CONVERGE COVID-19 Working Groups for Public Health and Social Sciences Research

Research Agenda-Setting Paper

This paper was written to help advance convergence-oriented research in the hazards and disaster field. It highlights areas where additional research could contribute new knowledge to the response to and recovery from the pandemic and other disasters yet to come. Questions about the research topics and ethical and methodological issues highlighted here should be directed to the authors who contributed to this paper.

Working Group Name:

Extreme Weather Events and Geohazards in a Time of COVID-19

Working Group Description:

This Working Group will explore how the impacts of COVID-19 will affect the ability of practitioners and communities to prepare for, cope with, and respond to extreme weather events and geohazards across the globe. The group will identify ways in which COVID-19 amplifies or attenuates risks to people and infrastructure associated with a wide range of weather hazards such as tornadoes, hurricanes, and heat waves. It also will address practical strategies to mitigate those risks. Similar issues arise with geohazards, from earthquakes to volcanic eruptions to landslides and tsunami, and therefore these related hazards are explored here as well. Further, the group will examine case studies including monitoring systems (ShakeAlert), and scenarios (Haywired), to better understand how these technologies and approaches can advance natural hazards mitigation and pandemic preparedness.

Introduction to the Research Agenda:

The COVID-19 global pandemic has brought many aspects of society to an unprecedented halt and altered daily life in countless ways. Unchanged, however, is the possibility that communities will need to prepare for, cope with, and recover from life-threatening extreme weather and geohazard events. Researchers and practitioners are now tasked with anticipating extreme weather and geohazard events and understanding how the risks they pose will be altered by COVID-19 and the public health mitigation strategies that have been enacted to suppress disease transmission.

Hazards and disaster researchers have long recognized that the concurrence of two or more hazard events introduces complexity, amplifies uncertainty, and can constrain response and recovery operations. Less understood are the potential complications when a pandemic is one of those hazards. Gaps in multi-hazard research include, but are not limited to: multi-hazard processes; changes in vulnerability, exposures, and resilience; how these changes interact with and create social, racial, and economic disparities and inequities; the links between research and practice; and regulatory or legislative preparedness and response frameworks (NERC, 2018).

Relevant multi-hazard terminology from the academic literature includes social and structural vulnerability and exposure, compound risk, interacting risk, interconnected risk, cascading risk, multi hazard risk, cumulative exposure (Kappes et al. 2012; Mohammad and Peek 2019; Tilloy et al. 2019), and broader concepts of resilience (Komendantova et al. 2016). The terms ***interacting and interconnected risk*** may be appropriate for framing risks associated with the concurrence of extreme weather or geohazard events during COVID-19 (following Pescaroli and Alexander 2018).

Our CONVERGE Working Groups (WG) on extreme weather events (e.g., hurricanes, tornados, floods, wildfire, heatwaves), geohazards (e.g., earthquakes, landslides, tsunamis, volcanic eruptions), and COVID-19 worked collaboratively in Spring 2020 to construct this research agenda exploring the following question:

How and why does COVID-19 amplify or attenuate extreme weather and geohazards risks to communities, and the people who serve them?

For this research agenda, we will focus on the risks to people, without excluding sociotechnical and socioecological systems considerations.

Research Themes:

This combined WG organized its discussion about how COVID-19 would change risks associated with extreme weather and geohazard events by framing risks to health and well-being as a function of hazard, exposure, and vulnerability with these definitions:

Risk—potential harm to people associated with COVID-19, extreme weather, or geohazard events.

Hazard— the occurrence of COVID-19, extreme weather, or geohazard event and its associated properties (e.g., intensity, duration).

Exposure— the presence of people, livelihoods, or physical, economic, social, or cultural assets in places or settings that could be adversely affected by COVID-19, extreme weather, or geohazard events (IPCC, 2014).

Vulnerability— the degree to which people are sensitive to and able to cope with COVID-19, extreme weather, or geohazard events by drawing on individual, community, and state resources (Adger, 2006).

