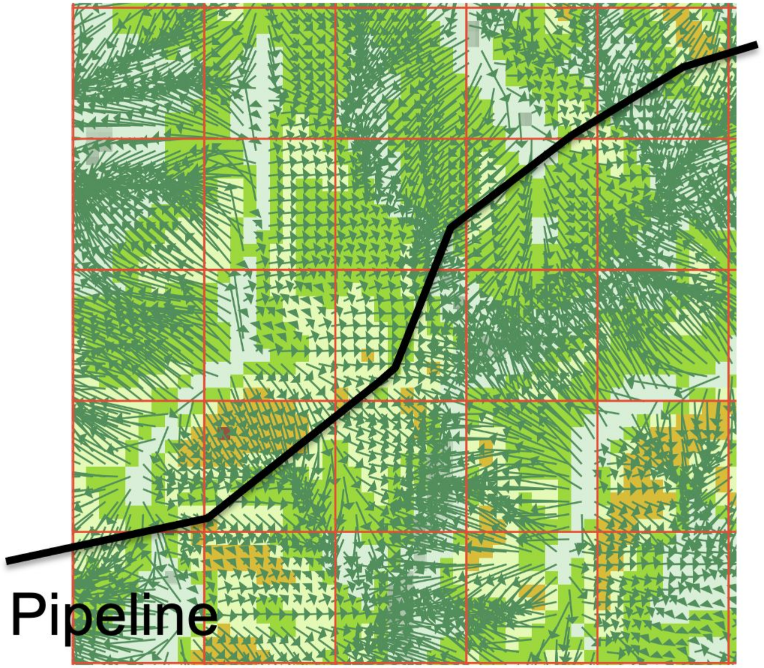
Perform regional landslide analysis using physics-based Newmark sliding-block approach

Scenario shaking maps (ground motions)



- Soil unit weight: γ → **Assume**
- Slope angle: α → **DEM**
- Strength: c', ϕ' → **Geology**
- Thickness of failure surface: t → **Judgement**
- Height of water: $m \cdot t$ → **Well data**

Uncertainties in logic tree



Pandemic lessons for earthquake resilience

Lisa
Grant Ludwig

All part of current pandemic experiment. Similarities to earthquakes:

- appear beyond our control
- global, disruptive & destructive, multiple spatial and temporal scales, long recurrence intervals
- human behavior is key but not enough (ShakeOut is great; collapse can still happen)

Failures in the past, but still happen, yet we have

- data
- science (smallpox eradicated)
- behavioral knowledge (don't smoke!)

Change to be driven by policy (informed by science-based intervention).
Example: masks required at work make it safer during pandemic

As scientists, we focus on publications, education, training...

We must step out of our comfort zone to support improved policies

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How can WE, the SCEC community, help:

Do the best possible science or engineering

Partner with others to develop solutions

Lead within your sphere of influence

The 2021 Nippes, Haiti, Earthquake

Sue Hough

Cascades of cascades: earthquake sequences (1860? →2010→2021), landslides, tropical storms, political unrest, pandemics

Support of USGS through USAID 2010+: data collection, PSHA, seismic monitoring, training, **capacity building**

Risk reduction is a PROCESS

History
Independence, reparations, corruption, AIDS, donor support

2010 Earthquake

Political & economic instability

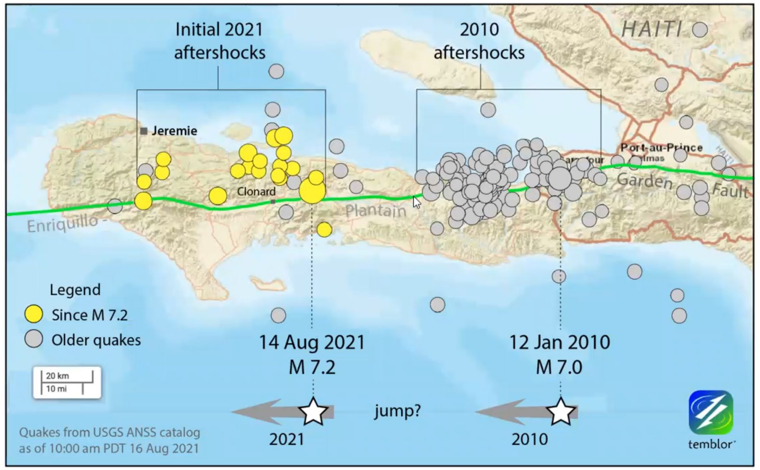
Pandemic

Earthquake

Landslides
- Landslide dam?
- Debris flows

Storms

Science?



