

**DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION
PLANNING IN NEW YORK CITY**

by

Benjamin D. Wallace

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Science in Disaster Science and Management

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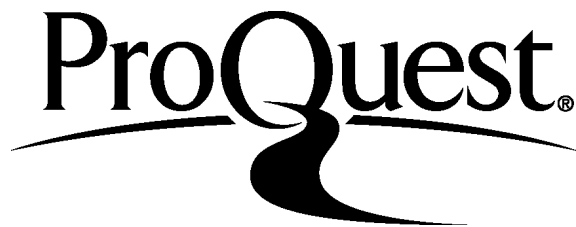
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PLANNING IN NEW YORK CITY**

by

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“Despite years of learning and preparation, we are sobered by the “new normal” that climate change is producing in our city, including more frequent and intense summer heat waves and more destructive coastal storms like Hurricane Sandy. We can’t know that the future will not repeat the past, so we must prepare on all fronts.” New York Mayor Michael Bloomberg

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ABSTRACT

Climate change has gained attention within disaster management as its current and projected impacts have become clearer. The potential for increased risk in some areas, like coastal cities, is an important part of both disaster risk reduction (DRR) and climate change adaptation (CCA). DRR addresses climate-related disasters like hurricanes and heat waves, and is increasingly focused on preexisting vulnerability that allows them to occur. However, its climate change-related efforts have been relatively limited, and often operate independently of similar CCA efforts. This disconnect creates inefficiencies in research and practice, and is a focus of this inquiry, which considers the relationship between the fields by developing an assessment framework. The framework is demonstrated by applying it in a case study of New York City (NYC) through a qualitative, computer-driven analysis of planning documents. Data from 2011-2015 is used, allowing some exploration of how Hurricane Sandy (2012) played a role by focusing attention on ongoing efforts. The results indicate that NYC leads in some ways, demonstrating the role of political leadership, interdepartmental coordination, cross-cutting measures, and incorporating a vulnerability perspective in planning efforts. However, it seems probable that NYC failed to effectively engage existing DRR efforts, or target socioeconomic vulnerability by engaging citizens. Thus, while there are many lessons to be learned from the extensive planning efforts undertaken by NYC, there may be vulnerability within the government itself, manifested as an inability to adapt to changing conditions or directly address root causes of socioeconomic vulnerability.

Chapter 1

A NEW PROBLEM FOR DISASTER MANAGEMENT

Climate change is recognized as a serious global challenge, and while communities have been adapting to climatic trends and extremes for centuries (Mercer, 2010), modern cities must adapt to a new threat in the form of relatively rapid climate change (Glantz, 2005). Climate change impacts a range of both hazards and vulnerabilities (Kelman & Gaillard, 2010), and as models produce a range of scenarios and predictions, social scientists are expected to determine how society should respond to them (Glantz, 2005). A well-known option for responding to climate change is climate change mitigation (CCM), which aims to prevent climate change, or lessen its impact, by managing human activities that have been linked to it. However, as these efforts have had difficulty gaining traction, climate change adaptation (CCA), focused on reducing disaster risk related to climate change, has become more important (Hallegatte, Green, Nicholls, & Corfee-Morlot, 2013).

This issue is particularly important in coastal regions, due in part to sea level rise (SLR), subsidence, and erosion. It is also particularly important in cities because of heat islands, rapid urbanization, and improper land use, according to the Intergovernmental Panel on Climate Change (IPCC, 2012). The IPCC is an important body that is referenced often in this inquiry which is working on both CCA and CCM. It is an international collaboration of thousands of scientists working on a voluntary basis to review and assess current knowledge related to climate change (IPCC, n.d.). Additionally, this is a complex issue impacts both hazards and vulnerabilities, as well as the work of many parts of

government, the private sector, communities, and individual citizens. When authorities and planners in coastal cities confront this problem, they may need to consider how to mainstream CCA into all kinds of sector work, including urban planning (Wamsler, Blaikie, Cannon, & Davis, 2013). However, related knowledge is scarce (Greiving & Fleischhauer, 2012). Moreover, there may be hesitation to invest in managing this problem for many reasons, including varying local impacts and governance contexts (Dover & Hezri, 2010), inadequate consideration of the needs of future generations (Mazmanian, Jurewitz, & Nelson, 2013), limited resources and funding (Measham et al., 2011), competing agenda items (CCD, 2008), and lack of political will (Scrieciu, Belton, Chalabi, Mechler, & Puig, 2014). Thus, while many cities are already engaged in related planning, the overall response to scientific information about climate change is "diffuse and uneven" often headed by a single agency or individual without proper legislative support, financial backing or human resources for implementing action plans (Solecki et al., 2011, p. 138), and even in cities where adaptation is seen as important there is little implementation (Wamsler et al., 2013).

This creates a context in which management of this problem may be difficult, and this investigation finds that researchers are advocating for more comprehensive efforts (Solecki et al., 2011), and coordination (Fraser, Dougill, Mabee, Reed, & McAlpine, 2006). Indeed, a central focus of this investigation, explicitly supported and implied in the methodological approach, is the considerable potential for synergy between ongoing DRR and emerging CCA efforts. A concept to describe this crossover is introduced, and a companion tool for assessing related plans is developed. The concept, referred to as climate change disaster risk reduction (CCDRR), is designed to explore the complexities

of the intersection of CCA and DRR, and provide a relatively concise way to talk about this area of crossover. However, it is important to note that the considerable crossover and potential synergies do not necessarily mean CCDRR should be a distinct pursuit. While the term CCDRR is conceptually useful, many CCA efforts related to disasters should be incorporated into DRR, and pursued in the broader context of sustainable development (Kelman, Gaillard, & Mercer, 2015). Other parts of CCA, such as the realization of benefits, or adaptation efforts unrelated to disasters (e.g., maximizing agricultural output), are also outside the purview of DRR, and should be addressed separately. The CCDRR assessment tool created for this inquiry contains criteria and related indicators that act as a framework for exploration of city planning related to climate change disaster risk. This will facilitate directed coding of CCDRR planning, and is intended to be a theoretically and practically valuable result of this investigation. Thus, this framework will serve as a theoretically-grounded tool for assessing adaptation efforts in the case study, NYC, and will also be adjusted based on this investigations findings in order to serve as a guide for future CCDRR planning efforts.

NYC was selected primarily because of its relatively high risk, but case selection also considered political context, affiliations to city networks, focusing events, and socioeconomic factors which allowed some exploration of additional factors. Miami and New Orleans were also considered as potential cases. Miami has relatively high risk, and the political climate in Florida could allow a fruitful exploration of the role politics plays in CCDRR planning. New Orleans is an appealing case because it could allow exploration of the role of focusing events (because of Hurricane Katrina). Ultimately, the scope of this inquiry limited it to one case, and NYC was chosen for a variety of reasons,

as discussed in the methodology chapter. Data consists primarily of organizational documents pulled from NYC's website, and computer-assisted qualitative document analysis software (CAQDAS) was used to apply the CCDRR assessment framework to the data. The following section situates this inquiry in relation to existing research by discussing the background related to this topic, then the next two chapters develop the CCDRR concept and related assessment tool, respectively.

Literature Review: Climate Change and Disasters, Coasts, and Cities

This section briefly discusses evidence of climate change, then addresses projected impacts on disaster risk, and the unique relationship between climate change, coasts, and cities. Because of the political and contentious nature of this issue, it is worth briefly discussing evidence of climate change and its impact on the planet. Climate change is seen as "one of the defining issues of our time" (The Royal Society, 2014a), and strong evidence shows that anthropogenic climate change is occurring, meaning most of the recent change is because of human activities (National Academy of Sciences, 2010; National Academies, 2005). Indeed, meteorologists state that the Earth's average temperature has risen from 15.5°C to 16.2°C in the last 100 years (WMO, n.d.). Few scientists disagree with this position (Oreskes, 2004), and there is a strong consensus amongst climate scientists that the climate is rapidly changing because of greenhouse gas (GHG) emissions, despite uncertainties surrounding long-term impacts (AAAS, 2009). Investigating this consensus, Oreskes (2004) analyzed 928 abstracts from papers published 1993-2003 and found that none disagreed with the consensus position (that humans are playing a role in climate change), or argued that current warming is natural.

Additionally, three more recent studies concluded that 97-98% of climate scientists support this consensus (Doran & Zimmerman, 2009; Anderegg, Prall, Harold, & Schneider, 2010; Cook et al., 2013). Doran and Zimmerman argue that debate about human influence on climate change “is largely nonexistent among those who understand the nuances and scientific bases of long-term climate processes. The challenge, rather, appears to be how to effectively communicate this fact to policy makers and to a public that continues to mistakenly perceive debate among scientists.” (2009, p. 23). This background is important because climate change can be a controversial issue. In fact, a 2014 survey shows that only 83% of Americans believe the climate is changing (Rice, 2014), let alone that it is anthropogenic. Notably, this may be increasing, as earlier polls found this number was 70% in 2012, and 52% in 2010 (Schiffman, 2012a), but there is still a significant gap between public opinion and scientific consensus. This sharp divide may be due to “campaigns designed to confuse the public about the level of agreement among climate scientists,” and improper media treatment of the issue that amplifies the views of a vocal minority (Cook et al., 2013, p. 6). Although exploration of this issue is outside the scope of this inquiry, public perception is relevant context because stakeholder involvement is an important part of CCDRR (Smith et al., 2009).

Disasters: changing hazards and vulnerabilities. Regardless of political controversy, city governments should consider how climate change may influence their disaster risk. Climate change is multifaceted, multidimensional, and has short, medium and long-term aspects and unknown outcomes, according to O’Brien, O’Keefe, Rose, and Wisner (2006), who say major international bodies (e.g., United Nations Framework

Convention on Climate Change, 1997 Kyoto Protocol) recognize serious potential hazards associated with it. These hazards vary by region, and include SLR, temperature extremes, flooding, landslides, windstorms, fires, spread of infectious diseases, famine, and drought (IPCC, 2012). Unfortunately, while projections are often available at global and regional scales, they may not be at the local level, and can be unreliable for taking actions with concrete, long-term financial and social implications (Prabhakar, Srinivasan, & Shaw, 2009). Furthermore, there are misconceptions about the relationship between climate change and disasters, such as some people blaming geophysical hazards and related disaster on climate change (Kelman & Gaillard, 2010), when climate change is linked to hydro-meteorological hazards (Helmer & Hilhorst, 2006). The majority of impacts are expected to materialize through climate variability and extreme weather, and climate change is already shifting the frequency and intensity of hazards like heavy rainfall, droughts, high sea levels, and possibly cyclones “with direct implications for disaster risk” (Mitchell & van Aalst, 2008, p. 4). Despite uncertainty, current trends and projections give researchers and practitioners an idea of how climate change will impact disasters in the future. One such trend is the increase in disasters related to hydro-meteorological hazards.

An increase in disasters over the past two decades has mostly been related to hydro-meteorological events, according to Birkmann and Teichman (2010), who claim “there is an obvious relationship between climate change and the increase in climate-related hazards.” (p. 172). Other researchers argue that more extreme weather events are being observed, with growing evidence that they are linked to GHG emissions (Panton, Deque, Chauvin, & Terray, 2008; IPCC, 2012), and the Stern Review of the Economics

of Climate Change and United Kingdom Department for International Development's DRR Policy state that "about two thirds of disasters are caused by climate hazards and these are increasing in number and severity due to climate change." (Mitchell & van Aalst, 2008, p. 3). Notably, changes in frequency and intensity of hydro-meteorological hazards vary by region. For example, some research projects decreased frequency of tropical cyclones of 6-34%, and an increase in intensity of 2-11% (Knutson et al., 2010), and central Europe may have experienced a decrease in flooding over the last 80-150 years (though this can partly be attributed to fewer strong freezing events which may enhance floods) (Mudelsee, Börngen, Tetzlaff, & Grünewald, 2003). Finally, Zahn and Storch (2010) show that climate change is expected to decrease the frequency of polar lows (high latitude mesoscale cyclones), in what they say is "a rare example of a climate change effect in which a type of extreme weather is likely to decrease, rather than increase." (p. 309). Thus, while disaster risk is changing, impacts vary by region, and are not easily predictable. This affirms the need for management of these growing threats, including not just emphasis on disaster risk management, but also how it should be done differently (Prabhakar et al., 2009, p. 12).

Changes in disaster risk are particularly important for coastal regions, which are an important part of this inquiry. Flooding in coastal zones, and the social, economic, and cultural impacts of climate change, are a focal point for research and policy making (Oliver-Smith, 2009). This includes the development of institutional mechanisms for managing coastal zones (Klein, 1999), and modeling coastal flooding related to climate change (Hunt, 2002). For example, it is estimated that the last time the Earth had this concentration of atmospheric CO₂, the sea level was around 15-35 meters higher (Hansen

et al., 2007). Indeed, there has already been an increase in extreme coastal high water related to SLR, according to the IPCC (2012), which says it is very likely SLR will drive future erosion and inundation. Researchers estimate SLR was occurring at a rate of 1-1.4 millimeters/year from 1901-1990, and 2.3-3.7 millimeters/year from 1993-2010 (Hay, Morrow, Kopp, & Mitrovica, 2015), indicating an increasing rate of rise. In addition to SLR, extreme weather, subsidence, erosion, and human behavior (e.g., removing natural barriers, building flood walls) can influence flooding. Researchers also suggest that heavy precipitation has already increased over the last century (Greenough, 2001), and further increases are predicted in some areas (IPCC, 2012). The frequency of cyclones – coastal storms also called hurricanes or typhoons (NOAA, 2014b) – is hard to accurately predict (Greenough, 2001), but some researchers believe there will be an increase in the frequency of the tropical cyclones, despite a mean global decrease (IPCC, 2012). Anecdotally, 2004 was a record year as 10 intense typhoons landed in Japan, breaking the previous record of six, set in 1990 and 1993, and the Japan Meteorological Society attributes this to climate change (Japan Meteorological Society, 2004, as cited by Prabhakar et al., 2009). Since 40% of humans live within 60 miles of the coast (UNFAO, 2014), and 39% of Americans live in a county that borders the ocean, which is expected to increase 8% by 2020 (NOAA, n.d.), densely populated coastal areas are an important focal point for research and practice.

In addition to coastal areas, cities deserve special attention regarding climate change and disasters. This is partially because the environmental changes humanity faces today are closely related to urbanization, and are happening with unprecedented speed and magnitude (EEA, 2012; O'Brien & Leichenko, 2008). Alongside changes in

socioeconomic conditions, this urbanization influences exposure and vulnerability, and rapid urbanization and inadequate land use have contributed to the creation of highly vulnerable urban communities (IPCC, 2012). To facilitate understanding of the relationship between urban areas and hazards, Wamsler et al. (2013) develop a concept they term the “urban fabric,” which includes visible changes brought about by urbanization that influence the environmental, socio-cultural, and economic aspects of urban areas. They say the urban fabric has distinctive physical features (e.g., population densities, coverage and vegetation, architectural details, organization of structure on space, relation of dwelling to topographic features), and argue that this concept facilitates understanding the complex ways cities interact with hazards. This table summarizes their conceptualization of the urban fabric’s relationship with the urban environment, hazards, vulnerability, and disaster recovery and response:

Table 1 The urban fabric (adapted from Wamsler et al., 2013, p. 71-74)

Urban climate The urban fabric impacts the environment, including changes in:	● Precipitation ● Temperature ● Wind, air quality, and humidity ● Solar radiation ● Soil ● Water quality ● Flora and fauna ● Noise ● Waste
---	--

Hazards The urban fabric can influence hazards by:	● Intensifying extant hazards (e.g., rainfall, wind, temperature) ● Creating new hazards (e.g., fires, landslides) ● Concentrated land use increasing the likelihood of compound hazards ● Contributing to climate change through GHG emissions
Vulnerability The urban fabric can influence vulnerability by:	● Direct/indirect creation of susceptible conditions including high population density, concentrated services, infrastructure, economic and political centers ● Inadequate construction materials or techniques ● Space restrictions and informal settlements ● Economic specialization ● Lower levels of social cohesion ● Decreasing ground stability, permeability and cooling ● More dynamic conditions that making risk management more difficult
Response and recovery The urban fabric and disaster response and recovery:	● Increased need for complex response and recovery mechanisms and structures due to the large populations and multifaceted context ● Impacts on mechanisms due to increased co-location with disasters ● Access/transportation/housing hampered by limited, crowded infrastructure ● Additional specialized functions for the urban environment ● Limited space for shelters and temporary housing ● Increased stressors and disturbing factors that diminish public ability to respond and recover (e.g., noise, contamination, reduced lighting, poor sanitation, lack of green areas, limited access to resources) ● Constantly changing extension, composition and layout of the urban fabric which makes up-to-date information harder to acquire or maintain

As indicated by this chart, cities differ from other areas for socio-cultural reasons, which can influence vulnerability (Wamsler et al., 2013). This is a reason that disaster resilience and sustainability through focusing on a broader system-resilience framing that facilitates living in a dynamic environment is a goal of both CCA and DRR (Cannon & Müller, 2010; Morss, Wilhelmi, Meehl, & Dilling, 2011). While disaster management does not typically focus on slow-onset disasters (Vlek, 2005), some researchers argue that it should (Birkmann & Teichman, 2010), and even if they remain outside the purview of

disaster management, hazards like heat-waves, drought, and disease can influence vulnerability and interact with other hazards. In other words, it could be important to systematically address vulnerabilities brought about by urbanization by using a broader approach that focuses on vulnerability and capacity building to address a range of rapid and slow-onset hazards. However, researchers have noted potential drawbacks. For example, Fekete, Hufschmidt, and Kruse (2014) argue that the terms “vulnerability” and “resilience” are not well defined (e.g., resilience is a vague, “umbrella” concept), that evaluations of the concepts are lacking, that focusing on resilience may sideline other standard approaches, and that resilience may function as a way to justify transferring responsibility from public authorities to citizens. As these authors point out, these terms and approaches can still be useful and appealing for multiple reasons, including the relatively flexible nature of their definitions (which may facilitate collaboration between fields), the potential for this broader approach to manage unexpected risk, and the possibility that resilience may have colloquial and policy appeal due to its positive and transformative nature (which can bring stakeholders together with a common goal). Thus, while these approaches may be useful, they are not always clearly defined, and drawbacks associated with their use should be considered.

The length and number of heat waves has probably already increased in many regions (IPCC, 2012), and it has been estimated that there will be a sizeable net increase in weather-related mortality if the climate warms as predicted (Kalkstein, 1999). Indeed, changes in mortality associated with exposure to ambient temperature are considered the most direct way climate change will impact public health, and heat-related mortality is projected to increase over 250% in the UK without adaptation (Hajat, Vardoulakis,

Heaviside, & Eggen, 2014). Cities are more at risk because of the heat island effect, which is the result of heat storage and radiation, and outlet air (Adam, 1988). Heat-waves are likely already more intense across North America, with models projecting that heat waves in some cities will become more intense, more frequent, and longer lasting in the second half of the 21st century (Meehl & Tebaldi, 2004). Notably, a 2003 Parisian heat wave caused almost 5,000 deaths (Dousset et al., 2010), 2014 broke the record for highest annual mean global surface and ocean temperature, and nine of the 10 warmest years on record have occurred in the 21st century (NOAA, 2014a).

Drought is another slow-onset hazard that can have a range of effects, as illustrated by a relatively recent disaster declaration in the U.S. which covered over 1,000 counties and made farmers eligible for low interest loans to manage drought and wildfires (Rippey, 2012). Indeed, research suggests that that warming is already decreasing some crop yields, which will likely continue as the Earth warms (Asseng et al., 2014). Another striking example is the ongoing drought in California, driven by reduced precipitation and record high temperatures, which is likely the worst drought in that area in 1,200 years (Griffin & Anchukaitis, 2014). O'Brien et al. (2006) predict that slow onset disasters may occur more frequently due to climate change, and some regions have likely already experienced more intense and longer droughts (IPCC, 2012). Droughts can also cause difficulty fighting fires (Scawthorn, 2000), increase the risk of wildfire when coupled with extreme heat and low humidity (IPCC, 2012), and, interacting with extreme temperatures, drought can stress already exhausted coping capacity (O'Brien et al., 2006).

In addition to heat-waves and droughts, disease may also be associated with

climate change, although understanding the relationship between diseases and climate has been challenging (Kovats, 2001; Reiter, 2001), and the role of non-climatic factors that impact epidemiology is not well understood (Campbell-Lendrum, 2006). However, research suggests that climate is associated with influenza epidemics (Viboud, 2004), and that differing local climates and vulnerabilities are expected to create uneven health impacts across the U.S. (Longstreth, 1999). Furthermore, some researchers argue that disasters caused by natural hazards related to rapid onset climate change are linked to increases in violent civil conflict (Nel, 2008), and some island nations are considering moving their populations (Bender, 2013). Thus, slow-onset hazards can cause vulnerability and stress, thereby contributing to disaster risk.

Climate change is likely to impact cities through heat waves and other hazards, in addition to influencing both vulnerability and exposure. Unfortunately, this problem is compounded by uncertain climate projections, a limited understanding of the causal relationship between climate and disasters, and unique features of cities that may increase their risk. According to Broto & Bulkeley (2013), cities are increasingly important for responding to climate change, and their global investigation of urban climate experiments found local governments leading 66% of the time. Looking specifically at adaptation, 46 of 76 experiments were led by local government, 19 by other government, and the remaining 11 were from private or civil society actors. Other researchers have found that wealthy nations put more emphasis on coordination between urban authorities and creating public-private partnerships than working with citizens in the advancement of risk governance structures (Wamsler et al., 2013). Thus, city governments are likely to play an important role in managing climate change disaster risk.

Risk in coastal cities. Human populations and assets are increasingly concentrated in coastal cities (Solecki et al., 2011), even as coastal settlements face a variety of hazards related to climate change (IPCC, 2012), which poses a serious threat to development, and will inevitably increase the susceptibility of urban societies without effective CCA (IPCC, 2007; UN Habitat, 2011). Subsidence and SLR are projected to increase flood losses globally, even if adaptation maintains constant flood probability, and some research suggests that present protection will need updating to avoid annual losses of US\$1 trillion or more (Hallegatte et al., 2013). Changes in rainfall and tropical storms impacting populations and infrastructure not designed for such conditions may add to this problem, according to Solecki et al. (2011), who say that climate change “is likely to increase the suite of hazards present in any particular urban area,” so it enhances the need for ongoing reassessment of disaster planning in cities (p. 136-137).

A recent study found that annual average losses (AAL) from flooding in the largest coastal cities could rise from about \$6 billion/year today to around \$1 trillion/year in 2050 without preventative action (Hallegatte et al., 2013). With preventative actions (e.g., levees, pumps, barriers, improved flood monitoring) which are estimated to cost around \$50 billion/year, these loss projections go down to \$63 billion/year, which is still a steep increase even without adaptation costs factored in. However, these authors point out that climate change is only one driver of increased costs among others, accounting for about \$11 billion of the \$63-billion-dollar projection. It is important to consider projections beyond the 2050 mark (Plumer, 2013), and a study by Nicholls et al. (2008) does so by projecting impacts in 2070. They suggest that total exposed population in port

cities could be three times as large due to SLR, storms, subsidence, population growth, and urbanization, and that asset exposure could increase tenfold to roughly 9% of projected global GDP. Importantly, they found that socio-economic growth and urbanization are the most important drivers of this increase, though climate change and subsidence significantly exacerbate the effect. Finally, even assuming very high protection levels everywhere, significant exposure “is likely to translate into regular city-scale disasters across the global scale” (p. 3). This means that the benefits of urban CCA policies are potentially great, and “failure to develop effective adaptation strategies would inevitably have not just local but also national or even wider economic consequences.” (p. 8). The U.S. is relatively vulnerable, and highly concentrated coastal flood risks mean that targeted flood reduction actions could be very cost effective (Hallegatte et al., 2013), so managing this problem in coastal U.S. cities is an important research topic for multiple reasons.

Managing Climate Change Disaster Risk: CCM, CCA, and DRR

According to the President of The Royal Society, “We have enough evidence to warrant action being taken on climate change; it is now time for the public debate to move forward to discuss what we can do to limit the impact on our lives and those of future generations” (The Royal Society, 2014b). Fortunately, there are multiple approaches to managing disaster risk related to climate change, including climate change mitigation (CCM), climate change adaptation (CCA), and disaster risk reduction (DRR). CCM aims to reduce GHG emissions, thus slowing climate change and avoiding some of its impacts (Prabhakar et al., 2009) by addressing the root of the problem. It received the

most attention initially, and it still tops the international development agenda, as it requires urgent attention (Mercer, 2010). Some researchers suggest that it would be foolhardy to continue current emissions (which can stay in the atmosphere for hundreds of years), that the Earth's climate has the potential for large rapid fluctuations, and that we will likely pass the dangerous level of atmospheric GHGs at least temporarily (Hansen et al., 2007). Even if all GHG emissions stopped immediately, the Earth's surface temperature would likely not return to the pre-industrial level for a very long time (The Royal Society, 2014a; Kelman & Gaillard, 2010). Despite such serious warnings, CCM efforts "are far from sufficient or able to make a significant dent in curbing the relentless rise in global greenhouse gas emissions" (Scrieciu et al., 2014, p. 262). Thus, climate change is a significant "long-term, global disaster." (Mercer, 2010, p. 248; Kelman & Gaillard, 2010, p. 30), and one approach to managing it is mitigation. CCM is worth introducing briefly because it provides context for understanding CCDRR planning – including the historical relationship with CCA and ability to reduce long-term climate change disaster risk – but it will not be focused on for three reasons. First, this inquiry is focusing on the synergy between CCA and DRR, and CCM does not share the same crossover as they do. Second, CCA and adjusted DRR efforts are necessary regardless of CCM efforts, because considerable changes are expected even with unrealistically successful CCM. Finally, because this inquiry focuses on city-level planning, CCM is not as applicable because its effects are global, not local.

CCA is a second approach for managing this problem, and is defined as "adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities." (UNISDR,

2009, p. 4). While the concept is very broad, strategies generally aim to reduce vulnerability and the threat of negative impacts, and potentially insufficient CCM efforts have made CCA the second primary response to climate change (Mercer, 2010). Because it is multidisciplinary, it uses a range of policies and strategies that involve participants and institutions across multiple sectors, and current efforts are generally piecemeal, often requiring clear leadership from somewhere in government, often an executive branch (Smith et al., 2009). The nascence of the field means related scientific knowledge and practitioner competence are scarce and fragmented (Wamsler et al., 2013), but researchers, disaster management professionals, policy-makers, and many other stakeholders are engaging the issue (UNFCCC, 2006). Aspects of CCA are already present in disaster management, water management, coastal protection, environmental management, public health, development planning, other parts of government, and the private and public sectors (Wamsler et al., 2013). Part of disaster management related to CCA is DRR, which is also multidisciplinary in nature, dealing with political, environmental, and economic factors related to hazards (Mercer, 2010). Good DRR increases resilience and prevents development efforts and other activities that increase vulnerability (UNDP, 2004; UNISDR, 2004). DRR is unlike disaster response and recovery because it is a “cross-cutting (or mainstreaming) issue which is of high importance during the whole disaster cycle.” (UNISDR, 2005). Unlike CCA, DRR does not exclusively deal with climate-related disasters, and, unlike DRR, CCA considers benefits associated with climate change, and is more focused on slow-onset and public health concerns. However, there is considerable overlap, as they share the goal of reducing risk from disasters related to climate change, and this investigation argues that

their combined perspectives and characteristics hold the potential for increasing efficiency and effectiveness. While balancing response to climate change among other concerns is important (Kelman & Gaillard, 2010), the IPCC predicts it will continue well beyond the 21st century under a wide range of scenarios (2012), so long-term adaptation and risk management are important. The next chapter develops the concept of climate change disaster risk reduction (CCDRR), which is essentially a conceptual tool that supports understanding and discussing about the intersection of the two fields. In other words, if something is part of both CCA and DRR it is considered CCDRR for the sake of clarity in this research, though it should be noted that this does not mean CCDRR should become a distinct pursuit.

Chapter 2

DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION

This investigation focuses the ways in which coastal U.S. cities are planning on managing climate change disaster risk, and this chapter develops a conceptual background by discussing the relationship between CCA and DRR. This is done primarily through the development of a concept labeled climate change disaster risk reduction (CCDRR). While CCM is an important, global option for long-term management of this problem, individual cities have very little control over global GHG emissions, so some will face changes in disaster risk regardless of any CCM efforts they make. An obvious part of adapting to climate change risk is through revising DRR efforts, and this potential change within DRR is an area under development in theory and practice. A common framework for addressing current disasters and long-term climate change is needed (Lei & Wang, 2013), many researchers have advocated for embedding CCA within DRR (e.g., see CCD, 2008; Prabhakar et al., 2009; Mercer, 2010, Kelman & Gaillard, 2010), and disaster researchers have begun using the concept of CCA in their work, even if they are not explicitly endorsing integration (Wisner, Blaikie, Cannon, & Davis, 2004; Cutter et al., 2008; Birkmann, 2006). Thus, there is no clear path towards the integration of efforts, many researchers recognize the importance of using similarities between the two fields to improve research and practice.

Because disasters up to the global level and with timescales of decades have been on the disaster agenda for a long time (e.g., desertification, climatic changes from

meteorites and volcanic eruptions) there is precedent for including long-term, global disasters like climate change as a subset of DRR (Kelman & Gaillard, 2010). Notably, these authors point out that CCA could be the dominant influence in local flooding and droughts, or it could have minimal impact, so CCA could be critical for some DRR practitioners and inconsequential for others. Also, DRR cannot entirely subsume CCA because disaster risk is only one of several CCA concerns, including agricultural adaptation, infrastructure development, public health, and potential benefits associated with a different global climate (IPCC, 2007; UNISDR 2009). However, it is clear that this is an area of interest, and this investigation will label this overlap climate change disaster risk reduction (CCDRR) in order to make discussion easier and increase clarity. An example of the need for this term comes from an international commission founded in order to propose ways to integrate DRR and CCA, which published a report focused on research incentives and constraints in this area that used the term “CCA/DRR” 38 times in a nine-page document (CCD, 2008). The following diagram illustrates some differences and similarities between the two fields. Within this section of crossover, no doubt there is potential for inefficiency if the two fields operate in isolation.

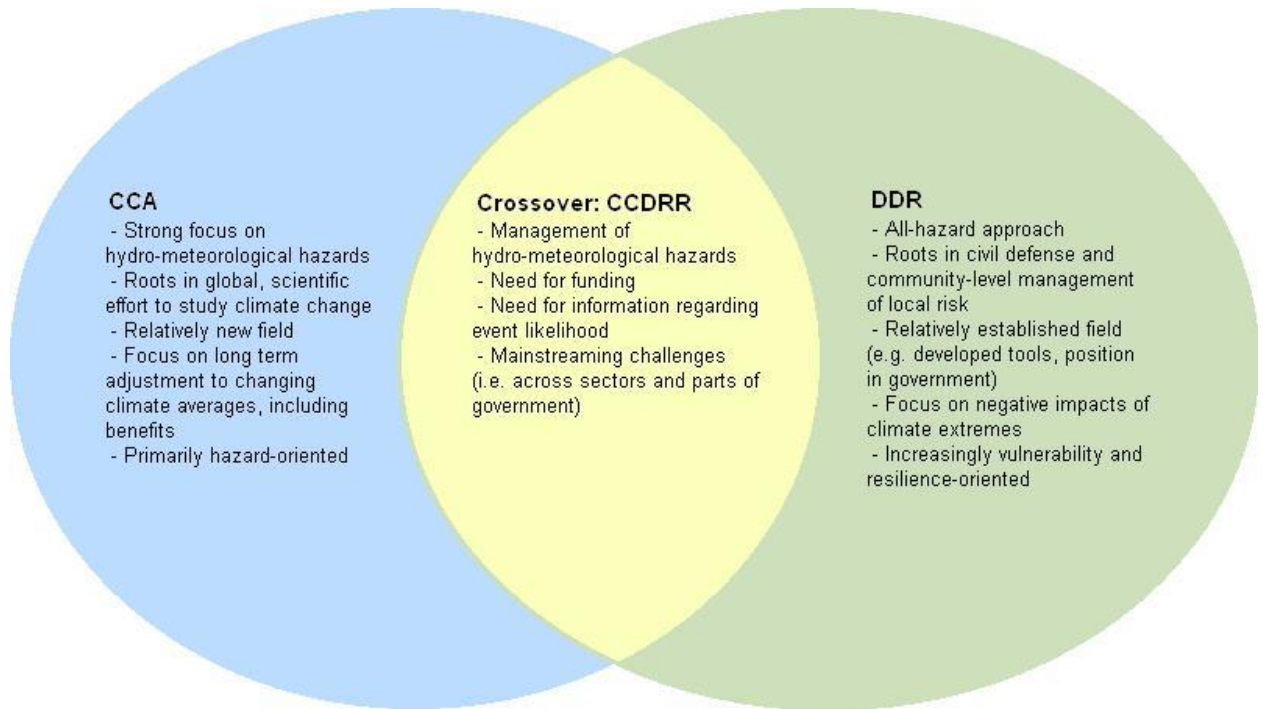


Figure 1 Illustration of CCDRR - the crossover between CCA and DRR.

Differences and Similarities

Conceptual delineation is a good starting point for understanding the relationship between the two fields, so the following section explores differences and similarities between CCA and DRR. Despite obvious crossover between DRR and CCA, major challenges hinder the combination of strategies, such as incoherent funding structures, affiliation to different parts of government, and insufficient data regarding the local effects of climate change (Birkmann & Teichman, 2010). Importantly, the two fields have developed independently (UN-IATF/DR, 2006), as DRR has roots in humanitarian assistance, and CCA in scientific theory (Mitchell & van Aalst, 2008; Tearfund, 2008). Thus, while DRR is relatively established, CCA science and policy have developed in

isolation from much previous work on adaptation and disaster management (Kelman & Gaillard, 2010), and at the international level, “frameworks, political processes, funding mechanisms, information exchange fora and practitioner communities have developed independently and generally continue to be separate.” (Mitchell & van Aalst, 2008, p. 11). So, there is no reasonable framework for framing climate change disaster risk that considers near-term disasters and long-term climate change (Lei & Wang, 2014). This is a critical factor to consider – DRR must continue to grow as a field by expanding its scope by looking further into the future.

