

STATE OF CLIMATE KNOWLEDGE 2021

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Climate change is here now and structural inequalities cause some people to be impacted more than others. Scientists and researchers want to support governmental and non-governmental organizations in the fight against climate change. In order for the scientific community to be credible, actionable, and accountable, there has to be a sustained process to understand what we know, don't know, and need to know about climate change and its impacts in New York City (NYC). In 2020, the Mayor's Office of Resiliency (MOR) initiated an engagement process, called the Climate Knowledge Exchange, to align research with climate resiliency and adaptation needs. This report, the State of Climate Knowledge 2021, is the first in an annual series that will maintain a public agenda for climate research in NYC.

This report communicates NYC's research needs to external partners, including academic scientists, federal researchers, philanthropic foundations, and community organizations. This in turn will catalyze new and creative partnerships to develop credible and actionable research products that address NYC's most pressing climate challenges. NYC is fortunate to have an internationally recognized model for climate assessment in the New York City Panel on Climate Change (NPCC), an independent panel of climate experts appointed by the Mayor. Since the NPCC's formation in 2008, they have developed highly accurate and detailed climate projections specific to the NYC region and have issued three Assessment Reports. NPCC3, their most recent assessment, was released in March 2019. MOR will also work directly with NPCC to address the priority issues identified in the State of Climate Knowledge reports.

The report was developed through a collaborative engagement process that included over 170 people from 21 City agencies and 27 non-governmental organizations from each of the five boroughs. Participants came from a wide range of backgrounds including conservation of nature, parks and recreation, environmental management, environmental justice, construction and housing, urban planning, health, disaster management, transportation, and law. To find recurrent themes, we analyzed notes from group discussions, survey responses, and over 30 different climate plans, reports, and studies developed by governmental and non-governmental organizations.

With a cross-cutting focus on equity and climate justice, the report identifies four key areas where additional research is most needed:

- How climate hazards will impact the daily lives of New Yorkers and which neighborhoods and demographics are most vulnerable;
- How to build using green and resilient design practices to lower carbon, reduce vulnerability, and improve the health of New Yorkers;
- How decision-making frameworks and cost-benefit analyses can better include equity, social factors, and non-monetary considerations; and
- How different climate communications increase perception and awareness of climate risk leading to individual and collective action.

In addition to identifying areas of greatest need for scientific inquiry, the 2021 State of Climate Knowledge also makes recommendations for strengthening future engagement related to climate science and risk communications. These recommendations include partnering with governmental and non-governmental organizations to host future workshops, fundraising to support partnerships between community organizations, scientists, and City agencies, incorporating educational materials and lived experiences in the engagement, and creating evaluation indicators to refine the program over time.

Adapting NYC to the impacts of global warming will involve the public sector, the private sector, the research community, civil society, and—ultimately—all New Yorkers. By creating a process for learning together, we can improve upon the past, bouncing forward and not back. As opposed to a plan or a study, this report – the State of Climate Knowledge 2021 – is a living climate research agenda. Building public participation in future versions of this agenda will help MOR broker innovation to address the climate crisis. A publicly-driven climate research agenda is not just what NYC needs; it is the climate research that NYC deserves.

STATE OF CLIMATE KNOWLEDGE REPORT

Motivation

New York City is already experiencing the impacts of climate change. Higher seas and heavier rains are causing some neighborhoods to flood as many as 25 times per year, while the warming atmosphere is causing more frequent and severe heat waves. We also know that structural inequalities cause some people to experience these impacts more often or more severely than others.

Scientists and researchers play a vital role in supporting governmental and non-governmental organizations in the fight against climate change and inequality. To effectively do that, they must understand what we know, do not know, and need to know about climate change and how it impacts New York City (NYC). In 2020, the Mayor's Office of Resiliency (MOR) initiated an engagement process, called the Climate Knowledge Exchange, to align research with climate resiliency and adaptation efforts. This report, the State of Climate Knowledge 2021, is the first in an annual series that forms a public agenda for climate research in NYC.

For many communities, issues like employment, affordable housing, and education are longstanding concerns which will be further impacted by climate change. Many communities call for a shift in focus from climate research to more climate action, and for further research to be directly responsive to community priorities. The challenge is that climate change alters the context for policy and action in ways that are not always widely known or understood. Consequently, new research questions arise, where scientific data and information is needed to: understand the problem; refine response options; and/or make clear the tradeoffs associated with various courses of action. For example, where a previous policy context may have focused on how to create jobs for everyone, climate change may raise new questions about how to ensure people can reliably commute to jobs if roads and subway tunnels are flooded more frequently.

The State of Climate Knowledge 2021 is the first milestone in a process to understand which issues related to climate resiliency require new science and research. Over the past decade of responding to climate change, community organizations, government agencies, and scientists in NYC have amassed a wealth of climate knowledge, applying scientific and local information and learning from experience. This report is based on those experiences. In many cases, the process of engagement that led to this report created opportunities to share information and strengthen social ties valuable for coordinating future response.

By revisiting this report annually, MOR intends to create responsive linkages between scientists, policy makers, and communities.

As opposed to supporting 'another study,' MOR will use the annual State of Climate Knowledge reports to raise funding for new research and assessment that results in credible, actionable, and accountable information. NYC is fortunate to have an internationally recognized model for climate assessment in the New York City Panel on Climate Change (NPCC)¹, and MOR will also work directly with NPCC to align its assessment efforts to the priority issues identified in the State of Climate Knowledge reports. Together, NYC and its partners can learn from and improve upon climate resiliency efforts.

Approach

The Climate Knowledge Exchange involves four key components that occur sequentially: 1) group discussion, 2) surveys, 3) focus area identification and refinement, and 4) reporting. By prioritizing personal interactions, the process helps build relationships that can be sustained in future phases. Face-to-face conversations also add elements of humanity and empathy when discussing daunting topics like climate change and, relatedly, racial and economic inequality. People are all coming from varying levels of background knowledge with climate change and can learn a lot from their peers. Another approach would be a representative sample, which aims to gather input from individuals that demographically represent NYC residents. We relied on group discussion to garner a deeper understanding of issues among important stakeholder groups across the city. This section provides an overview of the research design as well as the strengths and limitations. A more detailed summary of the methodology is included in Appendix 1.

¹ NPCC is a 20-member independent advisory body that synthesizes scientific information on climate change and advises City policymakers on local resiliency and adaptation strategies. NPCC was established in 2008 and was codified in Local Law 42 of 2012 with a mandate to provide an authoritative and actionable source of scientific information on future climate change and its potential impacts.

How well do these priorities reflect NYC?

The Climate Knowledge Exchange is designed to be participatory, data-driven, accountable and inclusive (Figure 1). The process should be participatory to allow for two-way exchange of information and knowledge; data-driven to focus on what we are hearing - not what we want to hear; accountable to ensure people see how we are responding to their concerns; and inclusive to empower people to respond to climate change. Given that we aspire to these principles, one question posed to our project team was – do these priorities reflect enough of NYC?

Scientists might frame this question in terms of sample size. Overall, the number of participants in the Climate Knowledge Exchange is low relative to the number of people in neighborhoods most vulnerable to climate hazards. However, participants do come from a wide range of stakeholder groups as seen in Figure 2. One third of non-governmental participants were from communities that are particularly vulnerable to climate-related hazards, as identified in previous work examining social vulnerability and climate risk factors.

As part of influential assessments like the National Climate Assessment, scientists developed frameworks for evaluating the strength of evidence in any one trend, pattern, or finding. The highest level of confidence can be attributed to findings where multiple sources of data and information converge. Because our sample size is small in this first pilot year, we looked to multiple sources: the notes from our group discussions, survey responses, and research developed by governmental and non-governmental sources. We saw a lot of convergence.

How confident are we in our findings? We feel confident that these concerns constitute a good starting point. While it is imperative to communicate how confident we are in our findings, this issue can easily distract us from a critical component of equity.

In formulating a research agenda, the point of the process is not to contest people’s concerns or perspectives. Instead, our challenge is to creatively translate those concerns into knowledge gaps that lead to innovation. We followed a structured process to reduce bias, and we followed a human process to facilitate open discussion for people to share their concerns and perspectives. Those practices help achieve both procedural and contextual equity (i.e. a fair and open process), not just distributive. The result is a living agenda that can lead to credible, actionable, and accountable innovation (see Improving the Climate Knowledge Exchange Process below).

