The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere

A white paper summary of presentations from session PA23B
at the 2018 Fall Meeting of the American Geophysical Union

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This report summarizes session PA23B: The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere, at the 2018 Fall Meeting of the American Geophysical Union on 11 December 2018, 1:40pm-3:40pm, in Washington, D.C.

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Executive summary

A combination of actions identified during this session will improve hazard communication by both individual scientists and institutions. Individual scientists should identify resources available to them through their institution and the broader scientific community, where applicable. Institutions should ensure they have a communications plan or strategy in place to respond to information needs, particularly during events. All parties benefit from defining and understanding roles and relationships prior to events, and there is a call for a more organized system of connecting scientists not responsible for a crisis response with responsible agencies to support communications efforts. Additionally, session participants called for and we endorse the development of communications training specific to the challenges faced by scientists regardless of their affiliations and institutional roles during geohazards-related crises.

Introduction and motivation

Accurate public communication of hazards science is critical; it can deliver timely information to emergency planners, improve public confidence in science, disseminate scientific findings and demonstrate the importance of science to society. However, scientists are often reluctant to publicly communicate science. Stories about misrepresentation, trolling, and sensationalized reporting deter potential communicators from entering into the public sphere.

This white paper compiles lessons learned and ideas shared during the 2018 AGU Fall Meeting session PA23B: The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere I on Tuesday, 11 December, 1:20-3:40pm. The session aimed to explore the concerns surrounding public communication of hazards and work towards finding solutions to some of the more common issues. The goal was to facilitate community-wide discussion about how scientists and communicators can more accurately, effectively and responsibly communicate science to a broad audience using various media and communications partnerships. Submissions explored research-based evidence and personal case studies of both the challenges and rewards of communicating science through social media, mass media, institutional communications teams, and more, with a focus on lessons learned and best practices. Seven 12-minute presentations were followed by an open discussion on what the scientific community writ large, and especially NSF Large Facilities, can do to improve geohazards communication.

Each contributor to the session was invited to provide a summary of their ideas. These summaries, along with a synopsis of the session's discussion and some brief recommendations based on the session outcomes, are presented here.

Earthquakes in Dallas-Fort Worth? Untangling the complex ways official and unofficial earthquake catalogs are reported to a concerned public[1]

Heather DeShon, Southern Methodist University

In November 2013 a series of magnitude 3.5 to 3.7 earthquakes shook communities northwest of Fort Worth, Texas. These earthquakes, known as the Azle earthquake sequence, were eventually linked to nearby wastewater injection and shale gas production activities by scientists at Southern Methodist University (SMU), the US Geological Survey (USGS), and the University of Texas. The Azle sequence was not the first, nor contained the largest, earthquakes in the Dallas-Fort Worth metropolitan area (DFW; population 6-7 million). But the Azle earthquakes were the impetuous for significant scientific and regulatory changes that elicited local to international media coverage and heavy public interest over the next three years. By the end of 2016, Texas had a new state-wide seismic network; seismicity rates in the Fort Worth Basin had decreased but had increased in the Permian Basin; and the idea that wastewater injection could induce earthquakes on pre-existing faults had become accepted in academic and industry circles.

Seismologists at SMU, a private university located in Dallas, had been operating temporary seismic networks and conducting studies on earthquakes in the Fort Worth Basin since the first earthquakes in 2008. In 2013, the USGS approached SMU to help deploy some stations in the Azle area. Seismicity rates continued to increase in the basin, and in 2015 magnitude 3.5+ earthquakes occurred within the cities of Irving and Dallas and south in Johnson County. While the USGS provided the official earthquake information of record, absolute location uncertainty in the catalog appeared on the order of 5-15 km once seismic stations were place within 10 km of the seismic sequences. SMU built up a seismic network of 40 stations at peak in 2015 and maintained a near-real time earthquake catalog with significantly lower uncertainties than the national catalog. The SMU seismologists were not equipped to provide real-time catalogs via web and the earthquake catalog was a research catalog where locations and magnitudes were in flux as new information on local geology became available.

