RAPID NHERI
Natural Hazards Reconnaissance

The RAPID Facility Science Plan

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RAPID Facility Workshop
25 June 2018, Los Angeles, CA
NSF Award Number: CMMI 1611820

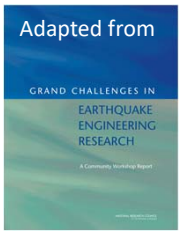
Outline

- NHERI RAPID Facility Community Workshop – Jan 2017
  - Aims
  - Participants and Activities
  - Outcomes
- NHERI Five-Year Science Plan – released Jul 2017
- NHERI RAPID Facility Science Plan
  - Grand Challenges
  - Informing Models
  - Strategic Approaches

Workshop Aims

- Identify data gathering opportunities and facility user needs
- Develop prioritized list of equipment for RAPID
- Identify challenges to disaster reconnaissance research (DRR) data collection and reuse
- Develop prioritized list of reconnaissance support needs

Workshop Outcomes: Grand Challenges Reconnaissance Data Needs



- **Community Resilience Framework**
  - Temporal recovery; how long does it take?
  - Data collection that addresses equity
  - Baseline pre-event data: social, infrastructure, topography
  - Large-scale data at community or regional scale that shows intersections between built, natural, social, political and cultural environments (i.e., networks, connectivity)
- **Hazard and Impact Simulation and Decision Making**
  - Population distributions at time of event (how does this influence death, damage, downtime and loss?)
  - Spatial distribution of all hazards
  - Multi-disciplinary timing and time histories of event: soil characteristics, wind speed and direction, ground motion, human behavior, structural behavior

Workshop Outcomes: Grand Challenge Reconnaissance Data Needs

- **Mitigation**
  - Evaluation of pre-existing hazard maps for "all hazard" – e.g., shaking, flooding, faults
  - Damage with respect to hazard forcing and structural characteristics; what worked? What didn't?
  - Document both successful and unsuccessful performance
  - Lifeline performance vulnerability curve design vs. performance
  - Multi-(geospatial) scale analyses; coarse information across large areas; detailed at specific sites.
- **Design Tools**
  - Measurements of dynamic demand (i.e., "forcings")
  - Design performance goals for structure, infrastructure, and critical systems
  - Performance of systems with protective technologies

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NHERI Five-Year Science Plan: Grand Challenge Subject Areas

- Identify and quantify the characteristics of earthquake, windstorm, and associated hazards—including tsunamis, storm surge, and waves—that are damaging to civil infrastructure and disruptive to communities.
- Evaluate the physical vulnerability of civil infrastructure and the social vulnerability of populations in communities exposed to earthquake, windstorms, and associated hazards.
- Create the technologies and engineering tools to design, construct, retrofit, and operate a multi-hazard resilient and sustainable infrastructure for the nation.

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NHERI Five-Year Science Plan: Key Research Questions

- How do we **characterize the transient and variable nature of the loading actions** imposed on the nation's civil infrastructure from earthquakes, windstorms, and associated hazards?
- How can the scientific community enable **robust simulation of the performance of civil infrastructure to loading** from earthquakes, windstorms, and associated hazards, while also considering individual- and community-level impacts?
- What are the **key physical responses, vulnerabilities, and factors influencing post-event recovery** of civil infrastructure and communities?
- What **are effective mitigation actions to achieve community resilience**, especially when considering different hazards, shifting vulnerabilities, emerging technologies, and sustainability goals?
- How can the scientific community more effectively **collect and share data and information to enable and foster ethical, collaborative, and transformative research and outcomes**?

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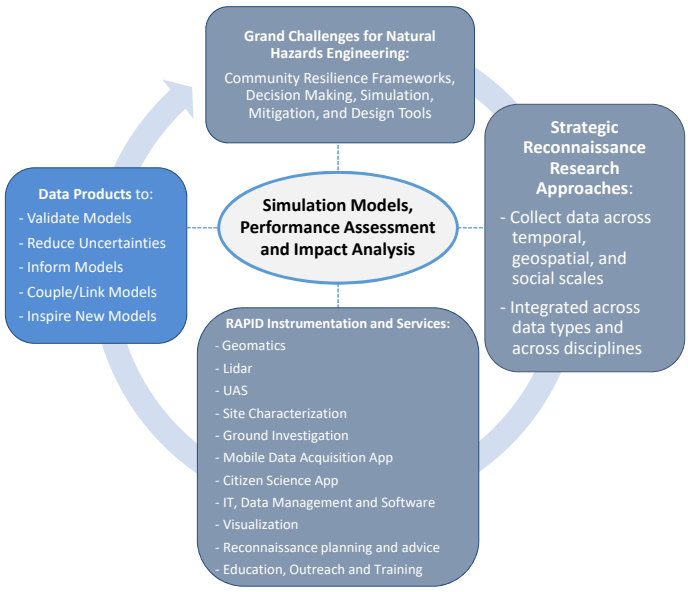
RAPID Science Plan