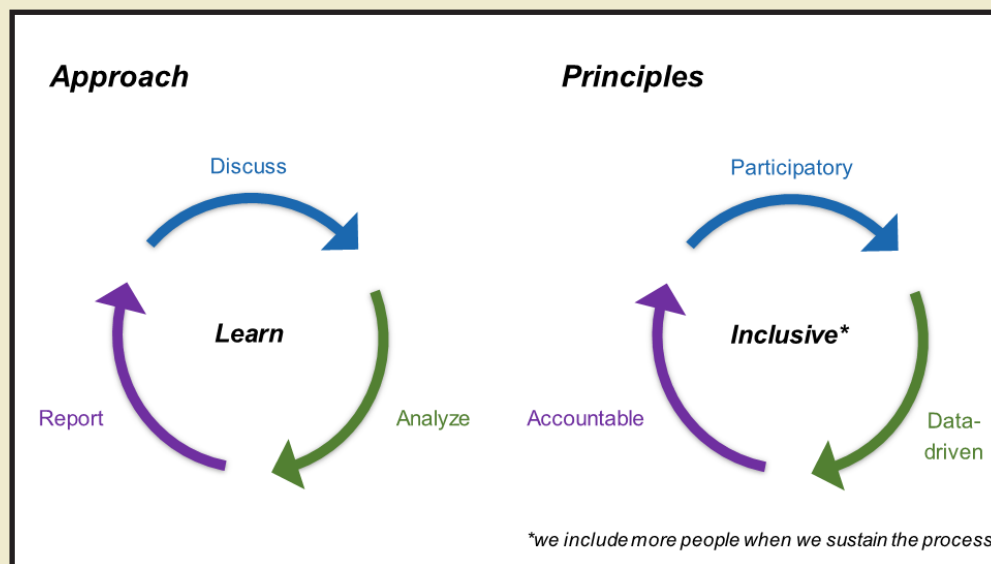


Figure 1. Process and principles

Overview of Research Design

The Climate Knowledge Exchange begins with discussion groups that help orient participants to climate risks, resiliency, and adaptation. These discussion groups were a forum for sharing information on the background of the initiative as well as a 20-minute introduction to NYC’s main climate risks as identified in NPCC reports. This introduction to core climate concepts covered coastal flooding, heat, and precipitation and served as a starting point for the open discussion that followed. The open discussion was organized in three main areas: 1) where we could improve our understanding of climate risks and resiliency, 2) where scientific information could help people cope with the impacts they already experience, and 3) where scientific information could help support actions to anticipate and minimize impacts in the future. We used a combination of open-ended questions, group ranking exercises, and polling on predefined statements to determine each group’s level of agreement.

From July 2020 to March 2021, we held 26 group discussions with over 170 participants. Collectively, we received feedback from 21 different City agencies and 27 non-governmental organizations, representing communities in each of the five boroughs. Among the City agencies and non-governmental organizations, participants came from a wide range of ages (including youth) and backgrounds including nature conservation, parks and recreation, environmental management, construction and housing, urban planning, health, disaster management, transportation, and law (Figure 2). Representatives from the transportation, energy, and telecommunications sectors provided key information related to data requirements and coordination activities that will be used to inform a more extensive assessment in next year’s Climate Knowledge Exchange.

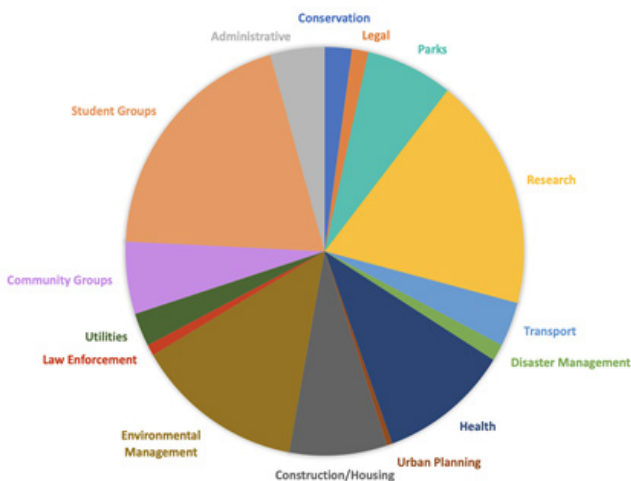


Figure 2. Sectors and Stakeholders Represented in the Climate Knowledge Exchange

Following the group discussion, a survey was distributed to individual participants (Appendix 1). The 40-question survey developed for City agency staff was based on questions from the ‘Climate Needs Assessment for New York State’² in an effort to coordinate between city and state climate assessments. Questions for City agency staff addressed how research is used to deepen our understanding across all aspects of resiliency and adaptation decision-making including scientific analysis, program or policy implementation, evaluation, and as-needed redesign. Questions for participants from non-governmental organizations and communities solicited more in-depth responses related to experiences coping with or preparing for climate risks and hazards, equitable access to and use of climate change information and engagement strategies, and climate related research priorities. Overall, the response rate was 25% for City agency staff and 35% for non-governmental participants. While these response rates could be considered low, the results were not meant to be representative of all NYC, nor even of those who participated in the group discussions, but rather, they provided additional insight into how individuals were weighing various considerations.

In addition to the data collected during workshops and from the surveys, a document analysis of reports from a range of stakeholders – including community-based organizations, City agencies, and researchers – was conducted (Appendix 2). The comprehensiveness of these reports provided access to greater depth and breadth of data than was possible to obtain in the discussion group format. A total of 34 governmental and non-governmental documents related to climate change adaptation were selected based on the following criteria: 1) specificity to NYC, 2) inclusion of climate change adaptation strategies, and 3) representativeness of stakeholder concerns and priorities, particularly those not well represented in the discussion groups.

To identify the focus areas for NYC’s climate research agenda, the discussion group notes, open-ended polling questions, survey responses, and documents were categorized, also referred to as coded, to specific climate adaptation themes. Team members collaboratively identified key themes that emerged from the data and grouped them according to the following categories: 1) scientific research on climate hazards and risks, 2) communication and engagement, 3) governance and institutions, 4) municipal services, and 5) the built environment and land use (Figure 3). Each of these categories included subcategories that were used in combination with a list of cross-cutting themes (See Appendix 1 for detailed methodology). All responses could be grouped into more than one theme.

² New York State Energy Research and Development Authority (NYSERDA). 2020. “Climate Needs Assessment for New York State,” NYSERDA Report Number 20-31. Prepared by A. LoPresti, R. Horton, and D. Bader, Columbia University, New York, NY. nyserdera.ny.gov/publications.

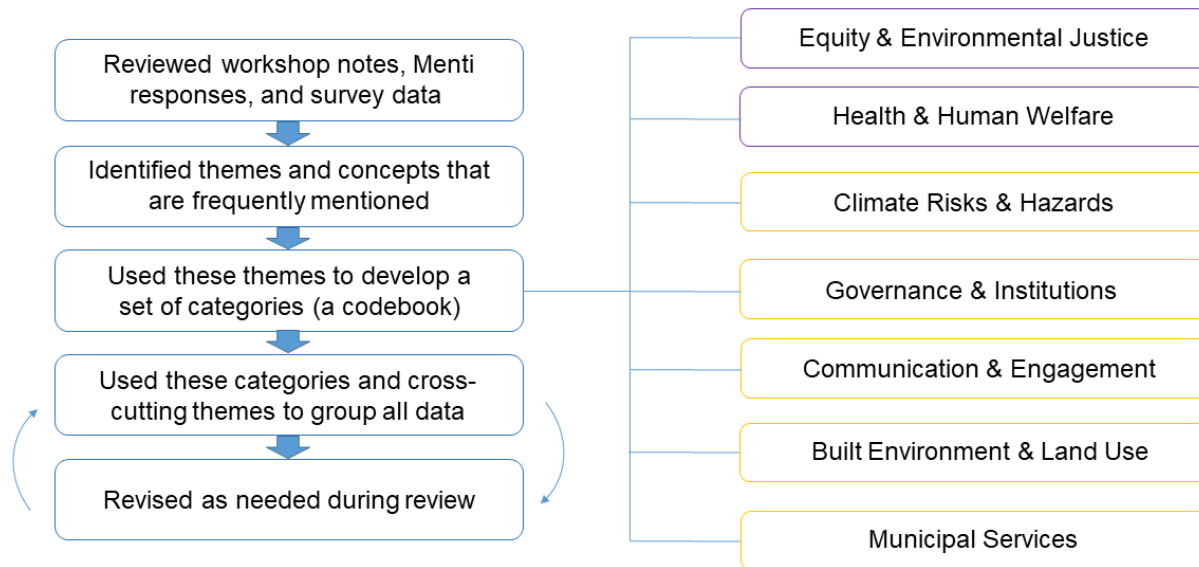


Figure 3. Main Categories (Or Codes)

Equity was one of the most frequently mentioned issues across all themes and was specifically evaluated in relation to differences in vulnerability to climate risks and hazards, access to risk communication information, inclusion in public discussion forums, and access to resources to prepare for and recover from climate and weather events. Recognizing that systemic inequalities have perpetuated differences across communities – both in the built environment and in how communities are able to contribute to city-level decision making – equity was considered a fundamental aspect of all focus areas.

