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Rapid Research and Assessment on COVID-19 and Climate in New York City

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In May 2020, the New York City (NYC) Mayor's Office of Climate Resiliency (MOCR) began convening bi-weekly discussions, called the Rapid Research and Assessment (RRA) Series, between City staff and external experts in science, policy, design, engineering, communications, and planning. The goal was to rapidly develop authoritative, actionable information to help integrate resiliency into the City's COVID response efforts. The situation in NYC is not uncommon. Extreme events often require government officials, practitioners, and citizens to call upon multiple forms of scientific and technical assistance from rapid data collection to expert elicitation, each spanning more or less involved engagement. We compare the RRA to similar rapid assessment efforts and reflect on the nature of the RRA and similar efforts to exchange and co-produce knowledge. The RRA took up topics on social cohesion, risk communication, resilient and healthy buildings, and engagement, in many cases strengthening confidence in what was already known but also refining the existing knowledge in ways that can be helpful as the pandemic unfolds. Researchers also learned from each other ways to be supportive of the City of New York and MOCR in the future. The RRA network will continue to deepen, continue to co-produce actionable climate knowledge, and continue to value organizational sensemaking as a usable climate service, particularly in highly uncertain times. Given the complex, rare, and, in many cases, unfamiliar context of COVID-19, we argue that organizational sensemaking is a usable climate service.

Keywords: Climate change; COVID-19; science–policy interactions; climate assessment.

1. Introduction

In the spring of 2020, New York City (NYC) faced the impending threat of compound and cascading risks posed by the COVID-19 pandemic and extreme weather events. Heat waves would soon be descending on the NYC as physical distancing measures were still in place, making a deadly combination even more lethal. The National Oceanic and Atmospheric Administration (NOAA) had forecasted above average tropical cyclone activity for the 2020 hurricane season. Though NYC COVID case rates began steeply declining in early May 2020, rising case rates in other parts of the United States and experience from other pandemics signaled that COVID-19 would linger well into 2020, if not 2021. City planners and managers were attempting to make sense of a situation that, in some cases, they had never faced.

In May 2020, the NYC Mayor's Office of Climate Resiliency (MOCR) began convening a limited-term series of bi-weekly discussions, called the Rapid Research and Assessment (RRA) Series with external experts in science, policy, design, engineering, communications, and planning. As a cross-cutting function in the NYC government, MOCR works with all City agencies to make their planning, operations, and services more resilient and equitable in the face of climate change. It is, therefore, the main City entity positioned to build resiliency into recovery processes. With COVID-19 unfolding, MOCR took the lead to capture resilience guidance related to the pandemic and to brief other City agencies with

that guidance. The goal was to rapidly develop authoritative, actionable information to help integrate resiliency into the City's COVID response efforts.

MOCR is organized by four policy teams: (1) Social Resiliency, (2) Land Use & Buildings, (3) Infrastructure and Energy, and (4) Waterfront Resiliency, and it also has three programmatic support teams: (1) Program Coordination and Delivery, (2) External Affairs, and (3) Climate Science and Risk Communications. MOCR's staff include climate policy experts, urban planners, architects, scientists, engineers, and lawyers. The RRA was initiated and led by the Climate Science and Risk Communications team as a targeted effort to help MOCR staff and their agency collaborators process information in a heightened, rapidly evolving response to the pandemic.

Extreme events present windows of opportunity to improve resiliency. As examples, after Hurricane Sandy, NYC faced difficult decisions regarding rebuilding in flood-prone areas. In lieu of continuing to reference current flood risk, the norm in most cities, the City shifted to base coastal protection projects on future flood risk, using information from the New York City Panel on Climate Change (NPCC), in turn improving the resiliency of those investments. MOCR coordinates many of those projects. Similarly, in collaboration with a number of City agencies, MOCR developed NYC's Climate Resiliency Design Guidelines (CRDG). CRDG encourage cooperation among City agencies and non-governmental partners for resilient design in built and natural environments, like Con Edison's multi-billion-dollar storm hardening measures. Lastly, in the winter of 2021, Intro 2092, a Local Law to amend the administrative code of the City of New York, in relation to climate resiliency design guidelines and resiliency scoring, passed City Council. It now requires MOCR and the Mayor's Office of Climate & Sustainability (MOCS) to further develop the CRDG for City capital projects and to use the CRDG to develop a climate resiliency score metric for capital projects. Such a metric will account for flooding risk, energy efficiency, energy resilience, and on-site water capture and management. Every City capital project above a threshold construction cost will be evaluated for its resiliency and will meet or exceed a minimum resiliency score. As these examples illustrate, Hurricane Sandy created a window to encourage broader use of climate resilient standards that account for future flood risk, though much work remains to adapt NYC to long-term future flood risk. COVID-19 presented similar policy windows, but much different policy questions.

How would the combination of the pandemic and extreme weather events affect residents' ability to cope with and emerge stronger from COVID? What actions could people take to limit their exposure to COVID while staying cool during a heat wave? What are effective strategies for limiting transmission and managing heat within and across NYC's diverse building typologies?

MOCR and its partner agencies still face these questions in 2021 as they build a case for measures that help NYC recover from COVID while also helping to build adaptive capacity over time. Developing and adjusting specific plans, policies, operations, and services following COVID recovery will unfold over years, just as the City is still responding to Hurricane Sandy nine years after the event. Given this unfolding nature, rather than address a specific decision or outcome, the RRA was designed to infuse MOCR's internal knowledge base with external, interdisciplinary perspectives drawing heavily on a new network of experts related to NPCC.

This commentary provides a reflection on the RRA in relation to the concept of co-producing actionable climate knowledge, including the idea that organizational sensemaking is one form of a usable climate service. We first describe conceptual underpinnings for the series and then use those concepts as means of comparing our RRA Series to similar "rapid assessment" efforts. We summarize cross-cutting themes from the Series and posit ways those themes will impact MOCR's evolving role in COVID recovery. Because the process itself is an outcome, we reflect on ways to refine interactions in the future, concluding with implications for MOCR's Climate Science and Risk Communications team.

2. Co-Production and Rapid Assessment

Co-production of climate knowledge[1] is increasingly recognized as a means of improving the effective generation and utilization of climate information to inform decision-making and support adaptation to climate change. However, as scholars and practitioners have illustrated, co-production does present potential pitfalls for scientists, decision-makers, and community members (Cvitanovic *et al.* 2019; Lemos *et al.* 2018). Notable concerns are the high transactional costs, blurring of professional boundaries, and perceived detriment to both science and policy integrity [for a recent review, see Cvitanovic *et al.* (2019)]. Therefore, a critical element of co-production is iterative engagement between scientists, decision-makers, and/or stakeholders. Iterative engagement helps build trust, establish group norms for healthy interactions, and align science to support specific decision requirements (e.g., temporal and spatial scales). However, scientists and decision-makers do not always have the luxury of time for explicit engagement activities.

[1]Hereafter referred to as "co-production." We define co-production as efforts that involved iterative interaction between scientists and stakeholders, where scientists are working together to tackle problems whose solutions cannot be achieved by any single discipline and where the process results in knowledge that meets the constituents' needs [after Lemos and Morehouse (2005)].