In order to effectively communicate with regulators, state and local government officials and emergency managers, SMU worked closely with the USGS.

[1] DeShon, H. (2019). Earthquakes in Dallas-Fort Worth? Untangling the complex ways official and unofficial earthquake catalogs are reported to a concerned public. In B. Bartel and W. Bohon (Eds.). *The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere: A white paper summary of presentations from session PA23B at the 2018 Fall Meeting of the American Geophysical Union*, UNAVCO and IRIS, 2019.

- For both the Azle-Reno and Irving-Dallas sequences, official letters from the USGS included SMU seismologists and were provided to city officials. The letters outlined where seismic stations were deployed, provided maps of relocated earthquakes, discussed where causative faults appeared to be located in absolute space, and outlined the USGS and SMU scientists' future plans.
- The mayors of Dallas and Irving additionally convened a working group of USGS and SMU scientists, emergency managers across Dallas County, and city and state officials that met in person or via conference call every 2-4 weeks while seismicity rates were high and felt events common through 2015 and early 2016. At these meetings, SMU scientists would provide updates on earthquake locations with static, dated maps that could be distributed by the cities. USGS and the Federal Emergency Management Agency would also provide updates and/or targeted information requested by the cities.
- SMU seismologists also provided testimony to state-level legislative subcommittees and provided information to the oil and gas regulatory body.

Communicating with the public through the local, national and international media, however, remained complex.

- SMU scientists were adamant to uphold the standard that only peer-reviewed research could be publicly discussed, but media requests for discussion of cause and for digital latitude/longitudes/depths/magnitudes of the SMU earthquake catalog for replotting to media standards were common.
- SMU Office of Communications assigned a highly-qualified former journalist with experience covering the Northridge earthquake to serve as clearinghouse for all media interviews, provide training for handling live interviews, and guidance in the development of public statements.
- It was decided that only two of the faculty seismologists would handle the bulk of media and government interactions. This decision freed the other seismologists and students to make rapid progress on research, simplified communication with SMU Communication, and lead to consistent messaging.
- All faculty provided traditional 20-60 minute lectures on the topic to local community groups and professional societies, conducted education and outreach at local schools and libraries, and developed material for the Perot Museum of Nature and Science in Dallas. All requests were honored but no systematic education and outreach program was developed and advertised.
- SMU Communications developed a project webpage that described the project, included a FAQ page and links to approved online resources, aggregated SMU research publications, and highlighted reporting showing how scientists interacted with federal and state officials.

- A science communication strategy that included social media was not developed due to limited experience, time, and staffing.

SMU received mostly positive but sometimes critical press, emails and phone calls. The public, press, university and the seismologists remained concerned about how funding, or even scientific collaboration with industry and regulators, constituted a conflict of interest. SMU seismologists decided that funding should be limited to university, federal, state and city monies. The seismic waveform data was sent directly to open archives for use by all scientists. The earthquake catalog was provided to all scientists and regulators upon request. SMU seismologists attended public and private meetings with regulators and industry scientists in order to develop a better understanding of the subsurface and rapidly progressing research. Research was published in traditionally peer-reviewed publications and made available via SMU or the journal.

Using communication science to communicate about science: A case study for aftershock forecasts[2]

Sara McBride, Michael Blanpied, Andy Michael, Jeanne Hardebeck, and Eric Martinez, USGS

The U.S. Geological Survey was faced with a challenge: how to communicate aftershock forecasts quickly and effectively to people who may not have experienced an aftershock sequence. Forecasts are intended to provide authoritative information about time-dependent probabilities to help communities prepare for potentially destructive earthquake aftershocks. For forecasts to be useful, they must be clear and understandable by the target audiences. At the USGS, we used communication science to develop an operational aftershock forecast product.