The WG recognized the critical role of protective actions as modifiers of the (often interactive) relationship(s) between hazard, exposure, vulnerability, and risk (see also Lindell, 2019 re: the Disaster Impact Model). In this context, protective actions reflect longer-term mitigation strategies, shorter-term preparedness actions, as well as response and recovery strategies, all of which can influence one or more of the three fundamental components of the risk "equation." The interactions between COVID-19, geohazards and extreme weather hazards, exposures, vulnerabilities, and protective actions may amplify or attenuate risks in unanticipated ways.

In hazards and disaster research, models like Protective Action Decision Making (PADM) (see Lindell and Perry 2012) implicitly or explicitly address a single decision situation or action. Such models might account for another risk by treating it as covariate or contextual factor. More complex models (e.g., system dynamics models) reflect feedback loops and other more complicated dynamics. There is a role for more dynamic modeling of attitude formation, decision-making, and the determinants of action using longitudinal data and attempting more aggressively to estimate causal models; yet even more complex models may still be based on relatively parsimonious conceptual models. More fundamental sociological and psychological theories may also be both useful and informative, such as dual-process or dual-systems theories (e.g., Kahneman 2011) to model how people make decisions about, for example, sheltering when already stressed by pandemic. The dynamics of interacting and interconnected extreme risks require a better understanding of such fundamentals, to enable more effective and equitable social and policy interventions to avert disasters.

The COVID-19 pandemic disrupts “typical” dynamics of the hazard-exposure-vulnerability-risk relationship. This disruption—or modification—occurs through two related, broad causal pathways. First, COVID-19 directly impacts the health and well-being of individuals who contract the virus and communities where it is experienced. Individuals who become sick with COVID-19 may lose the ability to take protective actions for extreme weather and geohazard events or become more susceptible to them. This concern extends to first responders and community leaders who assume key roles in hazard and disaster preparedness, response, and recovery. Second, a wide range of response strategies have been undertaken to reduce the risk of COVID-19 transmission. These response strategies, and the subsequent impacts they create, can also modify the dynamics of extreme weather and geohazard risk. For example, social distancing is one of the most widely adopted COVID-19 response strategies whereby mobility is restricted. Distancing may change depending on where people spend their time (exposure), where and how they might seek relief from extreme weather and geohazard events (protective actions), and factors that impact their susceptibility, including income, social networks, and mental and physical health (vulnerability).

Key concerns and research questions therefore arise for exposure, vulnerability, and protective actions during a pandemic. While there are no apparent major causal pathways by which COVID-19 might impact the occurrence of extreme weather or geohazard events, these events could in theory influence the occurrence or spread of COVID-19. Furthermore, COVID-19 has the potential to influence extreme weather event climatology at the broader scale through impacts on energy systems and greenhouse gas emissions.

Exposure

The global COVID-19 pandemic’s impacts on daily life and significant changes to human time-activity patterns will change the nature of exposure to extreme weather and geohazard events for some communities and populations. Under “stay home-stay safe” rules, residents will be more frequently exposed to hazards that impact their home, especially the indoor environment, but less frequently exposed to hazards that they might encounter away from home. For unhoused populations, outdoor exposure may increase as publicly- and privately-funded resources like homeless shelters grapple with COVID-19 risks. Over the longer term, significant increases in the number of unsheltered individuals are anticipated as stop-gap public funding created during the pandemic (e.g., the federal CARES Act and other, more localized policies) expire. These changes could act to both amplify or attenuate risks stemming from extreme weather and geohazard events, as well as cascading social risks, such as intimate partner violence. Changes in time-activity patterns can be measured with mobile apps (including time-activity logs/diaries), social media engagement, focus groups, and high temporal resolution surveys.

