NHERI Council Monthly Meeting No. 4, Y-3- Date: 11/7/2018- 4:00 to 5:00 PM ET

Zoom Meeting Details:

Topic: NHERI Council - Fall 2018 Series
Time: Sep 12, 2018 4:00 PM Eastern Time (US and Canada)
Sep 12, 2018 4:00 PM
Oct 3, 2018 4:00 PM
Nov 7, 2018 4:00 PM
Dec 5, 2018 4:00 PM
Please download and import the following iCalendar (.ics) files to your calendar system.
Monthly: https://DesignSafe-ci.zoom.us/meeting/644875759/ics?icsToken=afd60fb367ec34a8d21e31ec6571cff6e2df38098949d33073cf2a2f714478bf
Join from PC, Mac, Linux, iOS or Android: https://DesignSafe-ci.zoom.us/j/644875759
Or iPhone one-tap :
US: +16699006833,,644875759# or +16465588656,,644875759#
Or Telephone:
Dial(for higher quality, dial a number based on your current location):
US: +1 669 900 6833 or +1 646 558 8656
Meeting ID: 644 875 759
International numbers available: https://zoom.us/u/cau9txY3Y

Attending: A. Chowdhury (WOW EF); J. Conte (LHPOST EF); D. Cox (LWF… EF); M. Schoettler (SimCenter); F. Masters and J. Bridge (Vice-Chair, BLWT… EF); J. Ramirez (Secretary, NCO); T. Cockerill (DesignSafe-CI); J. Ricles (RTHS EF); Farn-yu Meng (TREX… EF); J. Wartman (RAPID EF); NSF: J. Pauschke; Guests: Jennifer Tobin (CONVERGE), Liesel Ritchie (User Forum), Kevin Johnson (Oklahoma State), Antonio Bobet (NCO)

Minutes

1. Attendance, Review and Approval of Minutes (previously distributed) of Meeting No. 3 (October 3, 2018) in Y-3 (Ross) -- Approved Minutes: https://www.designsafe-ci.org/facilities/nco/governance/nheri-council/

   Minutes were approved as distributed, Joe W. moved and Joel C. seconded.

2. Facility Items:
   a. NCO- (Julio)
      i. User Satisfaction Survey Y2 results and NIAC Annual Report. The User Satisfaction Survey is posted on designsafe-ci at: https://www.designsafe-ci.org/community/user-forum/ Prof. Liesel Ritchie, User Forum member and lead of the User Satisfaction Survey, and graduate student Kevin Johnson, will join the meeting to participate in the discussion. She will be supported also by Prof. Antonio Bobet, NCO Liaison to the User Forum. Please see the attached report to inform the discussion.

         Prof. Liesel Ritchie, Survey Lead for the User Forum went over the two documents distributed and focused primarily on the document "NHERI 2018 Action Items 10-21-18" attached to these minutes and asked the Council for feedback and help to improve it. Several action items were identified:
         - To enhance the response, the User Forum is looking at the timeline for it and is considering to move it earlier in the year.
         - Joy Pauschke noted that there were several efforts ongoing in NHERI to collect user input on level of satisfaction. She noted that several of the facilities in their AWP indicated that exit surveys of researchers are conducted. Jennifer Bridge said that University of Florida is conducting the survey and is willing to share the data with the User Forum. Prof. Ritchie suggested that the exit survey could be taken on line and data sent directly to the User Forum. This information would be used to supplement the User Satisfaction Survey.

Action Item: Facilities conducting the survey need to contact Prof. Liesel Ritchie (liesel.ritchie@okstate.edu) from the User Forum by e-mail to coordinate the exit researcher survey.

Prof. Ritchie recommended that the Council consider addressing the response to Question 9 of the survey shown below.

Q9 – Do you have any additional comments regarding information about NHERI Facilities and Resources (N = 13)?

Respondents were asked to share any additional feedback regarding information about NHERI facilities and resources in an open-ended manner. Responses to this question generally expressed concern for organization, comprehensiveness, and clarity of information about NHERI.

Respondents were concerned with the organization of information about NHERI facilities and resources, stating "there is not a clear, transparent system for scheduling," for example, or that "…information about the facilities needs to be more uniform and complete…" Several respondents expressed a perceived lack of clarity regarding costs associated with using NHERI facilities and resources. For instance, one respondent noted "…NHERI facilities through funded NSF proposals has been consistently advertised as 'free.' In fact, use of facilities is far from free, and information on pricing is not readily available for all (or most) facilities.

ii. Status of Supplement Requests in NHERI Council Annual Work Plan Year 3.
    1. NHERI Science Plan Workshop in March 2019- funded
       The Workshop Organizing Committee is fully engaged in the task of implementing the funded proposal to conduct the workshop. The dates for the 1.5-day workshop are March 18 and 19, 2019 in Alexandria VA.

       Action Item: Julio to share the supplement proposal with the Council and latest draft of the Agenda.

iii. NCO requests to Council:
    1. Please provide names of contacts for your twitter and facebook accounts (social media handles)
    2. Send to Marti stories/articles for dissemination in the newsletters etc.

b. University of California, Davis (Ross)
    i. Discussion of Facility Metrics uploaded to the NHERI Box in designsafe-ci.

       Action Item: Forrest requested that facilities upload metrics to the NHERI PIs box in designsafe-ci before the next meeting.

c. DesignSafe-CI- (Ellen)
   Tim reported on the publications effort to inform the data re-use and citations and thanked all the facilities for sharing those data. The spreadsheet containing the compilation of the information to August/September 2018 is available in the NHERI PIs Council Box. Tim proposed that the data be updated semiannually. Joy suggested that those data be updated in time for the Annual Report which for most of the NHERI facilities is due at the end of April. The data could then look back on the previous year.

d. University of Florida- (Forrest)
    i. NSF Big Idea Competition
       Forrest reported that the NHERI Big Idea had been submitted to the NSF competition.

ii. NSF EFRI
https://www.nsf.gov/pubs/2019/nsf19502/nsf19502.htm?WT.mc_id=USNSF_25&WT.mc_ev=click

Action Item: Follow up on this for next year.

e. FIU (Arindam and Ioannis)
   i. **2019 ASCE Convention.** It will be held in Miami and one of the seven key topic areas is Natural and Man-Made Disasters (see page 4 in the attached PDF). Opportunity to showcase NHERI through a booth and/or a paper session/round-table/panel discussion.
   Ioannis and Arindam proposed to organize a NHERI activity for this meeting. Julio noted that the NHERI Booth supplement was before NSF. The meeting is to be held on Oct. 9-10 2019. Ioannis and Arindam will put in an abstract for a NHERI session using the information collected for the session request for the 2019 Structures Congress that was not successful. The deadline to request the session is January 10, 2019.

   Action Item: Ioannis and Arindam will submit the session proposal and Julio will follow up on the booth request.

3. NSF Items (Joy Pauschke)

I. NSF has completed the reviews of all 11 NHERI awards for calendar 2018. Thank you all for your input.

II. If you have not submitted your interim quarterly report due October 31 (Experimental Facilities), please submit by November 9. Also, if your interim report does not include the following, please email ASAP to Joy:

a. Year four work plan
b. NSF projects that used your facility in year three
c. NSF projects that will use your facility in year four

III. NSF has issued a DCL on Mid-scale Research Infrastructure

https://www.nsf.gov/pubs/2019/nsf19013/nsf19013.jsp

IV. NSF workshops on Coastlines and People: https://coastlinesandpeople.org/

V. Any remaining carryover funds planned to use for equipment/instrumentation upgrades/acquisition need to be made and implemented early in year four. Not wise to hold funds to expend for such purposes near the end of year five – raises the question as to whether the equipment/instrumentation are really needed to support research.