Challenges to communicating forecasts include:

- Earthquakes often come without notice, so information is delivered to users who are in the midst of responding, overloaded, and possibly traumatized.
- Scientific forecasts are necessarily uncertain, and calculated in terms of probability, which may be complex or confusing.
- Authority and expert perspectives are increasingly challenged and held with skepticism by audiences.
- One-way communication and exclusionary social structures of science have also contributed to this erosion of trust.

Research into the communication of aftershock forecasts began in Christchurch, where forecasts went out as text, tables, figures and maps. Findings from New Zealand research include:

- People like information tables, numbers, narratives, scenarios and maps. Including all of these information types will address the preferred ways of understanding by many different groups.
- Build templates for initial forecast communication. Use a consistent format and content, with well-tested plain language. The information can then be completed and disseminated rapidly.

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[2] McBride, S., Blanpied, M., Michael, A., Hardebeck, J., and Martinez, E., *Using communication science to communicate about science: A case study for aftershock forecasts.* In Bartel and Bohon (Eds.), *The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere: A white paper summary of presentations from session PA23B at the 2018 Fall Meeting of the American Geophysical Union*, UNAVCO and IRIS, 2019.

- Using empathic tone and personal pronouns (“we” and “our”) creates heuristic connections and strengthens communication. It identifies the scientists as warm, approachable individuals, and makes messages more meaningful (Broome, 1991).
- Many found aftershock forecasts valuable and comforting, even if they did not understand them well (Wein et al., 2015).

Building off this, the USGS created a template that could be quickly or even automatically completed and posted, with format and content informed by communication science. Development steps included multiple drafts, user feedback, management review, briefing of partners, beta testing, and web integration. The forecasts are now produced regularly after an earthquake of significance in the U.S., either a large main shock (M5.0 +) or an earthquake of note (e.g., a smaller but widely felt event, or one located in a novel area). Feeding into the forecast, the underlying models combine the behavior of past sequences, data from the current sequence, and empirical statistical models into a probabilistic forecast, including uncertainty. The aftershock forecasts are posted to the USGS’s website (earthquake.usgs.gov) within the first few hours of a mainshock, supplementing existing situational awareness products such as ShakeMap, DYFI, and PAGER.

Presenting a hierarchy of information, the template starts with simple messages to help traumatized publics grapple with their new reality, and adds more detailed information that may be useful to first responders, emergency managers, infrastructure operators, and vested publics. Empathetic messaging has a demonstrated importance in past disasters, but was limited in this template because it will be used in a wide variety of situations ranging from moderate earthquakes unlikely to cause damage to significant disasters; however, the template may be customized with injectable text that can be used for further scientific explanation or advice on coping.

Specifically, the bulleted list in the template contains the basic information regarding the magnitude, date, location, time and relevance (nearest city) for the earthquake. The second bullet focuses on the concept that larger earthquakes could follow and that aftershocks will be continuing for some time, with some building safety information included (Wein et al., 2015). The third bullet focuses on where people can get more information, i.e., their emergency management office. Finally, the last bullet point provides personal safety information, to avoid fatalism (McClure and Sibley, 2012). The next section is a simple summary of the forecasts and re-enforces safety messages. The next section (about this earthquake) provides contextual information about the current state of the sequence.

During significant sequences, the forecasts will be updated over time, and may be supplemented by separate, fully customized messages. Further research includes a monitoring and evaluation plan to further iterate the template.

This new aftershock forecast system was implemented successfully for the November 30, 2018 magnitude 7.0 Anchorage earthquake. The forecast was posted within 55 minutes of the event, and updated daily. The forecast was cited widely in media, and USGS has collected insights into how the forecast was understood (or misunderstood) and used.

USGS started with a “minimum viable product” and is continuing to improve it in light of use and feedback. In coming months the USGS will be adding additional features such as maps and visualizations.