Changes in hazard exposure because of COVID-19 could manifest over the short term (days to months) in changes in daily travel and activity patterns that could affect hazard exposure. These exposure patterns will be strongly influenced by requirements and recommendations about protective actions, which are evolving rapidly. Individuals may also consider the possibility of exposure to “economic hazard” (e.g., job or healthcare insurance loss, financial precarity, housing instability) when changing daily patterns. Over the longer term (months to decades), relocation, migration, funding sources, employment shifts, and more permanent behavior changes may be catalyzed by multiple waves of pandemic--particularly a hypothesized migration away from dense urban cores toward more suburban communities. These changes could transform human exposures to extreme weather events and geohazards, while additional risks to critical infrastructure and other systems could add compounding effects.

Interacting, intersecting, competing, and cascading risks could also increase exposures to other public health hazards as a consequence of the pandemic, including through decreased vaccination rates and preventive maintenance of critical infrastructure (due to lost tax revenues, reduced budgets, stressed public health systems), elevating exposures to water and vector-borne diseases. Pandemic-induced economic stress could decrease preventive maintenance of infrastructure, decrease environmental protection efforts, and reduce preparedness expenditures, resulting in increased exposures to both primary (e.g., interrupted water and power supplies resulting in health risks) and secondary risks (e.g., fires, or contaminated water due to damaged storage facilities or broken pipelines) from extreme weather and geohazard events. Across all time frames and scenarios, specific populations may be more likely to bear the burden of changing hazard exposures, raising the importance of understanding diverse communities' relationships with different hazards in planning future policies and preventative actions.

Exposure – Research Questions

- In what aspects of daily life during a pandemic, and for whom, is the likelihood of exposure to extreme weather and geological hazards changed? How do we capture these changes over time?
- Under what conditions (e.g., occupation, location, circumstance) do essential workers become more or less exposed to extreme weather and geological hazards in responding to COVID-19?
- How do individuals perceive growth/densification after COVID-19; is it changing where people choose to live, and thus many other aspects of their life, including hazard exposure?
- What protection does the home environment offer relative to other settings, such as travel and work? How does that protection vary by hazard type and demographic characteristics? How does protection and exposure change for unsheltered populations?
- How do individuals perceive and respond to competing exposure risks when an extreme weather event or geohazard occurs simultaneously with COVID-19? What factors do they consider when choosing between the possibility of being exposed to an extreme weather event or geohazard versus being exposed to COVID-19?

Vulnerability

The differential impacts of the COVID-19 pandemic and hazards unfold in the context of existing discrepancies and differences in vulnerabilities across diverse populations and communities. Vulnerability is often conceptualized as the outcome of combined exposure, sensitivity, and adaptive capacity (Adger, 2006), overlapping with other portions of this research agenda and highlighting its importance for further investigation. Distinctions can be made between structural, geographic, and social vulnerability. The social scale—individual, household, and community—of vulnerability interacts with these and other aspects of demographic vulnerability as well as political and historical processes to create differential outcomes from a single hazard event. When addressing critical research needs it is important to carefully delineate vulnerability concepts and the scale(s) of analyses.

In multi-hazard contexts, some aspects of vulnerability may be reduced (e.g., reduction in vulnerability to job loss from natural hazard due to COVID-19 financial support measures) while others may be amplified (e.g., household economic instability from increased home energy costs due to increased time indoors). The many possible vulnerabilities created or exacerbated by COVID-19 range from reductions in lung capacity, to job and housing loss, poor health, racism, and innumerable negative impacts that might interact with natural hazards in the long-term to widen existing disparities. Responding to these impacts may be further hampered by the compounding vulnerabilities in other systems, including overburdened or inaccessible healthcare and mental health support systems, weaknesses in supply chain dynamics, widespread economic recession, and other macro-scale considerations.

Rethinking questions of scale and scope may provide opportunities to reconceptualize vulnerability. For example, the seasonality of different hazards like heat and hurricanes may interact with decreases or increases in COVID-19 vulnerabilities. Setting temporal boundaries on disasters (when a disaster begins and ends) is challenged by the trajectory of a pandemic. These challenges reveal vulnerabilities built into assumptions in disaster management infrastructure, such as warning and forecast systems that discretize hazards in the cycle of disasters rather than attend to how people experience them. Reconsidering vulnerability to extreme weather and geohazards while accounting for emergent dimensions of COVID-19 may reveal new ways of conceptualizing and operationalizing vulnerability.