Given the limitations of this pilot phase of the Climate Knowledge Exchange, the results of the analysis described above were compared to a related analysis conducted by Science for New York (Sci4NY), an initiative working to strengthen connections between science and policy in NYC. To determine priority science needs across NYC, a team of Sci4NY researchers synthesized: 1) environmental information and needs statements prepared by each of the City’s 59 Community District boards available from NYC Department of City Planning’s Community District Profiles, and 2) the NYC Community Health Profiles (available from the NYC Department of Health and Mental Hygiene). The Sci4NY assessment provided a city-wide lens that was used as one proxy for the opinions of communities not yet directly included in the Climate Knowledge Exchange process.

The results of the systematic analysis of the discussion group notes, polling responses, survey responses, document review, and Sci4NY analysis were considered in the context of previous assessments, reports and policy

priorities. The focus areas that emerged as a priority across all contexts were used to develop the preliminary list of priority focus areas. These areas were relevant to all stakeholders and had the greatest support for near-term research.

The preliminary list of focus areas was presented to participants in a series of feedback sessions and in one joint session held with the Environmental Justice Advisory Board and the NPCC in early April 2021. The sessions included a presentation of preliminary findings, an interactive ranking of draft focus areas, and a discussion to identify omissions. By engaging a diverse set of stakeholders, the research priorities identified in this process aim to be credible, actionable, and accountable. The multi-stage review process, which included a final review of the draft report and incorporation of review comments, aims to ensure the Climate Knowledge Exchange process is objective and transparent. A comprehensive list of focus areas that were raised, but that did not meet the criteria for inclusion as a top priority, is included in Appendix 3.

This process for determining focus areas sought to balance research needs for risk analysis, capacity building, and solution development. Any process of assessment includes subjective and normative assumptions that inform how we decide what is most important about the potential impacts of climate change. Scientific knowledge related to the timing, magnitude, and likelihood of occurrence of climate hazards must be considered in relation to the confidence experts have in the relationship between climate change and potential impacts.

Case Study - Sci4NY: Assessing Science Needs in NYC

Climate is often referred to as a global problem but understanding how climate change affects local communities is essential to building resiliency. One local initiative, Science for New York (Sci4NY), mobilized researchers to utilize publicly available data to reveal what local communities were most concerned about as it relates to science.

Last year, they produced a map (shown below) to help inform policy-related decisions that are more tailored to the needs of local communities. The overarching goal is to harmonize communication between scientists, policy makers, and most importantly community members, to the mutual benefit of all parties involved.

Sci4NY used publicly available data from NYC's 59 Community Boards, the Department of City Planning, and the Department of Health and Mental Hygiene to assess issues that were most important to local communities. These local priorities provide insight into the role science policy can play in helping meet neighborhood needs. By leveraging scientific skills and expert judgement to locate community research gaps, Sci4NY aims to enhance the overall policy decision process.

A priority issue that could be thought of as a science issue was identified for each of the 59 Community Districts. As seen in the map, many Community Districts throughout the city prioritized infrastructure resiliency in their budget requests. These findings work to verify the research priorities identified by the Climate Knowledge Exchange while also providing a city-wide lens for understanding how New Yorkers rank resiliency in relation to other locally specific issues.

Sci4NY's work underscores the importance of science in the decision-making process and in designing programs that improve quality of life. This work also illustrates how science can be used as a tool for community empowerment and helps ensure that climate solutions are made not only for the people, but by the people.

COMMUNITY SCIENCE IN NYC



Park space/unpopulated areas

Sci4NY
 COLAB FUTURES
 Data collected by Sci4NY
 Image by Karen S. Ingram

TOP SCIENCE TOPICS BY NYC COMMUNITY DISTRICT

ACCESS TO HEALTHY FOODS Manhattan 3, 11 Bronx 1, 2, 3, 4, 5, 6, 7 Brooklyn 5	AGING POPULATION Brooklyn 10, 13
AIR QUALITY Manhattan 5, 6 Bronx 1, 2, 3, 4, 5, 6, 7, 11 Brooklyn 1, 2, 7 Queens 1, 2, 3	CLEAN WATER Manhattan 8, 9
HEALTH OUTCOMES Manhattan 4, 9 Bronx 1, 2, 3, 4, 5, 6, 7 Brooklyn 1, 2, 3, 4, 5, 8, 16 Queens 4	MEDICAL ACCESS Bronx 11, 12 Brooklyn 4, 12 Staten Island 1
PARKS ACCESS Manhattan 2, 6, 10 Bronx 8, 12 Brooklyn 14 Queens 6, 11, 13	
CLIMATE CHANGE/FLOODING Manhattan 1, 11 Bronx 9, 10 Brooklyn 6, 13, 18 Queens 2, 5, 7, 8, 10, 12, 14 Staten Island 2, 3	
SANITATION Manhattan 5, 10 Bronx 1, 2, 3, 4, 5, 6, 7, 12 Brooklyn 3, 11, 12, 15 Queens 4, 5, 9	
STEM & BROADBAND ACCESS Manhattan 7, 8, 9, 12 Bronx 1, 2, 3, 4, 5, 6, 7 Brooklyn 7, 9, 17 Queens 3	

Likewise, inequalities in the distribution of impacts and vulnerabilities are linked to knowledge pertaining to the root causes of social vulnerability and place-based differences in exposure and access to resources for preparedness and recovery. In future years, the Climate Knowledge Exchange will work to refine a list of criteria for determining the relative importance and significance of climate-related impacts and the vulnerability of New York’s diverse communities, critical infrastructure, and natural environment.

NYC’s Climate Research Agenda

Based on engagement and analysis, this section outlines a comprehensive climate research agenda spanning a wide range of disciplines. Climate science is a field drawing on disciplinary work in physics, meteorology, earth science, and atmospheric science, among others. A common misconception is that climate research is the same as climate science. A wide range of research disciplines, from the sciences, humanities, and other areas of scholarship, are now engaged in research on climate change and its impact on society. The U.S. Global Change Research Act in 1990 was a pivotal moment that encouraged tremendous progress in research across disciplines (i.e. interdisciplinary research) and in collaboration between researchers, decision makers, and communities (i.e. transdisciplinary research). NYC’s Climate Research Agenda highlights areas for researchers to work together and with governmental and non-governmental organizations to catalyze new frontiers in NYC’s response to the climate crisis.

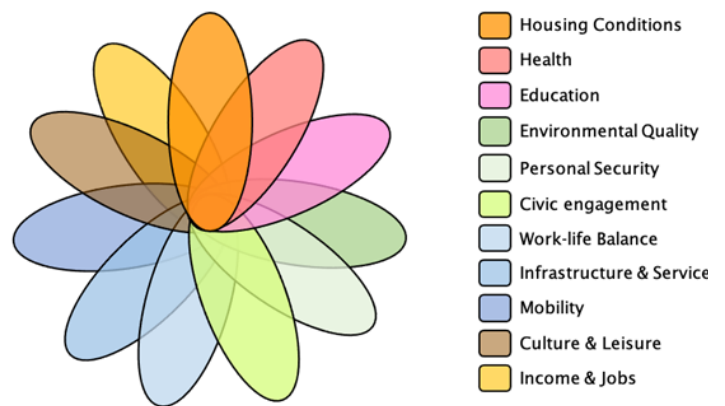
Focus Area 1 - Living with Climate Change

The impacts of climate change are something all NYC residents will have to reckon with at various times and to varying degrees. Some residents already live with impacts such as increased flooding or extreme heat. Still, a large proportion of residents are not engaged in climate issues, research, and information. Expanding research around how the impacts of climate change will affect the quality of life (Figure 4) for NYC residents is a prevailing suggestion gathered from discussion notes and survey feedback. For example, people want to know how hot their neighborhood will be or how often it will flood. People regularly cite the need to perform analysis of impacts and risks from climate on the daily lives of New Yorkers. There is a common sentiment that the vast majority of existing in-depth risk analysis was city- or borough-wide, and that it does not relate to people’s concerns over quality of life. Respondents advocated for information suited to as many specific contexts as possible, noting that connecting scientific research and information about climate hazards to an individual’s personal circumstance has the greatest impact on their understanding of climate hazards and their willingness to take action.

Connecting climate to how residents experience life in NYC, as climate change begins to impact more and more people’s daily lives, can be an effective method of information dissemination and engagement around climate issues. However, delivering tailored information to a city of 8.7 million people poses feasibility challenges. There are, instead, prevailing climate-related quality of life concerns which can be the focus of future research and provide similar levels of engagement and understanding that tailored information might.