Since only weak links connect knowledge, data, and work applied by scientists and practitioners in the two fields, communicating scientific information about climate change and related uncertainty can be a substantial challenge for practitioners (Birkmann & Teichman, 2010). Howes et al. (2014) agree that these language differences make common understanding difficult, pointing out that emergency services professionals consider levees mitigation, whereas climate researchers call them adaptation. Thus, linkage could be strengthened through common knowledge and understandings of terms (Solecki et al., 2011; Mitchell & van Aalst, 2008). Additionally, spatial scale mismatches exist partially because CCA research generally focuses on global issues (Lei & Wang, 2014), whereas “disasters have been studied in the respective regions and localities where they occur” (Birkmann & Teichman, 2010, p. 174). Traditional, community knowledge is the basis for DRR resilience, and it may be insufficient for resilience against changing risk (Mitchell & van Aalst, 2008; Tearfund, 2008). In addition to these spatial mismatches, functional mismatches act as a barrier between the fields, such as DRR’s focus on extreme events, relative to CCA’s focus on long-term adjustment to climate,

including typical weather (Mitchell & van Aalst, 2008), or DRR's focus on reducing vulnerability, and CCA's focus on physical exposure (Tearfund, 2008). A final mismatch is temporal, which is seen in the relatively historical perspective of DRR and relatively future perspective of CCA (Thomalla et al., 2006; Mercer, 2010). CCA is focused on future changes in hazards, and DRR decisions are often driven by the historical frequency of events. Despite these differences and challenges to integration, DRR and CCA concepts, goals, and processes have much in common (IPCC, 2012), and they are "connected through a common goal: reducing the impacts of extreme events and increasing urban resilience to disasters, particularly among vulnerable urban populations." (Solecki et al., 2011, p. 135).

Projecting event likelihood is important for both fields, and the need to adapt DRR planning to incorporate information about climate change is illuminated by the idea of nonstationarity, which is that the past observations that are often used in disaster risk assessments are no longer reliable predictors of future outcomes (Mazmanian et al., 2013). These authors point out that builders typically project investment life with the implicit assumption that historical frequencies of biogeophysical variations accurately predict future variations, and they suggest that this is no longer dependable, because "the death of stationarity is gradually becoming accepted in practice in some fields and has been evident in academia for a decade," and at least in water management the historical assumption of stationarity is effectively dead (p. 2). Solecki et al. (2011) agree, asserting that normal understandings of hazards may no longer be reliable for risk assessments because climate change brings "a clear understanding that past climate conditions are less and less useful as a guide for future conditions." (p. 136). They point out that disaster

preparedness is still built on an understanding of risk that is based on historical events and ongoing socioeconomic or biogeophysical trends, which suggests that there is a need to review DRR strategies and improve flexibility by focusing on enhancing resilience and reducing vulnerability. Thus, institutions, policies, and practices usually maintain existing activities with the assumption of a climatic stationarity, which can actually be counterproductive (Smith et al., 2009), current responses to disasters may no longer be sufficient in a different climate (Prabhakar et al., 2009), and projections and uncertainty surrounding hazards, exposure, and vulnerability related to climate change and development mean that the status quo is continually less sufficient for DRR and CCA (IPCC, 2012). Thus, both DRR and CCA share the need to project event likelihood and impact parameters in order to changing hazards, and if DRR practitioners do not address this it could impact their ability to achieve objectives, possibly even increasing vulnerability through reliance on inappropriate measures (Mitchell & van Aalst, 2008).

Of course, exposure and vulnerability are major factors in disaster risk, and addressing this is necessary in order to understand the role of climate change in disasters, then effectively respond through vulnerability reduction, which is a core common element of CCA and DRR (IPCC, 2012). This vulnerability reduction, or increasing resilience, is the “ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” (UNISDR, 2009). Indeed, increasing resilience has become a much more prominent subject in disaster literature (Wamsler et al., 2013), and it seems clear

that it is an important area where CCA efforts can learn from DRR. This illustrates a potential synergy between the two fields, as does the idea of connecting global CCA efforts with current community-based DRR efforts, and the potential for a more holistic approach that uses CCA climate projections in current DRR risk assessments. The next section will discuss this kind of potential in more detail.

Synergy: Recognition, Resources, Knowledge, Tools, Strategies, and Plan Implementation

Potential synergies between DRR and CCA, particularly in coastal U.S. cities, are the focus of this investigation, and they include recognition, resources, knowledge, tools, strategies, and implementation. According to the IPCC, closer integration of disaster risk management (DRM) and CCA in policies and practices could provide benefits at all scales, including local (IPCC, 2012). This is partially because DRR must address shifting risks while ensuring measures do not increase vulnerability, but it does not have the necessary knowledge or experience (Mitchell & van Aalst, 2008). The development of an all-hazards approach in the disaster management community in the last few decades (i.e. focused on underlying vulnerability and development) suggests a future perspective should be taken within DRR, which could include incorporating information about climate change (Mercer, 2010). Solecki et al. (2011) agree, pointing out that the field of disaster management has already undergone a mixing of diverse policy and research arenas when natural and technological hazards “effectively came together in an all-hazard approach to management in many cities” in the 1980s, which may indicate a flexibility

within DRR to integrate new concerns (p. 138). The nascent character of CCA may allow for flexibility from the other direction, and it is worth noting that learning is seen as central to good CCA (IPCC, 2012). DRR is already increasingly forward-looking, and existing climate variability is seen as a good entry point for CCA (Mitchell & van Aalst, 2008; Tearfund, 2008). In fact, DRR is a crucial part of adaptation efforts, particularly in vulnerable communities (Mitchell & van Aalst, 2008), so CCA policies can build on existing DRR efforts to increase efficiency, and DRR approaches must address the impact of climate change to be sustainable (Lei & Wang, 2014). Thus, DRR and CCA “can each greatly benefit from far greater synergy and linkage in institutional, financial, policy, strategic, and practical terms.” (IPCC, 2012, p. 28).

A significant difference between the two fields is the political and widespread recognition CCA achieves (Mitchell & van Aalst, 2008; Tearfund, 2008). As increasing climate change coverage has caused rising public interest and anxiety, it is advisable for disaster managers to know the implications of climate change for their region in order to improve preparedness and allay these fears (Prabhakar et al., 2009). Perhaps more importantly, it means that DRR can use this attention to support current efforts by accessing related funding and political recognition (Mercer, 2010). This could potentially connect DRR efforts to new policy and development resources, such as resettlement projects that move people and infrastructure out of harm’s way (Solecki et al., 2011). Conversely, the administrative position of DRR in city governments can improve response capacity by increasing visibility for CCA (Solecki et al., 2011). Another way in which recognition could be important is the “window of opportunity” present after many events that can be used for the implementation of DRR measures (Prabhakar et al., 2009;

Solecki et al., 2011; Lei & Wang, 2014). Unfortunately, this window is often ignored because of a widespread view that risks are primarily from external forces (Birkmann & Teichman, 2010), so a shared understanding of the nature of disasters and coordinated efforts during this window could be useful for both fields. Ultimately, while CCA and DRR share very similar objectives and challenges in gaining attention on agendas, they typically do not coordinate, and other than climate change entering discussions about climatic disasters, there is no sign of convergence in this area (Mitchell & van Aalst, 2008).

Linked to recognition, funding and resources are areas of potential convergence, because CCA and DRR share funding limitations as a barrier to action (Solecki et al., 2011). While CCA has sizable and growing funding streams, funding for both fields is insufficient (Tearfund, 2008), partially due to the fact that there is often little political will to prevent something instead pursuing more tangible investments (Mitchell & van Aalst, 2008). Integration could more efficiently use limited public resources, according to Howes et al. (2014), who point out that traditional funding might actually encourage detrimental interagency competition. Thus, there is potential at the intersection of these two fields for increased recognition that could provide needed funding and resources.

The combination of knowledge and tools is another area of potential synergy, since DRR brings tools and a developed knowledge base that can be used in CCA (e.g., probabilistic modeling, risk mapping, response and recovery planning), and CCA has knowledge needed for DRR to adapt to climate change. Two primary barriers to action for DRR and CCA managers are a paucity of research and lack of knowledge, including local, downscaled data of climate change impacts (Solecki et al., 2011). Notably,

interviews with 38 CCA experts conducted by Birkmann and Teichman (2010) found that around 95% of participants indicated that spatial resolution of climate change data and linking of short and long-term strategies should be improved. Thus, a combined effort to develop this knowledge could be useful. Regarding tools, researchers have found that there has been an increased focus on sharing DRR and CCA tools in order to facilitate learning and reduce duplication (Mitchell & van Aalst, 2008). This is useful for DRR because contemporary risk assessments often rely heavily on historical data at a given location (Prabhakar et al., 2012), and useful for CCA practitioners because they can use DRR tools like risk probability statements, which can simultaneously foster communication and cross-fertilization (Solecki et al., 2011). Thus, efficient use of combined resources and expertise could increase effectiveness financially and otherwise (Mercer, 2010; Howes et al., 2014).

Two final major areas of potential synergy between the two fields that are particularly important for this investigation are local strategizing and implementation, which often involve mainstreaming new concerns into current efforts. While responses to climate change come in a wide variety of forms of partnerships, which hold potential for new ways of governing climate change in cities, municipalities play a critical role (Broto & Bulkeley, 2013). Importantly, researchers argue that pressure for collaboration must come from below (CCD, 2008), and that community-based DRR could be a good entry point for CCA measures because it would connect policy and practice, and negate the need for new programs (Mercer, 2010; Lei & Wang, 2014; Solecki et al., 2011). Indeed, DRR has been embracing a more proactive approach, and community level CCA strategies are already similar to or the same as DRR strategies, so DRR can represent

advantages for local CCA because of its history of connecting to environmental and development efforts at the local level (Mercer, 2010). While DRR and CCA are relatively past and future oriented, respectively, this difference is generally inconsequential for practical application at the local level, and a combination of efforts could allow for a more comprehensive, all-hazards approach (Mercer, 2010). Thus, coordination between the two fields can increase recognition, funding, and resources, as well as improving research, efficiency, and effectiveness of efforts. In sum, the “the types of interactions, contact points, and discourses among researchers and practitioners — particularly how they conceive and approach the management of urban climate risks and associated impacts” are likely to influence the success of urban CCDRR efforts, with implications for the safety of urban populations (Solecki et al., 2011, p. 138).

Interviews with key actors working at the interface between the two fields show that there is “great interest in the topic of convergence of the two agendas, with general agreement about the need for further integration.” (Mitchell & van Aalst, 2008, p. 20). These authors also found that CCA specialists are now being hired from the DRR sector, there are examples of integrating scientific and traditional knowledge to provide learning opportunities, there is an increasing recognition that CCA needs more tools and should learn from DRR, and the DRR community is now engaging in CCA funding mechanisms. Thus, CCA has started emerging as a theme in DRR resilience building (Howes et al., 2014), there are signs of convergence, and there is considerable potential for increasing efficiency and effectiveness of CCDRR planning if efforts are coordinated as local governments attempt to adapt to changes in disasters linked to climate change. With this context in place, the next chapter develops a CCDRR planning assessment tool, which

will serve as a framework for analyzing the cases in this investigation, and is also intended to be a useful product once it is complete.

Chapter 3

A FRAMEWORK FOR ASSESSING URBAN CCDRR PLANNING

Many studies have focused on climate change impacts, vulnerabilities, and adaptation options, but very few have addressed the governance structure of decision-making bodies, or actual adaptation policy, such as building support, identifying policy strategies, and managing barriers to action (Smith et al., 2009). Furthermore, while planners are generally thought to be responsible for much of CCDRR (IPCC, 2007; Stern, 2006), the relevant roles, actions, and responsibilities of city authorities are often unclear (Greiving & Fleischhauer, 2012). Thus, context, content, and responsibility related to CCDRR planning are areas where guidance is needed, and this chapter addresses this need by developing a framework for assessing urban CCDRR planning, which is comprised of criteria in roughly the order in which they would be addressed in the CCDRR planning process. The first criterion focuses on problem definition and decision-making, which leads to the next criterion, which is management of the institutional and organizational context, and then the third - inclusion of stakeholders. Finally, the last two criteria address strategizing (e.g., linking multiple levels, appropriate use of measures) and ensuring plan sustainability. The criteria and associated indicators are summarized in a table at the end of the chapter, which will be used to support the exploration of the cases selected for this investigation and presented after revision as a final product of this investigation.

Problem Definition and Decision-Making

Deep uncertainty surrounding climate change projections is a considerable barrier to CCDRR planning, so defining the problem through identification of regional risk, and how climate change may influence it, is important (Thomalla et al., 2006). In order to understand this, a range of climate and socio-economic scenarios should be used to project future risk (Smith et al., 2009), though lack of high-resolution data and unaddressed uncertainties could be limiting (Prabhakar et al., 2009). Local risk and context analysis, inspired and supported by disaster risk management, can support the integration and effectiveness of CCA and DRM (IPCC, 2012), and most advancements in CCA planning tools come in the context of risk assessment, a necessary step in adaptation planning (Wamsler et al., 2013). Indeed, DRR offers related knowledge and developed tools such as probabilistic modeling, risk mapping, and response and recovery planning (Solecki et al., 2011), and DRR methodologies and tools at the local level can combine with policy agendas associated with global CCA efforts to facilitate urgent, practical development action and policy to increase effectiveness financially and otherwise (Mercer, 2010). Thus, use of established DRR tools is an indicator of good CCDRR planning.

Using the best available and disaggregated information, and consideration of macroeconomic assumptions, are also important parts of this problem definition. These include changes in population numbers, GDP, investment, trade, income and demographic distribution, health status, sectoral employment, government budgets, and policies (Scrieciu et al., 2014). Generally speaking, these authors suggest factoring in interactions between the economy, environment, and society, including their multiple

dimensions and non-monetized aspects. Other researchers recommend including capacity limitations, perception and awareness limitations, and economic limitations (Prabhakar et al., 2009), and need, feasibility, benefit (i.e. economic, ecological, social), and cost as factors in this scenario analysis and decision-making process (Lei & Wang, 2014). Production and use of this kind of demand-driven information can allow decision makers to act while also increasing awareness of risks and support for action (Smith et al., 2009), and decision-making tools can be useful for identifying and comparing choices surrounding uncertainty while defining the problem (Smith et al., 2009). In addition to projecting impacts, transparent baseline formulation that addresses uncertainty is important, so issues of transparency should be addressed by including explicit statements of definitions, the purpose of the baseline, and information on technology learning rates, and explicit treatment of uncertainty can include covering methods used to calculate GDP projections and what sensitivity analyses have been completed (Scrieciu et al., 2014). Thus, there are a range of factors to consider when defining the problem, and multiple researchers advocate for the use of scenario and decision-analysis tools.

Mainstreaming: Institutional and Organizational Context

After defining the problem, the interdisciplinary and interdepartmental nature of CCDRR planning makes consideration of the institutional and organizational context important (Smith et al., 2009; Scrieciu et al., 2014), because governance constraints are a barrier to action for both fields (Solecki et al., 2011). A considerable amount of the discussion about CCDRR planning implementation focuses on mainstreaming, which is modifying a core function in order to integrate a new aspect or topic and act indirectly

upon it (Holden, 2004), such as building on existing structures, mechanisms, and procedures, rather than a complete change of primary functions and goals (Wamsler et al., 2013). Unfortunately, while many cities are responding to climate change disaster risk, the response to scientific projections of impacts “remains largely diffuse and uneven, often driven by a single agency and/or a concerned official without defined legislative mandates, typically acting without significant financial or human resources needed to implement action plans.” (Solecki et al., 2011, p. 138). When formal CCA agendas do exist, they tend to be situated within environmental departments, with strategies linked to specific urban sectors like water management, public health, energy, and transportation, so city authorities rarely combine the range of CCA measures, and mainstreaming is generally left to single actions rather than being comprehensive (Wamsler et al., 2013). Furthermore, a report investigating links between climate change and DRR in several countries found “no concrete evidence of systematic integration of disaster risk management and adaptation in terms of project activities, coordination and fundraising.” (Mitchell & van Aalst, 2008, p. 15). So, though detailed discussions about the CCDRR agenda are underway, adaptation measures must often be justified individually, and integrative concepts in municipal strategies and practice are often left out, despite many studies suggest that adaptation should be a mainstreaming issue for urban planning (Wamsler et al., 2013). Thus, there seems to be a general consensus that CCDRR should be integrated into wider development planning (Mercer, 2010; Lei & Wang, 2014), and this research provides possible indicators of good CCDRR planning.

Mainstreaming requires institutionalization of CCDRR so that its integration at the program level is standard procedure, so organizations should cooperate to develop a

multi-level system for governing urban risk, and improve professional DRR and urban resilience education (Wamsler et al., 2013). A study by Howes et al. (2014) identified four common themes as important for coordinating CCDRR efforts, including interagency communication and collaboration, institutional improvement and learning, community engagement and communication, and a renewed focus on resilience. In order to support related efforts, the investigators proposed five reforms meant to guide improvement of interagency communication and collaboration, including, developing a shared policy vision, adopting multi-level planning, integrating legislation, networking organizations to build a culture of collaboration, and establishing cooperative funding. Additionally, they found that identifying “collaborative champions” within each agency in order to network can be important. So, these findings represent potential indicators of good mainstreaming and institutionalization of CCDRR efforts.

In addition to coordination of efforts within local government, the role of other levels of government should be considered. All plans and policies need to be underpinned by consistent legislation that provides clear policy intent and appropriate direction, and a key barrier is “the way in which the rights and powers of different levels of government has been legally constituted (Howes et al., 2014, p. 10). So, another important part of CCDRR planning is the state policy context that impacts these plans, and a study in Australia suggests, as does related literature, that land use planning is the best way to get state agencies and local government collaborating across boundaries and hazards (Howes et al., 2014). These researchers’ interviews with practitioners and related literature also suggested that logistical capacities, such as co-location of facilities and joint training with emergency services and climate change agencies, could help improve communication and

collaboration.

Finally, in addition to official institutional and organizational context, CCDRR planners should consider unofficial institutional and organizational context. Alignment with the new landscape of local institutions requires an understanding that informal relations and norms strongly influence local government and civil society actions, and the creation of an enabling environment that allows institutional, market, political, and public service changes is also part of CCDRR planning, and requires addressing the constraints and opportunities relevant to involved organizations (CCD, 2008). These authors argue that solutions within market relations focused on natural resources requires interventions that link CCDRR goals with local efforts to pursue market opportunities and overcome trade and investment constraints, so this could be an important indicator of good CCDRR planning. Thus, identification of context-specific institutional factors that impact implementation, including market and nonmarket barriers, implementation transaction and transition costs, and the contribution of the civic sector and social collective action is important (Scrieciu et al., 2014).

Stakeholder Involvement

After considering institutional and organizational context, stakeholder involvement is necessary to effectively and efficiently target their needs. This involvement can lead to discovery of policy options and barriers to implementation from a bottom up perspective, as well as reducing conflict (Smith et al., 2009), and it may increase support as stakeholders become involved in the planning process. Building on this decentralization requires engaging local actors in order to determine who should take

on roles within CCDRR, and awareness of uncertainties about who has responsibility for various parts of local decision-making structures that are related to CCDRR (CCD, 2008). Additionally, an integral part of this kind of stakeholder involvement is the valuation of benefits (Scrieciu et al., 2014). While traditional cost-benefit analysis tends to focus on monetized valuations, this kind of multi-dimensional planning with interactions between the economy, environment, and society is not always measurable in financial terms, so adaptation plans should "Explicitly state the value judgments underlying the (economic) analyses, particularly judgments about the importance of current versus future generations, with implications for discounting." (Scrieciu et al., 2014, p. 271). These authors also argue this should be done by applying the most established and least controversial valuations of non-market benefits that are reported in their natural units with qualitative appraisals.

Unfortunately, coordinating the interests of stakeholders is seen as one of the most difficult tasks for CCA practitioners according to Lei and Wang (2014), who give an example of the drought-related concerns of farmers, local governments, and central governments: farmers focus on their livelihoods, local governments on ecological problems, and the central government on yield losses and regional grain security. So, stakeholder priorities and social equality must be addressed, often through objective vulnerability assessments and risk analysis, and "tangible cooperation and coordination are needed to integrate the political, technological, ecological, and educational adaptation strategies together" (Lei & Wang, 2014, p. 1596). Furthermore, an indicator of good stakeholder involvement could be the intentional identification and inclusion of vulnerable people in the planning process. Thus, stakeholder involvement is important

because CCDRR planning is relevant to all urban-focused stakeholder groups (Solecki et al., 2011), and decision-making tools can be useful for facilitating stakeholder collaboration and valuation of externalities (Scrieciu et al., 2014). Two final, overarching issues that should be considered during the assessment of stakeholder involvement in CCDRR planning are the openness of the planning process, and to what extent the stakeholders actually have influence. No doubt this will vary between cases, but efforts made to spread information about planning (e.g., public announcements and forums, mechanisms for collecting input) and inclusions of stakeholder input (e.g., revisions based on stakeholder input, explicit treatment of stakeholder concerns).

Strategy: Integration and Appropriate Use of Measures

Once the context-specific problem is defined, context is considered, and stakeholders are being involved, developing strategies and selecting appropriate measures are a logical next step. CCA and DRR use strategies involving participants and institutions across multiple sectors (Smith et al., 2009), so linking bottom-up and top-down resilience and capacity building strategies may support sustainability and include outside knowledge (Fraser et al., 2006). At the community level, CCA and DRR strategies are already similar or the same, and the de facto linkage of CCA plans and hazard mitigation and disaster preparedness strategies means the administrative position of DRR in cities can provide advantages to CCA (Mercer, 2010). So, an indicator of good strategizing is the use of DRR's established position in cities to serve as a foundation for CCDRR efforts. Disaster management is conceptualized as a cycle of mitigation, preparedness, response, and recovery, and some researchers suggest that CCA plays a

role in all but response (Birkmann & Teichman, 2010). Therefore, integration into this cycle likely provides some useful indicators for assessing CCDRR strategizing.

CCA can be integrated into mitigation by identification of climate-related vulnerable areas, designing structural and nonstructural mitigation standards (e.g., building codes, public education), joint effort in public capacity development campaigns, combination and synchronization of resources and land use management, and increased focus in the DRR community on climate-related creeping hazards (Birkmann & Teichman, 2010, p. 182). Preparation and recovery (e.g., early warning systems, emergency health/social systems, shelters, evacuation roads, insurance and social protection systems) receive only minor attention in much CCA planning (Wamsler et al., 2013). However, there are important ways the two fields can work together in preparation and recovery, including sharing information and developing early warning systems (especially for creeping hazards), integration of CCA impact projections into response strategies in order to allow further adjustment during recovery, consideration of CCA in infrastructure reconstruction, systematic consideration of CCA in temporary and permanent sheltering, and medical care programs (Birkmann & Teichman, 2010).

In addition to integrating with the disaster management cycle, cross-cutting measures and integration are an important part of this interdisciplinary and interdepartmental issue. No-regrets (i.e. low-regrets, cross-cutting, win-win) strategic approaches in climate policy may be more robust (IPCC, 2007), as benefits can cut across many sectors, organizations, and people, and interact with other policies (Mechler, 2013). Therefore, they have high potential for reducing long-term risk while providing short-term benefits, and related information will normally be one of the first priorities in any

climate proposal, making explicit consideration of these options important (Scrieciu et al., 2014). Indeed, these authors point out that a significant barrier CCDRR is the upfront cost involved in shifting efforts and resources from current to more sustainable practices, so the potential for a robust strategy that delivers multiple benefits is appealing. Some cities are placing a special importance “climate planning,” which are combined CCA/CCM efforts (Davoudi et al., 2010) such as microgrids and green infrastructure. Microgrids are self-powered electric grids that can provide reliable power for critical infrastructure during power outages, and even during normal operation they can reduce emissions by drawing their power from renewable energy sources and using excess energy to heat water. Houston, Texas is an example of a city that is creating solar powered microgrids for disaster response efforts (Tompkins & DeConcini, 2014). Green or blue infrastructure emphasizes incorporation of natural processes when possible, and developed communities tend to place a relatively high priority on this option (Wamsler et al., 2013).

In addition to being less efficient, poorly thought out measures can be harmful, and, frequent reliance on structural solutions can be problematic for DRR (Kelman & Gaillard, 2010). Addressing the physical and nonphysical complexity surrounding CCDRR is necessary for sustainable urban transformation that recognizes changing planning principles and systematically addresses climate change risk (Wamsler et al., 2013). A few additional options suggested are structural flood projects that include easy upgrades as new information on climate change becomes available (Kelman & Gaillard, 2010), use of soft (i.e. social) measures in addition to hard (i.e. physical) interventions (Wamsler et al., 2013), and improvements in urban land use and territorial organization

processes (IPCC, 2012). Thus, it is important to consider the total impact of CCDRR measures, and develop strategies that facilitate this comprehensive approach. In other words, “opportunities for joint work towards the common objective of reducing risk to development must be seized wherever feasible.” (Mitchell & van Aalst, 2008, p. 6).

Sustainability

An important aspect of a CCDRR plan is its financial sustainability (Scrieciu et al., 2014; Smith et al., 2009), because short-lived plans are unlikely to effectively manage long-term climate change risk. An important step towards this is understanding city’s fiscal situation (e.g., possible funding sources), and explicitly defining the temporal scope of the plan (e.g., years till expiration, estimated length of benefits, expected contributions from future generations). Decision makers should explicitly consider the ways climate policy is projected to impact short and long term sustainability of fiscal systems (Scrieciu et al., 2014), which could include budget and expenditure estimates for projects. A long-term approach to funding that is able to shift from year to year could be important, as it would foster accumulated experience and knowledge as staff are retained as well as support coordination with development and humanitarian organizations eligible for funding (Birkmann & Teichman, 2010). This retention reduction of staff turnover could be important as the capacity for networking requires attention to this kind of human resources issue (Howes et al., 2014).

Indeed, few adaptation policies can be implemented with extant funding streams, and whether this funding focuses on incremental solutions or broader policy initiatives, governments must address "whether these expenditures will come from a new, dedicated

fund or from existing sources that invest in climate sensitive resources." (Smith et al., 2009, p. 58). These authors provide guidelines for allocating funds to CCA, concluding that most new adaptation funding needs to be mainstreamed into baseline funding for climate sensitive sectors and activities, and that finding ways to fund CCA may require some ingenuity since much of the literature has focused on damages, rather than adaptation costs and benefits. This leads to the conclusion that CCDRR mechanisms should be adapted to minimize transaction costs for local government frontline public service providers, and recurrent costs at the local level should be included as part of investment plans (CCD, 2008). Additionally, while fiscal sustainability may be the most obvious concern, long-term resource stability and environmental conditions are also important for CCDRR (Birkmann & Teichman, 2010), so incorporation of these into long-term CCDRR planning is important.

CCDRR Assessment Tool Summary

Problem definition, mainstreaming, stakeholder involvement, strategizing, and plan sustainability are criteria for CCDRR planning. This table provides a summary these criteria and indicators, and will be used to guide this inquiry's CCDRR plan assessment:

Table 2 Framework for developing and assessing urban CCDRR planning.

Criteria	Indicators
A - Problem	1. <i>A1 - Best information:</i> Use best available and disaggregated

Definition & Decision Making	information ○ <i>A1 – Best information (best practices):</i> Consider best practices ○ <i>A1 – Best information (experts):</i> Consult experts ○ <i>A1 – Best information (research):</i> Use high-quality research and studies 2. <i>A2 – Scenarios and modeling:</i> Use a range of scenarios and models to understand regional risk and the influence of climate change ○ <i>A2 - Scenarios (climate):</i> Use climate scenarios ○ <i>A2 - Scenarios (socioeconomic):</i> Use socioeconomic scenarios ○ <i>A2 - Scenarios (high-resolution data):</i> Use high-resolution data ○ <i>A2 - Scenarios (uncertainties):</i> Address uncertainties ○ <i>A2 - Scenarios (risk mapping):</i> Use local risk mapping and assessment ○ <i>A2 - Scenarios (probability):</i> Use probabilistic modeling ○ <i>A2 – Scenarios (assumptions):</i> Identify assumptions and limitations in plan 3. <i>A3 - Interactions (economic; environmental; social):</i> Factor in interactions between economy, environment, and society ○ <i>A3 - Interactions (macroeconomic assumptions):</i> Consider macroeconomic assumptions (e.g., changes in population numbers, GDP, investment, trade, income and demographic distribution, health status, sectoral employment, government budgets and policies) 4. <i>A4 - Decision-support:</i> Use decision-support tools and systems to identify and compare choices surrounding uncertainty 5. <i>A5 - Transparent baseline:</i> Formulate a transparent baseline ○ <i>A5 - Transparent baseline (definitions):</i> Include explicit definitions ○ <i>A5 - Transparent baseline (purpose):</i> Include the purpose of the baseline ○ <i>A5 - Transparent baseline (technology learning rates):</i> Include information on technology learning rates ○ <i>A5 - Transparent baseline (calculating GDP):</i> Treat uncertainty explicitly by covering methods used to calculate GDP projections ○ <i>A5 - Transparent baseline (sensitivity analyses):</i> Treat uncertainty by addressing sensitivity analyses 6. <i>A6 - Prioritize (priority):</i> Consider the importance of CCDRR planning relative to other needs and goals 7. <i>A7 – Goals (goals):</i> Set clear goals when possible
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B – Context and Collaboration: Laws, Institutions, Organizations, and Unofficial Context	1. <i>B1 - Context (institutional)</i>: Identify context-specific institutional factors that impact implementation 2. <i>B2 - Context (official)</i>: Mainstream CCDRR into official development planning ○ <i>B2 - Context (programming)</i>: Institutionalize CCDRR so integration at the program level is standard ○ <i>B2 - Context (intragovernmental collaboration)</i>: Network city entities to build a culture of collaboration ○ <i>B2 - Context (intergovernmental collaboration)</i>: Network with other levels of government to build a culture of collaboration ○ <i>B2 - Context (multi-level risk governance)</i>: Address organizational cooperation to develop a multi-level system for disaster risk governance, and adopt multi-level planning (e.g., use land-use planning to collaborate with state government) ○ <i>B2 – Context (legal framework)</i>: Consider relevant local, regional, and national laws, and how they are relevant ○ <i>B2 - Context (improve education)</i>: Improve professional DRR and urban resilience education ○ <i>B2 - Context (shared policy vision)</i>: Develop a shared policy vision ○ <i>B2 - Context (legislation)</i>: Integrate legislation ○ <i>B2 - Context (cooperative funding)</i>: Establish cooperative funding ○ <i>B2 - Context (collaborative champions)</i>: Identify collaborative champions in each agency ○ <i>B2 - Context (logistical capacity)</i>: Develop supporting logistical capacities (e.g., co-location of facilities, joint training with EM and climate change agencies) ○ <i>B2 – Context (responsibility)</i>: Assign responsibility (e.g., create a task force to oversee the process) 3. <i>B3 - Context (unofficial)</i>: Consider unofficial institutional and organizational context: ○ <i>B3 - Context (informal relations and norms)</i>: Recognize that informal relations and norms strongly influence local government and civil society actions ○ <i>B3 - Context (organizational constraints and opportunities)</i>: Address constraints and opportunities relevant to involved organizations ○ <i>B3 - Context (market opportunities, trade, and investment)</i>: Link goals with efforts to pursue market opportunities and
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	overcome trade and investment constraints
C - Stakeholder Involvement	1. <i>C1 - Stakeholders (local actor roles)</i>: Engage local actors in order to determine who should take on roles ○ <i>C1 - Stakeholders (uncertainties about responsibility)</i>: Be aware of uncertainties about who has responsibility for various parts of local decision-making structures related to CCDRR 2. <i>C2 - Stakeholders (valuation)</i>: Get valuation input from stakeholders ○ <i>C2 - Stakeholders (value judgements)</i>: Explicitly state the value judgments underlying economic analyses ○ <i>C2 - Stakeholders (future generations)</i>: Consider importance of current vs. future generations ○ <i>C2 - Stakeholders - (implications for discounting)</i>: Consider implications for discounting ○ <i>C2 - Stakeholders (qualitative valuations)</i>: Apply most established and least controversial valuations of non-market benefits reported in their natural units with qualitative appraisals ○ <i>C2 - Stakeholders (decision-making)</i>: Use decision-making tools to facilitate stakeholder involvement and valuation 3. <i>C3 - Stakeholders (vulnerability)</i>: Identify and include vulnerable populations in the planning process ○ <i>C3 - Stakeholders - (disabilities)</i>: include people with disabilities ○ <i>C3 - Stakeholders - (elderly)</i>: include elderly people ○ <i>C3 - Stakeholders - (health)</i>: include people with health problems ○ <i>C3 - Stakeholders - (language)</i>: include foreign-language speakers ○ <i>C3 - Stakeholders - (poor)</i>: include poor people 4. <i>C4 - Stakeholders (planning process)</i>: Ensure an open planning process ○ <i>C4 - Stakeholders (announcements)</i> Public announcements ○ <i>C4 - Stakeholders (forums)</i> Hold open forums ○ <i>C4 - Stakeholders (input mechanisms)</i> Employ mechanisms for collecting input ○ <i>C4 – Stakeholders (transparency)</i>: Ensure stakeholders have reasonable access to information in a transparent planning process

	○ <i>C4 – Stakeholders (information and warnings)</i>: Provide stakeholders with information about their risk as part of the planning process, and to facilitate individual risk management ○ <i>C4 – Stakeholders (sensationalism)</i>: Provide a clear understandable picture with realistic information 5. <i>C5 - Stakeholders (influence)</i>: Ensure stakeholder input has influence ○ <i>C5 - Stakeholders (revisions)</i>: Adjust and revise based on stakeholder input ○ <i>C5 - Stakeholders (stakeholder concerns)</i>: Explicitly address stakeholder concerns 6. <i>C6 - Stakeholders (support)</i>: Address stakeholder needs when possible
D - Strategy and measures: Integration and Appropriate Use	1. <i>D1 - Strategy (vulnerability and resilience)</i>: ○ <i>D1 - Strategy (top and bottom resiliency and capacity)</i>: Link bottom-up and top-down resilience and capacity-building strategies ○ <i>D1 – Strategy (vulnerability perspective)</i>: Address risk with an understanding that vulnerability as a root cause of disasters 2. <i>D2 - Strategy (DRR administrative position)</i>: Use the established administrative position of DRR 3. <i>D3 - Strategy (disaster management cycle)</i>: Integrate with disaster mitigation, preparedness, response, and recovery ○ <i>D3 - Strategy (climate vulnerable areas)</i>: Identify climate-vulnerable areas ○ <i>D3 - Strategy (mitigation standards)</i>: Use both structural and nonstructural mitigation standards (e.g., building codes, public education) ○ <i>D3 - Strategy (capacity development)</i>: Develop joint CCA/DRR capacity development campaigns ○ <i>D3 - Strategy (combined resources)</i>: Combine and synchronize resources ○ <i>D3 - Strategy (land-use)</i>: Combine and synchronize and land-use management ○ <i>D3 - Strategy (creeping hazards)</i>: Increase the DRR community's focus on climate-related creeping hazards ○ <i>D3 - Strategy (preparation and recovery information)</i>: Share information related to preparation and recovery ○ <i>D3 - Strategy (early warning systems)</i>: Joint development of

	early warning systems, especially for creeping hazards ○ <i>D3 - Strategy (response strategies)</i>: Integrate CCA impact projections into response strategies to facilitate further adjustment during recovery (e.g., consider CCA in infrastructure reconstruction after disasters) ○ <i>D3 - Strategy (sheltering)</i>: Systematically consider CCA in temporary and permanent sheltering ○ <i>D3 - Strategy (medical care)</i>: Systematically consider CCA in medical care programs 4. <i>D4 - Strategy (focusing events)</i>: Use focusing events as windows of opportunity (where applicable) 5. <i>D5 – Strategy (nonstationarity)</i>: Identify and address issues related to the loss of stationarity 6. <i>D6 - Measures (broad impact)</i>: Consider broad impact of measures ○ <i>D6 - Measures (cross-cutting)</i>: Use cross-cutting, no-regrets measures (e.g., climate planning, green and blue infrastructure options, microgrids, multi-purpose levees, beach replenishment) ○ <i>D6 - Measures (structural)</i>: Avoid over-reliance on structural solutions, and make structural flood projects upgradeable ○ <i>D6 – Measures (sense of security)</i>: Avoid developing or enabling a dangerous false sense of security ○ <i>D6 - Measures (social)</i>: Use soft (social) measures ○ <i>D6 - Measures (land-use)</i>: Improve urban land use and territorial organization processes (e.g., by zoning) ○ <i>D6 – Measures (retrofitting)</i>: Support stakeholder retrofitting efforts ○ <i>D6 – Measures (quality of life)</i>: Address quality of life implications 7. <i>D7 – Measures (insurance)</i>: Address changes in insurance, and use it to distribute risk 8. <i>D8 – Measures (critical infrastructure)</i>: Address critical infrastructure reliability 9. <i>D9 – Measures (scaling)</i>: Consider using scalable flood protection measures to address uncertainty in SLR projections 10. <i>D10 – Measures (public health)</i>: Address potential impacts on public health (e.g., increase in vector-borne diseases)
E: Implementation & Sustainability	1. <i>E1 - Sustainability (financial)</i>: Ensure financial sustainability ○ <i>E1 – Sustainability (estimate cost)</i>: Realistically estimate the cost of implementing plans (e.g., retrofitting, land buyouts)

	○ <i>E1 - Sustainability (funding streams)</i>: Address the source of funding (i.e. new or existing funding stream) ○ <i>E1 - Sustainability (fiscal systems)</i>: Consider impact on short and long term sustainability of fiscal systems ○ <i>E1 - Sustainability (shifting funding)</i>: Use funding that can shift from year-to-year in order to foster accumulated experience and knowledge, and development of humanitarian organizations ○ <i>E1 - Sustainability (recurrent investment costs)</i>: Incorporate recurrent costs at the local level in investment plans ○ <i>E1 - Sustainability (baseline climate funding)</i>: Mainstream adaptation funding into baseline funding for climate sensitive sectors and activities 2. <i>E2 - Sustainability (transaction costs)</i>: Adapt CCDRR mechanisms to minimize transaction costs for local government and frontline service providers 3. <i>E3 – Sustainability (other)</i>: Ensure long-term stability ○ <i>E3 - Sustainability (resource)</i>: Consider long-term resource stability ○ <i>E3 - Sustainability (environmental)</i>: Consider long-term environmental stability (e.g., support natural barriers) ○ <i>E3 – Sustainability (economic)</i>: Consider long-term economic impact ○ <i>E3 – Sustainability (technological development)</i>: Consider long-term projections related to technological development 4. <i>E4 - Sustainability (monitoring and revisions)</i>: Enable monitoring and revision of plans as needed 5. <i>E5 – Sustainability (implementation)</i>: Consider and support actual plan implementation ● <i>E5 – Sustainability (goals and timelines)</i>: Set goals associated with dates for action ● <i>E5 – Sustainability (transition to action)</i>: Transition quickly from planning to action
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Chapter 4

METHODOLOGY

With a background and analysis framework developed, this chapter proposes a research design for studying CCDRR planning in New York City. It begins by restating the problem, then summarizes the objective and research question, discusses the research design, data collection protocol, and framework for analysis needed to investigate this subject, then addresses validity, limitations, and reporting results.

