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ADVANCING THE SCIENCE AND PRACTICE OF INNOVATIVE, RELATABLE, AND ENGAGING DISASTER RISK COMMUNICATION (ASPIRE)

Workshop Report

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Advancing the Science and Practice of Innovative, Relatable, and Engaging Disaster Risk Communication (ASPIRE)

INTRODUCTION

In the summer of 2024, the Federal Emergency Management Agency (FEMA) convened the first Risk Communications, Crisis Communications, and Community Engagement Summit[1]. That event initiated a national dialogue on how to develop culturally competent and accessible communication strategies, strengthen disaster response, engage communities more effectively, and promote positive behavioral change to enhance preparedness, build trust, and improve outcomes during crises and emergencies. Building on this momentum, we planned and hosted the Advancing the Science and Practice of Innovative, Relatable, and Engaging (ASPIRE) Disaster Risk Communication Workshop on April 17-18, 2025, in the Institute of Behavioral Science (IBS) at the University of Colorado Boulder (CU Boulder)[2]. The event brought together 27 academic researchers, scientists, practitioners, and community leaders from across the United States, including California, Colorado, Illinois, New York, Virginia, and Washington (Figure 1). The aim of the two-day workshop was to discuss both theoretical and practical issues and solutions related to effective disaster risk communication. This report summarizes the different activities of the workshop, and assesses findings from a variety of sessions, as well as a pre- and post-survey by participants.

Figure 1: *The ASPIRE Workshop was held in April 20205 in Boulder, CO.*

[1] Federal Emergency Management Agency. (2024). *Risk communications, crisis communications, and community engagement summit report* (FEMA). https://www.fema.gov/sites/default/files/documents/fema_risk-communications-crisis-communications-community-engagement-summit-report-2024.pdf

[2] An IBS workshop grant (PI: Amir Behzadan, Co-PI: Mary Angelica Painter) and the National Science Foundation (NSF) through award #2406786 (PI: Amir Behzadan) jointly funded this event.

OBJECTIVES OF THE WORKSHOP

The overarching goal of the ASPIRE Workshop was to critically examine the role of human behavior, perception, and decision-making across all stages of disaster management, with a specific focus on disaster risk communication. A central aim was to explore how human-centered technology can be leveraged to craft tailored risk communication strategies that resonate with the needs, expectations, and diverse cultural backgrounds of at-risk populations. However, although this was the aim, much of the discussions and activities tended to focus on issues around risk communication more generally, and the barriers to providing messaging across different hazards, populations, and considerations. By convening a diverse group of participants, the workshop created a unique platform to advance both science and practice of disaster risk communication. The three interrelated objectives included: (1) evaluating the advantages, barriers, and potential drawbacks of integrating emerging technologies with existing communication strategies in disaster and emergency management; (2) emphasizing the integration of perspectives from a transdisciplinary group of participants, fostering collaboration in developing and disseminating best practices for risk communication; and (3) strengthening professional and community networks to improve collective capacity for risk and emergency communication in the future.

WORKSHOP STRUCTURES AND ACTIVITIES

Over the course of two days, participants engaged in a series of large-group, consensus-building sessions as well as smaller breakout discussions. The program kicked off with a keynote address from the Director of the Natural Hazards Center, Dr. Lori Peek. Participating graduate students also had the opportunity to present their emerging research in the natural hazards and disaster field. This structure was intended to balance collaborative dialogue, knowledge sharing, and opportunities for professional development.

PRE-SURVEY ANALYSIS

The survey includes 24 respondents[3], of whom the majority were women (79.2%), and most identified as members of the academic or scientific community (58.3%), followed by disaster management professionals (29.2%), with a smaller group in other roles. In terms of disaster experience, respondents most frequently mentioned flooding (44%) and wildfires (44%), followed by winter storms (36%), hurricanes (20%), tornadoes (12%), and earthquakes (12%)[4].

Most respondents express interest in technology (66.6% strongly agree, 25% somewhat agree) and agree that it improves their work performance (54.1% strongly agree, 37.5% somewhat agree). Similarly, the majority indicate that they regularly use technology at work (62.5% strongly agree, 33.3% somewhat agree). To note, we did not define "technology" for respondents; therefore, the survey represents individual perceptions on their use and favorability of technology. We later conducted an activity at the workshop around this definition (see Session 1).

[3] The remaining three individuals, i.e., workshop organizers and an administrative staff, did not fill out the pre-survey.
[4] The largest age group of pre-survey respondents was 25-34 years (37.5%), followed by 45-54 years (20.8%), 35-44 years (20.8%), and smaller proportions in 18-24 years (12.5%) and 55-64 years (8.4%).

Regarding disaster communication, 87.5% report that their work involves risk communication. Respondents strongly agree that technology improves the effectiveness of disaster risk messaging (57.1% strongly agree, 42.9% somewhat agree), and most agree it helps increase trust (57.1% somewhat agree, 19% strongly agree). Nearly all participants agree that technology provides timely and relevant information (76.2% strongly agree, 23.8% somewhat agree) and can ensure messages reach vulnerable populations (47.6% somewhat agree, 33.3% strongly agree). However, opinions are more divided on artificial intelligence (AI)-generated content: while 33.3% somewhat agree it is sufficient, 38.1% neither agree nor disagree, and about 28% disagree to some extent. Finally, participants highlight potential roles for AI in translation and language accessibility, alerts and real-time messaging, and data analysis/mapping, but also raised concerns about trust, ethics, and oversight, with a few expressing uncertainty or skepticism about AI's role.

DAY 1

Welcome Session

Workshop organizers, Dr. Amir Behzadan and Dr. Mary Angelica Painter, opened by outlining the vision and goals of the event, providing background context and the motivation behind the workshop, along with the intended outcomes. Participants then introduced themselves by stating their name, role, organization/affiliation, and one expectation or highlight they were looking forward to from the workshop.

Session 1: Definition of Key Terms

The first session of the workshop focused on building a shared understanding of the fundamental concepts that underpin disaster risk communication. Participants engaged in a collaborative exercise centered on a set of key terms including risk, communication, risk communication, technology, community, community engagement, relatability, research and practice (and their distinctions), and innovation (Figure 2). Table 1 summarizes these terms and their established definitions as drawn from scholarly literature. These initial definitions served as starting points in group discussions, rather than fixed endpoints. Over the course of 20-30 minutes, participants moved around the room, reviewing each definition and contributing their perspectives, experiences, and critiques. They were encouraged to reflect on questions such as what they believed needed to be added, removed, or changed. This exercise created space for participants to highlight gaps, surface disciplinary differences, and propose refinements that made the definitions more inclusive, precise, and applicable to real-world contexts. By collectively interrogating and refining these foundational concepts, the session established a common vocabulary for subsequent discussions. It also underscored the importance of ensuring that definitions used in risk communication are not only academically rigorous but also resonant and relevant to the diverse communities they are meant to serve.