Some of the most commonly coded under-researched areas gathered from participants were:

- Disproportionate impacts of climate change including environmental justice
- Impacts of climate change on human health and behavior
- Impacts of climate change on local economies
- Need for social science research on personal perception and barriers of climate risks



Adapted from: OECD. 2014. *How’s Life in Your Region?: Measuring Regional and Local Well-being for Policy-making*. OECD Publishing, Paris.

Figure 4. Quality of life considerations

Focus Area 2 - Managing Resiliency

City staff reported that they expect climate change to impact their agency’s work across a broad range of areas, but primarily in operations, capital planning, capital project implementation, and emergency response. Among agencies, many participants noted that there has been significant progress in the use of climate science information among agency staff and greater comfort with uncertainties. Notable progress was mentioned specifically in relation to climate data analysis and program development championed by the MOR, NPCC,

and the Climate Change Adaptation Task Force (CCATF). The most significant barriers to using climate information were reported as lack of capacity and lack of funding with moderate barriers reported to be lack of expertise, lack of information at the right geographic scale, and lack of information on needed variables. When asked further about barriers to implementation of resiliency programs, most rated financial constraints and narrow approaches to cost benefit analysis as the primary factors in addition to a lack of shared goals among stakeholders or approaches to consensus building. In sum, City staff expressed that resiliency efforts often involve many complex factors (e.g. intersecting infrastructure operating on different scales) and ambiguous factors (e.g. competing views), many of which have to do with the way people make judgments in response to risk. Although complexity was more frequently cited as a barrier to climate informed decision making, uncertainty remains a challenge. The loss of resolution at more distant time horizons continues to impact decision making. The shift to longer term planning practices was noted to be challenging, particularly in relation to capital planning. Staff working in infrastructure reported that they do consider the full life span of any asset – which in some cases is 100 or 150 years – but struggle to find ways to incorporate flexibility in long-term planning. Although many participants felt agencies are getting better at communicating, brainstorming, and sharing ideas, many agency staff felt there remains a need for new management approaches. Staff reported finding it particularly challenging to plan projects with co-benefits or that require cross-agency coordination.

Compounding and cascading climate risks contribute to uncertainty and pose a challenge for projecting and predicting the long-term efficacy and socioeconomic impacts of various adaptation options. Complexity regarding the impacts of such risks contributes to the policy implementation barrier. More integrative research on different combinations of risks is needed, including multiple climatic risks (i.e. extreme precipitation and storm surge) and socio-climatic interactions (i.e. COVID and extreme heat). In order to address cascading impacts across sectors, disciplinary and agency siloes must be bridged to facilitate the increased information and expertise sharing necessary to address complex, multi-hazard events. Predicting such events relies on climatic, socioeconomic, and infrastructural data at comparable spatial and temporal scales, which must be made accessible.

Structured approaches exist which can inform the process of making decisions under uncertainty and when faced with complexity. These approaches include decision science, adaptive management, flexible adaptation pathways, and scenario planning approaches, among others. More knowledge is needed on how to utilize

these approaches within NYC government to implement adaptation options and evaluate their effectiveness over time. Such approaches inherently rely on iterative, flexible planning processes which may be at odds with the ways in which agencies and decision-makers have historically structured and incentivized decision-making. There are several existing tools and datasets in the City’s portfolio, but participants frequently highlighted the need for new approaches to cost-benefit analysis. Specifically, participants noted a need for:

- New ways to assess which strategies are right for which areas
- Methods for assessing non-monetary values, equity, and other social priorities
- Incorporating health and socio-economic impacts into decisions, including valuation of the health costs of climate change
- Including community knowledge on risk experiences as inputs to decisions
- Analysis of which costs and benefits accrue for which stakeholders over what timeframes
- Improved methods for comparing the benefits of natural resource protection to other resiliency measures.

Finally, there is also a need to assess whether existing City policies and plans account for compound events, to prevent underestimation of current and future risks.

Focus Area 3 - Climate and the Built Environment

The built environment emerged as a topic of discussion in all workshops, with both agency and non-governmental groups. Reducing risks from extreme heat and flooding are major priorities for communities, and addressing inequality is seen as an important factor in improving infrastructure resiliency. Participants identified inequitable distributions of recovery and resilience funding as a barrier to equitable adaptation of coastal infrastructure, particularly in minimizing residential housing risk. Additionally, communities expressed that resilient infrastructure is not adequately incentivized, with property values failing to accurately reflect risk. At the individual level, community members are interested in utilizing climate information in their decisions of where to purchase property, in order to reduce their risk and exposure to flooding.

In sharing their visions of a resilient future, many participants described a high demand for green, resilient infrastructure that is compatible with ecosystem health and conservation. Equitable access to green space, increased use of green infrastructure, and affordable, resilient housing were recurring priorities for community members. Individuals referenced the ecosystem services

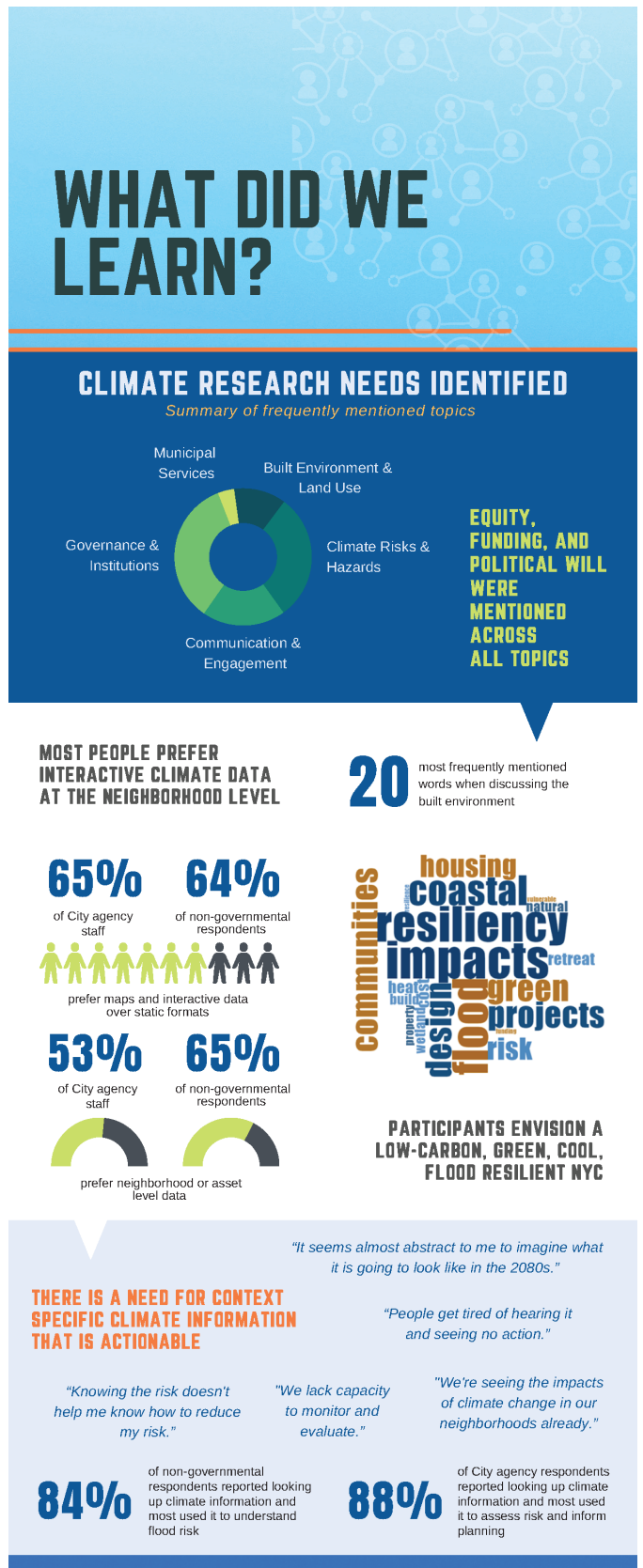
which nature provides (heat mitigation, coastal protection, mental and public health, among others), in addition to a desire to promote the intrinsic value of nature. Participants are interested in a built environment which is compatible with the natural environment and offers co-benefits between greenhouse gas (GHG) emissions reductions (mitigation) and resilience to extreme heat and the impacts of flooding (adaptation).

There is a need for research and governance structures which facilitate consideration of near-term risks when planning long-term infrastructure, and long-term risks when retrofitting existing infrastructure. The built environment sector must apply and translate climate data so that it is actionable at the site/building level, in order to assess risk and determine context-specific approaches across the spectrum of adaptation options from protection to relocation. Progress has been made in developing resilient building codes, and engineers and designers are interested in more information that can be directly incorporated into guidance for infrastructure planning. In cases where the data is available, it is often not communicated or packaged in ways that are easily accessible to the built environment community.

