NIEHS DISASTER RESEARCH RESPONSE TABLETOP EXERCISE ASSESSMENT

Final Report

September 2017

Executive Summary

The National Institute of Environmental Health Sciences (NIEHS) Disaster Research Response Program (DR2) was initially funded in 2013 by the Director of the National Institutes of Health (NIH) in response to the need for high-quality and timely research following disasters. The program continues through ongoing funding by the Director of the NIEHS and aims to create improved capabilities for timely environmental health disaster research. Through streamlined administrative process, readily available data collection tools and a network of trained research responders to help stakeholders overcome the challenges of implementing disaster research. The overarching goal is to improve the nation's ability to collect time-critical and longitudinal information to reduce adverse health impacts and improve future preparedness, recovery, and response efforts.

To achieve program goals, NIEHS conducted three tabletop exercises in Los Angeles, California (2014); Houston, Texas (2015); and Boston, Massachusetts (2016). The goals of these exercises were to:

- Assess state and local disaster research capability and capacity
- Bring together academic, governmental, and private organizations that have roles or interests in public health response and recovery
- Evaluate how federal, state, and local stakeholders can work together to conduct disaster research
- Facilitate networking and collaboration

To better understand the impacts of these exercises on federal, state, and local stakeholders, NIEHS conducted an assessment of the exercises via 1) a review of post-exercise evaluations, 2) an online survey, and 3) telephone interviews of selected participants. This report summarizes the results of this assessment. It is organized into two major sections. Section I provides a summary and an assessment of the three exercises, including an evaluation of the quality of the exercises (scenario, venue, format, facilitation, and organization), and the major themes, best practices, and lessons learned from the exercises. Section II provides an analysis of the online survey results and the interviews. It explores how the exercises changed state and local organizations' ability to plan and perform post-disaster health research, and reviews any new formal and informal relationships, as well as any new or revised procedures, protocols, standard operating procedures, or other guidelines that have resulted from the exercises. Findings from these two sections were used to develop a metrics framework that NIEHS staff and stakeholders can use to assess research response capacity and "research preparedness" in the future. This framework is located in Annex A.

Section I. Analysis of the Exercises and Post-Exercise Evaluations

To better understand whether the exercise objectives and goals were met and whether the exercise format was conducive to achieving these goals and objectives, exercise participants were asked to complete a post-exercise evaluation survey. These surveys were collected at the end of each exercise. A report summarizing the discussions, best practices, and lessons learned was also prepared following each exercise.

Tabletops were used as the preferred method for these discussions (as opposed to workshops) because they allow participants to examine how their organizations and other stakeholders would respond to the need for disaster research through a realistic scenario, rather than just talk about the development of a plan or policy. However, it was clear, based on the post-exercise evaluations, that all participants should be engaged and given the opportunity to actively participate throughout the exercise, possibly via breakout sessions. Scenarios and injects based on actual hazards and threats of the location were also essential for the participants to relate to the disaster, enabling them to walk through their role during a disaster research response. Community tours augmented the reality of the scenario by providing participants a vision of how the potential disaster can affect the local communities. The importance of engaging key stakeholders prior to the exercise was also emphasized, as it provides the opportunity to introduce the concept of DR2 and address major concerns and needs.

During the exercise, participants acknowledged that disaster research response needs to be integrated into emergency management—particularly the response and recovery plans. Participants also emphasized the need to engage a wide group of partners including federal, state, and local stakeholders, public and private, including communities, volunteer organizations, academia, hospitals, and private industry. These stakeholders should be engaged early on during disaster planning, as they have many unique resources to offer, can help collect data, and can augment local response/recovery.
While participants shared several challenges to conducting research response, including funding and Institutional Review Board (IRB) approvals, they also shared possible solutions to these issues, such as pre-approved protocols. Most participants understood the importance of DR2 and the need to continue this important conversation.

Section II. Online Survey and Interview Findings

Since the NIEHS tabletop exercises were held, participants have undertaken dozens of activities to promote disaster research. Approximately 75 of the 276 emailed tabletop exercise participants responded to an evaluation request,[1] and a robust catalog of their accomplishments is documented in this evaluation report. Equally impressive is the growth in awareness and commitment that so many participants experienced. The exercises also seemed to broaden a definition of disaster research from medical and environmental inquiries to also include resiliency and the community, to incorporate public health and occupational safety and health into the equation, and to emphasize the need for collaborations across professional and volunteer actors in a disaster. Emergency responders, community members, public health and environmental officials, worker-trainers, and academic researchers all learned the importance of collaboration if research is to grow and flourish. Integrating disaster response with research

[1] The exact number of individual respondents is unknown as personal identifiers for the online survey were only collected on a voluntary basis. There were seventy-four who responded to the survey and 39 to the interview, but the degree of overlap between the two groups is unknown.

remains a significant challenge, but important progress in several areas appears to have emerged as a result of participation in the three NIEHS tabletop exercises.

Introduction

In response to the need for a timely and high-quality research response to disasters, the Director of the National Institutes of Health (NIH) provided seed support to the National Institute of Environmental Health Sciences (NIEHS) to start the Disaster Research Response (DR2) project in August 2013. The NIH DR2 has evolved into a fully recognized Program under the leadership and support of, in collaboration with the National Library of Medicine (NLM). The DR2 Program aims to create a disaster research system of coordinated environmental health disaster research data collection tools and a network of trained research responders to assist stakeholders in overcoming the challenges of disaster research and to improve the nation's ability to collect timely information to reduce adverse health impacts and improve future preparedness. The goals of the DR2 program include:

- Improved access to data collection tools for researchers
- Improved NIEHS and partner capabilities to quickly collect data
- Trained researchers versed in disaster tools and issues
- Integration of research into planning and emergency response systems

In support of efforts to train a network of environmental health researchers that can safely and effectively contribute to the disaster research process and share the work of the program, NIEHS staff organized three tabletop exercises in Los Angeles, California (2014); Houston, Texas (2015); and Boston, Massachusetts (2016). These exercises brought key stakeholders together to identify capacities and capabilities, identify resources, network with colleagues, and discuss challenges associated with post-disaster research. A secondary goal of the exercises was to catalyze local and state ability to collect vital health information to reduce adverse health impacts and improve environmental health preparedness.

NIEHS initiated an assessment of the exercises to determine their impact on local and state capability and capacity to conduct disaster-related health research. This assessment was completed by three methods: a review of exercise evaluations completed at the end of each exercise; an online survey sent to all exercise participants; and telephone interviews of selected exercise participants. The focus is on impact, i.e., how the exercises resulted in changes in capability, capacity, and competence of researchers to conduct disaster research. The assessment extracts best practices and lessons learned based on written comments in the evaluations. Because of the possibility for conducting future exercises, NIEHS is also assessing ways to improve future exercises. Overall, the goals are to:

- Assess the quality of the exercises
- Identify best practices and lessons learned from exercise discussions and evaluations
- Assess the impacts (e.g., new relationships, activities, collaborations, research performed) resulting from participating in the exercises

- Evaluate how participation subsequently changed actual capacity and capability to participate in disaster research

This report is organized in two major sections. Section I provides an overview on the use of tabletop exercises to impact research response preparedness and evaluates the quality of the exercises as it relates to scenario, venue, facilitation, format, and organization. It summarizes the results of the exercises to determine the effectiveness of the process, the validity of the scenarios and format, the quality as determined by the tabletop exercise participant evaluations, and the lessons learned from DR2 staff and participants. Section II assesses the online survey results and interviews to explore whether the exercises have changed the ability of local and state organizations to plan and perform post-disaster health research. This section also reviews any new formal and informal relationships, as well as any new or revised procedures, protocols, standard operating procedures, or other guidelines that have resulted from the exercises.

Knowledge from this assessment will help to determine the overall impact of the exercises and aid NIEHS in deciding whether to conduct additional exercises and how to make any future exercises more effective. Findings from Sections I and II were used to develop the metrics framework in Annex A, which defines the measures/metrics that NIEHS staff and stakeholders can use to assess research response capacity and "research preparedness" in the future.

Background

The detrimental health and environmental impacts caused by disasters have been documented by several studies and are exemplified by recent disasters, including the Deepwater Horizon Gulf Coast oil spill, the West Virginia Elk River contamination, Hurricane Sandy, and the emerging Zika virus outbreak.[2,3,4,5] The process by which these and other disasters have been researched and analyzed has demonstrated the need and importance of obtaining high-quality and timely disaster research.

A search in PubMed for the term "disaster research" resulted in 195 articles, most of which were published between 2014 and the present. The search found limited information on the concept of disaster environmental health response and methods to conduct environmental health research in a disaster setting; however, several articles on the topic have been published. Lurie et al., Colf et al., and Yeskey et al. emphasized the concept of disaster research

[2] Assessing the Human Health Effects of Gulf of Mexico Oil Spill: An Institute of Medicine Workshop. Available: https://www.nap.edu/read/12949/chapter/1 [accessed 27 June 2017].
[33] Potential Research Priorities to Inform Public Health and Medical Practice for Domestic Zika Virus-Workshop in Brief. Available: http://www.nationalacademies.org/hmd/Activities/PublicHealth/ZikaResearch/2016-FEB-16.aspx [accessed 27 June 2017].
[4] National Toxicology Program. West Virginia Chemical Spill. Available: http://ntp.niehs.nih.gov/results/areas/wvspill/index.html [accessed 27 June 2017].
[5] Neria Y, Shultz JM. 2012. Mental health effects of Hurricane Sandy: characteristics, potential aftermath, and response. JAMA 308(24):2571-2572.

response and the need to integrate science into disaster response.[6,7,8,9] These authors stressed the importance of the post-disaster collection of information and data in a timely manner to improve decision-making, policy development, response, and preparedness. They also acknowledged and outlined some of the challenges to current processes of conducting research post-disaster and stressed the need to integrate research into the current response framework. In August 2017, the National Academies of Sciences, Engineering, and Medicine held a meeting for U.S. Department of Health and Human Services (HHS) grantees to assess the impact of Hurricane Sandy on public health policy and operations. While the report has yet to be issued, presentations from that workshop are available online.[10] Review of the presentations demonstrates the broad range of disaster research that can be performed and the challenges associated with this research.

Little has been written about disaster research methods, resources, tools, assessment, application, and implementation. Birnbaum, Daily, O'Rourke, and Loretti authored a series of special reports that provide details on the Disaster Logic Model and a set of five Frameworks on disaster research and evaluation.[11] The potential role and impact of academic medical centers in a disaster response was highlighted by Sklar et al. They used the deployment of disaster medical assistance teams sponsored by an academic medical center to Hurricane Katrina as an example.[12] Recent studies have also explored using the workforce to collect data. Understanding that disasters are local and that the local public health workforce is integral to emergency response, Walsh et al. assessed the role that the local public health agency workforce plays in performing disaster recovery-related duties. They proposed a behavioral framework to examine local workers' disaster recovery efficacy through an evidence-informed educational intervention.[13]

As more organizations engage in disaster response and recovery efforts, several articles have focused on ethical post-disaster research and Institutional Review Board (IRB)-approved

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[6] Miller A, Yeskey K, Garantiotis S, Arnesen S, Bennett A, O'Fallon L, Thompson C, Reinlib L, Masten S, Remington J, Love C, Ramsey S, Rosselli R, Galluzzo B, Lee J, Kwok R, Hughes J. 2016. Integrating health research into disaster response: the new NIH Disaster Research Response Program. Int J Environ Res Public Health 13(7):E676.
[7] Lurie N, Manolio T, Paterson AP, Collins F, Frieden T. 2013. Research as a part of public health response. N Engl J Med 368(13):1251-1255.
[8] Yeskey K, Miller A. 2015. Science unpreparedness. Disaster Med Public Health Prep 9(4):444-445.
[9] Colf LA, Brothers R, Murata CE. 2016. A role for science in responding to health crises. Health Secur 14(4):272-279.
[10] National Academies of Sciences, Engineering, and Medicine. 2017. Translating the Results of Hurricane Sandy Research Grants into Policy and Operations: A Workshop. Available: http://nationalacademies.org/hmd/Activities/PublicHealth/DisastersScienceCommittee/2017-JUL-20.aspx [accessed 22 Aug 2017].
[11] Birnbaum ML, Daily EK, O'Rourke AP, Loretti A. 2015-2016. Research and evaluations of the health aspects of disasters, parts I-IX. Prehosp Disaster Med.
[12] Sklar DP, Richards M, Shah M, Roth P. 2007. Responding to disasters: academic medical centers' responsibilities and opportunities. Acad Med 82(8):797-800.
[13] Walsh L, Garrity S, Rutkow L, Thompson CB, Strauss-Riggs K, Altman BA, Schor K, Barnett DJ. 2015. Applying a behavioral model framework for disaster recovery research in local public health agencies: a conceptual approach. Disaster Med Public Health Prep 9(4):403-408.

protocols. Resnik et al. explored the ethical issues raised in environmental health research with implications for public health as exemplified by what researchers encountered in the Gulf Long-term Follow-up Study.[14]

The role that scientific research plays in improving disaster response and preparedness and reducing the health impact in vulnerable communities is now slowly getting recognition; however, a major challenge persists on how to integrate health research into the immediate disaster response from the perspective of emergency management, which may be key to streamlining research in all disaster responses. The process of integrating health research into a disaster response still needs further improvement. [15,16]

Current Activities of the NIH Disaster Research Response Program

To date, DR2 accomplishments include:

- Ready-To-Go Health Data Collection Tools and Research Protocols
    - Developed a new repository, containing more than 340 relevant tools, questionnaires, and protocols, along with metadata to facilitate data collection and research for environmental health issues.
    - In collaboration with NLM, created a publicly-accessible DR2 webpage for information-sharing with partners and access to the repository.
    - Developed a new NIEHS IRB pre-reviewed disaster response protocol called "RAPIDD" to help facilitate timely deployment of researchers to acquire health information and biospecimens.