Background: Problem, Objective, and Research Question

Simply put, the problem being addressed is that as the Earth's climate changes so will disasters, especially in coastal cities, which is an important issue for these local governments to address. Coastal cities are at the forefront of this problem because of SLR, coastal storms, and unique features of urban areas that make them relatively exposed and vulnerable to some hazards. Mitigating climate change by reducing GHG emissions may be a good long-term approach for managing this problem, but many cities will face changes in disaster risk regardless of these efforts, so they must adapt to reduce their risk, which is a developing aspect of DRR. In developed areas, city governments are generally held most responsible for management of this issue, so this will be the focus of this investigation. The intersection of CCA and DRR is a relatively new area for research, and the increasing frequency of disasters and apparent long-term impacts of climate change make it an important issue, especially as CCM efforts falter. Within this

intersection, there is considerable potential for increased effectiveness and efficiency through merging parts of these two fields, as discussed in chapter two. Thus, research that guides CCDRR planning and assessment in coastal cities is important, as illustrated by some local leaders requesting guidance in this area (Tompkins & DeConcini, 2014). There have been calls for research on the integration of DRR and CCA, and investment in areas that naturally blend the two perspectives (Mitchell & van Aalst, 2008), and despite uncertainty surrounding projections there is a lot to do even without reliable risk projections, including bringing together stakeholders, capacity building, and developing case studies looking at long-term local impacts (Prabhakar et al., 2009). So, this investigation is focused on the potential for synergies between CCA and DRR which could facilitate effective and efficient management of this problem.

Several kinds of questions can guide inquiry (e.g., practical, applied, action-oriented, academic degree, discipline/specialization priorities) and they can have several purposes, including knowledge generation, evaluation, efforts to demonstrate a level of scholarship, and personal interest (Patton, 2002, p. 13). The question guiding this research was selected primarily to satisfy a degree requirement, but it may also be practical (i.e. the conceptual work and assessment framework could be useful) and generate knowledge. Extant theory is frequently found to be lacking, so concepts needed for new theories that can challenge or extend current theories must be developed through in-depth study and “built from scratch” (Ragin, Nagel, & White, 2004, p. 11), and this is the case with this investigation into relatively new territory, so as a foundation for this investigation, the concept of CCDRR and a related assessment framework were developed. Yin (2009) argues that defining the research question, including substance

and form, is likely the most important step in a research study. The substance of the question for this study is CCDRR planning in coastal U.S. cities, and the form is essentially “how.” The question in its most basic form is this: to what extent and how is New York City engaging in CCDRR planning?

Research Design: Context, Parameters, and a Case Study Approach

Research designs are the logic that links empirical data and conclusions to the initial research question, and every study has a research design, and ultimately, the main purpose is to avoid ending up with evidence that does not address the initial question (Yin, 2009). Creating an explicit research design may be challenging because there are no rigid rules or ideal standard, so they inevitably depend on “some imperfect interplay of resources, capabilities, purposes, possibilities, creativity, and personal judgments by the people involved.” (Patton, 2002, p. 12). However, it is difficult to evaluate proposals that do not have developed research designs, so qualitative researchers must articulate a plan for collecting and analyzing data that allows flexibility because their initial assumptions and interpretations may change as the study progresses (Ragin et al., 2004). This investigation uses a qualitative, case study design, and a descriptive approach, because this flexibility allows for exploration and theory building. While this subject is not uncharted territory, its complexity is a good reason to use this approach.

A qualitative approach is useful because it facilitates in depth study (Patton, 2002), provides rich descriptions of complex phenomena, allows initial exploration and theory development, and helps move towards explanations (Sofaer, 1999). Work on qualitative research has “exploded,” and even professional quantitative researchers in

social science are interested in learning about qualitative methods (Lincoln, Lynham, & Guba, 2011), but questions surround its legitimacy. While it has been the subject of debates in social science circles, these discussions tend to focus on criteria for judging designs, the proper role of theory, and the best way to draw convincing conclusions and present findings, rather than focusing on whether it is legitimate (Ragin et al., 2004). Ultimately, many users and consumers of social science research see this type of research as “suggestive rather than definitive,” and “illuminating rather than convincing” (p. 16), and this works well for this inquiry as the intention is to suggest concepts, illuminate current practice, and consider nuances. A quantitative approach would likely produce more generalizable results, including hard numbers, relatively concise analysis, and greater cross-case comparability. However, it would also likely be unable to capture many important aspects of the subject, and would limited exploration of the case significantly. In other words, “If we focus research only on what we already know how to quantify, indeed only on that which can ultimately be reliably quantified, we risk ignoring factors that are more significant in explaining important realities and relationships” (Sofaer, 1999, p. 1102). So, it is hoped that this investigation will offer what other qualitative researchers offer “a web of connections within each case.” (Ragin et al., 2004, p. 16), and useful theoretical propositions. Because there is enough relevant literature to move this investigation beyond the exploratory phase, a descriptive approach is used. While there are no theoretical propositions, the assessment framework provides sensitizing concepts that can drive the coding process.

One of the more common qualitative methods is the case study, and it will be used in this investigation. Case studies are empirical inquiries, often framed as how or why

questions, that investigate a contemporary, phenomenon in depth and in vivo where the boundaries between it and its context are not clearly evident and the investigator has limited control over events (Yin, 2009). Like other research, case studies can be exploratory, descriptive, or explanatory, and there is overlap between them (Yin, 2009). Since this inquiry stems from a how question, investigates a contemporary phenomenon with relatively unestablished boundaries in depth, and has no control over events, it seems likely that a case study approach is appropriate. A case study can involve single or multiple cases, chosen randomly or purposively in order to meet predetermined typology requirements, and researchers generally have some idea of what they are looking for, including whether it should be explored or controlled for (Sofaer, 1999). When given the choice, multiple cases may be preferable because the cross-case analytic conclusions will likely be stronger, and this introduces the possibility of direct replication or selection of cases that offer contrasting situations, according to Yin (2009). Unfortunately, exploring the massive amount of data required to properly explore multiple cases is outside the scope of this inquiry, so New York City will be the only case.

Case Selection: Selection Criteria, Unit of Analysis, and Unit of Observation

Case selection is an important step in conducting this kind of research, so careful consideration of relevant factors is important.

Projected risk. The first and most important selection criterion was the city's level of risk, as this is a critical part of CCDRR planning. NYC has very high levels of projected risk, both financially and to people. Only East and Gulf Coast cities were

selected because hurricanes, even without change in strength, can create serious flooding problems because of SLR. Hallegatte et al. illustrate this point in their 2013 study which shows that of the 20 cities worldwide with the highest projected annual loss in 2050, five are on the East or Gulf Coast, and none are on the West Coast. Furthermore, their 2005 estimates from the same study show that three East Coast cities – Miami, New York, and New Orleans – account for 31% of global aggregate projected losses in the 136 cities included in the study. Finally, 95% of the top 20 cities in terms of projected average annual loss in 2050 are subject to hurricanes and tropical storms. So, while there are likely many other factors that play a role in these estimates, it seems clear that the East and Gulf coasts face more serious risk than those on the West Coast because of these storms, meaning they are more likely to be engaging in CCDRR planning activities. Additionally, humans are migrating towards coastal regions, which can expose more people and assets to hazards, as well as potentially increasing vulnerability and environmental stress. Notably, NYC has experienced what some researchers call a focusing event (Birkland, 1997) in recent years (Superstorm Sandy). The possibility that this event influenced the creation of CCDRR planning is worth noting as an important aspect of this case.

Political context. As we have seen, in addition to scientific information, political will plays a role in CCDRR planning, so the political context may be important. This could include linkage to higher levels of government, the political leaning of the population and elected officials, the governance structure in the city, and membership in relevant organizations (e.g., ICLEI, C40, 100 Resilient Cities). In order to avoid

language, cost, and access barriers, only cities in the U.S. will be selected. Regarding both political leaning and affiliations, NYC is relatively liberal, and affiliated with two organizations (C40 and 100 Resilient Cities) that deal with climate change disaster risk. Notably, Broto and Bulkeley (2013) analyzed correlation between variables that might influence the creation of climate change experiments in cities, and found that “whether or not the city belongs to a city network has a stronger association with the number of experiments in each city than any of the other variables described above.” (p. 97).

Size and wealth. The third and final criterion is the combined size and wealth of the city. The primary reason for this is that it will likely prove easier to collect data from larger, wealthier cities because of their relatively large governments that have the ability to finance this kind of initiative. This may make information more readily available because of a higher volume of requests, more connections to NGOs and nonprofits, and more advocacy coalitions. However, it is to note that while larger cities may have more capacity or need to pioneer planning, their size and wealth may not accurately predict frequency of climate change initiatives. A 2013 study of climate change experiments in cities found that a city’s wealth, total population, and population density interesting does not accurately predict the occurrence of climate change experiments in the city (Broto & Bulkeley, 2013). This brings into question the role of CCDRR funding, so this may be a fruitful area for exploration, and investigating a relatively large and wealthy city (New York), may allow exploration of this dynamic.

Units of analysis and observation. The unit of analysis in this investigation, the

level at which conclusions and generalizations are made, is the city government, and the units of observation are the departments and agencies of emergency management, environment, sustainability, planning, or development, water, sewer, or storm, as well as executive offices, city councils, and committees or task forces focused on CCA and/or DRR. Unfortunately, variations in governance structure mean that the units of observation will likely never be identical when comparing NYC to other cases, and it is important to note that additional relevant sources of information will likely be discovered during collection.

Importantly, the metropolitan area of NYC-Newark is ranked as the third most vulnerable city in the world in terms of average annual losses (AAL) in 2005. It is currently one of the top ten large port cities in the U.S. in terms of population, asset, and wind-damage (i.e. cyclones) exposure, and one of two U.S. cities projected to be in the top ten in asset exposure in 2070 (Nicholls et al., 2008).

Protocol: Target Data, Procedures, Management, Preliminary Outline, and Behavior

Qualitative research proposals should provide a description of the data to be collected, including the kinds of evidence, modes of collection, and where data will be collected from, and the data should be archived and described, including a plan for maintaining confidentiality, so others can use it (Ragin et al., 2004). The sections below describe this project's data collection and management, including types of data, collection modes and sources, and a plan for data management and sharing. Then a preliminary outline for the analysis and results is discussed. It is important to remember

that “The quality of qualitative data depends to a great extent on the methodological skill, sensitivity, and integrity of the researcher.” (Patton, 2002, p. 5), so researcher behavior is addressed at the end of the section.

Target data: date range, type, and sources. For almost any topic, specific temporal boundaries defining the case are desirable (Yin, 2009). There is no need to set an endpoint for this inquiry (it is the conclusion of data collection) but selecting a starting point is necessary. Initial data collection will include anything from 2011 onwards, though this date range may be expanded if necessary. Notably, the selection of this start point is not based on the strength of this point as a good start point, but rather the lack of strong alternatives and considerations of the resources available for this inquiry. This date range produced a large amount of data, which necessitated systematic identification of the most relevant material in order to allow processing of the data corpus.

Types of data. Interviews, observations, and documents are three primary types of qualitative data (Patton, 2002), and this investigation will be using documents. As Patton points out, financial resources, time, people resources, and access/connections can be used to support the inquiry. Because this investigation is being conducted by a single researcher with financial, time, entre, and resource constraints, document analysis is the most feasible way to collect the necessary data. Interviewing and observing are not good options because in order to interview or observe the limited number of knowledgeable practitioners working on CCDRR planning, they would need to be located, agree to participate, the transportation would have to be funded, field notes would be developed

and coded, and transcription or other data processing might be necessary. Fortunately, documents can allow researchers to collect large amounts of data that is already often relatively processed and ready for analysis. Indeed, a valid, high-quality case study can be conducted without leaving the telephone or Internet (Berg, 2009).

Documents can come from organizational or program records, memos, correspondence, official publications and reports, as well as other written materials captured in a way that records and preserves context (Patton, 2002). For this study, they came from departments and agencies of emergency management, environment, sustainability, planning, or development, water, sewer, or storm, as well as executive offices, city councils, and committees or task forces focused on CCA and/or DRR. They were obtained from websites by using the search engine Google to search the NYC government website for documents and pages related to climate change with the following query: "'climate change' OR 'global warming' site:nyc.gov." Then the browser add-on SearchWP was used to highlight the terms disaster, hazard, vulner, emergenc, "extreme weather," "climate change," "global warming," flood, storm, hurricane, "sea level," resilien, adapt, and risk. Terms like "vulner" are used in order to capture all relevant words (e.g., vulnerability, vulnerable, vulnerabilities), and quotation marks are used to force highlighting of the enclosed phrase.

Management and analysis. Document collection, storage, analysis, and archiving were done via computer. Data was then stored locally and backed up on a remote server. Qualitative research proposals should describe a plan for archiving data (Ragin et al., 2004), so, it is worth noting that after the research has been completed and

presented, the final version will likely be stored online and accessible via URL.

Document analysis can include studying excerpts, quotations, and entire passages from records, memoranda and correspondence, publications, and reports, among other things (Patton, 2002), and all of these were included in analysis. Computer assisted qualitative data analysis software (CAQDAS) can be an indispensable tool for some qualitative research, partially dependent on the size of the project, funding, time, and researcher inclination and expertise (Saldaña, 2009). It efficiently stores, organizes, manages, and configures data to enable human analysis, which can facilitate development of evolving, complex coding systems for “at a glance” reference, and also offer search functions, the ability to shift quickly between analytic tasks and quickly revise codes, auto-coding which can support coding efforts, and other useful actions (Saldaña, 2009, p. 24-26). Thus, it was natural to use this tool for this investigation for its benefits. The Atlas.ti CAQDAS program was selected because of its features, availability, and popularity.

Yin (2009) suggests that less experienced researchers will not easily determine which analytic techniques to use, or anticipate what data they need to properly use the selected techniques (p. 34). According to Ragin et al. (2004) researchers analyze data during collection and “often decide what data to collect next based on what they have learned” (p. 12), procedures are not codified, there are no standards and conventions that can easily be used to assess the validity of data or credibility of analysis, and the kinds of data central to qualitative research are difficult to systematically analyze (p. 13). So, this stage of the research was particularly challenging in this master’s-level investigation. However, there are some general guidelines that can facilitate the process, such as aiming

towards analytic generalization, which is important in case studies (Yin, 2009), and this was one of the primary goals during analysis.

Two kinds of document analysis were used in this inquiry, including analysis for the facts of a situation and analysis for meanings embedded in language and images, which typically involves identifying assumptions, values, and priorities, possibly illuminating actor's perceptions (Sofaer, 1999). This investigation focused on the facts contained in publications and reports, since the focus was the actual plans more than the process or social context surrounding them. However, in order to maintain flexibility while collecting and analyzing data, other sources of information and analytical approaches were used, including looking for meanings, purpose, process, perceptions, and assumptions.

This search for the facts of the situation were driven by the CCDRR planning assessment tool – the criteria and indicators in the tool summary (table 2) were used during collection and analysis. The criteria were not numerically rated, but they were focal points in the analysis. Because this tool in its initial form was theoretically-based and untested, adjustments were made between coding cycles. This allowed for refinement of the tool that resulted in a hybrid theory-practice framework that was applied to the data corpus in discrete phases.

Preliminary outline. In addition to describing the analysis plan, qualitative research should discuss the strategy for refining concepts and constructing theory, and plans for seeking and analyzing disconfirming evidence like alternative explanations,

unexpected findings, and new interpretations, according to Ragin et al., who say they should “try to be wrong as well as right.” (2004, p. 17). One way of addressing this is to systematically search for evidence that would lead to the rejection of emerging patterns that could become hypotheses, and this is an important step to protect against researcher bias (Sofaer, 1999), so disconfirming evidence was sought for emerging patterns.

Concepts were refined based on the data being analyzed. For example, the language used in the documents, perspectives of the authors, and frequency of terms, among other things, played a role in conceptual development and revising the framework. Emerging concepts, patterns, and themes formed the basis for theoretical propositions.

The descriptive nature of this investigation precluded the development of a detailed prediction of what the analysis and results would look like, but a basic outline was developed to facilitate assessment of the proposal. This outline suggested that results would likely: 1) address collection of documents from the first case and corresponding revisions to the case study protocol and assessment tool, 2) analyze the data case by case 3) assess apparent patterns, themes, and theoretical propositions 4) reconnect the work back to the literature, and 5) present the final results, including the revised planning guide and assessment framework, theoretical propositions, and connections with current theory.

Investigator bias and values. In qualitative investigations, the researcher’s voice is part of the inquiry, and reflexivity is both serious and problematic (i.e. the researcher’s thoughts and ideas may lead to bias in the work) (Lincoln et al., 2011). Indeed, the researcher is the primary data collection instrument (Ragin et al., 2004), so they must explain and show how they are devoting themselves to a rigorous methodological path

(Yin, 2009; Sofaer, 1999). Unfortunately, the skills needed for case study research have not been formally defined, and even some prominent statisticians recognize the challenge of this approach (Yin, 2009). Ragin et al. (2004) argue that qualitative proposals should assess the impact of the researcher's presence and biography from the point of problem selection through analysis. They point out that it is important to know about the topic before collecting and analyzing the data, though this may leave them with preconceptions that limit insights. Creating useful, credible findings in qualitative content analysis "requires discipline, knowledge, training, practice, creativity, and hard work" (Patton, 2002, p. 5), and Saldaña argues that qualitative researchers, particularly while coding, should be organized, persevere, deal with ambiguity, be flexible, be creative, be rigorously ethical, and, perhaps most importantly, use an extensive vocabulary, suggesting that "There's a lot of art to social science." (2009, p. 29). Yin says that investigators must work hard to report all evidence fairly, and that some people were simply never meant to do case study research in the first place, as it is remarkably hard despite its reputation for being soft.

In order to support this investigation, an extensive, interdisciplinary literature review was conducted, resulting in a background built on over 135 sources (not including almost 200 documents collected for analysis). Not only did this create a knowledge foundation for data collection and analysis, but it also demonstrated researcher discipline, organization, and perseverance, which are important parts of this kind of investigation. Despite the inherent difficulty and potential for investigator bias inherent to this kind of research, the loss of rigor that accompanies quantitative research is more than offset by the flexibility and insight provided by using a human instrument (Patton, 2002). Simply

put, the credibility and utility of this kind of research can come down to the question “would I feel sufficiently secure about these findings to construct social policy or legislation based on them?” (Lincoln et al., 2011, p. 120), and this idea guided the inquiry.

Validity: Construct, Internal, and External

According to Yin (2009) three tests - construct validity, internal validity, and external validity - have been used to establish the validity of empirical social research, and they deserve explicit attention. He argues that construct validity requires ensuring correct operational measures for the concepts being studied, and this can be done by using multiple sources of evidence, and establishing a chain of evidence during data collection. The investigator, he says, must develop specific terms and concepts related to the study’s original objective, and identify matching operational measures, preferably citing published studies that make the same matches. The operational measures and procedures for maintaining a chain of evidence have been presented in order to ensure construct validity, and multiple sources of evidence will be used to generate conclusions.

Internal validity is focused on causal relationships, therefore it is mainly important for explanatory case studies (Yin, 2009), thus it was not a primary concern for this descriptive research. However, Yin notes that concerns about internal validity can be problematic for case studies that make inferences when events cannot be directly observed. Essentially, when the researcher infers things about earlier occurrences based on indirect evidence, like documents, this assumption should be acknowledged and questioned. So, while specific tactics for tackling this problem are not always clear,

studies should anticipate these questions. Pattern matching, explanation building, and considering rival explanations were good ways to manage this concern (Yin, 2009), and were used in this inquiry. In other words, pattern matching and explanation building allowed exploration of potential theoretical propositions, and alternative explanations were intentionally considered in order to maintain internal validity.

Yin (2009) say external validity is defining the “domain to which the study’s findings can be generalized.” (p. 40). This kind of validity is not as applicable to this investigation because generalization is not a strong focus since it is limited to one case. So, some analytical (not statistical) was possible, but it was limited. The tradeoff, of course, was a deeper exploration of this complex issue.

Limitations: Theoretical Foundation, Single Data Type, Self-Reporting, and Scope

There are significant limitations to this inquiry that impact conclusions, including a limited theoretical foundation, consideration of only one kind of data, heavy reliance on self-reporting, and a limited scope. Adaptation research is interdisciplinary, including behavioral economics, psychology, organizational theory, natural hazards management, and other fields which can help move society towards effective action (Smith et al., 2009). Unfortunately, the CCA field has had limited time to grow, so related scientific knowledge is scarce and fragmented (Wamsler et al., 2013). In addition, disaster management is interdisciplinary, and has not yet incorporated climate change information. Thus, this work is exploratory in some ways, which may mean that the theoretical foundation is not as strong as comparable work. A second limitation is the consideration of only one type of data. While document analysis allowed a broader scope

(because of lower time and resource requirements), the exclusion of other data – such as surveys, interviews, and observations – was a significant limitation. Triangulating with the inclusion of other types of data would improve the results of the investigation.

A third limitation is the reliance on self-reporting (i.e. documents), which may focus on designing measures rather than their implementation in practice, as well as reporting successes more than failures (Broto & Bulkeley, 2013). For example, one multiple case study found that various academic and other groups have had difficulty working with city governments when they do not consider implementation (i.e. groups produced ideas but did not consider exactly how they would be put into practice) (Szanton, 1981; as cited by Yin, 2009). Echoing this sentiment, Sofaer (1999) says programs are rarely implemented exactly as planned, and that in multi-site evaluations “considerable variation typically occurs in the nature and extent of implementation of the ‘same’ intervention across sites.” (p. 1107). Thus, self-reporting and the plan-implementation disconnect were important limitations. A final significant limitation is the fact that only one city was considered. So, generalizations to other cities, especially in other states or countries, or with different risk, resources, population demographics, or political contexts, may be weak.

Assessment of Findings

While all inquiry designs are affected by their purpose and intended audience, special emphasis should be placed on these aspects in qualitative studies, as the criteria for judgement may be poorly understood even by qualitative researchers (Patton, 2002). The primary audience for this investigation is a thesis committee composed of

researchers and academicians, although it is possible it will be published or disseminated to practitioners in some form. Patton (2002, p. 13) suggests several kinds of criteria that can be used to judge the quality of findings, including traditional criteria (e.g., rigor, validity, reliability, generalizability), evaluation standards (e.g., utility, feasibility, propriety, accuracy), and nontraditional criteria (e.g., trustworthiness, diversity of perspectives, clarity of voice, credibility of the inquirer to primary users of the findings). Lincoln et al. (2011) argue that trustworthiness, authenticity, the inclusion of a catalyst for action, credibility, transferability, dependability, and confirmability are important. Indeed, the researcher is an instrument in the research, so the credibility of the work “hinges to a great extent on the skill, competence, and rigor of the person doing the fieldwork - as well as things going on in a person’s life that might prove a distraction.” (Patton, 2002, p. 14). Thus, explicit, thought-out methodological planning is only part of what is needed to ensure quality, as ultimately the quality of the investigation is also dependent on the investigator, and these criteria can guide assessment of both planning and the planner.

Chapter 5

ANALYSIS

This chapter discusses data collection, the coding process, and the City's governance structure, then goes through the assessment framework piece-by-piece. The next chapter will conclude by summarizing the results, discussing strengths and weaknesses of the framework and the approach taken in this investigation, highlighting more prominent or theoretically interesting parts, reconnecting to theory, and suggesting future research.

The Data Corpus: Data Collection

In order to collect the data, the procedures outlined in the methodology chapter were followed. Searching the New York City's official website for all documents with the phrase "climate change" or "global warming" (i.e. using Google.com search query "'climate change' or 'global warming' site:nyc.gov") produced 461 document and web page results for 2011-2015. A web browser plugin was used to highlight relevant search terms within the results, and any documents or web pages including these terms were downloaded (i.e. disaster, hazard "vulner," "emergenc," "extreme weather," flood, storm, hurricane, "sea level," "resilien," adapt, risk, C40, C-40, ICLEI, CCA, DRR). Web pages were printed to PDF files so they could be imported into Atlas.TI (the CAQDAS program used for coding). This resulted in over 200 files in the program – the data corpus. Notably, replicating this search on Miami and New Orleans' city websites

(miamigov.com, Miami.fl.us, nola.gov, and nolacitycouncil.com) results in only 24 results from 2011-present. While the relative size of the cities is no doubt an important factor, it seems that there is a much higher focus on CCDRR in NYC, which is an important contextual factor that may influence generalizability of results from this case study.

Precoding and Filtering

Precoding by going through and marking striking material can be an important opportunity, according to Saldaña (2009), who says the investigator should start coding as they collect and format data, and that the majority of researchers will code during and after collection. Accordingly, coding began during data collection and an initial reading of the documents, as well as conceptual note-taking and searching for general themes (i.e. holistic coding). Attention was focused on the broader themes and the concepts embedded therein. Importantly, rather than using an approach derived from the assessment framework, conceptual development was driven by the data. This approach was employed in order to avoid over-reliance on the assessment framework, and to allow the data to speak for itself.

During this phase of the data analysis, the large size of the data corpus became apparent, which had two important implications. First, the abundance of data was welcome because it meant there was likely enough data to apply the assessment framework in a relatively comprehensive way (despite only approximately four years of planning being considered). Second, it meant that some filtering was likely in order. In other words, with only some of the many thousands of pages of available data being

relevant to this investigation, logic for focusing on the most relevant parts of the data became necessary. Qualitative research methodologists sometimes disagree on the amount of the data corpus that should be coded, but many qualitative research methodologists feel that only “salient” portions of the data corpus “merit examination,” so up to half of the corpus might be ignored in order to focus on the most relevant pieces, even though this may exclude important portions (Saldaña, 2009, p. 15). In this case, a filter was used to sort data into three categories: primary, secondary, and tertiary.

Primary documents. Primary documents are CCDRR plans, or contain actual CCDRR planning, such as city government projects, measures, initiatives, and goals. In order to be considered CCDRR planning, the documents must address both disaster management and climate change. These documents were fully coded in multiple passes through the data, which included both a data-driven open coding phase and a framework-driven coding cycle. An example of a primary document (arguably the central document in this research) is *PlaNYC - A Stronger, More Resilient New York*, which is a 400+ page document focused on recovery from Sandy and long-term adaptation to climate change in a variety of ways. This document contains a wealth of information about the planning process and is an actual plan, describing the problem, assessing measures and strategies, including information about intragovernmental planning and stakeholder engagement, introducing many initiatives, and giving an overview of current and proposed funding.

Secondary documents. Secondary documents do not contain actual planning, but do contain relevant information (e.g., projections, studies, research, reports, assessments,

testimony, legislation, budgets, agendas). In these documents, relevant sections were coded, as determined by the presence of information related to planning efforts. Some secondary documents were fully coded if the entire document is relevant to planning efforts. Examples of secondary documents include the New York City Panel on Climate Change (NPCC) documents. While these documents are important parts of the planning process, some parts – like the nuanced details of climate projection methodology – are not an important part of planning. It is important for plans to use good information, but the underlying methodology is outside the scope of this inquiry, and these documents are not CCDRR planning. Another example is the series of annual Mayor's Management Reports, which only have limited relevant information, but some sections include valuable data that should be included.

Tertiary documents. Finally, tertiary documents do not contain either planning or information that directly supports planning, as determined by an initial read-through. In other words, these documents were included in the initial data collection because they contained keywords central to this research, but after review it is clear they are not actually part of the city's CCDRR planning process. For example, a document might have been collected because it contains the phrase “climate change,” but the document could be entirely focused on climate change mitigation (e.g., the reduction of GHG emissions), having nothing to do with adapting to climate change or disaster management. These documents will be kept as part of data corpus in order to be searchable or analyzed with CAQDAS (e.g., word clouds, auto coding), but they will not be coded. Examples of these documents are the “Best Practices” documents produced by the New York City Global

Exchange, which are summaries of best practices from cities around the world, and are not specific to NYC. If these practices are incorporated in city planning, it is assumed the plans themselves will reference this information sufficiently. This filtering approach will no doubt exclude useful and interesting information, but the tradeoff is that the central plans and planning process will receive additional attention.

Coding

When it comes to actually coding, collections of coding methods can offer helpful filters, but ultimately the investigator's own personal involvement affects how they perceive and document their data, and, all coding is a judgement call that "does not have to be approached as if it were some elusive mystery or detective story with deeply hidden clues and misleading red herrings scattered throughout." (Saldaña, 2009, p. 15). Codes are words, names, symbols, tags, or labels for organizing ideas applied to items or data, or to the answers to the questions asked about the data (Lofland et al., 2005). Thus, there is room for flexibility, and "Coding is not a precise science; it's primarily an interpretive act," which is "the transitional process between data collection and more extensive data analysis" (p. 4). Coding essentially occurs via two sorting and categorizing processes: initial coding and focused coding, according to Lofland et al. (2005), and that was roughly the procedure used for this inquiry. The first cycle was initial, data driven coding (i.e. decoding), and the second cycle was driven by the framework (i.e. encoding), which was in turn revised based on information from the first cycle of coding.

First Cycle: Initial Coding. In the first cycle, initial, or open, coding is "Where

the rubber hits the road” as data is condensed and organized into categories while being examined line by line, and each chunk of information is considered by asking what it is, what it represents, what it is an example of, what is happening, what people are doing or saying, what assumptions are made, and how the structure and contexts of the information impact actions and statements (Lofland et al., 2004, p. 201). The portion of data coded in this cycle included single words up to entire page in an attempt to balance the desire for detail with a need for expediency (due to the large size of the data corpus). The approach where larger blocks of data are coded is known as lumping, and is an expedient coding method that leaves the researcher with the possibility of subcoding and developing codes at a later point (Saldaña, 2009, p. 20). So, lumping was utilized during the first cycle to pull concepts out of the data, refine existing concepts in the CCDRR framework, and assess how to best get useful information out of the data in subsequent cycles. Many codes were generated, covering a wide range of concepts, perspectives, and other information. As some codes were populated more often and were clearly more salient than others for theoretical reasons, the coding became more focused and adjustments were made to the assessment framework. After approximately 100 codes were generated in the first cycle during the open approach, and integrated into the CCDRR assessment framework, the framework had received its first major revision, and the framework could be applied to the data.

Second Cycle: Focused Coding. Lofland et al. (2005) define coding as a process through which we define what the data are about by relating them to our ideas, thus “The essence of coding is the process of sorting your data into various categories that organize

it and render it meaningful from the vantage point of one or more frameworks or sets of ideas.” (p. 200). In the second cycle, focused coding overlaps with initial coding, and is more directed, selective, and conceptual, according to Lofland et al. (2005, p. 202), who say it begins after initial coding has produced expanding or analytically interesting initial codes. In other words, focused coding often begins when promising codes developed through initial coding have been selected as appropriate for categorizing the data. This second cycle used some of the codes found in the initial framework, some codes that emerged from the data, and some codes resulting in the synthesis of the two.