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Wein, A., Potter, S., Johal, S., Doyle, E., and Becker, J. (2016). Communicating with the Public during an Earthquake Sequence: Improving Communication of Geoscience by Coordinating Roles. *Seismological Research Letters; 87*(1), 112–118. DOI: https://doi.org/10.1785/0220150113

What if your institution forgets your role during a hazard event?[3]

Steven C. Jaume and Norman S. Levine, College of Charleston

The Lowcountry Hazards Center (LHC) in the School of Science and Mathematics at the College of Charleston is a multi-disciplinary research and education center focused on natural hazards in South Carolina, especially those that impact the coastal plain (i.e., the Lowcountry). The mission of the LHC explicitly includes communication with policy makers, emergency managers and the general public before, during and after natural hazard events. This mission was well known within the College of Charleston administration circa 2010, as the LHC was moved into a new earthquake- and storm-resistant building and the campus emergency manager was housed adjacent to the LHC.

As an example of LHC's role during a natural hazard event, we provided real-time GIS mapping support to the South Carolina Emergency Management Division (SCEMD) during the historical rainfall event of October 2015. This proved to be more difficult to do in October 2016, since the College of Charleston was closed and the coastal counties of South Carolina evacuated as Hurricane Matthew approached. As a consequence of the 2016 experience, once path projections of 2017 Hurricane Irma included coastal South Carolina, we contacted SCEMD to "game plan" support during a potential landfall event. We also began engaging the general public via social media (Facebook, etc.) in support of state and local emergency agencies, primarily to help combat misinformation regarding Hurricane Irma.

A garbled version of this public outreach effort reached the office of the Dean of the School of Science and Mathematics (SSM) at the College of Charleston. The misinformation given to the dean suggested that the Lowcountry Hazard Center had assumed an official role in ordering evacuations of the South Carolina coastline. This led to an overreaction by the Dean's office, which directed LHC faculty to immediately stop the public communication efforts *and stop working with emergency management officials during the event.* LHC faculty were advised instead to simply "collect data and write papers"; i.e., traditional academic scientific activities.

During the event SCEMD was depending on the LHC for information, modeling and support, and had the LHC adhered to the dean's edict it would have jeopardized these efforts. We reviewed this experience following the 2017 hurricane season and realized that numerous personnel changes had occurred in several College of Charleston administration positions (including Dean

[3] Jaume, S.C., and Levine, N.S., *What if your institution forgets your role during a hazard event?*. In Bartel and Bohon (Eds.), *The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere: A white paper summary of presentations from session PA23B at the 2018 Fall Meeting of the American Geophysical Union*, UNAVCO and IRIS, 2019.

of SSM, Provost's Office and the President's Office) plus the campus emergency manager's office had been relocated away from the LHC. This likely led to the "disconnect" between the LHC and the College's administration and played a role in the administration forgetting and/or misinterpreting the LHC's role during a hazard event.

Following the 2017 event SCEMD wrote a letter commending the LHC for its help and support and thanked the College for its role in protecting the citizens of South Carolina. With a new College of Charleston President and new SSM Dean starting in 2019, LHC faculty plan to "reconnect" with the administration and educate them regarding our role before and during natural hazard events.

Sifting fact from science fiction for the public during a geohazard media event: Lessons from Kīlauea volcano in 2018[4]

Kenneth Howard Rubin, University of Hawaii at Manoa

Geohazard events can affect local communities quickly. Access to technically correct data and interpretation, conveyed in plain language, is critically important for affected people. Nowadays, news of these events can spread quickly, often aided by citizen reporters on social media, broadening the number of people who want access to credible information. The dramatic eruption-related events at Kīlauea Volcano in 2018 highlighted some of the issues of communication between the public and other scientists.

This Kīlauea eruption included lava flowing through populated areas, explosive ash emissions, thousands of earthquakes, copious volcanic gas emissions, and associated hazards at a popular tourist destination. The issues faced by scientists on site included:

- The public expecting immediate access to information
- Traditional and new media outlets, and even citizen scientists, of variable qualification and with variable access to reputable information, collectively publishing a great deal of content of variable quality
- A resulting information stream that included some excellent factual content alongside misinformation, exaggerations, and unlikely doomsday scenarios.