The principal scientific goal of the RAPID is

to *inform natural hazards computational simulation models, infrastructure performance assessment, and socioeconomic impact analysis by supporting the collection, development, and assessment of high-quality disaster data sets*



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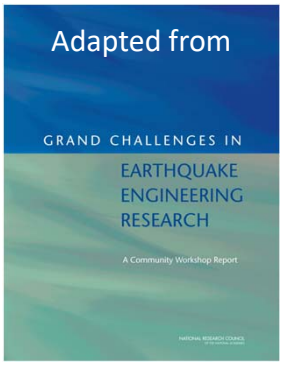
Science Plan: Grand Challenges for Natural Hazards Engineering and Science

- Community Resilience
- Hazard and Impact Simulation and Decision Making
- Mitigation
- Design Tools



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Science Plan: Grand Challenges for Natural Hazards Engineering and Science

- Community Resilience: RAPID tools
  - Enable the systematic collection and archiving of integrated, interdisciplinary post-disaster data pertinent to engineering and the natural and social sciences, needed to evaluate the utility and validity community resilience frameworks
- Hazard and Impact Simulation and Decision Making
- Mitigation
- Design Tools

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Science Plan: Grand Challenges for Natural Hazards Engineering and Science

- Community Resilience
- Hazard and Impact Simulation and Decision Making: RAPID elements address the need for
  - extensive data sets for model development and testing of complex simulations, including high-quality data (e.g., initial and boundary conditions) at multiple geospatial scales.
- Mitigation
- Design Tools

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Science Plan: Grand Challenges for Natural Hazards Engineering and Science

- Community Resilience
- Hazard and Impact Simulation and Decision Making
- Mitigation: RAPID's multi-scale tools provide
  - the means to develop computational models and construction standards capable of identifying critical vulnerabilities and quantifying the impacts of risk reduction measures, as well as
  - post-event data needed to evaluate loss estimation methodologies, such as HAZUS-MH, and the effectiveness of mitigation approaches.
- Design Tools.

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Science Plan: Grand Challenges for Natural Hazards Engineering and Science

- Community Resilience
- Hazard and Impact Simulation and Decision Making
- Mitigation
- Design Tools: RAPID tools provide
  - high-quality performance data to define model relationships (e.g., fragility functions) for performance-based design.

Science Plan: Strategic Approaches – Acquire and integrate data over a range of temporal and spatial scales, across disciplines

EARTHQUAKE EXAMPLE ILLUSTRATING LINKS BETWEEN STRATEGIC APPROACHES, INSTRUMENTATION, AND DATA COLLECTION PRODUCTS

Overarching Strategic Reconnaissance Research Approaches

1. Collect data across temporal scales, e.g. evolution of co-seismic landslide with time, recovery and return to home for affected persons
2. Collect data across geospatial scales, e.g. community-level and site-specific damage mapping, regional geology trends and site period
3. Collect data and integrate across disciplines, e.g. collect building damage and socio-economic data in identical effected communities

UAS lidar: Aerial mapping of ground failure to obtain high-resolution, bare-earth DEM

UAS camera: Aerial mapping of building damage patterns to obtain orthophotos and DEM

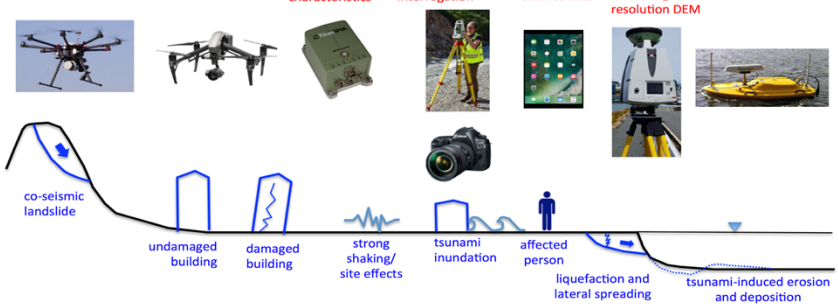
Seismometer: measure natural period and aftershocks to obtain site characteristics