Moving into the second cycle, the revised framework was applied in a shift from data-driven to theory-driven coding. Each criterion and indicator in the framework received a code, such as *C1 - Stakeholders (local actor roles)* which covers the criteria C part one (local actor responsibility), and *B2 - Context (logistical capacity)* which focuses on the importance of developing shared logistical capacity as part of criterion B, which focuses on the institutional and organizational context. In these examples, the criteria – “stakeholders” and “context” – roughly represent categories and patterns, while the parenthetical component is the code. The framework and open codes were combined – the first real meeting of theory and practice. While some open codes were directly applicable to parts of the assessment framework, others were not easily integrated, which highlighted potential gaps in the theoretical approach, or areas for special focus during coding. Examples of this include a focus on building codes (only briefly addressed in the framework), the development of an “experts” code as a way to assess use of best information, and codes related to the prominence of Sandy as an obvious focusing event.

Categories, Patterns, Themes, Theory, and Propositions. Moving on from the second, final coding cycle, the CCDRR assessment framework was revised once again in a way that supported a structure of categories, patterns, and themes in order to allow for theoretical development and the possibility of propositions. Categories were developed as patterns in the data were discovered by grouping things that were similar or had something in common. Ultimately the aim was to compare and consolidate major categories in order to develop themes, and help move the investigation towards concepts and theory.

The revised version of the assessment framework used during the second coding cycle included five themes, and over 110 codes, which enabled a relatively granular approach during analysis. However, this would be an unwieldy tool for practitioners, so the framework was revised a second time to allow for a clearer analysis and summary of the results. This results in retention of the five original criteria and simplification of the 110+ indicators (also used as codes) into approximately 20 categories. For example, the financial sustainability indicator was divided into multiple codes (e.g., estimation of implementation costs, funding sources, impact on fiscal systems), but for the final analysis and in order to support the creation of a useable tool, these were synthesized into one indicator under the sustainability criterion.

As themes began emerging, through coding and restructuring the framework, possible connections to relevant theory developed. Of course, creating useful theoretical propositions, useful concepts, and a refined, theoretically-based tool for assessing CCDRR planning are important goals in this research, so generalization from this case was an important consideration during analysis. Yin (2009) makes an important

distinction between analytic and statistical generalization, saying that understanding the distinction between them may be one of the most important challenges in doing case studies. He claims that the role of theory in qualitative case study research is analytic generalization, so an important part of analysis is reconnection to theory in order to allow analytical generalization. Researchers should evaluate and extend theory by linking leads to theoretical and substantive knowledge (i.e. consistent or inconsistent with current concepts) throughout their research because “almost every qualitative investigation has the potential to ‘strike gold’ if the researcher pursues the right leads” (Ragin et al., 2004, p. 12). Thus, as the second coding cycle was completed, the inquiry was left with a theoretically-based framework shaped by observations from the real world, and an open possibility of reconnection to theory in order to allow useful generalizations and theoretical propositions. In order to develop context and create a foundation on which useful theory can be built, the next section summarizes the relevant governance structure.

New York City Governance and Organizational Context

The complex process of CCDRR planning involves many stakeholders, across disciplines, sectors, and levels of government. Obviously, City governments and their relevant governance and institutional context can vary widely in many ways. The following table introduces the relevant city governance structure, state and federal partners, and nongovernmental organizational context in order to provide an overview of the system in which planning and implementation takes place.

Table 3
Programs.

Relevant City Governance Structure, Plans, Initiatives, and

Governance Structure	
Mayor: Michael Bloomberg was the Mayor of NYC from 2002-2013, and Bill de Blasio took office January, 2014. Bloomberg started many initiatives that de Blasio continued, including PlaNYC, Build It Back, the Climate Change Adaptation Task Force (CCATF), the New York City Panel on Climate Change (NPCC), the Office of Long-Term Planning and Sustainability (OLTPS). The importance of executive leadership was highlighted in the literature review, and was apparent during data collection and analysis. It will be discussed in the next chapter as an important theme.	
Michael Bloomberg	Build it Back: Originally called Rapid Repairs, and designed to support NYC’s housing recovery efforts after Hurricane Sandy, Build it Back efforts were taken over by the Office of Housing Recovery under Mayor de Blasio. Climate Change Adaptation Task Force (CCATF). The CCATF was launched by Mayor Bloomberg in 2008, and worked with the NPCC to develop adaptation strategies to secure the city’s infrastructure against the impact of climate change. It is made up of city and state agencies, authorities, and private companies that operate, maintain, or control critical infrastructure in the city. Green Codes Task Force (GCTF): Convened at the request of Mayor Bloomberg and City Council Speaker Quinn, this task force released a 2010 report with 111 recommendations aimed at supporting climate change adaptation and mitigation actions. National Panel on Climate Change (NPCC): The NPCC was convened by Mayor Bloomberg in 2008 as a part of PlaNYC, and has since been codified into City law, required to give regular climate projection updates. PlaNYC: A long-term sustainability and resiliency planning effort started in 2007, one of the central documents used in this research is PlaNYC’s <i>A Stronger, More Resilient New York</i>. Special Initiative for Rebuilding and Resiliency (SIRR): Convened in the wake of Hurricane Sandy to support the creation of a more resilient city. Resulted in the publication of <i>PlaNYC – A Stronger, More Resilient New York</i>, a comprehensive, collaborative effort to intended to make the

	city more resilient to climate change.
Bill de Blasio	One City: Mayor de Blasio’s approach to making all publicly-owned buildings more climate resilient and less polluting while supporting creation of local jobs. It builds on PlaNYC’s efforts.
Mayor’s Offices	
Office of Emergency Management (OEM)	Renamed Emergency Management under Mayor de Blasio, this agency plans and prepares for emergencies, educates the public about preparedness, coordinates emergency response and recovery, and manages emergency information. This inquiry found this agency had a limited role in CCDRR efforts. Hazard Mitigation Plan: This office played a central role in the development of the City’s hazard mitigation plan, including working with a core group of 13 agencies on the Mitigation Planning Council.
Office of Environmental Remediation (OER)	This office worked with the private sector to clean up brownfield sites and support climate resiliency. It also worked with the Office of Long-Term Planning and Sustainability (OLTPS) to oversee the City’ environmental review process and administer the Green Buildings program.
Housing Recovery Office (HRO)	The Housing Recovery Office (HRO) played a central role in housing recovery efforts after Hurricane Sandy, including overseeing the Build It Back program.
Office of Long-Term Planning and Sustainability (OLTPS)	Formed under Mayor Bloomberg, this office played a central role in the City’s CCDRR efforts, including being the steward of PlaNYC and working with the New York City Economic Development Corporation (NYCEDC). Additionally, the office worked on Hurricane Sandy recovery efforts, supported SIRR’s efforts, and used Community Block Development Grant – Disaster Recovery (CBDG-DR) funds to work on long-term climate resilience efforts. “This bill assigns to the Office of Long Term Planning and Sustainability the responsibility of planning for resiliency and climate change and beginning in 2015, and every four years thereafter, OLTPS will include in their plan that is submitted

	to the Mayor and the Speaker of the City Council a list of policies, programs and actions that the City will undertake relating to resiliency issues.” (Office of the Mayor, 2013b, p. 2).
Office of Management and Budget (OMB)	Collaborated with the Office of Recovery and Resiliency to provide the state with Hazard Mitigation Grant Program applications, worked towards obtaining federal funding for resiliency projects, and oversaw distribution of CCDRR funding to city agencies.
Office of Recovery and Resilience (ORR)	The Office of Recovery and Resiliency (ORR) was formed under Mayor de Blasio, and was tasked with implementing a comprehensive, citywide plan to protect against climate risk. “Mayor’s Office of Recovery and Resiliency, formed to serve as the focal point for the coordination of the city’s major capital investments, its long-term resiliency planning, and the management of the complex relationships with its federal, state and private partners. This office will oversee the implementation of the city’s resiliency management and planning efforts and will be responsible for ensuring that we are less vulnerable in the years to come.” (<i>One City, Rebuilding Together - A Report on the City of New York’s Response to Hurricane Sandy and the Path Forward</i>, 2014, p. 2).
Office of Sustainability (OS)	Under Mayor de Blasio, OER and OLTPS were combined into one office, which was tasked with reducing contributions to climate change.
Departments	
Department of Buildings (DOB)	This department supported the City’s hazard mitigation plan update, supplied information on buildings to support vulnerability assessments, and worked with the Department of City Planning to prompt FEMA to update the National Flood Insurance Program to more accurately reflect current and future flood risk.
Department of City Planning (DCP)	In addition to participating in the Green Codes Task Force, DCP works closely with ORR to support PlaNYC, worked with OEM to support the hazard mitigation plan update, and other CCDRR efforts. In addition, the department led the

	development of <i>Designing for Flood Risk</i> , a document meant to support Hurricane Sandy recovery and long-term resilience efforts. Additionally, the department conducted Neighborhood Resiliency studies across 10 areas impacted by Hurricane Sandy, participate in a HUD planning consortium focused on sustainable communities, and works to develop planning and zoning initiatives.
Department of Environmental Protection (DEP)	This department played an important role in the City's CCDRR efforts, including supporting revisions to the hazard mitigation plan, rigorously documenting Hurricane Sandy's impact on the City's critical water infrastructure, developing a long-term effort to project the impact of climate change on the City's water supply (the Climate Change Integrated Modeling Project), working with the Department of Parks and Recreation to expand green infrastructure, and exploring funding opportunities for unfunded climate resiliency projects.
Department of Information Technology and Telecommunications (DoITT)	This department was tasked with focusing on telecommunications regulation and resiliency planning, including working with private sector stakeholders to ensure this critical infrastructure is reliable by encouraging preparedness and requesting business continuity plans.
Department of Transportation (DOT)	Works on the implementation of PlaNYC initiatives, supported the 2014 update to the City's hazard mitigation plan, and participated in the City's Green Codes Task Force.
Department of Parks and Recreation (DPR)	This department is collaborating with USACE on multiple PlaNYC initiatives (e.g., emergency beach renourishment), supported updating of the City's hazard mitigation plan, worked with DEP to develop green infrastructure in its parks, supported PlaNYC efforts, and participated in the Green Codes Task Force.
City Council: The City Council had limited involvement in CCDRR planning, but it showed clear support through endorsement of a march supporting action on climate change, codifying the NPCC in order to have regular high-resolution climate projections to support the City's long-term planning efforts, and many other pieces of legislation supporting CCDRR efforts.	
Public Benefit Corporations	
Housing Authority (NYCHA)	Operating over 2,500 buildings throughout the City (many of which were impacted by Hurricane Sandy), the Housing

	Authority has its own team of experts doing climate modeling to project impacts, and is including innovative green infrastructure and resiliency considerations as it rebuilds from Hurricane Sandy and prepares for the future.
New York City Economic Development Corporation (NYEDC)	The NYCEDC is supporting PlaNYC efforts, working with some stakeholders to support coastal resiliency (e.g., the Port Authority), supporting efforts to acquire additional resiliency funding, and supported grant administration for certain resiliency projects.
Federal	
Department of Housing and Urban Development (HUD)	Community Block Development Grant (CBDG): This program provides a wide range of community development funding, including some targeted at disaster relief, and it was a major source of funding for the City's CCDRR measures. National Disaster Resilience Competition (NDRC): HUD oversees the NDRC, which is a grant-awarding competition focused on helping communities recover from disasters and increase their resiliency.
Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program: National Flood Insurance Program:
State	
Governor	Governor's Office of Storm Recovery: Working within and outside of New York City, this office focused on Hurricane Sandy recovery and long-term planning, including through the New York Rising Community Reconstruction (NYRCR) Program which bought out some high-risk properties in a land-use measure.
Networks and Unofficial Organizations	
Building Resiliency Task Force	Convened at the City's request following Hurricane Sandy, the task force consisted of over 200 members charged with making recommendation for improving building resiliency and supporting preparedness for future weather extremes.

There were several factors worth discussing that provide valuable additional context for this case study. The time range selected was one major factor that impacted the results in significant ways. The range did not capture the creation of the PlaNYC process (2007). Furthermore, it failed to capture the actual implementation of many important measures. Specifically, a critical part of this case study was PlaNYC's *A Stronger, More Resilient New York*, and despite extensive work put into planning, the true test of these efforts will be taking the written plans and implementing them in a complex reality. While PlaNYC is an obvious example of this chronological limitation, the same restrictions apply to other planning processes, such as the IPCC and CCATF.

A second factor to consider is the influence of a massive focusing event that occurred during the relatively brief time frame considered. Hurricane Sandy certainly influenced CCDRR-related planning, as well as the results of this investigation. In some ways, this event may have increased focus on this subject, creating more data to analyze and a deeper exploration of the issue. However, it is also important to consider the impact this event has on the generalizability of this inquiry's conclusions. Will the framework, concepts, and other results be applicable to other cases? Answering this difficult question would require analysis of other cases, cross-case comparison, and possibly consideration of additional data from NYC outside of this time frame. These are just a couple of examples of what makes this case unique, but there are many more.

With the analysis process summarized and some background on the relevant parts of government given as context, the revised assessment framework can be introduced, after which it will be broken down piece-by-piece in a rich, qualitative exploration of the City's CCDRR planning efforts.

Framework

The original framework, developed through synthesis of theory, was an important step towards assessing in vivo CCDRR planning. However, the collection and analysis of the data corpus provided an important opportunity to develop the tool by including information from practice as well as theory. Thus, the framework was modified in a variety of ways in order to improve it. Some criteria were combined with others, some were simply removed, and new indicators were added. The general, relatively-linear structure of the assessment framework stayed the same, with five major criteria covering problem definition, governance and institutions, stakeholder involvement in planning, strategy and measures, and sustainability. However, indicators were significantly changed, partly driven by the goal of producing a practical, useful tool as a product of this investigation. A piece-by-piece breakdown of the framework is presented here, giving a more granular discussion that reveals how the tool was transformed during the data collection and analysis process. This is followed by a summary of the revised tool – a combination of theoretically-based then practically shaped framework designed to help theory and practice at the intersection of two increasingly important fields.

Problem Definition

This assessment framework is organized in a roughly linear manner. Though this does not fully capture the complex reality of CCDRR planning, it is a useful way to conceptualize and organize this kind of planning. The first step in this process, the first criterion in the assessment framework, is to understand the problem. Within this criterion

there are several indicators, including use of best information, developing a transparent baseline, using scenarios and modeling, employing decision-support tools, and prioritizing and clarifying goals.

Best information. According to the framework, planners should use the best available information. This indicator is essentially a combination of separate indicators in the original framework, including consideration and development of best practices, consulting experts, and conducting and/or reviewing high-quality research. As is the case throughout the revised framework, indicators are often combined in order to simplify the framework in order to make it more useable for planners.

NPCC. Originally convened by Bloomberg in 2008, this body of leading climate and social scientists and risk management experts was formally codified by the council in the first city institutionalization of a “process for updating local climate projections and identifying and implementing strategies to address climate risks,” which includes updating climate projections at least every three years (Office of Recovery and Resiliency, 2015, p. 33). NPCC used the most updated climate models, recent observations about trends, and new information about GHG emissions to update its 2009 projections when it was convened on an emergency basis after Hurricane Sandy. Notably, the city used experts from over 10 different universities, including well-known researchers from top-tier schools, to develop their 2013 report, which was used in PlaNYC (P76, p. 1). The NPCC’s most recent report has helped to pave the way for this initiative by providing recommendations for future research, including improved probability estimation and modeling, with a focus on future coastal flooding, better

mapping of neighborhood vulnerability, a system of indicators to track climate risks, and ways to communicate information on how climate change will affect future hazards (Bloomberg, 2013c, p. 6).

Designing for Flood Risk. Another important effort was *Designing for Flood Risk*, a document from the Department of City Planning (DCP). According to DCP Director Amanda Burden, DCP and the architectural and design community created *Designing for Flood Risk* as the product of “intensive collaboration between City Planning and the architectural and design community” which can be used to guide both public and private efforts to build resilient buildings in the wake of Hurricane Sandy (Department of City Planning, 2013a, p. 4). In a half-day event in 2012, DCP worked with professionals to produce transdisciplinary findings that were included as part of *Designing for Flood Risk* (Department of City Planning, 2013a, p. 5). The event included the creation of eight teams that were tasked with adapting a new building to a high flood elevation, and which addressed issues like how the building interfaces with the public realm. For example, some teams shaped buildings in order to allow more light to reach the low levels that had low ceilings and limited access to daylight, and other teams suggested using this space for temporary program like pop-up retail or community facilities enclosed in mobile structures (Department of City Planning, 2013a, p. 20). Findings and suggestions include recommendations for dry flood-proofing that keeps water out, mixed-use buildings that can withstand flooding on lower levels by allowing water to enter and leave the structure when necessary, and elevation of buildings to remove them from harm’s way (Department of City Planning, 2013a, p. 17).

The work of the NPCC and this DCP effort are only two examples of the City’s

production and use of some of the best information available, from a variety of sources, with varying purposes, and using a mixture of methods. The Hazard Mitigation Plan 2014 update used “best available data” that was consistent with SIRR (Hazard Mitigation Plan Overview, 2013, p. 21), and DEP used both IPCC and NPCC information (Pierson, 2012, p. 79), in addition to other well-recognized sources of information such as NOAA (Pierson, 2014, p. 9591). The city also used information from historical damage records in order to develop assumptions for the future NYC environment, and modeling based on FEMA data input (Office of Recovery and Resiliency, 2015, p. 23).

Best practices. The City made clear efforts to develop and use best practices. For example, NYC used information from Toronto to understand the relationship between climate change, air quality, and public health, including multi-level “smog summits,” establishment of a clean air council, and strategic programming (Best Practice: Green Schools, 2011, p. 1-3). As part of this same Global Partners Exchange, NYC also considered efforts in Buenos Aires designed to educate people about the environment, including installation of green roofs (Best Practice: Demonstrating Air Quality and Climate Change Impacts on Public Health, 2011, p. 3). Another notable effort to develop and use best practices was the creation of the Jamaica Bay Science and Resilience Center, which is meant to communicate scientific findings and best practices through synthesis and dissemination of research, partnering with non-profits, organizing symposia, and advocating for scientifically-supported policy initiatives and associated funding (City of New York Mayor's Office and National Park Service, 2012, P.7). Other efforts related to best practices include the previously mentioned *Designing for Flood Risk*, adaptation strategies and supporting frameworks for coastal protection (*Urban Waterfront Adaptive*

Strategies), support for understanding retrofit options (*Retrofitting Buildings for Flood Risk*), and a FEMA-funded study focused on planning within the city's flood-prone industrial areas (*Resilient Industrial Areas Study*) (Bloomberg, 2013b, p. 177). Also informing best practices, Hurricane Sandy provided opportunities to learn what works in NYC, including coastal features that performed well during the storm (Mayor's Office, 2013, p. 50). Finally, PlaNYC's success was attributed partially to an external Sustainability Advisory Board which provided best practice advice and guidance (Mayor's Office, 2013, p. 409).

Experts. Input from experts is also an important part of ensuring use of best available information. NYC worked with the City University of New York (CUNY) to get seven post-doctoral researchers to support its modeling efforts (Department of Environmental Protection, 2014, p. xvi), and an expert panel review in a DEP water modeling project that looked at changes expected with climate change (Department of Environmental Protection, 2014, p. 96). Of course, a critical group of experts involved in CCDRR planning in NYC was the NPCC, which included a range of experts working in multiple phases over several years to understand and project climate change impacts in NYC (Department of City Planning, 2013a, p. 9). More specific to disaster management, the Hazard Mitigation Plan used OEM, DCP, and OLTPS officials as well as a core group of 13 agencies on a steering committee (the Mitigation Planning Council [MPC]), and other stakeholder outreach to get expert input on planning efforts (Hazard Mitigation Plan Overview, 2013, p. 5). Sometimes agencies have their own experts and capabilities, such as the NYCHA team of experts that run climate change and SLR models that show risk impacts and work with federal agencies and academic institutions to “provide and

translate the most up-to-date climate change data.” (Office of Recovery and Resiliency, 2015, p. 17).

Research. While bringing experts directly into the process is important, there are many opportunities to build on cutting edge knowledge by conducting studies and building on research. For example, in the City’s Climate Change Integrated Modeling Project (Department of Environmental Protection, 2013), research articles are regularly used as support, and the involvement of researchers from multiple, highly-regarded universities in the NPCC demonstrates the same thing. Of course, the NPCC played a critical role in the City’s attempts to understand risk and plan for change. Not only did they use a range of techniques, established research, and prominent experts to develop their recommendations, but they also highlighted needs by recommending future research. These needs included developing improved methods for estimating probabilities of changes in hazards, improving computational and statistical modeling of the climate system, improved representation of future coastal flooding via improved modeling, improved mapping of neighborhood vulnerability, a system of collaboratively-developed indicators for monitoring risk, and improved communication methods for data and information on climate changes (P76, p. 6).

Outside research from federal partners is also used, including FEMA’s Flood Insurance Studies (FIS) which produce the widely-used Flood Insurance Rate Maps (FIRMs) (Department of City Planning, 2013a, p. 13), and a study funded by HUD’s Sustainable Communities Regional Planning Grant which develops best practices for NYC and other regional governments (Department of City Planning, 2013b, p. iii). Another example of research being used in planning is SLR estimates based on Goddard

Institute of Space Studies Atmospheric Ocean Model and IPCC GHG emission scenarios (Department of Environmental Protection, 2008, p. 41). USACE also worked with the city to conduct many studies over the years that “have addressed the need for coastal protections” as far back as 1965, and as recently as 2013, when the U.S. Congress authorized USACE’s North Atlantic Coast Comprehensive Study that can play a role in the first comprehensive flood protection study for the Upper New York Bay (Mayor’s Office, 2013, p. 41). According to PlaNYC, the City’s collaborative efforts will be led by OLTPS and include DCP, DPR, NYCEDC, DEP, and NYCDOT (Mayor’s Office, 2013, p. 64).

The NYC Green Codes Task Force recommended that the city undertake a study to determine how building codes and zoning regulations should be strengthened to protect against SLR and flooding, as well as studying urban-design strategies to “ensure streetscape vitality is not a casualty” of the city’s proactive measures (Climate Adaptation Committee, n.d., p. BR 3, 1). DCP is leading resiliency research initiatives including “Neighborhood Resiliency studies across ten communities impacted by Hurricane Sandy, planning studies related to retail and industrial resiliency City-wide, and zoning text amendments to provide for the repair and elevation of damaged homes in coastal communities.” (Office of Recovery and Resiliency, 2015, p. 12). Another research effort that is particularly relevant to this inquiry is a document developed by OEM, DCP, and ORR – *NYC’s Risk Landscape - A Guide to Hazard Mitigation* – which builds on the existing body of literature (e.g., FEMA’s FIS, DCP and DHMH research) in order to develop a guide to mitigating hazards in NYC. The document incorporates a considerable amount of climate change research in its risk assessment, and, notably, has a focus on

usability within and outside of the City's government (Lenten, 2014, p. 159).

The mayor and DEP's collaboration with many stakeholders to develop the *NYC Wastewater Resiliency Plan – Climate Risk Assessment and Adaptation Study* is another important example of research related to CCDRR. While the effort is not strictly CCDRR (i.e. it lacks a strong focus on disaster), it is an important part of the City's effort simply due to the importance of water management as part of CCDRR efforts. The plan was “was a tremendous effort, with vital data sharing and intensive discussion between operators, risk analysts, climate specialists, and policy makers. The study greatly improved understanding of wastewater infrastructure risks and resulted in identification of a portfolio of robust adaptation strategies that will be incorporated in DEP design standards and capital planning.” (Bloomberg & Strickland, 2013, p. 22). Driven partly by SIRR, the study supported DEP risk evaluation, resiliency upgrades, storm water management, and ecosystem management, leaving DEP “well positioned to better protect the City's water infrastructure and waterways on multiple fronts” (Bloomberg & Strickland, 2013, p. 22). Notably, the study found that potential damage to pumping stations and wastewater treatment plants is “extremely high and warrants protection,” so it developed strategies for each facility, and important parts of the City's critical infrastructure, that included upgrading/retrofitting plant generation systems to incorporate new technologies, establishing safe houses for staff during storms, and having electrical and mechanical contractors ready to provide immediate repairs (P. 79, p. 17).

Clearly, there are many examples of the City developing and using some of the best information available, developing best practices, consulting experts, and building on existing research to support its planning efforts. Indeed, this coverage is not

comprehensive – the city also used aerial photographs to assess coastline protection (Mayor’s Office, 2013, p. 55), planning work done by the Nature Conservancy (Mayor’s Office, 2013, p. 62), collaboration with the Port Authority to study innovative coastal protection measures (Mayor’s Office, 2013, p. 256), and zoning, mitigation, and building code studies (Mayor’s Office, 2013, p. 258). According to a PlaNYC presentation, projections are grounded in “latest scientific literature” and “observed climate data for the region and globe” (*NYC Panel on Climate Change*, 2013, p. 5), and it seems this claim is clearly supported by the available data.

Transparent baseline. Once information has been collected, it is important to formulate a transparent baseline with the information available, including explicit definitions, a clear purpose, technology learning rates, and methods used to calculate GDP projections. These components of this indicator can be found in the original framework, with a notable removal of using sensitivity analyses to treat uncertainty because this is part of decision-support systems and it was thought this was too in-depth to be addressed here. Additionally, this indicator was moved to earlier in the framework because generation of a baseline is likely appropriate earlier in the planning process, rather than later. Related to the use of planning assumptions is the formulation of a transparent baseline on which to build climate scenarios, risk assessments, and planning. The development of a transparent baseline was not as apparent as the collection and use of information, but there was still a significant amount of information available to shed light on this part of the planning process. The City’s approach to developing a climate baseline was clear, including using minimum and maximum temperature and daily

precipitation data from NCDC-recognized stations (Department of Environmental Protection, 2013, p. 4), baseline and projected number of days the West of Hudson (WHO) watershed will be under emergency, warning, and watch drought conditions (Department of Environmental Protection, 2013, p. 29), baseline air temperature, precipitation, SLR numbers, heat waves and cold weather events, intense precipitation, and coastal floods at the Battery based on data from 1971-2000 (Bloomberg, 2013c, p. 5), in addition to more extensive data on mean temperature, precipitation, and SLR dating back to 1900 (Bloomberg, 2013c, p. 11), and FEMA's FIS work based on tidal information and characteristics of the local land and water (Department of City Planning, 2013a, p. 13). So, there is information about climate and hazards.

Additionally, there were explicit definitions used as a foundation for much of the planning, creating a strong conceptual foundation on which to build a shared understanding during the planning process. Many good examples come from the 2013 NPCC report, including definitions of climate change, climate hazard, risk, and uncertainty (Bloomberg, 2013c, p. 8), regional scales (Bloomberg, 2013c, p. 9), extreme events and heat waves (Bloomberg, 2013c, p. 12), heat index, short duration drought, multi-year drought, ice storms, seasonal snowfall, downpours, lightning, tropical storms, and hurricanes (Bloomberg, 2013c, p. 23), adaptation, climate forcing, climate hazards, emissions scenarios, GCMs, hazard, mitigation, NPCC, GHGs, paleoclimate, RCPs, relative sea level, risk, time slice, uncertainty, and scenario (Bloomberg, 2013c, 33-35). While not all primary terms were clearly defined, it was clear that there was a strong conceptual foundation on which the City could build its planning. It is important to note, however, that the extent to which these definitions permeated throughout the city is not

addressed by this inquiry, and that terminology and a shared conceptual understanding are important aspects of this interdisciplinary work.

The assessment framework called for a transparent development of a GDP baseline, but this was not a clear part of the City's efforts, though there is substantial consideration of the relationship between CCDRR and the City's economy. The purpose of the baseline seemed to be implied, but there was very little information about projected technology learning rates.

Scenarios and modeling. In this case, this indicator is essentially the same as it was in the first framework, except that it has been adjusted for brevity and clarity, and “A3 – Interaction (economic; environmental; social)” has been combined with it. A critical part of understanding the problem of climate change is developing scenarios that give predictions about future change. Planners should use a range of scenarios and models (e.g., climate, socioeconomic) and high-resolution data and risk mapping to understand regional and local risk. This includes assessment of magnitude and probability of events, as well as identification of assumptions and limitations. An important part of this may be interactions between the economy, environment, and society, including macroeconomic assumptions about population, GDP, investment, trade, income, demographic distribution, health status, sectoral employment, and government budgets and policies.

Modeling. DEP developed models for exploring land use, population density, ecosystem processes, climate, and watershed management policies (Department of Environmental Protection, 2014, p. xv). In order to project future changes in water

management, water supply researchers developed initial projections by using an ensemble of GCMs and emission scenarios which found more confidence in estimates of increases in mean air temperature than estimates of changes in precipitation (Department of Environmental Protection, 2013, p. 10). Some of the most important modeling efforts in this area are climate modeling. Global climate models (GCMs) are a good source from which scenarios can be developed though there is a “mismatch of spatial scales between GCMs on the one hand, and local observations and local impact assessments” on the other (Department of Environmental Protection, 2013, p. 5). One way of managing this mismatch was employing an ensemble of GCMs and emission scenarios in an attempt to compensate for discrepancies between different models (Department of Environmental Protection, 2013, p. 10). Projections released by the NPCC in early 2015 provide climate change projections in 30-year intervals, including the 2050s, 2080s, and through the end of the century (Office of Recovery and Resiliency, 2015, p. 33). In 2013, these projections out to 2100 were based on low, middle, and high estimate scenarios developed by combining 35 GCMs, built on a baseline of data from 1971-2000 (*Draft for Distribution - NPCC2 Climate Risk Information 2013*, 2013, p. 6).

Nonstationarity. Some of the assumptions used during the development of GCMs include assumptions about water demands and river flows and that certain system indicators can be calculated based on historical patterns (Department of Environmental Protection, 2013, p. 32). This reveals an important concept that can be used to help conceptualize part of climate adaptation closely related to assumptions – nonstationarity. Nonstationarity is essentially the idea that historical patterns may not have the same predictive power as the climate changes, so it is particularly important to recognize and

address these assumptions as part of planning. An example of this comes from the City's sewer system, which "was designed to meet an engineering assumption about rainfall intensity for a 5-year storm base," resulting in a taxed sewer system trying to manage a climate trend toward heavier rainfall (Lenten, 2014, p. 77).

Developing assumptions. Planning processes can use information generated from research as assumptions on which to build and make decisions, which can be a critical part of the planning process because of the potential funding and public safety issues in CCDRR planning. While there can be many such assumptions used in planning, a good example in this case relates to SLR. As part of PlaNYC, the City used NPCC SLR projections in its storm surge modeling efforts, which illustrates the importance of scenarios and modeling to support the planning process (Mayor's Office, 2013, p. 50). That is to say, GHG emissions assumptions impact GCMs and, in turn, SLR projections, which are then used as assumptions while modeling future storm surge. FEMA's revised flood maps are an excellent example of the need for this careful inclusion of assumptions, since they ignore potential changes in coastal storms and SLR, and therefore do not reflect the full risk to NYC's buildings, which could expand to include an additional 20,000 buildings by the 2020s, and more than 114,000 buildings by 2050 (Mayor's Office, 2013, p. 68).

High resolution data. Developing high-resolution data that can support local planning efforts is also important, since GCMs generally lack the high-resolution needed to generate a good level of confidence in probability estimates. Fortunately for NYC, there are already some external sources for understanding local projected impacts, such as the National Climate Data Center's climatological rankings, which uses a 5-km

gridded approach (Department of Environmental Protection, 2014, p. 9) and the Water Research Foundation's framework for assessing climate change vulnerability and defining robust risk management strategies for water utilities, which included a pilot study on NYC (Department of Environmental Protection, 2014, p. 111). Not only did the City have this data to draw on, but it also made significant efforts of its own, including the DEP's multi-phase, scenario-driven Climate Change Integrated Modeling Approach (CCIMP), focused on addressing watershed issues in the City's water supply (Department of Environmental Protection, 2014, p. 95), and, of course, the NPCC. The NPCC developed some of its most recent projections for the NYC metropolitan region by using a coupled intercomparison GCM model, observed data, and projection methodologies used in the IPCC's fifth assessment report. They found that their projections were "generally consistent with the projections of other major assessments," such as the first NPCC report, IPCC's AR5 (IPCC 2013), the 2013-2014 National Climate Assessment, the NOAA Sea Level Rise Report, and the National Research Council Report. (*Draft for Distribution - NPCC2 Climate Risk Information 2013*, 2013, p. 2).

These locally-relevant predictions included a 5.3 to 8.8-degree F increase in temperature by the 2080s, based on middle range projections, and a potential threefold increase in heat wave frequency, accompanied by an increased average length one and a half times longer than present day (Office of Recovery and Resiliency, 2015, p. 33). In addition, the City has already experienced nearly twice the average global rate of SLR (almost 1.1 feet since 1900), which is expected to increase another 22–50" by the end of the century, based on middle range projections, with high end projections predicting an additional 6 feet by the end of the century (Office of Recovery and Resiliency, 2015, p.

34). Framing it another way, the City explains that with more than 2.5 feet of SLR the City's 100-year flood plain in 2050 could be 24% of the city, which contains well over 100,000 building, 97% of the City's power generation capacity, and 20% of its hospital beds, which would leave more people in the 100-year floodplain than residents in the entire city of Boston (Office of Recovery and Resiliency, 2015, p. 35). Supporting the idea that the NPCC, and NYC, recognize the importance of high-resolution data, the NPCC's recommendations for future research include not only improved methods for estimating probabilities of changes in hazards and better computational and statistical modeling, but also a better understanding and mapping of neighborhood vulnerability (Bloomberg, 2013c, p. 6). In order to continue developing a high-resolution understanding of NYC's risk, the City passed a law in 2012 that requires the NPCC to meet regularly, often building on IPCC publications, which should provide valuable information on which to base future planning (Bloomberg, 2013c, p. 7).

Taking a different approach to getting locally-relevant data, an optimistic perspective on Hurricane Sandy recognizes that it provided an excellent opportunity to develop a better understanding of local risks, such as the risk to the City's wastewater treatment plants and pumping stations, which were estimated to have received over \$95 in damage during the storm. Seizing this opportunity, DEP staff "rigorously documented flood depths, providing valuable information regarding the impacts of flooding on sire" (Bloomberg & Strickland, 2013, p. 5).

The City's also assesses infrastructure-specific risk in other ways, including in its hazard mitigation plan, which projects that increased energy demand during more frequent heat waves coupled with population growth could strain the system, and says the

increasing risk to critical energy systems and telecommunications facilities due to flooding (Office of Emergency Management, 2014, p. 341). Another effort even more focused on understanding the risk of was the convention of the New York City Climate Adaptation Task Force (CCATF), which was tasked with assessing the vulnerabilities of the city's critical infrastructure, and it identified more than 100 types of infrastructure that climate change could affect, including water, energy, transportation, and communications (Department of City Planning, 2011, p. 108). According to Vision 2020, the city's "comprehensive waterfront plan," the city only recently obtained high-resolution data that allowed them to make an accurate assessment of the elevation of coastal land and buildings because of the acquisition of light detection and ranging (LiDAR) elevation data, which can improve risk assessment (Department of City Planning, 2011, p. 108).

