The NHERI RAPID Facility

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RAPID Facility, Operations Director

University of Washington

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RAPID NHERI
Natural Hazards Reconnaissance

The NHERI RAPID Facility

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Operations Director
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NHERI@UCSD Workshop

NSF Award Number: CMMI 1611820

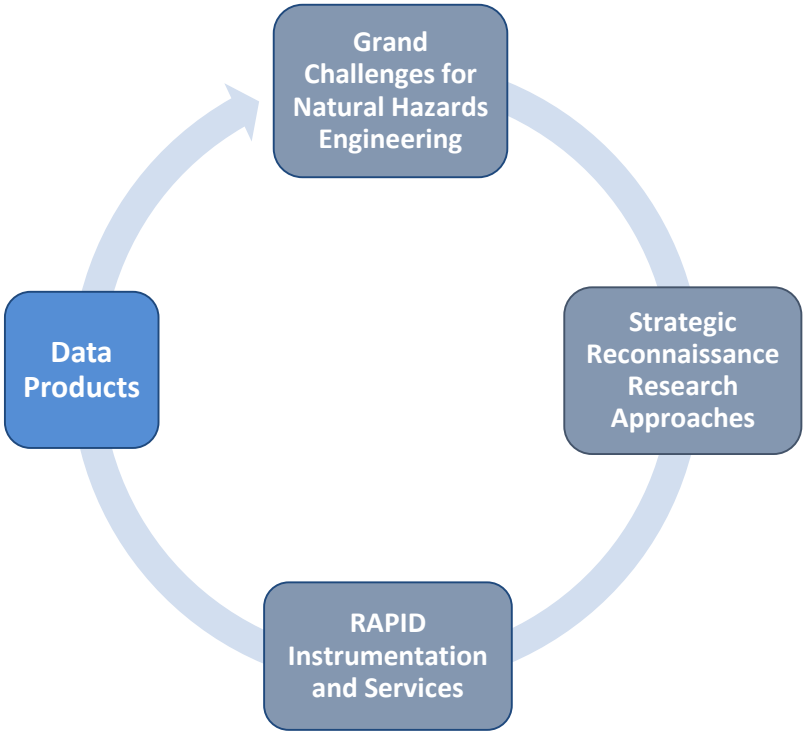
RAPID Facility Team

Left to Right:
Kurtis Gurley (UF), Wind Hazards Specialist
Michael Olsen (OSU), Technical Director
Jennifer Irish (VT), Coast Hazards Specialist
Ann Bostrom (UW), Social Science Specialist
Laura Lowes (UW), Structural Engineering Specialist
Troy Tanner (UW-APL), IT and Data Director
Jeffrey Berman (UW), Site Operation Director
Jake Dafni (UW), Site Operations Manager
Scott Miles (UW), Social Science Specialist
Joseph Wartman (UW), Director

NSF Award Number: CMMI 1611820

Mission: Transforming Natural Hazards Reconnaissance

- Unprecedented amount of high-resolution, open-source disaster data collected using systematic data acquisition practices
- Integrated collection of engineering, geophysical, and social science data sets
- Greatly expanded community of reconnaissance investigators

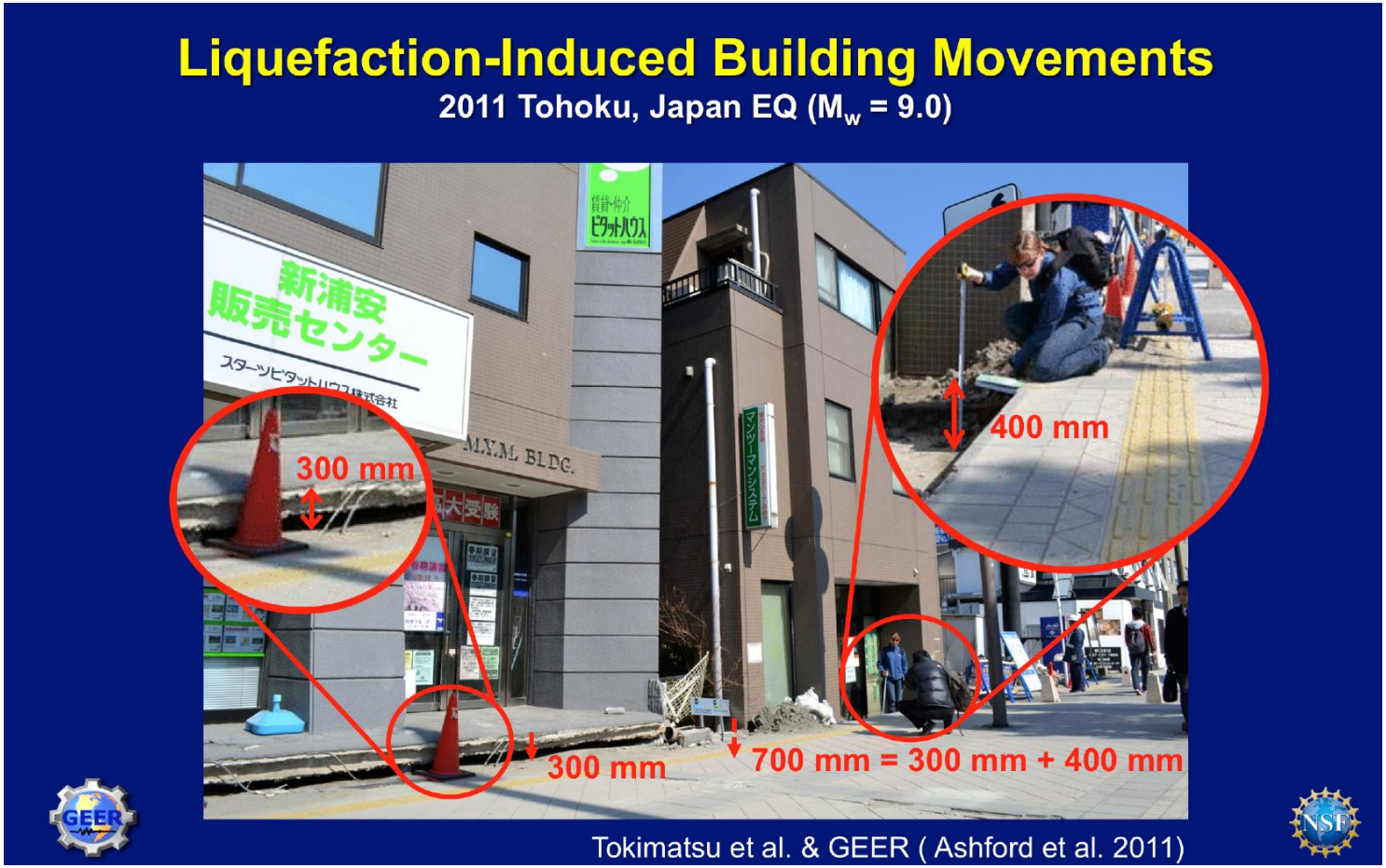


RAPID Facility Strategic Activities

To achieve its mission, the RAPID facility engages in the following strategic activities.