Drawing from literature in organizational behavior, specifically the work of Karl Weick, we recognize the importance of sensemaking structures in high-stress/high-risk environments (Weick 1995). Weick's premise, borne out through numerous forensic studies, argues that "reality is an ongoing accomplishment that takes form when people make retrospective sense of the situations in which they find themselves." Weick (1995: 159) describes "committed sensemaking" as "focusing attention, uncovering unnoticed features, and imposing value." Such a structured approach allows for clarity in times of high stress when reversion to first-learned behaviors is far more normalized (Barthol and Ku 1959). Beyond the challenge of COVID-19, work on climate change and resiliency is very much emergent with its distinctive, disciplinary norms and even language. As compounded, unfolding events, MOCR's COVID-19 pandemic response and efforts to improve resiliency represent an intellectual frontier where structural processes for framing the work must be developed in parallel with disaster responses in high-stress/high-risk contexts. As such, we find relevance in sensemaking offered by the RRA wherein committed sensemaking processes are recognized as valuable outcomes on their own and provide a usable climate service (Wall *et al.* 2017).

Collaborations such as the RRA appear to rely on (at least) five factors: (1) Motivating events that catalyze the need for new kinds of collaborations; (2) a lack of time to follow more traditional scientific processes; (3) established relationships that act as launching pads for assembling network responses; (4) cross-cutting sector involvement that furthers technical assistance with local knowledge; and (5) asynchronous collaboration tools that allow participation to occur as possible, across digital literacies, while simultaneously documenting progress to date. RRAs rely on, or result in, a range of outputs such as the development of reliable networks, the conduct of site assessments, and the preparation of tools or processes. The following precedent RRAs draw on a wide range of experiences and introduce benefits as well as lessons for future applications. Note that these precedents draw from the MOCR RRA participant experiences and thus represent a sample of the kinds of RRA that might occur, not an extensive overview of the range of RRA typologies.

2.1. *What's happening on the ground?*

2.1.1. *OpenStreetMap/Kathmandu Living Labs Nepal — site assessment*

OpenStreetMap/Kathmandu Living Labs' (KLL) leveraging of local expertise, technology, and crowd-sourcing an established network of collaborators enabled a rapid assessment that improved emergency response and broadened baseline understanding in preparation for future events. Starting in 2013, KLL used OpenStreetMap to crowd-source its version of a wiki that illustrated community assets,

such as health facilities, schools, and roads in Kathmandu Valley, Nepal. Recognizing earthquake risks, KLL began working with experts and community members to advance the digital platform and build a baseline dataset that highlighted resources and encouraged participation. When a 7.8-magnitude earthquake struck near Kathmandu in 2015, the Government of Nepal immediately requested international assistance (Shrestha and Pathranarakul 2018). The level of damage severity, geographical reach, and isolation amplified the difficulties of the rescue response. While the Nepali Army and humanitarian agencies prepared for rescue and recovery, KLL expanded its efforts to understand the context and need better. KLL invited community members to document damage and location and asked its international network of over 9,000 mappers to assist with the data. Through its reporting site, Quakemap.org, KLL community members identified impact areas through "hotlines, SMS or an online form." KLL verified information and, through Humanitarian OpenStreetMap, created a baseline of impact areas shared with the response teams. In parallel, Code for Nepal developed a community platform using Facebook and Google DOCS to solicit the needs and resources by region. Mobile Citizen Helpdesk focused its outreach on last-mile relief needs, e.g., built-in feedback loops that allowed community members to understand better relief status (Mulder *et al.* 2016). Speaking at the Understanding Risk Forum in 2016, Pradeep Sapkota of the Nepali Army noted that this community response improved the Army's ability to prioritize resources, bringing relief to communities far sooner (World Bank 2016).

- KLL represents distributed technical teams who share a common mapping language and collaborate extensively with thousands of distributed community members creating real-time, situational awareness while building community capacity to better understand and engage in risk reduction.
- Lessons learned focus on the acute challenge of managing such a large group of participants, coordinating feedback from governmental and humanitarian responses, and the time required to vet community contributions against other datasets.
- KLL demonstrates distributed social and technological systems and crowdsourcing, ground-truthing, or opening the aperture, as part of response networks.

2.2. *What do we prioritize?*

2.2.1. *USACE Ecological Modeling — process development*

The USACE Ecological Model is an example of a formalized network that has risen from rapid assessment, adapting to become a long-term standing resource. The U.S. Army Corps of Engineers funded research to develop a common approach to hands-on workshops geared toward environmental problems. In Herman

et al. (2019), the authors describe how their approach "demystifies technical issues and educates participants on the modeling process." The research highlights the known gaps between technical experts, stakeholders, and decision-makers and the need for new approaches that overcome consistently challenging communication gaps. In codifying their approach, the team emphasized the importance of co-development and the need to break through technically-driven, implicit assumptions. Iterated over the last decade, and based on hands-on learning from ecosystem restoration projects, the process promotes capacity-building within complex team structures in order to truly co-create knowledge and improve decision-making.

- USACE Ecological Modeling engages collaborators on specific questions requiring deep technical expertise, selective stakeholder participation, and a codified process.
- Observations over more than a dozen iterations of the workshop model yielded expected lessons-learned about communications and transparency, but also more subtle lessons about the need to encourage stakeholders to accept themselves as part of the process, rather than observers to it.
- USACE Ecological Modeling demonstrates a foundational methodology that underpins various aspects of the RRA process engaged in New York with MOCR.

2.3. *What is the state of the body of knowledge?*

2.3.1. *Urban Climate Change Research Network — process development and resources*

Established in 2007 and based at Columbia University's The Earth Institute, the Urban Climate Change Research Network (UCCRN) is a global network of 1,000+ members focused on climate change mitigation and adaptation in urban environments. The organization hosts regional hubs connecting more than 150 cities and hosts urban design climate workshops to enable climate change integration in city decision-making. UCCRN provides a welcome complement to the work products of consultants supporting cities. UCCRN works via problem-based learning between researchers, students, and collaborators to advance the integration of climate science and to build capacity amongst participants. UCCRN provides networked collective assessment along with a database of resources for use by the collective.

- UCCRN, like SEAN, connects highly selective experts focused on unique questions to deepen the knowledge base and sharpen the resources that the collective might use.

- UCCRN demonstrates the power of networked collaborators to help one another and to better support cities as the network builds capacity and resources.

2.3.2. *Societal Experts Action Network — advisory network and expert guidance*

The National Academies of Science, Engineering and Medicine (NASEM) recognized the need for new combinations of expertise for COVID-19 response and assembled its Societal Experts Action Network (SEAN) to support that need. Referred to as Rapid Expert Consultation, SEAN connects social, behavioral, and economic sciences (SBE) with governmental decision-makers. Drawing from a broad range of experts vetted by NASEM, SEAN assembled resources and cultivated shared perspectives to develop consensus-responses for use by policy makers. Within a very short time, SEAN prepared policy briefs for contact tracing, adoption of protective behaviors, and data evaluation. These resources (summary briefs and full reports) were published on the NASEM website, underscoring a level of consensus necessary for broader adoption. Importantly, the resources acknowledged the need for further feedback and invited readers to email or call the SEAN team to discuss usefulness of the consultation.