Participants provided mixed feedback about the relative priority of focusing on new construction or the existing building stock when it comes to resilience planning; however, the discussions trended toward agreement that: a) NYC must address both categories of buildings in order to scale resiliency to the city level, and b) retrofitting the existing building stock presents unique barriers which must be addressed with context-specific approaches. For both categories of buildings, participants expressed that the long-time horizons associated with infrastructure planning often pose a challenge, due to mismatches with other policy timelines and shorter-term climate action planning. According to City agencies, progress has been made on infrastructure permitting, resilient building codes, and in communicating information about flooding impacts. For many, Hurricane Sandy is still considered a watershed moment in NYC infrastructure and resilience planning, and one which is often used as a reference point for considering the built environment in a changing climate. Meaningful progress from post-Sandy resilience initiatives was acknowledged – for example, elevation of homes – although it is a widely shared belief that there is much progress yet to be made in the area of coastal resiliency.

There is a need to better understand the ways green, resilient design can achieve multiple benefits. Assessment of potential co-benefits associated with different infrastructure resilience options is needed in the following areas:

- Research related to climate risk perception, including



how climate information is factored into decision making and what types of information impact risk perception

- Identifying the co-benefits and potential trade-offs between flooding and heat resiliency approaches
- Understanding the co-benefits between emissions reductions and resilience planning
- Assessing the co-benefits of various ecosystem services provided through green infrastructure and land use planning.

Despite uncertainty in particular climate variables – for example, extreme precipitation – progress can be made in improving the resilience of the City’s infrastructure. In order to provide resilience at scale, approaches need to be tailored for the existing building stock and new construction, in recognition of the differences in the physical, legal, economic, and policy options available to each.

Focus Area 4 – Climate Communication, Education, and Engagement

Participants expressed interest in the development of communication and outreach strategies which motivate action, connect with various audiences, and improve trust and transparency. In addition to more inclusive and sustained engagement processes, addressing these priorities requires developing a greater understanding of how different communities connect with various forms of information; how individuals perceive their climate risk; and improved understanding of how communication strategies contribute to individual and collective action.

Participants reported being very concerned or somewhat concerned about all hazards with many people reporting to have direct experience with flooding from heavy rain. When asked how much time and energy they spend preparing for the impact of weather and climate hazards, over half reported spending a moderate amount or a little. In contrast, when asked how much time people spend coping with the impact of climate and weather hazards, 70% responded a lot or a moderate amount. Communities reported they do access data on climate hazards, particularly related to flooding and social impacts, but they felt there was a need for more neighborhood level information that would help them prepare. Specifically, priority information needs among communities included specific information for environmental justice communities who experience compounding risks from environmental hazards, more visualizations of flood zones and heat maps, renderings of what communities could look like in different scenarios, and K-12 climate education materials.

The need for climate curricula tailored to different learning communities, including students, youth, the public,

and private sector entities, was expressed. Incorporating climate and environmental information into formal and informal educational opportunities is seen as an avenue for improving climate literacy and motivating action, and equal access to such educational opportunities is a priority. Participants indicated that education contributes to more accurate assessments of climate risk at the individual and community scale and therefore has the potential to inform decision making. To understand the causal links between education and action, participants suggested that research be conducted on the impacts of K-12 climate education for future engagement with climate issues. Evaluation of the efficacy of climate education and communication strategies may benefit from the integration of psychology, behavioral science, sociology, history, and other social science perspectives.

Strategies to address the gaps in this focus area also include, among other things:

- Test the use of multi-media and traditional formats for communicating climate information
- Incorporating climate and climate justice into curriculum at multiple education levels, and conducting research related to the pedagogy and best practices in implementation of climate curriculum
- Integrating of psychology, behavioral economics, and other social science disciplines in the development of communication and outreach materials.

Improving the Climate Knowledge Process

Across governmental and non-governmental organizations alike, participants cited lack of funding, lack of political will, and an uneven flow of information across the city as barriers to resiliency. Over time, improvements to the Climate Knowledge Exchange process can address some of these issues. Below, we outline strategies to refine the Climate Knowledge Exchange process and future State of Climate Knowledge reports.

Create partners in the process

The Climate Knowledge Exchange project team will work with individuals in governmental and non-governmental organizations alike to host their own workshops. Discussion prompts, facilitation guides, training on the research methods, and channels for reporting back the information will all help interested collaborators in their own engagements, thereby working through existing networks and increasing shared ownership of the process. Existing research on sustained civic engagement has proven that such empowering approaches help reach wider circles of people over time, leading to broadly inclusive processes. Similarly, research on civic engagement illustrates that these approaches help increase

awareness of each other's concerns and efforts, building and sustaining political will.

Raise funding to support partners

Participants expressed ideas not just on what climate research is needed, but also how funding mechanisms need to be restructured to support partnerships with researchers. Communities need funding to support the additional work required to engage their networks and build capacity to participate in research and information sharing. Grants to researchers should include funding for communities to act and/or build on ideas generated collaboratively. MOR will work with community and agency partners to raise funds to support participation and capacity-building partnerships.

Improve information sharing and knowledge development

Our approach begins with group discussion prompted by a presentation on climate risks and resiliency. To better communicate and connect with communities which have been disproportionately impacted by climate change, environmental justice must be central to the communication process and materials produced. Information that is interactive, time-sensitive, and locally specific is seen as necessary to improve resilience, including access to data on social vulnerability. Working with partners in non-governmental organizations, we will tailor our communications and outreach materials to different communities, accounting for access to information technology (including internet connection), preferred language, cultural norms, legacies of injustice, and current understanding of climate vulnerability and risks. Part of this translation will be to incorporate stories and lived experiences from those already impacted by climate change. Art and educational games are promising techniques for improving future State of Climate Knowledge reports. With additional resources, the materials developed in the process can be curated by audience and stored online. This approach will help elevate local and community knowledge and integrate that knowledge with formal scientific efforts like NPCC.

Develop evaluation indicators

Learning is central to our approach. Refining our evaluation framework will help us learn from each successive process and report. A theory of change can help track how the process and products lead to beneficial outcomes. For example, in addition to tracking the number of participants in the process, our evaluation will take into account the quality of the engagement. An indicator of the quality of engagement may be a better

understanding of climate change. One measure of the quality of engagement would then be tracking if there is a year-over-year increase in the number of participants who report to have learned something from the Climate Knowledge Exchange. Because funding is a perennial concern, another example may be tracking how well the process and products support fundraising. One way to track fundraising may be citations of the State of Climate Knowledge reports in successful funding proposals that support partnerships between researchers, agencies, and communities. Evaluation will help maintain an evidence-based approach to the program and meet the goal of accountability.

Conclusion

We all play a part in responding to climate change. NYC's climate choices will involve the public sector, the private sector, the research community, civil society, and—ultimately—all New Yorkers. By creating a process for learning together, we can improve upon the past, bouncing forward and not back. As opposed to a plan or a study, this report – the State of Climate Knowledge 2021 – is a living climate research agenda. Building public participation in future versions of this agenda will help MOR broker innovation to address the climate crisis (Figure 5). A publicly-driven climate research agenda is not just what climate research NYC needs; it is the climate research that NYC deserves.

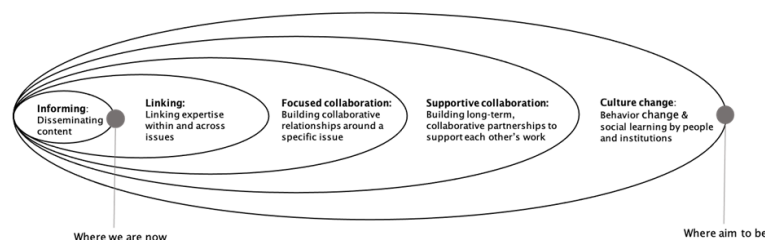


Figure 5. Brokering research and innovation for public good. Based on Campbell, C.A., et al., *Designing environmental research for impact*, *Sci Total Environ* (2014), <http://dx.doi.org/10.1016/j.scitotenv.2014.11.089>

APPENDICES

APPENDIX 1

Discussion Groups

Participants for this pilot phase of the Climate Research Exchange were recruited through existing networks of both City staff and non-governmental organizations working in climate and resiliency related fields. High priority neighborhoods for engaging non-governmental and community-based organizations were identified by assessing the overlap between the Social Vulnerability Index, the Heat Vulnerability Index, areas heavily impacted by COVID-19, and areas vulnerable to flooding. The 90-minute discussion group sessions had an average size of nine participants and were held virtually using Webex for video conferencing. Each of the 26 sessions were moderated by a member of the research team with at least one note taker present at each session. The total number of workshop participants was 177 (51% from non-governmental organizations). The intent of the discussion group was to both share up-to-date information on climate risks and hazards and to document perspectives on the following questions:

- Where are we, as a city, making the most progress in addressing climate change, and where are the biggest barriers?
- What are the primary barriers to address climate risks?
- What data, information, or research is needed to better understand climate risks?
- How well do we understand climate risks?
- How well does research build capacity to prepare for and recover from climate risks?
- How well does research support specific actions to minimize future climate impacts?