Figure 2: *Workshop participants worked together to establish a share vocabulary for disaster risk communication.*

Table 1: *Key terms and their initial definition from the literature.*

Term	Initial Definition
Risk	The likelihood of a hazard event resulting in an adverse condition that causes injury or damage
Communication	How people use messages to generate meanings within and across various contexts.
Risk communication	The real-time exchange of information, advice, and opinions between experts or officials and people who face a hazard or threat to their survival, health, or economic or social well-being.
Technology	The application of organized knowledge to create products, processes, or systems that improve our quality of life or enable us to achieve tasks more efficiently.
Community	A group of people with diverse characteristics who are linked by social ties, share common perspectives, and engage in joint action in geographical locations or settings.
Community engagement	The process of working collaboratively with and through groups of people affiliated by geographic proximity, special interests, or similar situations to address issues affecting the wellbeing of those people.
Relatability	People can see themselves in something or identify with it, often because it reflects their own feelings, experiences, or perspectives.
Research and practice	Theoretical and exploratory, aiming to create new knowledge / Implementation-focused, applying existing knowledge.
Innovation	The process of creating and implementing new ideas, products, or services that lead to significant improvements by adding value, solving problems, or meeting evolving needs.

1. Risk

Risk was initially defined by the organizers as, *"the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."* While this framing stresses probability and adverse outcomes, participants highlighted that the concept is more complex and context dependent.

During the session, participants expanded upon and, in some cases, challenged this framing. Many highlighted that **risk is not limited to injury or damage**, but also encompasses harm, which can

manifest differently depending on individual or group circumstances. Several participants stressed that risk is **dynamic rather than static**, evolving with changing conditions, behaviors, and exposures. In this sense, risk is not a fixed measure, but a fluid construct shaped by context.

Another recurring theme was **subjectivity in the perception of risk**. Participants noted that the same hazard may be interpreted differently by different people, groups, or societies. For example, what is perceived as harmful in one context may be viewed as an opportunity in another, such as in sensation-seeking behaviors or activities where risk is accepted or even valued. This recognition led to discussions about the **dual nature of risk**, which may carry both negative and positive meanings depending on the actor and the setting.

Participants also emphasized the importance of **exposure and vulnerability** in shaping risk. Some argued that risk should be understood as the interaction of hazard, exposure, and vulnerability, echoing established frameworks in disaster risk reduction. This perspective underscores that without exposure, there can be no risk, even if a hazard exists. Similarly, vulnerability shapes the degree of harm, such that groups with fewer resources or protective capacities face higher levels of risk. Several contributions also called for the inclusion of the societal level, noting that risk extends beyond individuals or groups to broader systems, institutions, and infrastructure.

Finally, participants debated **quantitative vs. qualitative approaches** to defining risk. While some preferred framing risk in terms of likelihood, consequences, and impacts (sometimes expressed as the probability of an event multiplied by its potential outcomes), others stressed that risk cannot be reduced to a purely mathematical formula. Instead, they argued risk must also account for the subjective and lived experiences of those affected.

Taken together, this discussion highlighted that risk is a multidimensional concept, encompassing both objective measures and subjective perceptions. It involves probability, exposure, and vulnerability, but also human behavior, societal context, and cultural interpretation. Establishing this deep understanding early in the workshop provided a critical foundation for subsequent sessions on risk communication and community engagement.

2. Communication

Communication was initially defined by the organizers as, *"how people use messages to generate meanings within and across various contexts."* Participants, however, emphasized that communication extends beyond this phrasing, encompassing diverse modes, interpretations, and exchanges.

A central theme was that communication is **multifaceted and multimodal**. Participants emphasized that messages are not limited to words but also encompass content, format, tone, intonation, images, and body language. These nonverbal elements carry meaning and influence interpretation. Several participants suggested replacing "use" with "interpret" to stress that communication involves both expression and understanding. Moreover, they argued that the term "contexts" might be better expressed as "modes".

Equally important, participants underscored that communication is **transactional rather than one-way**. It is not simply the act of transmitting information, but rather a two-way exchange that also depends on how people receive, interpret, and respond to messages. This framing reflects a more dynamic understanding of communication as an interactive process, where the receiver's perspective is just as crucial as the sender's intent.

Participants also drew attention to the **audience-centered nature of communication**. They stressed that communication cannot be "one-size-fits-all" and must be effective, inclusive, and usable by all intended audiences. Suggestions included explicitly adding "…and audiences" to the definition, as well as incorporating key components such as source, channel, message, and receiver. Clarity, respectfulness, and cultural appropriateness were also identified as essential qualities.

Another major area of discussion was the **purpose and intent of communication**. Beyond exchanging information, communication aims to connect people and share thoughts and feelings, and in risk-related contexts, to influence behavior or support decision-making. Participants noted that intent should be made explicit: what change in understanding, behavior, or action is communication meant to achieve?

Finally, participants emphasized the **challenges and barriers** inherent in communication. They pointed out that simply repeating a message, i.e., "saying the same thing louder," does not guarantee comprehension. Misinterpretation, misinformation, and disinformation can interfere with the intended meaning. Thus, communication also involves recognizing and addressing these barriers to ensure that messages are received as intended.

Overall, the discussion highlighted communication as a complex, dynamic, and audience-centered process. It involves not only sending but also receiving and interpreting messages, across multiple modes and channels, with clear intent and sensitivity to diverse contexts and audiences.

3. Risk Communication

Risk communication was initially defined by the organizers as, *"the real-time exchange of information, advice, and opinions between experts or officials and people who face a hazard or threat to their survival, health, or economic or social well-being."* One of the main points of discussion centered on **who communicates risk and to whom**. Several participants questioned whether the definition should focus narrowly on "experts or officials," arguing that risk communication is not the exclusive domain of authorities. Instead, it can emerge from community members, peer networks, or organizations tasked with specific hazard responsibilities. Some suggested striking the term "opinions," and even replacing "advice" with "direction" or "guidance," to reflect the more practical orientation of risk messaging. This broadened framing better acknowledges the diversity of communicators and recipients involved in risk contexts.

Participants also emphasized the **diverse forms and modalities of risk communication**. Risk messages are disseminated through both traditional channels such as news media and emerging platforms, including social media. Participants debated whether risk communication should be standardized, which ensures consistency, or customized, which increases relatability. They also

noted that while rapid delivery is critical during hazards, speed may limit the ability to tailor messages to specific audiences.

The discussion highlighted that **clarity, accessibility, and trust are central to effective risk communication**. Participants stressed the importance of plain language, actionable content, concise instructions, and timely follow-ups. Trust between communicators and audiences is a precondition for effective exchange, as is the need to be transparent about uncertainties rather than offering false certainty.

The **temporal dimension of risk communication** was also debated. While the original definition emphasized "real-time," participants argued that risk communication spans multiple stages: before, during, and after an event. They noted that risk communication must adapt to evolving community needs as hazards unfold.

Finally, participants examined the **purpose and function** of risk communication. At its core, risk communication provides information that enables individuals, households, and communities to make informed decisions in the face of threats. It can take the form of imminent warnings or ongoing education, and it should involve two-way, iterative processes that consider not only what messages are sent but also how recipients act upon them. Importantly, participants emphasized that risk communication often seeks to inform and empower rather than merely to instruct or command, and that its ultimate aim is to reduce harm and impact.