Risk mapping. An important way of understanding risk visual representation on a map, which supports identifying and understanding risk in specific areas. A central aspect of NYC's vulnerability is the City's 520-mile coastline – the longest and most diverse waterfront of any U.S. city (Department of City Planning, 2013a, p. 4). Part of the City's effort to understand and communicate this risk include a map representing storm surge inundation zones (Hazard Mitigation Plan Overview, 2013, p. 18), historical tropical storm and hurricane tracks (Hazard Mitigation Plan Overview, 2013, p. 19), and projected future 100 and 500-year flood zones in the 2020s and 2050s (Bloomberg, 2013c, p. 5-6).

Probability. There were clear, seemingly effective efforts to assess the probability of hazards the City faces, and this is an important part of the risk equation (though the

other part of this equation, vulnerability, does not receive the same amount of attention). As the NPCC puts it “choosing among policies for reducing future losses from extreme events such as Hurricane Sandy is an exercise in risk management” (Bloomberg, 2013c, p. 9). One way to increase confidence in probability is through the use of an ensemble of GCMs and emission scenarios, especially because “It is not uncommon for output from different GCMs for the same geographic area to differ not just in magnitude but even in the direction of future change for some variables, reflecting different assumptions for key processes among the climate models.” (Department of Environmental Protection, 2013, p. 10). The City’s Climate Change Integrated Modeling Project, used a range of models and found that while most models were in agreement with each other in predicting future changes in air temperature, snow accumulation, and winter-spring streamflow, there was far less certainty regarding predictions of increased summer precipitation (Department of Environmental Protection, 2013, p. 32), and the City explicitly states that the findings should represent “‘first cut’ estimates of some of the potential effects of climate change, because of the many issues relate to data limitations, uncertainties, and modeling assumptions” (Department of Environmental Protection, 2013, p. 56).

The NPCC chose to use the IPCC’s method for clearly defining the way it talks about probability (e.g., “more likely than not” is a $> 50\%$ probability of occurrence, “extremely likely” is a $> 95\%$ probability of occurrence), employed visual representations of projected future flood zones, and identified improved methods for estimating probabilities as an important future research need (Bloomberg, 2013c, p. 6). Furthermore, they note that there are several important sources of uncertainty, including random uncertainties in the climate system, and uncertainties related to climate measurements,

climate models, and future climate drivers (Bloomberg, 2013c, p. 10). Finally, the NPCC summarizes projected changes in air temperature, precipitation, SLR, a variety of extreme events, and various flood-related probabilities by breaking them down into low, middle, and high range estimates (10th, 25th-75th, and 90th percentiles, respectively) (Bloomberg, 2013c, p. 19, p. 21), which may be a good middle ground between an oversimplification of predictions that leads to misunderstanding, and a detailed breakdown of probabilities that is too complex to use. This same method of representing probability is also used by Mayor de Blasio in his One City plan (*One City, Rebuilding Together - A Report on the City of New York's Response to Hurricane Sandy and the Path Forward*, 2014, p. 23-24). Notably, there are examples of City efforts that do not use this way of conveying risk, such as the 2014 Hazard Mitigation Plan, which says scientists are “fairly certain” of some specific changes in future storms (Office of Emergency Management, 2014, p. 135). This is noteworthy because using consistent language is an important part of CCDRR planning because it supports communication, development of a shared policy vision, and inclusion of stakeholders.

Projections:

- Designed to facilitate risk-based decision-making
- Used ranges of model-based outcomes and likelihoods based on scientific literature
- Based on results from 35 global climate models and 2 scenarios of future greenhouse gas emissions

NPCC2 CRI, 2013

Note: model-based outcomes do not encompass the full range of possible futures

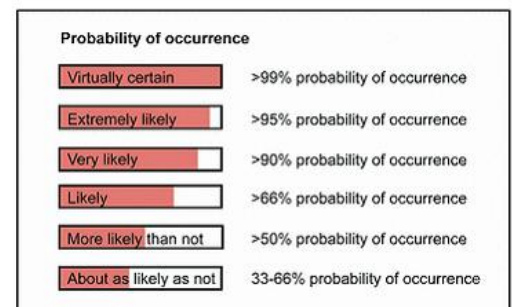
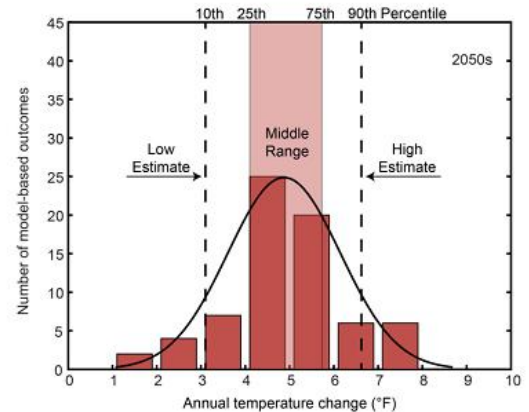


Figure 2 NPCC Management of Probability and Risk Management
(New York City Panel on Climate Change 2015 Report, 2015)

Of course, the probability of changes in hazards is only one part of predicting future risk, and a hazard mitigation document by Emergency Management, DCP, and ORR points out that key factors may also include “population growth and demographic trends, land-use development, new technologies, economic conditions, and City, State, and federal fiscal capabilities.” (Lenten, 2014, p. 38). Even when only considering specific hazards, multiple factors can play important roles. For example, the City notes that climate scientists predict warming ocean temperatures will increase the frequency of

the most intense tropical cyclones, while the overall frequency will decrease. However, they note that SLR independent of climate influence on these events, increasing sea levels will impact these hazards (Lenten, 2014, p. 56).

There are examples of City planning addressing socioeconomic issues in *PlaNYC* – *A Stronger, More Resilient New York*, including an assessment of industry, business, and the arts community in the Brooklyn and Queens waterfront (Mayor’s Office, 2013, p. 244), residential factors (e.g., housing types), businesses and attractions in Southern Brooklyn (Mayor’s Office, 2013, p. 338), rates of home ownership (Mayor’s Office, 2013, p. 339) Hurricane Sandy’s impact on local businesses, their employees, and food availability (Mayor’s Office, 2013, p. 343) in Coney Island, an assessment of public housing vulnerability (Mayor’s Office, 2013, p. 401-402), and, importantly, potential impacts in Southern Manhattan, an area with a high population density, important role as a global business hub, a significant amount of vulnerable infrastructure, over 61,000 residents in the 100-year floodplain, significant low-to-moderate-income populations (e.g., Chinatown, Lower East Side), and an expected increase in threats “as more people reside in the floodplain” (Economic Development Corporation, 2014, p. 5). As part of the planning process, the Southern Manhattan Coastal Protection Study team assessed the demographics and current real estate conditions of neighborhoods within the study area, considering potential flood protection options that address the area’s existing context and needs while being financially feasible (Economic Development Corporation, 2014, p. 14). The 2014 New York City Hazard Mitigation Plan also considered climate change and socioeconomic issues, saying that “Land use and development trends in New York City are influenced by changes in the economy and the population, and are guided by

strategic planning initiatives designed to accommodate future growth and climate change challenges.” (Office of Emergency Management, 2014, p. 97).

Decision-support. The complex nature of this planning means that using decision-support tools and systems to identify and compare choices, including treatment of uncertainty by conducting sensitivity analyses, can be important. In this case, the indicator is unchanged from the first iteration of the framework. As revealed by the literature review on which this inquiry is built, some researchers advocate for the use of multi-criteria decision analysis (MCDA), and the more traditional cost-benefit analysis (CBA) could also be a useful way of approaching this very complex issue. One example of the potential utility of decision-support systems and approaches is from a Bloomberg request for proposals (RFP) to study the potential development of a “seaport city” in Lower Manhattan that would protect the area from the impacts of climate change. The RFP included the need for a comprehensive assessment that considered “all the relevant aspects needed to develop a multi-purpose levee,” including the “technical and physical configuration of the levee, infrastructure requirements, environmental issues, legal issues, costs, and implementation strategies” (Office of the Mayor, p. 2). This is just an example of the complexity that a single initiative can create, and does not even include consideration of social/quality of life issues or impact on the local economy. While the City’s use of decision-support tools seems to be limited, FEMA’s Benefit Cost Analysis (BCA) software was used to project future damages and potential avoided losses (Office of Recovery and Resiliency, 2015, p. 23), as were Swiss Re (a reinsurance company) models that calculate expected losses and “enable cost-benefit estimates of proposed

interventions” (Mayor’s Office, 2013, p. 36).

Goal priority and clarity. Thus far this discussion has covered the initial criterion in the assessment tool (problem definition and decision making), which is focused on collecting good data, using models and scenarios to develop an understanding of the situation, then using decision-support systems (e.g., CBA, MCDA) to evaluate choices. The final part of this first phase (i.e. initial criterion) is to consider the importance of CCDRR planning relative to other needs and goals, select among competing CCDRR priorities, and then set clear goals as the planning process moves on to engaging other official partners in the process. This indicator is a combination of two indicators in the original framework:

- *A6 - Prioritize (priority):* Consider the importance of CCDRR planning relative to other needs and goals
- *A7 – Goals (goals):* Set clear goals when possible

Goal clarity was an additional consideration added to this indicator in order to show that clarifying goals is an important part of prioritizing them. Notably, the Hazard Mitigation Plan included a similar approach to planning, which included establishing goals and objectives, identifying mitigation actions, analyzing their feasibility, and the prioritizing actions as follows:

Mitigation Actions Overview

New York City Hazard Mitigation Plan Update

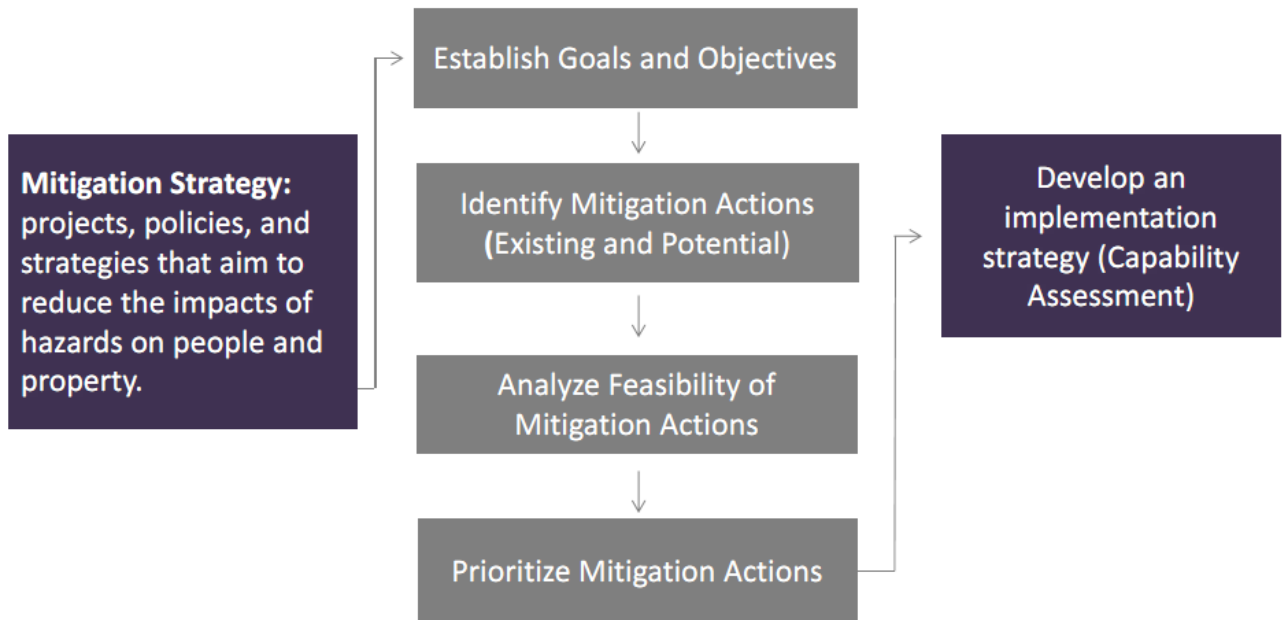


Figure 3 NYC Hazard Mitigation Plan Mitigation Actions Overview (Hazard Mitigation Plan Overview, 2013).

The City highlighted several important priorities that reveal a number of intentions and underlying assumptions. While the City recognizes the impact of hazards on people as a paramount concern, it also paid attention to “critical infrastructure systems – energy, telecommunications, transportation, and water and wastewater” upon which much of the city depends (Lenten, 2014, p. 17). This approach is reiterated in *PlaNYC - Stronger, More Resilient New York*, which describes how Mayor Bloomberg asked City agencies to take “stock of the resiliency investments that may be needed to ensure that the City can provide essential services over the long term, as the climate changes,”

resulting in at least \$100 million of these investments being identified as high priority, being funded by an incremental addition to the City’s capital budget (Mayor’s Office, 2013, p. 402). Another priority for the City was the impact on the environment. For example, one of DEP’s primary concerns was the “nature and details of the potential impacts of climate change on the availability of high quality water” (Department of Environmental Protection, 2013, p. 1).

An additional important consideration when prioritizing CCDRR efforts is the timeline for expected benefits from action. An initiative may make an immediate, obvious difference to a community (e.g., a multi-purpose levee that creates a new community space and provides obvious protection from storm surge), but it could also take a long time for benefits to be apparent. Of course, this can become a deeply political issue, as some people will not support long-term efforts that do not clearly benefit them. PlaNYC addresses this issue by pointing out that “certain elements of the City’s plan can begin almost immediately, making New Yorkers safer today, rather than waiting years or perhaps even decades for a solution that may never be complete.” (Mayor’s Office, 2013, p. 50).

Governance and Institutions

According to the assessment framework, once the problem has been defined and explored, the next step is to engage relevant parts of the government and institutions, as well as external factors that influence these. This criterion has been simplified from the original, primarily by combining the sub-indicators into three primary indicators: Official context, institutional context, and unofficial context. Official context is the primary

concern in this criterion, but unofficial/semi-official institutions and non-governmental organizations and businesses are also considered. Individual stakeholders, a critical part of this planning process, are addressed as part of the next criterion. The indicators are slightly changed from the first iteration of the framework. “Institutionalization of CCDRR so integration at the program level is standard,” and “improving related education” are now part of the “institution” indicator, which has been moved to after the “official context” indicator as official context is deemed more important.

Official context. Engaging official stakeholders is an important step towards mainstreaming CCDRR into official development planning and legal frameworks, networking city and other levels of government to build a culture of collaboration, and developing a shared policy vision that supports a multi-level system of risk governance and planning (e.g., use land-use planning to collaborate with state government). This can be supported through identification of collaborative champions in relevant agencies, cooperative funding of efforts, supporting logistical capacities (e.g., co-location of facilities, joint training with EM and climate change agencies), and assignment of responsibility (e.g., create a task force to oversee the process). There are multiple examples of the City’s efforts to coordinate government and institutional stakeholders, including the Mitigation Planning Council Steering Committee, Climate Change Adaptation Task Force (CCATF), Special Initiative for Rebuilding and Resiliency (SIRR), Office of Long Term Planning and Sustainability (OLTPS), and the Office of Recovery and Resiliency (ORR).

Hazard Mitigation Plan (HMP). The Mitigation Planning Council Steering

Committee helped to develop and implement the Hazard Mitigation Plan (HMP), and is comprised of a core group of “13 local agencies and regional organizations that own or manage some of the city's largest infrastructure networks and/or engage in planning for or regulating these systems (Office of Emergency Management, 2014, p. 4). These agencies include OEM, DCP, OLTPS, DOB, DEP, DPR, DOT, MTA and the regional planning association, and, for the 2014 update to the HMP, DOHMH, HRO, NYPD, and FDNY. This allowed for coordination between many different agencies, and provided expertise in “emergency management, land use planning, building codes, housing recovery, public health, public safety, transportation, infrastructure protection, climate change, regional planning, and natural resource protection.” (Office of Emergency Management, 2014, p. 4).

Climate Change Adaptation Task Force (CCATF). Another important part of the City’s effort more closely focused on climate change is the Climate Change Adaptation Task Force (CCATF). The Task Force is composed of 41 City, State, and federal agencies, public authorities, and private companies that operate, maintain, or control critical infrastructure in New York City, and the task force worked to quantify impacts on critical infrastructure then develop strategies to make them more resilient (PlaNYC Progress Report 2009: A Greener, Greater New York, 2012, p. 25). Recognizing that “Making our city’s buildings more resilient to coastal flooding and other climate hazards is a challenge that requires collaboration among government, designers, engineers, and building owners, among others,” City Planning Commissioner Amanda M. Burden praised the CCATF’s work for exemplifying “the kind of innovation and cooperation necessary to prepare our city for a changing climate.” (Office of the Mayor, 2013c, p. 2).

Special Initiative for Rebuilding and Resilience (SIRR). Another important way the City brought together stakeholders was through Mayor Bloomberg’s Special Initiative for Recovery and Resiliency (SIRR) which was an important part of recovery from Hurricane Sandy and long-term CCDRR efforts. The City seized the opportunity to use attention focused on recovery in order to support climate adaptation, which will be discussed subsequently. SIRR drew on information from DOB to analyze damage during the storm and assess ways to reduce future damage (City of New York, n.d., p. 14).

Office of Long-Term Planning and Sustainability (OLTPS). During the Bloomberg administration, the Office of Long Term Planning and Resiliency (OLTPS) played a central role in coordinating CCDRR efforts. Following Hurricane Sandy, OLTPS played a critical role working with utilities and their customers to restore services, conducting climate analysis and mapping as part of SIRR, and using federal Community Block Development Grant – Disaster Recovery funding to “execute a variety of long-term planning efforts in areas such as coastal protection and flood protection, in addition to overall coordination of implementation of resiliency efforts.” (City of New York, n.d., p. 18). A significant responsibility given to OLTPS was to be steward of *PlaNYC – A Stronger, More Resilient New York*, and oversee its implementation because of its expertise related to climate change and its impacts on the City, and practice driving development and implementation of long-term planning (Mayor’s Office, 2013, p. 409).

Office for Rebuilding and Resilience (ORR). ORR was established by Mayor de Blasio in 2014 to lead Hurricane Sandy recovery and rebuilding efforts, as well as “prepare the City for long-term risks associated with extreme weather and rising sea levels” (De Blasio, 2014b, p. 15). In other words, “ORR’s role is to provide oversight,

guidance, and to facilitate coordination and collaboration among City agencies on all aspects of the City’s resiliency plan and implementation. ORR is actively engaged in organizing work across disciplines at the City level, as well as State and Federal partners,” (Office of Recovery and Resiliency, 2015, p. 14) making it a critical part of the City’s CCDRR efforts. As such, ORR works with OLTPS to oversee and guide NYC’s climate change resiliency efforts. ORR now implements PlaNYC’s *A Stronger, More Resilient New York*, reporting directly to the Mayor and working closely with OEM, DCP, many other City agencies, and a long list of partners including “architects, economists, engineers, lawyers, marketing and communications experts, planners, policy analysts, and expert advisors.” (Lenten, 2014, p. 12)

Intergovernmental collaboration and multi-level risk governance. In addition to collaboration between parts of the City government, significant efforts were made to work with other parts of government. For example, the City recognized the regional value of the NPCC’s projections, and how this could inform planning across multiple government scales and support coordination of integrated climate adaptation initiatives (*Draft for Distribution - NPPC2 Climate Risk Information 2013*, 2013, p. 3).

Additionally, DCP participated in bi-state regional planning consortium as part of the HUD Sustainable Communities Regional Planning Grant Program, which worked “to advance citywide strategic planning efforts for building climate resilience.” (Bloomberg, 2011, p. 119). In addition to these regional considerations, a very important part of addressing governance and institutional context is the inclusion of the Federal Government.

Federal Emergency Management Agency (FEMA). For example, in New York

State compliance with the National Flood Insurance Program (NFIP) is mandatory. This program, run by FEMA, subjects development efforts within the 100-year flood zone to building zone standards designed to mitigate flood risk. The NPCC combined information from FEMA about 100 and 500-year base flood elevations with SLR projections in order to estimate the scope and direction of the impact of SLR through Preliminary Working Maps (Bloomberg, 2013c, p. 25). Additionally, DOB and DCP worked with FEMA to support development of “an aggressive Federal agenda to (among other things) make changes to the National Flood Insurance Program” (Bloomberg, 2013b, p. xxi).

United States Army Corps of Engineers (USACE). Another important federal player is the United States Army Corps of Engineers (USACE), which is required by statute to conduct studies addressing flood risk to vulnerable populations in areas affected by Hurricane Sandy. According to the City, this study is a “unique opportunity to guide Federal investment designed to reduce the future risks of climate change to the region,” and it recent experience has shown that this effort will likely require robust local partnership to succeed (Mayor’s Office, 2013, p. 64). Additionally, USACE and DPR worked together on emergency beach renourishment projects (Bloomberg, 2013b, p. xxi).

Legal framework and legislation. Existing legal frameworks and legislation are an important aspect of official and institutional context. For example, DCP establishes regulations for building use, density, and bulk throughout the City by initiating City Council Zoning Resolutions, and proposing planning and zoning changes to promote orderly growth and development of the City (Mayor’s Office, 2013, p. 71). As mentioned previously, the City codified the NPCC with Local Law 42, requiring that it meet at least

twice a year, and update climate projections at least every three years (Office of Recovery and Resiliency, 2015, p. 33). Notably, in a move indicative of the City Council's attitude towards and support for climate change action, the Council passed a resolution recognizing the dangers associated with climate change and endorsing the People's Climate March preceding the United Nations Summit on Climate Change in 2014 (New York City Council, 2014b, p. 1).

In addition to its own internal legal and regulatory efforts, the City also worked with federal and state funding and regulatory agencies – including USACE, HUD, FEMA, and the New York State (NYS) Department of Environmental Conservation – to advance coastal protection initiatives (*One City, Rebuilding Together - A Report on the City of New York's Response to Hurricane Sandy and the Path Forward*, 2014, p. 26). NYS also worked directly with utilities to ensure that critical facilities would be hardened and “made sufficiently resilient to meet the latest federal flooding projections plus an allowance for sea level rise.” (*One City, Rebuilding Together - A Report on the City of New York's Response to Hurricane Sandy and the Path Forward*, 2014, p. 27).

Potential Regulatory Framework / Permitting Processes

Federal, State, and City laws and regulations that will be analyzed for the study:

Potential Congressional Actions

Environmental Impact Review

- National Environmental Policy Act (NEPA)
- New York State Environmental Quality Review Act (SEQRA)
- New York City Environmental Quality Review (CEQR)

Transportation

- Clean Air Act
- U.S. Department of Transportation
- Smart Growth Public Infrastructure Policy

Historic Preservation

- National Historic Preservation
- New York City Landmarks Preservation Commission

Major Environmental Statutes, Executive Orders, and Regulators

- Multi-Agency Determinations
- U.S. Army Corps of Engineers (ACOE)
- U.S. Environmental Protection Agency (EPA)
- National Marine Fisheries Service
- U.S. Fish and Wildlife Services
- New York State Department of Environmental Conservation (NYSDEC)
- New York State Department of State (NYSDOS)

Figure 4 Framework/Permitting Process (Seaport City Feasibility Study, 2013).

Shared policy vision. An important way to bring stakeholders together is to identify individuals that can pioneer City efforts, and to develop a shared policy vision to move towards. Two good examples come from SIRR and ORR, which played important roles in developing and promoting a shared vision.

Special Initiative for Rebuilding and Resilience (SIRR). A critical effort that supported a shared policy vision across the City government was SIRR's PlaNYC, which stated that "Based on this understanding, SIRR developed a comprehensive action plan to improve New York City's preparedness for the risks that future extreme weather events

and climate change will bring. The plan, released in June of 2013, and known as “A Stronger, More Resilient New York,” included 257 cost-effective and achievable initiatives to strengthen the coast, upgrade the city’s building stock, protect the city’s critical infrastructure and services, and make New York’s neighborhoods safer and more resilient. This includes a variety of physical resiliency investments across all infrastructure sectors, but also requires a coordinated set of economic and social resiliency efforts, coupled with important policy changes, to achieve its goals.” (*One City, Rebuilding Together - A Report on the City of New York’s Response to Hurricane Sandy and the Path Forward*, 2014, p. 24).

Office of Rebuilding and Resilience (ORR). With its responsibility to provide oversight and facilitate coordination between City agencies on the City’s resiliency plan and implementation, ORR actively organized work across disciplines at the city, state, and federal levels. One example of this work was the creation of a forum comprised of senior resiliency designees from DPR, DCP, DEP, DOT, NYCEDC, and the City Law Department that discussed projects, regulatory issues, and research, as well as share best practices, leverage resources, and coordinate timelines (Office of Recovery and Resiliency, 2015, p. 14-15). One of ORR’s more important efforts was coordination of the City’s efforts to participate in HUD’s National Disaster Resilience Competition (NDRC). It outlined a vision by saying “The City’s goal is to protect people and property vulnerable to climate change through adaptive resiliency strategies based on the best available science through at least the year 2050, while considering the long-term (through 2100) consequences and measures that will be required” (Office of Recovery and Resiliency, 2015, p. 34), saying that a resilient city is “first, protected by effective

defenses and adapted to mitigate most climate impacts; and second, able to bounce back more quickly when those defenses are breached from time to time.” (Office of Recovery and Resiliency, 2015, p. 43). ORR then outlines the City’s goals: 1) to embrace the coastline, with its waterfront neighborhoods, critical infrastructure, natural and cultural resources, 2) to plan ambitiously, making investments in smart, effective protections for the City, and modify strategies as more is learned about risk from climate change, and 3) to create a stronger, more resilient city that can withstand climate change and bounce back when extreme weather strikes (Office of Recovery and Resiliency, 2015, p. 43). To advance these resiliency goals, the City identified four outcomes: 1) strengthen coastal defenses, 2) make buildings more resilient, 3) protect core infrastructure and services, and 4) create safer, more connected neighborhoods (Office of Recovery and Resiliency, 2015, p. 49).

Responsibility. “An initiative without a clear owner is destined to fail. That is why the key to successful implementation of this plan is ensuring that each and every initiative is owned by a designated agency or office, with interagency working groups where appropriate and coordination by a single entity.” (Mayor’s Office, 2013, p. 408). This quote succinctly conveys a critical part of planning, and in this case the City seemed to give clear responsibility for many aspects of CCDRR planning to several key entities.

The NPCC was convened in 2008 to help initiate a response to climate change in the City, and support aspects of PlaNYC, the City’s long-term sustainability plan (Bloomberg, 2013c, p. 4). It was charged with advising the mayor and CCATF, producing a set of climate projections specific to the City in 2009 and thereafter (Bloomberg, 2013c, p. 7). CCATF was tasked with identifying areas of the City where

investments and adaptation efforts should be targeted (*PlaNYC Progress Report 2009: A Greener, Greater New York*, 2009, p. 43). In the wake of Hurricane Sandy, Mayor Bloomberg convened SIRR, which was charged with “analyzing the impacts of the storm on the city’s buildings, infrastructure, and people; assessing the risk the city faces from climate change over the medium term (2020s) and long term (2050s); and outlining ambitious, comprehensive, but achievable strategies for improving resiliency citywide.” (Office of Recovery and Resiliency, 2015, p. 25). As city efforts continued and became more complex, OLTPS was tasked with overseeing efforts (Mayor’s Office, 2013, p. 65 and 409). OLTPS called upon FEMA to adjust future revisions of Flood Insurance Rate Maps (FIRMs), and worked with DCP to promote closer coordination between Federal agencies to improve project outcomes (Mayor’s Office, 2013, p. 65). DCP, as discussed, is also responsible for overseeing citywide regulations, including those related to climate adaptation (Mayor’s Office, 2013, p. 71). As Mayor de Blasio took office, much of this OLTPS work was shifted to ORR, and its role is “to provide oversight, guidance, and to facilitate coordination and collaboration among City agencies on all aspects of the City’s resiliency plan and implementation.” (Office of Recovery and Resiliency, 2015, p. 14).

OEM also received some climate-specific DRR requirements, which included creating, maintaining, and regularly updating the New York City Climate Change Flood Map, showing high tide on the coastline and projecting flood plains for 100-year floods (Climate Adaptation Committee, n.d., p. BR 1 1). The City also called on NYS to provide guidance for retailers (Mayor’s Office, 2013, p. 228), and identified some responsibility gaps, such as the fact that the liquid fuel supply chain has many owners (who share almost no operational information with each other or third parties) and there is little

regulatory oversight with respect to infrastructure climate resilience (Mayor’s Office, 2013, p. 133).

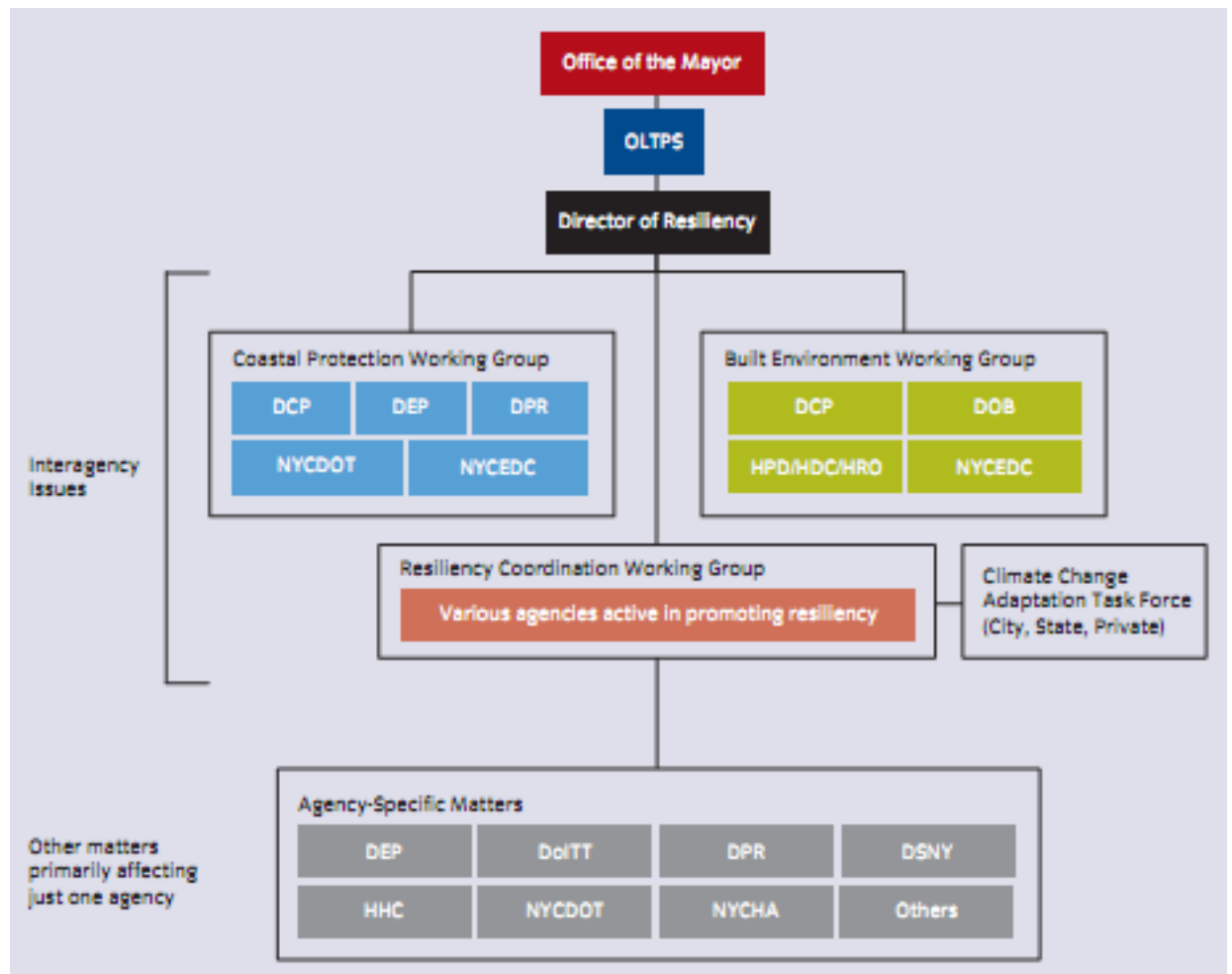


Figure 5 High-Level Implementation Structure (Mayor’s Office, 2013).

Institutional context. In addition to addressing official governance context, it is

important to identify context-specific institutional factors that impact implementation. Part of this is support for the institutionalization of CCDRR so integration at the program level is standard and improving professional DRR and urban resilience education. The City's integration of CCDRR into programming and education is demonstrated by efforts like the one that produced the documents *Designing for Flood Risk* which was developed in collaboration between DCP and the architectural and design community, including the NYC chapter of the American institute of Architects (Department of City Planning, 2013a, p. 4). While it was difficult to find information on how the City might be planning on improving education in order to support CCDRR, there were indications that it was considered. For example, the City's 2014 Hazard Mitigation Guide lists "A deeper understanding of specific hazards, some of which are expected to worsen with climate change" as one of four primary things readers can gain from the guide. Also, though it is not targeted at planners or other involved officials, the City launched a "consumer education campaign" as part of *PlaNYC – A Stronger, More Resilient New York*, which aimed to inform owners of properties in new flood zones of their obligations related to floods and insurance (Mayor's Office, 2013, p. 103). Similarly, another initiative built into this plan was a campaign aimed at informing "insurance providers about the comprehensive measures the City is taking" to minimize loss and disruption, in order to convince executives, underwriters, catastrophe modeling experts, and other stakeholders to consider the City's strategies as they set rates (Mayor's Office, 2013, p. 103).

Unofficial context. While addressing official and institutional factors is important, unofficial context also plays an important role in the beginning of the planning

process. CCDRR planning should consider unofficial context by recognizing the role of informal relations and norms that influence local government and civil society actions, addressing constraints and opportunities relevant to involved organizations, and linking goals with efforts to pursue market opportunities and overcome trade and investment constraints (e.g., incentives, penalties). For example, while much of the shoreline is owned and managed by public entities, several private sector parties play roles, so an integrated approach for managing coastal risks involving major structural protections, environmental controls, and regulatory and policy controls is appropriate (Lenten, 2014, p. 62). There are many possible strategies to pursue this goal, including managing risks in pier-based coastal businesses on the waterfront is to work through the Port Authority via NYCEDC (Mayor's Office, 2013, p. 256), requesting business continuity plans from City franchisees (Mayor's Office, 2013, p. 171), working with insurers to help them understand the City's efforts in order to influence the availability and pricing of insurance (Mayor's Office, 2013, p. 103), redesigning the regulatory framework that governs the City's energy systems in order to help utilities identify and appropriately fund long-term capital projects to make systems more resilient (e.g., developing a cost-effective system upgrade plan, reflect climate risks in system designs and equipment standards, establishing performance metrics for climate risk response) (Mayor's Office, 2013, p. 122).