- SEAN represents distributed technical teams paired with government decision-makers and a nationally recognized organization known for its scientific integrity and convening power.
- SEAN demonstrates the potential for an existing network of trusted experts to rapidly develop actionable consensus-based outcomes that meet the scientific and publication quality expected at the NASEM. This is particularly relevant for MOCR given prior network development following Hurricane Sandy.

2.4. *What is necessary to build capacity?*

2.4.1. *Houston Harris Heat Action Team — site assessment*

In August 2020, the Houston Harris Heat Action Team (H3AT) conducted a one-day heat mapping campaign that engaged 85 community science volunteers along with technical experts to collect data related to heat stress. With funding from NOAA, collaboration from scientific and government organizations, and through CAPA Strategies, the platform of the organization, this rapid assessment linked H3AT to 13 other communities in the 2020 heat awareness campaigns. As part of the broader CAPA Strategies, HeatWatch initiative, this effort includes training, deployment, and feedback to enable communities to build awareness of heat stress and guidance for investments to reduce it. In this approach, community members

learn how to address heat stress in their personal contexts and become advocates for broader community improvements to minimize heat exposure through established networks. As CAPA continues to solicit annual cohorts, it also builds network capacity, across communities, for better understanding of heat as a public health threat and connecting investment decisions to reduce that threat. This effort is similar to post-Harvey assessments present in Houston Resiliency Innovation Workshop (Stantec 2019), and PSI Post-Sandy Initiative Report in NYC (AIANYC 2013).

- H3AT is a replicable RRA and is in continuous use by the City of Houston and the Houston Area Research Consortium (HARC). Also, NOAA's intent is to link HeatWatch campaigns across the United States, including the campaigns for the Bronx and Brooklyn in 2021. In this way, H3ET is both an example and a future collaborator for MOCR's work on extreme heat.
- H3AT (and the U.S. Climate Resilience Toolkit) demonstrates significant community involvement and access as well as widely ranging capacities, yet both rely on empirical bases for their processes.

2.4.2. *U.S. Climate Resilience Toolkit — tools and resources*

The U.S. Climate Resilience Toolkit (USCRT) represents a significant resource for rapid assessments. Developed over a six-month period in 2014 by a partnership of federal agencies and organizations led by NOAA, the Toolkit continues to expand and grow over time, primarily in response to user needs and feedback. Its initial emphasis was to provide the US federal government with climate-related information and decision support resources using a range of tools, such as Climate Explorer and case studies, to put science in the hands of any viewer. The Climate Explorer functions as an easy-to-access/easy-to-understand, zip-code-based summary of historical records and potential scenarios for precipitation and temperature. Accessible to anyone, USCRT also acts as a primer on resilience, offering a five-step process replicable by communities. Beyond the capacity-building that is inherent in the transparency that the resource affords, the USCRT also offers access to variety of experts by types, such as State Climatologists, NOAA teams, Regional Climate Hubs, and similar vetted resources. With a growing database of Climate Service Providers, the USCRT connects technical experts to one another and decision-makers or interested community members to those experts. Finally, the USCRT continues to evolve with updates to the core data as well as growing numbers of case studies and expert resources.

- Via their Ask an Expert portal, the USCRT connects a network of climate experts. Vetted by the USCRT team, these experts are available to anyone seeking additional information on their respective topic areas.
- USCRT demonstrates the potential for putting technical expertise and ease of access in a community platform and the required commitment to maintain that platform as science evolves and knowledge broadens.

The examples vary from well-established, steady networks to rapid research teams and, as well, in the degree of selectivity of participants (see Figure 1). This model does not value a particular RRA approach but seeks to describe the types of relationships between the examples, the degree of selectivity in participants, and the range of steady-state versus rapid response approaches. Each type holds benefits for specific applications and seeks to answer unique questions.

- Nepal represents distributed technical teams who share a common mapping language and collaborate extensively with thousands of distributed community

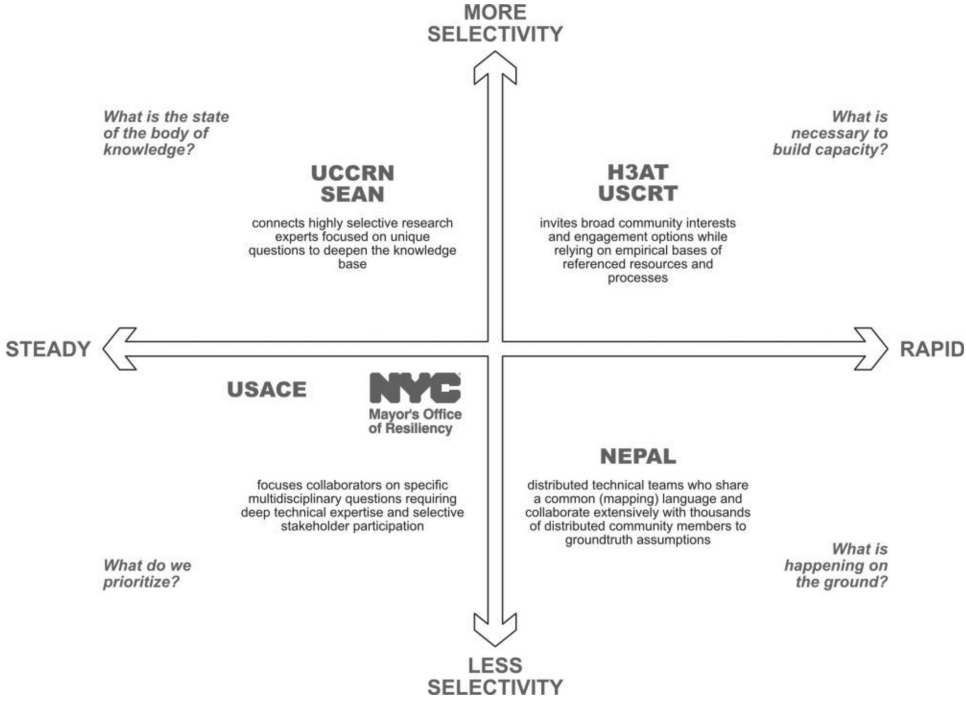

Figure 1. Rapid Research Assessment Typologies

members rapidly engaged in ground-truthing those maps. This quadrant asks, "What's happening on the ground?"

- H3ET and USCRT represent significant community involvement and access as well as widely ranging capacities. Both rely on empirical bases for their processes, a selective process for applicants, yet both readily welcome novice users. This quadrant asks, "What is necessary to build capacity?"
- USACE focuses collaborators on specific questions requiring deep technical expertise and somewhat selective stakeholder participation in a codified process. It asks the participants, "What do we prioritize?"
- UCCRN and SEAN connect highly selective research experts focused on unique questions to deepen the knowledge base. It asks, "What is the state of the body of knowledge?"