Responses to the above discussion questions, sometimes combined with ranking exercises, were documented using the audience response software Mentimeter and by note takers present during the discussion group.

Survey Design

The surveys used in this study were designed to collect data on current practices of climate information use, access to climate information, and climate research or information related needs. The research team developed two questionnaires (below) – one for city agency staff and one for non-governmental organizations or community members. The questionnaire for city agencies included eight questions collecting demographic data in addition to 10 open-ended questions and 28 closed-ended questions. The questionnaire for non-governmental participants included six demographic questions, 13 open-ended, and 22 closed-ended questions. The survey was distributed following the discussion group to collect more in-depth data on personal use of climate information and information needs. The city agency questionnaire had a response rate of 25% and a completion rate of 82%. The non-governmental questionnaire had a response rate of 35% and a completion rate of 75%.

The survey design process included a pretesting phase that took place from July to August 2020. This multi-stage design process allowed for iterative adjustments and the collaborative selection of questions, based on survey respondent feedback, able to accurately capture climate related opinions and experiences.

Survey Questionnaire: City Agency

Demographic data		
1.	Agency	Open-ended
2.	Department/Bureau	Open-ended
3.	Home zip code	Open-ended
4.	Years of experience in your role	Open-ended
5.	Gender	Male/Female/Non-binary/Other/Prefer not to say
6.	Age	18-24 25-34 35-44 45-54 55-64 65+

Demographic data		
1.	Agency	Open-ended
2.	Department/Bureau	Open-ended
3.	Home zip code	Open-ended
4.	Years of experience in your role	Open-ended
5.	Gender	Male/Female/Non-binary/Other/Prefer not to say
6.	Age	18-24 25-34 35-44 45-54 55-64 65+
7.	Race	White or Caucasian Black or African American Hispanic or Latino Asian or Asian American American Indian or Alaskan Native Native Hawaiian or other Pacific Islander Another race
8.	How familiar with climate change are you?	Extremely familiar (I have over 10 years of experience directly dealing with climate, its impacts on my agency and department, and developing programs, etc.) Very familiar Somewhat familiar Not so familiar Not at all familiar (I know about it from the news)
Context for climate risks in your work		
9.	Please list the items most relevant to your work. Select all that apply.	People, communities, and culture Environment and open space Critical infrastructure Buildings and housing Business and commerce Finance Government Law Technology Other (please specify)
10.	Please rate the potential impact of the following climate change hazards on your work.	Rating Scale (Extreme, Very, Somewhat, Slight, Not at all) Heat Flooding from heavy rains Droughts Coastal flooding Coastal storms Cold snaps
11.	What aspect of your agency's work is most impacted by climate change?	Operations Capital planning Implementation Other (please specify)

12.	How familiar are people in your department with climate resiliency and adaptation?	Extremely familiar Very familiar Somewhat familiar Not so familiar Not at all familiar I'm not sure
13.	How familiar are people in your department with climate risks?	Extremely familiar Very familiar Somewhat familiar Not so familiar Not at all familiar I'm not sure
14.	How often do you factor climate change into your work?	Daily Weekly Monthly Annually Every 5 - 10 years Never Other (please specify)
15.	In the past, have you used any data or information on climate change or other hazards in your work? If yes, what data have you used? Please enter all that apply.	Heat Flooding from heavy rains Droughts Coastal flooding Cold snaps Social impacts I have not used any data or information on climate change Other (please specify)
16.	If you have not, what data and information do you need?	Open-ended
17.	If yes, where did you get this data? Select all that apply.	NPCC reports NOAA Northeast Regional Climate Center Research Institutions (e.g. IRI) I have not used climate data Other (please specify)
18.	If yes, how did you use this data?	Open ended
19.	If yes, how helpful was the data?	Very helpful Somewhat helpful Slightly helpful Not at all helpful
20.	Have you ever used NPCC assessments?	Yes/No
21.	If yes, how have you used them?	Background research and information Direct input to a decision (used data directly in project work) Making the case for a decision to factor in climate change Introducing new knowledge to develop new capabilities or innovations

22.	If yes, which report was most useful?	NPCC 2010 NPCC 2013 NPCC 2015 NPCC 2019 Other (please specify)
23.	If yes, what weather or climate-related information from the NPCC reports did you find most helpful?	Heat Flooding from heavy rains Droughts Coastal flooding Coastal storms Cold snaps Other (please specify)
24.	In what format would the climate data or information be most helpful to you?	Report/static graphs Maps/interactive Other (please specify)
25.	Over what spatial scale would the information be most helpful to you?	Metro area Citywide Borough-wide Neighborhood Asset Other (please specify)
26.	Over what temporal scale would the information be most helpful to you?	Sub-hourly Hourly Daily Monthly Seasonally Annually Decadal Multi-decadal
Who or what is at risk?		
27.	Socioeconomic and health factors play a role in how individuals and communities are able to respond to and recover from climate risks. How often do you use data related to these differences in your work?	All the time Often Sometimes Rarely Never
28.	Do you have a formal method for factoring socioeconomic and/or health factors into your work? If yes, please describe. If no, write N/A.	Open-ended
29.	Within your work, what are the barriers to using climate information and how significant is each barrier?	Not a barrier/Minor barrier/Moderate barrier/Significant barrier Lack of information at the right geographic scale Lack of information at the right time horizon Lack of information for the right variable Lack of expertise Lack of access to data Lack of funding Lack of capacity
30.	What is the biggest science or research gap related to your work?	Open-ended

31.	Do solutions exist to address climate risks for your work (social, technological, engineered, etc.)?	Yes/No
32.	There can be barriers to both solution development and implementation. What is the biggest barrier to developing solutions?	Open-ended
33.	Please rank how much of a barrier these factors are to developing solutions.	Funding/finance Lack of agreement among stakeholders Lack of approaches to effective consensus-building Scientific or engineering analysis of tradeoffs Lack of shared goals Lack of capacity to explore innovative “out of the box” solutions Existing laws and/or regulations Narrow cost-benefit definition
34.	How much would development or implementation of solutions benefit from engagement with communities and stakeholders?	A great deal A lot A moderate amount A little None at all
35.	In your work, how many solutions address long-term climate risks?	All Most Some A few None
36.	How quickly can these solutions address climate risks?	Solutions have not been developed Immediately 1 - 3 years 5 - 10 years >10 years
37.	What do you want to know about potential solutions?	Open-ended
38.	What do you think is the biggest barrier to implementation?	Open-ended
39.	Please rank how much of a barrier these factors are to implementation.	Funding/finance Lack of agreement among stakeholders Lack of approaches to effective consensus-building Scientific or engineering analysis or tradeoffs Lack of shared goals Lack of capacity to explore innovative “out of the box” solutions Existing laws and/or regulations Narrow cost-benefit definition
40.	A bond measure is passed that allocates \$15 million per year over 30 years for actions that support a socially and environmentally just transition to a climate resilient city. With these measures in place, what does the City, or your neighborhood, look like in 2060 (~40 years from now)? In 2-3 sentences, describe your future vision.	Open-ended

41.	What kind of engagement activities would help your agency build capacity to address climate change? Please select all that apply.	Workshops Newsletters Panel discussions Other (please specify)
42.	What kind of engagement activities would help your agency work with communities to address climate risks?	Workshops Newsletters Panel discussions Other (please specify)
Feedback/Evaluation		
43.	How would you rate the presentation during the workshop?	Rating scale
44.	How would you rate this survey?	Rating scale
45.	Do you have any comments or feedback on the workshop or survey that you would like to share?	Open-ended
46.	If you want to opt-in to future steps please leave your email address. This is completely optional and your email will be kept confidential.	Open-ended

Survey Questionnaire: Non-governmental

Demographic data		
1.	Home zip code	Open-ended
2.	Gender	Male/Female/Non-binary/Other/Prefer not to say
3.	Age	18-24 25-34 35-44 45-54 55-64 65+
4.	Race	White or Caucasian Black or African American Hispanic or Latino Asian or Asian American American Indian or Alaskan Native Native Hawaiian or other Pacific Islander Another race
5.	Priority Issues	Please rank the following issues in order of importance to you. Health Care and Human Services Youth Education and Child Welfare Public Safety and Emergency Services Core Infrastructure City Services and Resiliency Housing, Economic Development and Land Use Transportation Parks, Cultural, and Other Community Facilities