Together, these reflections highlighted that risk communication is a multi-layered, multi-actor, and iterative process. It involves not only the rapid dissemination of clear and actionable information but also the cultivation of trust, the acknowledgment of uncertainty, and the long-term work of education and collaboration.

4. Technology

Technology was initially defined by the organizers as, *"the application of organized knowledge to create products, processes, or systems that improve our quality of life or enable us to achieve tasks more efficiently."* Participants both questioned and elaborated on this view, noting that technology is not inherently beneficial and must be evaluated in context.

A central point of discussion was whether technology always **improves quality of life**. Several participants argued that this assumption should be removed, noting that technology can also create complications, distractions, or unintended harms, and that in some cases, there may not be a real problem for technology to solve. This discussion highlighted the dual nature of technology, with both positive and negative implications depending on context and implementation.

Participants also raised the need to **clarify what is meant by "application"** in the definition. Is technology best understood as a device, a platform, or a process? Many suggested replacing "application" with "tools," emphasizing that technology functions as the means, not the solution itself. For example, platforms and tools are created through the organization of knowledge, which can then be used to solve problems and achieve tasks more efficiently.

Another theme was technology as an **ongoing process of change and adaptation**. Participants described technology as emerging when new methods allow us to perform the same tasks in easier or better ways. They also noted that technology is inseparable from its users and their experiences; it is shaped not only by innovation but also by the ways people adopt, adapt, or resist it. The dynamics of early adopters versus the broader public were noted as critical to understanding how technologies are implemented and accepted.

Equity and ethics emerged as a recurring concern. Participants emphasized that technology is not neutral: biases in design or data can perpetuate existing inequities, while digital divides, particularly for aging populations, may create new vulnerabilities, including mental health challenges. Ethical considerations, such as how data is collected and used in training models, must therefore be integral to any definition of technology.

Finally, participants highlighted the role of technology in **spreading knowledge and information**. While technology can facilitate rapid dissemination, this capability can have both positive and negative consequences, depending on the accuracy, framing, and intent of what is shared.

Overall, participants articulated technology as a set of tools, platforms, and processes derived from organized knowledge that both enable and complicate human life. Technology is not inherently beneficial but must be critically assessed for its impacts, equity implications, and ethical considerations. Its effectiveness is determined as much by human adoption and social context as by technical capability.

5. Community

Community was initially defined by the organizers as, *"a group of people with diverse characteristics who are linked by social ties, share common perspectives, and engage in joint action in geographical locations or settings."* Participants enriched this framing, stressing the importance of **lived experiences, trust, and inclusivity**, while also questioning whether shared perspectives or joint action are always present.

Several participants emphasized **broadening the attributes that constitute community**. They suggested incorporating lived experiences alongside demographic or social characteristics. Participants also noted that communities may be formed around a shared mission, practice, or interest, even if not all the elements in the original definition are present. Communities can be place-based such as neighborhoods, counties, or states but they may also be temporary or fluid, including visitors, seasonal residents, or people who are "passing through." Some participants further argued that community should encompass those directly or indirectly affected by the decisions of those in power, raising questions about inclusion and agency.

The discussion also highlighted the **relational qualities of community**. Trust, connectedness, and unity were repeatedly identified as essential for communities to function well, though participants acknowledged these can vary in strength, ranging from strong to weak ties. Communities may be linked by time, resources, or shared culture, and relationships within them are not static but evolve over time. At the same time, participants challenged the assumption that communities necessarily **share common perspectives**. Indeed, some argued that communities may not always be linked,

may not engage in joint action, and may lack common perspectives, **challenging the rigidity of the original definition**.

While shared values or experiences, whether positive or negative, can unify a group (e.g., assault survivors, school alumni), there are also instances where communities are fragmented, with some members engaged and others isolated. This complexity underscores that communities are not uniform, and perspectives within them may diverge widely. Some communities form around shared goals and practices, while others exist primarily as collectives shaped by geography or circumstance. Nevertheless, communities were described as **essential for a thriving society**.

Taken together, participants conceptualized community as a flexible, context-dependent construct, encompassing place, practice, lived experiences, social ties, and shared or divergent perspectives. Trust, unity, and inclusion were highlighted as central, while acknowledging that communities can also be fragmented, relative, and dynamic.

6. Community Engagement

Community engagement was initially defined by the organizers as, *"the process of working collaboratively with and through groups of people affiliated by geographic proximity, special interests, or similar situations to address issues affecting the wellbeing of those people."* Participants broadened this understanding, framing engagement as a dynamic, iterative process rooted in collaboration, reciprocity, and inclusivity.

One of the first areas of discussion focused on **broadening the scope of engagement**. Participants suggested that engagement is not limited to addressing issues but can also serve as a platform to connect, learn, or share knowledge. They also proposed expanding the affiliations that define communities to include shared experiences, culture, or values, in addition to geography or interest. Recognizing cultural backgrounds was highlighted as essential, as was clarifying the meaning of the term "engage" itself, which can vary across contexts.

The discussion also underscored the **principles that should guide engagement**. Effective community engagement was seen as inherently collaborative and two-way, as opposed to prescriptive. Participants stressed the importance of planning with, rather than planning for, communities, ensuring reciprocity and opportunities for feedback. Recognizing and valuing local expertise was considered vital, as was aligning efforts behind community-led priorities. Several participants noted that engagement should **create genuine buy-in by meeting people where they are** and allowing for societal input into research, challenges, and decision-making.

Another major theme was **inclusion and representation**. Participants cautioned against assuming that the most vocal or accessible members represent the whole community. Instead, they called for deliberate inclusion of vulnerable and marginalized groups, which requires identifying and engaging populations who may otherwise be overlooked. Trusted community connectors, such as leaders within immigrant or otherwise invisible communities, were highlighted as essential intermediaries. Engagement was also described as fluid, varying across different communities and evolving within sub-communities.

Participants emphasized that **trust and continuity** are central. Engagement should not be limited to crises but should occur before, during, and after emergencies to build and maintain enduring trust. Finally, participants debated the **values and outcomes** of engagement. They questioned whether community engagement has an inherent normative value and stressed the need to evaluate whether engagement efforts generate positive and lasting benefits for communities.

Overall, participants framed community engagement as a reciprocal, inclusive, and evolving process that extends beyond problem-solving to encompass trust-building, knowledge sharing, and empowerment. It is most effective when guided by community priorities, responsive to diversity and vulnerability, and designed to produce meaningful outcomes for all members of the community.

7. Relatability

Relatability was initially defined by the organizers as, *"people can see themselves in something or identify with it, often because it reflects their own feelings, experiences, or perspectives."* Participants enriched this definition by pointing to the roles of culture, trust, intersectionality, and lived experiences, underscoring that relatability is never static.

One recurring theme was the importance of **embedding values, culture, and lived experience**. Relatability requires more than mirroring perspectives; it demands a human-centered approach that acknowledges and resonates with the diversity of backgrounds and experiences within a community. Participants noted that understanding lived experience, particularly of groups often excluded from dominant narratives or policies, is essential, while also recognizing the limits of external understanding (as one person stated, "we don't know what we don't know").