These include categories of situational response such as the work in Nepal, replicable processes such as the USACE Ecological Modeling Workshops, research–policy integrations such as SEAN and UCCRN, Open Data access to build awareness and capacity as well as to highlight regional expertise, such as the U.S. Climate Resilience Toolkit, and community science such as the Houston Harris Heat Action Team. Some rapid assessments draw on existing literature while others are more geared toward monitoring and/or response.

Each offers lessons in RRA for MOCR including the importance of delineating the timeframes of rapid assessments as these examples widely vary. The choice of what type of assessment to consider given the context that MOCR is tackling relies on understanding the value of outcomes or products that each offers. For example, the work in Nepal built upon a network of collaborators established prior to the earthquake, thus a trusted cohort who could subsequently activate their own networks when rapid mapping responses and data processing were required. The work began years prior as a prescient community member with a relevant technical background recognized a gap in knowledge of community asset locations and earthquake risks. He also recognized that this work required a multi-generational approach to big data development and monitoring and so engaged youth early on in the process. Finally, he recognized that community members needed to be actively involved in the process to build capacity (Shrestha and Pathranarakul 2018). Similarly, in Post-Harvey Houston, Baker Ripley, a well-established community organizer, rapidly assembled a relief effort under County Judge Emmitt's directive, helped in no small measure by the previously established relationships between those entities (Pugh 2018). In the RRA findings that follow, the importance of such trusted voices becomes a central criterion.

Comparatively, the USACE process, modeled out over multiple iterations, stands ready to deploy when similar ecological challenges occur. This is an example of a formalized network that has risen from rapid assessment, adapting to become a long-term standing resource. Its timeframe is quite focused in terms of actual engagement, but the process development timeframe is much longer. In the reflections on the MOCR RRA, the assembly of resources and the process by which to engage, document, and integrate warrants similar vetting.

Lastly, the U.S. Climate Resilience Toolkit's approach to accessible and apprehensible resources and data offers a way of thinking about NYC's own approach to Open Data and how the City might elaborate its resources, such as case studies and its network of experts, to broaden perspectives, encourage dialogs, and engage the private sector as well as others in the communities of New York. USCRT functions as an ongoing, adapting resource, developed over many years and continuously updated and improved with cases, experts, and climate data.

While RRA hews a little closer to SEAN through the coupling of a highly selective group of technical experts across a wide range of topical areas, it could be connected to efforts similar to Houston's, like FloodWatch, a joint program of MOCR, the Science and Resilience Institute, Sea Grant, and others, which collects community observations of flooding.

Other NYC rapid assessment networks to leverage include the Emergency Operations Center (EoC), the Post-Sandy Sea Lake and Overland Surge from Hurricanes (SLOSH) mapping and response, the Emergency Management (EM) Cascading Effects Taskforce, the buildings Safety Assessment Protocol (SAP) network, and the Code Enforcement Disaster Assistance Response (CEDAR) network on surge potential (Gibbs and Holloway 2013). In the case of CEDAR, this opens a new case in adapting existing, proven, networks that can be activated and re-tasked to accommodate data intake through standing assessment techniques. Rather than rapidly assessing damage to buildings, CEDAR was tasked to identify and assess viability of buildings to meet the criteria set forth by the Department of State in New York. The need was to catalog buildings throughout the state that could be pulled into service in response to the coming medical space surge during COVID-19 pandemic. Within a 24-h period, CEDAR, in partnership with American Institute of Architects (AIA), identified over 1,000 buildings that met the state criteria. As MOCR evaluates opportunities to integrate RRA into its ongoing work, considering the roles of these various resources offers insights.

3. RRA Process and Approach

MOCR first compiled a list of approximately four experts, having recently completed an open nominations process for the fourth NPCC assessment process. The call for nominations was disseminated widely and resulted in over 80 nominations for 20 seats on NPCC. MOCR and agency partners made sure to disseminate the call for nominations to outside experts who had previously worked on various committees, projects, and advisory panels. Using this approach allowed MOCR to draw on new expertise, but consistent with other rapid assessment efforts, use the existing relationships and networks as well. The number of qualified experts far exceeded the number of seats on the Panel, and during MOCR's review of nominations with NPCC Co-Chairs, there was strong desire to involve many of the nominees in NPCC 4, regardless of whether they were officially nominated. Because the RRA Series preceded the first full convening of NPCC 4, MOCR felt the RRA might help form relationships and align expertise while NPCC 4 was being developed. Also, because MOCR and partners were extensively involved in the review of NPCC nominations, we could be assured that we had relevant expertise for each of the four MOCR policy teams (Waterfronts, Land Use & Buildings, Social Resiliency, and Energy and Infrastructure).

From this list, a one-time, opt-in communication was sent to the group indicating that participation was entirely voluntary. The initial invitation was limited to 44. Assuming half of the people would participate, that would result in a manageable number for discussion in the online meetings (i.e., ∼20). MOCR expanded the group over time, particularly where the need for additional expertise arose. From this initial communication, a core group of 33 participants was identified with a wide range of expertise from climate science to epidemiology to built-environment to disaster recovery to forest ecology (Figure 2).

MOCR's Climate Science and Risk Communications team organized a cross-office discussion to identify topics for the RRA Series, as well as questions related specifically to the COVID crisis for each topic. Those topics included the following:

- **Social cohesion.** How has social cohesion been activated in this crisis (COVID-19) and how has this challenged/confirmed our understanding of social resiliency from other crises? Lessons learned from Hurricane Sandy response emphasized the value of social cohesion in resilience readiness and recovery.
- **Risk communication.** How can pandemic risk communication evolve dynamically to help agencies shape program messaging (e.g., guidance for implementation of AC/cooling program)? Evolving risks such as COVID-19 require a

Figure 2. RRA Expertise — Word Cloud based on Keywords Identified by Experts Who Opted into the RRA Series

different type of response from those toward a sudden, but finite, event such as Hurricane Sandy.

- **Buildings.** What operational and design strategies could be most effective over the immediate- and long-terms to mitigate COVID transmission risks within buildings? Which of these strategies would minimize energy consumption and extreme heat-related risks? How might these strategies diverge between commercial/mixed-use buildings, multi-family buildings in neighborhoods suffering from high COVID infection rates, houses of worship/cultural facilities, and schools? Building design and operational strategies were emergent even as awareness of disease transmission mechanisms grew.

These topics align closely with MOCR's Land Use & Buildings, Social Resiliency, and Climate Science and Risk Communications teams, but were conceived together with staff from all of MOCR's teams. In each case, staff from partner agencies were invited to the discussions. Although we intended to continuously poll MOCR staff for input on additional topics, the focus shifted from expanding the list of topics to integration across the first three topics (e.g., making sense of what was learned thus far) and an emergent theme related to engagement. Thus, the final two sessions were focused on the following:

- **Cross-cutting themes.** What are the common threads cutting across the discussion of social cohesion, risk communication, and design strategies?
- **Engagement.** What can we learn from research and evidence-based approaches on civic-engagement related to climate adaptation? COVID responses required

community engagement in ways that far exceeded post-Sandy recovery or ongoing resilience strategies. The situation warranted, and still warrants, everyone acting in concert toward a common goal.