- Bringing Together Communities, Researchers, and Government
    - Sponsored a two-day workshop, "Enabling Public Health Research During Disasters," in collaboration with the HHS Assistant Secretary for Preparedness and Response (ASPR), NLM, the Centers for Disease Control and Prevention (CDC), and the Institute of Medicine (IOM) on June 12-13, 2014, Bethesda, MD.
    - Building partnerships, including hosting annual meetings at NIH, with federal agencies to coordinate integration of federal disaster researchers.
    - Convened an IRB workshop, "Best Practices Working Group for the Development of Special Considerations for IRB Review of Disaster and Emergency Related

[14] Resnik D, Miller A, Kwok R, Engel R, Sandler D. 2015. Ethical issues in environmental health research related to public health emergencies: reflections on the GuLF STUDY. Environ Health Perspect 123(9):A227-231.
[15]National Biodefense Science Board. 2011. Call to Action: Include Scientific Investigations as an Integral Component of Disaster Planning and Response. Available: https://www.phe.gov/Preparedness/legal/boards/nprsb/Documents/nbsbrec14.pdf [accessed 27 June 2017].
[16] Yeskey K, Miller A. 2015. Science unpreparedness. Disaster Med Public Health Prep 9(4):444-445.

Public Health Research,"[17] on July 27-29, 2016, in Research Triangle Park, North Carolina.

- Information Sharing
  - Presented at numerous conferences about disaster research, including the American Public Health Association annual conferences, Health Coalition Preparedness Conference, Preparedness Summit, Society of Toxicology, International Society of Environmental Epidemiology, etc.
  - Published articles in peer-reviewed journals (see list in Appendix A).
  - Participation in federal disaster science working groups, including the ASPR Science Preparedness Research Interagency Team (SPiRIT) and the Subcommittee for Disaster Reduction (SDR).
  - Working with international partners such as Canada, Japan, and Taiwan.

- Other Activities
  - Working with the NIH Office of Human Subjects Protection to develop policies to ensure rapid IRB review of disaster-focused protocols.
  - Chair the NIH Disaster Interest Group (I-DIG) consisting of about 50 representatives from 15 differing Institutes or program offices to discuss ongoing activities and promote disaster research efforts.
  - Inspiring local partnerships for disaster research.

More about the DR2 program can be found on its website.

Methodology

A review of exercise reports and post-exercise evaluations, and an assessment of online survey responses and interviews were completed to develop this report.

A review of the exercise evaluations and reports was conducted to identify suggested best practices and lessons learned, and any comments about potential impact resulting from the exercises. This information was captured and used to develop online survey questions and telephone interview questions.

A review of all the exercises' participant lists resulted in a consolidated list of participants. Duplicate names were scrubbed from the list. Data compiled included name, professional affiliation, organizational affiliation, email address provided at the time of the exercise, telephone number provided at the time of the exercise, and the location of the exercise(s) attended. Some participants attended more than one exercise and this was noted.

[17] Joan P. Packenham, Richard T. Rosselli, Steve K. Ramsey, Holly A. Taylor, Alice Fothergill, Julia Slutsman, and Aubrey Miller. 2017. Conducting Science in Disasters: Recommendations from the NIEHS Working Groups for Special IRB Considerations in the Review of Disaster Related Research. Environ Health Perspect; DOI:10.1289/EHP2378

Questions to assess the possible impacts of the three exercises were developed by DR2 (Appendix C: Survey and Interview Questions). These questions were reviewed by a panel of NIEHS/DR2 advisors and were revised based on those comments. A total of 30 unique questions were created. The questions were loaded into a commercial-off-the-shelf online survey tool and beta-tested by DR2 staff. Skip logic was used to ask unique questions to participants of different professional affiliations. The estimated time to complete the survey was 20 minutes. The questions were posted to the online survey tool and an email from the DR2 program director went to all exercise participants requesting their participation. Reminders were sent to participants approximately every three weeks. The survey remained available for nine weeks. Participants in the online assessment were offered anonymity and all responses were non-attributional for the purposes of reporting.

Interview questions were developed by the same group that developed the online assessment questions. They were reviewed by a panel of NIEHS/DR2 advisors and the person conducting the interviews. Seventy-six candidates for interviews were selected by the DR2 staff based on several factors, including level of participation in an exercise, professional affiliation, and willingness to participate. Candidates were contacted by email and telephone, inviting them to participate. Interviews were conducted over an eight-week period. Comments made were non-attributional for purposes of reporting.

Section I. Summary and Analysis of Exercises and Post-Exercise Evaluations

NIEHS conducted three tabletop exercises to facilitate integration and coordination among government agencies, academia, communities, public health agencies, workers, industries, and others to improve their understanding and capacity to develop and implement timely and quality research following disasters.

The goals of these exercises were to:

- Assess state and local disaster research capability and capacity
- Bring together academic, governmental, and private organizations that have roles or interests in public health response
- Evaluate how federal, state, and local stakeholders can work together to conduct disaster research
- Facilitate networking and collaboration

Tabletop Exercises

Use of Tabletop Exercises in Disaster Preparedness

The DR2 program hosted tabletop exercises to foster development of new plans for the consideration and performance of disaster research where no plans existed, test and improve plans where they do exist, and integrate plans across professional disciplines and governmental

jurisdictions. The tabletop exercises were also used as a platform to introduce the roles of federal, state, and local stakeholders in any disaster research response and to test state and local disaster research readiness. Exercises are useful tools to familiarize participants with new concepts, roles, and responsibilities, and provide a chance to foster new or strengthen existing relationships. The Homeland Security Exercise and Evaluation Program (HSEEP) notes that "exercises play a vital role in national preparedness by enabling whole community stakeholders to test and validate plans and capabilities."[18]

Tabletops were chosen as the preferred method for these discussions (as opposed to workshops) because they allow participants to examine how their organizations and other stakeholders would respond to the need for disaster research through a realistic scenario, rather than just talk about the development of a plan or policy. By walking through a scenario, participants can also better assess their capabilities and capacities to plan, conduct, or participate in a disaster research, as well as the process to engage other stakeholders to participate in such effort. Tabletop exercises also allow each participant to see all the different players involved in the process of initiating and conducting an effective research response. The DR2 tabletop exercises brought together a diverse group of stakeholders to hold an honest conversation about disaster research needs and capabilities, particularly the processes, logistics, and relationships with other federal, state, and local stakeholders that are necessary to initiate and sustain needed research investigations. Participants were selected based on the organization for which they worked (academic, public health, emergency management, etc.) and were asked questions related to their organization's role in disaster response.[19]

Selection of Sites, Planning Committee, and Site Visits

Each site was selected based on: 1) the interests shown by local academic and community stakeholders in exploring disaster research in their local communities, 2) availability of a suitable venue, 3) engagement of the state and local health departments, and 4) the region's experiences with frequently occurring natural disasters. NIEHS identified local NIEHS grantees who were willing to host the exercise, and worked closely with them at each of the three sites to coordinate logistics and plan the event.

Once the location and local partners were established, a planning committee was formed to begin organizing the exercise. Each planning committee was composed of state and local stakeholders, including representatives from academia, state and local public health departments, state and local emergency management offices, and federal (regional) public health and emergency management offices. In addition to planning committee calls, NIEHS staff and contractors conducted site visits to meet with the planning committee and local stakeholders. The site visits permitted DR2 staff to introduce DR2 exercise goals and objectives and to discuss the exercise format and scenarios. These face-to-face discussions were

[18] Department of Homeland Security. 2013. Homeland Security Exercise and Evaluation Program (HSEEP). Available: https://www.fema.gov/media-library-data/20130726-1914-25045-8890/hseep_apr13_.pdf.

[19] The Boston event was called a "workshop" instead of an "exercise," as the format was more workshop-like (with breakout sessions).

instrumental in getting buy-in from key local stakeholders and resulted in key modifications to the scenario, format, and the participants. The site visit also served as a forum in which most, if not all, federal, state, and local stakeholders were able to meet to discuss the importance of research in disasters. For many, this was their first in-depth discussion of disaster research. The site visits also allowed organizers to review the exercise venue and finalize site logistics prior to the exercise.

Development of Scenario

A realistic disaster scenario was developed for each exercise based on the risks and hazards specific to the area. In all three exercises, scenarios were supported by previously published scientific reports about natural and environmental hazards in the surrounding region. In Los Angeles, the scenario was supported by a report from the U.S. Geological Survey (USGS). The Houston exercise was based on a report regarding hurricane preparedness and the Houston ship channel. A report on flooding served as the foundation for the Boston scenario. Efforts were also made to invite vulnerable communities that were going to be most affected by the disaster scenario to the exercise. The scenarios were also vetted by the planning committee and local stakeholders during the site visit.

For each scenario, a series of injects and questions were developed that were then posed to participants at the appropriate time in the scenario. Injects are new data, information, or scenario events that are inserted into the scenario to stimulate discussion and test procedures, policies, or protocols. Questions were sometimes organization-specific or professional discipline-specific. For example, participants representing state and local public health institutions were asked about their capacity to conduct health research following disasters and how to request support from federal agencies. Participants representing academic institutions were asked about the role academic institutions could play in conducting research in support of local public health institutions and about IRB requirements. A facilitator was used to generate discussion and ensure logical flow of the scenario. More questions for participants can be found in the exercise participant manuals. In addition to the facilitator, the Boston workshop used discussion leaders for the breakout sessions. Specifics on each scenario are described later in this report.

Tours

In the Los Angeles exercise and Boston workshop, participants were provided with the opportunity to participate in community tours that showcased the areas that may be impacted by the scenario. The tour provided participants with a mental image of the devastation that communities located in the proximity of hazards may experience and the possible research needs that these communities might need if the disaster occurs. In the Los Angeles exercise, participants received a tour that highlighted the density and proximity of industrial plants to communities in the Wilmington neighborhood. Participants heard from members of community organizations, local worker unions, and others about their environmental health concerns and potential damage that a tsunami, as described in the scenario, would have on their neighborhoods. The tour provided participants with a mental image of potential hazardous exposures, including the refineries, rail yards, and ports, as well as the impacts these hazards

have on nearby communities and the potential devastation that it could cause if a catastrophic event occurred. Participants of the Boston workshop received a tour of the Chelsea community. Through the tour, participants were also able to visualize the dangers that communities located in proximity to chemical/petroleum facilities may face due to a flood event. A tour was not conducted in Houston due to the lack of interest by the planning committee since most participants were local to the area.

Participants

The success of the exercises depended on having federal, state, and local stakeholders represented in the exercise—those who might be conducting the health research, those who will be impacted by the disaster, and those who respond to disasters. While each exercise was open to the public (as permitted by space limitations of the venue), most of the participants were invited to participate based on their position in their organization and possible role in a disaster research response. These included, but were not limited to, state and local government officials (e.g., health departments, emergency management offices, police, fire departments); academia; local community members and organizations; local worker unions and organizations; local public health organizations (e.g., hospital organizations); and federal government representatives, including the Federal Emergency Management Agency (FEMA) and HHS. The breakdown of total participants by affiliation can be found in Table 1.