Climate risks		
6.	How familiar with weather and climate hazards are you?	Extremely familiar Very familiar Somewhat familiar Not so familiar Not at all familiar
7.	Please rate how concerned you are about the following weather and climate hazards affecting your neighborhood.	Rating Scale (Very concerned, Somewhat concerned, Not so concerned, Not at all concerned, I'm not sure) Heat Droughts Coastal storms Cold snaps Flooding
8.	If flooding is a concern for you, which of the following causes of flooding have you experienced most often?	Heavy rain High tides and waves
9.	How familiar do you feel people in your community are with weather and climate risks?	Extremely familiar Very familiar Somewhat familiar Not so familiar Not at all familiar I'm not sure
10.	How much time and energy do people in your community spend preparing for the impact of weather and climate hazards?	A great deal A lot A moderate amount A little None at all I'm not sure
11.	How much time and energy do people in your community spend coping with the impact of weather and climate hazards?	A great deal A lot A moderate amount A little None at all I'm not sure
12.	In the past, have you looked up any data or information on climate hazards and risks? If yes, what information have you used? Please enter all that apply.	Heat Flooding from heavy rains Droughts Coastal flooding Cold snaps Social impacts I have not used any data or information on climate change Other (please specify)
13.	If yes, how did you use this data?	Open ended
14.	If yes, how helpful was the data?	Very helpful Somewhat helpful Slightly helpful Not at all helpful
15.	If you have not, is there any data or information on climate hazards and risks that you are interested in?	Open-ended

16.	Have you ever seen the reports of the New York City Panel on Climate Change (NPCC)?	Yes/No
17.	If yes, what weather or climate-related information from the NPCC reports did you find most helpful?	Heat Flooding from heavy rains Droughts Coastal flooding Coastal storms Cold snaps Impacts of hazards in different areas of the city Other (please specify)
18.	In what format would the climate data or information be most helpful to you?	Report/static graphs Maps/interactive Other (please specify)
19.	At what geographic scale would the information be most helpful to you?	Metro area Citywide Borough-wide Neighborhood Block Other (please specify)
20.	How often would you like to see updated information?	Daily Monthly Seasonally Annually Every 3-5 years
Who or what is at risk?		
21.	How prepared do you think your community is to respond to climate related hazards?	Very prepared Somewhat prepared Slightly prepared Not at all prepared
22.	Do you feel you face a greater risk for climate related hazards than other areas of New York City?	Yes/No
23.	If yes, what factors increase your risk?	Open-ended
24.	Is there any climate risk topic that is important to you that you feel should be better researched?	Open-ended
Climate action		
25.	Have you taken any steps to prepare for climate hazards?	Yes/No
26.	If yes, what have you done?	Open-ended
27.	Do solutions exist to address climate risks for your community (solutions could be social, technological, engineered, etc.)?	Yes/No
28.	What is the biggest barrier to developing solutions?	Open-ended

29.	Please rank how much of a barrier these factors are to developing solutions.	Funding/finance Lack of agreement among stakeholders Scientific or engineering limitations Lack of shared goals Lack of capacity to explore innovative “out of the box” solutions Existing laws and/or regulations Other (please specify)
30.	What would you like to know about solutions to address climate risks?	Open-ended
31.	Imagine a bond measure is passed that allocates \$15 million per year over 30 years for actions that support a socially and environmentally just transition to a climate resilient city. With these measures in place, what does the City, or your neighborhood, look like in 2060 (~40 years from now)? Describe your future vision.	Open ended
Learning and engagement		
32.	What kind of engagement activities would help your community build capacity to address climate change? Please select all that apply.	Workshops Newsletters Community meetings Other (please specify)
33.	Have you ever taken part in any City-led initiative on climate change or resiliency?	Yes/No
34.	If yes, which initiative or program? List all that apply.	Open ended
35.	If yes, how informative were the engagements to your community?	Very informative Somewhat informative Slightly informative Not at all informative
36.	If yes, how could the engagements be more informative to you and your community?	Open-ended
37.	Is there anything else you would like to share related to your priority concerns?	Open-ended
Feedback/Evaluation		
38.	How would you rate the presentation during the workshop?	Rating scale
39.	How would you rate this survey?	Rating scale
40.	Do you have any comments or feedback on the workshop or survey that you would like to share?	Open-ended
41.	If you want to opt-in to future steps please leave your email address. This is completely optional and your email will be kept confidential.	Open-ended

Coding

Qualitative data analysis was conducted by systematically coding, or categorizing, text from the notes and open-ended Mentimeter responses from each discussion session, responses to open-ended survey questions, and documents. To develop the codebook, three members of the research team systematically evaluated a representative selection of discussion group notes and open-ended Mentimeter responses and developed an initial list of codes. The list was not based on a priori codes but was developed iteratively during the review process. Two team members took the lead in developing the initial list by independently coding the same representative text, which was then reviewed by the research team. After reaching agreement on initial codes and sub-codes, the codebook (below) was completed with definitions of each code and examples to improve clarity and provide guidance for the student team that applied the codes. Two coders independently coded the same representative text to compare consistency of coding using NVivo. The documents were coded by date of workshop and Speaker IDs were assigned to all participants to ensure anonymity. The coding process continued with periodic checks for coding density and intercoder agreement. A second review of coding was undertaken to assess the key themes emerging from the most applied codes: equity and environmental justice, political will, the build environment and land use, funding, decision analysis, and communication and engagement. As the coding process is subjective, coding applications were checked by at least two team members and findings were vetted with the whole team.

Climate Knowledge Exchange Codebook

Theme	Sub-theme (level 1)	Sub-theme (level 2)
Climate Risks & Hazards	Under researched subject	Risk matrix
	Different spatial scale	Household level impact data
		More granular data
		Regional data
	Different temporal scale	
	Disparities in vulnerability or adaptive capacity	
	Co-production of knowledge	
	Hazard mitigation	Storms
		Sea level rise
		Tidal flooding
		Heat stress
Cold snaps		
Groundwater		
Communication & Engagement	Procedural equity	Access to information
		Local partners
	Public outreach materials	Data clarity
		Benefits of resiliency action
		Plain language
		Neighborhood level information
		Household level/Quality of life information
	Public outreach process	Tailored to cultural context
		New engagement approaches
		Resiliency network

		Progress updates
		More online outreach
		More resources offline (multi-media)
	Education curriculum	Informal
		Formal
Governance & Institutions	Political will	Leadership
		Consensus building
		Advocacy
	Funding	Budget
		Capital planning
		Federal funding
		Funding/need mismatch
		Low-cost/no-cost strategies
		Perceived prioritization of high income areas
	Policy	Policy design
		Science-policy connection
	Multi-level governance	
	Laws	
	Regulations	
	Collaboration (external)	Private sector engagement
		Public service programs
	Participatory processes	
	Intra-agency information dissemination	
	Operations & Management	Comprehensive plan
		Strategic planning practices
		Coordination (intra-agency)
		Monitoring and evaluation
		Impact of science-based policies & projects
Catalyzing procedural change		
Integration of comprehensive plan		
Knowledge management		
Group procedures/brainstorming		
Approaches to goal-setting		
Decision analysis	Science-based decision making	
	Cost-benefit analysis	
	Local knowledge	
	Politicized data	
	Competing priorities	

		Complexity/ambiguity
	Contextual equity	
Municipal services	Water	
	Stormwater management	Green infrastructure
		New gray infrastructure
		Upgrades/Retrofits
	Parks	
	Transportation	Subway
		Multi-modal
		Streets
	Sanitation	Solid waste
		Sewer
		CSO
	Electricity	
	Gas	
	Schools	
	Food distribution	
Public Safety		
Emergency management	Preparedness	
	Response	
	Recovery	
	Logistics	
Built environment & land use	Residential	
	Commercial	
	NYCHA properties	
	Hospitals/clinics	
	Factory/warehouse/industry	
	Coastal resiliency	Shoreline hardening (new construction)
		Conservation/Restoration
Retreat/shoreline density		

Cross-cutting Codes

Progress
Barrier
Gap
Environmental justice
Inequality, Equity, Vulnerability, Minority
Low-income
Health, ill, mortality, death, morbidity, injury, medical
Heat, A/C, cool, temperature
Capacity building
Pace of implementation
Infrastructure
Design standards
Guidelines
Youth
Mitigation
Sandy
Trust
Inaction
Information dissemination
Awareness
Uncertainty
Engagement fatigue
Contaminants
Incompetence
Frustration
Flood insurance
Environmental behavior
Data visualization

Document Review

The highest-level codes were used to categorize the research needs identified in the 34 documents included in the systematic content analysis (Appendix 2). Content analysis is commonly used to analyze documents or other media. The research team reviewed the set of documents with the specific aim of identifying research needs or priorities and assessing the priority of the need when possible. This review allowed the research team to infer research needs from the authors of the documents and to standardize the combination of these inferences with the coded data from the discussion groups and survey results.