The initial objective was to send framing questions at least one week prior to the discussion sessions. During that week, MOCR hoped to identify and align the most relevant experts for a given topic, with the intent to draw more heavily on a group of approximately 5–7 experts whose work most closely aligns with a given topic. The assumption was that refining the topic to fit very specialized decision contexts would not only make the knowledge developed more relevant and usable, but also make it easier for specific experts to manage their level of participation. For example, on the topic of social cohesion, while everyone would be invited to participate in the discussion, MOCR assumed primarily experts and policy staff whose work focused on social dimensions of resiliency would lead the discussions.

In addition to identifying relevant experts, we requested relevant research studies, data, information, and report with an emphasis on longstanding research, like influential studies, long-term datasets, or well-vetted case studies. Given the rapidly evolving data and information on COVID, the intent was to balance emerging evidence with well-established theory or experience. References sent by the RRA expert network were added to a Zotero, a free and open-source bibliographic resource library for future use by MOCR and other City partners.

MOCR's Climate Science and Risk Communications team synthesized collected materials and prepared a summary of key findings to focus each discussion session. The discussion sessions each had a consistent structure. After MOCR presented the key takeaways, experts identified as primary discussants responded to the key takeaways, which then prompted large group discussion of the topic. The Zoom online meeting software allowed for synchronous discussion through both audio and chat. The team recorded each session for notetaking, not for attribution of comments.

From the discussion, MOCR's Climate Science and Risk Communications team finalized summaries of each topic. Each summary needed to be brief in order to increase uptake by those with little time to review detailed reports. Each was sent first to the primary discussants for review and then to the whole research network. The team aimed to produce the summary within a week of the discussion and based them on the key takeaways discussed during the meeting. The team typically allowed for 1–2 weeks for review of the summary. Once comments and edits were incorporated, the team distributed the summary to MOCR for use in their ongoing climate resiliency efforts.

4. Findings from the RRA

The RRA identified recurring themes including Public Realm, Risk Communications, and Trust, Inequities, and Wellbeing. A summary table of the findings from each discussion session is provided in Appendix A. While these summaries drew from the discussions and research sent to MOCR before each panel, limited time and resources meant that the summaries included neither a substantial literature review nor comparative analysis. However, the combined experience and expertise of 20–30 participants per session, often totaling decades of experience and research, offered substantial insights, resources, and ways to apply knowledge. Many of the contributors were (and still are) collating and digesting data in real-time as the response to the crisis continued.

4.1. *Public realm*

Following months of lockdown, cold weather, and widespread shutdowns of businesses, public space (also referred to as "public realm") was a consistent topic. Important for many reasons, public space supports spreading actionable risk communication (e.g., storm preparedness), emergency response (e.g., cooling during heat waves), and reducing social isolation. There was considerable discussion about cataloging public spaces, especially those areas that fall outside the normative City park system (e.g., streets, empty businesses, rooftops). Participants noted that such a catalog would be useful beyond the response phase and into long-term recovery, highlighting places that could be used as roof-top gardens, extra school space, and for community development projects.

When describing cataloging of spaces or thinking through redesigns of streets, participants highlighted the need for a bottom–up inclusive approach to these conversations to support and empower resilient communities. One participant noted ongoing work by the AIA, which was working with the New York City Economic Development Corporation (EDC) and the Department of City Planning to match businesses with architecture and *pro-bono* design services to help utilize unoccupied spaces. Another initiative between Columbia University and a coalition of community-based organizations in Red Hook, a neighborhood in Brooklyn, aimed to expand on NYC's OpenStreets initiative. Participants identified a future opportunity for workshops with community groups, City agencies, and partners to examine other ways to better utilize streets, parking lots, and other underused spaces in a pedestrian-heavy city. These discussions fell against the backdrop of NYC's OpenStreets initiative (reduced vehicular use and increased outdoor dining). However, these practices, not necessarily best practices, warrant further research on community engagement in re-imagining public

spaces to help improve social resiliency. To that end, the City recently invited community members to propose streets for consideration in OpenStreets. Business owners described the value of the program to sustaining their livelihoods during COVID-19. Scoping the future of the program, the City must consider multiple forms of knowledge and perspective, in this case the scientific knowledge from the RRA Series on the value of the open space substantiates the practical knowledge of business owners.

Participants highlighted emerging research on COVID and public space. Data on the use of parks and open space in NYC suggests there is a large gap between perceived and actual access to parks (Mustafa *et al.* in review). Concerns of people not adhering to social distancing guidelines and wearing masks prevent many from having safe and easy access to parks and open outdoor spaces. In the highlighted study, New Yorkers who responded to a survey had both variable access to parks measured by spatial distance as well as high variation in perception of parks and open space as safe and easy to access. This sort of data, revealing inequities and warranting more equitable responses, plays a vital role in shaping recommendations for use of these spaces and potentially future policies.

Emerging guidance for reopening buildings from organizations like the AIA, ASHRAE, and the World Health Organization (WHO), seemed most relevant. While challenging to synthesize multiple sets of guidelines related to buildings, the discussion provided a helpful contrast especially considering the need to adapt strategies as evidence of more and less successful strategies emerged.

Finally, the connection between climate and COVID became more explicit around unintended and cascading consequences of seemingly simple measures like remote work and additional stress on the energy grid. This finding also indirectly highlighted the intersection of pandemic response and long-term adaptation.

4.2. *Risk communications*

Various sessions reinforced the importance of a multi-layered approach to risk communication and civic engagement. In between extreme weather events, the response to climate change unfolds much more slowly than the pandemic response, so the focus on risk communication provided experiential learning for MOCR and city staff regarding conventional and state-of-the-art knowledge.

Extensive research suggests that the most effective risk communication strategies are actionable, memorable, sustained, and periodically reviewed. Messages with clear action points for what to do before, during, and after an event make it easier for people to grapple with complex phenomena (CRED 2009; Mileti and Sorensen 1990). For example, during the pandemic, widespread messages on the

importance of wearing masks and washing hands helped limit transmission while also giving people a greater sense of control over their exposure.

Actionable messaging is not always short messaging; people need enough information to support decision-making (Mileti and Sorensen 1990). Discussants noted that people will seek more information and weigh personal factors so it is crucial to provide sufficient, accurate detail to help people to become knowledgeable about, and to prepare for, potential hazards and risks (CRED 2009; Mileti and Sorensen 1990). Using visuals and graphics that clearly illustrate the action points, e.g., photos of people wearing masks, improves mental models of preparedness behaviors, which increases the chances of people acting to reduce their exposure to risks. Actionable messaging has multiplying effects as it encourages the public to talk with their networks about what they are doing, thus reaching people the initial message may not have. In this regard, focusing on actionable and sustained risk communication can also promote individual response, a necessary complement to the citywide response by MOCR and other agencies.