VI. NSF presented information on NHERI and NHERI Science Plan at NEHRP Advisory Committee meeting on November 7.

4. Ongoing Action Items
   a. Raise awareness about the availability of the Science Plan (all)
   b. NSF Big-Idea (Forrest) (This Item has been completed and will come out of the next Agenda)

5. Next Meeting- **December 5, 2018 4:00 PM**

6. Adjourn
Meeting adjourned at 5:00 PM Eastern.

Q9 – Do you have any additional comments regarding information about NHERI Facilities and Resources (*N* = 13)?

Respondents were asked to share any additional feedback regarding information about NHERI facilities and resources in an open-ended manner. Responses to this question generally expressed concern for organization, comprehensiveness, and clarity of information about NHERI.

Respondents were concerned with the organization of information about NHERI facilities and resources, stating "there is not a clear, transparent system for scheduling," for example, or that "…information about the facilities needs to be more uniform and complete…" Several respondents expressed a perceived lack of clarity regarding costs associated with using NHERI facilities and resources. For instance, one respondent noted "…NHERI facilities through funded NSF proposals has been consistently advertised as 'free.' In fact, use of facilities is far from free, and information on pricing is not readily available for all (or most) facilities."

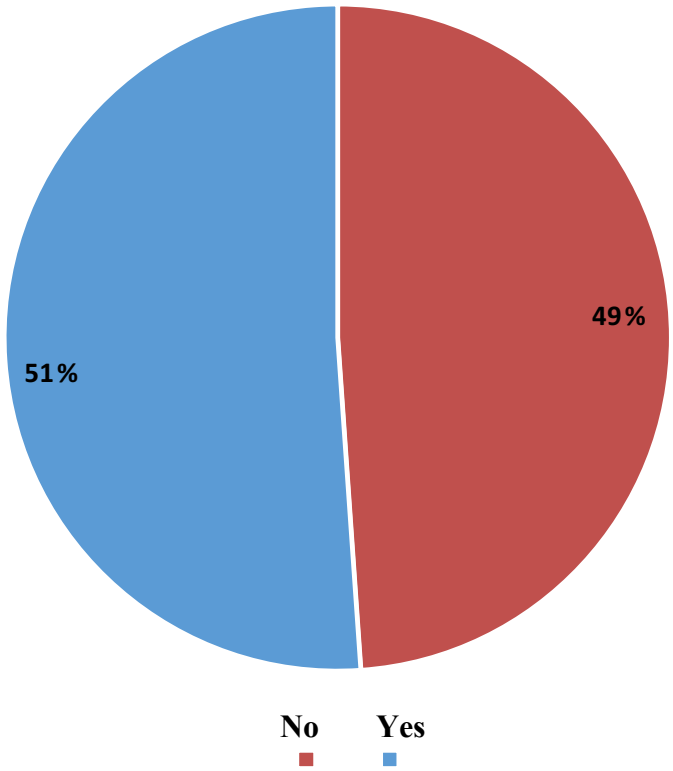
Q15 – Do you have any additional comments about NHERI Facilities' and Resources' staff, scheduling, and equipment (*N* = 9)?

Respondents were again asked to provide additional feedback – this time regarding staff, scheduling, and equipment in an open-ended manner. Those who provided feedback described inconsistency amongst facilities and perceived informal barriers to navigating facilities. One respondent spoke to the uniqueness of each facility by stating:

> "I think each site is very unique – some sites do it better than others. Some sites are extremely understaffed – and this needs to be made WELL known prior to having a PI come to site. In fact, if I didn't have my own general contractors on site, there is no way we would have finished the test with the site only having one full time staff."

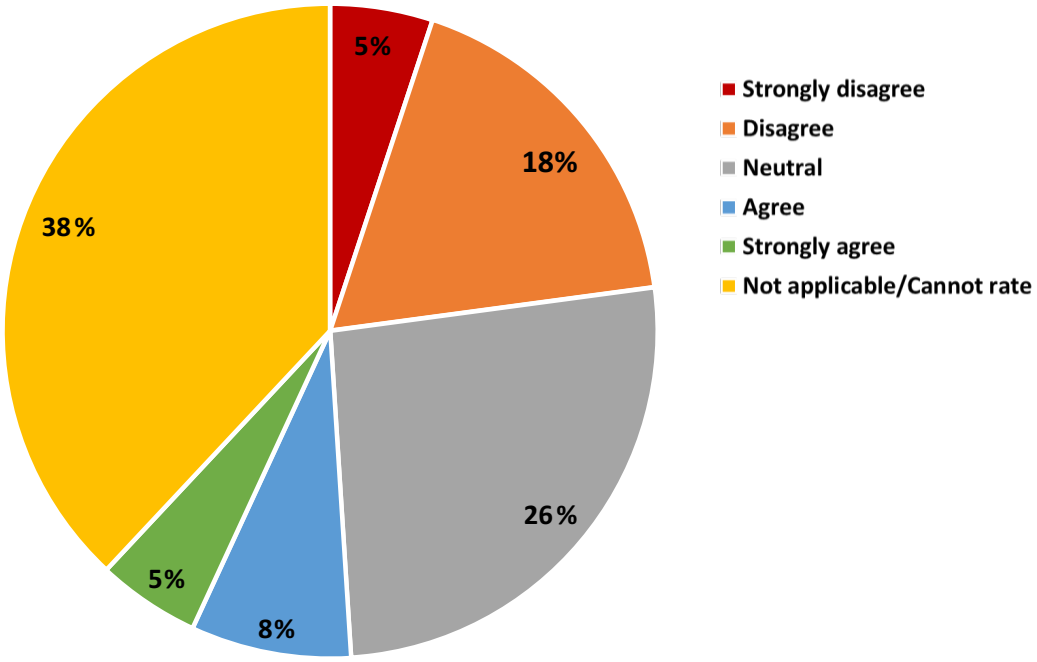
Other respondents described what they considered to be informal barriers regarding information and knowledge. For instance, one respondent noted that NHERI facilities and resources "seems like a small fraternity, with limited access," while another explained that "there are not clear guidelines for whether scheduled time is guaranteed." These concerns should be contextualized with those concerning inconsistency from one facility to another.

Q17 Have you participated in any of the proposal writing workshops and/or seminars, or utilized NHERI support resources (*N* = 41)?