- Acquiring, maintaining, and operating state-of-the-art data collection equipment
- Developing and supporting mobile applications to support interdisciplinary field reconnaissance
- Providing advisory services and basic logistics support for research investigations
- Facilitating the systematic archiving, processing and visualization of acquired data in DesignSafe-CI
- Training a broad user base through workshops and other activities
- Engaging the public through citizen science, as well as through community outreach and education

Transforming Natural Hazards Reconnaissance

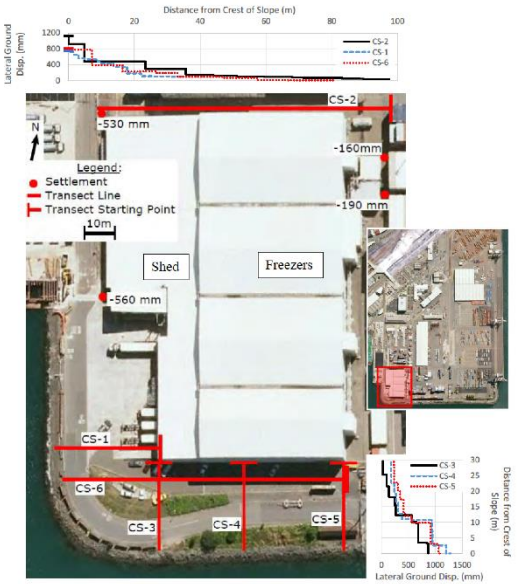


Courtesy of J. Bray (2017) Ishihara Lecture, Simplified procedure for estimating liquefaction-induced building settlement

- Fundamental insights
- Critical data for validation
- 2D "point" data
- Manual measurements
- 10 cm resolution
- Lots of highly perishable data

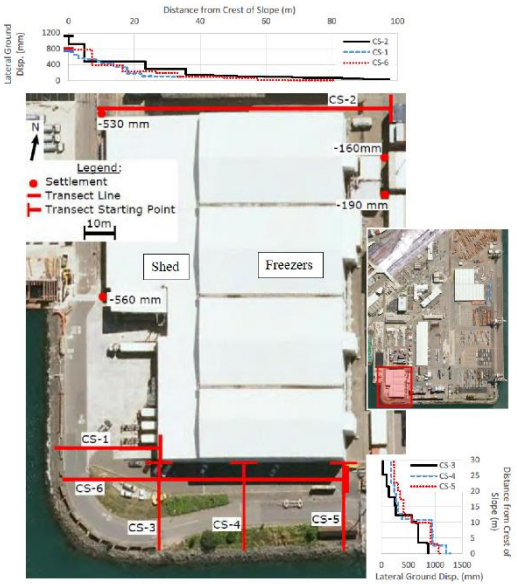
Transforming Natural Hazards Reconnaissance

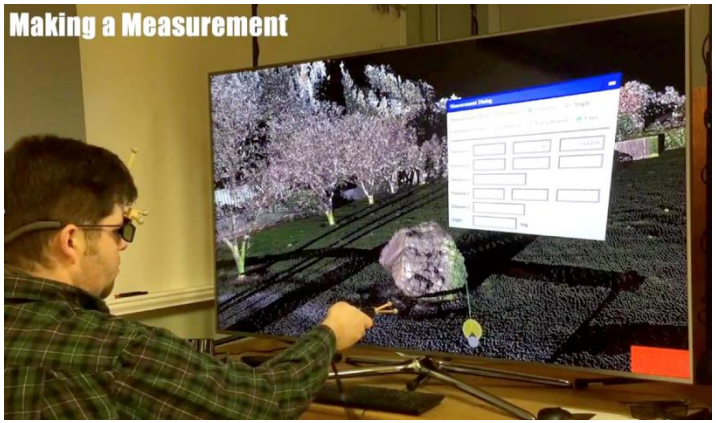
3D Point Cloud Model from Lidar Data

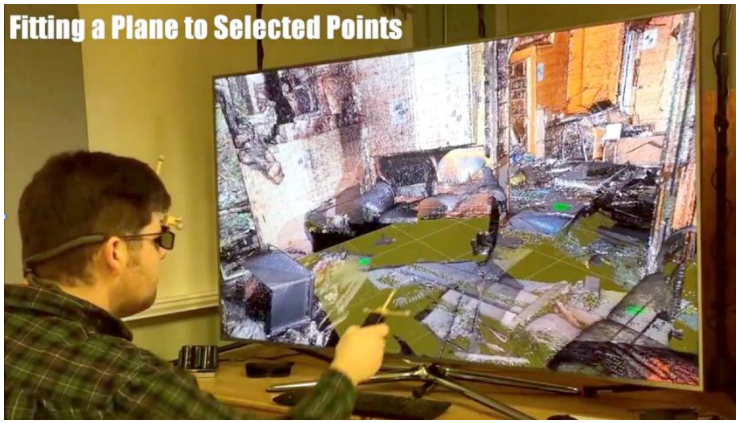


- Large amount of high-quality data
- High-resolution (mm's), systematic data collection
- 3D (and 4D)
- Automation
- Efficient data collection
- Shared resources, broadened user base

Transforming Natural Hazards Reconnaissance

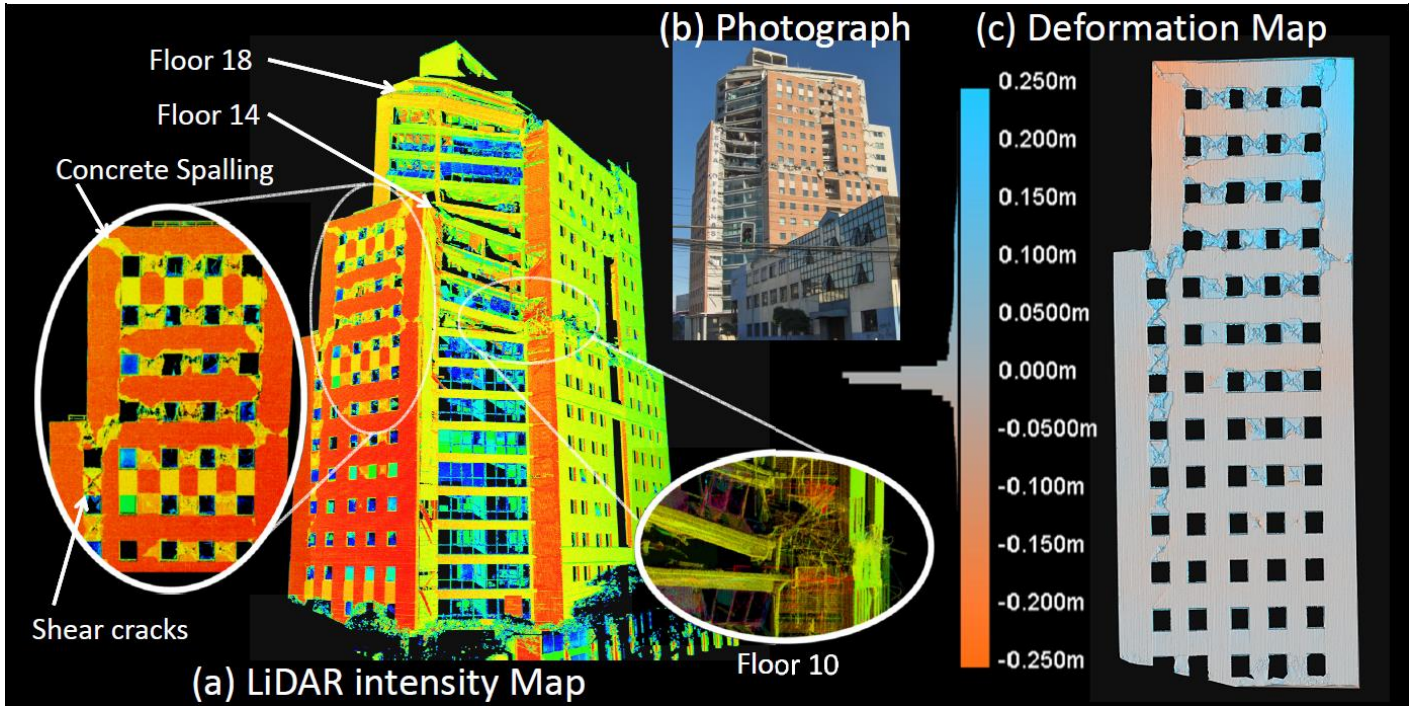






- Large amount of high-quality data
- High-resolution (mm's), systematic data collection
- 3D (and 4D)
- Automation
- Efficient data collection
- Shared resources, broadened user base
- Geo-referenced data sets that can be later analyzed and interrogated

Example Reconnaissance Data Set
2010 Maule Chile Earthquake and Tsunami



Data from the 2010 Maule earthquake collected using Riegl VZ-400 scanner (Olsen et al., 2012). Image (c) shows out of plane displacement due to rotation at 10th story computed using lidar data.