Analysis

The aim of the Climate Knowledge Exchange was to develop a process for exchanging climate knowledge and to collaboratively determine the primary research needs of all stakeholders. An analysis was conducted of the coding results together with unweighted survey and polling data. Trends in the survey and polling data were assessed to determine key patterns. The coding process allows for data reduction and simplification while also transforming the data into meaningful units. The codes were developed iteratively based on themes emerging from the text. Following the coding process, the issues that were most frequently mentioned were more specific than the initial highest level coded categories and are therefore conveyed with greater specificity when summarized as the findings in the main report.

There was overall strong convergence of priorities across stakeholders. Notable differences included a greater focus on municipal services and communication and engagement among non-governmental stakeholders. As no areas that received significant mention were omitted, and the focus areas are not ranked, these differences were not used to weight or select the final priority research areas. A framework for selection criteria will be developed for future cycles of the Climate Knowledge Exchange in order to instill transparency in the event there is strong divergence of priority research needs among stakeholders.

The review process for the findings included comparison to the analysis of the Community Board Needs Assessment conducted by Sci4NY, a series of feedback sessions with participants (three sessions with City agency staff and two with community members), one joint briefing with the Environmental Justice Advisory Board and the NPCC, an expert review of the draft report, and incorporation of review comments. These review procedures aim to ensure transparency.

APPENDIX 2

POLICY DOCUMENTS

Aligning New York City with the Paris Climate Agreement (The City of New York, 2020)
An Equitable Recovery for NYC (Climate Works For All, 2020)
Climate Change Vulnerability Study (Con Edison, 2021)
Climate Resiliency Design Guidelines (The City of New York, 2020)
Cool Neighborhoods NYC (The City of New York, 2017)
Every Neighborhood Comprehensive Resilience Strategy for NYC (Rise to Resilience, 2020)
NPCC3 2019 Report
NY Rising Community Reconstruction Plan (2014)
 Canarsie
 Rockaway East
 Gravesend and Bensonhurst
 Southern Brooklyn (Brighton Beach, Coney Island, Manhattan Beach, and Sea Gate)
 Rockaway West
 Southeast Brooklyn Waterfront (Bergen Beach, Georgetown, Marine Park, Mill Basin, Mill Island)
 Lower Manhattan
 Gerritsen Beach and Sheepshead Bay
 East Bronx Waterfront
 Broad Channel (updated 2016)
 Breezy Point
 Idlewild Watershed Communities
 Staten Island
 Red Hook
 Howard Beach
NYC Climate Justice Agenda 2020/A Critical Decade for Climate, Equity, & Health (NYC-EJA, 2020)
NYC's Risk Landscape: A Guide to Hazard Mitigation (NYCEM, 2019)
NYC's Roadmap to 80X50 (The City of New York, 2014)
One City Built To Last Technical Working Group Report (The City of New York, 2016)
Resilient Edgemere (HPD, 2017)
SIRR: A Stronger, More Resilient New York (The City of New York, 2013)
Staten Island's North Shore Community Resiliency Assessment (North Shore Waterfront Conservancy of Staten Island. Inc., 2015)
STEW-MAP (USDA, 2017)
The Cost and Affordability of Flood Insurance (RAND, 2017)
WE ACT 2019 Policy Agenda Campaigns & Initiatives
WE ACT Extreme Heat Policy Agenda 2020
Where We Live (HPD, 2020)

PARTICIPATING ORGANIZATIONS

AT&T
Barnard College
Baruch College
Brooklyn College
Brooklyn Community Services
Canarsie Neighborhood Alliance
Canarsie Community Development Corporation
Catholic Charities Brooklyn and Queens, Rockaway
Church of God Christian Academy
Climate Adaptation Partners
Columbia University
Con Edison
Consensus Building Institute
Cornell University
Cypress Hills Local Development Corps
Drexel University
East New York Farms
Eastern Generation
Economic Development Corporation
Environmental Defense Fund
Fresh Creek Civic
Hudson River Foundation
Hunter College
National Grid
National Wildlife Federation
Natural Resources Defense Council
Nutral Areas NYC
New Hamilton Beach Civic Association
New York City Panel on Climate Change
New York Sea Grant
New York University
Nos Quedamos
NY Power Authority
NYC Department of Buildings
NYC Department of City Planning
NYC Department of Citywide Administrative Services
NYC Department of Environmental Protection
NYC Department of Health and Mental Hygiene
NYC Department of Parks and Recreation
NYC Department of Sanitation
NYC Department of Transportation
NYC Design Development and Construction
NYC Emergency Management
NYC Housing and Preservation Development
NYC Housing Authority
NYC Mayor's Office of Climate Policies and Programs
NYC Mayor's Office of Resiliency
NYC Mayor's Office of Sustainability

PARTICIPATING ORGANIZATIONS, CONT.

NYC Office of Recovery
NYC School Construction Authority
NYC Police Department
Port Authority
Public Agenda
Rockaway Beach Civic Association
Rutgers University
Sarah Lawrence College
SCAPE
Science and Resilience Institute at Jamaica Bay
Solar One
Stevens Institute of Technology
The Nature Conservancy
The New School
The Point
The Trust for Public Land
University of Maryland
Vital Strategies
Waterfront Alliance
Wildlife Conservation Society
Youth Ministries for Peace and Justice

APPENDIX 3

LIVING WITH CLIMATE

- Impacts on human health/behavior
- Connecting science and climate risk info to individuals
- Social science research on personal perception/barriers/behaviors
- Heat
- Coastal/Tidal Flooding
- Disproportionate impacts of climate change
- Climate extreme's impact on local economy
- Community impacts/risks, granular
- Education on climate change/hazards
- Advance understanding of extreme events
- Financial costs of climate change
- Impact of COVID-19, including on GHG emissions
- Transportation

CLIMATE AND THE BUILT ENVIRONMENT

- Ecologically grounded solutions/interventions
- Testing/research before adaption implementation
- Impact of individual actions to aggregate impact
- Adaptation evaluation research
- Groundwater risks
- Develop dynamically downscaled storm and wind simulations
- Standardized data on infrastructure
- Consumption/waste and energy legislation

MANAGING RESILIENCY

- Compounding events
- Impacts on wildlife/ecosystem
- Disproportionate impacts of climate change
- Connecting existing research to implementation
- Solution/adaption implementation
- Future energy trends/patterns
- Risk scenario modeling
- Advance understanding of extreme events
- Managed retreat
- Cost savings research
- Flow of information
- Disproportionate levels of resiliency by neighborhood
- Describing uncertainty of climate risks
- Sub-daily precipitation
- Impact of individual actions to aggregate impact
- Developing consensus and focus on most impactful projects

NOTED BARRIERS TO CLIMATE ACTION

- Underutilized city property and buildings
- Lack of mobility in vulnerable areas
- Interruptions in services – water/sanitation/electricity
- Addressing health inequities related to siting of peaker plant
- Information on what existing city processes will “break”
- How to communicate through trusted sources
- Connecting meaningfully to the climate justice movement
- Valuation of disaster response and mobility to dollars and cents for homeowner
- A robust understanding of uncertainty, models that integrate data from other sectors that also assess the impact on different sectors outside of climate
- What can individual building owners do to prevent and mitigate flood damage
- Develop economic models that support the prioritization of climate mitigation

MORE RESEARCH TOPICS

- Infrastructure resilience
- Inland Flooding
- Challenges meeting LL97 requirements
- Scaling up communications
- Inland flooding
- Passive cooling
- Existing building adaptation
- Climate change in other regions
- Establish standardized data to identify climate vulnerable communities
- Industrial waterfront pollution
- Funding coastal resiliency
- Cell service
- Different timescales of climate change
- Collect personal narratives from climate extremes
- Access to parks/green space
- Communicating local knowledge to decision makers
- Fiscal risk as indicator to measure progress
- Contextualization of climate risks vs other risks
- Level of personal control around climate vulnerability
- Community co-production of data
- Corporate impact/accountability on climate change
- Social media’s impact on climate risk perception
- Stewardship & Volunteer hours
- Data accessibility
- Small efforts and aggregate impact
- Climate change outside NYC
- Adaptive re-use
- Natural climate cycles
- Effective visual tools
- New flood zone building typologies
- Equitable cost-benefit analysis
- NYC specific information on benefits
- Movement during and after disasters
- Guidelines for infrastructure agencies and risk tolerance
- Small buildings
- Community adaptation, local and beyond
- Barriers to policy implementation
- Who needs to be communicated to
- Energy grid
- Social impacts
- Baseline information on existing conditions
- Community adaptation, local and beyond
- Energy security – renewable tech
- Impact on children
- Financial benefits of social cohesion

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