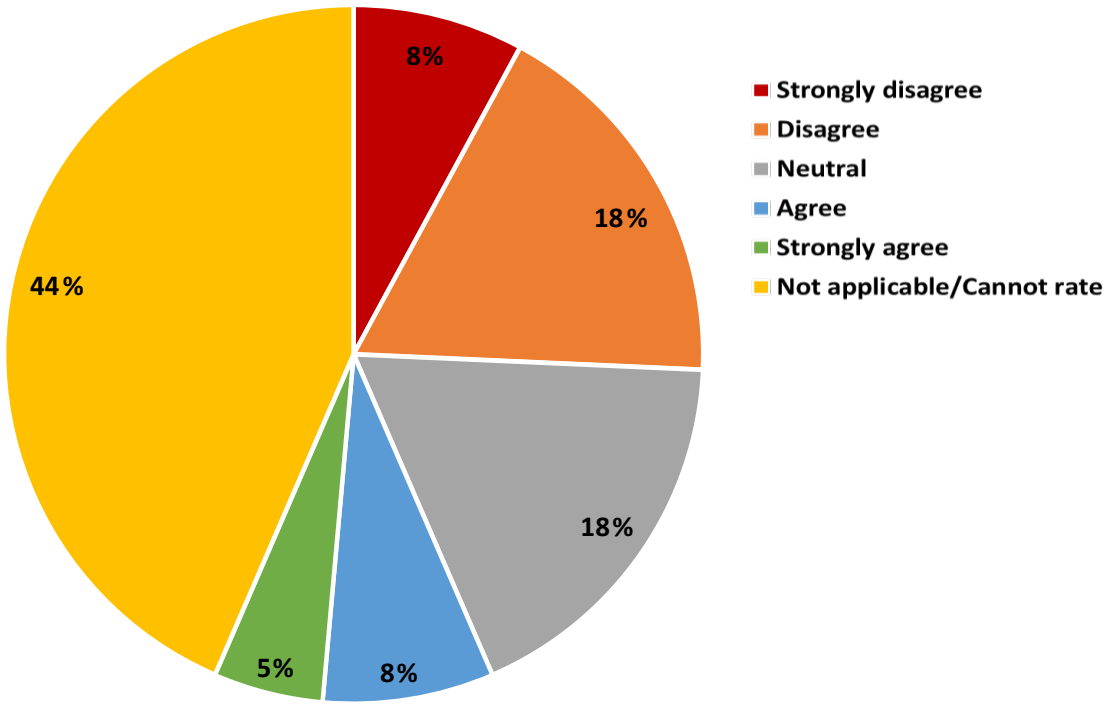
About half of respondents reported participating in writing workshops, seminars, or utilizing NHERI support resources. While follow ups to this question were not asked, it may be useful moving forward to determine why respondents did not utilize support resources. Changes could be made depending on these reasons, for instance, were those that said no more experienced and did not feel they needed assistance, or were those that said no not aware of certain support resources?

Q22 The process of uploading my data is easy to complete (*N* = 39).



This question was also featured on the 2017 survey. 38% of respondents could not rate their data uploading experience, while 13% agreed or strongly agreed the process was easy (compared to 22% from 2017). 26% of respondents felt neutral about this statement (compared to 13% from 2017), while 23% of respondents disagreed or strongly disagreed that the data uploading process was easy (compared to 11% from 2017). This reflects a downward trend in ease of use, indicating data uploading could be an area for improvement.

Q22 The process of adding metadata matches my expectations (*N* = 39).



This question was also featured on the 2017 survey. 44% of respondents could not rate the process of adding metadata, while 13% agreed or strongly agreed the process met their expectations, similar to responses in 2017 (14%). 18% of respondents were neutral regarding this statement (compared to 14% from 2017), while 26% of respondents disagreed or strongly disagreed that the process of adding metadata met their expectations (compared to 8% from 2017). Similar to data upload experiences, this is also a potential area of improvement.

Q24 – Do you have any additional comments regarding NHERI data (*N* = 8)?

Participants were also asked to provide comments regarding data. Respondents described grievances with website navigation and usability. One respondent noted that, "the searching capability to find data sets should be improved. There should be more variables one can search on, such as the hazard class or keywords or the NHERI Experimental Facilities." Another echoed these sentiments, by stating, "it would be helpful if the information on datasets was in the forefront and not after clicking on the data link for each project. DesignSafe could prepare brief summaries to inform the user about the general content of each dataset."

Other respondents spoke to usability issues with the website interface. One said simply that,

"publishing and providing access is difficult." Another respondent noted website speed as a critical gate to user experience by stating, "…spooling times are excruciatingly slow…" and that the website interface is "…clunky and buggy."

Q27 – What is the most important change to NHERI's services, tools, and resources that would improve your experience with them (*N* = 17)?

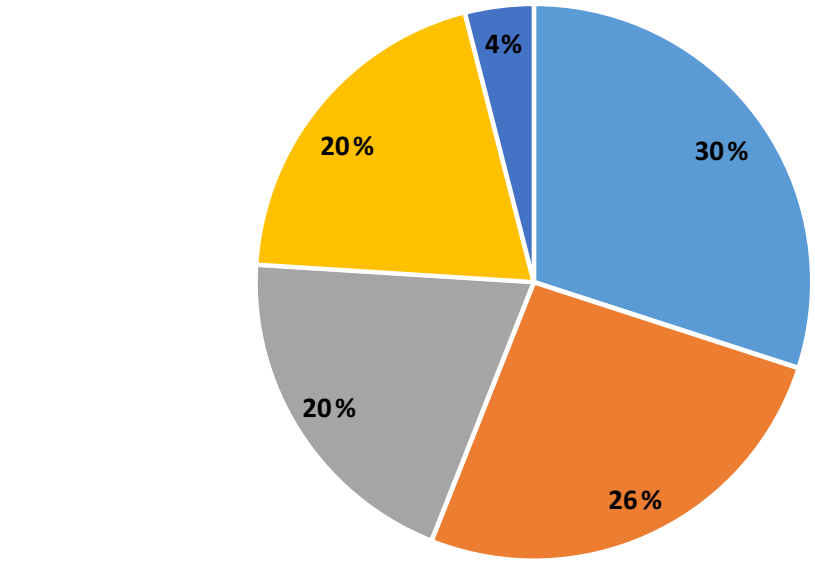
Respondents spoke primarily to the perceived need for improvements to access, speed, organization, and navigation. Two respondents requested improvements to "user access and login," as well as "open access…" to information. Others described processes slowed by website usability by noting, "the website is very, very slow," and "speed of uploading and downloading data, [is] not really [an] intuitive process yet." Another described speed and navigation together by noting, "speed and reduce the number of clicks to get to information." Additionally, one user again described informal barriers to access by suggesting to, "make tools and information known outside of the small user club."

Others echoed requests for improvements to organization and navigation. One respondent requested "an easier to navigate website." Others expressed concerns with the media through which information is conveyed by asking for "more written documentation" rather than information via videos. Regarding videos, another respondent suggested that "'how-to' videos should be organized in a more logical order."

Q28 – What service, tool, or resource not currently in NHERI should be added (*N* = 9)?

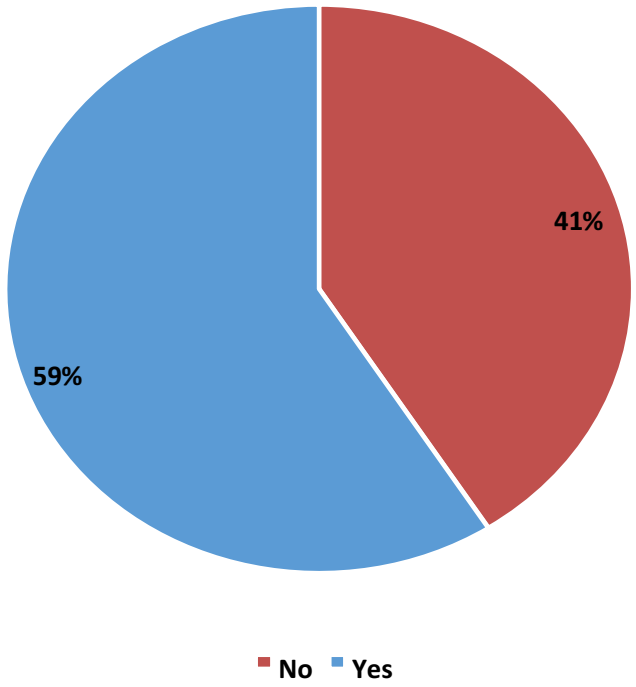
When asked about adding resources not currently offered by NHERI respondents had various suggestions. One respondent requested "a calendar of events," while another requested "workshops with one or more facilities to describe opportunities." One user specifically suggested "VisualSFM and Pix4D" software for NHERI users. Additionally, a respondent requested data generated during NEES be made more accessible, describing it as "hard to find."