While there are fact sheets and information products related to flooding, much more needs to be done to create actionable messages related to the many different facets of climate resilience and adaptation, particularly those actions and behaviors not triggered by an immediate emergency or related to an individual hazard.

The RRA findings validated the role of trusted local voices and familiar shared spaces, key actors in the process of risk communication, as a necessary complement to outreach and dissemination. Local organizations, schools, and faith-based programs have established communication pathways that often reach further into communities. These organizations are often well respected by their constituencies, and their words carry weight. RRA noted the potential of having informal science educators, such as hairdressers, who could be trained in science information and then talk to their customers about key issues (Rickard 2011). Strengthening partnerships with these groups and learning from them about what works is essential to reach all corners of society. Those organizations that bridge systems, those keystone species critical in this regard (Nardi and O'Day 1999), are a reminder that communication strategies should not solely rely on a website or a particular group.

While it would be easy to revert to intuition when communicating risk, the RRA helped introduce evidence-based and behavioral approaches to risk communication. As MOCR creates an embedded capacity for risk communication on climate change, the RRA findings and the broader literature referenced will continue to be mined by MOCR staff.

4.3. *Trust, inequities, and wellbeing*

The Series, especially the first and last two sessions, highlighted trust as an essential factor in resilient recovery. Discussants highlighted that people tend to lean on their communities, families, and loved ones in times of crisis. COVID-19 disrupted NYC's social fabric and social cohesion, by preventing people from seeing and caring for each other as they once did. Furthermore, lockdown restrictions limited people from going to their local trusted organizations which in turn possibly prevented information sharing. Discussants frequently spoke of the importance of boundary organizations and trusted community leaders to strengthen future risk communication and engagement processes.

The RRA findings reinforced the need to understand chronic weaknesses, such as spatial inequities or socially isolated groups, and direct preventative and curative approaches as part of the pandemic response. The pandemic amplifies such "gray rhinos," or highly probable/high-impact but frequently neglected threats. These introduce teachable moments through careful observation of how embedded chronic stresses exacerbate the consequences of COVID-19 (Wucker 2016). While it did not directly translate to specific actions or policies, the finding of mental health and trust-building reaffirmed a crucial missing element to MOCR's current resiliency efforts — most of which have focused on epidemiological shocks and stresses or a direct physical threat such as floodwaters.

The importance of social ties and social and community resiliency stood out. There was a shared sense that neither the City nor the expert community understood the full magnitude of COVID-19's health impact. Based on Google's COVID-19 Search Term Data, searches related to "depression" peaked in New York City in early July and remained high until late August or early September. The sessions highlighted a largely explored dimension of MOCR's resiliency efforts — the connection to mental health.

5. Lessons Learned

The RRA Series provided a unique and urgent opportunity to consider climate resiliency as part of pandemic recovery. It was both ambitious and practical in nature. It was ambitious in the sense that MOCR would be able to produce authoritative, actionable information even as the nature of pandemic response and recovery fluctuated during the limited three-month window. It was practical in the sense that knowledge and information sharing do not always have to be actionable to provide immediate value. Simply seeking ways to improve science–policy interactions and the modes of co-production is another tool in the toolkit (e.g., very deliberate, long-term projects versus rapidly seeking expert advice

in an emergency). Here, we critically reflect on the process and the impact of the process.

5.1. *Improvements to the process*

To better understand how discussants perceived the process, MOCR developed a brief survey instrument to collect feedback. All 44 invited discussants were asked to participate in the survey to gain perspectives on each session, on motivation to participate, and on possible improvements. Responses were received from 27 participants. Of those, 24 participated in at least one RRA.

The RRA Series had higher attendance in the first session on Social Cohesion and experienced drop-off in the following three sessions on Risk Communications, Resilient Buildings, and Cross-cutting Themes. The final session on Engagement had the third highest attendance. Given that the RRA Series occurred over the summer, the drop-off in attendance might well be attributed to lack of availability, as identified by one participant, but it clearly also related to the relevance of the topics to people's work. When asked about the relevance of the session topics to discussants' work on COVID-19, Risk Communications and Engagement consistently outranked other sessions which is in keeping with the key takeaways from the summaries wherein community networks, trusted voices, and familiar environments were important contributors. Considered relevant by most respondents, a significant 20 percent ranked the Buildings session as "not so relevant" to work on Climate Resiliency.

Several respondents noted that attendance might have increased with better timing and more detailed advanced agendas. Time limitations were inherent to the process. Broadly casting for feedback while having little time together meant that discussions were necessarily foreshortened. Without a deeper parallel asynchronous process for ongoing improvements to the resources, the coverage on any one topic was delimited. Experts used the time available and their standing knowledge bases to provide the best resources and feedback possible, acknowledging where there was more work to do. However, this was the nature of the activity: to seek good feedback and to catalyze action with a level of immediacy that is perhaps atypical for some, a daily need for others. While there are many improvements to be made, feedback points to at least two important process adjustments: refinement of topics and curation and expansion of an expert network.

First, refinement of topics to ensure greater "fit" (Lemos *et al.* 2012) would help increase the relevance of the sessions. With greater involvement of City staff, MOCR and its agency partners can refine topics more closely to specific actions, decisions, or outcomes. As noted above, the RRA sessions coincided with a

feverish effort to deploy 74,000 air conditioners to low-income seniors, requiring substantial commitment of all staff at MOCR and the Mayor's Office of Sustainability (a sister organization). It also took longer to refine questions and identify topics than anticipated, which then meant the team got topics to the discussants later than hoped. That translated to less time to align the right researchers and create summaries. Even then, however, positive outcomes may not always be tied to tangible or tactical actions (see Section 5.2). Whereas emergency response and regular operational decision-making in some city agencies require continual action, the RRA is explicitly designed to rethink or infuse new thinking into the way MOCR makes decisions. Improving the process in this way would require both more time between discussions sessions and/or making clear which participants are central to which discussion.

Second, MOCR could work with the RRA participants to curate and expand an expert network, thereby further combating any selectivity bias and reducing transactional costs. For example, some participants in the RRA were heavily involved in the COVID response framework of NYC Emergency Management (NYCEM), meaning that they were engaged by NYC multiple times for the same crisis response. Additionally, both experts and practitioners crossed more disciplinary and subject matter boundaries than originally anticipated. Policy staff whose primary focus may be buildings, for example, wanted to participate in discussions of social cohesion, and experts outside of the social sciences were eager to share experiences in civic engagement. While great for harnessing experiential knowledge, this dynamic created a challenge for grounding in formal knowledge. MOCR intends to build a relational database of experts using the keywords originally submitted by the participants, which would help broker knowledge more efficiently — e.g., matching city staff with multiple experts to address emerging questions. While the spirit of the RRA would remain inclusive and transparent, MOCR might also reduce transactional costs by making clear when a discussion aligns with a particular expert's interest and qualifications.