Table 1. Breakdown of Total Participants of the Three Exercises by Affiliation

Affiliation	Count	Percent
Academic	72	23%
Community	25	8%
Federal	45	15%
Industry	7	2%
State or Local Gov't /Other	34	11%
State or Local Public Health	27	9%
Trainers	76	25%
Other	4	1%
State or Local Emergency Management	19	6%
Total	309[20]	100%

Exercises highlighted the vast network of participants needed to make a disaster research response successful. It was important that participants understood why they were invited to the exercise. For the Houston exercise and Boston workshop, the list of invited stakeholders was adjusted based on experience and feedback from the previous exercise(s). For the Houston

[20] This total includes NIEHS staff and contractors that also attended the tabletops.

exercise, representatives from industry and local emergency were also invited to broaden the stakeholder engagement. The Boston workshop invited public health organizations, including hospital organizations, and the Regional HHS Office of the Assistant Secretary for Health. While invitations were extended to major private industries in Boston, most declined to participate. The Boston workshop also integrated presentations from Massachusetts Emergency Management Agency (MEMA), GreenRoots, and Harvard Education and Research Center—Harvard T.H. Chan School of Public Health into the scenario. Each presenter discussed their organization's "current" position during selected times in the exercise.

Exercise Quality/Best Practices/Lessons Learned

At each exercise, participants were provided with a post-exercise evaluation during the meeting to evaluate the exercise format, content, and organization. These evaluations were collected at the end of the exercise. Using the Likert scale, participants were asked to rate on a scale of 1 (strongly disagree/not met objective) to 5 (strongly agree/met objective) the preparation of the tabletop exercise and materials, the tour (if applicable), the exercise (including venue and facilitation), and whether the objectives of the exercises were met. Participants were also provided with a chance to provide qualitative written comments regarding the mentioned topics. Table 2 provides the response rates for each exercise and for the three exercises.

Table 2. Post-exercise Evaluation Survey Response Rate

Exercise	Response Rate
Los Angeles	31%
Houston	52%
Boston	40%
Overall	41%

Following each exercise, a report was drafted that summarized the organization and format of the exercise, and the participants' discussions, best practices, and lessons learned. These reports can be found on the DR2 website. The following section highlights some of the best practices and lessons learned from the three exercises.

Exercise Format

Regarding the format of the exercises, participants mostly agreed that the format of the exercises was helpful to achieving the goals and objectives of the exercises (average rating of a 3.88 in a post-exercise evaluation). However, the participants did note that their ability to participate in the discussion was limited in the Los Angeles and Houston exercises, as the main conversation was focused on the main tables consisting of a smaller group of lead agency/organization representatives. The Boston exercise took this feedback into consideration and reorganized the exercise into small group discussions followed by a report-out, still walking through the scenario and using similar facilitated questions.

Realistic scenarios based on actual environmental hazards and threats were developed based on existing assessments and previous disasters. These scenarios were also validated by local stakeholders. Real-life scenarios were an important component of the exercises, as it allowed participants to relate to the exercises and visualize their roles in a potential research response to the scenario.

During the Boston exercise, key stakeholders gave a brief introduction to their organization's roles at a particular time during the scenario. Respondents of the Boston post-exercise evaluation noted that each of these presentations helped enhance their understanding of the scenario and the roles each stakeholder could possibly take to initiate or contribute to a research response. Injects were incorporated into the scenario and participants were asked questions to stimulate the discussion. The injects and questions aim to encourage participants to talk through the process of identifying procedures, resources, and relationships that can be used to respond to and recover from disasters. In the post-exercise evaluation, participants generally agreed that the facilitation of the exercise generated productive discussion (average rating of 4.06 out of 5).[21]

Pre-meetings (tours and safety and health training)

A pre-exercise webinar was conducted to prepare participants for the Los Angeles exercise. This webinar included a brief safety and health training on the hazards found on disaster sites. Due to time limitations and the fact that some participants were unable to attend the webinar, it was not rated high. However, researchers and public health workers in both the Los Angeles and Houston exercises did voice the need to better understand the incident command system (ICS) during a disaster response. As a result, a safety and health training was provided to participants at the Boston workshop who were interested in learning more about responding to a disaster. The Boston workshop included a brief discussion regarding safety and health considerations for those who may be working or performing research in disaster areas and an incident command training session that provided information about the ICS and the importance of integrating research efforts with these response and recovery systems. Participants who had no previous disaster response experience (academics) found this session to be very useful in helping them understand how their organizations fit within the local incident command structure.

As mentioned earlier, participants in the Los Angeles and Boston exercises were able to participate in a community tour. In the post-exercise evaluation, participants who attended the community tour indicated that the tour provided an added experience to the exercise (average rating of 4.48) and agreed that the tour helped participants understand the issues facing the community and their organization's role as it relates to disaster research response (average rating of 4.36).

[21] This question was only asked in the Los Angeles and Houston exercises, which were led by one facilitator. The question was not asked in the Boston exercise, as it consisted of a breakout workshop format.

Best practices

- Engage participants in discussions throughout the exercise
    - Pre-scripted questions and injects
    - Breakout sessions and report sessions to entire group
- Develop scenarios based on actual hazards and threats using existing science and reports
- Pre-exercise site visits
    - Introduce DR2 Program and goals to all stakeholders
        - Stakeholders can introduce themselves to each other
    - Address their needs and concerns
    - Get a feel for local procedures and relationships
- Conduct tours of the areas affected in the scenario
    - Provide a better understanding of the socioeconomics, geography, and proximity to threats that will be discussed in an exercise

Lessons learned

- Need to bring all participants up to a standard level of understanding
    - Presentations on ICS, health and safety, state/local response organizations
- Provide all participants with an active opportunity to participate
    - Breakout sessions
        - Make sure instructors have training before participating

Capabilities and Capacities

While the lack of an established disaster research response plan at the state and local level was expected, the exercises did highlight the importance of having such plans integrated into the existing response and recovery plans. The exercises revealed to state and local health departments that they most likely will need outside support to conduct research, as in most cases, their resources may be tied to the immediate response of an event. Of note, state and local organizations, including health departments that participated in the exercises, have limited capacity and capability to conduct disaster research, and are even more limited in their capacity or capability to conduct long-term longitudinal research. The exercises clearly revealed that the gap in capability and capacity to conduct and sustain research will need to be filled by other local organizations, institutions, and establishments, such as academia, community organizations, private industry, and local volunteer organizations. Participants emphasized the importance of collaboration and constant communication between various stakeholders, including public health and emergency management. The DR2 exercises helped establish relationships between the various disaster response stakeholders, and helped them understand the respective roles each play during a disaster response.

Best practices

- Communities need a research response plan that integrates into the local and state response and recovery plans
    - Discuss perceived capabilities and capacities to find upper limits
        - Locations tend to overestimate both

    - Most localities do not have a disaster research plan
- Collaboration of response/recovery organizations improves opportunities for disaster research to take place and succeed
    - Exercises helped determine relationships among response organizations
        - Many do not work with one another on a regular basis or are compartmentalized and that hinders collaboration
- Local resources can be used to augment local governmental response/recovery organizations
    - Private industry and academia have specialized resources that can augment response/recovery efforts to expand local capability and capacity

Lessons learned

- Disasters that impact multiple jurisdictions pose challenges of cross-jurisdictional planning and response coordination, and disaster research will be hampered by the lack of robust jurisdictional planning and coordination

Stakeholder Involvement

Participants from all three exercises agreed that discussion on disaster research response is necessary to support the goals of disaster preparedness and response, especially for vulnerable communities located near the environmental hazards. Clear communication and coordination between local, state, and federal agencies; communities; industry; and workers are extremely important and should be maintained, informally or formally (e.g., via memorandums of understanding), even when there is no ongoing disaster response. Each stakeholder group offers unique resources and perspectives that can enhance a disaster research response. For example, participants emphasized using the community based participatory research model as a good approach to actively involve community members in the disaster research response process.

Best practices

- Engage community advocate groups, volunteer organizations, and private industry in disaster planning, response, and recovery activities
    - They can help plan research, provide access to vulnerable communities, prioritize community issues, collect data
- Use non-traditional groups to collect data
    - Residents of affected communities, fire/safety personnel, volunteer organizations are willing to collect data for research purposes
    - Assess current technologies that permit data collection by volunteers
- Engage local/regional academic institutions in disaster planning, response, and recovery activities
    - They have unique expertise, community trust, personnel that are useful in pre-/post-disaster activities
    - Academic organizations should organize and collaborate prior to events to address:
        - Data collection

        - Data sharing
        - Protocol approval by IRBs
        - Research proposal writing, funding, and resource sharing
    - Academic institutions have training resources that can be accessed by responders before and after disasters
- Involve community and neighborhood advocates in disaster research planning, execution, and analysis
    - Research addresses relevant community health issues and concerns
    - Researchers must gain the trust of communities through transparent and honest, understandable communications in languages and customs appropriate to the affected populations
    - Data collection can be conducted by community members using the appropriate technologies
    - These groups can identify vulnerable populations and assist researchers in accessing and engaging affected populations
    - Informal community leaders bring credibility and trust to research activities when they are engaged
- Involve private industry in disaster research response
    - Many industries have protocols and operating procedures that complement community protocols
    - Industry often has baseline data on exposed employees
    - Industry is often willing to share protocols, plans, expertise, etc. with public health responders
- Include hospitals in preparedness, response, and recovery planning
    - There is a reluctance to share information due to regulations and laws protecting the privacy of patient information and legal concerns
    - Hospitals need to fully understand privacy laws and determine how those factor into their disaster research response efforts

Lessons learned

- Residents and community organizations provide a valuable source of information to disaster researchers
    - They can help identify local health issues and concerns, lend credibility to researcher efforts, and solicit participation of vulnerable populations
- There are citizen-based groups who can use non-traditional data collection methods to gather data early in a response

Response/Recovery Infrastructure

The exercises highlighted the importance of integrating disaster response into a national framework, so that it is recognized as a key component of a response and to ensure a coordinated and integrated response, and to maximize the use of limited resources. The discussions from the three exercises highlighted that the decision to engage in any disaster research response begins with a local request from the community to the local government, from the local government to the state government, and from the state government to the

federal government. In other words, the federal response resources need to be invited in by the state agency. Moreover, state and local public health and emergency management organizations are the lead organizations in post-disaster response and should coordinate research efforts to ensure that community priorities are being addressed and that resources and response/recovery efforts are used efficiently and effectively. One concern expressed by participants is that emergency management is reluctant to include disaster researchers because of concerns that researchers will impede life-saving response efforts or become injured while working in the disaster setting.

Best practices

- Emergency management that includes disaster research as part of the response/recovery activities
    - Researchers should receive ICS and health and safety training
    - Emergency management can include scientists on the command staff
    - Research can begin after the initial response period and still gather important data
        - That period appears to be after the first 1-2 weeks

Lessons learned

- Resistance to disaster research by emergency managers can be overcome by education and outreach by public health and academic organizations
- Optimal times for engagement by research responders varies by disaster type, but was generally considered to be most optimal after the immediate live-saving response has been completed and before the commencement of recovery efforts

Disaster Research Process

Participants held discussions on the process of initiating, planning, and implementing a research response and the challenges that they face in the process. The issue of IRBs approving research protocols was raised during the meetings, as protocol approval poses the greatest challenge to timely data collection. In both the Houston and Boston exercises, participants mentioned that though pre-approved IRB protocols maybe helpful, it would still pose a challenge to organizations to acquire them. Participants also noted that an inventory of data collections tools and materials, such as the NIH DR2 resources, NLM data collection, and the Rapid Acquisition of Pre- and Post-Incident Disaster Data (RAPIDD) protocol, facilitate the rapid initiation and implementation of research investigations.

Another challenge raised by the participants of the three exercises was the difficulty of getting important baseline information. Though the availability of funding was an assumption in the scenario, it was still a challenge raised by several organizations in terms of assessing and identifying the availability of resources for a research response. Participants discussed possible funding options, including rapid funding opportunities.

Best practices

- Protocols undergo conditional approval from IRBs prior to their use

    - IRB process remains an issue for expedient research
    - IRBs should be approached to work with researchers on protocols and approval processes as early as possible, preferably such interactions should begin prior to an incident
    - Protocols and collection tools can receive conditional approval prior to their use
- Funding for disaster research is made available on a timeframe that permits early data collection
    - Research organizations must be prepared to accept and distribute funding quickly
    - Lack of funding is the major impediment for disaster research

Lessons learned

- Technology and contributions by local citizens can facilitate initial data collection

Recommendations

While the need for timely and effective research response persists, the NIEHS DR2 program has realized many accomplishments over the past four years, including conducting three disaster research response exercises. These exercises were successful in bringing together stakeholders from the federal, state, and local level and the private and public sectors to discuss how to effectively conduct environmental health research following a disaster. Through a facilitated dialogue using a realistic scenario, participants of the exercises were able to position their organizations in the scenario. Participants were also able to share their capabilities and capacities at a particular point in the scenario and how they can contribute to the research response. They also shared best practices and lessons learned and put forward challenges to conducting disaster research, such as IRB issues and lack of funding. Through the exercises, participants were able network with other stakeholders to better understand the role of their organizations as well as other organizations during a disaster research response. Most participants agreed that more discussion is needed, but the exercises provided the platform to initiate such dialogue.