Participants also stressed the **audience-centered nature** of relatability. It depends on whether individuals believe a message applies to them directly and whether they perceive themselves as having the capability to act upon it. If communication fails to establish this connection, people may disengage or feel excluded. Moreover, **trust** emerged as a key component. Relatability is inseparable from the perceived credibility of the message sender; even a well-crafted message may fail if the audience does not trust the source.

Finally, participants highlighted the **complexity and evolving nature** of relatability. It is not static and can be particularly challenging in diverse societies marked by intersectionality, where individuals share some identities (e.g., ethnicity, economic background) while differing in others (e.g., historical experiences, cultural perspectives). This layered identity context means that strategies to foster relatability must be flexible and attentive to both shared and divergent experiences.

In summary, participants framed relatability as a dynamic, trust-dependent, and culturally grounded process. It requires embedding values, acknowledging lived experience, and recognizing exclusion, while ensuring that audiences perceive both relevance and agency. Relatability, therefore, is central to ensuring that risk communication resonates authentically and equitably with diverse communities.

8. Research and Practice

Research was initially defined by the organizers as, *"theoretical and exploratory, aiming to create new knowledge,"* and practice as, *"implementation-focused, applying existing knowledge."* Participants emphasized, however, that these categories are not mutually exclusive; instead, research and practice exist along a spectrum where each informs and strengthens the other. Participants expanded the concept of **research** beyond theory, stressing that it can be applied as well as exploratory. Research may analyze potential scenarios or respond directly to societal needs, and in doing so, it often informs policy and action through the development of best practices. Several noted that research should not be detached from implementation but rather should emerge from practical necessities and remain oriented toward solving real-world problems.

Similarly, participants enriched the definition of **practice**. While practice typically involves applying existing knowledge to implementation and everyday needs, participants emphasized that it also produces knowledge. Practice is often experience-based and may rely as much on instinct as on organized knowledge. Systems and processes within practice were highlighted as critical spaces where challenges and opportunities arise.

A major theme was the **mutual dependence between research and practice**. Research is necessary to identify best practices, while practice provides the lived experiences and contexts that inform meaningful research. Participants emphasized that practice should shape research priorities, just as research should guide and improve practice. Several argued for reframing the distinction as a spectrum, one that includes applied research and collaborative approaches. This framing avoids treating the two as discrete or oppositional, instead encouraging integration that leads to both more relevant research and more informed practice.

Participants also reflected on the **philosophical and normative dimensions** of this relationship. They asked fundamental questions about what constitutes knowledge and whether lived experiences must sometimes precede formal research ("do you always run before learning to walk?"). The purpose of research and practice, they argued, should ultimately be to do good for society, raising questions about who benefits from research outputs and whether outcomes address the needs of communities and end users. Participants agreed that outputs must not remain abstract but should be incorporated into tangible improvements that matter to people's lives.

In summary, participants conceptualized research and practice as complementary, intertwined processes. Research can be theoretical, applied, or both, while practice both applies and generates knowledge. Rather than rigid categories, they should be seen as points along a continuum, oriented toward societal benefit and grounded in reciprocity between discovery and implementation.

9. Innovation

Innovation was initially defined by the organizers as, *"the process of creating and implementing new ideas, products, or services that lead to significant improvements by adding value, solving problems, or meeting evolving needs."* Participants engaged with this framing, pointing out that innovation is not always positive and that its value depends on context, community acceptance, and societal impact.

At its core, participants described innovation as involving **new or improved ideas and out-of-the-box thinking.** They suggested refining the definition to explicitly include services that "meet a need" and highlighted that innovation is meaningful only when tied to recognizable problems and solutions. Importantly, participants argued that not all change is improvement, recommending that the term "improvements" be replaced with "changes" to acknowledge that innovation can sometimes yield unintended or negative consequences.

A recurring theme was the **centrality of community acceptance and involvement**. Innovation was seen as impactful only when communities adopt, implement, and find value in the tools or ideas being introduced. Participants emphasized that effective innovation must be grounded in community feedback and aligned with community-recognized needs. Without this grounding, new ideas risk being labeled "innovative" in name only, without delivering real benefits.

Participants also highlighted the **dual impacts of innovation**. While some innovations can move society forward and reshape norms, these impacts may be either positive or negative. Innovation can empower, solve problems, and generate value, but it can also create inequities, reinforce harmful norms, or distract from genuine needs. Several noted that innovation has become something of a buzzword, often invoked to promote new products or ideas regardless of their broader societal impact.

Overall, participants conceptualized innovation as the creation and implementation of new or improved ideas that produce meaningful change, dependent on community acceptance and relevance to real needs. While often framed positively, innovation can also be disruptive or destructive, underscoring the importance of grounding it in inclusivity, ethics, and social responsibility.

Toward a Shared Vocabulary

Together, these discussions illustrate that the language we use to describe concepts such as risk, communication, risk communication, technology, community, community engagement, relatability, research and practice, and innovation is neither fixed nor undisputed. Participants emphasized that definitions must remain dynamic, inclusive, and context-sensitive, reflecting the diversity of lived experiences, values, and needs across communities. A recurring theme was the importance of trust, equity, and reciprocity, as well as the recognition that these concepts are not purely academic but carry tangible consequences for how risk is perceived, communicated, and managed.

By critically examining and refining these foundational terms, the workshop created a shared vocabulary that can guide future dialogue and collaboration. At the same time, the conversations underscored that no definition is final; rather, each must continue to evolve alongside emerging challenges, technologies, and societal changes.

This collective framing of key concepts provided an essential foundation for the sessions that followed, where participants moved from definitions toward exploring practical strategies, collaborative approaches, and innovations in disaster risk communication.

Invited Talk: The Ethics of Community-Engaged Risk Communication

This session, led by Dr. Lori Peek, Director of Natural Hazards Center, explored the ethics and practice of community-aware and community-engaged risk communication (Figure 3). The talk emphasized the importance of researcher positionality, recognition of community diversity, and reciprocity as foundations for building trust and effectiveness in communication with at-risk populations. Dr. Peek provided an overview of the evolving landscape of risk communication, beginning with reflections on high-profile failures, from the 2011 tsunami in Japan to the COVID-19 pandemic, along with natural hazards like tornadoes and hurricanes. These events raise essential questions: Why does risk communication fail, and when is it most likely to break down? Despite being a priority concern for over 50 years in research and practice, risk communication remains inherently difficult, especially as the world undergoes dramatic transformations.