Q30 Of the following which would you be most interested in participating in or using (*N* = 42)?



Respondents were asked to rank each of these from most interested [1] to least interested [5]; responses shown are proportions of sums of respondent rankings of one and two (i.e., reported the most interest in). Respondents were most interested in a calendar of events, followed closely by a newsletter summarizing NHERI related information, an annual workshop meeting for NHERI researchers, and video footage of experiments. Only 4% of responses favored a social media group featuring NHERI related information and news.

Q33 Have you been made aware of the NHERI Science Plan (*N* = 49)?



59% of respondents reported being made aware of the NHERI Science Plan. This was a new question for the 2018 survey.

Q35 – Do you have any addition comments regarding NHERI services and information (*N* = 7)?

Respondents who opted to respond to this question were generally satisfied with their experiences. One respondent suggested that specificity be added to the Science Plan by stating

"the science plan remains fairly general in how it can be applied in the context of NHERI activities."

Q36 – Do you have any final comments regarding NHERI Facilities and Resources (*N* = 9)?

Respondents provided diverse feedback to this open-ended question. One user noted that "the system is still not operating like a multidisciplinary network," but did not suggest a solution.

Another echoed previous sentiments regarding website interface by stating "the server needs to be faster so that users actively upload/download data…" Another user recommended "a scheduling system…where researchers can see their time slots on [a shared schedule]," presumably so users can schedule their time with facilities more efficiently.

NHERI Science Plan Workshop

Agenda Day 1

(This portion of the agenda will be available via remote participation)

8:00 Welcome and Opening Remarks – **NSF**

8:15 Objectives of the Meeting – **Julio Ramirez, Purdue University**

8:30 Summary of NHERI 5-Year Science Plan and Social Science View – **Lori Peek, PhD,** University of Colorado Boulder.

8:50 **Speaker: Expanding the vision of science and engineering for the Natural Hazards Community**

9:30 Break (coffee and refresments)

9:45 Panel – six early career invited researchers get five slides, ten minutes on vision for future hazard mitigation/disruptive technologies not addressed in NHERI Science Plan and campaign formation

10:45 Visionary Design - infrastructure of 2050, Ed Kavazanjian, Regents Professor and Ira A. Fulton Professor of Geotechnical Engineering, Director, Center for Bio-mediated and Bio-inspired Geotechnics (www.biogeotechnics.org), School of Sustainable Engineering and the Built Environment, Arizona State University

Science of team science – best practices, team formation, **Edward T. Palazzolo**, **PhD,** Army Research Office on Social and Cognitive networks

Example of research campaign from another research community with large facilities, Joseph A. Giaime, professor of physics & astronomy (LSU), observatory head, LIGO Livingston, Caltech (Invited)

12:15 **Lunch (on your own)**

13:00 Expectation and Organization of Afternoon Breakout Sessions A-C

13:15 **Breakout Sessions[1] – I**

a) Advanced computational methods and high-performance computing, **Chris Gill, PhD**, Washington University, St. Louis
b) Data-driven science, **Lori Peek, PhD,** University of Colorado Boulder, **Maria Dillard, PhD,** NIST, **Elaina Sutley, PhD,** University of Kansas
c) Robotics, **Kyle Edelberg,** Jet Propulsion Lab, NOAA

14:30 **Break (coffee and refreshments)**

14:45 **Breakout Sessions – I (Continued)**

d) Bio-inspired design, **Jerome P. Lynch, PhD,** University of Michigan
e) Additive manufacturing, **Zhijian Pei, PhD,** Texas A&M University
f) Advanced materials, **Pablo Zavattieri, PhD,** Purdue University

16:00 **Break**

16:15 **Report- Results of Breakout Sessions – I**
(This portion of the agenda will be available via remote participation)

17:15 **Expectation and Organization of Day 2**

17:30 **Adjourn**

Agenda Day 2

8:00 **Breakout Sessions[2] – II – Examples of Research Campaigns:**
Operation of research campaign – team selection & coordination, implementation, and best practices

1. Example 1: Earthquake and Tsunami Hazards and related landslides – scope, using NHERI facilities, community engagement, metrics for success
2. Example 2: Windstorm Hazards– scope, using NHERI facilities, community engagement, metrics for success
3. Example 3: Storm Surge in Coastal Areas– scope, using NHERI facilities, community engagement, metrics for success

(Examples will be defined by the Workshop Committee and distributed before the Workshop. Each session will be led by a member of the organizing committee.)

10:15 **Break**

10:30 **Report- Results of Breakout Sessions – II**
(This portion of the agenda will be available via remote participation)

11:30 Visionary – hazard risk mitigation for tomorrow, not solving today's problems, **Thomas Denis O'Rourke, PhD,** Thomas R. Briggs Professorship in Engineering, Cornell University

13:00 **Adjourn[3]**

A Workshop to Advance the NHERI 5-Year Science Plan

PROJECT SUMMARY

Civil infrastructure shelters and sustains communities and their activities. This infrastructure is built on a network of facilities and services that include housing, schools, business, religious and cultural structures, water, gas, electricity, sanitation, communications, and transportation, among others. All are interconnected and must be designed, constructed, and maintained with the expectation that they will provide adequate performance when subjected to effects of earthquakes, landslides, windstorms, and related natural hazards of tsunami and storm surge. Failure of civil infrastructure adds considerable strain to communities and puts lives, health, and societal functions at risk.

The Natural Hazards Engineering Research Infrastructure (NHERI) is a distributed, multi-user, national facility that provides the natural hazards engineering community with state-of-the-art research infrastructure ensuring that it has the well-coordinated testing and computational facilities required to meet the research challenges of the 21st century and achieve global leadership in natural hazard risk mitigation. Funded by the National Science Foundation (NSF), NHERI enables researchers to explore and test ground-breaking concepts to protect people and the places where they live out their lives from earthquakes, landslides, and windstorms, including tsunamis, storm surges, and waves, enabling innovations to help prevent natural hazards from becoming societal disasters.

The NHERI Five-Year Science Plan is organized around three Grand Challenges each with five Key Research Questions to guide NHERI research activities. It provides the earthquake, wind, and coastal hazards community, including NSF and other federal and state agencies, a roadmap for high-impact, high-reward, hazards engineering research at NHERI facilities. The research results are intended to enable damage mitigation and prevent loss of life from natural hazards through delivery of technical breakthroughs to improve the resilience and sustainability of existing and future civil infrastructure, also known as the built environment. High priority research subject areas are also provided for each of the key research questions to assist future researchers in achieving Grand Challenges. While the research plan is meant to provide guidance, it is also written in an open manner to ensure the ingenuity and creativity of the broader community is fully encouraged.

The funds requested herein are to organize a workshop to update and broaden the NHERI 5-year Science Plan, originally posted on July 14, 2017, within geotechnical, structural, architectural, materials, coastal, wind and construction engineering. The development of this five-year NHERI Science Plan was guided by the Science Plan Task Group appointed by the Network Coordination Office (NCO) with broad representation from the NHERI facilities, members nominated by the facilities, and a group nominated by the NCO with the goal of having a broad representation from practice and research communities. The version posted on July 14, 2017 was further reviewed and had input from the NHERI facilities, the NCO, and

broad community-based participation of earthquake, wind, and coastal engineering professionals, as well as engineering education experts. The NCO and each of the experimental facilities submitted a science plan with their proposals to NSF; these were used as input for the plan.