The following recommendations are based on the best practices and lessons learned from the three exercises:

Exercise Development/Organization

- Exercises are a productive method for bringing stakeholders together to discuss disaster research issues.
    - Exercises need to be interactive, based on realistic scenarios, and include a broad swath of community and state stakeholders.
    - Encourage participation from all participants by providing opportunity to speak and present, e.g., by breakout groups, presentation on role of organization, etc. This can also help stakeholders understand the roles of other participants and encourage development of possible partnerships.

    - State and local emergency management offices should be engaged from the beginning of the exercise planning to get buy-in and to incorporate their issues into the scenario. They can also help with the development of scenarios based on actual hazards and threats.
        - Many are familiar with FEMA Homeland Security Exercise and Evaluation Program (HSEEP) exercise guidance and can provide valuable expertise in understanding existing local and state response/recovery plans.
- Detailed incident command and disaster site safety and health training should continue to be provided to researchers and other research responders so they understand how they fit in to a disaster response and incident command.
    - FEMA ICS training could be used to serve as the core for learning important ICS concepts and terminology.
    - The NIEHS Worker Training Program should build upon its disaster health and safety training clearinghouse and experience to build relevant health and safety core curriculum for the research community and other stakeholders.
    - Local tours of vulnerable communities and nearby industries provide visual images of how local communities would be impacted by the disaster scenario. Tours also help participants understand the possible research needs should such a disaster occur, and help them prepare for disaster research response.
- DR2 should continue to look for opportunities to conduct additional exercises at the local level.
    - Future exercises require an interested and engaged host.
    - A workshop format provides more interaction for participants.
        - If this approach is used, facilitators require training on the injects and objectives of the exercise.

Disaster Research Response

- State and local emergency management offices should consider integrating disaster research response as part of the research response plans.
    - State and local disaster exercises should incorporate a research collection component.
- Disaster research should address the short- and long-term health issues faced by local communities.
    - Community members should be engaged at the beginning of the research response planning process, as they can provide insight on possible research needs; provide a valuable source of information, including baseline data; and help collect health and environmental information in non-traditional manners early in the response.
    - Community advocates can identify vulnerable populations and assist with gaining access to those populations.

    - Academicians should serve as a resource to governmental response organizations, as they have expertise that can support governmental research activities.
- Local and state disaster research capabilities and capacities should be evaluated.
    - Exercises were unable to accurately assess the disaster research capabilities and capacities, although they determined that the three sites would not be able to orchestrate a complex, long-term health study without external resources. It is uncertain from the exercises where the tipping point was for those locations.
    - Coordinating local capabilities and capacities between all stakeholders (e.g., communities, academia, local public health departments, emergency management offices, etc.) can help facilitate disaster research response. Formal partnerships can be established via existing memorandums of understanding or other formalized relationship contracts.
- IRB review and approval of protocols has been identified as a challenge for disaster researchers to conduct timely research.
    - NIEHS IRB workshop findings should be widely disseminated and should continue to lead the discussion regarding innovative ways to obtain conditional and unconditional approval of research protocols.
- Quick funding mechanisms need to be developed so that research organizations can be deployed to disaster areas to collect data in a timely manner.
    - Local organizations lack the necessary funding to build sustainable capacity and capability.
- Compile best practices and lessons learned from previous disasters so that others can learn from previous disaster research responses.
    - The NLM DR2 website is the recommended repository for best practices and lessons learned.

Section II. Assessment of the Online Survey Results and Interviews

As mentioned previously, to better understand how the exercises have impacted stakeholders after participating in the exercise, follow-ups were conducted via online survey and interview (see Methodology).

Seventy-four participants of the 276 emailed participants (over 25 percent) from the tabletop exercises responded to an online survey.[22] Thirty-nine of the overall participants were interviewed. Table 3 shows that participants in the evaluation had an over-representation of academics and federal participants and an under-representation of community advocates and state or local government other (environment, law enforcement, fire, EMS, etc.)

[22] The first invitation to participate on the survey reached out to 290 stakeholders (stakeholder participants and planning committee members, but does not include NIEHS staff and contractors). Out of the 290 emailed, 276 emails were successfully delivered (or not bounced backed).

Table 3.Participants by Self-Identified Affiliation Percentage Comparison of All Exercise Participants, Survey Respondents, and Interviewees (Rounded to the Nearest 5 Percent)

Professional Affiliation	All Exercise Participants	Survey Participants	Interview Participants
Academia	25%	30%	40%
Community or Local Advocate	10%	5%	5%
Federal Government	10%	20%	15%
Industry	5%	5%	5%
State or Local Emergency Management	5%	10%	5%
State or Local Gov't Other (Environment, Law Enforcement, Fire, EMS, etc.)	10%	5%	0+%
State or Local Public Health	10%	5%	15%
Trainers	25%	25%	10%
Total Number of Participants	276	74	39

Note: Numbers are rounded to the nearest 5 percent (and, therefore, do not add to 100).

Sources: Survey Monkey Survey; MDB, Inc.; Data collected in interviews

It is not clear whether the relative activism of those who responded to the survey and interview request is reflective of the 276 participants in the DR2 exercises successfully reached via email. The mere act of participation in this evaluation may reflect greater activism by those who participated. Those who chose not to participate may or may not have declined to respond because they had little to report. Some, clearly, were extremely busy with their work or had personal reasons that prevented their participation, but we are unable to determine whether non-participants were involved in fewer, the same, or more disaster research-related activities since the tabletop exercises.

Summary of Overall Results of the Evaluation

Survey and interview results showed: 1) increased awareness and knowledge of disaster research; 2) the beginnings of activities by those who had not previously engaged, or even thought of, disaster research in the past; and 3) deepening relationships and work by those who were previously experienced in disaster research. Below are examples of activities occurring after attendance at the tabletop exercises.

The evaluation was tasked to find specific improvements mentioned in the goals of this assessment. While there are many general statements that support the objectives of this study (and these are discussed later in the report), what follows are specific examples that were provided through the surveys and interviews:[23]

[20] Some of these activities may have begun before the tabletop exercises. Respondents were not always clear on the dates. All of these activities are listed in other places, throughout the subsequent pages of this report.

Evaluate what participants and stakeholders specifically gained and learned from participation

- Among federal employees and contractors, half had considered inclusion of activities such as citizen science to help support research in disasters.
- One participant participated in new disaster research-focused meetings.
- One participant presented the DR2 concept and resources at a West Coast academic symposium.

Assess new relationships and collaborations

- A Boston-based academic collaborative has inspired some on the West Coast to collaborate with them on a similar project.
- A respondent from a hospital said they were entering a multi-center system with a common IRB, and conducting joint research on infectious disease.
- One institution developed relationships in their community disaster work, with Job Corps and the Council on Aging.
- One institution is developing a Gulf Coast Environmental Health Network, comprising many different disciplines and communities.
- One institution increased its work with immigrant workers, through two local organizations—working on hazmat disaster preparedness and training groups in "muck and gut" in Spanish.
- One institution is planning to collaborate with the Center for Environmental Toxicity.
- One professor approached a colleague at his institution and they are collaborating on a personal protective equipment (PPE) project.
- One Texas academic institution has developed a contract relationship with another Texas university.
- One union has deepened its relationship with the Latin American Council for Labor Advancement (LACLA) and done lead and mold awareness training for them.

Identify how lessons learned led to additional projects and new activities

- Thirty percent had worked to advance IRB policies or processes for disaster research.
- Twenty percent had added new activities associated with disaster research.
- Nearly 25 percent had developed a plan to support deployment to a disaster.
- A group partnered with city and county health departments to put on a Zika Birth Defects Symposium.
- Another respondent said that as a result of the exercise, they now have a policy group, and they now place research at the center of their disaster planning to design appropriate response.
- One group is considering adding community health workers to participate in after-action review.
- One had a study accepted for 2017 publication in the *Journal of Environmental Health* on response and recovery and resilience to oils spills and environmental disasters.
- One institution is creating an online learning module on infectious diseases as part of a public website.

- One participant from a hospital said they are looking into what can be done in the emergency room with electronic records to provide data for research.
- One participant had a paper accepted for the August 2017 issue of *Disaster Medicine Public Health Preparedness Journal*.

Assess how participation changed behaviors for future disaster research responses

- Sixty-five percent of workers and worker-trainers had changed training to include concepts from the tabletop exercises.
- Thirty percent of workers and worker-trainers had participated in training for disaster researchers.
- Twenty percent had added preparedness planning efforts.
- Among federal employees and contractors, 20 percent had developed new processes, guidelines, or policies for their agency related to involvement in disaster research.
- Ten percent of respondents who had not seen vulnerable populations as part of their work in disaster research and environmental hazards, now are considering them.
- One participant had discussed the role of the California Department of Health, Drinking Water Division and National Weather Service scientists in response and recovery from an incident.
- One had outlined training requirements for a scientist or researcher.
- The California Office of Emergency Services has developed the Emergency Management Career Track Credentialing Program.
- Two had considered questions such as long-term health outcomes that could be investigated after a disaster.

Evaluate how participation changed actual capacity to perform or participate in disaster research

- Twenty percent added committees or working groups.
- Twenty percent added community groups or environmental justice efforts.
- Twenty percent of workers and worker-trainers had included disaster research in a funding proposal or funding request.
- Thirty percent had submitted a disaster research-specific proposal.
- Thirty percent had worked to advance IRB policies or processes for disaster research.
- A university participant invited an occupational medicine doctor with infectious disease training to their campus.
- At least one representative said their institution had applied for supplemental funding to be able to operate in a disaster.
- Lead awareness material is now available in Spanish.
- One institution funded a consortium on community resilience.
- One institution hosted an advisory board workshop.
- One institution hosted speakers.
- One participant took two courses from the FEMA Emergency Management Institute after the tabletop exercises.

- One respondent said their institution had increased the amount of staff research planning by 24 percent since attending the 2014 California DR2 exercise.
- Over half had begun to identify experts and skills within their institutions able to address specific research issues and needs.
- Over half had included disaster research in a funding proposal.

<u>Develop a framework and tools to ongoing assessment and assistance with disaster preparedness and response capacity</u>

- A union representative did a workshop on lead at the 2016 convention of the Coalition of Black Trade unionists.
- A union representative, in conjunction with a local church, created a skit on lead awareness for the Flint community.
- A university medical group carried out a mock exercise to study the response to Ebola.
- An academic-public health collaboration in New York organized a Cyber Terrorism tabletop exercise.
- One attendee had consulted with local scientists or universities regarding a health threat.
- One had developed a place in the ICS for scientists.
- One had explored the potential for research to improve management and response.
- One union developed a disaster preparation course (that had already run four to six times at the time of this evaluation survey).
- One union developed a Spanish language Disaster Train-the-Trainer program, with the first course in spring 2017.

A. Online Survey Results of 74 Participants of the Disaster Research Response Tabletop Exercises

Several participants attended more than one tabletop exercise. The 74 respondents to the survey represented 92 attendance spots for the exercises. Of the 92, over half attended the Boston exercise, 45 percent attended the Los Angeles exercise, and nearly 30 percent were Houston participants. (See Table 4.) Approximately 45 percent had been an NIH grantee. (See Table 5.)

Table 4. In which DR2 tabletop exercise(s) did you participate? (Select all that apply)		
Exercise Location	Responses	
Boston [2016]	51.35%	38
Houston [2015]	28.38%	21
Los Angeles [2014]	44.59%	33
Answered		**74**
Skipped		**0**

Table 5. Are you, or have you ever been, an NIH grantee?

Answer Choices	Responses	
Yes	44.12%	30
No	55.88%	38
Answered		**68**
Skipped		**6**

The five most beneficial aspects of participation, in order, were (all from 63 percent to 49 percent of those responding in descending order): (See Table 6.)

- Understanding local response capabilities to collect information or perform needed studies.
- Discussing health and safety considerations and training.
- Understanding the importance of disaster research.
- Understanding local emergency response procedures and processes.
- Exploring community-based participatory research.