Community boards, community-based organizations, civic groups, faith-based organizations, and other neighborhood stakeholders also play a role in various parts of the City, and all worked in Hurricane Sandy response and recovery efforts (Mayor's Office, 2013, p. 346). Throughout the development of PlaNYC's *A Stronger, More Resilient New*

York, SIRR engaged these groups and individuals formally and informally (Mayor's Office, 2013, p. 346). Along these same lines, the City engaged many leading private and non-profit stakeholders interested in playing a role in the Science and Resiliency Institute at Jamaica Bay (City of New York Mayor's Office and National Park Service, 2012, p. 4).

Market opportunities, trade, and investment. In addition to informal relations and norms and organizational constraints and opportunities, market opportunities, trade, and investment can be an important part of the unofficial context CCDRR planners should consider. It is not clear that the City effectively addressed these considerations, but there were clear efforts to consider the impact planning would have on the local economy. For example, the City's *Designing for Flood Risk* paid substantial attention to supporting commercial use of spaces, and considering how accessibility issues in planning might impact them. The document says that businesses in flood zones may be greatly affected by resiliency standards, and that "Some may altogether disappear because of the expense and constructability hurdles of implementation of such resiliency measures. If these businesses disappear, this could have grave long-term consequences for the character and ultimately the sustainability of neighborhoods." (Department of City Planning, 2013a, p. 31). Bloomberg's administration made other efforts to address this issue, including millions of dollars for business loan, grants, investments in business resiliency, \$41 million for a competition designed to support development of resilient technologies, and the "Game-Changer Investment Competition" using \$90 million "to reward innovative ideas for spurring economic development in hard hit areas" (P166, p. 2). De Blasio's administration deemed the "Game-Changer" program inactive, and reallocated the funds to the Build It Back Program and other business-related initiatives."

(Office of the Mayor, 2014b, p. 2-3). Some of the de Blasio administration's efforts are outlined in ORR's National Disaster Resilience Competition (NDRC) application, including:

- A \$48 million Hurricane Sandy Business Loan and Grant Program, serving at least 150 businesses impacted by Hurricane Sandy;
- The Business PREP (Preparedness & Resiliency for Emergencies Program) program designed to assist businesses implementing operational and physical resiliency measures;
- Resiliency Innovations for a Stronger Economy (RISE: NYC): A \$30 million competition to identify and allocate, funding for the most innovative and cost-effective technologies that help prepare small businesses for future climate events;
- \$15 million in Coney Island Green Infrastructure Improvements to enhance ongoing green infrastructure work with the installation of right-of-way bioswales along business corridors; and
- Rockaways Commercial Corridor Resiliency: An investment of \$15 million for streetscape and stormwater management upgrades and redevelopment of underutilized properties in key commercial corridors (Office of Recovery and Resiliency, 2015, p. 55-56).

Thus far, problem definition and official and institutional context assessment have been addressed. Following the assessment frameworks roughly-linear progression, the next step is to engage stakeholders.

Stakeholder Involvement in Planning

Ultimately, the main purpose of CCDRR planning is to protect and improve the lives of the people within the planner's jurisdiction. Engaging local actors, getting input from citizens, including individuals with disabilities, bringing stakeholders into the planning process, and providing support for people living in the jurisdiction are important parts of the planning process. Hurricane Sandy, a major focusing event and theme that appears throughout NYC's CCDRR planning, prompted some of the initial engagement discussed here. Several months after the hurricane, the City engaged thousands of New Yorkers through meetings, public workshops, and other efforts to discuss the City's long-term planning (Office of Recovery and Resiliency, 2015, p. 25-26). Additionally, the City engaged over 30 government agencies at multiple levels, over 65 elected officials, 19 community boards, and over 320 business, civic, community-based, environmental, faith-based, and labor organizations, saying that "These briefings garnered valuable feedback from the leaders on the ground representing their communities." (Office of Recovery and Resiliency, 2015, p. 25-26).

Local actor roles. According to the assessment framework, engaging local actors in order to determine who should take on various CCDRR roles and being aware of uncertainty about who has responsibility for various parts of local decision-making structures related CCDRR is a useful first step. In this case, local actor roles originally had a sub-indicator focused on uncertainty about responsibility, and it was simply folded in to the main indicator. The City recognized that implementing resilience strategies would require actions from private property owners, businesses, and communities

(Department of City Planning, 2011, p. 106), saying that “Everyone from government to homeowners to insurance companies will need to consider the implications of climate change and sea level rise and make decisions about resilience strategies. It will be important to integrate resilience considerations into planning on a continuing basis.”

(Department of City Planning, 2011, p. 11). Unfortunately, there was not much more information on the subject of determining which local actors should take which roles, or where that kind of CCDRR-related responsibility generally lies.

Stakeholder valuation. It is important to get valuation input from these stakeholders, explicitly state the value judgments underlying economic analyses, consider the importance of current vs. future generations, consider implications for discounting, apply the most established and least controversial valuations of non-market benefits reported in their natural units with qualitative appraisals, and use decision-making tools to facilitate stakeholder involvement and valuation. This indicator is simply a combination of the previous sub indicators into the main indicators in order to make the framework simpler and more useable.

One example of the City requiring input from stakeholders is related to CBDG-DR funding from HUD, because “Any change greater than \$1 million in funding committed to a certain program, the addition or deletion of any program, or change in the designated beneficiaries of a program constitutes a substantial amendment and such amendment will be available for public review and approval by HUD.” (*The City of New York Action Plan Incorporating Amendments 1-7*, 2014, p. There were more substantial, concerted efforts to get stakeholder valuation, including SIRR’s numerous formal and informal working sessions with “a wide array of elected officials at the Federal, State,

and local levels,” “three Community Boards,” and “a large number of community-based organizations, civic groups, faith-based organizations, and other neighborhood stakeholders.” (Mayor’s Office, 2013, p. 282). In addition, “SIRR also held two public workshops in March of 2013 in Staten Island, part of a series of such workshops held citywide in which over 1,000 New Yorkers participated to discuss issues affecting their neighborhoods and communicate their priorities for the future of their homes and communities.” (Mayor’s Office, 2013, p. 282). Some of these attendees expressed concerns that programs designed for other parts of the City would not work in their communities, which is an excellent example of stakeholder valuation, and the City claims that “the on-the-ground insights provided at these public workshops helped SIRR staff to develop a deeper understanding of the specific priorities of, and challenges facing, the communities of the East and South Shores”, revealing several important priorities, including:

- Developing coastal/shoreline protections, while still ensuring public access to the waterfront;
- Protecting low-lying areas, by exploring more effective drainage systems, including the accelerated build-out and ultimate completion of Bluebelts;
- Developing programs to address the financial and physical challenges of rebuilding homes;
- Revitalizing local business corridors and waterfronts and marinas; and
- Preserving neighborhood character and affordability during neighborhood recovery and rebuilding. (Mayor’s Office, 2013, p. 282).

Very similar efforts in Southern Manhattan revealed similar but slightly different priorities:

- Protect critical infrastructure—power, transit, telecommunications—from outages;
- Protect residential buildings and their vulnerable populations from building system outages;
- Protect retail and commercial businesses from flooding;
- Improve infrastructure to prevent future events from having widespread impacts; and
- Continue to strengthen post-event communication," (Mayor's Office, 2013, p. 282).

It is not clear that these goals can be generalized to the larger community populations, and, of course, this data is being relayed through official City channels, which no doubt influence it in some ways. However, this information is useful in that it reveals some of the stakeholder's priorities, gives insight into this planning process, and demonstrates that even though they live in the same City, various communities may have different resiliency goals. In sum, PlaNYC's community engagement goals included listening to input from residents, collaborating on design options with the community, and exploring opportunities and trade-offs together (*East Side Coastal Resiliency Project*, 2015, p. 11).

Another consideration that may be accompanied by considerable political complexity is the inclusion of future generations in the planning process. Clearly, some present-day investments will have important implications for future generations. If

careful mitigation investments bring near-term benefits, no doubt there are similar opportunities to make important choices related to long-term climate resiliency. Indeed, a 2014 report from the President's Council of Economic Advisors estimate that "delaying climate policy actions by a decade could increase total climate change mitigation costs by about 40 percent. Taking no action would risk substantial economic damage." (Lenten, 2014, p. 14). It seems likely that this aspect of climate mitigation also applies to adaptation efforts. In an address focused on shaping the City's future after Hurricane Sandy, Bloomberg considered future generations by saying "We may or may not see another storm like Sandy in our lifetimes, but I don't think it's fair to say that we should leave it to our children to prepare for the possibility. We are a coastal city, a harbor city, surprise, surprise. And sea levels are expected to rise by another two and a half feet by the time a child born today reaches 40 years old, and that's going to make surges even more powerful and dangerous." (Office of the Mayor, 2012, p. 2). In this case, the extent of the City's chronological planning scope is fairly clear: "The City's goal is to protect people and property vulnerable to climate change through adaptive resiliency strategies based on the best available science through at least the year 2050, while considering the long-term (through 2100) consequences and measures that will be required." (Office of Recovery and Resiliency, 2015, p. 34). Is this appropriate? The answer to this question is well outside the scope of this inquiry, but it is clear that this is an important question to consider.

Stakeholder vulnerability. A theoretically fascinating aspect of engaging stakeholders, that is also an important, developing part of disaster management, is using a

vulnerability perspective. Rather than the more traditional approach of focusing on hazards, planners are now considering what allows these hazards to have negative impacts, and this is essentially preexisting vulnerability. This vulnerability comes in many different forms, including individual vulnerabilities (e.g., disabilities, poverty, language barriers), structural vulnerabilities (e.g., infrastructure, buildings) systemic problems (e.g., weaknesses in governance and social systems).

According to PlaNYC, Hurricane Sandy demonstrated where the City is most vulnerable by impacting the young and old disproportionately, as well as residents of public housing located on the coast (Mayor's Office, 2013, p. 14). NYCHA operates 2,596 throughout the City housing over 400,000 residents, including vulnerable populations, and there are significant concentrations on the waterfront (Mayor's Office, 2013, p. 85). PlaNYC notes that the most important communication flow from communities to the City is "with regard to vulnerable populations such as the elderly, sick, and disabled who may have a limited ability to help themselves or even to seek help from others." (Mayor's Office, 2013, p. 157). Additionally, the City claims that "Sandy underlined the need to rethink how to build or rebuild in vulnerable coastal areas by promoting more flood-resistant building designs and encouraging land uses that can accommodate periodic flooding. Sandy also highlighted the need to ensure access to critical services for older adults, populations with disability, and other vulnerable communities." (Office of Emergency Management, 2014, p. 261).

This no-doubt informed one of the City's more important CCDRR efforts: *NYC's Risk Landscape – A Guide to Hazard Mitigation*, which has a clear focus on vulnerability. The document recognizes the importance of this issue by saying: "For some

New Yorkers, factors such as age, disability, chronic health conditions, poverty, and language barriers can increase vulnerability to certain hazards. With population growth, the number of vulnerable New Yorkers will also likely grow.” (Lenten, 2014, p. 19). Additionally, a hazard mitigation plan presentation recognizes that “Roughly 2.5 million people currently live in an area prone to storm surge,” and that “Most at-risk populations are elderly, low-income, non-native and physically or mentally disabled.” (Hazard Mitigation Plan Overview, 2013, p. 20). The vulnerability assessment conducted for the 2014 Hazard Mitigation Plan used DCP’s demographic and land use data and applied SIRR analysis to find that age, income, linguistic isolation, and health conditions are a significant consideration in the 100-year floodplain – approximately 15% of those living in this area are over 65 years old, and 40% of this elderly population suffers from a disability, with 20% living in poverty (Hazard Mitigation Plan Overview, 2013, p. 23).

Even the NPCC, with its focus on climate science, delved into social vulnerability by stating that “Vulnerable groups include the old and the very young; women; those with preexisting physical, mental, or substance-abuse disorders; residents of low-income households; members of disadvantaged racial/ethnic groups; workers engaged in recovery efforts; and those with weak social networks.” (New York City Panel on Climate Change 2015 Report, 2015, p. 13). In other words,

“Storms are not ‘equal-impact events’ because social and physical geographies interact to expose vulnerable populations to elevated risk. Not all populations are exposed to the same degree of flooding: some will experience more wave action and greater flood heights than others, and not all populations have the same

capacity to prepare for, respond to, and recover from a flood event. An overall flood vulnerability index that combines both social and biophysical vulnerability can characterize site-specific levels of risk to flood hazards and identify communities that may require special attention, planning efforts, and mobilization to respond to and recover from such disasters and hazards.” (New York City Panel on Climate Change 2015 Report, 2015, p. 54).

Building on the IPCC’s work (IPCC, 2012), the NPCC defines vulnerability as “The propensity for the health of individuals or groups to be adversely affected as a result of exposure to a climate hazard. Vulnerability is an internal characteristic of the affected system and includes the characteristics of persons or groups and their situation that influence their capacity to anticipate, cope with, resist, and recover from an adverse climate event. Different levels of vulnerability will lead to different levels of health damage and loss under similar conditions of exposure to physical events of a given magnitude.” (New York City Panel on Climate Change 2015 Report, 2015, p. 69)

ORR’s NDRC application also recognizes the utility of the vulnerability perspective, saying that “New York City faces significant risk from extreme weather events such as hurricanes, severe storms, and severe temperatures, each amplified by a changing climate and rising sea levels. The impacts of these events are magnified by the City’s aging infrastructure and housing stock, with disproportionate impacts on the city’s vulnerable populations.” (Office of Recovery and Resiliency, 2015, p. 1). So, the City’s CDBG-DR Action Plan allocates \$60 million for “comprehensive resiliency retrofit measures necessary to protect vulnerable residents from loss of critical building services

in the event of a storm.” (Office of Recovery and Resiliency, 2015, p. 6). The NDRC application also claims that the City and its agencies “have extensive experience in engaging communities in robust processes to address resiliency and recovery, with a particular emphasis on engaging vulnerable populations and a wide variety of stakeholders.” (Office of Recovery and Resiliency, 2015, p. 25).

In addition, the City is engaging municipal agencies that serve vulnerable populations, such as NYCHA, HPD, and the Mayor’s Office of Immigrant Affairs (Office of Recovery and Resiliency, 2015, p. 42). One interesting method the City used to include vulnerable populations in Mayor de Blasio’s *One City, Rebuilding Together* was by including them in a coastline risk “heat map.” The map considers areas with highest storm surge probability, most ‘floodable FAR’ and density, most critical infrastructure, and most vulnerable populations (*One City, Rebuilding Together - A Report on the City of New York’s Response to Hurricane Sandy and the Path Forward*, 2014, p. 24).

Stakeholders with disabilities. One of the more important vulnerable populations is individuals with disabilities – people with access and functional needs. While it was not clear to what extent the City engaged these populations, there is enough information to give an outline. For example, the City conducted public hearings for the NDRC in ADA-accessible spaces (Office of Recovery and Resiliency, 2015, P. 42), and PlaNYC also discusses intentionally considering the concentrations of individuals with disabilities while assessing the impact of hazards on the built environment and critical infrastructure (Mayor’s Office, 2013, p. 47). The City’s efforts to include elderly people and individuals with health issues also indicate support for people with access and functional needs.

Stakeholders with health issues. Often related to disabilities, individuals with health issues are another vulnerable population that should be considered, and the City did so in multiple ways. For example, it recognized that climate hazards “stress the healthcare system and place the health of the medically fragile at risk,” saying that more than 1 million New Yorkers are in poor health, 800,000 under 5 and over 80 are relatively vulnerable and more likely to need critical medical care, and that “20% of the city’s hospitals, 34% of adult care facilities, 19% of nursing homes, and 11% of other residential facilities are in the 100-year and 500-year floodplains.” (Office of Recovery and Resiliency, 2015, p. 39). Hurricane Sandy demonstrated the importance of protecting the vast, complex NYC healthcare system by shutting down six hospitals and 26 residential-care facilities, causing 6,400 patients to be evacuated and straining providers who remained open as they tried to fill the “healthcare void” – facilities repurposed lobbies, siphoned gas from vehicles for power generators, and had staff live on-site for days waiting for replacements to arrive (Mayor’s Office, 2013, p. 145). So, SIRR made increasing healthcare provider resiliency a goal of *PlaNYC – A Stronger, More Resilient New York*, attempting to ensure that facilities can operate continuously during extreme weather, requiring new facilities to be built to higher standards, and working with existing providers to protect critical systems, saying that “Making our healthcare system more resilient will benefit our most fragile populations—and all New Yorkers.” (Mayor’s Office, 2013, p. 145).

Elderly stakeholders. Potentially vulnerable because of disabilities and health issues, elderly populations are an important consideration during climate resilience planning. Once again, Hurricane Sandy revealed vulnerabilities in some cases by leaving

residents in some buildings that did not experience flooding without light, heat, refrigeration, potable water, as well as trapping many residents in upper floors of high-rise buildings (Mayor's Office, 2013, p. 375). *A Stronger, More Resilient New York* attempted to address risk from extreme weather events by requiring retrofitting of 19 adult care facilities in floodplains through mitigation standards and requiring the installation of backup power generators (Mayor's Office, 2013, p. 262). Particularly relevant to elderly populations, heat waves may increase the rate of heat-related impairments and death as the City's population ages and some research suggests that the "number of heat-related deaths will increase sharply throughout the 21st Century." (Lenten, 2014, p. 101).

Poor stakeholders. Another vulnerable population that should be considered is poor people. Lack of resources can play a critical role in their mitigation, preparation, response, and recovery efforts related to extreme weather events. In New York City, "18% of the population living in the 100-year floodplain is living at or below the poverty level," (Office of Recovery and Resiliency, 2015, p. 28) so it is clear that there is a significant population with relatively high risk. A particularly salient and serious problem for poor New Yorkers is that some models predict that many flood insurance premiums will increase by \$1,000-\$2,000 per year, and that annual premiums for over 28,000 one to four family homes newly re-zoned in high-risk areas "could soar from \$429 to between \$5,000 and \$10,000 for the same amount of coverage," which poses an enormous economic hardship on the 30% of homeowners in the floodplain making less than the City's median income (Stringer, 2014, p. 6). These average rates can hide discrepancies among neighborhoods. For example, in Southern Manhattan, Chinatown has a 40%

poverty rate and \$26,100 median household annual income, which stands in stark contrast to Battery Park City, Tribeca, and the West Village have poverty rates less than half the City average and median household incomes over \$105,000 (Mayor's Office, 2013, p. 370). Furthermore, residents in public housing developments, often located on the coastline, are particularly vulnerable, with 400 NYCHA buildings containing approximately 35,000 units that lost power, heat, or hot water during Hurricane Sandy (Mayor's Office, 2013, p. 13).

Language barriers. Language barriers present another potential vulnerability that planners should consider. An example of the City's efforts to include non-English residents in the planning process is a flyer advertising an East Side Coastal resiliency Project community engagement session written in both English and Spanish (Mayor's Office of Recovery and Resiliency, 2015, p. 1). In addition, a slide deck giving an overview of the hazard mitigation plan gives linguistic isolation as one of four significant considerations in the 100-year floodplain (Hazard Mitigation Plan Overview, 2013, p. 23), and the City's Hurricane Sandy Aid notice, related to CBDG-DR funding, notes that the Action Plan A and public commenting forms are available in English, Spanish, Russian, and simplified Chinese (Bloomberg, 2013, p. 1). Finally, NYCHA used a specialized team of multilingual outreach specialists to work with communities to reach vulnerable populations (Office of Recovery and Resiliency, 2015, p. 28), and the hearing for this National Disaster Resilience Competition Phase 1 Application included a hearing with interpretation available for Spanish, Russian, Cantonese, and Mandarin-speaking New Yorkers (Office of Recovery and Resiliency, 2015, p. 43).

Stakeholders in the planning process. Delving further into stakeholder involvement issues, including stakeholders in the planning process is an important step that can help to ensure those the planning will impact the most have input. In order to do this, the assessment framework suggests planners should ensure an open planning process that uses public announcements, open forums, and mechanisms for collecting stakeholder input. Additionally, they should ensure that stakeholders have reasonable access to information, provide them with information about their risk, and give a clear understandable picture with realistic information. Finally, planners should make sure that stakeholder input has influence by adjusting and revising based on feedback, and explicitly addressing stakeholder concerns. This indicator was adjusted by a combination of indicators C4 and C5, which focused on including stakeholders in the planning process and ensuring stakeholders have influence. Furthermore, the sub-indicators were combined into the primary indicator (involving stakeholders in the planning process), the removal of the sub-indicator focused on sensationalism (because it is covered elsewhere in the framework).

Transparency. Ensuring a transparent process is one way to promote public involvement. In fact, one of the NPCC's recommendations was to "Improve ways to communicate data and information on how changes in climate will affect the frequency of climate hazards and their impacts in the future, and the uncertainties surrounding these estimates, to provide greater transparency to potential users at city, state, and national levels." (Bloomberg, 2013c, p. 28). There were some indications that transparency was important, such as a claim that HRO took steps to improve transparency under the de Blasio administration (*One City, Rebuilding Together - A Report on the City of New*

York's Response to Hurricane Sandy and the Path Forward, 2014, p. 16), and the City acknowledged the need to have public hearings as part of HUD's NDRC (Office of Recovery and Resiliency, 2015, p. 42). Unfortunately, there was limited information available on this subject.

Announcements, information, and warnings). Including people in planning means they have to be informed, so announcements can play an important role. The City acknowledges that rebuilding and long-term thinking “requires a strong framework to structure ongoing engagement,” and community outreach was conducted with community boards, local businesses, civic and nonprofit associations, faith organizations (NYC Special Initiative for Rebuilding and Resiliency, n.d., p. 1). An example of a notice is the Hurricane Sandy Aid Notice, announcing a comment period on the CBDG-DR Action Plan A (Bloomberg, 2013, p. 1), and, as mentioned previously, the City launched an outreach initiative to inform property owners in the floodplain of their risk, requirements to purchase flood insurance, and options for managing both (de Blasio & Glen, 2014, p. 59). This effort included working with other agencies and non-profit organizations involved in Hurricane Sandy recovery to share flood risk information, working with FEMA to mail letters, and launching a public awareness campaign using advertising and community events to spread flood risk information (Office of Recovery and Resiliency, 2015, p. 27). Additionally, a long-term approach to providing New Yorkers with information about CCDRR is the development of the Jamaica Bay Science and Resilience Center, which aims to communicate scientific findings and best practices about resilience to a wide variety of audiences in multiple ways (City of New York Mayor's Office and National Park Service, 2012, p. 7).

Input mechanisms and forums. As well as ensuring a transparent process and spreading information, including stakeholders in the planning process also requires ways for the City to collect input (e.g., forums, workshops, online mechanisms, focused competitions, task forces, briefings). There are many examples of the City using these kinds of input mechanisms to involve stakeholders. A good one is the engagement strategy used during the East Side Coastal Resiliency Project, which itself was the result of a HUD competition. The project's community engagement goals were 1) identifying stakeholder needs, 2) understanding and managing issues, expectations, and challenges, 3) developing a body of community feedback data, 4) strengthening project design and implementation through public understanding and discussion, and 5) establishing a clear structure for public feedback (Office of Recovery and Resiliency, 2015, p. 26). Another example comes from SIRR, which held one-on-one briefings with over 60 elected officials, met with over 100 community based organizations, and hosted 10 public meetings in areas impacted by Hurricane Sandy to solicit input on resiliency priorities (*The City of New York Action Plan Incorporating Amendments 1-7*, 2014, p. 9).



Figure 6 Ongoing Public Engagement for PlaNYC (*East Side Coastal Resiliency Project*, 2015, p. 42)

A particularly interesting input mechanism used to support development of the HMP was a 2013-2014 survey that received 207 responses. 65% of respondents reported being impacted by a disaster, over half were extremely concerned about the possibility of being impacted by a disaster, but only 17% of home owners in a FEMA flood zone reported having flood insurance, and severe weather and utility failures were thought to pose the greatest risk to respondents' neighborhoods. 70 of the respondents chose to write in mitigation actions they felt the government should take, including enhancing warning systems for non-English speakers, improving communication with special needs

populations, structural efforts to protect the City from storm surge, backup generation for critical facilities, providing education on climate change, supporting environmental cleanup, improving waterway maintenance, and holding city-wide exercises (Office of Emergency Management, 2014, p. 5-6).

Stakeholders (influence). Once stakeholders have been identified, a transparent process is in place, information has been spread, and mechanisms have been used to get their input, a final critical step is ensuring that the input actually influences the process. In other words, understanding stakeholder concerns may be useless if it does not lead to revisions. Unfortunately, it was very difficult to use official documents to assess how well stakeholder input was incorporated into planning. There is some evidence to support the idea that there were significant efforts to engage citizens and incorporate their feedback, such as a quote from a Council Member saying “many cultural groups played an instrumental role in helping our city recover in the days, weeks and months that followed.” (Office of Emergency Management, p. 2).

Strategy and Measures

Once the problem has been defined, the governance and institutional context is addressed, and stakeholders have been brought into the planning process, a logical next step (and criterion in the assessment framework) is to develop strategies and measures, then implement them. This criterion was originally fairly complicated, having 10 indicators and several sub-indicators. In order to make it more manageable and for clarity, the indicators and sub-indicators were reduced to three primary indicators: incorporating CCDRR into current disaster management efforts, considering the broad

impact of measures, and addressing structural efforts. Sub-indicators were adjusted significantly, primarily in order to accommodate this revision.

The first two indicators in the original version of the framework are no longer present in this version. The indicator, and sub indicators, focused on vulnerability and resilience were simply deemed redundant, since vulnerability is given significant attention elsewhere. The second original indicator, using DRR's administrative position, was also thought to be redundant as this is explored in some detail in the "CCDRR in disaster management. This is the first indicator remaining in the revised framework, originally called D3 – Strategy (disaster management cycle). It was renamed to recognize that more than just the disaster management cycle is in play. Also, some sub-indicators were removed, including:

- climate vulnerable areas (incorporated elsewhere in the framework under the vulnerability indicator),
- mitigation standards and retrofitting (now covered under mitigation in the disaster management cycle)
- early warning systems, response strategies, sheltering, and medical care (now covered under preparedness in the disaster management cycle – this is an excellent example of where some detail was sacrificed in order to increase usability)

The focusing event indicator was simply removed because, despite being somewhat fascinating, it seemed out of place in a guidance/assessment framework. The nonstationarity indicator met a similar fate – while it is an important perspective on this

problem, it seemed inappropriate to leave it as part of a criterion talking about strategy and measures. The indicator focused on the broad impact of this kind of planning was retained, though the sub-indicators focused on structural measures and social measures were removed because they were too broadly defined to be particularly useful, as well as being somewhat redundant. The indicator focused on retrofitting was essentially absorbed by the mitigation aspect of the disaster management indicator. Land use was moved here from the indicator focused on the disaster management cycle because it seemed to be a better fit. Finally, a separate indicator, public health, was added to this indicator because it seemed to fit comfortably as part of the broad impact of these kinds of measures.

The final indicator in the revised framework is the result of the combination of two indicators in the original framework focused on critical infrastructure and scaling. These two are very important consideration related to structural measures that are not covered elsewhere in the framework. Thus, the following section addresses the three remaining indicators in the revised framework: incorporation of CCDRR into existing disaster management, considering the broad impact of measures, and aspects of structural measures.

CCDRR and disaster management. In addition to recommendations in the literature that established DRR governance structures should be used in CCA, it is not hard to see places where the office might have played a bigger role. Examples include the creation of the Office of Long-Term Planning and Sustainability (OLTPS), Office of Recovery and Resilience (ORR), and Special Initiative for Rebuilding and Resiliency (SIRR).

There are some important examples that shed light on OEM's role. There is a recommendation from the Green Codes Task Force that OEM should create and regularly update maps showing coastal flood risk, including climate change projections (Climate Adaptation Committee, n.d., BR 1 1), but a web search indicates that these were never created. Also, ORR, which is in charge of implementing PlaNYC's *A Stronger, More Resilient New York* "works closely with NYC Emergency Management," as well as many other City agencies (Lenten, 2014, p. 12), and OEM oversees the Community Emergency Response Team (CERT) program, which trains volunteers to increase community preparedness. Finally, the Bloomberg administration worked with the City Council to require OLTPS to issue a "comprehensive, long-term resiliency plan" every four years which would be updated in concert with the City's Hazard Mitigation Plan, which is produced by OEM in partnership with DCP and other City agencies (Mayor's Office, 2013, p. 411). A clear role OEM had in the wake of Hurricane Sandy was working with OMB to identify projects that were eligible for hazard mitigation funding as Public Assistance projects (Mayor's Office, 2013, p. 404), but it seems this may be one of the few examples of OEM addressing mitigation efforts in the data corpus.

CCDRR and the disaster management cycle. Taking a broader perspective than a single office, another consideration is the extent to which CCDRR planning employs the disaster management cycle perspective. As discussed previously, CCA and DRR rarely share a common history, so established disaster management theory is an important thing to consider during CCA efforts. To do so, planners should integrate with disaster mitigation, preparedness, response, and recovery by developing joint CCA/DRR capacity development campaigns (including combining and synchronizing resources), increasing

the DRR community's focus on climate-related creeping hazards, and sharing information related to preparation and recovery. Unfortunately, there was very little information in the data corpus about joint CCA/DRR capacity development campaigns, or combination and synchronization of resources.

Creeping hazards. While examples of the use of the extant the DRR administrative and governance structure, and integration with the disaster management cycle, were not common, there was relatively clear focus on creeping hazards. For example, the Green Codes Task Force (GCTF) recognizes the possibility that climate change will expand the habitat of tropical insects, pointing out that “In addition, according to the Centers for Disease Control and Prevention (CDC), climate change may expand the distribution of insect-borne diseases in the United States (Climate Adaptation Committee, n.d., p. EF 8 1). Also, DEP's report on climate change's impact on water management addresses the possibility of droughts (Pierson, 2012), but neither of these received as much attention as heat waves.

The reason for this is clear: “Extreme heat causes more fatalities annually than any other extreme weather event in the United States” and this risk is increased in NYC because of the heat island effect, endangering vulnerable populations and straining infrastructure (Lenten, 2014, p. 99). Elevated heat levels compromise comfort and health, exacerbate respiratory disorders, disproportionately impact vulnerable populations, and even increase the rate of ground level ozone formation (Climate Adaptation Committee, n.d., p. EF 12 2). Two strategies proposed by GCTF to manage this risk were the use of “cools roofs” – light roofs that deflect energy more easily than darker colors (Climate Adaptation Committee, n.d., p. EF 11 2) and reducing the amount of paved open lots in

the City that contribute to the heat island (Climate Adaptation Committee, n.d., EF 12 1). Of course, other approaches employed by the City could also effectively reduce the heat island effect, including green infrastructure and improving the reliability of critical energy infrastructure to ensure access to air conditioning.

Broad impact. A more general consideration in CCDRR planning is the broad impact of the measures being suggested and implemented. For example, land use measures can have wide-reaching implications for quality of life, structural efforts can create a false sense of security, microgrids can increase infrastructure resiliency while improving efficiency, and green infrastructure can impact flood risk, neighborhood character, air quality, heat waves, and food availability.

Land-use strategy. An important strategy for reducing risk from flooding is controlling land use, often through zoning. The combination of storm surge and SLR are seen as the greatest climate threat to NYC's building stock, as demonstrated by significant changes in FEMA's recent flood risk maps and the fact that SLR is expected to increase the number of buildings in the floodplain to 88,000 in the 2020s and 114,000 in the 2050s (City of New York, n.d., p. 15). The City uses FEMA's zones to assess risk and support land use efforts. A Zones are in the 100-year floodplain, coastal A Zones are parts of A Zones that are subject to breaking waves between 1.5-3 feet, V Zones are portions of the A Zones that are also subject to high-velocity wave action (waves over three feet), and shaded X Zones are in the 500-year floodplain (Mayor's Office, 2013, p. 45). So, the City works with FEMA to assess flood risk and, working with FEMA's National Flood Insurance Program (NFIP), mitigate financial damage to homeowners

most at risk.

Another example of the City's efforts to appropriately manage land-use in order to address changing risks driven by climate is the *Resilient Neighborhoods* initiative, which "supports locally specific strategies, such as land use changes and infrastructure investments, for long-term community resiliency." (Lenten, 2014, forward). One of the goals of this initiative is to "coordinate land use planning with rebuilding activities" (*Promoting Flood Resilience, Preserving Affordability*, n.d., p. 6), which seems to be an excellent example of the City using Hurricane Sandy as a focusing event to promote CCDRR.

Designing for Flood Risk is a good demonstration of the City's focus on land-use policy and designing buildings for mitigation. Noting that NYC has substantial populations and infrastructure in flood zones, this report "identified key design principles to guide architecture, design, and public policy in flood zones, along with several key proposed changes to New York City's zoning that will promote practical, high-quality flood-resistant buildings that may differ from earlier, less resilient construction but are sensitive to the existing context and built heritage of neighborhoods." (Department of City Planning, 2013a, p. 39). Thus, it supported City climate resilience planning efforts, as well as serving as a valuable resource during citywide rebuilding after Hurricane Sandy.

A Stronger, More Resilient New York also addressed land use fairly extensively by:

- Adapting parks and expand green infrastructure to protect parks and adjacent communities by improving their capacity to absorb water (Mayor's Office, 2013,

p. 108).

- Hardening and modifying shoreline parks and roadways through hardening or elevating infrastructure, constructing levees or floodwalls, and using flood-tolerant materials during construction in order to protect adjacent communities (Mayor's Office, 2013, p. 108).
- Having DPR work with DEP to expand green infrastructure to absorb stormwater, decrease the urban heat island effect, increase pedestrian and traffic safety, and beautify neighborhoods (Mayor's Office, 2013, p. 198).
- Working with NYS to buyout buildings "using an objective set of criteria developed by the City including extreme vulnerability, consensus among a critical mass of contiguous local residents, and other relevant factors." (Mayor's Office, 2013, p. 258).
- Increasing coastal edge elevations with bulkheads, beach nourishment, and other measures in an adaptive approach that allows for iterative investment as better information on SLR becomes available (Mayor's Office, 2013, p. 46).

Two final land use approaches apparent in the data corpus included: 1) a FEMA-funded study focused on environmental, public health, and financial/economic risks in the City's flood-prone industrial areas (Office of Recovery and Resiliency, 2015, p. 21), and 2) a component of the NDRC application focused "the integration of access to open and recreational space with nature-based flood protection or the mitigation of urban heat and localized flooding through neighborhood-scale green infrastructure and wetland projects." (Office of Recovery and Resiliency, 2015, p. 47). So, there are many examples

of the City considering land use as part of its CCDRR planning efforts.

Cross cutting measures. One of the more exciting and interesting concepts addressed in both the assessment framework and City planning is the use of cross-cutting, win-win, or no-regrets measures. The simple idea is that measures with multiple benefits are more desirable and more politically feasible. There are many examples of the City using this approach, including green roofs, green and blue infrastructure, combined heat and power (CHP) generators and distributed generation, and multi-purpose levees.