Point Clouds:

- Offers potential for rapid data collection
- Digital site preservation.
- Lidar data can be used to *manually* identify and quantify damage.
- Current research addresses automated damage detection and quantification.

Recent Reconnaissance Example: Perceptions of Mexico's Earthquake Early Warning

- Issue: How do Mexico City residents perceive SASMEX (earthquake early warning system)? How did they respond to warnings for the September 2017 earthquakes relative to the system's performance?

- Approach: Interdisciplinary team of seismologists, sociologist, psychologist, and urban geographer. In-depth interviews. Convenience sample of the public, government officials, academics, business, & NGOs.

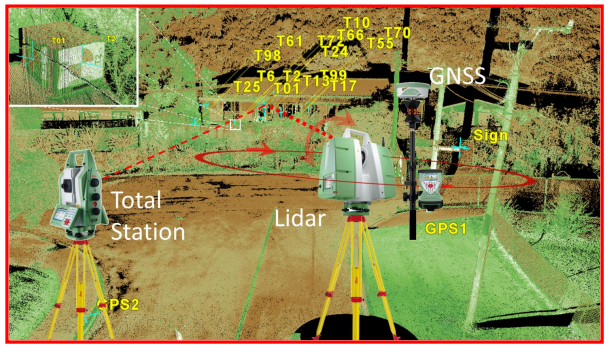
- Outcome: Recommendations for earthquake early warning system development in the United States published in *Science*.

Allen, R.M., et al. (2017) "Quake warnings, seismic culture", *Science*

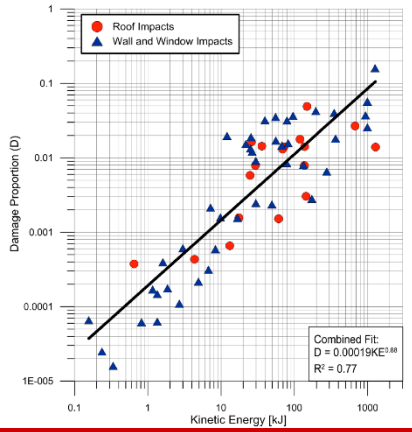
Recent Reconnaissance Example: Impact of Co-Seismic Rockfall on Buildings

- Issue: landslide risk practices require that the vulnerability of communities to landslides be known, but information was not available to support such assessment.

- Approach: lidar-scan ~30 homes/sites damaged by rockfall during the Christchurch earthquake , and relate impact energy to building damage indices; geotechnical-structural collaboration



- Outcome: A series of rigorous, data-driven fragility relationships to support risk assessment and land-use policy



Grant et al. (2017) *Landslides*

Example Reconnaissance Data Set

Example Reconnaissance Data Set

Transforming Natural Hazards Reconnaissance

Amanda South, reporter, Newstalk ZB, 8-5-12.

I: Right, let's start with February 22, can you describe your key experiences on that day?

IP: I was actually at home, ironically, because the Christchurch City Council was having its first dedicated earthquake recovery meeting so I would have started work at 1, so I was always haunted by that, but I was in Angus' bedroom getting him off for a nap and I guess the rest is history. The house started to explode around us. I just took him in by body in the middle of the room and things just fell around us. We were in this little bubble in the middle and it was horrific because everyone has that internal counter and you thought `Oh my god this is going to on too long, it's supposed to stop'. It got angrier and stuff was just erupting in the hallway. I can just remember knowing it was horrific and trying to think about my kid and I can remember my

Eyewitness Interview Transcript

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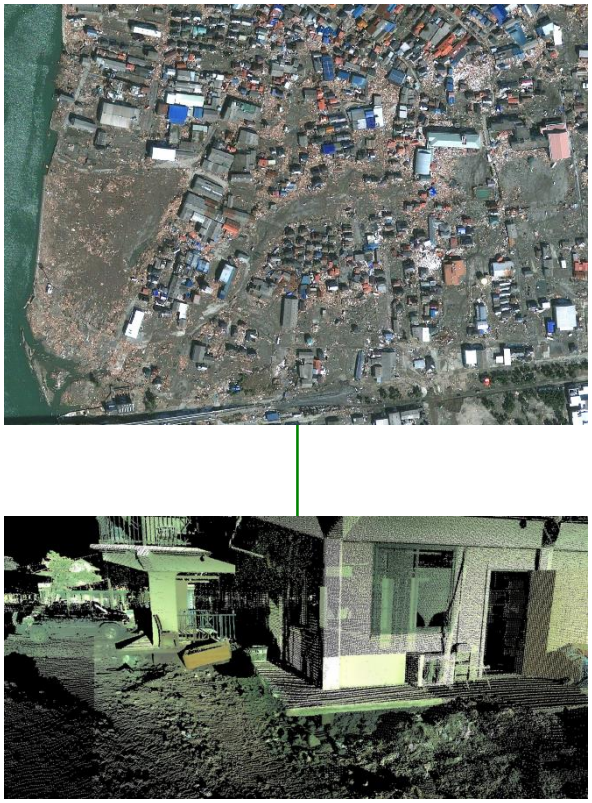
Earthquake Damage Distribution

Transforming Natural Hazards Reconnaissance



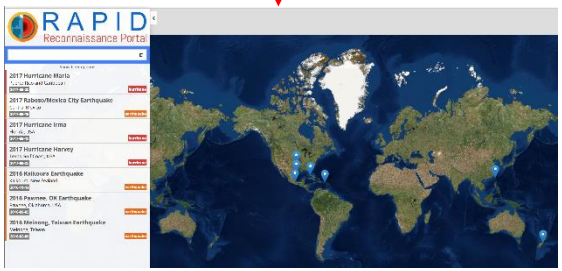
Tsunami Inundation

Transforming Natural Hazards Reconnaissance

Tsunami inundation

Transforming Natural Hazards Reconnaissance

DESIGNSAFE-CI
A NATURAL HAZARDS ENGINEERING COMMUNITY



Tsunami Inundation

Complementing Laboratory Instrumentation

Obtain 3D high- resolution point cloud models for NHERI experiments

- Record damage
- Determine precise instrument locations
- Benchmark experiments to field observations
- Develop damage detection and load history determination methods

Facility Resources

- Advanced Geomatics Technologies
- Seismic Instrumentation
- Wind and Storm Surge Instrumentation
- Social Science Reconnaissance Equipment
- Ground Investigation
- Imaging Equipment
- Software Tools
- Data Processing
- Full list:

https://rapid.designsafe-ci.org/

UAS Resources

- Hobbyist drones: lower resolution data for damage assessment
- Consumer-grade: aerial photography for SfM
- Industrial: weatherproof, high-resolution data for SfM
- MiniRanger: lidar system, survey grade, can also be mounted to vehicle