Vulnerability – Research Questions

- Which pre-existing vulnerabilities (and to whom) are most likely to be exacerbated by health outcomes from COVID-19 or job losses from policy responses?
- What are the impacts of COVID-19 on communities that have become more vulnerable from repeated exposure to natural hazards and systemic inequity? (and vice versa)
- What new vulnerabilities or vulnerable groups, if any, will COVID-19 reveal? What old vulnerabilities might be reduced or increased in frequency or scale?
- What are the most important/critical intersecting vulnerabilities between COVID-19 and other hazards?
- What are the historical and existing policies that create conditions for populations to be vulnerable and exposed to COVID-19 and other hazards?
- What kinds of policies will reduce individual and community vulnerabilities in these multi-hazard contexts?

Protective Actions: Mitigation, Preparedness, Response, and Recovery

The feasibility and accessibility of protective actions spanning the hazard and disaster management cycle, and at all social scales, could be altered by the pandemic. Causal pathways that connect the pandemic to protective actions are diverse, from direct (e.g., providing sheltering while maintaining social distancing), to more indirect (e.g., deteriorating trust in sources of hazard information). Concerns about differential access to information and protective actions for diverse communities are amplified by global anti-racism protests. Messaging is changing rapidly, for both COVID-19 and concurrent hazards, resulting in a need for translations of protective action information, which may currently be insufficient to reach all who need them. Further, prior work demonstrates the importance of socializing protective actions like Drop, Cover, and Hold On for earthquakes (McBride, 2019), which faces novel challenges in the pandemic. New models of social risk dynamics will need to go beyond current models such as PADM and the Social Amplification of Risk Framework (e.g., Ng et al., 2018).

Challenges related to evacuation and sheltering exist for many different hazard types, as illustrated by recent severe thunderstorms and tornadoes in the American southeast, abnormal early-season extreme heat in the American southwest, and earthquakes in Utah during pandemic. Facilities typically available for sheltering may be closed or have limited capacity due to pandemic. Which hazard is more important to seek protection from, an impending weather or geohazard event, such as a hurricane, volcanic eruption or COVID-19? In the absence of clear guidance, understanding risk perceptions is critical, as is accelerating risk communication research to produce guidance for responding agencies and individuals. Further, there may be decreased trust in policing organizations who often assist with evacuations, given the unrest and racial injustice that has occurred over this time period.

For a deeper treatment of risk communication during the time of pandemic, see the CONVERGE Working Groups focused on risk community. In addition, it is important to note that the potential for competing and conflicting messaging raises concerns about trust, information sources, and disinformation. Difficulty interpreting messages related to COVID-19 may change residents' receptiveness to and the credibility of messages about other hazards. Typically, emergency managers strive for consistent messaging. In the rapidly changing pandemic environment, there is a high potential for inconsistent messaging and resulting confusion across local, state, regional, national, and international boundaries.

Protective actions and their immediate and long-term impacts may interact. For example, individuals and households facing economic hardship as a result of the pandemic, may have reduced capacity to implement protective measures for other hazards in the short term, while affecting where and how people live in the longer term, further reducing their protective action capacity (e.g., selling a personal vehicle, moving to an unfamiliar community, and losing access to social networks). Economic hardships facing local, regional, and national governments could similarly constrain the availability and efficacy of many protective actions and emergency responses (e.g., shelters, emergency medical care), and change how governments function (e.g., closing communities and government operations to reduce pandemic spread, as illustrated by checkpoints near Iwi land of Māori (NZ) and some North American tribal nations).