Green roofs can lead to more efficient buildings that have year round plant growth, reduced heating and cooling costs, lower urban temperature due to heat islands, improved CO₂ levels, and increased environmental awareness (Best Practice: Demonstrating Air Quality and Climate Change Impacts on Public Health, 2011, p. 3). The City notes that “Increasingly, New Yorkers are making better use of their roofs – now potential sites for greenhouses, farms, or green infrastructure projects,” that these are important tools in increasing the City’s resilience to climate change, and that the City Council has pushed a number of policy changes to make these efforts easier, including waiving floor area and height limits for some rooftop greenhouses (New York City Council, 2013, p. 10).

The same concept applied to green roofs can also be applied elsewhere, through green and blue infrastructure. According to the City, “Green/natural drainage uses natural features of the landscape for infiltration and storage. Natural drainage corridors – including streams, ponds, wetland areas, parks, and open spaces – help convey, store, and filter stormwater,” and the award-winning Staten Island Bluebelt wetland preservation program is an excellent example of this (Lenten, 2014, p. 81). DEP’s Commissioner

acknowledges the potential utility of green infrastructure, saying that “As we join communities in the recovery effort, we recognize the important role green infrastructure plays in creating a resilient city that can not only manage its stormwater but recover more quickly from the impacts from climate change.” (*NYC Green Infrastructure - 2012 Annual Report*, 2012, p. ii). For example, NYC street trees are estimated to reduce annual storm water runoff by almost one billion gallons annually, an estimated value of over \$35 million (Lower East Side Greening Acceleration Program: Phase Three, n.d., p. 6). Alongside DEP, NYCHA implemented new innovations in green infrastructure during its recovery from Hurricane Sandy (Office of Recovery and Resiliency, 2015, p. 45). Examples of projects using green infrastructure in CCDRR planning include a \$15 million initiative to “enhance ongoing green infrastructure work” in Coney Island, which is expected to improve stormwater retention, filter and maintain water quality, and enhance the area through beautification (Office of Recovery and Resiliency, 2015, p. 55), and PlaNYC initiatives aimed at reducing combined sewer overflows with green infrastructure (Mayor’s Office, 2013, p. 266), and expanding the City’s Greenstreets through the development of over 50 acres of green space (Mayor’s Office, 2013, p. 329).

Another interesting cross-cutting option is using combined heat and power (CHP) to increase energy infrastructure resiliency through alternative power generation, increase efficiency by using heat from generation (financially and environmentally desirable), and benefit the City’s already strained grid through frequency regulation (Office of Long Term Planning and Sustainability, 2013, p. 61). One of PlaNYC’s initiatives is to work towards scaling up distributed generation and micro-grids since there is potential for significant expansion of distributed generation systems in the City by addressing barriers

in order to reach a goal of 80 MW by 2030 (Mayor's Office, 2013, p. 129).

A final cross-cutting measure employed by the City is multi-purpose levees, which perform the function of a typical levee, but also play additional roles, such as providing parking, residential/commercial uses, or serving as open space (Mayor's Office, 2013, p. 56). These are some of the more prominent examples of cross-cutting measures, but this is not an exhaustive list.

Sense of security. Another important strategic consideration is the unintended consequence inaccurate information or certain measures might have of making people choose to live or remain in a high-risk area because they feel safe. For example, the City's current effective Flood Insurance Rate Map (FIRM) dates from 1983, meaning it does not use modern risk and modeling techniques, which have changed significantly (Office of Recovery and Resiliency, 2015, p. 38), nor does it include recent SLR or future SLR projections. So, individuals may perceive their risk to be lower than it actually is. On another note, the City makes an interesting observation by saying that:

“the terms "100-year" and "500-year" can be misleading and perhaps even provide a false sense of security. A 100-year flood is not the flood that happens once every 100 years. Rather, as defined above, it is the flood that has a 1% or greater chance of occurring in any given year. Experiencing a 100-year flood does not decrease the chance of a second 100-year flood occurring that same year or any year that follows. Even the 1% concept can be misleading—because when the years add up so does the probability. For example, a 100-year flood today, without considering future impacts from sea level rise or climate change, has a

26% chance of occurring at least once over the life of a 30-year mortgage.

Similarly, a 100-year flood today has a 45% chance of occurring over the 60-year life of a power substation.” (Office of Emergency Management, 2014, p. 200).

Another way people might end up with a false perception of security is when physical barriers are constructed to protect them. The City seems to recognize, to some extent, the danger of creating structures like this to protect from flooding, and says that “Generally, the City will seek measures that minimize damage if overtopped.” (Mayor’s Office, 2013, p. 46). Of course, this does not eliminate the possibility that this kind of measure will be overtopped or fail, as some levees did during Hurricane Katrina, causing very serious harm. One concerning potential measure suggested by “A variety of observers” is that the City could construct harbor-wide barriers, and that “during storm events, however, the gates would be closed, in theory, blocking surge waters.” (Mayor’s Office, 2013, p. 49). Of course, if people feel safe because of these efforts and build in areas they otherwise would avoid, the reliability of this “theory” is critical. Despite this potential misstep, the City takes what may be a better approach by stating in *A Stronger, More Resilient New York* that

“the right approach to coastal protection is an integrated system of discrete coastal projects, that together would constitute the elements of a multilayered approach also involving resiliency measures for buildings and protections for critical infrastructure. The advantage of this approach is three-fold. First, it diversifies the city’s exposure to given technologies, reducing the chance of devastating failure,

as occurred in New Orleans during Katrina, when the city's main defensive system, its levees, failed, leaving many parts of the city completely unprotected. Second, the City's proposed approach also has the advantage of being scalable to available resources, rather than requiring all resources to be secured before anything moves forward.” (Mayor’s Office, 2013, p. 50).

Regardless, PlaNYC contains many initiatives focused on hardening shorelines, building “gray” infrastructure, and otherwise using physical protection to lower risk (Mayor’s Office, 2013, p. 198, 255, 256-257, 285, 319, and 350). While these efforts no doubt lower risk for areas currently threatened by flooding, it is important to consider the possibility that it will encourage people to build in areas they should not, and to recognize that SLR could have a serious impact on how effective these physical barriers will be.

Quality of life. A final, critical “broad impact” consideration is the impact measures will have on quality of life. Indeed, SIRR held two public workshops in Staten Island to get input from residents and other stakeholders, and one of the priorities that clearly emerged was the need to preserve neighborhood character and affordability during recovery and rebuilding (Mayor’s Office, 2013, p. 282). *A Stronger, More Resilient New York* brings this issue up multiple times. It claims the City will study how natural areas can be used to both protect adjacent neighborhoods and maintain neighborhood quality of life (Mayor’s Office, 2013, p. 46), and that it evaluated measures in light of other considerations, including waterfront access, navigation impacts, recreational benefits, contribution to social justice, and impact on neighborhood character and quality of life for residents (Mayor’s Office, 2013, p. 50). More specifically, it

addresses urban design challenges introduced by increases in flood protection, including visual connectivity issues between the first floor of buildings and the sidewalk, meaning that “traditional flood-protection methods, therefore, have the potential to impact the neighborhood fabric in a negative way and could undermine the vitality of street life.” (Mayor’s Office, 2013, p. 79). In an attempt to address this issue, DCP worked with representatives from the local design community to develop urban design principles that would prevent these “negative effects on streetscape, building access, public safety, ground floor activity, architectural quality, and neighborhood character.” (Mayor’s Office, 2013, p. 82). On another note, despite Hurricane Sandy exposing vulnerabilities on the waterfront, there was a clear decision to continue using the waterfront for recreational, commercial and natural purposes (Mayor’s Office, 2013, p. 64).

Structural measures. A significant number of CCDRR measures are likely to be structural, and the assessment framework calls two important factors to be considered. First, due to the uncertainty embedded in climate change projections, it is useful to make structural flood protection measures scalable, and second, planners must address the reliability of critical infrastructure.

Scaling. There was limited discussion of the scalability of structural measures. While this does not clearly indicate that the measures are not scalable, it may indicate that this is not a priority for the City. However, PlaNYC’s *A Stronger, More Resilient New York* does indicate that scalability was a consideration by saying that together 37 of its coastal resilience measures will not only reduce vulnerability, but also “demonstrate the effectiveness of a wide range of coastal protection technologies that could be scaled up in

the future.” (Mayor’s Office, 2013, p. 57). Additionally, coastal protection solutions in Southern Manhattan are intentionally being implemented in phases as financial resources become available (Economic Development Corporation, 2014, p. 24), allowing for risk reduction that can better address uncertainty embedded in climate and SLR projections.

Critical infrastructure. Critical infrastructure reliability is an important thing to address within typical disaster management as well as climate adaptation. In NYC’s case, the growing population and aging infrastructure and critical systems couple with a changing climate to create a unique problem (Lenten, 2014, p. 19). Once again, Hurricane Sandy played a prominent role in focusing the City’s attention on this issue, and it was deemed “a wake-up call for all of us to get serious about climate change and its consequences,” leading the City to conduct a comprehensive analysis of infrastructure vulnerabilities outlining recommendations for mitigating those vulnerabilities (Department of Information Technology and Telecommunications, 2014, p. 1). The 2014 Hazard Mitigation Plan highlights transportation, water, energy, and communications as key infrastructure systems vulnerable to failure (Hazard Mitigation Plan Overview, 2013, p. 24; Lenten, 2014, p. 17).

Transportation vulnerabilities were revealed by the fact that Hurricane Sandy shut down mass transit for over 11 million daily commuters (Office of Recovery and Resiliency, 2015, p. 1). Water issues, with a relatively high potential to be impacted by climate change, are also important. With a sewer system designed based on past rainfall levels, “the climate trend toward more and heavier rainfall is taxing the sewer system’s capacity.” (Lenten, 2014, p. 73), and the potential damage to the City’s wastewater treatment plants considered extremely high, the City’s Wastewater Resiliency Plan

recommends upgrading and retrofitting plant generation systems to incorporate new technologies, and having contractors ready to make immediate repairs following flood events (Bloomberg & Strickland, 2013, p. 17). With over two-thirds of critical energy generation and distribution assets in the 100-year flood zone, there are “fundamental questions” about how to reconfigure and redefine the power sector (Office of Long Term Planning and Sustainability, 2013, p. 50). In fact, almost 2 million people lost power during Hurricane Sandy, and 84,000 lost natural gas service. Part of the City’s efforts to address this came through a \$30-million-dollar competition aimed at identifying and funding innovative and cost-effective technologies that would help promote energy infrastructure, building systems, and telecom networks (Office of Recovery and Resiliency, 2015, p. 20). Telecom networks are another critical infrastructure that were addressed by the City, including the establishment of an office within DoITT to focus on “telecommunications regulation and resiliency planning” (Department of Information Technology and Telecommunications, 2014, p. 3). Generally speaking, there was considerable focus on the issue of critical infrastructure in many parts of the City’s CCDRR planning.

Sustainability

The final major criterion – after problem definition, contextual analysis, stakeholder engagement, and developing appropriate strategies and measures – is to ensure the plan is sustainable. The assessment framework calls for financial sustainability as a primary consideration, as well as environmental and technological factors.

Importantly, it also suggests that long-term monitoring and revisions be considered. This criterion is essentially unchanged from the original framework, except that the sub-indicators were combined into their parent indicators, the transaction costs indicator was moved into the financial sustainability indicator, and the monitoring and revisions indicator was combined with the implementation indicator.

Financial sustainability. A good plan relies on funding, so planners should ensure financial sustainability by realistically estimating implementation costs (e.g., retrofitting, land buyouts), addressing the source of funding (i.e. new or existing funding streams), considering the impact on short and long-term fiscal systems, using funding that can shift from year-to-year (in order to foster accumulated experience and knowledge, and development of humanitarian organizations), incorporating recurrent costs at the local level in investment plans, mainstreaming adaptation funding into baseline funding for climate sensitive sectors and activities, and adapting CCDRR mechanisms to minimize transaction costs for local government and frontline service providers.

Baseline climate funding. One of the more obvious ways of ensuring financial sustainability is to develop baseline climate funding. Instead of funding project-by-project, this long-term issue could have dedicated, baseline funding. The City did make some clear efforts to dedicate regular funding to CCDRR efforts, such as the funding of OLRPS and ORR, and requiring regular reporting from the NPCC. However, it also used other funding sources for many of its efforts, and, in some cases, relied on potential funding in its plans. For example, *A Stronger, More Resilient New York* called for DEP to explore funding opportunities for climate change resiliency projects not funded in the

capital plan (*The New York City Municipal Water Finance Authority - Fiscal Year 2014 Consulting Engineer's Report*, 2014, p. 30). In some cases, it is clear that some important questions about funding have not been answered. For example, the City plans to create a \$1.2 billion program for building retrofitting program “subject to available funds” (Mayor’s Office, 2013, p. 83).

Funding streams. An important aspect of the City’s plans related to funding is that the plan is intended to allow flexibility during implementation. Part of this flexibility is that it is “scalable to available resources, rather than requiring all resources to be secured before anything moves forward.” (Mayor’s Office, 2013, p. 50). However, the City generally describes where the funding for proposed initiatives might come from, and “until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.” (Mayor’s Office, 2013, p. 57), which leaves open a very important question: Where will the funding come from? *A Stronger, More Resilient New York* concludes a section on funding by saying that approximately \$10 billion of the plan is funded by the City or Sandy-related federal aid, and another \$5 billion is expected to be funded by the City, but this still leaves an estimate \$4.5-billion-dollar gap (Mayor’s Office, 2013, p. 401). Enacting the remaining proposals, the plan says, will require the cooperation of NYC and the federal government (Mayor’s Office, 2013, p. 401), which seems to leave the door open to the possibility that this significant portion of the central plan will not be funded.

Fiscal systems. Impact on fiscal systems is also an important consideration, though this complex issue did not seem to be explicitly addressed very well. However, the City did make an important observation about the impact change in flood insurance

might have on homeowners, saying that some New Yorkers may “be required to spend a staggering 12 percent of his or her household income on flood insurance.” (Mayor’s Office, 2013, p. 99). Another part of the impact on fiscal systems considered by the City was the fact that coastal protection infrastructure should be recognized as a new class of assets that will require maintenance and operation (Office of Recovery and Resiliency, 2015, p. 47).

Funding that can shift and consideration of transaction costs may also be important aspects of CCDRR planning, but there was limited information in the data corpus to shed light on these subjects. There is an example of shifting funding in Mayor de Blasio’s move to reallocate \$100 million from HUD (*One City, Rebuilding Together - A Report on the City of New York’s Response to Hurricane Sandy and the Path Forward*, 2014, p. 4), but regular consideration of the possible need for shifting funding was not apparent in the data. Unfortunately, there was no useful information on what role transaction costs played in the process.

Economic sustainability. A plan’s impact on the economy is also an important factor of long-term sustainability, and the City regularly incorporate economic considerations into its plan, noting that “The size of New York City’s financial assets and economy and our role in the regional, national, and global economies mean that damage to us can reverberate well beyond our borders.” (Lenten, 2014, p. 19). Notably, the City’s *NYC’s Risk Landscape – A Guide to Hazard Mitigation* recognizes that “By reducing risk, investments in risk management measures can reduce the costs of disaster recovery. It is estimated that for every dollar invested in hazard mitigation, an average of four dollars is saved. A July 2014 report by the President’s Council of Economic Advisors

estimates that delaying climate policy actions by a decade could increase total climate change mitigation costs by about 40 percent. Taking no action would risk substantial economic damage.” (Lenten, 2014, p. 14).

The City also recognizes the importance of supporting New Yorkers by ensuring economic opportunities by using residents during the implementation of CCDRR projects. Bloomberg’s administration recognized the potential for resiliency projects to boost economic development (Office of the Mayor, 2013, p. 1), and de Blasio’s administration focused on this through ORR and the Mayor’s Office of Workforce Development to develop partnerships with workforce development programs and various organization to connect local workers with projects (*One City, Rebuilding Together - A Report on the City of New York’s Response to Hurricane Sandy and the Path Forward*, 2014, p. 32).

Other sustainability considerations. The assessment framework calls for several other kinds of sustainability to be considered, including long-term economic impact, non-financial resource and environmental stability (e.g., supporting natural barriers), and long-term projections related to technological development.

Environmental sustainability is considered regularly throughout the City’s planning efforts. In part, the City is focusing on green infrastructure as a cross-cutting measure with environmental benefits, and part of the reason for this may be that Hurricane Sandy “highlighted the importance of open space and natural areas such as coastal wetlands for climate resilience.” (PlaNYC Progress Report 2009: A Greener, Greater New York, 2013, p. 17). Another example comes from the Jamaica Bay Science and Resilience Center, which is intended to offer opportunities to test strategies that could

be “of critical value to other compromised areas of the city and to other urban estuaries around the world.” (City of New York Mayor's Office and National Park Service, 2012, p. 4), including providing coordination and long-term strategic planning for restoration and management of the “highly integrated urban-ecological system.” (City of New York Mayor's Office and National Park Service, 2012, p. 5). Revisions to the City’s Waterfront Revitalization Program (WRP) also recognized the importance of facilitating economic development while protecting natural resources, and aimed to improve projects in the coastal zone towards this goal while promoting climate resilient designs (Bloomberg, 2012, p. 158). Additionally, some of NYC’s 2014 *Hazard Mitigation Plan* included mitigation actions intended to preserve and restore natural habitats (Hazard Mitigation Plan Overview, 2013, p. 31).

Two other plans that highlight the importance of including environmental sustainability as part of CCDRR planning are PlaNYC and *Vision 2020*. According to the 2011 PlaNYC update, “Because 14% of city land is City parkland, even small changes in the sustainability of operations will have a huge impact,” so the City used internal practices, developed in a joint effort with Design for Public Trust, to support the development of parks as “climate-resilient landscapes that enable recreation, detain stormwater, and function as ecological corridors.” (*PlaNYC update April 2011: A greener, greater New York*, 2011, p. 45). Furthermore, according to the 2013 PlaNYC progress report, the City launched the Natural Areas Conservancy, tasked with advancing conservation and management of natural landscapes in 10,000 acres of NYC parks as they are deemed “increasingly vital to sustaining air quality and the natural channeling of storm water, as well as to the formation of neighborhood identity, increased property

values, recreational opportunities, and a climate resilient city.” (PlaNYC Progress Report 2009: A Greener, Greater New York, 2013, p. 18-19). PlaNYC also considers the broader picture by encouraging the development of clean distributed energy generation (*PlaNYC update April 2011: A greener, greater New York*, 2011, p. 133). *Vision 2020* also considered environmental sustainability by stating that “continued investment in infrastructure must be coupled with new, innovative solutions to cleanse our waterways,” and proposing maximization of the use of green infrastructure to capture stormwater, enhance communities, and further the City’s sustainability efforts (Department of City Planning, 2011, p. 65).

Technological development. Technological developments can also play an important role in planning for this long-term problem, and the City made considerable efforts to address this. One example comes from the Resiliency Innovations for a Stronger Economy (RISE) competition which dedicated \$30 million to the identification and funding of innovative and cost-effective technologies that help prepare small businesses for changing risks by supporting development of their energy infrastructure, telecom networks, and building systems (Office of Recovery and Resiliency, 2015, p. 20). Another example from the City’s New York City Climate Challenge is focused on how “Installing efficient on-site generation, such as combined heat and power (CHP) or solar panels, can help protect against power losses during storms and other emergencies while also reducing a building’s overall energy use.” (Tatum & Irvine, 2013, p. 2). Part of Mayor Bloomberg’s efforts included \$4 million for a competition to develop resilient technologies (P166, p. 2), and de Blasio’s *One City, Rebuilding Together* launched the RISE competition, which received over 100 applications from around the world, and

approximately 100 small business owners applying to become installation sites (*One City, Rebuilding Together - A Report on the City of New York's Response to Hurricane Sandy and the Path Forward*, 2014, p. 33).

Monitoring and revisions: A final indicator, and a fitting way to conclude this fairly linear conceptualization of the CCDRR planning process, focuses on implantation, monitoring, and revisions. The plan should support implementation (e.g., set goals associated with dates for action, transition quickly from planning to action) and enable monitoring and revision of plans as needed. This is important because flood risk can change over time with the climate, dynamic shorelines, an evolving built environment, and changes in infrastructure, neighborhood composition, and land use (Lenten, 2014, p. 71). The NPCC recommended that the City work with stakeholders and scientists to develop a system of indicators that track climate risks, hazards, and impact in order to inform climate-related decision making in the City (Bloomberg, 2013c, p. 6).

Importantly, the City has identified relatively concrete indicators that can help them track and assess CCDRR planning implementation. Under the de Blasio administration, ORR is tasked with “Developing consistent standards for resilient design that are consistent with climate change projections, working with agencies to identify asset criticality and lifespans to guide climate change adaptation efforts,” and “Providing policy direction to the city’s offices and agencies making infrastructure investments to ensure outcomes related to resiliency” (*One City, Rebuilding Together - A Report on the City of New York's Response to Hurricane Sandy and the Path Forward*, 2014, p. 28). Overseen by ORR, PlaNYC uses 30 Sustainability Indicators designed to provide quantifiable metrics

for each PlaNYC goal in order to monitor implementation (PlaNYC Progress Report 2009: A Greener, Greater New York, 2012, p. 28).

Summary. This breakdown of the framework provided an explanation of the transition to the final version, and gives detailed information about each indicator. The following chapter contains the final version of the framework summarized in a table, interpretation of what the results may mean, includes suggestions on how researchers can build on this work, and discussed how the framework might be applied by practitioners working in this area.

Chapter 6

RESULTS AND CONCLUSIONS

This chapter summarizes the analysis with a piece-by-piece analysis of the results of applying the framework, touches on several themes that emerged, suggests topics for future research, and summarizes this inquiry by suggesting how the framework should be applied in theory and practice. A quote from Scrieciu et al. (2014) summarizes the purpose of this research fairly well by saying that “innovative and guiding conceptual frameworks are demanded to foster the mobilization and uptake of interdisciplinary knowledge and catalyze action on the climate policy front.” (p. 283). The intent was to develop a framework that could assess the multidisciplinary intersection of CCA and DRR, and potentially prove useful in future theoretical development and practical application. As discussed in the first chapter, the two disciplines have different origins, and there is considerable potential for increased efficiency and effectiveness in their combination. So, a conceptual framework was created, shaped by real-world data, then applied to assess a case.

Review of the Assessment Framework

The assessment framework played a central role in this research – it was the main product of the literature review, and the primary driving force behind the data analysis. This investigation, and the framework, had a broad scope in order to allow a more comprehensive exploration of the subject, but this meant that this broader illumination of

the subject came at the expense of being able to highlight specific parts (i.e. a deeper understanding of many of its facets). While this hybrid framework may have less theoretical rigor because of adjustments made based on the data, and its strongly-theoretical foundation may be disconnected from on-the-ground reality, it is intended to be a useful step towards incorporating climate adaptation and resiliency efforts into the emergency and disaster management field. The following table breaks the framework down piece-by-piece summarizing the results of applying it to NYC. As this analysis is built on a qualitative methodology, it will also be qualitative. While a quantitative ranking (e.g., Likert) would provide an opportunity to compare within the framework by identifying relative strengths and weaknesses, and would also allow much cleaner comparison with other cases, it was simply not feasible for this inquiry.

Table 4
Framework

NYC's CCDRR Planning and the CCDRR Assessment

Framework Criteria and Indicators	Results Summary and Notes
Problem Definition	
Best information: The framework calls for Use the best available and disaggregated information, including consideration and development of best practices, consulting experts, and conducting and/or reviewing high-quality research.	This investigation concluded that not only did the City use some of the best available information, but it pioneered efforts in this area. A prime example, and critical part of NYC's effort, was the creation and ongoing use New York City Panel on Climate Change (NPCC). It seems the City successfully used this information, as there are many examples of information being shared between agencies and with stakeholders.
Transparent baseline: Formulate a transparent baseline with the information available, including explicit definitions, a clear purpose, technology learning rates, methods used to calculate GDP projections.	NYC already had extensive information available to assess a wide range of baseline issues, and it was able to get more insight into its baseline during and after Hurricane Sandy, then use clear definitions to define the problem and set clear goals. Unfortunately, examples of NYC considering technological learning rates and methods used to calculate things like GDP were limited or non-existent, possibly indicating gaps in planning or limited transparency.
Scenarios and modeling: Use a range of scenarios and models (e.g., climate, socioeconomic) and high-resolution data and risk mapping to understand regional and local risk. This	NYC performed well on this indicator, using a range of scenarios and modeling to develop planning assumptions related to this complex problem, though there was a strong focus on modeling hazards rather than vulnerabilities. So, it is clear that extensive efforts have been made to develop and use both high-resolution data covering projected

includes assessment of magnitude and probability of events, as well as identification of assumptions and limitations. An important part of this may be interactions between the economy, environment, and society, including macroeconomic assumptions about population, GDP, investment, trade, income, demographic distribution, health status, sectoral employment, and government budgets and policies.	changes in climate and hazards, but also social and structural vulnerability.
Decision-support: Use decision-support tools and systems to identify and compare choices surrounding uncertainty, including treatment of uncertainty by conducting sensitivity analyses.	While there are examples of decision-support systems being used, this is an area that may be a weakness in the City's generally robust approach. It is possible that this methodology was unable to uncover some of the situations in which the City used decision-support systems, but the available data seems to show only a few relevant examples.
Goal priority and clarity: Consider the importance of CCDRR planning relative to other needs and goals, and the priority of various possible goals, then set clear goals.	The City set many clear goals, and often indicated what kind of a priority they were. Additionally, other needs and goals were not only considered, but regularly integrated with CCDRR efforts.
Governance and Institutions	

Official context: Mainstream CCDRR into official development planning and legal frameworks, network city and other levels of government to build a culture of collaboration and shared policy vision that allows a multi-level system of risk governance and planning (e.g., use land-use planning to collaborate with state government). This can be supported through identification of collaborative champions in relevant agencies, supporting logistical capacities (e.g., co-location of facilities, joint training with EM and climate change agencies), and assignment of responsibility (e.g., create a task force to oversee the process).	Unfortunately, the coding process did not reveal any useful information on collaborative champions (individuals tasked with leading efforts). This could mean many things – that they were not deemed necessary, or were simply not apparent in the data (generally formalized documents) – so the implications are unclear. This theoretically-based indicator appears to have utility as a guide during planning, but it may not be able to play a significant role in assessment, especially when this kind of data is used. However, there were clearly efforts to develop a shared policy vision across the City government. With the possible exception of failing to properly engage the City’s emergency management community, it seems official context was carefully considered from a variety of angles. This allowed a multi-level system of risk governance and planning (e.g., use land-use planning to collaborate with state government), including assignment of responsibility.
Institutional context: Identify context-specific institutional factors that impact implementation, institutionalize CCDRR so integration at the program level is standard, and improve professional DRR and urban resilience education.	It is unclear whether the City is or is not making a concerted effort to improve education related to CCDRR, and this may be an area of potential improvement. This is especially important given the amount of misinformation and political controversy surrounding the subject, and, of course, the fact that disaster management professionals must learn to manage these same issues in a more dynamic climate. Regarding institutionalization of CCDRR at the program level, results were mixed. In some cases, there was clear programmatic development or creation of new programs, but in other cases the efforts seemed to be standalone measures that were not

	integrated with the City's other efforts.
Unofficial context: Consider unofficial institutional and organizational context by recognizing the role of informal relations and norms that influence local government and civil society actions, addressing constraints and opportunities relevant to involved organizations, and linking goals with efforts to pursue market opportunities and overcome trade and investment constraints (e.g., incentives, penalties).	A general potential weakness in the City's approach is a failure to engage social vulnerability and, more broadly, social issues. Part of this theme includes limited evidence that informal relations and norms played an important role in the government's efforts. There were limited efforts to address constraints and opportunities of involved organizations. There were, however, some clear efforts to link goals with market factors, and trade and investment constraints also received some attention.
Stakeholder Involvement in Planning	
Local actor roles: Engage local actors in order to determine who should take on roles, and be aware of uncertainty about who has responsibility for various parts of local decision-making structures related to CCDRR.	While it was difficult to clearly assess the quantity and quality of stakeholder engagement, there were significant efforts to include people in the planning process. However, it is difficult to be certain to what extent their input was captured, and perhaps even harder to determine how much it was used in the planning process. This may be due to limitations of this inquiry, or perhaps because the City simply did not engage stakeholders in this way. Generally speaking, it seems that this is part of a broader theme, which is a failure to involve the whole community in these disaster mitigation efforts. It is possible that one of the City's primary vulnerabilities is the government's focus on structural measures over social measures. This is not an uncommon theme in related research.
Stakeholder valuation: Get	While there are many examples of mechanism for

valuation input from stakeholders, explicitly state the value judgments underlying economic analyses, consider importance of current vs. future generations, consider implications for discounting, apply the most established and least controversial valuations of non-market benefits reported in their natural units with qualitative appraisals, and use decision-making tools to facilitate stakeholder involvement and valuation.	stakeholders to have input in the process, it was very difficult to actually see how this input impacted the planning process. A good example comes from the CBDG-DR grant application. HUD, the agency providing the grant, require the City to allow stakeholders to have input if there were certain changes, but it was not apparent how these changes would be expected to impact the planning. Of course, this requirement is driven by HUD – not the City. It would be useful to have more information on the content of these efforts – how did the City present its baseline and other information about its problem definition and assessment of governance and institutional context? De Blasio’s administration stated its project outreach and engagement goals were to “(1) identify the needs and desires of stakeholders; (2) understand and manage issues, expectations, and challenges; (3) develop a body of community feedback data that supports project direction and decision making; (4) strengthen project design and implementation through public understanding and discussion; and (5) establish a clear structure for public feedback.” (Office of Recovery and Resiliency, 2015, p. 26). Unfortunately, there was limited data available to shed light on how well these goals were addressed.
Stakeholder vulnerability: Address vulnerable populations in the planning process by including people with disabilities, elderly people, people with health problems, foreign-language speakers, and poor people. Also, use a broader scope to look for other vulnerabilities (e.g., economic, structural, institutional).	What preexisting vulnerabilities can CCDRR planners recognize and address in order to effectively and equitably lower risk? The assessment framework calls for planners to address vulnerable populations in the planning process by including people with disabilities, elderly people, people with health problems, foreign-language speakers, and poor people, as well as considering other vulnerabilities (e.g., economic, structural, institutional). An example of this kind of effort is the City’s planning to address the public housing issue by implementing “targeted efforts to strengthen building resiliency against future extreme weather events by designing and constructing improvements to public housing directly impacted by Sandy.” (Mayor’s Office, 2013, p. 84). Of course, this barely scratches the surface of the much larger

	issue of vulnerable poor populations. This is related to another important issue: CCDRR must be mainstreamed into other development efforts in many ways, and there is a strong argument to be made that CCA should be integrated with ongoing disaster management efforts, since there is already a considerable base to build on. Another example was the seemingly limited focus on including residents of Chinatown in the planning, where residents are relatively poor, relatively likely to speak English as a second language, and in one of the more physically-vulnerable parts of the City. As development and DRR professionals continue to develop efforts in this area, CCDRR planners should consider the potential to work within the same frameworks.
Stakeholders in the planning process: Ensure an open planning process that uses public announcements, open forums, and mechanisms for collecting stakeholder input. Ensure that stakeholders have reasonable access to information, provide them with information about their risk, and give them a clear understandable picture with realistic information. Finally, ensure stakeholder input has influence by adjusting and revising based on stakeholder input, and explicitly addressing stakeholder concerns.	An important aspect of CCDRR planning is having an open planning process so that stakeholders can see what is going on and participate. It was not clear from the data, or the investigative process itself, just how transparent the process was. This may have been a weak point in the City's efforts – if an investigation clearly focused on the issue has difficulty uncovering information, how easy was it for residents to obtain this information? A search for examples of stakeholders being engaged and then providing input that influences the process was essentially fruitless. Creating input mechanisms for stakeholders to provide feedback does not necessarily mean that this input will influence the process.
Strategy and Measures	

CCDRR and disaster management: Integrate with disaster mitigation, preparedness, response, and recovery, developing joint CCA/DRR capacity development campaigns (including combining and synchronizing resources), increasing the DRR community's focus on climate-related creeping hazards, and sharing information related to preparation and recovery.	This inquiry found that while OEM was often involved in CCDRR planning, it was usually not a key player. Since OEM plans and prepares for disasters, educates the public about preparedness, coordinates emergency response and recovery, and collects and disseminates emergency information (NYCEM – Overview, n.d.), then why did it not have a larger role in these recovery and long-term resiliency efforts? Perhaps the City perceives this as an area that could be improved, as the OEM website now says the agency “is undergoing a rebranding process as part of a comprehensive effort to increase the public's awareness of our presence and role in the city.” (NYCEM – Overview, n.d.). The City's requirement for OLTPS to issue a comprehensive, long-term resiliency plan every four years, to be updated in concert with the City's Hazard Mitigation Plan, is one of the clearer example of efforts that have the potential to be assigned to OEM. Would it not be preferable to have this resiliency plan developed by the same agency developing the Hazard Mitigation Plan? Indeed, the City included climate change as a hazard under the 2014 Hazard Mitigation Plan (PlaNYC Progress Report 2009: A Greener, Greater New York, 2012, p. 48), and incorporated climate projections and other related information in the plan. This may indicate, as did the apparent limited involvement of OEM, that established disaster and emergency management efforts and resources were not used as they could have been – this was one of the most interesting themes that emerged from this analysis.
Broad impact: Consider the broad impact of measures including land use, quality of life, public health (e.g., vector-borne diseases), and the potential for enabling a dangerous false sense of	The potentially broad impact of this kind of planning efforts should be well-established at this point in this thesis, and the analysis indicated that NYC did a good job of considering this issue. One exception may be the potential false sense of security some measures may create, since the City tended to lean on structural measures over softer, social measures. There are many examples of the City using things like green

security. Use cross-cutting, no-regrets measures (e.g., green and blue infrastructure options, microgrids, multi-purpose levees).	and blue infrastructure, which both have excellent cross-cutting potential. Quality of life was regularly considered as part of many aspects of the planning, and other factors (e.g., economic, environmental) were regularly considered.
Structural measures: Make structural flood protection measures scalable to address uncertainty in SLR projections and address the reliability of critical infrastructure.	The City seemed to rely heavily on structural measures, but there were only a few examples of the City considering the potential need to scale structural measures beyond the limited planning horizon. Critical infrastructure was heavily focused on, but the same issue applies. When climate change – including SLR – is expected to continue for hundreds of years, a planning horizon well under a century may not be the most effective way of managing issues. A way of dealing with this limit is to make structural measures scalable, but it may be that the City missed out on this opportunity.
Sustainability	
Financial sustainability: Ensure financial sustainability by realistically estimating implementation costs (e.g., retrofitting, land buyouts), addressing the source of funding (i.e. new or existing funding streams), considering the impact on short and long-term fiscal systems, using funding that can shift from year-to-year (in order to foster accumulated experience and knowledge, and development of humanitarian organizations), incorporating	Financial sustainability is easily one of the most important parts of CCDRR planning. Even limited soft measures could be expensive, and the easily multi-billion-dollar price tag associated with NYC’s plan demonstrate the potential cost of structural measures. It seems very difficult to tell how reasonable the City’s cost estimates are, so it may be that only time will tell, but a range of funding streams are already being used, with more in the pipeline. However, many of these seem to be temporary streams, so it seems long-term funding is not as stable as shorter-term funding. However, the creation of agencies dedicated to CCDRR may negate this, since these agencies can seek funding as necessary. The stability of these various funding streams remains to be seen, and could have a significant impact on the City’s CCDRR efforts.

recurrent costs at the local level in investment plans, mainstreaming adaptation funding into baseline funding for climate sensitive sectors and activities, and adapting CCDRR mechanisms to minimize transaction costs for local government and frontline service providers.	
Other sustainability considerations: Ensure long-term sustainability in terms of environmental (e.g., support natural barriers) stability, long-term economic impact, and long-term projections related to technological development.	In addition to financial sustainability, environmental, economic, and technological stability and sustainability should be considered. Generally speaking, the City seems to already be making a concerted effort to address environmental sustainability issues, and this was apparent in much of the data corpus. As well, the economy received a considerable amount of attention – these two issues seemed to be well-covered. However, technological development did not receive as much attention. Perhaps it this subject was deemed too difficult to include in the planning process (predicting technological development is not necessarily easy), and reflection on the analysis does not reveal a strong need for this issue to be addressed.
Monitoring and revisions: Consider and support actual plan implementation (e.g., set goals associated with dates for action, transition quickly from planning to action) and enable monitoring and revision of plans as needed.	A final kind of sustainability addressed within the framework is sustainability of the efforts themselves. Can the plan actually be implemented? Are there mechanisms for it to be monitored and then revised, if necessary? Unfortunately, there was little data on this criterion. Perhaps it is simply in order to give the agencies handling the issue more flexibility, but it could also indicate a potential weakness in the City’s efforts.