Mavic Pro/Air

Parrot Disco Adventurer

Phantom 4 Pro+

Inspire 2

Matrice 210

MiniRanger

3D Laser Scanning Resources

Leica BLK360 (x3)

Maptek XR3

Maptek LR3

- Short and long range systems
- Simple, easy to use interfaces
- Portable and durable
- Streamlined workflows

Surveying Technologies: Equipment

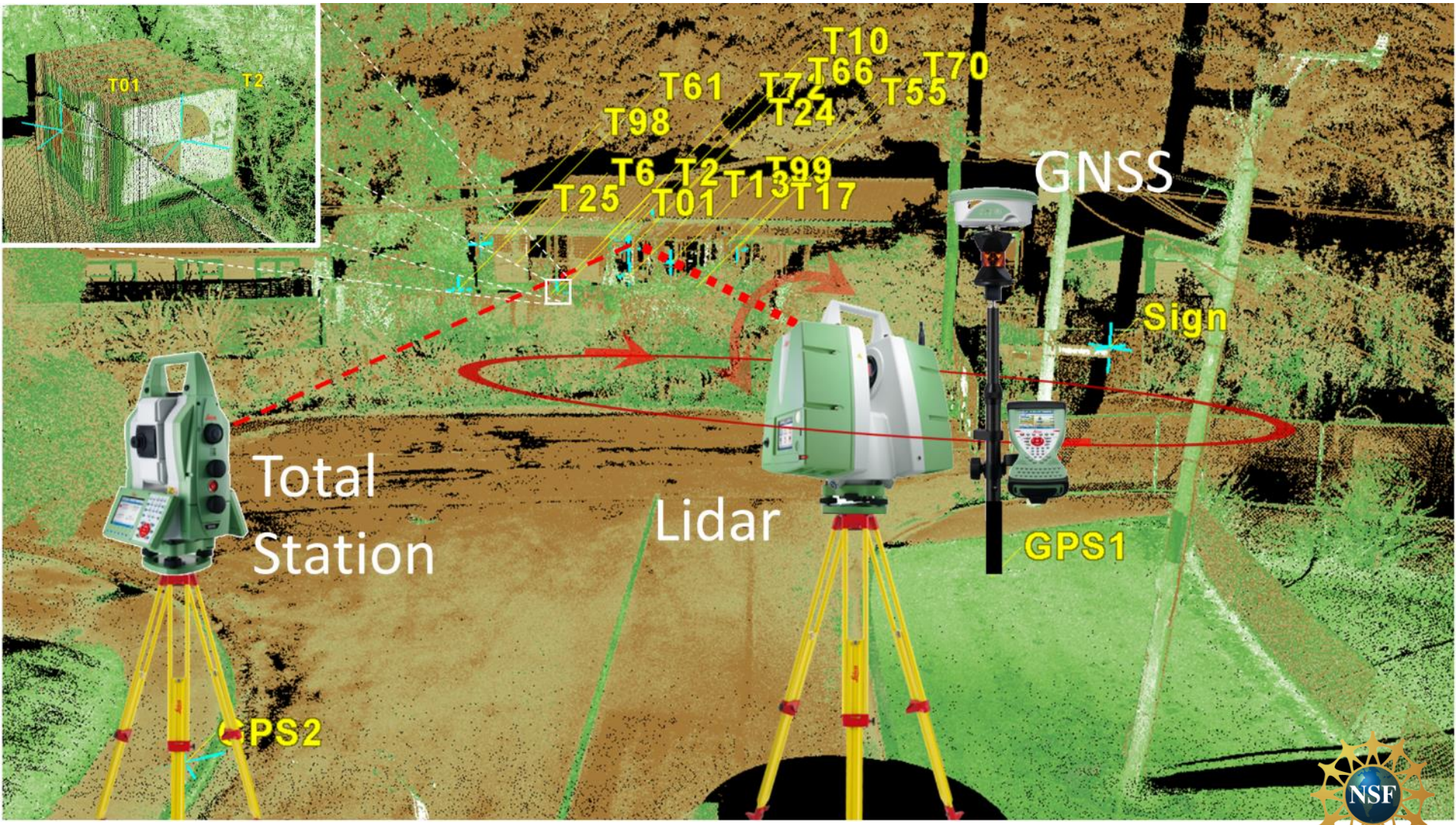
Leica Nova TS16 Total Station

Leica GS18 GNSS (x4)

Leica LS15 Digital Level

- Total station with reflectorless, robotics, and imaging capabilities
- GNSS receiver with improved positioning with obstructions
- High precision digital level

Surveying Technologies: Example Applications



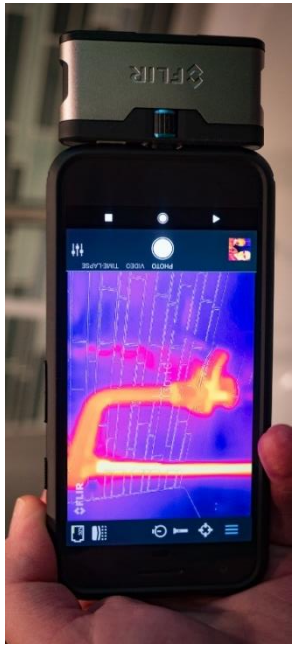
Seismic Rockfalls, Christchurch, New Zealand (Olsen & Gillins, 2015)

Applied Streetview

Google Streetview deployment after Tohoku Earthquake

- Your own, personal Streetview
- 360-degree, car-mounted camera
- GNSS georeferencing
- Scrub sensitive info (faces, license plates)
- Easy mount to vehicle
- Visualization Software for organizing and querying projects
- Interest already from social science and engineering

Other Imaging



Flir Thermal Camera (x5)

Canon 7D Mark II (x2)

DJI Osmos & 4K Camera (x3)

Gigapan Epic Pro V

Insta360 ONE (x5)

Rap Pack, Communications and Safety

- Ready to go backpacks with smaller tools important for recon
- Additional items:
  - Portable Power Generators
  - NHERI RAPID safety vests with iPad pocket
  - Pelican Cases
  - Power Inverters

Coastal: Equipment

- **Surface UAV with singlebeam sonar**
- Accurate bathymetric transects
- Teledyne Z-Boat with Odom CV100 Echo Sounder
  - Bottom type/features
  - Erosion/deposition
  - Infrastructure damage
- Researcher-supplied equipment

Coastal: Equipment

- **Pressure sensors (20)**
- Time series of:
  - Flow depths
  - Surge heights
  - Runup heights
  - Storm waves
- TruBlue 255 x 20
- Water level and wave measurement. Onshore and nearshore/offshore (using beacons) for storm surge etc.