5.2. *Impact and outcomes of the RRA*

Some outcomes may be hard to evaluate at this stage. Information related to climate resiliency can be useful to help clarify thinking, justify action or non-action, and/or rapidly re-evaluate a given practice (Wall *et al.* 2017; VanderMolen *et al.* 2020). Impact and outcomes of a given process can be broader than using a specific piece of information in a decision. While the overarching goal was to produce "actionable" information, that term seems too narrow, in retrospect, to evaluate processes like the RRA. While there was an expressed desire on the part

of RRA participants to provide instrumental value (direct input to a specific action), the RRA Series provided conceptual clarity and justification for the resiliency work in progress.

Emphasizing and enumerating the importance of public space is directly relevant to NYC's OpenStreets program, which is hailed as a successful element of the pandemic response. There is a history of different proposals to more effectively utilize street space in NYC for multiple benefits (e.g., expanded bike transport, open space, and green infrastructure). Reaffirming the value of open space as a passive cooling strategy during a heat wave and expanding the perceived value to include strengthening of social ties can be valuable for making the case to continue an existing program (or decision). Additionally, with renewed interest in public space, experts in the RRA may be inspired to develop and share additional scientific evidence to bolster support for programs like OpenStreets. As noted there is an immediate need to develop and host workshops on OpenStreets, particularly timely as the City enters its next spring/summer season with COVID-19 active.

Similarly, the findings from the Risk Communications session were used in refining strategies for the City's Comprehensive Waterfront Plan, which the Department of City Planning is required to update every 10 years. MOCR's Climate Science and Risk Communications team used the summary from the RRA Series to ensure the framing and strategies associated with risk awareness and action were more inclusive of communities as actors in both defining and responding to risks. While substantial progress has been made on this front via MOCR and other city partners through programs like FloodWatch, much of the focus on risk communication is still dedicated to online dissemination of information and information tools.

Building on this point, MOCR is using the RRA Series as a pilot to scope new assessment products that can be co-produced between and among scientists, decision-makers and community-based organizations. Drawing on the process improvements above, MOCR will be initiating a series of co-produced issue briefs in 2021. The intent is to use the process of developing information products a part of knowledge and information sharing, while also tailoring climate communications to specific audiences. These products will be produced in collaboration with NPCC and governmental and non-governmental partners making the process of risk assessment and response more inclusive, ongoing, and dynamic.

The RRA Series will also be useful for NPCC, which has been a crucial element of NYC's climate response. NPCC assessments help the City anticipate capital investments with longer design life cycles and fewer maintenance costs, while also mitigating risks for climate and environmental justice communities. Given so many new panel members, the RRA Series helped form relationships with new members

and with outside experts whom the Co-Chairs and MOCR wanted to involve in the fourth NPCC assessment process. Aside from relationship-building, the RRA Series complements the open nominations process as a means of recognizing non-Panel expertise.

RRA participants directly cited the value of information exchange. New threads of inquiry emerged underpinning a lasting effect of the interactions of the RRA. Respondents were primarily motivated to participate to learn from others and apply lessons to ongoing work. Their exposure to others' work, its application to their own, and the broadening of their professional and research networks were cited as consistent motivations.

Consideration of the RRA and team formation process as "seeding" the growth of expertise could build capacity for improved future efforts. As part of this reflection, are there ways to expand the RRA via snowball sampling, which could address the selectivity bias inherent in stressful times? Could a more open and inclusive framework, including public participation in some form, lead to a more inclusive process? Could it also involve adaptive and emerging networks that support sustainability and resilience in the City? As mentioned above, a directory in the form of a relational database might help City practitioners identify groups of scholars for specific issues not taken up in the central process, further guarding against selectivity bias. Some standards or qualifications will be necessary to ensure the credibility of participants. How might these questions be integrated in future RRA work?

Lastly, this NYC RRA effort would benefit from seeking out other cities that developed similar approaches to the RRA. The networks described herein and those developed and emerging elsewhere in this country and others stand to improve through the process of sharing collective experiences and the opportunities to improve. As we face increasing likelihoods of future pandemics, and turn more toward broader definitions of resilience, leveraging processes and outcomes, and strengthening intercity cohorts to bolster preparedness and responsiveness, is an obvious need.

6. Concluding Thoughts

As of writing this commentary, NYC continues to face the prospect of cascading and compound risks from weather, climate, and COVID. Spring is coming, and now MOCR must prepare for the prospect of Nor'easters, which have historically dealt power outages and floods among other impacts. Coinciding with these potential risks, as of March 2021, we are only now seeing indications that the second wave of COVID-19 cases is dropping.

At the outset of the RRA, MOCR postulated that the process could result in a stronger internal knowledge base, more accurate or actionable risk communication, and adaptive resiliency solutions. Despite a rapidly evolving response effort, the Series did offer lessons learnt for co-producing knowledge in a crisis: (a) How to glean information, data, and perspective from diverse experts; (b) how much weight to assign to specific pieces of research, data, and information; and (c) how to continuously refine MOCR's knowledge base, based on those interactions? Essentially, the RRA Series offered an alternative way to develop, review, and/or test knowledge.

It has also been helpful to illustrate the importance of continual attention to effective science–policy interactions, and it has highlighted ways to align institutional settings and motivations from both sides of the science–policy boundary. While not always immediately actionable. the RRA Series continues to be a valuable resource. Sustained assessment and co-production of knowledge ultimately require trust-building and iterative engagement that often takes longer than City staff have during an unfolding pandemic. In many cases, MOCR personnel and other City staff in agencies heavily involved in both climate and the COVID-19 response have built trusted relationships with experts. Though it must be stated here that there can be too much trust between experts and government personnel, resulting in blind faith and cognitive lock-in (Lacey *et al.* 2018). The format of the RRA Series offers a complement to more sustained efforts like NPCC. During the pandemic, it is even more important to bolster science–policy interactions and avoid these potentially negative outcomes.

In times of heightened stress, brought about by increased complexity and uncertainty, structural frameworks provide procedural roadmaps to improve and cohere thinking. These rough guides channel attention while bridging technical expertise and deeply local knowledge. The RRA represented such a framework. Through guided discussions on policy-team-relevant topics, the RRA coalesced a trusted team of experts, connecting one to the other and to the key issues that MOCR sought to address. While imperfect, the RRA already contributes to City planning as well as COVID-19 response. Over the coming years as the NPCC develops its next iteration and as the City institutes more resilience guidance, the RRA network will continue to deepen, continue to co-produce actionable climate knowledge, and continue to value organizational sensemaking as a usable climate service, particularly in highly uncertain times.