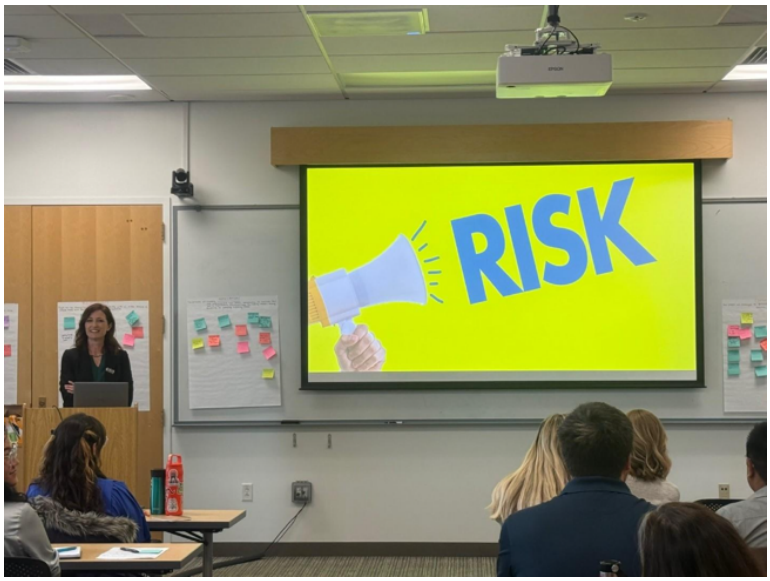

Figure 3: *The invited talk focused on the ethics and practice of risk communication.*

Over the past five decades, risk communication had to adapt to rapid and complex changes. Shifts in social and demographic dynamics, evolving ethical norms, technological and environmental transformations, and the disappearance of traditional media have all contributed to a dramatically altered communication environment. The rise of social media has further complicated efforts by enabling the rapid spread of misinformation and disinformation. Changing government structures and leadership styles add to this complexity, making the work of risk communicators more demanding across increasingly diverse and fragmented environments.

Still, the session emphasized that the conversation should not only focus on failures, but also on possibilities. In a recorded interview featured during the session, the former Director of the Natural Hazards Center, Dennis Mileti, highlighted foundational principles of risk communication. He stressed that attitudes toward risk can change, but only through meaningful engagement. Rather than prescribing solutions, communicators should inspire communities to co-develop their own, ensuring that local voices are genuinely heard and respected. The principle “be in the community, for the community” underpins this participatory approach.

A compelling case study on landslide risks during Hurricane María illustrated how interdisciplinary collaboration between academia, government, students, and local community leaders can offer new insights, even when addressing issues that often receive less attention than larger scale disasters. Importantly, this case reinforced the idea that we must prioritize process over product, focusing on inclusive, ethical, and adaptive methods.

The session closed with a focus on key principles for ethical and effective risk communication. These included ethical engagement, cultural competence, active listening, inclusive decision-making, empathy, and convergence research, all grounded in reciprocal, non-hierarchical relationships. Mentoring across generations (i.e., nested mentoring), maintaining adaptability in the face of changing conditions, and practicing reciprocity are central to meaningful community engagement. Ultimately, as social, political, and economic challenges grow increasingly complex, these principles offer a pathway forward for more resilient and just risk communication practices.

Session 2: Risk Communication and Relatability of Information

In this session, participants collaborated in small groups of 8-9 people to examine how personalized risk messaging can affect both the timing and likelihood of individuals taking preventive action during disasters. They discussed and brainstormed how emerging technologies could enhance communication across different cultural contexts and personal preferences. Each group was given 20 minutes to address a series of questions and later presented their insights to the larger audience (Figure 4).

Figure 4: *The small-group activity aimed at understanding how personalized risk messages influence preventive actions and how technology supports cross-cultural communication.*

The first question centered on **how emerging technologies can support communication across socio-cultural contexts and individual preferences**. One of the key insights from the session was the growing potential of AI to support tailored risk messaging. Participants discussed how AI can personalize communication by adjusting the tone and format of messages based on individual

needs; for example, using prompts like *"talk to me like I am..."* to generate explanations appropriate for different audiences. AI tools were also seen as valuable in delivering messages in a variety of tones, from serious to reassuring, depending on the context and urgency. Moreover, AI was recognized for its ability to offer information through multiple modalities, such as text, audio, or visual formats, making risk communication more accessible and responsive to diverse preferences and capabilities.

Building on these discussions, participants also emphasized the importance of using multiple modalities and languages to expand the reach and inclusivity of risk communication. Translation services were seen as essential tools for engaging a broader range of communities, especially when powered by AI and machine learning. These technologies can help reduce the manual labor involved in creating translated materials, particularly for complex forms such as the American sign language (ASL), which relies heavily on facial expressions that are difficult to replicate digitally. However, participants raise strong concerns about the reliability and equity of these tools, especially when used as a translation service. While these tools have the potential to improve accessibility, they can overlook cultural nuances. They acknowledged the major issues that may arise from AI interpretation and emphasized the need for standardized phrases, clear formatting procedures, and active community involvement to train AI systems and set expectations for messaging.

Advancements in technology have also increased communication access in remote and hard-to-reach areas, such as the backcountry. However, as access expands, so does the need for new messaging strategies that match the evolving capabilities of these technologies. Participants raised the critical question of how to ensure communication with individuals who either cannot or choose not to engage with new tech. To address this, the group explored low-tech and low-cost solutions that remain effective, such as multi-tone sirens, blinking lights, and variable messaging signs. These tools provide essential backup systems, ensuring that everyone, regardless of technological access, can receive timely and life-saving information. The session closed this segment by noting that as technology continues to evolve, communication strategies must also adapt to meet new message needs without leaving anyone behind.

The second question prompted participants to reflect on **what makes risk messaging relatable, and how communication strategies can be tailored to resonate with diverse communities**. A central theme was the importance of designing messaging that is accessible, inclusive, and user-centered. Participants emphasized that effective communication must move beyond a "one-size-fits-all" approach and instead be systematic yet customizable, accounting for cultural, linguistic, and regional differences.

Relatable messaging, according to the group, starts with plain language, culturally relevant content, and a strong awareness of the audience's lived experience. Visual aids such as infographics and realistic imagery can help convey complex messages more effectively, especially in communities with varying levels of literacy or for whom English is a second language. Participants also noted the value of local news, radio, and trusted community figures as communication channels, recognizing that people are more likely to respond to sources they know and trust.

Community engagement was considered critical, both before and after a hazard event. Building relationships with community members, partnering with local leaders, and training communicators to recognize unconscious biases were all seen as key steps in designing messages that resonate. In particular, testing risk message drafts with real community members was suggested as a method for fine-tuning language, tone, and delivery for specific populations.

The discussion also highlighted the need to acknowledge differences in relatability based on residency status (e.g., tourists vs. locals), communication tools tailored to context (e.g., sirens in rural areas), and how perceptions of risk vary depending on people's prior experiences and competing life challenges. Messaging, participants noted, should be empathetic, context-aware, and capable of addressing conflicting risks and motivations, whether economic, social, or environmental. Finally, the group agreed that relatable messaging requires ongoing trust-building and collaboration, so that communities see themselves reflected not only in the content of the message, but also in the process by which it is created.

The third question invited participants to consider **how personalized risk messaging can influence preventive action in the context of disasters**. A key insight was that personalization plays a critical role before, during, and after a disaster, helping individuals assess their specific risk, identify appropriate actions, and overcome barriers to response. Participants emphasized that for messaging to be effective, it must not only communicate risk, but also highlight actionable steps people can take, otherwise, it risks becoming fearmongering rather than empowering. Messages that promote agency, self-efficacy, and response efficacy (i.e., the belief that one's actions will make a difference) were seen as crucial for motivating behavior change.