USGS 2017

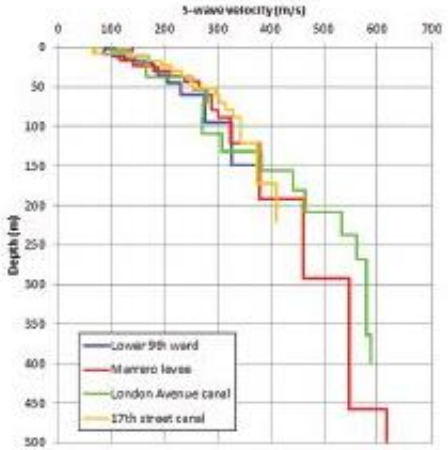
Trillium Compact Seismometers and ATOM Wireless Seismic Data Acquisition

Trillium Compact Seismometer (x6)

Centaur Digital Recorder (x6)

- Broadband seismometers (x6)
- Robust recorders (x6)
- Easy to use, easy to carry

ATOM wireless seismic data acquisition system (x24)



Shear wave velocity-depth plots

- Wireless seismic data acquisition system
- For: multichannel analysis of surface waves (MASW)
- Shear wave data up to 1km deep
- GPS controlled timing
- Retrieve data with WiFi

Ground Investigation: Equipment

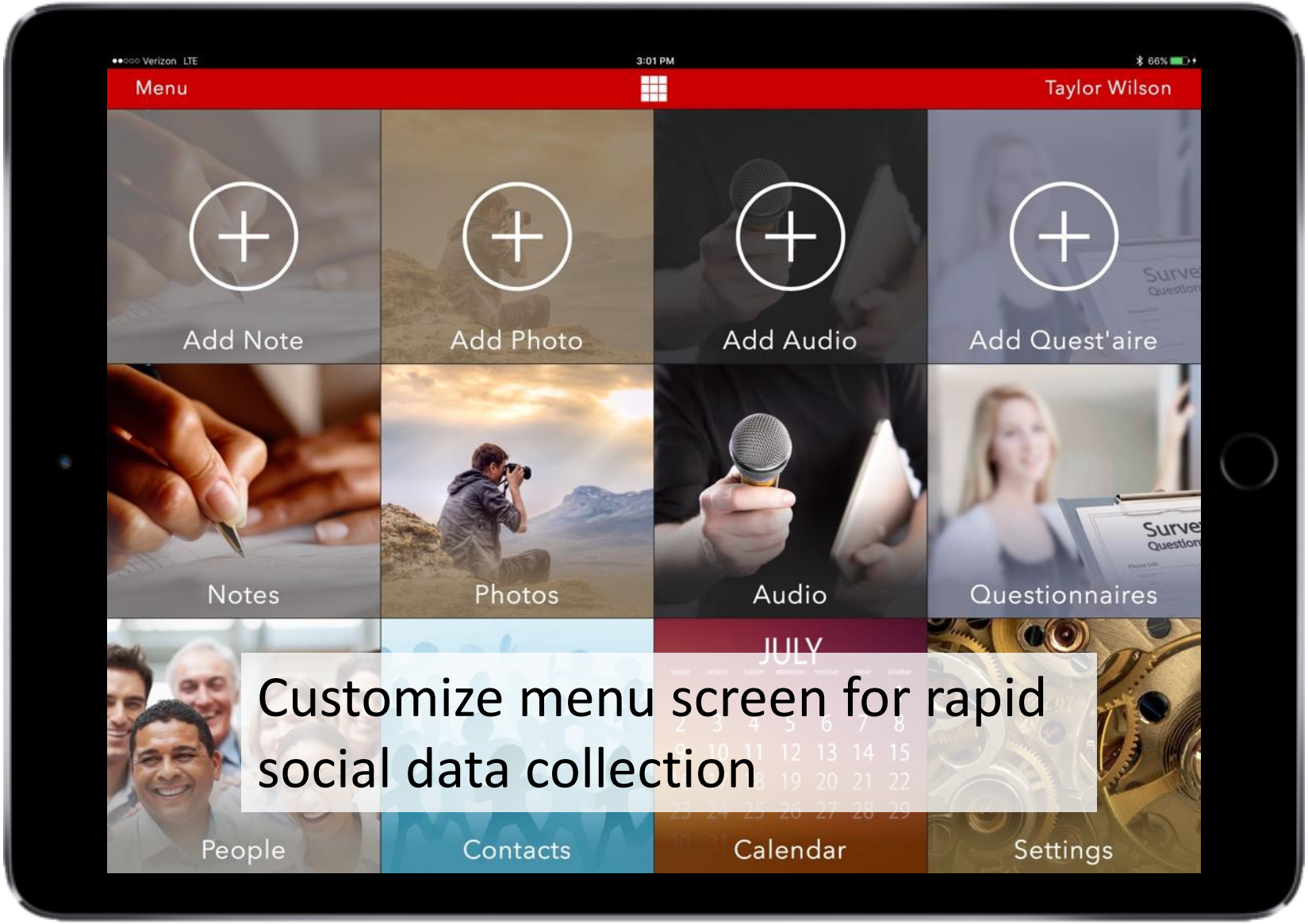
Hand-held Smart Dynamic Cone Penetrometer

Basic Soil Sampling Kit

SilverSchmidt and RockSchmidt Hammer

Pocket Penetrometer

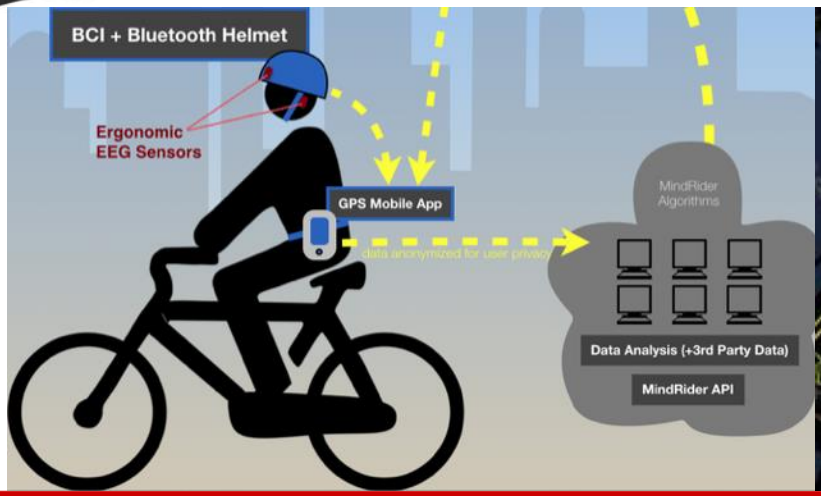
Social & Citizen Science: RApp for Social Data



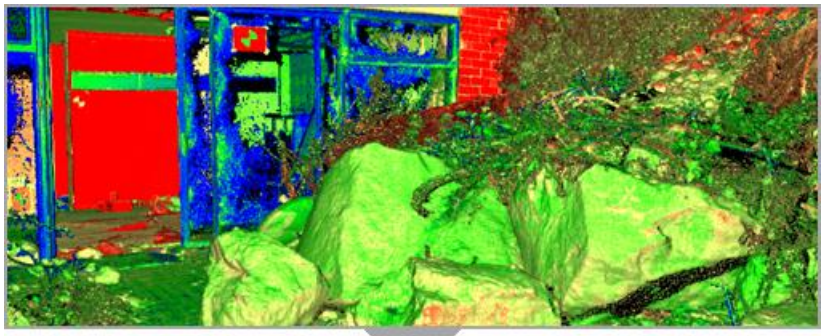
Social & Citizen Science: Equipment

- EMOTIV EPOC+ 14 channel wireless EEG (electroencephalography)
  - Mobile Wireless Brain-Computer Interface
  - Track conscious thought, emotions, facial expressions, head rotation, and location (w/ smart phone or tablet)

For example….