A potential solution for managing information during a similar crisis is to put more expert-level scientists with good communication skills into the information pathway. Having a list of previously vetted experts from academia, government and the private sector could help organizations such as the USGS communicate around the clock during major events. Such groups could form regionally or internationally, perhaps coordinated through a professional society, on the common geohazard topics.

Even though there are many pitfalls, and it takes time away from other aspects of their career, scientists should be encouraged to participate in this manner as part of their service to the public. Some communications training is helpful, but not required if folks prepare ahead of time and employ good communications strategies. Some suggestions for such participants include:

- Develop a media and messaging strategy (and stick to it)

[4] Rubin, K.H., *Sifting fact from science fiction for the public during a geohazard media event: Lessons from Kīlauea volcano in 2018*. In Bartel and Bohon (Eds.), *The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere: A white paper summary of presentations from session PA23B at the 2018 Fall Meeting of the American Geophysical Union*, UNAVCO and IRIS, 2019.

- Learn the facts from reliable sources daily
- Vet interview requests and set limits, but always respond to interview requests in a timely manner
- Anticipate “wild” questions
- Steer your responses to questions towards the key messages you want to reinforce
- Push content on social media and refer interviewers to it
- Stay ahead of sensationalized aspects of the story so you aren’t surprised during an interview – politely but firmly debunk

#EruptionImminent! Wielding the double-edged sword of Twitter during a volcanic crisis[5]

Janine Krippner, Concord University

Social media was designed as a place to be social. It was not designed to be a crisis communication tool, but has been utilized for hazards communication around the world.

A recent example of this is the Agung volcano crisis in Bali, Indonesia, beginning in September 2017. Agung volcano has produced multiple large eruptions and killed over 1100 people in 1963, and research suggests that it could again produce a similar scale of eruption, so when the activity level at Agung rapidly increased in September 2017 the volcano alert was raised to the highest level. Agung did not erupt for more than two months after the warnings were issued and for those two months there was a misinformation disaster, rather than a geologic disaster.

Even though Indonesian authorities were putting out information across multiple platforms, many people did not know where to get the official information and they often didn't understand it when they were able to access it. This was largely due to the tourism industry in Bali leading to many people on the island at any given time being international visitors. This also meant that this crisis was of immense international media interest. Language was a barrier; when using Google Translate to understand the information released by Indonesian officials, one post translated as "Medium cauldron smoke with 200 meters high. The magma movement in the magma kitchen urges rocks to continue." Thus, even if the public and media were trying to get the correct information it was difficult to understand.

During a real or perceived crisis, if there is a gap in clear communication something will move in to fill that void, and often the easiest information for people to find online is incorrect or fearmongering tabloid headlines. When performing a Google search on a volcano or a particular hazard situation, the worst headlines are near the top of the list, e.g., "Vesuvius ERUPTION WARNING: Europe's supervolcano threatening – 'it's BOILING!" from The Daily Express. This gets shared on social media around the world. Given the shear number of problematic news sources, it's difficult for the lay public to know what information to trust. In the case of Agung, people turned to both traditional media and social media, sometimes with problematic results. With the rampant misinformation circulating during the Agung crisis, worst-case scenarios

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[5] Krippner, J., *#EruptionImminent! Wielding the double-edged sword of Twitter during a volcanic crisis*. In Bartel and Bohon (Eds.), *The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere: A white paper summary of presentations from session PA23B at the 2018 Fall Meeting of the American Geophysical Union*, UNAVCO and IRIS, 2019.

(impossible or very, very unlikely) were perpetuated by tabloid headlines and shared on social media. The fears these headlines created led to people cancelling travel to Bali, and the local economy suffered.

Social media allows scientists to see rumors forming in real time, as well as receive instant feedback when something is misunderstood. Science communicators must keep working to clarify their message for interested communities and be mindful of the learners who are hearing these concepts for the first time. Also, scientists innocently expressing excitement over traumatic events on social media have been seen by people directly affected by the disaster, making the scientists seem cold and callous to the real human suffering involved during these crises. Additionally, once scientists have identified themselves as a subject matter expert their words are *as* a subject matter expert and representative of the field. Mass media may place social media posts directly into media stories as a quote from an expert. This can help or harm the efforts of official agencies.