Camera and geomatics control: SfM survey to map building damage to obtain 3D model for interrogation

iPad App: interview affected persons to obtain social science data

Terrestrial lidar: map ground failure and affected structures to obtain high-resolution DEM

AUV/single beam: submarine mapping to obtain bathometry



Science Plan: Strategic Approaches – Acquire and integrate data over a range of temporal and spatial scales, across disciplines

WIND (HURRICANE) EXAMPLE ILLUSTRATING LINKS BETWEEN STRATEGIC APPROACHES, INSTRUMENTATION, AND DATA COLLECTION PRODUCTS

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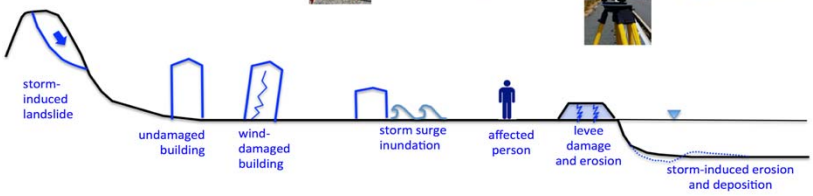

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RAPID Facility Basics

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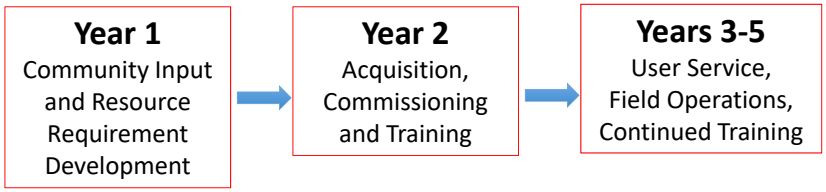
RAPID Timeline



September 2016-September 2017

- Developing facility headquarters
- Hiring staff
- Workshop
- Science plan revision
- Specification development
- Trial equipment deployment and testing
- Coordination with DesignSafe
- Facility operating documents
- Advertising
- Mobile app development

September 2017-September 2018

- Procurement and commissioning
- Staff training
- Facility operating plan and site users manual
- User training workshops (4)
- REU program
- IT cyber security
- RApp development and testing
- Fiscal operating plan
- Proposal support

September 2018 and beyond

- Supporting field missions and data use/reuse
- Training
- Maintenance
- Updating

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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

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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*

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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
- 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

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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

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User Training and Site User Manual

- User training:
  - Recommended but not required
  - 1-Day overview workshops (like this)
    - General focus, Arlington, VA, March 26
    - Wind-focused training in collaboration with NHERI WOW, Miami, May 17-18
    - Earthquake-focused training at the NCEE in Los Angeles, June 25
    - Joint GEER-RAPID training in San Francisco, week of September 17
  - 4-Day intensive hands-on workshops (at RAPID headquarters in Seattle)
    - July 24-27, at capacity
    - Creates cadre of RAPID equipment experts
    - List of participants and expertise will be maintained on https://rapid.designsafe-ci.org/
- Site user manual:
  - In progress, will be posted on the RAPID website by September 1

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What to Think About Before Requesting Equipment

- Is the project funded or is it in the proposal stage?
- Will our equipment meet you 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)?

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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

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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
  - User's ***may*** need to:
    - Ensure your agency will cover liability and damage/loss when under your use
    - Most universities have general policies that will cover your use of our equipment
  - See updates on RAPID's website coming by September 1

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User Rates and Fees *(tentative)*

- Final rates will be published by September 1
- Preliminary rates (NSF users, for illustration only):
  - Equipment: $5 (small UAV) to $500 per day (long range lidar)
  - RAPID staff in field: $500 per day + travel
  - RAPID data processing (see next slide): $750 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: $1000 (conservative)
    - Overhead: $300
    - Total: $4050

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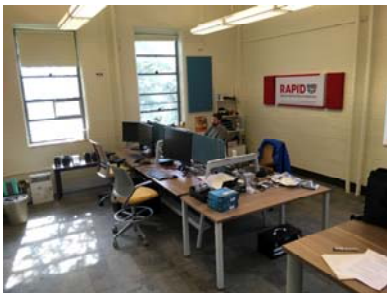
Data Processing

- 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/associates come to RAPID HQ, or borrow a high-power laptop computer and work at your location
  - Work within the DesignSafe cloud enviroment
  - Ask us to process



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Questions?

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