Reconnaissance Data Collection, Processing and Archiving



RAPID NHERI
Post-disaster Rapid Response Research Facility

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A NATURAL HAZARDS ENGINEERING COMMUNITY

Field Reconnaissance

- Plan Reconnaissance Effort
- Collect Data

RAPID Facility

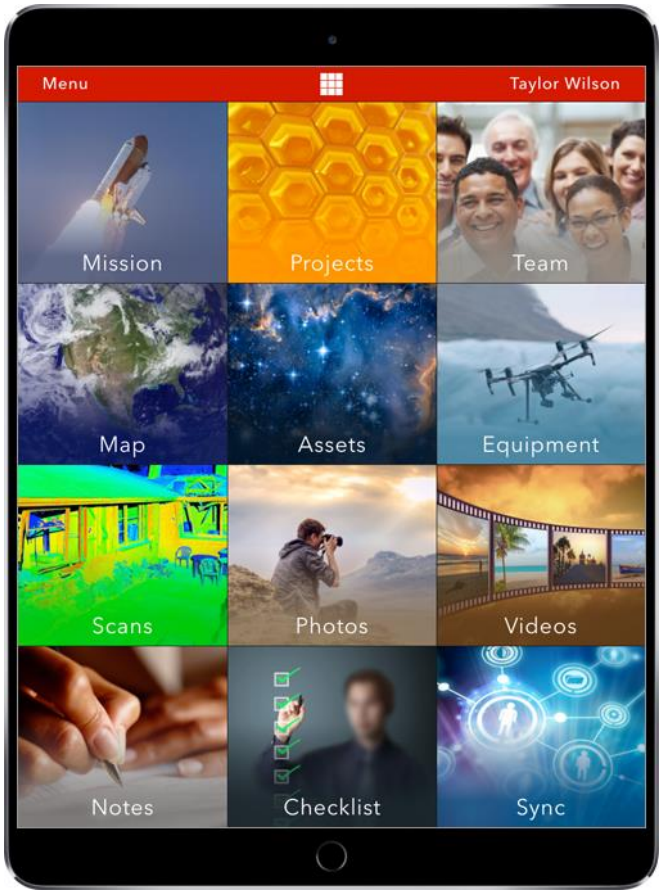
- Analyze Data and Create New Products
- Tag and Upload Data

DesignSafe-CI

- Cyberinfrastructure
- Upload, Tag, Explore, Share, and Publish Data

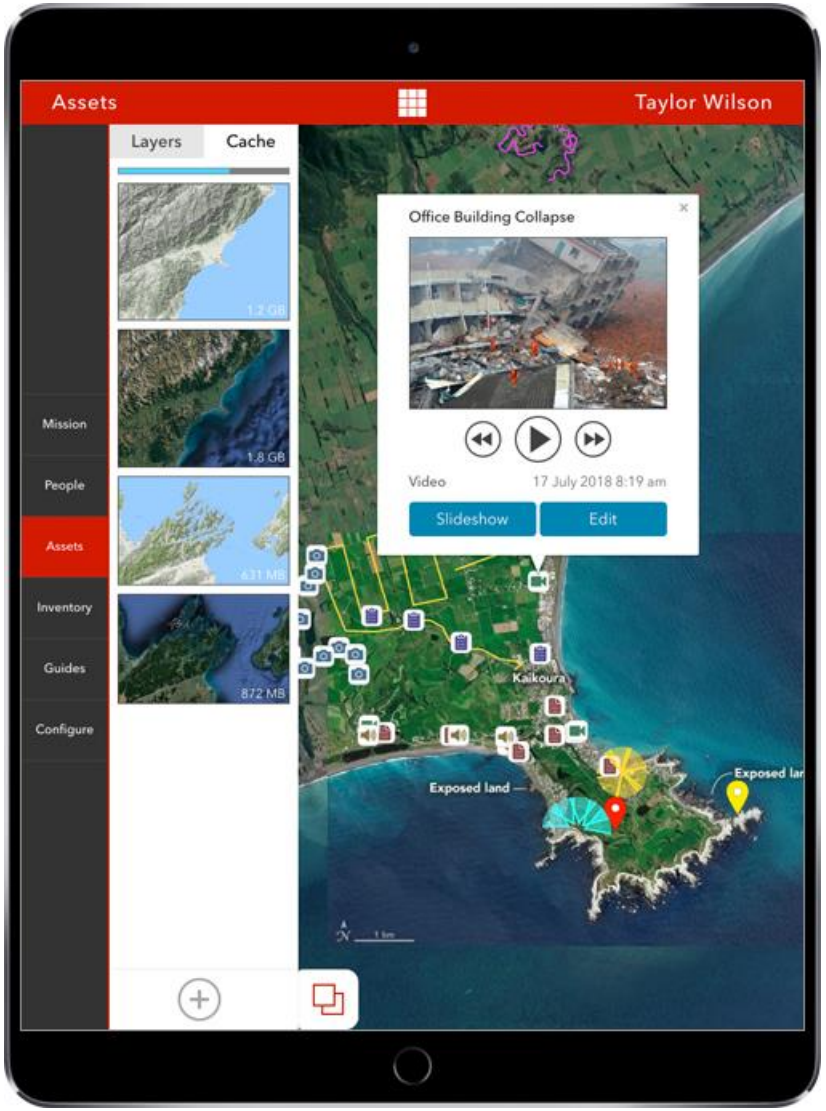
RApp

RApp, the RAPID App, integrates mission planning, data collection, and data management into a single, unified package



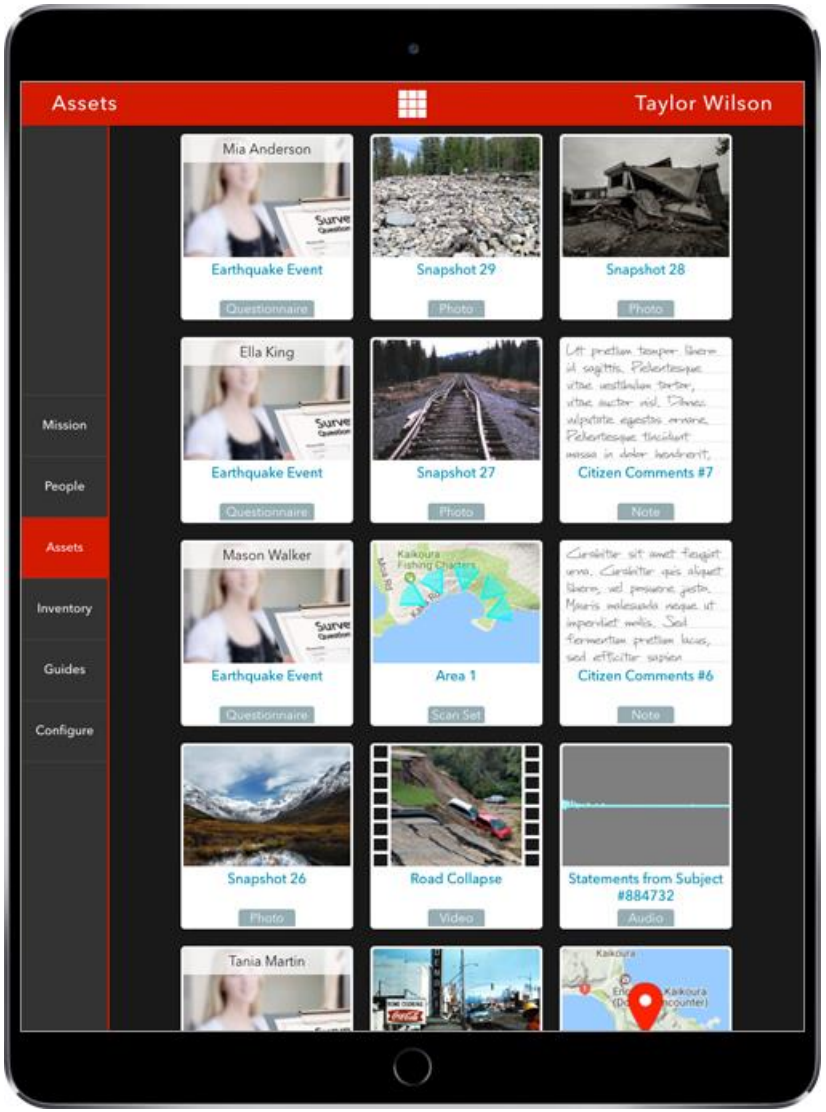
- All data collected is treated equally, allowing novel approaches to organization and comparisons
- Tedious tasks are simplified, allowing field recon teams to spend more time on data collection efforts