COVID-19 might also fundamentally alter perspectives about the disaster management cycle and the practice of disaster management more generally. Perspectives on what a "recovery" phase for the pandemic looks like appear mixed, potentially creating dissonant expectations and fatigue, but also potentially setting the agenda for improving preparedness for extreme hazard events.

Protective Actions: Mitigation, Preparedness, Response, and Recovery – Research Questions

- How do land use, urban density, and resettlement patterns relate to long-term protective action for COVID-19? How will related changes impact exposures and vulnerability to other hazards?
- What impact will the economic downturn due to COVID-19 shelter in place and quarantine orders have on potential hurricane or wildfire evacuations?
- How do requirements of COVID preparedness/response/recovery affect diverse populations' abilities to be prepared/respond to/recover from other hazard events?
- How does COVID-19 impact warning systems, like ShakeAlert and other scientific monitoring systems, as science responders become ill or are at risk?
- Are there protective actions for COVID -19 that are counter-productive for weather or geohazards events and vice versa? Are there co-benefits from specific protective actions or across types of actions?
- What protective actions can help individuals and communities cope with the mental health effects of interacting risks/hazards?
- Is there a hierarchy of hazards/risks that can be used to resolve competing/conflicting advice for what to do in competing risk events/situations? How do/would people prioritize?
- How does preparedness compare across multiple hazards (e.g., meteorological, geo- and biohazards) and result in preparedness for compound hazards? How does disaster fatigue impact public receptiveness to messaging/recommendations from authorities for other hazards? How does it impact first responders and emergency managers?

- What are the policy issues around storing inventories/supplies for PPE and other resources needed for other hazards?
- How have COVID-19 restrictions impacted death management, and particularly communal grieving processes?

Methodological and Ethical Challenges and Opportunities:

With respect to social science multi-hazard research, major issues include sampling methods and potential limits regarding the generalizability and replicability of certain types of research, as well as ethical concerns about how data generated from more limited samples should be used to influence policy and practice. Any research that deals with individuals and communities that have been impacted and stressed by COVID-19 and other hazards is sensitive in nature and should be coordinated with this in mind (for further background, see the CONVERGE Training Modules at: https://converge.colorado.edu/resources/training-modules). Researchers themselves also face hazard-related physical, mental health and economic challenges. Further, travel restrictions and pandemic-related prejudices against minority communities may lead to decreases in workplace diversity and long-term shifts in where research is done.

There are numerous methods available to social scientists to explore the human experience (Alasuutari et al, 2008; Peek et al. 2020); COVID-19 presents unique challenges as well as opportunities to develop or expand on methods. Previous cascading and multi-hazard research provides a suite of research methodologies for studying simultaneous events; but this literature has primarily focused on natural and technological hazards rather than public health events such as a pandemic. Extreme weather and geohazard events during COVID-19 therefore represent an opportunity to expand current intersecting hazards thinking.

While community spread is common, methods like in-person interviews, laboratory experiments, and in-person surveying may not be feasible. These restrictions may spur the development of new methods (i.e., virtual focus groups; CCTV footage analysis of human behavior; activity tracking with mobile phones). These techniques, however, may privilege more affluent research groups or threaten to increase surveillance of already-stigmatized populations. Pre-existing longitudinal digital citizen science initiatives, like Did You Feel It? from the USGS and other similar initiatives afford the potential for revealing before, during, and after COVID comparisons.

Further, the use of computer science can assist researchers to gather large amounts of data and perform preliminary automated analysis, potentially reducing time in the research process. Because of the sensitive nature of multi-hazard research, it has the potential to amplify violent harms being inflicted on communities by conditions of racial and social injustice. Ethical research in this context requires explicitly engaging with these realities to actively oppose systemic social marginalization and its effects. In light of these concerns, it is essential to conduct research with **ethics of respect, inclusion and engagement, and accountability.** Physical exposure to hazards, vulnerability to risk, and lack of resilience are related to social, political, and economic marginalization. Further, the cumulative effects of living with systemic marginalization, including but not limited to structural racism, are incredibly harmful and may accumulate across the life course (Mohammad and Peek 2019). Engaging explicitly with these and other issues is one way to engage in an **ethics of respect** for the visible and invisible conditions of community experiences and to develop a stronger more coherent **ethical toolkit** (Browne and Peek 2014).