Table 6. From your participation in the exercise(s), which of the following did you find to be beneficial? (Select all that apply)

Answer Choices	Responses	
I don't remember much from the event	8.22%	6
Understanding the importance of disaster research	53.42%	39
Understanding local response capabilities to collect information or perform needed studies	63.01%	46
Understanding local emergency response procedures and processes	50.68%	37
Meeting potential disaster responders	42.47%	31
Meeting potential academic collaborators	35.62%	26
New data collection tools and resources	26.03%	19
Discussing IRB requirements	19.18%	14
Exploring community-based participatory research	49.32%	36
Discussing health and safety considerations and training	63.01%	46
Other (please specify)	12.33%	9
Answered		**73**
Skipped		**1**

When asked about activities since the exercises, even though 30 percent of participants said they had not yet made revisions to disaster research items, nearly 30 percent had made changes in training and 20 percent to exercises. Nearly 15 percent of participants had: 1) revised protocols and/or guidelines for research deployment; 2) added committees and working groups; or 3) made funding requests. Ten percent had made changes to data collection instruments for research deployment or IRB procedures. (Because of multiple responses, in some cases, the numbers do not add to 100 percent. See Table 7.) Other responses included, one organization hosting speakers, another reported hosting an advisory board, another had funded a consortium on community resilience, and lastly one attendee had developed a

disaster preparation course that had already been run four to six times at the time of the survey.

Table 7: Since the exercise(s), have you or your organization made any revisions to the following disaster research items? (Select all that apply)		
Answer Choices	Responses	
Protocols and/or guidelines for research deployment	12.50%	9
Data collection instruments for research deployment	11.11%	8
Committees/working groups	12.50%	9
Call-down rosters of experts or others to assist with disaster research	4.17%	3
Training	27.78%	20
Exercises	19.44%	14
Nothing yet	0.00%	0
Funding requests	13.89%	10
IRB processes, procedures, or practices	8.33%	6
Nothing Yet	31.94%	23
N/A	0.00%	0
Other (please specify)	15.28%	11
Answered		**72**
Skipped		**2**

Over 45 percent of the respondents, after the exercises, had participated in new disaster research-focused meetings, collaborations, or activities, either formally or informally. Of those, approximately nearly 40 percent had initiated the meetings, collaborations, or activities. One of the activities, specifically mentioned, was presenting the DR2 concept and resources at the Center for Occupational and Environmental Health symposium at Berkeley focused on the Aliso Canyon gas release. Possible collaborations were with representatives of academia, state or local government agencies, federal agencies or contractors, community organizations or advocates, trainers or worker representatives, or with private industry, in that order—all between 55 percent and 25 percent, but some had multiple answers. Some mentioned the specific institutions for pending collaborations, and these included the University of Southern California; UCLA; University of Oregon; University of North Carolina; City of Houston Health Department; ExxonMobil; Seattle Department of Health; National Fire Protection Association; the National Academies of Science, Engineering and Medicine; Gulf of Mexico Research Initiative (GoMRI); Los Angeles County Health Department; Northeastern University; FEMA; and New Jersey Department of Human Services. Almost 70 percent of these activities and collaborations were with organizations that did not participate in the exercises. Among these "new" organizations were the National Tsunami Hazard Mitigation Project, Brown University, Boston University, ExxonMobil, National Oceanic and Atmospheric Administration, USGS, National Disaster Medical System, Texas One Gulf Center of Excellence, GoMRI, and University of Washington. In only 6 percent of these cases was there a formal agreement in place; but in

over 35 percent there was a committed engagement, and in 45 percent of the pending collaborations there were ongoing informal discussions.

Limited capacity to do disaster research was an issue for many. While nearly 55 percent of respondents said their organization had some components necessary to do disaster research before the exercises or could do disaster research on a limited basis, less than 10 percent said that they could perform most of the activities associated with disaster research. Less than 15 percent had actually done disaster research, with another 5 percent saying they had a fully capable program but had not yet done disaster research. After the exercises, an additional three respondents felt that they had a fully capable program and they had performed disaster research—up from six to nine out of 66 and 67 respondents respectively.

Respondents were asked to assess their capability to support or perform disaster research before and after participating in a DR2 exercise. Table 6 illustrates the responses.

Table 8: Capability to perform disaster research before and after exercise(s)			
	Before (%)	After (%)	Change (%)
No capacity to perform research	12	6	-6
Some capacity, need considerable assistance	23	26	+4
Perform basic functions	29	28	-2
Perform most functions	9	9	0
Fully capable program, but not performed disaster research	3	4	+1
Fully capable program and performed disaster research	9	13	+4

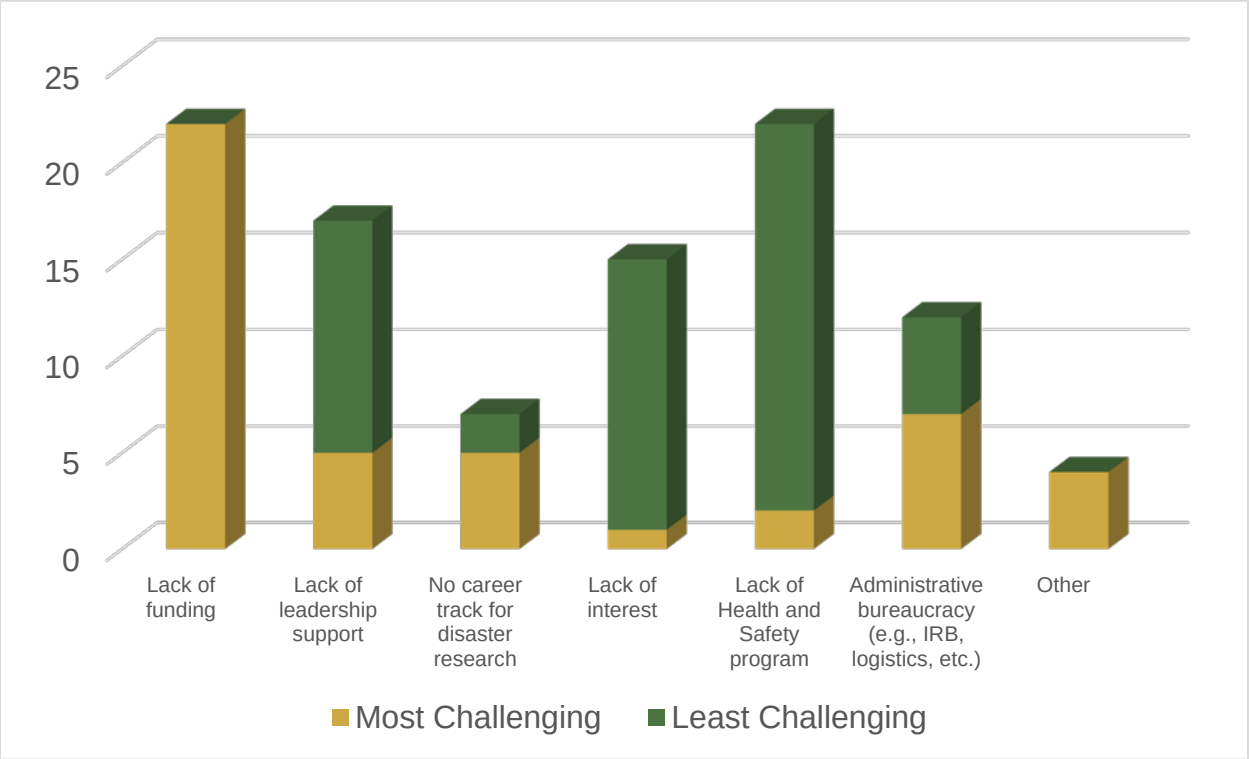
While 35 percent of respondents said they had not yet been involved with any new disaster research activities, of the 66 who responded, 20 percent said they had added new activities associated with disaster research. Twenty percent had added committees or working groups, 20 percent had added community groups or environmental justice efforts, and 20 percent had added preparedness planning efforts. There were also increases in trainings, exercises, funding requests, and disaster research plans. Thirty-five percent had not yet expanded their efforts. (See Table 9.)

Table 9. Since the exercise, have you or your organization been included in, or added to any new disaster research activities such as: (Select all that apply)		
Answer Choices	Responses	
Committees/working groups	21.21%	14
Development of disaster research plans, rosters, etc.	6.06%	4

Trainings	16.67%	11
Exercises	13.64%	9
Funding requests/proposals	16.67%	11
Preparedness planning	19.70%	13
Community groups/Environmental justice efforts	21.21%	14
Nothing yet	36.36%	24
Other (please specify)	16.67%	11
Answered		**66**
Skipped		**8**

Not surprisingly, most often mentioned as the biggest challenge—by 35 percent of respondents—was funding (See Graph 1). The next largest response was administrative bureaucracy, at 10 percent. With a weighted average, the next biggest challenges, after funding and administrative bureaucracy, were no career track for disaster research, lack of interest, lack of leadership support, and lack of a health and safety program. (See Graph 1.)

Graph 1. Please indicate how challenging these capacity issues are to establishing a disaster research program or policy at your organization or community:



While none of the participants said they had visited the DR2 website before the exercise, over 60 percent had visited it by the time of the survey. While only 55 percent of respondents answered the next question, most of them (nearly 95 percent) had reviewed the site for

general information. Nearly 45 percent of them (45 percent of the 55 percent of respondents, or 25 percent of total participants) had downloaded a publication, report, training materials, or other information. And approximately 35 percent (35 percent of the 55 percent of respondents, or 20 percent of total participants) had searched or downloaded some of the data collection tools. Less than 10 percent (or 5 percent of all 74 respondents) had downloaded a research protocol.

All five of the state or local public health workers answered the question about activities since the exercises. Four of the five had considered topics of interest to their organization that might involve research or questions such as long-term health outcomes that could be investigated after a disaster. Three had considered topics of interest that research could inform. Two had explored their organization's capacity to conduct or support disaster research without external support and two had explored partnerships with an organization to supplement their capability to perform surveillance and research. One had consulted with local scientists or universities regarding a health threat.

Four of the seven state or local government emergency management workers answered a question about supporting disaster research, developing a place for scientists in the ICS, and outlining training requirements for a scientist or researcher so they could safely join in a response research effort. One had developed a place in the ICS for scientists, one had explored the potential for research to improve management and response, one had outlined training requirements for a scientist or researcher, and two had considered questions such as long-term health outcomes that could be investigated after a disaster. Another commented that they had discussed the role of the California Department of Health, Drinking Water Division and National Weather Service scientists in response and recovery from an incident, as well as further training to develop knowledge and skills. Since then, California's Office of Emergency Services has developed the Emergency Management Career Track Credentialing program.

Approximately 70 percent of those who identified as academics or researchers (13 of 19) responded to a question about their post-tabletop activities. Over half had included disaster research in a funding proposal and 30 percent had submitted a disaster research-specific proposal. Over half had begun to identify experts and skills within their institutions able to address specific research issues and needs. Thirty percent had worked to advance IRB policies or processes for disaster research. Nearly 25 percent had published literature or reports on disaster research.[24] And nearly 25 percent had developed a plan to support deployment to a disaster. (See Table 10.)

Among workers and worker-trainers (with nearly 70 percent, or 11 of 16, responding), nearly 65 percent had changed training to include concepts from the tabletop exercises. Thirty percent had participated in training for disaster researchers and 20 percent had included disaster research in a funding proposal or request. Ten percent (one person) had developed a training

[24] One study accepted for 2017 publication in the *Journal of Environmental Health* was "Response, Recovery, and Resilience to Oil Spills and Environmental Disasters," http://eprep.oregonstate.edu.

for disaster research. None had published literature or reports on disaster research since the tabletop exercises. (See Table 10.)

Seven respondents—from the community, from "other" state or local organizations, or from industry—answered the question about post-exercise activities. Eighty-five percent of the total (six of seven) said they continued to participate in, or be interested in, furthering their ability to support or participate in disaster research. And 85 percent had considered a role for their organization in disaster research or response. One person had considered activities such as citizen science as a tool for research in disasters, and one had developed new processes, guidelines, or policies for their agency related to involvement in disaster research. (See Table 10)

Among federal employees and contractors, 10 of 12 responded about their post-exercise activities. Eighty percent said they had worked on activities to further a role for their organization in disaster research and/or response. Seventy percent continued to participate in, or be interested in, furthering their ability to support or participate in disaster research. Half had considered inclusion of activities such as citizen science to help support research in disasters, and 20 percent had developed new processes, guidelines, or policies for their agency related to involvement in disaster research. (See Table 10.)