RApp: Mission Planning



- Mission Coordination
- Cacheable Maps
- Location Tracking
- Inventory
- Equipment Information
- Checklist
- Data Synchronizing
- *and More*

RApp: Data Collection

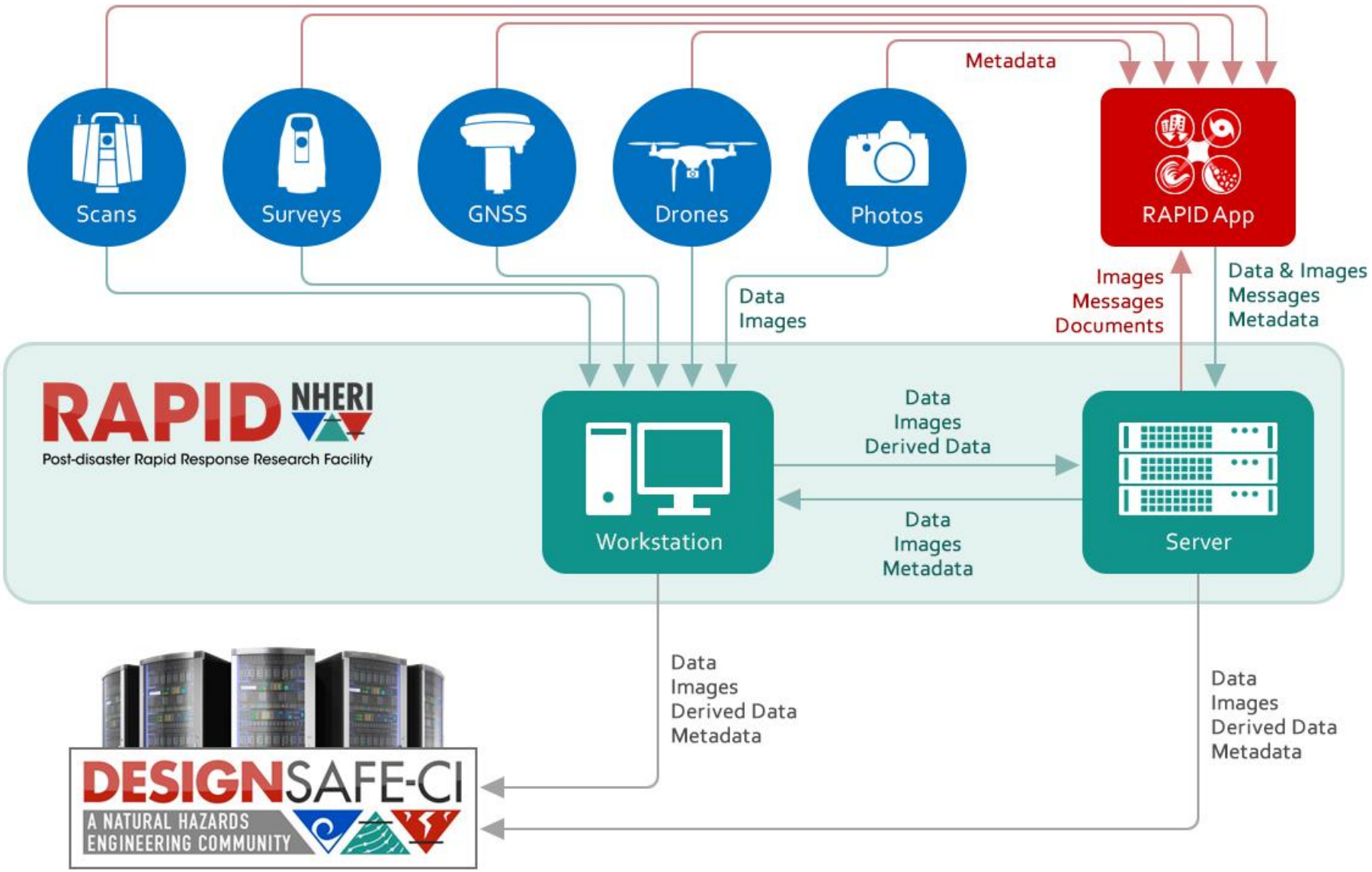


- Customizable Menu
- Photos & Videos
- Equipment Aware Scans
- Surveys & Questionnaires
- Grid, List, & Map Views
- Data Tagging
- Data Upload to DesignSafe
- *and More*

Mobile Software Suite

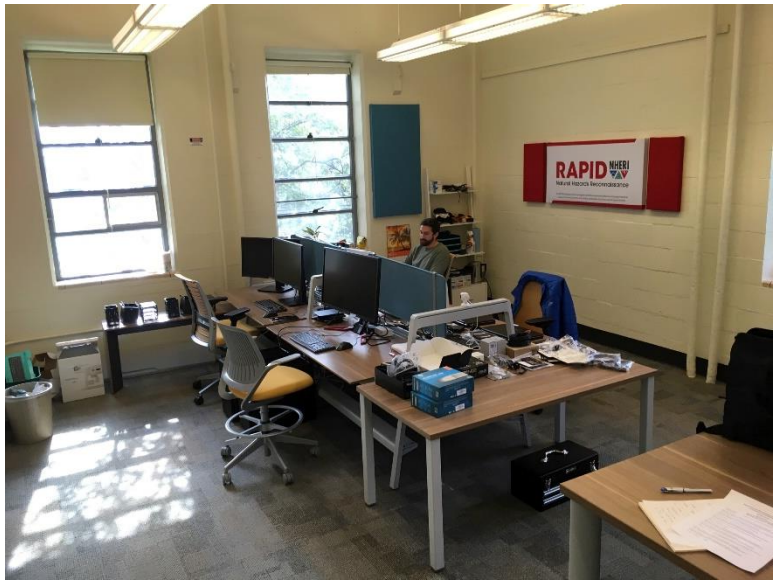
- Companion apps will be included on RAPID iPads alongside RApp to provide additional capabilities.
- Users can install their own apps on RAPID iPads to further customize the RAPID mobile software suite to meet their needs.

Data Workflow



Data Processing

- Included for all NSF users at no cost:
  - Registration of lidar data
  - Upload of raw (and registered) data to DesignSafe
- RAPID HQ at UW has:
  - High speed processing computers
  - 3D CAVE for visualization and inspection of data sets
- Additional processing options (point cloud development from lidar and/or images):
  - You or your students and associates come to RAPID HQ, or borrow a high-power laptop computer and work at your location
  - Work within the DesignSafe cloud environment
  - Ask us to process



Overview of Using the RAPID

Before Deployment

Before Requesting Equipment:
- Read RAPID Site User Manual
- Review equipment list and specifications
- Review User Agreement
- Review user rates and fees
- Verify liability insurance
- Verify reconnaissance funding source
- Complete user training (recommended)

Request Equipment (Preferred 2 Weeks Prior to Deployment):
- Check current status of equipment
- Complete the RAPID Equipment Request Form

Discussion Between RAPID And User (Within 2 Business Days of Equipment Request):
- Equipment needs
- Schedule
- Rates
- Shipping logistics
- Complete RAPID User Agreement

Setup RApp (if Needed):
- User setup of RApp via web interface
- RAPID prepares field tablets
- Verify DesignSafe account is active

Receive Equipment:
- Options: At home, in field, from RAPID HQ, carried by RAPID staff, handoff from another team