While volcanoes might be largely unpredictable, the rumors and misinformation largely are not, and we can often foresee and address them before they get out of hand. Scientists and communicators can work together across hazards fields to circulate good information and proactively work with media to amplify it. Different fields have a responsibility to work together to ensure that global communities have easy access to the correct information. Individual scientists can assist the authorities, in the case of Agung the local volcano observatory, to understand what the priority information is, and can work to fill the gaps of basic hazards and preparedness information. They can also direct people to the official sources across platforms. By utilizing social media and working in collaboration with mass media sources, scientists using social media can amplify potentially life-saving information around the world.

Lessons from the epicenter of a global media earthquake: How to handle nonlinear coverage about hazards[6]

Rebecca Bendick, University of Montana

Science media coverage is more about human beings and their interactions than about the fundamentals of scientific discoveries. Stories that trigger particular human responses are nearly impossible to control, and therefore investigators cannot enforce normal scientific standards of information quality. In particular, stories that address natural disaster risk and response cross over from science journalism to general interest. Regardless of the impossibility of enforcing scientific norms, scientists involved in global media coverage of topics with specific human impacts retain an obligation to explain scientific methods, to express uncertainties and assumptions transparently, and to share their findings in ways that are maximally accessible to non-experts. In doing so, we communicate not only our findings, but also the ethics and practices of science in general.

Editors' note: This presentation referred to media coverage following presentation of the author's preliminary work at the 2017 Annual Meeting of the Geological Society of America in Seattle, Washington: A five year forecast for increased global seismic hazard in session T217. Challenges in Tectonics: Synergies between Meeting Societal Needs and Advancing Interdisciplinary Research in Tectonics and Structural Geology.

[6] Bendick, R., *Lessons from the epicenter of a global media earthquake: How to handle nonlinear coverage about hazards*. In Bartel and Bohon (Eds.), *The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere: A white paper summary of presentations from session PA23B at the 2018 Fall Meeting of the American Geophysical Union*, UNAVCO and IRIS, 2019.

What to say when the microphone is in your face: A reporter's perspective on hazard communication[7]

Alexandra Witze, freelance science journalist and correspondent for Nature

A little bit of preparation can go a long way in helping scientists work with the media in the fast-moving, stressful wake of a natural disaster.

First, be aware of the media landscape. After all, "the media" are not a monolith. Outlets and reporters vary widely. When you get an interview request, take a minute to research what sort of stories the reporter has written before. This will help you calibrate your expectations.

Be connected. Some of the most effective examples of science journalism come from local or regional reporters who have built up a deep expertise in their beat. Sandi Doughton of the Seattle Times, Ron Lin of the Los Angeles Times, and Anna Kuchment of the Dallas Morning News have all developed long-standing relationships with local seismologists, accumulating knowledge that they can draw on when disaster hits. Get to know your local reporters: send them story tips and become a trusted source whom they know to call.

Be camera-ready. Your agency or institution's press office should be able to arrange media training, or at least take you through mock interviews to prepare for dealing with reporters. AGU's Sharing Science website (sharingscience.org) lists resources for those without institutional resources. Don't forget to include training in social media.

Be prepared with numbers. Whatever your area of expertise is, develop backgrounders or tip sheets ahead of time. This could be as simple as gathering relevant statistics into a personal Google doc, or as advanced as Katharine Hayhoe's climate-science explainers on her website. You'll want to be able to quickly tap into information that will put a disaster into context for the public, such as "This is the 10th earthquake of this size to strike Alaska in the last century."

Be ready to debunk. From Yellowstone supervolcanoes to Ring of Fire earthquake connections, there is a lot of misinformation floating around out there. Fight it by responding to inane questions with sane answers. Janine Krippner's Twitter postings involving the 2017 Agung crisis in Bali are a model example of how to do this.