Appendix A. Findings of the New York City RRA Series

RRA Session Central Topic and/or Question	Findings	Further Questions
Social Cohesion	• Strengthening cohesion has multiplying effects to mitigate direct and indirect impacts. • Community cohesion methods, communications, and metrics require baselines. • Public space roles warrant greater evaluation in terms of cohesion opportunities and communications.	• How do social distancing policies compounded with other factors (e.g., rent burdens, evictions) impact social cohesion? • What role can public spaces serve? How are their historical roles different in light of the COVID-19 pandemic and recent racial inequality/police brutality protests? Where there is no service, what gaps might be improved? • What established networks or communication pathways exist (before COVID-19) that could be utilized to spread information and receive feedback on City efforts? • How might MOCR and its partners best support CDCs/CBOs to promote social cohesion and resiliency?
Risk Communication	• Focus on actionable and sustained risk communication to promote public engagement. • Engage various actors to disseminate information. • Periodically evaluate strategies and establish a means to receive feedback from the public. • Consider how to leverage the public realm as part of this effort.	• To what extent are curricular integrations possible? How can different generations play a role, e.g., senior storytellers as advisors, youth's inter-community connections? • What products or clear messages ("Drop, Cover, Hold On") could be disseminated to trusted partners of key nodes in networks? How might these networks be activated when needed?
The Built Environment	• Reference step-by-step guides that outline specific design and operational strategies (including reopening) from organizations such as ASHRAE, CDC, AIA, and WHO. • Reinforce recommended behaviors through concrete actions, which in turn increases adoption and makes implementation smoother. • Commonly noted operational strategies to prevent the spread of COVID-19 are (1) deploying touch-free devices, (2) encouraging frequent handwashing and widespread mask-wearing, (3) decreasing social density, (4) reconfiguring building spaces, and (5) expanding the use of the	• How are old responses to previous pandemics, for example, the 1920s influenza, informative for this context? • How can NYC envision the future of streets? For example, how might the City re-purpose car "spaces" for bikes and pedestrians?

(Continued)

	public realm. For the latter, a catalog of potential public realm resources would help. • Center vulnerable neighborhoods in these discussions, especially those who are low-income, energy insecure, or disproportionately shouldering environmental harms.	
Cross-cutting Themes	• Lacking data on social isolation caused by the pandemic or the long-term mental health effects of COVID and COVID recovery, recognizes that most forms of isolation exacerbate pre-existing mental health conditions. • City-owned public space and temporary leased space is underutilized for cooling, congregating, and evacuating, all of which are critical to social and environmental resilience. • It is especially important to engage people in low-income communities of color in all phases of pandemic response and recovery. • Studies of social and economic impacts are still sparse but suggest underestimation of the consequences to businesses and individuals.	N/A
Engagement	• Working with leaders, organizations, and initiatives already in a community helps build trust and increase participation. • Using familiar convening spaces is also important to build trust. • Boundary spanning organizations and individuals can promote shared accountability and bi-directional information flows, further building trust. • For communities to be empowered for engagement in climate resilience planning and accountability for plan implementation, efforts are needed to make data both more meaningful and accessible to communities, journalists, and stakeholders.	N/A

References

Allen, KL (2020). Social cohesion and public health. *Resilience*, June 2, 2020. https://www.resilience.org/stories/2020-06-02/social-cohesion-and-public-health/[].

Barthol, RP and Ku ND (1959). Regression under stress to first learned behavior, *Journal of Abnormal and Social Psychology*, 59: 134–136.

Center for Research on Environmental Decisions (CRED) (2009). The psychology of climate change communication: A guide for scientists, journalists, educators, political aides, and the interested public. http://guide.cred.columbia.edu/pdfs/CREDguide_full-res.pdf [].

Cvitanovic, C, Howden M, Colvin C, Norströmd A, Meadow A and Addison PFE (2019). Maximising the benefits of participatory climate adaptation research by understanding and managing the associated challenges and risks. *Environmental Science & Policy.*

Gibbs, LI and Holloway, CF (2013). Hurricane Sandy after action: Report and recommendations to Mayor Michael R. Bloomberg. May 2013. https://www1.nyc.gov/assets/housingrecovery/downloads/pdf/2017/sandy_aar_5-2-13.pdf [].

Herman, BD, McKay SK, Altman S, Richards NS, Reif M, Piercy CD and Swannack TM (2019). Unpacking the black box: Demystifying ecological models through interactive workshops and hands-on learning. *Frontiers in Environmental Science*, 7: 122. doi: 10.3389/fenvs.2019.00122.

Lacey, J, Howden, M, Cvitanovic, C *et al.* (2018). Understanding and managing trust at the climate science-policy interface. *Nature Climate Change*, 8: 22–28, https://doi.org/10.1038/s41558-017-0010-z.

Lemos, M, Kirchhoff, C and Ramprasad, V (2012). Narrowing the climate information usability gap. *Nature Climate Change* 2, 789–794, https://doi.org/10.1038/nclimate1614.

Lemos, MC *et al.* (2018). To co-produce or not to co-produce. *Nature Sustainability*, 1: 722–724.

Lemos, M and Morehouse B (2005). The co-production of science and policy in integrated climate assessments. *Global Environmental Change*, 15: 57–68.

Mileti, DS and Sorensen, JH (1990). Communication of emergency public warnings: A social science perspective and state-of-the-art assessment. Technical Report No. ORNL-6609 ON: DE91004981, Oak Ridge National Lab. doi:10.2172/6137387.

Mulder, F, Ferguson J, Groenewegen P, Boersma K and Wolbers J (2016). Questioning Big Data: Crowdsourcing crisis data towards an inclusive humanitarian response. *Big Data & Society*, 2016: 1–13. doi: 10.1177/2053951716662054.

Mustafa, A, Kennedy C and McPhearson T (in review). A social media and spatial analysis of perceived and geographic access to urban green spaces in NYC during COVID-19. *Landscape and Urban Planning*.

Nardi, BA and O'Day VL (1999). *Information Ecologies: Using Technology with Heart*. Cambridge, MA: The MIT Press.

Rickard, LN (2011). In backyards, on front lawns: Examining informal risk communication and communicators. *Public Understanding of Science*, 20(5): 642–657.

Shrestha, B and Pathranarakul P (2018). Nepal government's emergency response to the 2015 earthquake: A case study. *Social Sciences*, 7: 127.

Stantec (2019). Summary report: Houston resiliency innovation workshop. Houston 2020 Visions Initiative, June 21. https://www.stantec.com/en/ideas/spotlight/2019/houston-of-the-future/summary-report-houston-resiliency-innovation-workshop [].

VanderMolen, K, Meadow A, Horangic A and Wall T (2020). Typologizing stakeholder information use to better understand the impacts of collaborative climate science. *Environmental Management*, 65: 178–189. doi: 10.1007/s00267-019-01237-9.

Wall, TU, Meadow AM and Horganic A (2017). Developing evaluation indicators to improve the process of coproducing usable climate science. *Weather, Climate, and Society*, 9(1): 95–107. https://journals.ametsoc.org/view/journals/wcas/9/1/wcas-d-16-0008_1.xml [March 22, 2021].

Weick, KE (1995). *Sensemaking in Organizations*. Thousand Oaks: SAGE Publications.

World Bank (2016). *Understanding Risk: Building Evidence for Action: Proceedings from the 2016 UR Forum*. Washington, DC: IBRD/World Bank. https://understandrisk.org/wp-content/uploads/UR-venice-proceedings.pdf and https://understandrisk.org/event-session/bridging-the-divide/ [].

Wucker, M (2016). *The Gray Rhino: How to Recognize and Act on the Obvious Dangers We Ignore*. New York, NY: St. Martin's Press.