Deployment

Collect Data:
- Use manufacturer or RAPID developed equipment manuals (loaded on RApp or otherwise provided)
- RAPID remote support as needed
- RAPID staff in-field (if needed)

Return Equipment:
- Options: Shipping, returned by hand, returned by RAPID staff, handed off to another team
- RAPID will inspect and verify equipment condition

After Deployment

Data Archival:
- Raw data uploaded to DesignSafe by RAPID staff
- Good practice to back up data during deployment as well on backup devices or computers

Data Processing:
- If needed RAPID HQ has processing capabilities
- Can setup as part of initial user agreement or arrange afterwards
- Processed data uploaded to DesignSafe by user

Pay User Rates:
- RAPID invoices per the user agreement
- Payment expected within 30 days

The RAPID's Roles

- Maintain and calibrate equipment for you to use
- Provide staff assistance for use when necessary
- Assist with proposal preparation:
  - Advice
  - Integration with science plan
  - Provide budget information for RAPID equipment and staff
- Logistical support:
  - Arrange and assist with equipment delivery
  - RApp (RAPID App) to help with team organization/coordination

- ***Outside our scope:***
  - *Coordinating reconnaissance missions*
  - *Setting the scientific objectives for reconnaissance missions*
  - *Providing funding for reconnaissance*

Where can the RAPID Equipment be Deployed? (Anywhere!)

- Locations following natural hazards:
  - Priorities are wind events, earthquakes, and tsunamis but others possible
  - Immediate response
  - Recovery monitoring
  - Pre-event
- To supplement instrumentation at large-scale experimental facilities
  - Priorities are tests at other NHERI facilities
- Other uses we haven't thought of: Just ask
- Focus on short term deployments:
  - Longer term deployments possible
  - More than two weeks will require a user agreement to ensure equipment can be returned for high priority use if it is needed

Who can use the RAPID? (You can!)

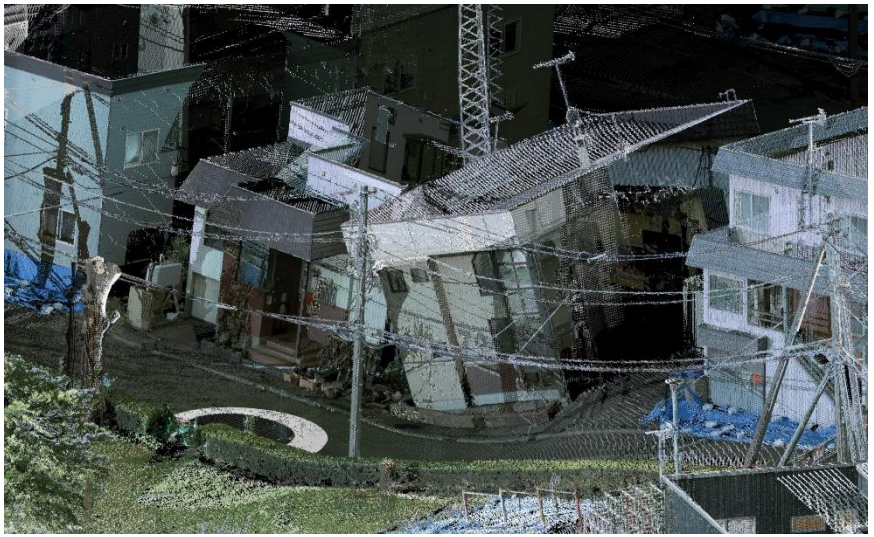
- Open to anyone:
  - Academics, government agencies, private industry, etc.
  - Different rates for NSF vs. non-NSF (RAPID equipment is subsidized by NSF)
  - Different priority for equipment requests
  - **We aim to accommodate all requests**
- NSF Grants:
  - RAPID equipment can be requested for any NSF research
  - Reconnaissance possibilities:
    - RAPID grants
    - NSF supported reconnaissance organizations (GEER http://www.geerassociation.org/ , ISEER (https://hazards.colorado.edu/news/center-news/102)
    - Other NSF proposals

User Training and Site User Manual

- User training:
  - Recommended but not required
  - 1-Day overview workshops
  - 4-Day intensive hands-on workshops (at RAPID headquarters in Seattle)
    - July 23-26, 2019
    - Creates cadre of RAPID equipment experts
    - List of participants and expertise will be maintained on https://rapid.designsafe-ci.org/
- Site user manual:
  - On website

What to Think About Before Requesting Equipment

- Is the project funded or is it in the proposal stage?
- Will our equipment meet your needs?
  - Review the available equipment and capabilities (https://rapid.designsafe-ci.org/equipment-portfolio/)
- Do you know how to use the equipment you want?
- Will you need field assistance from RAPID staff (required for certain equipment)?
- Will you need assistance processing the data (especially lidar data and development of point cloud models)?



How to Request RAPID Equipment?

- Steps:
  1. Go to the RAPID website at https://rapid.designsafe-ci.org/
  2. Determine the desired equipment from the equipment portfolio at https://rapid.designsafe-ci.org/equipment-portfolio/
  3. Check that it is available for the dates you want
     - New page coming by June showing deployment of RAPID equipment in a calendar format
  4. Complete the preliminary equipment request form at https://rapid.designsafe-ci.org/
     - Button coming to our main page soon
  5. Wait for us to contact you (less than 24 hours)
  6. Work through scheduling, logistics, and rates with us
  7. Complete user agreement

RAPID Priorities for Equipment Requests

- The RAPID will make every effort to accommodate all requests
- When we can't, this table sets our priorities
- We have and continue to establish MOU's with other organizations that have similar equipment to help handle intensive drawdowns

User	Data Collection Activity				
	Near-Term Response to a Priority Natural Hazard[1]	Recovery Phase for a Priority Natural Hazard[1]	Experiments at NHERI Facilities	Other Natural Hazards	Other Applications
NSF Supported	1	2	2	3	3
Non –NSF Federal Agency	4	5	5	5	5
Other	5	6	6	6	6

[1] Priority Natural Hazards: Hurricanes, Tornados, Other Windstorms, Storm Surge, Earthquakes, Tsunamis, and Landslides

Equipment Delivery

- The RAPID will organize the shipping of equipment
  - It may meet you in the field
  - You may retrieve from the UW
  - Our staff may meet you with it
  - You may receive a hand-off from another reconnaissance team
- You will be responsible for some of the delivery costs
- The site user manual (coming to the RAPID website) will have detailed requirements
- The RAPID will help with import/export controls
  - Instrument specific
  - Limitations on certain countries

User Agreements and Insurance

- Users are required to sign a user agreement:
  - Safe conduct
  - Read user manual
  - For equipment operated by you:
    - Transfer of liability to you (your agency and/or university)
    - Agreement to replace if lost or damaged in your care
- Insurance (details still forthcoming)
  - RAPID's insurance will cover:
    - Use by our staff
    - Equipment during delivery
    - Damage and loss in possession of users (who are listed on the User Agreement)
  - User's ***may*** need to:
    - Ensure your agency will cover liability
    - Most universities have general policies that will cover liability for any of your field research

User Rates and Fees

- Available on RAPID website
- Preliminary rates (NSF users, for illustration only):
  - Equipment: $5 (various cameras) to $516 per day (long range lidar)
  - RAPID staff in field: $750 per day + travel
  - RAPID data processing (see next slide): $76 per day
- 8% overhead on all costs
- Estimated typical mission cost:
  - Long range lidar + medium UAV for 5 days in field without RAPID staff:
    - Equipment: $2750
    - Shipping: $400 (conservative)
    - Overhead: $220
    - Total: $3370

Thank You https://rapid.designsafe-ci.org/

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