Participants discussed the need for risk messaging to connect with what motivates individuals, such as the desire to protect dependents or personal safety, and stressed that tailoring messages based on socioeconomic status, local context, and available resources can make abstract threats feel more concrete and manageable. For example, personalized location data can help individuals quickly determine whether they are in a hazard zone and what actions to take. However, participants also cautioned against the over-personalization of uncertain risks, noting that precision is not the same as accuracy, and overly specific messages could result in misinterpretation or unintended consequences.

The discussion also explored the importance of flexibility and adaptability in risk messaging. Disasters are inherently dynamic, and risk communication must remain responsive to evolving situations. Participants stressed the need to consider different audience types, such as visitors unfamiliar with the area, and tailor messages that identify who is being addressed, what protective actions are feasible, and which resources are available or lacking. Importantly, personalization should not imply a one-size-fits-all solution; rather, it should account for alternate responses, varying needs, and community diversity.

Ultimately, personalized risk messaging can enhance buy-in, make risks feel real and relevant, and support timely decision-making, but only when it is thoughtfully designed. Participants agreed that the goal of personalization should be to connect risk with needs, empower people to act, and maintain a balance between targeted information and broad applicability across communities.

Session 3: Community Engagement and Resources

In this session, participants took part in a rotating fishbowl discussion to explore strategies for improving community engagement in disaster planning and response. Small groups rotated into an inner circle to discuss key themes such as technology integration, digital divide, trust, and access to mitigation resources, while others listened and later joined the conversation (Figure 5). The discussion also covered the use of storytelling, local knowledge, community mapping, and potential and limitations of tools such as low-bandwidth apps, offline platforms, and SMS-based alerts to enhance access and inclusion.

Figure 5: *The rotating fishbowl discussion focused on strategies to improve community engagement in disaster planning and response.*

Group One: Storytelling, Local Knowledge Integration, and the Digital Divide

The first group began their discussion by reflecting on the power of storytelling in risk communication. Participants emphasized that stories rooted in personal or community experience can be a compelling way to convey risk, build awareness, and motivate action. Sharing how individuals first became involved in risk communication revealed that lived experiences often serve as a powerful entry point into preparedness work. These narratives help translate abstract threats into relatable and memorable messages, reinforcing that experience fosters readiness and strengthens community engagement.

The group then moved on to the topic of digital divide, identifying it as a major barrier to equitable communication. A key concern raised was the misinterpretation of messages, particularly when information is filtered through rapidly evolving or unfamiliar platforms. While it was acknowledged that both younger and older populations use technology, the way they interact with it varies significantly, influencing how risk messages are received and understood. Participants stressed the importance of knowing your audience and their position within the communication landscape, whether they rely on social media, traditional media, or low-tech methods like sirens. In contexts where digital access is limited or absent, alternative methods must be put in place. Finally, the group highlighted the growing challenge of misinformation on social media,

underscoring the need for trustworthy sources and diverse communication strategies to ensure accurate, actionable information reaches all segments of the community.

Group Two: Access to Planning Resources and the Role of Technology

The second group initially focused on the challenges related to access to planning and mitigation resources, particularly the role of federal agencies in risk communication. Participants questioned whether federal entities realistically have sufficient time and capacity to meaningfully engage in community-level communication. As an alternative, they emphasized the importance of direct, one-on-one community engagement, highlighting that building trust and understanding often requires personal interaction at the local level.

The group then explored the limitations and potential of existing technologies, especially emerging tools like AI. While some participants expressed reluctance to fully embrace AI due to ethical concerns such as bias and lack of transparency in algorithms, there was also a willingness to explore its potential, provided that its moral and ethical issues are acknowledged and addressed. The discussion concluded with a call to consider policies or frameworks that could guide the ethical and equitable use of technology in risk communication, ensuring that innovation supports, not replaces, community needs and values.

Group Three: Community mapping and Technology Integration

The third group began by discussing community mapping, emphasizing that many residents are unaware of the locations of community shelters which is a critical gap in disaster preparedness. The group noted that even when this information exists, it can be difficult to access or update, highlighting the need for better data collection and dissemination strategies.

The conversation then shifted to technology integration to improve situational awareness and engagement. Participants emphasized the importance of data sharing and using empowering, collaborative tools that allow community members to actively participate in preparedness efforts. One promising approach discussed was crowdsourced mapping, with real-time, ground-level input from residents that can inform emergency response strategies. Tools that allow people to answer, “What am I seeing?” in their environment were seen as especially valuable for building shared awareness and enabling quick, informed action during crises.

Across all three groups, participants emphasized the importance of community-centered approaches to risk communication, grounded in local knowledge, accessible technology, and collaborative engagement. Storytelling and one-on-one outreach were seen as powerful tools for building trust and preparedness, especially where access to digital platforms is limited. Concerns around the digital divide, misinformation, and bias in emerging technologies like AI highlighted the need for thoughtful integration of tech that supports human connection. Whether through community mapping, crowdsourced data, or policy support for equitable tech use, the discussions reflected a shared goal: to make risk communication more relatable, inclusive, and actionable for all.

DAY 2

Welcome Session

The second day of the workshop began with a welcome from the organizers, Dr. Amir Behzadan and Dr. Mary Angelica Painter. They provided a brief summary of the key discussions and activities from the first day, followed by an overview of the second day agenda and expected outcomes. The purpose of this opening session was to ensure continuity between the two workshop days and to set the stage for deeper exploration of technology, policy, and frameworks in disaster risk communication.

The recap of the first day of workshop activities included a collective effort to define key terms in disaster risk communication, while also reflecting on overlaps, contradictions, and missing concepts. Participants discussed challenges in implementing effective communication strategies and the need for shared understanding across research and practice. Dr. Lori Peek's talk was revisited, particularly her emphasis on empathy as a critical and teachable element of risk communication, which participants described as a "stuck in my head" moment. The group also reflected on the difficulty of identifying success stories, noting that it is often easier to recognize when risk communication fails rather than when it works.

Other highlights included the group activity on communication and relatability, which underscored both the positive and negative impacts of technology on communication. In the fishbowl discussion, participants raised questions about sustaining progress in the face of funding cuts and highlighted that emergency managers often remain unseen by the public they serve. Key reflections captured the spirit of the first day: "We know how to identify problems but not how to produce solutions," and "Lots of agreements yesterday."

Together, these reflections provided a strong foundation for the second day of the workshop, orienting participants toward actionable strategies and practical frameworks to advance the goals of the workshop.

Session 4: Role of Technology in Enhancing Communication

This session explored how emerging and existing technologies can strengthen disaster risk communication by improving the timeliness, clarity, and reach of emergency messages. The goal was to identify best practices for leveraging tools such as AI, Internet of Things (IoT) devices, and accessibility technologies to optimize disaster message generation and distribution. A central focus was on tailoring communication to high-risk groups and adjusting message content in real time based on evolving data. The expected outcome was a clearer understanding of both the opportunities and limitations of technology in ensuring equitable, effective, and trusted communication during disasters. During this session, participants worked in small groups to address four guiding questions and then shared their findings with the broader group (Figure 6).