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[7] Witze, A., *What to say when the microphone is in your face: A reporter's perspective on hazard communication*. In Bartel and Bohon (Eds.), *The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere: A white paper summary of presentations from session PA23B at the 2018 Fall Meeting of the American Geophysical Union*, UNAVCO and IRIS, 2019.

Be responsive. Time is crucial in delivering your message. Call reporters back right away (that handy list of pre-prepared statistics will give you something to talk about with them). If you're involved in a broader crisis-response effort, always tell reporters at the end of a briefing when you expect the next update to take place. This allows everyone to know what's coming next — and in the midst of a disaster, everyone wants to show semblance of control.

Session discussion

A thirty-minute discussion period was built in to the session following presentations to allow for the exchange of suggestions, concerns, and areas for growth identified by session attendees. Suggestions for improving individuals' comfort, capacity, and efficacy in communicating hazards included identifying and exploring existing institutional resources such as trainings, emergency managers, public information officers (PIOs), and public affairs offices (USGS: answers@usgs.gov). Also, individuals and groups can benefit from considering and practicing communications for a possible event within their field of study (earthquake, active volcano, etc.).

Concerns from attendees included the responsibility and potential negative repercussions from speaking on behalf of their scientific community, being judged negatively by peers within the scientific community, being misquoted by media, and not being understood or heard.

We would like to particularly highlight suggested areas for growth, which informs the role that NSF Large Facilities such as UNAVCO and IRIS, as well as AGU, can play in improving hazards communication. The recommendations for hazards communication support include:

- Identify and make discoverable a network of scientists who are interested in talking to the media about specific hazards
- Provide a clear set of guidelines for the two different communication modes:
    - Event response, which requires fast yet measured and impassive communication
    - New scientific findings, which benefit from expression of excitement, with no immediate threat perceived
- Establish a support system for unaffiliated scientist communicators or those who otherwise don't have institutional support
- Provide scenario trainings where participants are able to learn and practice the skills required for effective hazards communication during an event

Poster session

An accompanying poster session under the same session name featured additional perspectives on hazards communication from around the world. Seven presenters participated in PA21G: The Hazards of Hazard Communication: Importance, Rewards, and Challenges of Science in the Public Sphere Posters on Tuesday, 11 December, 8:00am-12:20pm. The range of hazards addressed included earthquakes, tsunamis, volcanic unrest, and air quality, and covered the challenges of communicating uncertainty and controversial results.

Synopsis

These sessions highlighted the challenges and rewards of working in the rapid-onset disaster communications sphere. Some themes that emerged from the talks and the following discussions are outlined below.

- Much of the groundwork for handling rapidly evolving hazards situations must be laid before the hazardous event begins.
  - Communications strategies need to be in place with duties and responsibilities distributed amongst personnel.
  - Pre-vetted scientists and communication specialists outside of the reporting organization can help to lessen the media communication load during the crisis.
  - Relationships with the media and other organizations can facilitate rapid information dissemination and consistent messaging.
  - The roles and responsibilities for talking to the media must be defined within and between organizations.
  - Communications training may not be necessary for scientists, but can be quite helpful, including recognizing the different needs of print vs. broadcast journalists. Training can also help alleviate or lessen fears the scientist may have about speaking with the media.
- Organizations must be proactive in getting messaging out quickly in order to avoid an information gap that can be filled with misinformation. Supporting networks of organizations and individuals should be created to amplify messaging.
- Scientists involved in communicating need to be responsive to questions and concerns and need to approach the issues with empathy for the people being affected.
- Misinformation needs to be addressed quickly to prevent panic and the spread of bad information.
- Where appropriate, scientists can take the opportunity to communicate the process of science, and show that our understanding evolves with more information and perspectives.
- Communicators must be aware that people are making decisions based on the information they are providing.

We hope this document will help inform future work on effective geohazards communication with both lessons learned and identification of areas for growth.