Table 10: Summary of post-exercise activities by affiliation

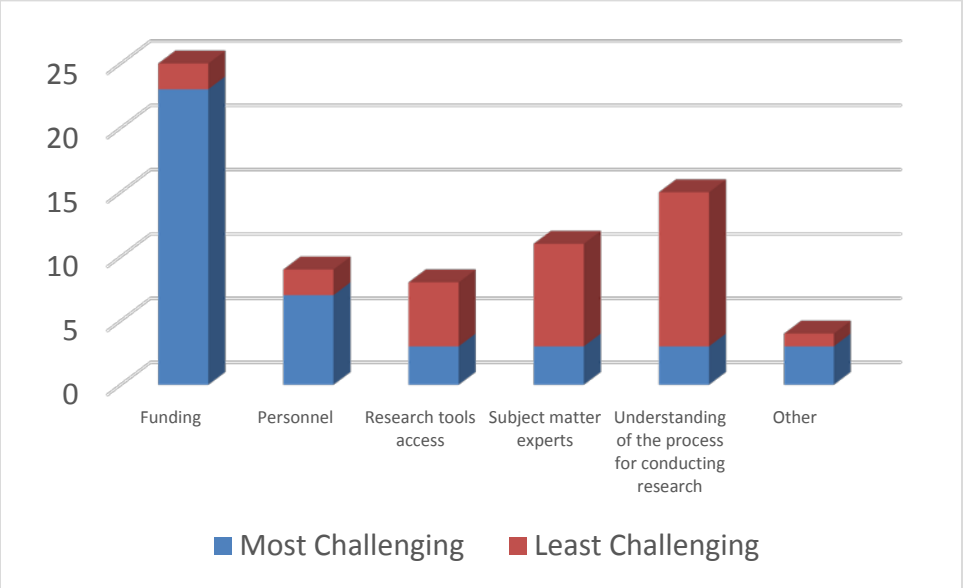
	Local Public Health n=5	Emergency Management n= 4	Academia n=13	Trainers n=11	Community/Private industry n=7	Federal Staff/ Contractor n=10
Expanded capacity for research	40%					
Considered topics of interest to your organization	60%					
Considered long-term health outcomes for research	80%	50%				
Consulted with local scientists or universities	20%					
Explored partnerships to augment capability	40%					
Explored integration of research into response		0%				
Developed a place in ICS for scientists		25%				
Explored research to improve management		25%				

Outlined training requirements for scientists		25%				
Published in the literature			23%	0%		
Participated in disaster research			38%			
Included disaster in a research proposal			54%	18%		
Submitted a disaster research proposal			31%			
Designed a disaster protocol			23%			
Advanced IRB policies			31%			
Identified subject matter experts (SMEs)			54%			
Developed a deployment plan			23%			
Participated in training for disaster researchers				27%		
Developed training for disaster research				9%		
Revised training due to the exercise				64%		
Continue to participate in disaster research					86%	70%
Considered citizen science as a research tool					14%	50%
Considered a role for your organization					86%	80%
Developed new processes for your organization					14%	20%

Of the 65 respondents who answered the question about vulnerable populations in disaster research and environmental hazards, most had considered these populations before the tabletop exercises. Seven (just over 10 percent) had not seen these issues as part of their work before the exercises, but it now is a consideration.

When asked about the most challenging capacity issue to their organization to maintain an ongoing presence in a disaster setting, the primary response was "funding." Nearly 70 percent said it was either the biggest challenge (40 percent) or a major challenge (30 percent). Based on a weighted average, the next most challenging issues for maintaining capacity were personnel, research tools access, subject matter experts, and understanding of the process for conducting research. (See Graph 2.)

Graph 2. Please rate the most challenging capacity issues to your organization maintaining an ongoing presence in a disaster setting:



In the summary question, of the 85 percent (53 of 62) who answered the question about the value of the exercise to the individual or their organization, 55 percent said it was of value to them and their organizations and 30 percent said it was of value to them. Less than 10 percent (five of 62) said it was of value neither to them or their organizations.

Participants were asked, "What do you consider the most important topics and concepts for the future of disaster research?" There were approximately 60 separate comments (see Appendix D: Survey and Interview Responses). Responses primarily focused on the following areas:

Comments on value of exercises to participants:

- *I learned about new research techniques and was inspired with new ideas.*
- *It strengthened our spring advisory board meeting and our interactions with other responders, academic researchers, and the local EJ community.*
- *We have added new elements to worker and resident training.*

- Research/Data Collection
  - Access to subject matter experts
  - Promoting environmental health literacy
  - Data collection management and privacy concerns
  - Rapid funding mechanism
  - Rapid IRB/Office of Management and Budget (OMB) approval of protocols
  - Environmental health impacts and exposure assessments of natural disaster and human events
  - Use of technology
- Stakeholders
  - Engaging communities throughout the whole process
  - Engaging local politicians and bureaucrats
  - Promote networks and ongoing support for planning and ability to respond and continual partnership/collaborative efforts
- Preventing Future Disasters
  - Prevention of future disasters through lessons learned and research to assist decision-making processes
- Response
  - Government policies on disaster research
  - Developing cohesive research agenda

Participant Accomplishments and Achievements

• Our organization developed a Spanish Language Disaster Train-the-Trainer program, which was held this past spring.
• In response to a large number of civic and faith-based groups in our region with members who volunteer, we used TNEC resources to develop a 1-hour 'what to expect when you get the disaster,' so that folks are able to protect against hazards.
• We are developing a Gulf Coast Environmental Health Network, comprising many different disciplines and communities.
• Thus far our disaster preparedness training (a one-day course) has targeted municipal and state workers. We have trained approximately 170 workers from about 6 state agencies (representing 3-6 unions) as well as workers from 15+ cities/towns representing 5+ municipal departments.

B. Interviews with 39 Participants of the Disaster Research Response Tabletop Exercises

The participants in the three tabletop exercises were ranked by NIEHS into four tiers for the purposes of priority in obtaining interviews. Both the survey and interview populations were from the same 276 people successfully emailed that attended at least one of the three tabletop exercises. Over 14 percent of the total group of participants were interviewed by telephone (one in person), in conversations that lasted approximately 30 minutes each. Many of those interviewed also completed the survey, but because many chose anonymity in answering the survey, it is impossible to know how many total individuals responded to just the survey or to both instruments. Those interviewed were 40 percent from the Boston exercise, 35 percent from Houston, and 25 percent from Los Angeles. They were approximately 35 percent academics; 25 percent state and local (with most from public health, but also emergency management and other); 15 percent federal employees; 10 percent trainers; 5 percent from industry; 5 percent community advocates; and one person self-identified strictly as medical. They came from nine states, the District of Columbia, and Canada.

The DR2 exercises seemed to be a good beginning in efforts to further disaster research. There is a clear need, even among subject matter experts, to change attitude and awareness before building the infrastructure for integrating research into disaster response and recovery. The DR2 exercises clearly helped in both the building of awareness and changed attitude and, also, steps in contributing to the growth of disaster research.

Not every interviewee answered every question and two participants, who worked together, were interviewed together.

What follows is a summary of the 39 interviews carried out with a broad range of DR2 participants. For detailed comments, please see Appendix D: Survey and Interview Responses.

Importance of Collection of Disaster Data

When asked whether the interviewee had participated in a disaster research or data collection project, nearly 60 percent (19 of 33) of those interviewed had been involved in some type of disaster research, though the terms “research” and “data collection” were not defined, and some considered such simple activities as counting the number of people treated as data collection. Among academics it was nearly 75 percent (11 of 15) who had participated in research or data collection and among non-academics, the percentage was 45 (8 of 18).

Interviewees were asked how the exercise changed their thinking about the need to collect information through timely research as part of the disaster response and how exercises like the DR2 exercises change state and local understanding and preparedness to support or perform disaster research.

The responses were mostly positive as it has increased awareness of disaster research, emphasized the role of the community, underscored the importance of communication and

collaboration, and increased commitment of organizations/institutions. Some comments that highlight each of these broad areas are as follows:

Increased awareness

- Before the exercise, I knew intuitively that collecting data was important. Afterward, I came to understand the importance of lessons learned to inform the public health and business communities. The exercise raised several questions for me: who is responsible for collection locally? And what data needs to be collected? There are two changes in my interest in disaster research: 1) I was made aware that it is important to review the research results and do a snapshot of the results in order to integrate them with planning for the future, and 2) I saw afresh the need for after-access—the hot-wash process.
- I had never thought about it. Volunteer organizations are already struggling to serve the community during a disaster. Data collection is a part of what we do but to conduct more detailed and extensive disaster research would require additional personnel, time, and money, especially in any kind of massive disaster, where our resources are stretched to the limit.
- It broadened my view of research to be collected and gave me a better understanding of effective action and quantitative measures. It brought home the matter of social determinations and advanced my understanding.
- It was enlightening. A police officer during the tabletop in Houston said, “We don’t know what we don’t know!” There was a lot of collecting and analyzing data and disseminating the results after both 9/11 and Hurricane Sandy in 2012. Especially during natural disasters, people are gung-ho. They work very hard and don’t rest properly, then they hurt themselves. Plus, they are exposed to so much, including respiratory problems.

I have a new appreciation for the role of the community

- First, revealed the critical role of community health workers in every state of a disaster and, second, the focus of the DR2 exercise appeared to be on environmental disasters, where ours is clinical care—acute and chronic, like the Boston Marathon Bombing.
- Importance of community reinforced.
- It brought home to me the importance of rapid community engagement before an event.
- It was enlightening in LA to learn about the mapping work done in the community and their work on drain pipes and wastewater from oil.
- Learned about the importance of longer-term commitments and community funding for recovery and resilience.

Need for communication and collaboration

- It highlighted the importance of communication among the parties—first responders to research.
- MIT and Harvard have been working together to supplement the work of NIEHS, serving as a catalyst for developing systems for collecting data from other NIEHS centers…the MIT/Harvard collaboration has inspired folks in Oregon to want to collaborate with us on a similar project.
- More cognizant of the importance of collaboration of state and federal entities that end up at disaster sites and to see that they're included in responses.
- Proved the need for standard data collection tools like IRB and templates to streamline the systematic collection of relevant data. Also made me keenly aware of the need for public and private collaboration in the collection of data.

Examples of increased commitment

- It provided a feedback loop and a focus on the concern for certain populations with functional needs, such as language, socioeconomic status, etc.
- The exercise had a major impact: it reinforced awareness of the gaps in knowledge and research. The major issue is funding silos, which limit needed collaboration, but has not changed the function.
- The exercise made me begin to consider how to incorporate research into our disaster response. It was very helpful to absorb other perspectives and to begin to consider how to be involved in data collection and research in the middle of disaster response. We are currently drafting a Recovery Annex, and one of the topics we need to address is to identify the source of data. In the future, we need to be systematic and ask the right questions, so we need to know how to become better at identifying sources of research information. And there is the question of how to fund data collection and research. The exercise opened my eyes to the need for the education arena instead of the responders to study the causes and outcomes of disasters. Previously, it was our practice to meet after a disaster to conduct "After Actions and Lessons Learned." The process is much more beneficial when the academic community is involved.
- Training—1,500 homeowners during Sandy in four-hour mold course—what to do yourself and what not. What to do if you have allergies. Training of volunteers after 9/11.

For some interviewees, there was no change in their thinking, primarily because they were already an advocate for disaster research and already understand the importance of disaster research. There were three negative comments: "didn't know people before and won't see them after—not as useful;" "limited value;" "mock play for days is better than tabletop."

Interest in Disaster Research

On whether the exercise in any way changed the interviewee's interest in participating in or performing needed research in response to a disaster or if the exercise in any way encouraged the interviewees to include disaster science/research in his/her thinking and/or actions related to disaster response, respondents shared both their increased interest and pending activities emerging from increased commitment to the disaster research field. Some comments are as follows:

Increased or continued interest

- After the tabletop exercise, I reconnected with a colleague and we responded to a state agency RFP for consultants for chemical emergency preparedness and response. In all I have submitted more than 12 proposals for research funding.
- The DR2 exercise reinforced the need for stronger relationships with the public health community. A big takeaway was to sustain and build those relationships between the public health community and the emergency management coordinators.
- Emergency response personnel get caught up in the ABCs of disaster management, so consequently have no time to research how to improve our disaster response. Data research should be in the toolbox and on the checklist when life and safety are no longer at risk.
- Increased my understanding of the roles of specific groups in data collection during a disaster.