Figure 6: *The small-group activity aimed at exploring how technologies can enhance disaster risk communication through more timely, clear, and widespread messaging.*

Q1: What new technologies (and in which ways) can optimize disaster message generation and distribution?

Discussions highlighted the role of AI in both generating alerts and conducting real-time risk assessments, while IoT devices were seen as valuable for detecting hazards and monitoring infrastructure. However, participants cautioned that technology is not always appropriate for every community, and barriers such as cost, complexity, system integration, and lack of user-friendly design persist. Advances in cybersecurity and resilient infrastructure (e.g., longer-lasting batteries) were identified as essential, and participants emphasized that innovation should also focus on improving existing tools, not only on developing new ones.

Q2: How can new technologies be used to adjust message content based on real-time data?

Participants noted that AI can tailor alerts based on live forecasts, environmental conditions, and user context. Location-based messaging was recognized as an existing but powerful method for customization. Concerns were raised about ethical issues when using personal data from social media or online activity, as well as risks of bias in AI-generated messaging. While data collection has improved, synthesizing abundant local-level data into clear communication remains a major gap. Participants also pointed out that broad AI models (e.g., ChatGPT) must be specifically trained for disaster communication tasks to ensure accuracy and trustworthiness.

Q3: How can new technologies be used to target specific communities and population groups that are considered high-risk?

Groups discussed how devices can filter information by hazard type, language, and location to make alerts more relevant. At the same time, they recognized that communities without digital access require outreach through trusted local leaders and informal networks. The conversation

emphasized the importance of community input at the very beginning of technology development and the need to balance standardized alerts with personalized, culturally relevant messaging. Ethical issues surrounding data collection and high costs of acquiring community-specific data were identified as key barriers, particularly in underserved regions.

Q4: What are the needs for and limitations of accessibility technologies to improve communication for all audiences?

Participants identified gaps between the availability of detailed community-level data and the ability to effectively synthesize it for communication. They noted that technologies must be tailored for specific uses, such as weather alerting, to avoid miscommunication. Integrating older communication methods (e.g., TV chyrons) with modern digital systems was seen as critical for reaching broader audiences. While the cost of technology is decreasing, inequities in access remain, and many people are unaware of available tools. Finally, participants stressed the need to provide clear pathways for people to know where to go or whom to call when seeking disaster-related information.

Overall, the session concluded that while technologies hold strong potential to improve disaster communication, their impact depends on ethical and transparent use of data, active engagement with communities, and sustained investment to overcome barriers of access, cost, and trust.

Students Lightening Presentations

This session, moderated by Dr. Amir Behzadan (workshop co-organizer), featured 7-minute presentations by participating graduate students and post-docs, on either their current research related to risk communication, or a topic they want to explore within risk communication. A presenter-led panel discussion and Q&A session followed at the end of this session. Table 2 summarizes the topics and presenters' information.

Table 2: *Students lightening presentations covered a wide range of topics related to disaster risk communication and community preparedness.*

Presentation Topic	Presentor(s)
From risk to resilience: Enhancing communication for floodplain communities along the Shunganunga Creek	Zoe N. Caryl, University of Illinois Urbana-Champaign
The effect of flood risk information on human perception and preparedness behavior	Armita Dabiri, University of Colorado Boulder & Subashree Dinesh, University of Colorado Boulder
Can generative artificial intelligence make disaster risk messaging more relatable? An experimental study	Arunima Maitra, University of Colorado Boulder
Risk communication in real time: Examining individuals' smartphone use during the 2021 Texas winter storm	Michelle Ng, Stanford University
Blupix: Reimagining risk communication for flood emergencies	Renooh Sivakumar, University of Colorado Boulder
Improving walkability for older adults in a Latino neighborhood & Communicating climate change health risks	Raquel Yupanqui, University of Colorado Boulder

Session 5: Evaluating Effectiveness and Impact

This session, moderated by Mary Angelica Painter (workshop co-organizer), featured a panel consisting of six representatives from academia, emergency management, and practice. Panelist #1 was a Senior Scientist at a federally-funded atmospheric research center, Panelist #2 was a Research Associate specializing in natural hazard and risk education, Panelist #3 was a Senior Scientist specializing in emergency and risk communication, Panelist #4 was a State Emergency Manager, Panelist #5 was a State Emergency Communications Director, and Panelist #6 was a Postdoctoral Fellow specializing in bilingual climate risk communication.

The goal of this panel discussion was to explore how technological advances can be used to track and analyze the effectiveness of disaster communication strategies, while drawing on case studies from the panelists' own domains (Figure 7). The expected outcomes included identifying principles for effective risk communication, exploring strategies for accessibility and trust, and generating ideas for evaluating impacts of communication strategies in practice. During this session, panelists responded to six guiding questions, with attendees actively participating and building on their insights.

Figure 7: *Panel discussion on using technology to evaluate disaster communication strategies, supported by case studies from panelists' fields.*

Q1. What are the potential risks or consequences for not communicating risks effectively?

Panelist #1 emphasized the importance of risk perception, noting that people's judgments about hazards are shaped by social and environmental cues and by how much control they feel they have. Panelist #3 described the goal as closing the gap between subjective and objective risk perceptions, while Panelist #2 added that perception itself is multi-dimensional, including risk perception, perception of protective actions, and perception of stakeholders. Panelist #6 pointed out that people who have never experienced a hazard perceive risks differently, highlighting the importance of culturally resonant communication. Panelist #5 shared that people often call for explicit guidance during events, even when threats are visible, while Panelist #4 stressed the need

to evaluate where individuals stand in their perceptions. Panelist #1 also noted that people manage multiple risks in their lives, which shapes their responses to communication.

It was further discussed that to ensure communication of risk, collective action can play a powerful role. Panelist #4 suggested encouraging group actions that reinforce individual behavior. Panelist #3 raised the issue of resource availability, noting that challenges often extend beyond messaging. Panelist #6 recommended using simulations (e.g., driving in a snowstorm) to help people safely experience risk, while Panelist #2 suggested preparedness surveys (e.g., "Do you have a family plan?") to assess resource gaps. The panel moderator raised the challenge of reaching people who have never experienced a hazard, and Panelist #6 reminded broadcasters to consider tourists or newcomers who may be unfamiliar with local risks.

Q2. What do you think is the key principle for effective risk communication?

The panel emphasized clarity and timing. Panelist #3 advocated for plain language and avoiding jargon. Panelist #1 stressed tailoring messages to the current phase of a disaster, since appropriate actions depend on timing. Panelist #6 highlighted the importance of building strong foundations through disaster education and local storytelling. The panel moderator pointed out that repeated exposure to hazards may cause people to take warnings less seriously, raising the question of how to counteract complacency. Panelist #3 also noted limitations in current communication tools and visuals that need to be addressed.