The proposed Workshop will include collaboration with researchers that will bring opportunities for investment in areas of transformational technologies including bio-inspired design, advanced computation, data science, materials science, additive manufacturing, robotics, and control theory to help achieve the plan's vision of a more resilient and sustainable civil infrastructure. In addition to the engineering community, this proposal recognizes that contributions from social and behavioral scientists are essential to achieve resilient communities. With this in mind, we will actively engage the participation from researchers in the social sciences—including sociology, political science, human geography, economics, and beyond--to advance the goals of the NHERI Science Plan.

The Workshop will catalyze formation of research teams and coordinated research campaign(s) nationally and internationally that will accelerate the pace of research towards improving the resilience of civil infrastructure through damage mitigation and prevention of loss of life from natural hazards. It will also explore the science of team science, a new interdisciplinary field that empirically examines the processes by which large and small scientific teams, research centers, and institutes organize, communicate, and conduct research.

The main products to be derived from the Workshop are:

a) A report documenting the Workshop findings and recommendations incorporated in the 5-Year and Beyond NHERI Science Plan to be published within four months following the event. The report will include a research agenda developed with input of participants from the NHERI community and substantive input from disruptive technology areas. It will present a summary of example research campaigns and recommendations for conducting the proposed research campaigns.

b) A recorded video of the plenary session presentations and discussions.

c) A journal article based on the findings of the workshop suitable for review and publication by organizations such as EERI, ASCE, and ACI.

PROJECT DESCRIPTION

1. Project Need

The Natural Hazards Engineering Research Infrastructure (NHERI) is a distributed, multi-user, national facility that provides the natural hazards engineering community with state-of-the-art research infrastructure. Funded by the National Science Foundation (NSF), NHERI enables researchers to explore and test ground-breaking concepts to protect homes, businesses, schools, and infrastructure lifelines from earthquakes, landslides and windstorms, including tsunamis, storm surges, and waves, enabling innovations to help prevent natural hazards from becoming societal disasters.

The NHERI Five-Year Science Plan is posed as a set of three Grand Challenges with five Key Research Questions to guide NHERI research. The three Grand Challenge subject areas are:

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

The research will deliver technical breakthroughs to improve the resilience and sustainability of existing and future civil infrastructure, also known as the built environment. In the Science Plan, high priority research subject areas are also provided for each of the key research questions to assist future researchers in achieving Grand Challenges. The plan, while instructive, is sufficiently broad to still encourage creative and groundbreaking ideas from the broader community.

Since the inception of NHERI, there have been significant and substantive advances through disruptive technologies that can be impactful to the design, repair and resilience of civil infrastructure under natural hazards. To provide a platform for incorporating, where appropriate, these technologies into the 5-Year Research Plan, the NHERI Network Coordinating Office (NCO) proposes to organize a workshop in October 2018 or March 2019 to advance the NHERI Five Year Science Plan with the following goals:

A. Elucidate possible research agendas for investigating how the following emerging and disruptive technologies can help mitigate the vulnerabilities of civil infrastructure to natural hazards (earthquakes and windstorms):

i. Advanced computational methods and high-performance computing
ii. Data-driven science
iii. Robotics
iv. Bio-inspired design
v. Additive manufacturing
vi. Advanced materials

B. Identify best practices and concepts from the science of team science in forming and implementing research teams (disciplinary, multidisciplinary, international, industry) to address the research agenda in the 5-Year and Beyond NHERI Science Plan.

C. Recommend actions that the natural hazards community can implement to organize community-led and community-building research campaigns (theoretical, computational, experimental, data-driven) around a specific research agenda and provide examples for several of the above topics.

2. Intellectual Merit

Today's grand challenge of improving the resilience of civil infrastructure against natural hazards- earthquakes, tsunamis, windstorms and coastal inundation- and reducing their impact on society cannot be answered by any single discipline. It requires the confluence of multiple disciplines -- biological, physical and natural sciences, social and behavioral sciences, engineering and information technology -- to foster transformational research (Goal A). The proposed workshop will provide the "Agora" where experts in various disciplines will critically examine the 5-Year Science Plan of NHERI in order to advance it by elucidating how disruptive technologies may create new ways to enhance the resilience of civil infrastructure against natural hazards that challenge current approaches. Transformative or disruptive technologies have potential to transform our approach to sustainable infrastructure and provide resilience in natural hazards. Through the science of team science (Goal B) we will develop stronger research teams that are more focused on outcomes while growing in disciplinary, multidisciplinary, and international expertise. An important aspect of selecting suitable disruptive technologies to mitigate hazard vulnerabilities of civil infrastructure will be to identify crucial obstacles to progress in research areas essential to the NHERI Five-Year Science Plan.

Further, we will gather additional information from practicing professionals and academic leaders across a range of disciplines to advance the NHERI Five-Year Science Plan and to organize community-led and community-building research campaigns, (Goal C) foster the creation of research teams and elucidate how NHERI can best support their efforts to improve the resilience of civil infrastructure against earthquakes, windstorms and associated tsunami and storm surge in coastal areas.

3. Broader Impacts

The outcomes of this Workshop will help researchers and practitioners to reduce injuries/deaths, mitigate damage, improve continuity of essential operations and facilitate community recovery by improving the resilience of civil infrastructure to natural hazard events that are the focus of NHERI. Experts from areas of disruptive technologies working with the NHERI community will catalyze collaborations for development of research concepts and proposals in the US and internationally that have high-impact on state-of-practice for resilience and sustainability of existing and future civil infrastructure. Practitioners and researchers focusing together on transformative means to improve resilience will bring stronger bonds with improved technology transfer. The nexus of engineers, social scientists, and other experts working in disruptive technologies will provide the stimulation for further collaborations and closer integration of alternative technologies and earthquake, wind, tsunami and coastal engineers. These collaborations will be critical to creating a climate of political will, social acceptance, political adoption, and code enforcement to natural hazard research results to drive more resilient communities and sustainable infrastructure.

4. Recent Meetings on Natural Hazards, Disruptive Technologies, and Related Subjects

42nd Annual Natural Hazards Research and Applications Workshop, July 9-12, 2017, Omni Interlocken Hotel, Broomfield, Colorado.

The 10th Australasian Natural Hazards Management Conference (ANHMC 10), July 14, 2017. Perth, Western Australia

Natural Hazards Risk Assessment and Management (Held in association with Indian Geotechnical Society), December 12-14, 2017 New Delhi, India.

International Workshop on Bio-Inspired Methods and Large-Scale Monitoring, NSF supported Workshop held July 12-13, 2010, Tokyo, Japan

1st International Conference on Natural Hazards and Infrastructure, June 28-30, 2016, Chania, Crete Island, Greece.

Disruptive Technologies Conference, Sept. 7, 2017, University of Texas, Austin Texas.

Disruptive Technologies and Innovation Foresight Minds, Nov. 20-21, 2017, Berlin, Germany

Disruptive Technologies in Information Sciences, Orlando, 17-18 April 2018

NSF Workshop on Additive Manufacturing for Civil Infrastructure Design and Construction, July 13-14, 2017, National Science Foundation, Arlington, Virginia. https://events.tti.tamu.edu/wp-content/uploads/2017/04/nsf-3dp-workshop-report.pdf

TransTech Conference, Wiring Humanity for the Future, Palo Alto, Oct. 13-14, 2017.