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The 2021 Nippes, Haiti, Earthquake

Sue Hough

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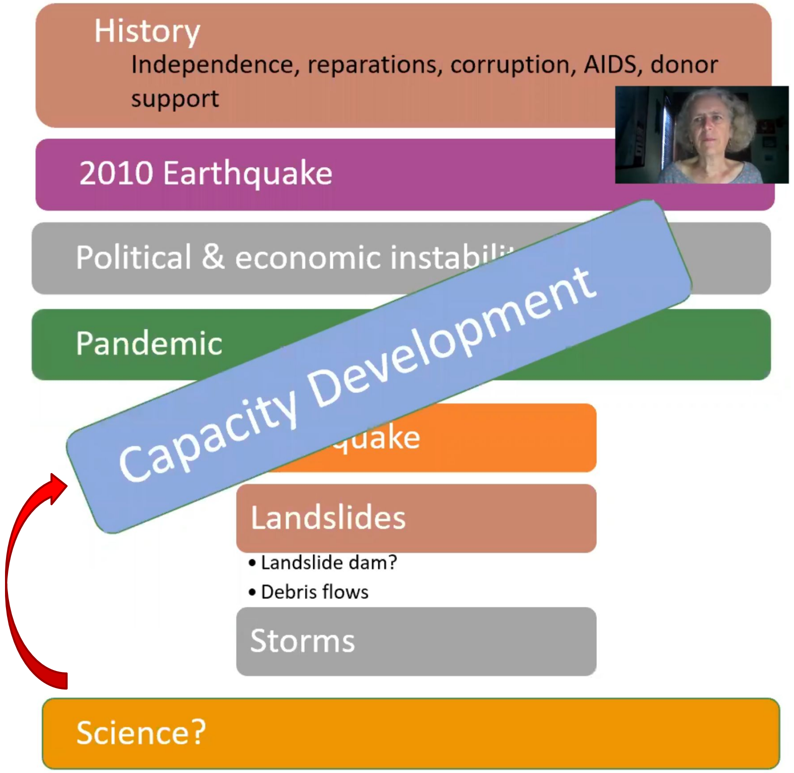

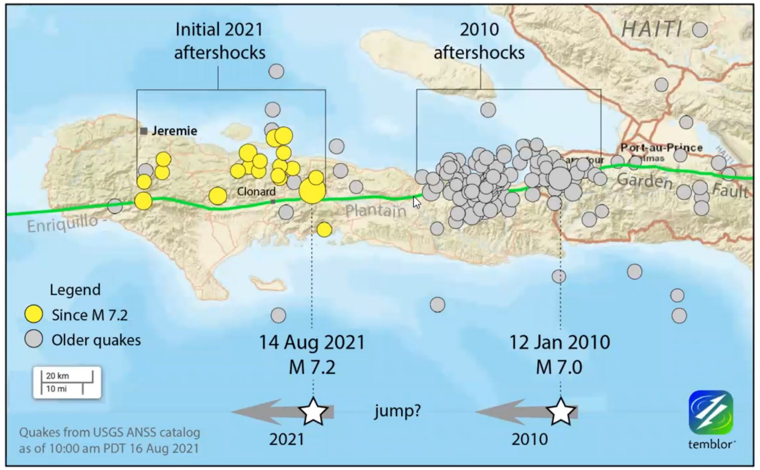

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Discussions: now and then… Hoping for

- More engagement in capacity building
  - Local professionals move risk reduction forward in a sustainable way
    - We can help train THEM
  - Need to recognize “parachute science” and the harm that it can have, even if intentions are good
- About uncertainties
  - Critical to continue quantifying uncertainty - new data and improved modeling will reduce uncertainty
  - Must learn to communicate uncertainty outside of science (to the general public, uncertainty = we don’t know)
- On communication, education and outreach (CEO)
  - SCEC CEO doing great with ShakeOut and Earthquake Country Alliance (ECA)
  - Can they help the SCEC scientific community with broader communication targets?
- Improved access to SCEC ground motion simulation time series
- Increased coordination between scientists and engineers (cascading hazards, recon), AND social scientists^{++} (policy development)

Thank you!