It was further discussed that technology can support these principles by providing tools for evaluation and engagement. For example, simulations can allow people to experience risk in controlled environments, while surveys can assess preparedness and capability for action. This highlighted the importance of linking human-centered communication principles with the design of technological tools.

Q3. How can we ensure that risk communication is accessible, understandable, and culturally competent?

Panelist #1 noted that people rely on cues like tone of voice that shape how they interpret risk. An audience member raised the challenge of encouraging both trust in government and individual responsibility. Panelist #5 advocated for clear, plain-language directives that balance past approaches ("we're coming to help you") with newer messages ("you can do this"). She stressed being honest about what agencies can deliver, while also giving people specific, immediate actions. Panelist #4 reinforced this point, noting the importance of transparency: "People are coming to help you, but you need to be on your own for a while."

It was further discussed that, when dealing with complex technologies or diverse communities, communicators must recognize that people often expect someone will come to save them, yet agencies are not always able to meet those expectations. It is important to be transparent, provide honest guidance, and clearly tell people what actions they need to take. Participants also emphasized tailoring information to the disaster timeline, ensuring that messages focus on immediate steps during the crisis rather than on long-term next steps.

Q4. How do we conduct outreach about risk communication technologies with communities?

Panelists emphasized that outreach must be both practical and culturally grounded. Panelist #5 suggested modeling the behaviors we want others to adopt, while Panelist #2 highlighted the power of local storytelling to create emotional impact. Joseph stressed the importance of explaining hazards clearly, outlining protective actions, and ensuring cultural resonance. Panelist #6 pointed out that children often influence parents' actions because of frequent school drills, underscoring the role of education in outreach.

Q5. What potential communication risks might we face with technological integration of risk communication, such as with emergency alerting?

Panelists advised treating technology as a tool rather than a solution in itself. They raised concerns about whether different sources of information communicate consistent messages and whether people trust local sources as much as official alerts. The discussion emphasized the importance of consistency, trust, and integration across communication channels.

Q6. What are some ways that we can evaluate impacts of risk communication, both positively and negatively?

Panelist #2 stated that evaluation is a persistent challenge, asking, "What exactly are we measuring, and how do we measure it?" Panelists agreed that impact should be assessed not just by message delivery but by people's capacity to take protective actions.

It was further discussed that timing of message delivery is critical, and that newcomers to a community may not know what steps to take when receiving alerts. Researchers and practitioners must work together to bridge these gaps, combining academic evaluation with practical knowledge to improve both communication design and implementation.

At the end of the session, the panel agreed that evaluating effectiveness and impact requires blending technology with cultural and behavioral understanding. Clear, plain-language messaging, tailored to context and disaster phases, was identified as a critical principle. Technology can enhance evaluation through tools like simulations and surveys, but trust, transparency, and community engagement remain central to successful communication.

Session 6: Policy and Framework Development - Next Steps

This final session brought all workshop participants together to collaboratively develop policy, programmatic, and practical recommendations to advance innovative, relatable, and effective disaster risk communication. The goals of the session were to outline guidelines and best practices for improving communication strategies, address critical concerns such as privacy, accessibility, timeliness, effectiveness, and trustworthiness, and consider socio-demographic and ethical challenges.

Figure 8: *In the final session, participants discussed and co-developed policy, programmatic, and practical recommendations for improving disaster risk communication.*

The expected outcome was a roadmap for future research and practice that is both actionable and grounded in real-world needs. Participants engaged in discussions around three thematic areas: (1) guidelines and best practices, (2) privacy, accessibility, timeliness, effectiveness, and trustworthiness, and (3) socio-demographic and ethical considerations.

Guidelines and Best Practices for Disaster Communication

Participants emphasized that disaster communication frameworks must remain dynamic, adapting to evolving hazards and human behavior. One practical framing tool was "start, stop, continue, change" when designing or revising plans. Several participants highlighted the importance of teaching protective actions and disaster behaviors at an early age to create a foundation for preparedness. A recurring challenge discussed was the definition of terms such as "effectiveness," which may differ between researchers and practitioners, whether it refers to predictive accuracy, quality of decisions, or other outcomes. Terminology barriers, like the varied uses of "inclusive," were noted as impediments to collaboration. Participants stressed integrating practitioners into research processes at key stages, as well as balancing simplification of complex systems with the need for robust verification. Advocacy was also identified as critical to safeguard legacy systems and resources that risk being lost, such as data archives, funding, and long-standing institutional models. Storytelling was highlighted as a creative and qualitative approach to evaluate impact alongside quantitative methods.

Privacy, Accessibility, Timeliness, Effectiveness, and Trustworthiness

The conversation underscored that communication should not only deliver messages but also support informed decision-making. Effectiveness, therefore, was framed as leading to actionable outcomes rather than mere message dissemination. Participants stressed that disaster communication must be ethically grounded as well as technically sound. Concerns were raised about the premature deployment of untested technologies, with calls for practitioner involvement in evaluating tools and guiding their use in real-world contexts. The group identified a gap in

computer science education, where societal and ethical issues are rarely addressed. To bridge this, interdisciplinary teaching that draws on engineering, sociology, and atmospheric sciences was recommended. Ethical oversight was also emphasized, including the need for AI-related hiring to involve voices from the humanities and philosophy to ensure responsible development.

Socio-Demographic and Ethical Considerations

Participants highlighted that planning should be done "with" communities rather than "for" them, emphasizing reciprocal relationships and co-design in risk communication. The use of AI in disaster contexts should always be justified by clear benefits and evaluated against potential risks and alternatives. Sustained risk communication, beginning as early as K-12 education, was recommended to build long-term resilience. The session concluded that disaster risk communication must evolve into broader risk education, ensuring continuous engagement and empowerment of communities across the lifespan.

Overall, this session synthesized insights from the entire workshop into forward-looking recommendations, stressing that effective disaster communication frameworks must be interdisciplinary, community-driven, ethically grounded, and continuously adaptive to emerging hazards and societal needs.

SUMMARY AND CONCLUSION

The ASPIRE Workshop convened 27 researchers, practitioners, and community leaders to critically examine the intersections of disaster risk communication, human behavior, and technology. Through pre-survey analysis, various sessions, breakout discussions, and invited talks, participants engaged with foundational concepts, such as risk, communication, community, relatability, and innovation while evaluating their relevance in practice. The workshop highlighted both the promise and challenges of integrating emerging technologies, particularly AI, into disaster communication strategies. Key themes included the importance of plain language, cultural competence, audience-centered messaging, and building trust. Across sessions, participants emphasized the role of community engagement, the need for equitable access to information, and the ethical implications of technology adoption.

The workshop underscored that disaster risk communication must be dynamic, interdisciplinary, and community-driven. While technology offers new opportunities for personalization and rapid dissemination, its effectiveness depends on equity, ethics, and trust. Building shared vocabulary and frameworks is essential, but success ultimately depends on continuous engagement with communities, transparency in communication, and collaborative innovation that responds to lived experiences. Moving forward, the insights from ASPIRE provide a roadmap for advancing both the science and practice of disaster communication, shifting from short-term messaging to long-term resilience, inclusivity, and empowerment.

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