Workshop/Collaborative Research: Interdisciplinary Methods for Disaster Research, NSF Award No. 1744225, February 8-9, 2018, University of Colorado at Boulder, Boulder, CO.

International Conference on Disruptive Technology and Innovation 2016, Madurai, India, April 1-2, 2016.

Robotics Inspired Biology Workshop, Int. Conf. on Intelligent Robots and Systems (IROS), Vancouver, Sept. 2017.

TransTech, Engineering the Future of Human Flourishing, Palo Alto, CA, Nov. 9-10, 2018

International Symposium on Experimental Robotics, Tokyo, Japan, Oct. 3-6, 2016

IS&T Electronic Imaging: The Engineering Reality for Virtual Reality, IS&T Springfield VA, Jan 29–Feb 2, 2017

Multi-hazard Engineering Collaboratory for Hybrid Simulation: Breaking Barriers & Building Capacity Workshop, San Diego CA, 2017

SCITS 2017 – Science of Team Science Conference, Clearwater Beach, June 12-14, 2017

CSCE'18 - The 2018 World Congress in Computer Science, Computer Engineering, & Applied Computing, Jul 30-Aug 02, 2018

The 10th International Conference on Advanced Computational Intelligence 2018, Xiamen, China, March 29-31, 2018

International Conference on High Performance Computing & Simulation, The 16th Annual Meeting, Orléans, France, July 16-20, 2018

ICDCS 2018: International Conference on Distributed Computing Systems, ICDCS, Vienna, Austria, July 2-6, 2018

SCITS 2018 – Science of Team Science Conference, Galveston, TX, May 21-24, 2018

In addition, ASCE, AGU, MTS, and IEEE, typically sponsor conferences with sessions or papers related to engineering for resilience from natural hazards including earthquakes, tornados, tsunamis and coastal storm surge every year.

Recently there were two NSF research awards that illustrate the focus of new technological innovative concepts. Although they are both awards in materials, they connect transformational approaches to support the overarching objectives of NHERI related research. These awards are listed below.

CAREER: A Micromechanics-Based Approach to Ductile Fracture Simulation in Additively Manufactured Steels for Seismic Structural Fuse Design, Award Number:1751699; Principal Investigator: Gary Prinz; Organization: University of Arkansas; NSF Organization: CMMI Start Date:05/15/2018; Award Amount: $500,000.00; https://nsf.gov/awardsearch/showAward?AWD_ID=1751699&HistoricalAwards=false

CAREER: Using Metamodeling to Enable High-Fidelity Modeling in Risk-based Multi-Hazard Structural Design, Award Number:1750339; Principal Investigator: Seymour Spence; Organization: University of Michigan Ann Arbor; NSF Organization: CMMI Start Date:09/01/2018; Award Amount: $500,000.00; https://nsf.gov/awardsearch/showAward?AWD_ID=1750339&HistoricalAwards=false

5. Organizing Committee

- Chair – Julio A. Ramirez, Ph.D., Professor of Civil Engineering and NHERI-NCO Center Director, Purdue University
- Co-Chair - Billy L. Edge, P.E., Ph.D., Dist. M. ASCE, Professor of Practice, Civil, Construction, and Environmental Engineering Department, North Carolina State University
- Antonio Bobet, Sc.D., Professor of Civil Engineering, Purdue University
- William T. Holmes, S.E., N.A.E., Senior Consultant, Rutherford + Chekene Consulting Engineers
- Ian Robertson, P.E., Ph.D., Arthur N.L. Chiu Distinguished Professor of Civil and Environmental Engineering, University of Hawai‘i at Manoa
- Thomas L. Smith, AIA, RRC, F.SEI, TLSmith Consulting Inc.
- Lori Peek, Ph.D., Director of the Natural Hazards Center and Professor of Sociology, University of Colorado Boulder
- Ross Boulanger, Ph. D., Professor Civil and Environmental Engineering, University of California Davis, CA.
- Edward T. Palazzolo, PhD, Army Research Office on Social and Cognitive Networks, CIV USARMY RDECOM ARL (US).
- Forrest Masters, Professor and Assoc. Dean for Research and Facilities, Herbert Wertheim College of Engineering, University of Florida
- Christopher Gill, Sc.D., Professor of Computer Science and Engineering, Washington University in St. Louis
- Zhijian (ZJ) Pei, Ph.D., Professor of Industrial and Systems Engineering and holder of TEES Research Professorship, Texas A&M University, College Station, TX
- Stephanie Paal, Ph.D., Assistant Professor, Zachry Department of Civil Engineering, Texas A&M University, College Station, TX
- Jerome P. Lynch, PhD, Department of Civil and Environmental Engineering, University of Michigan

6. Workshop Location, Dates and Participants

Location

The Workshop will be held in Alexandria, Virginia at the National Science Foundation or at a nearby hotel, such as the Westin. The budget includes an estimate for room rental costs in the event that it is at a hotel nearby to NSF. This location will allow for further engagement across directorates and with other government agencies with complementary missions such as NIST, DHS, and FEMA amongst others.

Dates

Tentatively, the Workshop is planned for March 2019.

Participant Selection

In order to maximize the outcomes of the Workshop, potential participants will be identified and invited to submit a white paper to be evaluated by the Organizing Committee. Special attention will be paid to invite participants that will create a diverse group. The final selection will seek a balanced group of participants including professorial rank, disciplinary expertise, gender, race, and ethnicity. Practitioners and academics will be encouraged to submit papers, as well as participating partners from other federal agencies. In the matrix of participants, we will also seek a balance between NHERI researchers and those from disruptive technologies and team science including

a. Advanced computational methods and high performance computing
b. Data-driven science
c. Robotics
d. Bio-inspired design
e. Additive manufacturing
f. Advanced materials

Moreover, we will strive to engage participants that understand the importance of the science of team science. Using the information provided by the visionary presentation on Team Science, we will ask the Breakout sessions on the second day to consider how best to integrate the science of team science.

This process of selecting participants for the Workshop will provide an excellent opportunity to engage attendees to cross over the traditional boundaries of earthquake, windstorm and coastal engineering with transformative technologies and social sciences. Participants will be recognized professionals in their respective fields with an appropriate practitioners' presence. It is possible that a few of the participants may be international. While most participants will receive some or full travel support, 10 or 15 participants will be invited at their own expense. The latter would likely be local and affiliated with governmental agencies, engineering

design firms, or nonprofits.

Participants will also be invited to join remotely by announcement on the DesignSafe-CI website, the Natural Hazards Center publication *Disaster Research* (which reaches over 7,000 subscribers from the hazards and disaster research and practice community), the NIST Center of Excellence distribution list, and by individual contacts. The remote participants will be informed of means and open times for them to connect; likely all sessions except the breakouts will be available as shown in the schedule below. Remote participants will be invited to submit written comments to the NHERI NCO (Network Coordination Office) and the Organizing Committee after the workshop.

7. Workshop Organization and Agenda

The Workshop activities will last two days. The Workshop itself will conclude at 1:00 PM of day-2, and will be followed by a ½-day meeting of the workshop organizing committee and some selected participants to prepare the draft final report (see Note 3 of the Agenda). Our workshop will be aligned with the intersection of the NHERI Science Plan (SP) focusing on civil infrastructure with disruptive technologies. The NHERI SP definition of civil infrastructure is consistent with the NSF Program CMMI Resilient and Sustainable Infrastructure, Engineering for Civil Infrastructure (ECI) focus on the physical infrastructure, such as the soil-foundation-structure-envelope-nonstructural building system, geostructures and underground facilities.