Changes or pending changes

- Pushed for educating non-English speaking workers and developed train-the-trainer curricula. As a result, there have been more train-the-trainer programs in disaster preparedness.
- The tabletop exercise inspired us to pursue our efforts to solve the hazardous materials problems in our harbors. We have a grant application to mitigate hazards in our locale. The grant is entitled "Preventing the Inevitable" and the $100,000 for which we have applied will fund research and evaluation.
- The training is easily accessible and can be very rewarding. We are creating an online learning module on infectious diseases as part of a public website. It contains a number of learning modules and is free for everyone to use: www.p2r.academy.org.
- The major significant outcome for us is to consider adding community health workers to participate in the after-action review. We held multiple meetings before the exercise and see the potential for opportunities to collaborate. We see a need to expand the scope of the circle of participants. [a Boston hospital]

- Yes, it did. As a result of the exercise, we now have a policy group, and we place research at the center of our disaster planning to design appropriate response. [a public health department]
- We have applied for supplemental funding for our center to be able to operate in a disaster.

New Partnerships/Collaborations and Activities

Nearly 55 percent (21 of 39) who responded to whether they have been involved in any new relationships, activities, and collaborations with others who attended the exercise, either had begun to develop collaborations, or others in their organizations had moved forward or there were specific possibilities pending. Twelve interviewees said that there had not been any new relationships, activities, or collaborations. Another five said, “No,” but either expressed an interest or said there had been some brief exchanges of phone calls immediately after the exercise, or that they had known everyone at the tabletop, so no new activities emerged. Of those who had emerging collaborations, there were a range of pending and existing activities.

Examples of New Activities

- Collaboration of ASPR, Chemical Workers Union, and MassCOSH to develop modules in Spanish on mold, but 2014-2016.
- Contract relationship with the University of Texas School of Public Health. [another Texas academic]
- Deepening relationship with Latin American Council for Labor Advancement (LACLA).
- Has increased work, through Green Roots and MassCOSH, in working with immigrant workers on hazmat disaster preparedness and training in muck and gut in Spanish.
- I belong to a group working with Dr. Aubrey Miller and the NIEHS. The group is collaborating on research regarding Hurricane Katrina using the Social and Scientific Systems (SSS) research protocol developed under the NIEHS.
- I came into contact with a colleague at University of Texas and we are collaborating on a PPE project.
- Job Corps and Council on Aging in Flint.
- We have had increased collaboration with the DR2 team, resulting in a paper which was published in the August 2017 issue of the *Disaster Medicine Public Health Preparedness Journal*.
- Yes, the collaboration with MIT has been a result.
- Yes, conversations within our program have inspired us to obtain IRB approval. We applied for IRB approval, we received it, and it is in place, so we are better prepared to respond in the event of a disaster. [OSU]
- Yes, I have. We partnered with the City of Houston Health Department and the Harris County Health Department to put on a Zika Birth Defects Symposium. [Galveston County Health Department]

Capacity and Capability to Support/Participate/Conduct Disaster Research

When asked about the capacity and/or capability to support, participate in, or conduct disaster research, just over 50 percent (17 of 33) had comments that ranged from specific changes such as updating and collaborating on IRBs, increasing research staff, and acquiring tools and methods to conduct research, to general changes such as increasing awareness of the importance of disaster research and the resources that are available (i.e., limited by lack of funding). Comments include:

Specific changes

- Learned about incident command structure and how it affects worker health and safety.

- Only in the sense that we continue to expand the ways we can test and the tools we have with which to test.
- The exercise especially reinforced the utility of the NIEHS tools.
- We are entering a multicenter system now with common IRB, and conducting joint research on infectious disease. [Mass General]
- Yes. We have increased the amount of staff research planning by 24 percent since 2014 when we took part in the DR2 exercise in Los Angeles.

Support from National Institutes of Health

Those interviewed offered at least 67 separate suggestions for what NIH could do to help promote disaster research. Some did not offer suggestions. Respondents encouraged NIH to facilitate and support collaborations between various stakeholders, including emergency management offices, grantees, other federal institutions (e.g., CDC, ASPR, Office of Foreign Disaster, private organizations, etc.), and academic institutions. Respondents also encouraged NIH to host more forums and conferences to bring stakeholders together and promote disaster research and facilitate communication. Providing funding was also recommended by respondents, especially making in-time funding available for disaster research. NIH should also promote data collection (e.g., storehouse of research projects) and protocol development (e.g., identifying research questions as part of preparedness). Respondents also suggested that NIH support pilot projects and capacity building, such as training modules, creating a cadre of research responders, and fostering training of physicians. Other suggestions include a weekly newsletter, a research portal to connect with others, and establishing a rapid review panel to promptly strengthen an understanding of the results of disaster science research.

"Development of partnerships helps to bridge the divide between disaster science and emergency management. There is an enormous benefit in utilizing applied science to help emergency managers understand its utility and put it to use."

"There is an urgent need to enhance collaboration between responders and the academic community. For example, NIH should expand its efforts in translation and dissemination."

"I would recommend that the NIH assume a more influential role in advance preparation for the conduct of disaster research. As part of the incident command structure, it would be very beneficial to make it as clear as possible as soon as possible the way the response structure is expected to function as regards data collection."

Success Stories

Respondents were asked to share anecdotes or stories about his/her interest or participation in disaster research activities as it relates to the tabletop exercises. Some respondents had specific anecdotes to relate. Others had more general comments. Some related what they had done personally. Others related activities of their institutions. While some shared anecdotes from before the tabletop exercises, the following are some anecdotes that occurred after the exercises:

- After the exercise, I took two online courses from FEMA: Emergency Response and Worker Surveillance Emergency Response System.
- After Tropical Storm Irene in Vermont, FEMA studied the high-water marks from the floodwaters to see if the 50-year and 100-year flood ratings were valid.
- Created a skit on lead awareness for the Flint community.
- Did a session on lead and mold at the Latin American Council for Labor Advancement convention in August 2016 and the convention passed a resolution on the Flint crisis.
- We emphasized our analytical capacity and emergency medical faculty… An outcome of the DR2 exercise in Los Angeles in 2014 was to promote community outreach and engagement, which I believe are critical.
- I have an interest in building research into our recovery work. We should include research in our assessments and plans. I would benefit from knowing how we standardize data collection. [A state department of health]
- I do want to emphasize the urgent need to engage more public officials and their deputies in the work being done in disaster preparedness. One of the biggest problems is a local official who lacks any interest or concern for these issues. Public safety is at the heart of these efforts and must not be compromised by lack of political clout or indifference or by those whose financial strength creates a conflict of interest instead of focusing on the needs of the community.
- Our academic medical center carries out an annual disaster research response drill. The 2016 drill was to focus on hydrofluoric acid from a local site. The acid poses an enormous risk for the local population of 640,000. During preparation for the drill there was an incident in which 116 individuals inhaled the HF accidentally. As a result, the number attending the 2016 drill grew to over 100.
- The NYU Global College of Public Health and the New York City Department of Health have developed an ongoing relationship. We have learned a lot about the dynamics of communications among members. And our group organized a Cyber Terrorism tabletop exercise for the NYC Department of Health.
- We are piloting a project in communication with the disadvantaged in order to increase our capacity to utilize data from other sources. We are in the process of incorporating citizen science in our work that comes out of our community engagement strategy and

empowers them. We are finding that there are multiple facets that we can utilize to maximize our effectiveness. [A county health department]

- We carried out a mock exercise to study the response to Ebola and to issues such as: transporting Ebola patients to the University Medical Center, including PPE, taking the patient in and out, cleaning the ambulance, and who goes in and out. [A county health department]
- We invited, to campus, an occupational medicine doctor who has infectious disease training and became very interested in her future role. [Harvard University School of Public Health]
- Worker trainers, esp. at single corporate sites, are having their ERT teams better able to work in communities when there are emergencies and disasters. [Ford, UAW, and Midwest Consortium]

National Library of Medicine DR2 Website

At least 25 people had been to the website and 10 had not. Two were unsure. Most of those who had not been to the website were from business and community groups. The majority of those who had been to the site either went just after the tabletop or in preparation for the survey and interview activities of this evaluation. Many had only visited the site once.

Most were enthusiastic about existence of the site and found it to be a great resource, as it contains great information and provides a useful tool. One tabletop participant found it particularly useful, saying, "It was helpful in our work to win IRB approval for our department."

"The website is well-organized and provides a lot of information"

"A key way to make sure that data collection tools and methods are easily and readily available."

But, 20 percent of those who had been to the site (five) had critical comments as some were not clear about how to navigate the website or were unclear about their own organization's research capacity to use the website.

A few implied there were redundancies between the DR2 site and other sites, such as the Texas Health Department, and can be useful if collaborated with GeoHealth.

Nearly 25 percent of interviewees (nine) said they had read or used information or training materials from the website. One said that an epidemiologist in their organization has used them and another said he had not, but had referred others to the site. Only four gave specific examples of how they used the website:

- Yes, I have used it extensively. We have selected all our instruments based on the site, such as the one for stress, among many others. We also use the rapid protocol from the website and the informed consent.

- Yes, we have. For contacts.
- Yes. I have found it particularly useful in helping our disaster research colleagues.
- Yes. My task for today is to bring it to the high school seminar participants!

Two of those interviewed had downloaded information from the site.

Future Communication

Communication was seen as a key component of the NIEHS role. On how NIEHS can better communicate disaster research information to researchers, local government, and communities following any disaster, suggestions include:

- Use regional grantees.
- Use email and listserv.
- Use city and county health departments as conduits.
- Communicate lessons learned and common challenges.
- Promote local and regional networks of researchers and communities.
- Hold tabletop exercises, conferences, and webinars and present in other conferences.
- Promote the sharing of research protocols and protocol templates.
- Promote federal partnerships.
- Focus on preparedness and pre-disaster communication.
- Be prepared to communicate in real time.
- Promote media, social media, and press coverage.
- Assist with funding and sharing of funding opportunities.
- Promote partnerships and collaborations.

Safety and Health Training

The safety and health of anyone conducting disaster research is a big component of the DR2 and was a key discussion during the exercises. Respondents were asked about specific training types and content that he/she feels should be required for a researcher to safely work in a disaster setting. There were several areas of focus for training. They ranged from general education on disasters and emergency management procedures to personal protection of one's safety and health, including risk communication and hazard awareness and pre-incident training that covers psychiatric first aid covering stress and burn-out. This is an area where more discussion and a more cohesive concept of training for disaster researchers would be helpful. Some responses focused on the disaster response environment. For instance, some suggestions include more collaboration and training between researchers and responders to better understand each other's role during a response, and a better understanding of how to work within the incident command structure and the National Incident Management System to understand the organizational structure of a disaster response. NIEHS Worker Training Program (WTP) grantees have significant expertise in this area and could perhaps help guide such a discussion. Several suggestions focused on using existing disaster worker courses, as provided by the WTP and the National Institute for Occupational Safety and Health (NIOSH). Clearly each

type of disaster creates its own challenges. Site-specific training was recommended, as the challenges vary by disaster.

National Network of Disaster Scientists

On whether the respondent felt that they could play a role in a "national network of disaster scientists," 60 percent of interviewees (22 of 37) were positive about the potential for a national network of disaster scientists, several of them enthusiastically so ("I would love to." "I would love to be involved." "Absolutely."). Not surprisingly, many of the "non-scientists" did not see a personal role for themselves, but some (three of all 37, or 8 percent) still thought it would be useful to their organizations. Two definitively said, "No."

Other comments included:

- I believe this is critical. Dr. Birnbaum has provided leadership in this area. An example from Galveston Island is Jay Olaguer from the Houston Advanced Research Center who has developed a system of drones with the ability to collect data on regional air quality.
- It depends on the hazard. Researchers need to know how to protect themselves and be self-sufficient. The training needs are specific to the disaster. One must ask, "What are responders facing?"
- It's very important for the right subject matter experts to be the key participants. So often in this kind of case the content is just a review of readings by individuals with no real knowledge. It's crucial to seek out those with practical experience to provide the training.
- Not a formal network probably. There's the issue of how to use the information and what's in it for me. What would the structure of the network be? Only as active as the group is active. Good if it could be ramped up during a disaster. Structure of the network and communication is important. Perhaps it should be regional. Lessons learned are always a good thing.
- The CDC has a key role in Public Health Preparedness and Response. The CDC's Division of State and Local Readiness manages CDC's Public Health Emergency Preparedness cooperative agreement. Of special importance now is environmental health.
- Yes, I believe such a network would have some utility. It could directly benefit companies and health departments. Companies could play a role in disaster research where at present, I understand that less than 10 percent of scientists are involved.
- Yes, we never get enough information or subject matter experts to support our work. We need a network to call upon and such a network would serve as a great way to expose the need for and validity of disaster research.