Co-production of research questions and methods is crucial to maximize the efficacy and applicability of research. Further, the value of co-production is particularly important to avoid either exploitation or neglect of communities' needs and knowledge. The principle of consent and the right of refusal to participate in research, inclusion in defining research questions and methods, in analyzing research, and communicating findings are all important parts of an **ethics of inclusion and engagement.** Finally, these interacting and interconnected risks and our responses to them exist in historical context. Meaningful relationships between stakeholders may be those of trust or of hurt, and our work must not assume that figures like researchers, government, or police appear value-neutral or positive to communities we seek to study and support. An **ethics of accountability** means taking these relationships seriously and considering the consequences that our actions and recommendations might have. Current codes of ethics regarding professional or practitioner groups, e.g., the International Association of Emergency Management Code of Ethics, should be consulted.

Engagement with Practitioners and Community Members:

Engaging with the "practitioner" community requires acknowledging that the community is large in scope and needs an expansive perspective. *Practitioners* in disaster research often refers to emergency managers and first responders, but in this intersecting and interacting risk context it includes public health officials, science responders (e.g., National Weather Service, USGS, WHO and United Nations organizations), and even policy analysts, decision makers (politicians, community organizers), planners for long term mitigation, engineers and infrastructure providers, and social workers. One useful engagement tactic may be to engage with professional organizations directly, such as the International Association of Emergency Managers (IAEM) or Earthquake Engineering Research Institute (EERI). Grunig's Excellence theory with the vested publics model (1992) may be a useful framework here to identify and segment groups of interest (see also McBride, 2017). Another consideration with collaborating with practitioners is that they, themselves, may be potential research respondents, however, it is important to be respectful of their time and energy. Emergency managers, public health officials, science responders, and others may be overly stretched at this time. While the ideal is to have co-created research opportunities among these groups, it is critical to be mindful of the limits of their personal and professional limitations at this time.

Synthesis and Conclusions:

In this combined CONVERGE Working Group agenda, we have provided both the research and methodological foundations for researchers to explore the attenuation and amplification of risk of geohazards and extreme weather events when combined with COVID-19. We found evidence that suggests the manner in which extreme weather and geohazards events impact communities, and how they respond, is expected to be seriously altered by the presence of the global pandemic. The natural hazards scientists and practitioners from around the world who participated in Working Croup conversations used the framing of risk as a function of exposure, vulnerability, and protective actions to reveal different causal mechanisms by which the global pandemic would act as a risk modifier, amplifying risks in certain circumstances, and attenuating risks in others.

The Working Group identified many interdependencies and complexities that add uncertainty and unpredictability to the nature of hazard mitigation, planning, response, and recovery during the pandemic and also make it challenging to clearly delineate causal pathways and mechanisms as solely attributable to singular aspects of the conceptual model. Echoing calls already in the literature related to multi-hazard events more generally, this Working Group advocates for improved conceptual models that can help advance understanding of and response to the interconnected and interacting risks at the intersection of COVID-19 and extreme weather and geohazard events. Discussions also revealed specific ways in which the practice of research itself, in the context of extreme weather and geohazards, would be altered by the pandemic, which compelled attention to emergent ethical challenges and sensitivity around engagement with community actors. Disaster exhaustion, increased vulnerabilities, alarming increase in exposure, and confusing or novel protective actions advice makes it a further complex environment to navigate for all researchers. In these times, we call for increased attention to ethical and compassionate data gathering, analysis, and research to answer these challenges.

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Sample Guidelines for Extreme Weather and Geohazard Event Preparedness and Response during COVID-19

https://disaster.unl.edu/severe-weather-preparedness-during-covid-19

Identified Funding Opportunities

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