The first morning of the workshop will focus on elucidating multiple research agendas for investigating how engineers can engage emerging and disruptive technologies to help mitigate damage from natural hazards (Goal A). The afternoon of the first day will provide participants the opportunity to not only learn more from two different transformative technologies but to also use the science of team science to shape individual teams within the group (Goal B). On the second day participants will conduct a community-building research campaign for a specific hazard to be identified prior to the workshop by the organizing committee (Goal C).

The Workshop will begin with visionary statements invited from both expert practitioners and researchers to motivate and inspire the participants to explore collaborations between the traditional natural hazards research area with other professionals from intersecting fields such as bio-inspired design, advanced computation and control, data science, additive manufacturing, and robotics. During the workshop, concurrent breakout sessions will be held to foster focused interest and development of engineering research needs in natural hazards. A leader is identified in the Agenda below for each of the breakout sessions. Each leader will provide a 15-minute summary of the session topic and the remainder of the session will be for the group to identify how the information could be used or adapted by NHERI to facilitate an approach to a more resilient infrastructure to natural hazards. The Workshop may explore holistic building systems with an integrated view of construction, geotechnical, structural, architectural design, innovative strengthening methods and transformational construction process. Prior to the Workshop all attendees will be provided access to the NHERI 5-Year Science Plan. A preliminary agenda for the meeting is presented next.

Agenda Day 1

	(This portion of the agenda will be available via remote participation)
8:00	Welcome and Opening Remarks – **NSF**
8:15	Objectives of the Meeting – **Julio Ramirez, Purdue University**
8:30	Summary of NHERI 5-Year Science Plan and Social Science View – **Lori Peek, PhD,** University of Colorado Boulder.
8:50	Visionary – hazard risk mitigation for tomorrow, not solving today's problems, **Thomas Denis O'Rourke, PhD,** Thomas R. Briggs Professorship in Engineering, Cornell University
9:30	Break
9:45	Panel – six early career invited researchers get five slides, ten minutes on vision for future hazard mitigation/disruptive technologies not addressed in NHERI Science Plan and campaign formation
10:45	Visionary Design - infrastructure of 2050, Speaker 1 Science of team science – best practices, team formation, **Edward T. Palazzolo**, **PhD,** Army Research Office on Social and Cognitive networks (Invited) Example of research campaign from another research community with large facilities, Joseph A. Giaime, professor of physics & astronomy (LSU), observatory head, LIGO Livingston, Caltech (Invited)
12:15	**Lunch**
13:00	Expectation and Organization of Afternoon Breakout Sessions A-C
13:15	**Breakout Sessions[1] – I** a) Advanced computational methods and high performance computing, **Chris Gill, PhD**, Washington University, St. Louis b) Data-driven science, **Lori Peek, PhD,** University of Colorado Boulder, **Maria Dillard, PhD,** NIST, **Elaina Sutley, PhD,** University of Kansas **c)** Robotics, **Kyle Edelberg,** Jet Propulsion Lab, NOAA
14:30	**Break**
14:45	**Breakout Sessions – I (Continued)** d) Bio-inspired design, **Jerome P. Lynch, PhD,** University of Michigan e) Additive manufacturing, **Zhijian Pei, PhD,** Texas A&M University f) Advanced materials, **Pablo Zavattieri, PhD,** Purdue University
16:00	**Break**
16:15	**Report- Results of Breakout Sessions – I** *(This portion of the agenda will be available via remote participation)*
17:15	**Expectation and Organization of Day 2**
17:30	**Adjourn**

Agenda Day 2

8:00 **Breakout Sessions[2] – II – Examples of Research Campaigns:** Operation of research campaign – team selection & coordination, implementation, and best practices

1. Example 1: Earthquake and Tsunami Hazards and related landslides – scope, using NHERI facilities, community engagement, metrics for success
2. Example 2: Windstorm Hazards– scope, using NHERI facilities, community engagement, metrics for success
3. Example 3: Storm Surge in Coastal Areas– scope, using NHERI facilities, community engagement, metrics for success

(Examples will be defined by the Workshop Committee and distributed before the Workshop. Each session will be led by a member of the organizing committee.)

10:15 **Break**

10:30 **Report- Results of Breakout Sessions – II**
(This portion of the agenda will be available via remote participation)

11:30 **Lunch and Speaker: Expanding the vision of science and engineering for the Natural Hazards Community**

13:00 **Adjourn[3]**

Notes:

[1]For each of the breakout sessions a chair and facilitator/recorder will be responsible for keeping the session focused on their assigned topic and recording the discussions and conclusions. Before the Workshop they will be charged with developing key points to cover and stimulate thoughtful discussions during their breakout. The chair and facilitator/recorder will be responsible for sharing the key points of the discussion and a summary of the results and conclusions in the following reconvened session. Following the workshop, the chair and facilitator will prepare a short report from their session to be combined in the final report of the Workshop. When the participants register for the Workshop, they will be asked to prioritize the breakouts in each session to indicate which subject matter they would prefer to discuss. The organizers will then try to place the participants in the breakout sessions trying to meet each individual's interest while trying to maintain a balance in each group.

[2]To stimulate discussions during Breakout Sessions II, the organizing committee will prepare three examples of potential topics of research campaigns. The examples will be realistic and indicative of NHERI research needed in three areas – earthquakes, tornadoes, and tsunamis and storm surge.

[3]A report will be prepared by the organizing committee following the Workshop and will include three examples of research campaigns aligned with the breakout discussions in Day 2. An additional half-day will be dedicated to writing the workshop report draft (to serve as the basis for refinement of the Science Plan) by the organizing committee and a team of selected workshop participants. Following the workshop, the Science Plan Task Group in charge of the development of the Science Plan, will incorporate the workshop outcomes to refine the NHERI 5-Year Science Plan. An executive summary of the Workshop will be developed for publication on DesignSafe-CI as a news item and for distribution to other media outlets and our partners and the final report will be published within two months following the event. The new edition of the Science Plan will be published within four months following adjournment of the Workshop. Audio of each breakout session will be recorded to support follow up after the Workshop.

8. Results from Prior NSF Support

Natural Hazards Engineering Research Infrastructure: Network Coordination Office (1612144; $4,170,965; July 1, 2016- June 30, 2021). PI: Ramirez; Co-PIs: Bobet, Browning, Edge, Zuo. The Natural Hazards Engineering Research Infrastructure (NHERI) is supported by the National Science Foundation (NSF) as a distributed, multi-user national facility to provide the natural hazards engineering research community with access to research infrastructure. NHERI is comprised of separate research infrastructure awards for a Network Coordination Office (NCO)-this award, Cyberinfrastructure, Computational Modeling and Simulation Center, and Experimental Facilities for earthquake and wind hazards engineering research, including a post-disaster, rapid response research (RAPID) facility. The NCO serves as the leader and focal point for NHERI, building a global, multi-hazard, collaborative research community and research infrastructure focused on mitigating the impacts of earthquakes, windstorms, and related hazards of tsunamis and storm surge on civil infrastructure. The NCO provides the following activities for NHERI: (a) convene and support the governance groups, (b) schedule NSF-supported users at the NHERI Experimental Facilities, including the RAPID facility, (c) coordinate an annual NHERI-wide work plan, (d) develop and maintain the NHERI Science Plan, (e) form national and international strategic partnerships that can leverage and broaden NHERI resources, and (f) implement an education and community outreach (ECO) program. The ECO program includes an annual NHERI-wide research experiences for undergraduates (REU) site program, an annual NHERI Summer Institute, broadening participation of groups underrepresented in natural hazards engineering research, and dissemination of information about NHERI accomplishments and impact. *Intellectual Merit:* NHERI offers unique opportunities to create a catalytic environment that fosters critical improvements in the performance of civil infrastructure against natural hazards. To make substantial advances in reducing the enormous vulnerability of the civil infrastructure to natural hazards, our understanding must be expanded from component- to system-level where we can consider more broadly the consequences at the regional scale and from disaster response to recovery. The powerful combination of NHERI's human, physical, and cyber resources will empower researchers to achieve enhanced national resilience and sustainability. *Broader Impacts:* the NCO will lead, build, and integrate a vibrant multi-hazard community and, through effective coordination of the NHERI resources, increase the impact of research, cyberinfrastructure, and education and community outreach initiatives. *Publications, Evidence of Research Products and their Availability:* 5-Year NHERI Science Plan available in DesignSafe-CI.org.