Importance of Collaboration

During the exercise(s), collaboration was a key theme. No one expressed an opinion other than the key and important role that collaborations play in promoting quality disaster research, but also disaster response, preparedness, and prevention. Examples of collaborations include responder representatives: public health, first responders, statisticians, academics with the right subject matter specialties, and NIH.

Several respondents stressed collaboration with the community. One respondent stressed the importance of collaboration between the public and private sectors in disaster research response.

> *"Collaborate with the residents. Don't leave the community. It takes a long time for resilience to happen."*

On whether collaboration can help get funding, no one said, "No." Twelve individuals said, "Yes." One person added that having more collaborators makes for a stronger final funding application. Another said that it is important to coordinate with FEMA because that opens the flow of funding.

Of those who answered who they felt would need to collaborate successfully on disaster research, all said it would be a combination of public sector, academia, public health, and emergency responders.

Primary Responsibility of Disaster Research

Respondents were asked, based on their opinion, which organization has primary responsibility for including disaster research into disaster response—academics, public health, emergency management, other—and why?

It is not altogether clear that interviewees all heard the question the same way. It could be that some were answering a question about who should lead the implementation of the research and others may have been answering a question about who should design the research.

There were 27 respondents to this question. Eight refused to take a position.

Of the remaining 19 respondents, public health led a divided group with nearly 50 percent (nine of 19), and nearly 60 percent when adding in the two people who thought it should be public health and academic experts together. There was one who thought it should be public health and emergency management. Four voted for academics taking the lead and one person said it should be NIEHS and another said, "Other."

Three of the four who said academics should take the lead were themselves academics.

"I think there are two ways to look at it. Those observing from outside examine the data and come to conclusions and recommendations. You also need 'boots on the ground' to ensure that the conclusions reached and implementation proposed are practical."

"It really needs to be a collaboration amongst the three. At face value, the academic community with its research protocols has to lead, but emergency management needs to target recent goals derived from disaster response."

Summary

The DR2 exercises have clearly helped to move the cause of disaster research forward. As a relatively small and new field for academics, there is substantial room for strengthened programs and protocols. As a relatively new arena for emergency responders, public health officials, worker-trainers, community advocates, and all those at the local, state, and federal level who are affected by disasters, building bridges across professions, especially in and around emergency situations, is a significant challenge. Expecting immediate results is probably unrealistic. One should be heartened by slow and steady building of relationships and protocols and mutual respect. The DR2 exercises contributed to these important needs.

Appendix A: List of DR2 Publications

- Packenham, J, Rosselli R, Ramsey, K, Taylor, H, Fothergill, A, Slutsman, J, Miller, A. 2017. Conducting Science in Disasters: Recommendations from the NIEHS Working Group for special IRB considerations in the review of disaster related research. • Environ Health Perspect; DOI:10.1289/EHP2378

- Strauss-Riggs K, Yeskey K, Miller A, Arnesen S, Goolsby C. 2017. Translating battlefield practices to disaster health. Disaster Med Public Health Prep 11(4):510-511; doi:10.1017/dmp.2016.196.

- Miller A, Yeskey K, Garantziotis S, Arnesen S, Bennett A, O'Fallon L, Thompson C, Reinlib L, Masten S, Remington J, Love C, Ramsey S, Rosselli R, Galluzzo B, Lee J, Kwok R, Hughes J. 2016. Integrating health research into disaster response: the new NIH Disaster Research Response Program. Int J Environ Res Public Health 13(7):E676; doi:10.3390/ijerph13070676.

- Yeskey K, Miller A. 2015. Science unpreparedness. Commentary. Disaster Med Public Health Prep 9(4):444-445; doi:25898771:10.1017/dmp.2015.53.

- Miller A, Birnbaum L. 2015. Preparing for disasters. Letter to the editor. Science 348(6236):766-767; doi:10.1126/science.348.6236.766-c.

Appendix B: Specific Exercise Summaries

The first exercise in Los Angeles focused on the disaster research response concept of operations and how it fits into the national response framework. The second exercise explored the importance of timely health research and the challenges of performing research as well as the tools that can be used to collect disaster data. The third and most recent exercise assessed the relationship between the federal, state, and local stakeholders prior to, during, and after a disaster research response.

Los Angeles, California

Background

The first tabletop exercise took place on April 7, 2014, at the Banning's Landing Community Center in Los Angeles, California. The main goal of this exercise was to assess the applicability of a DR2 Concept of Operations (ConOps) for NIEHS, which outlined the responsibilities for the preparation and deployment of a research team and its integration into the national system of disaster response and recovery. Specific objectives of the exercise included:

- Assess the need to perform disaster research
- Discuss activation of the disaster research response team
- Demonstrate integration into the HHS/Emergency Support Function #8 operations
- Demonstrate process for initiating a research protocol
- Identify issues with the engagement and research ConOps
- Access the NLM disaster research website
- Engage selected stakeholders and partners
- Explore opportunities for community-based research
- Engage state and local agencies

A planning committee composed of NIEHS staff, NIEHS Worker Training Program and Core Center grantees, and contractors supporting the exercise was formed to provide feedback on the exercise goals and objectives, agenda, materials, participants, and scenario. To prepare participants for the exercise, organizers hosted a webinar that provided background information on DR2 and ConOps, introduced the scenario, delivered a brief worker safety and health training, and provided instructions on the format of the exercise.

Scenario and Format

The exercise scenario was based on the USGS Science Application for Risk Reduction Tsunami Scenario, in which a 9.1 magnitude earthquake occurring offshore the Alaska Peninsula triggered a tsunami that hit the coast of California. The strong currents and flooding from the tsunami caused electrical problems at a refinery located near the Port of Long Beach. The facility exploded and caught on fire, resulting in a toxic plume and releasing oil into the floodwaters impacting nearby communities.

During the morning of the exercise, participants received a tour of the “impacted areas” from the scenario to highlight the potential hazardous exposures, including refineries and rail yards, that may impact the nearby communities during the aftermath of a tsunami. The exercise

began in the afternoon and consisted of a three-hour facilitated dialogue on how to determine if a research response team would be needed, how a research response team from NIEHS would engage and be involved in the aftermath of a disaster, how they would transition out of the disaster, and how efforts would be sustained in the recovery phase.

For this first exercise, participants were organized into three main seating areas: the main table, filled by key decision-makers and representatives of specific affinity groups; plus-1s, filled by the counterparts of the decision-makers and liaisons between the decision-makers and affinity groups; and general participation, where participants were seated in tables based on similar affiliations. The facilitated dialogue followed the three phases of the ConOps: Decision to Engage, Engagement, and Transition. A summary of the major findings can be found in the Los Angeles tabletop exercise report.

Houston, Texas

Background

The second tabletop exercise took place in the Denton A. Cooley, MD and Ralph C. Cooley DDS University Life Center in Houston, Texas, on February 16, 2015. The main goals of this exercise were to assess stakeholder perspectives on the relative importance of timely health research and to discuss the challenges of performing research in the immediate post-disaster period. Specific objectives of the exercise included:

- Determine state and local disaster research capabilities
- Determine state and local ability to prioritize research needs
- Explore ways to access federal research resources
- Explore existing and potential response and recovery relationships
- Explore how nongovernmental organizations (NGOs) and academia can be engaged in disaster research

A separate, but related component in the afternoon was dedicated to the exploration, review, and discussion of the value of DR2 strategies and disaster research instruments, including user-friendly tools such as the RAPIDD research protocol and the DR2 website, developed to support timely disaster research responses.[25]

A planning committee was comprised of representatives from NIEHS, exercise contractors, the University of Texas at Houston (UTH), the University of Texas Medical Branch (UTMB), the Texas Department of State Health Services, the South East Texas Regional Advisory Council, Harris County Public Health and Environmental Services, the Harris County Office of Homeland Security and Emergency Management, HHS ASPR Region 6, and the Galveston County Health District. Two weeks prior to the exercise, NIEHS staff and contractors conducted a site visit to meet with local organizers and stakeholders to further introduce the DR2 and the exercise, and to review site logistics and the venue.

[25] For the purposes of this assessment, this report will not explore the afternoon session in detail.

Scenario and Format

The scenario of the second exercise was based on previous hurricanes, such as Hurricane Katrina and Ike, and projections from the Severe Storm Prediction, Education, and Evacuation from Disasters Center. The scenario portrayed a Category 4 hurricane making landfall during high tide at the northern end of Galveston Island. The hurricane caused a 20-foot storm surge up the Houston Ship Channel, flooding and damaging storage tanks and barges, which caused oil and chemical leaks and fire. Areas for many miles inland, including vulnerable communities, were flooded with water containing debris, chemical residue, and sediments. Smoke plumes from fires also traveled into the communities.

Participants in this second 3.5-hour exercise included representatives from academia, government, and the local community. Similar to the first exercise, a main table comprised of select key leaders from federal, state, and local government; academia; communities; public health organizations; and industries were posed questions about the conduct of post-disaster research to determine short- and long-term health impact. Other stakeholders sat at tables in the room with participants from different affiliations to encourage interaction and participation across agencies, organizations, and stakeholders. The seating arrangement for the tables was changed from the first exercise, where participants were seated with similar affiliations, as a reflection of the first post-exercise evaluations.

For more detailed information about the exercise, please read the exercise report.

Boston, Massachusetts

Background

The third exercise took place in Boston, Massachusetts, on July 19, 2016. The Boston workshop[26] brought together stakeholders to better understand how long-term, large-scale research is requested at the local and state level, and the process in which outside assistance research requests are managed. The objectives of the workshop included:

- Discussing the decision-making process by which post-disaster research is initiated and conducted
- Assessing the process by which research resources are identified, trained, coordinated, and deployed
- Describing how research protocols are developed, approved, and implemented
- Examining how data is managed and results shared with stakeholders
- Identifying opportunities for integrating research into the emergency response infrastructure
- Enhancing relationship building and knowledge sharing between local, state, and federal stakeholders

[26] The planning committee and stakeholders requested that this third exercise be referred to as a workshop.

The planning committee for this exercise consisted of federal health and emergency management offices (NIEHS, ASPR Region 1, HHS Office of the Assistant Secretary for Health Region 1, Agency for Toxic Substance and Disease Registry Region 1, FEMA); state and local health and emergency management agencies (Massachusetts Department of Public Health, Massachusetts Emergency Management Agency, Boston Public Health Commission); academia (Harvard University, University of Massachusetts Lowell, Massachusetts Institute of Technology, and Boston University); and public health organizations (Brigham and Women's Hospital, Conference of Boston Teaching Hospitals). NIEHS staff and contractors conducted a site visit prior to the workshop to meet with organizers, stakeholders, and the planning committee and inform them of the DR2 efforts, the concept of disaster research, and the workshop. The visit also served to review the site and finalize plans and materials.

Scenario and Format

The scenario for the Boston Workshop consisted of a Nor'easter making landfall in Boston during high tide, bringing rain, strong winds, and a 5-foot storm surge and causing heavy flooding. This scenario was based on a 2013 report by the Boston Harbor Association, "Preparing for the Rising Tide," which describes flooding to Boston and its surrounding communities. As a result of the surge, oil storage tanks and chemical storage containers located along the Mystic River and inland were damaged and toxins leaked into the Mystic and Chelsea Rivers and floodwaters. Flooding moved debris, oil, chemical residue, and sediments into the homes of the nearby communities. Community members in Chelsea and East Boston thus requested the health commission to investigate the hazardous exposures that might be causing symptoms and health effects, and the communities also wanted to be included in developing any health studies provided to affected populations.

A day prior to the Boston workshop, a community tour took place to visit the Chelsea neighborhoods and other areas that may be most impacted by the scenario. The workshop also provided a brief pre-deployment safety and health and incident command training session. The format of this exercise switched from discussions between key stakeholders at the main table to breakout group discussions to allow for more participation among all participants. This format allowed all participants to have a chance to voice their thoughts and ideas.

The facilitated dialogue was organized into two phases:

- Phase I. Development of Research Plan and Request for Federal Support: Participants were asked to identify and assess organizational resource and capacity, understand the research request, identify efforts for collaboration, and develop a request for federal assistance.
- Phase II. Implementation of Research Plan: Participants identified collaborative efforts between federal, state, and local organizations; assessed how data can be shared; and discussed how a research response process can be implemented.

For a more detailed description of the workshop, please see the Boston workshop report.

Appendix C: Survey and Interview Questions (attached separately)

Appendix D: Survey and Interview Responses (complete) (attached separately)

Annex A: Disaster Research Response Program Metrics Framework (attached separately)