9. Data Management Plan

Intellectual property and data generated under this project will be administered in accordance the NSF data sharing policy described in Award & Administration Guide (AAG) Chapter VI. D.4., and Purdue University. This document presents the data management plan for the proposed workshop project.

Expected Data Generated in the Project

This workshop project handles various types of data as resources, discussion items and outcomes. The primary types of data in the project are summarized below:

Reports and documents: this workshop will produce report and documents in the form of white papers, videos and PowerPoint presentations that are intended to promote the realization of the 5-Year NHERI Science Plan and beyond. Another important goal of the project is to increase the awareness of the plan amongst research and practicing communities at large.

List of participants: A core group of researchers and individuals is formed as the Steering Committee of the workshop to accomplish its objectives. The identified researchers and individuals will share their contact information, background, and expertise to facilitate group discussion and foster peer-to-peer communications.

Knowledge and experience: knowledge and experience of the individual participants are critical resources for this workshop project. They are collected through recommendations summarized in a written or tabular form in the final workshop report.

Publications and literature: papers, reports, websites, and any other resources that aid discussions in the workshop project will be collected.

Priorities and action items: this workshop project is conducted to gather additional input from leaders in the field to improve the NHERI Five-Year Science Plan and to organize research campaigns, identify possible research teams and elucidate how NHERI can best support the efforts of researchers to answer the key research questions to support the Grand Challenges to improve the resilience of civil infrastructure against earthquakes, windstorms and associated tsunami and storm surge in coastal areas. Another important goal of this meeting will be to elucidate how to best bring to bear disruptive technologies to mitigate hazard vulnerabilities of civil infrastructure. Action items for a roadmap to promote the resilience of civil infrastructure will be identified and prioritized as significant outcomes of this project. Including, but not limited to, short-and long-term items and evaluation criteria for the progress toward the goals and subsequent revisions of the plan, if necessary.

In addition to all of the above, other forms and types of data may be generated as the outcomes of the project and will be accommodated if that occurs.

Data Formats and Storage Location

The primary choice for preservation and sharing of the data generated within this project is the NHERI DesignSafe cyberinfrastructure (CI) on storage resources at the Texas Advanced Computing Center. Digital data and other digital artifacts described above will be stored in generally accessible formats such as Word, Excel, PowerPoint, html, jpeg, mpeg, mp4, pdf, etc. The DesignSafe-CI is a cloud-based environment for research in natural hazards engineering supported by the National Science Foundation Natural Hazards Engineering Research Infrastructure (NHERI) program. Currently, the science plan is located in the

DesignSafe-CI, and then new data generated in the proposed will be uploaded and managed with those existing data in the DesignSafe-CI. Specific tools that are used in the DesignSafe-CI include DataDepot to access to the complied project information and publications, and Jupyter Notebooks, an electronic notebook, to take notes of discussions in the web meetings, workshops, and other activities. Prior to our event and preparatory meetings, a brief tutorial about the DesignSafe will be provided to the Steering Committee members if necessary.

Period of Data Retention and Long Term Preservation

The NHERI DesignSafe cyberinfrastructure (CI) is based on storage resources at the Texas Advanced Computing Center. Data and network materials will be available for at least five years after the end of the project period. Development of archiving and sharing policies are in progress, as well as the possibility of digital object identifiers (DOIs) or another type of permanent identifier.

Backup Plan

If a backup plan becomes necessary, we would use the Purdue University Research Repository (PURR), Purdue's institutional data repository, for access to data (as defined previously) from the project. PURR utilizes HUBzero®, a web-mediated software platform designed for scientific collaboration and sharing of scientific data that was developed with support from the National Science Foundation and Purdue University. PURR provides workflows and tools for ingestion, identification and dissemination of data as well as services to ensure data security, fidelity, backup, and mirroring. Datasets published using PURR would be assigned Digital Objects Identifiers (DOIs) and will be exposed to the web using open standards to maximize discoverability and scholarly reuse of data. Data and finding materials would be available through PURR platforms for at least five years after the end of the project period. All data on PURR will be maintained and housed on their servers for the duration of the life of the Hub itself, but for a minimum of 5 years. The PURR digital preservation program complies with the Open Archival Information System (OAIS) reference model standard and other digital preservation standards and practices as they evolve.

Purdue Libraries will provide stewardship of data in the Repository and will supply consultations and tools to facilitate ingestion of data and appropriate metadata conforming to community standards. It also maintains hardware, software, and storage media containing archival content in keeping with prevailing best practices, including adherence to environmental standards, quality control specifications, and security requirements.

10. Budget Justification

The Workshop activities will last two days. The 1.5-day workshop and a ½-day meeting of the workshop organizing committee and selected workshop participants to prepare the draft final report (see Note 3 of the Workshop Agenda).

Participant Support Domestic Travel costs for airfare, hotel and food expenses

For invited participants who are not members of the organizing committee or selected to participate in the additional ½-day activity of report writing, the travel costs are based on an average airfare cost of $750 per person assuming participants from the West Coast, Denver, CO, which is near the middle of the country, and some East Coast participants and provides a good estimate of the travel. Actual locations are TBD. Lodging estimated as two-nights in the Arlington area for $200 per night, for a total of $400. Food reimbursement, not including lunch on the first and second day of the workshop, is estimated as $100/person. This results in an estimated reimbursement of $1250 for invited participants in this category.

Members of the organizing committee and selected workshop participants to the ½-day report writing session

The estimate described above of $1250 will be supplemented for these participants with one additional hotel night of $200 per person and additional food reimbursement of one more dinner and breakfast of $70 per person for a total estimated cost of $1520 per person. *Note that three members from Purdue University are in this category, two on the organizing committee, plus one more invited participant to join the report draft session.*

International Participant Support Travel costs for airfare, hotel and food expenses

These costs are based on an average of airfare cost of $1750 per person assuming participants from Asia and Europe. Actual locations are TBD. Lodging estimated as three nights in the Arlington area for $200 per night, for a total of $600. Food reimbursement, not including lunch on the first and second of the workshop, is estimated as $150/person. This results in an estimated reimbursement of $2500 for invited participants in this category.

Meeting Room Rental

Room rental is based on information provided by the organizers of the recent NSF Large Facilities Workshop at the Westin Hotel near NSF HQ of $3000/day/per room, we are estimating a total of $13,500 total cost. This is based upon the workshop needs of 3 rooms for a full-day on day 1 and 3 rooms for half-day on day 2 as described in the Agenda.

Subsistence

The estimate is based on providing coffee and refreshments during both days and lunch on days 1 and 2.