Themes

Many themes emerged from the analysis of this relatively large data corpus, but only a few have been selected for additional focus here. First of all is the use of focusing events – in this case that is Hurricane Sandy – in order to promote planning efforts. The second is the City’s use of the vulnerability perspective, which included a consistent focus on social and economic vulnerability, but a limited recognition of a potentially serious vulnerability embedded in the city’s government itself. Finally, the role of executive leadership is briefly explored. Several other notable themes will be discussed briefly, including a clear choice not to retreat from the coastline despite clear increases in risk and an apparent lack of transparency or focus on social measures.

Focusing events. A clear, theoretically interesting theme that emerged from this particular case was the obvious use of Hurricane Sandy as a focusing event, or window of opportunity. Indeed, “Extremes such as floods, droughts, and heat waves have even unfortunately been referred to as ‘useful catastrophes’ that might motivate action on climate change.” (Morss et al., 2011), and the City capitalized on this “useful catastrophe” to promote its ongoing efforts. As *A Stronger, More Resilient New York* notes, “By the time Sandy was forming in distant waters, progress on PlaNYC’s resiliency efforts had advanced substantially,” including work on updating building codes, restoring and enhancing wetlands, and other efforts to prepare the City for a future with climate change (Mayor’s Office, 2013, p. 1). In fact, a week before Hurricane Sandy hit the City, OLTPS initiated a formal request to USACE to evaluate additional ways to

reduce the impact of coastal storms (Office of the Mayor, 2012, p. 7). However, while climate resilience planning efforts were already well underway, Hurricane Sandy was a clear focusing event that was intentionally used as a window of opportunity to promote CCDRR efforts.

Building on Kingdon's (1995) conceptualization of windows of opportunity for policy change, Birkland (2004) considers how this theory can apply to disasters with the idea that some disasters are focusing events. According to Kingdon, windows of opportunity appear when three "streams" come together: political (state of politics and public opinion), policy (potential solutions to the problem), and problem (attributes of the problem). When these streams meet for some reason – such as a change in our understanding of the problem, a change in the political stream that favors change, or a change in our understanding of the tractability of the problem given current solutions – there is a possibility that policy will change. Birkland focuses on the September 11th attacks as a focusing event that had a widespread impact on disaster management and other policy, but in this investigation Hurricane Sandy was a clear focusing event for the city of New York. Birkland defines a "potential focusing event" as:

"an event that is sudden, relatively rare, can be reasonably defined as harmful or revealing the possibility of potentially greater future harms, inflicts harms or suggests potential harms that are or could be concentrated on a definable geographical area or community of interest, and that is known to policy makers and the public virtually simultaneously." (1997, p. 22).

Clearly Hurricane Sandy fits this definition, so it can be seen as a potential focusing event for NYC. In this case, Hurricane Sandy had significant impact on the political stream – it greatly increased attention on the issue. It was easier to see it as a present-day issue, rather than a future, intangible problem. Additionally, it impacted the policy stream by highlighting weaknesses and clarifying what actions can be taken to reduce risk from future events, and no doubt the also impacted the problem stream by more clearly defining risk posed by extreme weather and climate change.

Political stream. The political stream was clearly impacted, as not only did this significant event focus long-term attention on the issue, but it was clearly embraced by officials as an opportunity to promote and strengthen ongoing efforts. According to City Council Speaker Melissa Mark-Viverito, “Hurricane Sandy was a wake-up call for New York City and highlighted the urgent need to storm harden our homes and communities against future weather emergencies” (Department of City Planning, 2014, p. 1). Echoing the sentiments of many other City Council members, Council Member Vincent J. Gentile said that “It is crucial that we learn as much as we can from Hurricane Sandy in order to prepare for the next storm, I commend the NYC Building Resiliency Task Force for working to identify important measures to mitigate climate change and increase building resilience. Together we can ensure that our City is even better prepared to meet Mother Nature’s next challenge.” Council Member Sara M. Gonzalez said “I am proud to be part of the City Council’s ongoing efforts to better prepare for future storms as the challenges of climate change facing our City become increasingly apparent. As I fought to help Red

Hook recover from the damage caused by Hurricane Sandy, what I couldn't help but wonder was why the City was not better prepared. I strongly believe in being proactive to prevent future damage and make our waterfront neighborhoods more resilient.” (Office of the Mayor, 2013c, p. 3). These quotes represent only a few of many similar quotes by prominent figures in NYC's government. Indeed, the City claims that the discussion resulting from Hurricane Sandy “has expanded an understanding of the need to adapt to a changing climate and, consequently, of the importance of resiliency investments.” (Economic Development Corporation, 2014, p. 1). More specifically, City agencies were impacted by the storm individually, including DEP, which “made a clear decision to continue and strengthen its work on climate change adaptation and resiliency” after the event (*The New York City Municipal Water Finance Authority - Fiscal Year 2014 Consulting Engineer's Report*, 2014, p. 11). Other levels of government also saw this in a similar way, including NYS Governor Cuomo, who said “We are continuing to learn from recent storms so we can build a stronger, more resilient New York.” (Office of the Mayor, 2014, p. 1). Finally, this was not the first time the political stream has been impacted by extreme events. As *A Stronger, More Resilient New York* points out, City-USACE collaborative studies “typically were initiated following major storms, and some led to important projects that have been completed or are underway.” (Mayor's Office, 2013, p. 42).

Policy stream. The policy stream was impacted in a unique way. Hurricane Sandy presented an opportunity for the City to gain considerable funding that could be used to promote CCDRR measures. As discussed previously, FEMA and HUD funding played a

critical role in the City's recovery, and a clear focus throughout much of the recovery was rebuilding in a way that would increase resilience to changing risk driven by climate change.

Problem stream. Finally, the problem stream was impacted because Hurricane Sandy delivered, alongside serious damage, a wealth of information about the City's specific vulnerabilities. According to the 2014 Hazard Mitigation Plan update, "Sandy brought a number of city needs to light," including the need for updated FEMA flood zones and hurricane evacuation zones, the need to rethink "how to build or rebuild in vulnerable coastal areas by promoting more flood-resistant building designs and encouraging land uses that can accommodate periodic flooding," the importance of ensuring critical services for vulnerable populations, and the need for improved climate forecasting (Office of Emergency Management, 2014, p. 262). Additionally, the plan discusses the impact on the problem stream by saying that "

Prior to Sandy, New York City's vulnerability to hurricanes and climate change had been well established, but few people anticipated the devastation that such a coastal storm could bring. Moreover, although New York City had already been factoring climate change into its planning and undertaking resiliency initiatives, Sandy revealed that these efforts should be expanded and accelerated. Although a direct link between Sandy and climate change cannot be proven, sea level rise will continue to exacerbate the impacts of storm surge in the future." (Office of Emergency Management, 2014, p. 262)

Other documents from the data corpus point out that Hurricane Sandy highlighted that the City’s energy systems are vulnerable to climate change (Office of Long Term Planning and Sustainability, 2013, p. 50), and that there is a need a for open space and natural areas (e.g., coastal wetlands) (Mayor’s Office, 2013, p. 17). *A Stronger, More Resilient New York* claims that the storm made two things “devastatingly clear:” that the City had been right to invest in protections against extreme weather, and “the threat of ever greater risks from climate change also taught a second lesson: we needed to redouble our efforts.” (Mayor’s Office, 2013, p. 1). As ORR points out in its NDRC application, “The storm itself propelled the City into action to rebuild, not just what was, but better and smarter, so that our neighborhoods and infrastructure are ready for a future with climate change.” (Office of Recovery and Resiliency, 2015, p. 45).

As Kingdon makes clear, windows of opportunity, do not necessarily lead to change, but in this case study it seems clear that Hurricane Sandy was regularly, intentionally used to promote CCDRR planning. Notably, this seemed to be part of another prominent theme that emerged both from literature and analysis of the data corpus: the important role leadership can play in this kind of planning. In sum, “Until recently, the types of storms that have prompted studies on coastal protections have occurred infrequently. As a result, following these storms, interest in protection tended to wane, with impacted coastal communities often unable to secure the requisite funding needed to move forward with more effective protection measures. Sandy, however, has focused renewed attention on the need for such measures in New York City and brought

into better focus the risks that extreme weather poses for the coast.” (Mayor’s Office, 2013, p. 42).

Leadership. There are two important ways leadership played a role in this investigation. First, there was the leadership role the City seemed to embrace as an entity, seeing itself as a pioneer in this area with the potential to influence planning in other places. A second, perhaps more important, kind of leadership that was apparent in this case was the role both mayors played in developing and championing these efforts.

City leadership. In this case, the city government was a leader not only for the city of New York, but also as an example for other cities. In fact, NYC sees itself as a leader in the “fight to prevent climate change.” (New York City Council, 2014, p. 2). An example is the leadership role the city plays as it works with the U.S. Department of Housing and Urban Development (HUD) and mayors from other NYS and Connecticut cities to “improve the environment and create a strategy to build resilience to the effects of climate change in New York City, with applications for other parts of the region.” (Sustainable Communities - New York City Department of City Planning, n.d., p. 1). The City claims that “Cities around the world look to PlaNYC as the model for urban sustainability policy due to its grounding in the best available science and rigorous data analysis; its focus on high-impact and low-cost solutions; its accountability to the public through detailed annual reporting and frequent policy publications; and its extensive engagement with the private and not-for-profit sectors as well as community groups.” (Bloomberg, 2013b, p. 23), which is demonstrated partially by the establishment of

“ORR, the first office of its kind established in a major U.S. city, is implementing strategies laid out in PlaNYC: A Stronger, More Resilient New York and its 2014 update. These reports used the best available science to create an action plan to strengthen coastal defenses, make our buildings more resilient to the risks of wind, flood and prolonged power outages, harden City infrastructure and protect critical services, and make our neighborhoods safer and more vibrant.” (De Blasio, 2014b, p. 15). According to the current NYC Mayor, Bill de Blasio, “We also know, in everything we do, we have the potential to be the progressive leader. In everything we do we have the potential to change the way things are done for the better. And when it comes to sustainability, we have the potential to be the most sustainable big city in the world.” (New York City Mayor’s Office, 2014, p. 3).

Executive leadership. As would be expected based on the literature review conducted for this inquiry, executive leadership from both mayors played a critical role in CCDRR planning efforts. The CCDRR agenda has been driven partially by the city council, officials within various agencies, and some other parts of government (especially in the wake of Hurricane Sandy), but the clear leadership from both mayors considered in this case (Michael Bloomberg and Bill de Blasio) stands out as a critical factor.

It seems from the data considered in this inquiry that Bloomberg pioneered the City’s CCDRR efforts in many ways. In fact, Mayor Bloomberg seemed to be intentionally developing NYC as a pioneer in this area, saying that “The biggest challenge that we face is adapting our city to risks associated with climate change,” and that “compared to any other American city, we’ve got a running head start.” (Office of

the Mayor, 2012, p. 6). “Cities are not waiting for national governments to act on climate change” said Mayor Bloomberg, “Whether or not one storm is related to climate change or is not, we have to manage for risks, and we have to be able to better defend ourselves against extreme weather and natural disasters. We don’t know whether the next emergency will be a storm, a drought, a tornado or a blizzard, but we do know that we have to be better prepared for all of them.” (Office of the Mayor, 2012, p. 3).

Several years into implementing climate resilience initiatives, Hurricane Sandy struck the City, and Mayor Bloomberg seems to have clearly recognized this as an opportunity, saying that

“Despite years of learning and preparation, we are sobered by the ‘new normal’ that climate change is producing in our city, including more frequent and intense summer heat waves and more destructive coastal storms like Hurricane Sandy. We can’t know that the future will not repeat the past, so we must prepare on all fronts. However, we can say this with confidence: we will mobilize the same spirit, ingenuity, and accountability to make New York a greener, greater, more resilient city.” (PlaNYC Progress Report 2009: A Greener, Greater New York, 2013, p. 4).

Indeed, it was very clear that Mayor Bloomberg recognized the importance of such events for the City because he pointed out in a speech that the City responded to:

- The Great Fire of 1835 by damming a river and building an extensive aqueduct to

deliver water for firefighting;

- The Great Blizzard of 1888, which paralyzed elevated trains, by creating the largest underground subway network in the country;
- The Triangle Shirtwaist Fire of 1911 that killed almost 150 garment workers by developing health and fire safety codes, restrictions on child labor, and other workplace protections; and
- The 9/11 attacks by building the largest counterterrorism operation of any city in the world (Office of the Mayor, 2012, p. 3-4).

“After each one of those calamities,” Bloomberg said, “New Yorkers recognized that the city had to survive and thrive, and we are only going to do that if we adapt. And in each case, New Yorkers put politics-as-usual aside and set a new course that would redefine the future of our city.” (Office of the Mayor, 2012, p. 4).

De Blasio also made Hurricane Sandy recovery and long-term resilience a priority, saying that “We’ve made progress - but there is more work to be done. This administration is committed to completing this work and making sure that all New Yorkers fully recover. At the same time, we are working to make our City better prepared for the types of extreme weather events that will become more frequent with a changing climate.” (Office of Recovery and Resiliency, 2014, p. 1-2). An example of Mayor de Blasio’s commitment to “make New York City more resilient in response to global climate change” is DCP’s *Retrofitting Buildings for Flood Risk*, a guide for New York City homeowners living flood zones (Department of City Planning, 2014, p. 1).

City officials also seem to think Mayor de Blasio is doing a good job prioritizing CCARR planning, commending his administration for its “proactive approach to protecting at-risk communities” (Office of the Mayor, 2014b, p. 7) his leadership moving forward on recovery as well as focusing on resiliency (Office of the Mayor, 2014b, p. 8), his administration’s continued commitment to neighborhoods recovering from Hurricane Sandy, and attention to resiliency efforts (Office of the Mayor, 2014b, p. 6), and his overhaul of Build it Back to quickly rebuild homes that are built to last (Office of the Mayor, 2014c, p. 4).

Vulnerability. Another fascinating theme that emerged from the analysis was the way the City approached vulnerability. While it used the vulnerability perspective fairly consistently when considering social, economic, and structural issues, there was much more limited focus on vulnerability within the government itself. It seems probable that several potential vulnerabilities, and opportunities to reduce risk, were overlooked. For example, the lack of decision-support tools in the planning may be indicative of the institutional vulnerability of the City’s approach to managing a long-term, complex planning problem with deep embedded uncertainty on which planning assumptions are built. Another important potential vulnerability was the apparent failure to engage the City’s extant emergency management structures in CCARR planning. Finally, there seems to be a domination of the City’s emergency and disaster management by a relatively hierarchical culture led by the police and fire departments and systematically tied to the Incident Command System (ICS). While this approach may be useful or ideal

in some situations (e.g., responding to sudden events), it may not be as good at addressing social issues, which means it has limited ability to target complex vulnerability in populations.

Conceptualizing vulnerability and resilience. Before moving on to a discussion of possible gaps in the City’s approach, and vulnerabilities within the government itself, some conceptual clarification is in order. The City’s NPCC leans on the IPCC’s (2012) definition of vulnerability, defining it as “The propensity for the health of individuals or groups to be adversely affected as a result of exposure to a climate hazard. Vulnerability is an internal characteristic of the affected system and includes the characteristics of persons or groups and their situation that influence their capacity to anticipate, cope with, resist, and recover from an adverse climate event. Different levels of vulnerability will lead to different levels of health damage and loss under similar conditions of exposure to physical events of a given magnitude.” (New York City Panel on Climate Change 2015 Report, 2015, p. 69). Closely tied to the concept of vulnerability is resilience, which is sometimes seen as the opposite of vulnerability. According to *NYC’s Risk Landscape*, “Resiliency requires both preparedness for hazard events and the capacity to rebound quickly from them. Damage to and disruption of some vulnerable features of our city can be repaired in mere hours; in extreme cases, recovery can take years.” (Lenten, 2014, p. 17). The same document again ties the two concepts together by saying that “Climate change boosts risk, and looking back over this chapter, it is clear that – given the extent of New York City’s vulnerabilities to natural and non-natural hazards and their potential severity – the stakes at the risk and resiliency table are high and warrant the broad array

of risk management strategies that our City and its partners now employ and are working aggressively to strengthen.” (Lenten, 2014, p. 39). However, the relationship between the two may be more complex than simply being positive or negative. They may concepts may have emerged at different times, for different reasons. They may have different components and focal points, such as a vulnerability perspective that encompasses a broader range of factors, and a resilience perspective that focuses on a society’s ability to adapt. Ultimately, there is conceptual and methodological “haze” surrounding resilience and vulnerability, which hampers the transfer of knowledge within disaster risk science, but also offers opportunities for communication between science, policy, and practice (Fekete et al., 2014). This brief discussion is far from conclusive, but it should serve an important function in this inquiry: To highlight the fact that while the terms “vulnerability” and “resilience” are used often in NYC’s planning efforts, there is considerable conceptual uncertainty.

Sandy and vulnerability. Hurricane Sandy played an important role in revealing some of the City’s vulnerabilities, including the need to “rethink how to build or rebuild in vulnerable coastal areas,” the importance of critical infrastructure for vulnerable populations, and the need to improve weather and climate forecasting and communication (Office of Emergency Management, 2014, p. 261). It was a reminder of the interconnectedness of the City’s systems, highlighting vulnerabilities within them and in certain geographic areas of the City (Mayor’s Office, 2013, p. 14). The City notes that the storm caused over \$19 billion in damage and lost economic activity, damaging buildings and infrastructure, costing almost 50 people their lives, and exposing “other underlying

challenges in many neighborhoods, where many of the city's most vulnerable populations live, and where individuals and families are at even higher risk of disruption, dislocation, and displacement.” (*One City, Rebuilding Together - A Report on the City of New York's Response to Hurricane Sandy and the Path Forward*, 2014, p. 2). Unsurprisingly, the *A Stronger, More Resilient New York* says that City learned from the storm “that neighborhoods with higher community capacity tended to prove more resilient,” so it proposed conducting a pilot community needs assessment, where OEM and the City's Center for Economic Opportunity would work with residents to identify strengths and needs, then develop recommendations for improving preparedness and response capacity (Mayor's Office, 2013, p. 158). Thus, it is clear that after Hurricane Sandy the City recognized that the storm had revealed some vulnerabilities it should address, including social, economic, and structural issues.

Limited focus on social measures. While the City clearly recognizes social vulnerability as an important factor, and the assessment framework calls for it to be addressed, it seems that it was less prepared to actually focus on it in plans. Indeed, a relatively small portion of CCDRR-related funding has been dedicated to social efforts (e.g., education, public awareness, capacity building), despite some obvious vulnerabilities in parts of the City. For example, some parts of the waterfront have median household incomes of \$47,700, with a 33% poverty rate, whereas in others these numbers are \$167,700 and 5%, respectively (Mayor's Office, 2013, p. 243-244). Another example is Lower East Side and Chinatown area, a relatively poor and ethnically distinct area with a high population density. The population in this area is expected to grow, and

it already has well over 30,000 people in the 100-year flood plain, alongside “1,600 residential and commercial buildings, historic landmarks, hospitals, telecommunication facilities, subway stations and lines, power stations, and vehicular tunnels.” (Economic Development Corporation, 2014, p. 5). While this area may seem to be an obvious target for CCDRR efforts, it did not seem to be a focal point in the City’s planning efforts. It is possible that the City, as a whole, is joining the disaster management community in seeing vulnerability as a critical part of risk, but the relative focus on and selection of measures targeting structural and economic vulnerability indicates that this aspect of planning may still be developing.

Institutional/governance vulnerability. A fascinating consideration is that, while the City focused on many different kinds of vulnerabilities, including some attention paid to confronting social vulnerabilities, there was limited consideration of vulnerability within the government. No doubt it is possible that some root causes of vulnerability in a society exist within the government and institutions. SIRR, NPCC, and other efforts do indeed demonstrate important governance adjustments that may have reduced New York’s vulnerability. Furthermore, the City clearly recognized a vulnerability in FEMA’s NFIP: The complete exclusion of climate change projection information in risk mapping efforts. However, despite some recognition of governance and institutional vulnerability, the City may have ignored some other important weaknesses in the government that could be addressed to reduce risk. This section discusses three areas where it may be possible for the City to improve its CCDRR efforts by making adjustments within the government in order to reduce vulnerability. First, if decision-support systems were used

more often in the planning process, it may allow improved understanding of the problem, more objective decision-making (and possible clearer/more transparent), and better options for including stakeholder input. Second, more inclusion of the City's emergency and disaster management communities might be able to make the City's efforts more effective and efficient. Finally, it is possible that the command and control approach to emergency management within the City is ill-prepared to deal with the complex, long-term, socially-conscious aspects of CCDRR planning.

Decision-support tools, including cost-benefit analysis and multi-criteria decision making, are relatively objective ways to approach problems, and are particularly useful for exploring and understanding complex problems. In addition, they offer opportunities to integrate stakeholder concerns in a clear, easy way, compared to some other approaches. Some authors point out that there is a need to adopt multiple strategies, mixing technological and nontechnological interventions with traditional measures while attempting to reduce baseline vulnerability (Morss et al., 2011, p. 16). Given this complexity embedded in CCDRR planning, as well as the need to collaborate with a range of stakeholders, it seems like an excellent candidate for using decision-support tools, but there were only a few examples of the City openly using these tools in the data corpus. Thus, it is reasonable to suggest that improved use of these tools might help the City improve its efforts in multiple ways, and that this may be a weakness in the government's approach.

Another aspect of this theme is that the City may have been able to more effectively and/or efficiently develop and implement CCDRR plans if it had used extant

disaster management (e.g., administrative structures, resources, research). Certainly the City made extensive efforts to address the problem of changing disaster risk driven by climate change, but it seems that addressing this problem as a disaster management issue, rather than treating it as a separate planning problem and creating corresponding government structures, could have been preferable. Perhaps there are reasons the City did not do this (e.g., political factors, actual or perceived limitations within the City's disaster management community), but it seems probable that increased inclusion of OEM and other relevant parts of the disaster management community would be preferable. Perhaps the City's approach to disaster management is focused on government, physical measures, and response, rather than being community-oriented, implementing social measures, and taking a more comprehensive approach by addressing the whole disaster management cycle. It is also possible that the disaster management community was more involved than was apparent based on the data corpus, but it is worth considering the potential to improve the City's planning process by building on and adapting ongoing disaster management efforts rather than creating new government structures and processes for confronting changing risk.

A final potential vulnerability with NYC's government, and also a possible factor in the failure to build on and adapt existing efforts, is the apparent command and control emergency management approach employed by the City. For example, the City's disaster management efforts are generally led by the fire and police departments, as demonstrated by the Citywide Incident Management System (Office of Emergency Management, n.d.). NYPD's successful efforts to reduce crime over the last few decades, and FDNY's

critical role in responding the terrorist attacks on 9/11 may demonstrate that these agencies are dedicated and capable, but addressing vulnerability is unlike dealing with crime or terrorism. Are these agencies able to effectively manage heat waves, slow-onset disasters, sheltering needs, and socially-aware cross-cutting initiatives that improve the City's resilience? In other words, an inability to confront the socioeconomic roots of disasters may be a vulnerability created by the government itself. As disaster management officials confront hazards like Hurricane Sandy, perhaps they are failing to confront the vulnerabilities that allow this predictable storm to cause such extensive damage. Indeed, "one cannot discuss strategies for adaptation to weather extremes in a changing climate without considering how people cope with weather extremes more generally." (Morss et al., 2011).

Perhaps a shift from a command and control approach that regularly employs structural measures to a whole community, capacity building approach that takes a long-term approach to reducing systemic vulnerability within society would be preferable. Morss et al. argue that managing current risks from extreme events is difficult, and that responding to potential future changes in risk is even hard. Attempts to address them, they say, may prove to be successful in the short term, but increase vulnerability over time or for other populations, so effective long-term coping and adaptation will involve "applying a broader system resilience framework." (2011, p. 13).

No retreat. "Although Sandy exposed vulnerabilities on the city's waterfront, the storm did not diminish the City's resolve to continue using this waterfront for a variety of

recreational, commercial, and natural purposes.” (Mayor’s Office, 2013, p. 64). This quote succinctly encapsulates the City’s clear choice not to retreat from the waterfront. While this may seem like a natural choice given the high importance and value of waterfront real estate in NYC, it is important to remember that the City has a 520-mile coastline the is seeing a relatively rapid level of SLR and is exposed to hurricanes. It is also important to consider the planning horizon – as the City plans for decades into the future, sea levels and the climate are projected to continue changing for centuries.

Limitations

There are important limitations to this inquiry that should be clear to anyone considering its utility and theoretical implications.

Methodology. An important limitation is the qualitative nature if the inquiry, which means that subjective bias is an unavoidable aspect of the results. Merriam (1998) states, “our analysis and interpretation -our study’s findings - will reflect the constructs, concepts, language, models, and theories that structured the study in the first place” (p. 48). In other words, preconceptions were an intrinsic part of this research. Self-reporting bias is another limitation of this work. Ideally, self-reporting bias could be confronted through direct observation, interviews, or member checking, but, as discussed before, this was not feasible due to the resource and access constraints on this study. This means that all of the data used in this study came from the City, no doubt filtering out many relevant bits of information, especially the kind that might detract from the City’s efforts. A future

investigator might find it worthwhile looking for other sources of information to get a second angle on the subject.

The broad scope used in this inquiry is another important limitation. While the choice to take a more comprehensive approach to this topic allowed a better exploration of the entire CCDRR planning process, including the creation of the assessment framework, it made it difficult to delve into some of the material. Many of the framework's 100+ individual indicators could easily provide a topic for an entirely separate investigation, and there were many cases where increased focus on particular elements could have provided a deeper explanation of parts of the planning process. Several have been discussed here as themes that emerged from the analysis, but there is no shortage of opportunities for future research.

Case context. There are several important aspects of New York City that should be considered before applying the results elsewhere through analytical generalization. First, as a coastal city with a long waterfront, there is a relatively strong focus on hydrometeorological hazards, so, these results may not apply to inland cities. Second, it is one of the more developed and built-up areas on the planet, so less developed areas may face entirely different risks, and require different strategies and measures. Third, the political context of the City should be considered, including the NYS and federal legal framework. Fourth, NYC is a relatively wealthy city, so some of the approaches it used may not be financially feasible in other parts of the world (how many other cities could dedicate billions of dollars to PlaNYC's *A Stronger, More Resilient New York?*). Finally,

New York is unique in that it recently experienced a major focusing event. While efforts were already being made, this event certainly played a major role in the City's CCDRR efforts.

Further Work

There are many ways this work could be expanded upon including theoretical development, expanding the scope to consider other kinds of cities (especially relatively vulnerable cities that could greatly benefit from development), and focusing in on parts of the scope for a more in-depth exploration of the issue.

A clear theoretical proposition related to this research is that governments in coastal, urban areas that develop CCDRR plans in line with this assessment tool will reduce risk from climate change effectively and efficiently relative to those that do not. Properly testing this hypothesis would likely require assessment of multiple cases over a period of time, as examples of practice in this area are relatively limited.

Developing cities and countries. Another critical area for future research is CCDRR in developing cities and countries. Notably, “5 of the 20 cities facing the steepest flooding costs are located in China,” perhaps indicating why China has placed an increased focus on this area recently (Plumer, 2013). Indeed, rich cities are better protected than poorer ones, with 17 of the top 20 cities with highest projected absolute flood loss risk are in developing countries (Hallegatte et al., 2013, p. 802). Vulnerability in cities with some of the lowest resilience can derive from inequality, poor infrastructure

provision, environmental degradation, and climate vulnerability, with many of these cities also having low adaptive capacity (Grosvenor, 2014, p. 14). Furthermore, “Negative impacts of climate change and natural hazards have a multiplying effect on bad governance, as evidenced by the increasing incidence of conflicts that are intertwined with natural disasters.” (CCD, 2008, p. 6).

Applying the framework: Theory and Practice. A central purpose of this inquiry was to create a useful tool for both researchers and practitioners. The result is a hybrid framework with a strong theoretical foundation that has been shaped by analysis of an excellent example of a City involved in CCDRR work. The following two paragraphs will summarize, in relatively plain language, some important things researchers and practitioners using this framework should consider.

Researchers applying this framework should consider two things. First, the framework would likely benefit greatly from criticism. As a hybrid that attempts to bridge theory and practice, there are no doubt theoretical holes that should be explored, potentially resulting in revisions that improve the framework. Additionally, there are many opportunities for research to explore the conclusions reached by this inquiry. They could tie results back to other research, and further research could explore specific parts of this work in more detail to support or reject it. Finally, researchers could use this framework, revised or as-is, to assess other cases, possibly in a multiple case study.

Practitioners using this framework would have completely different goals in mind. For them, this would function less as a theoretical curiosity, and more as a guide or

a kind of check list. The framework is certainly not a one-size-fits-all solution for planners, but it provides a theoretically-grounded then tested tool that can, at the least, help planners tackle this growing and complex issue. Importantly, every part of this framework can be explored in much more detail, either by looking at the research on which the framework is based, or by exploring the freely accessible documents that created the data corpus. Planners will need to consider the unique context in which they must develop and implement plans carefully, but these 200 pages, as well as the many, many thousands of pages on which they are based, can provide a strong starting point.

Both researchers and practitioners can benefit from starting with an understanding of how this issue can be spread out amongst many different parts of government, and can involve many individual and organizational stakeholders. This case demonstrates how many different agencies can be involved, and, importantly, how much complexity that can bring. Who is responsible for various parts of this planning? Who plays a coordinating role? In this case, there were several key agencies and individuals playing important roles, including OLTPS, ORR, and both mayors, but other agencies had critical roles, including at the federal level. Also, as has been argued here, it may be preferable for other agencies to play the coordinating role (i.e. OEM), due to the nature of the planning. Choosing the organizational home of this kind of planning is a critical first step in addressing this long-term issue, and there is a strong argument to be made that agencies already involved in disaster mitigation and preparedness are relatively prepared for this additional responsibility.

Conclusion

Publicly available information was pulled from the City's website in a search for insight on its CCDRR planning process and products. Almost 200 PDFs, including thousands of pages from documents and websites, was put together and analyzed with CAQDAS software and a framework containing over 100 primary codes. This large amount of data and fairly comprehensive framework was unable to thoroughly explore individual issues, but did give a broad picture of what kind of CCDRR planning is taking place in this case. A complex planning process reaching across many parts of the City's government, other levels of government, businesses, community organizations, and individuals resulted in many different initiatives, often with broad impacts on the City, and sometimes intended to satisfy multiple objectives. While these planning efforts did not begin because of Hurricane Sandy, the storm played an important role in driving efforts – it was used by leaders to focus attention on this need, and CCDRR efforts were often integrated with recovery. Of course, some dimensions of this issue were not captured by the framework, including insider insight into the planning process (e.g., impact stakeholder input actually had), and how decisions about oversight/responsibility were made. Interviews with key players would likely provide a fascinating insight into this process, which could be useful for both research and practice. A multiple case study would allow comparison of different processes, possibly revealing best practices, and certainly allowing a stronger critique that could support generalization of results. Since this was limited to a single case study, theory and practice were brought together as the

theoretical framework was applied to a case in order to strengthen the results. The research-driven initial version of the framework was revised significantly as it encountered data, and much of this research was carried out in the complex space in between theory and practice. Some parts of the framework were deemed unnecessary or redundant, whereas others focused the analysis on very fruitful areas, revealing important parts of the City's efforts.

There is a change coming in development, DRR, and disaster management. While historical data has generally had good predictive power when used to assess future risk, there are some instances where this is no longer the case. A new field called climate change adaptation has emerged as a response to current and projected changes in climate, often driven by the need to adapt to changing risk. However, this field sometimes replicates the work of another relatively established field: disaster management. In fact, current focus on climate change may be a good opportunity for disaster management to lower future risk by using this attention to support initiatives that might otherwise be difficult to pass. Additionally, by incorporating these considerations into the current administrative structures, and throughout the disaster management cycle, climate adaptation practitioners may be able to do their work more efficiently and effectively. Thus, disaster management researchers and practitioners should see current attention on climate change as an opportunity, and climate change researchers and practitioners should use existing disaster management structures and research.

Cities can play an important role in developing the intersection of these two fields and promoting action that mitigates the risk that accompanies a changing climate. The

case study selected for this inquiry, New York, is an example of a pioneering leader. Ongoing efforts, refocused by Hurricane Sandy, have been continued throughout two mayoral administrations. According to the assessment framework developed for this inquiry, built with a strong theoretical foundation, then filled out by an assessment of practice, the City has a relatively comprehensive approach to managing this problem, involving many City agencies, other levels over government, institutions, businesses, other organizations, and a range of stakeholders.

Problem definition. The City has developed a strong foundation with the help of modeling, scenarios, experts, and historical records on which it developed a shared understanding of the risks the City faces. While it may have benefited by using decision-support tools to analyze the information and potential actions, and some aspects of its baseline were not fully-developed, it considered a wide range of information from many sources in order to prioritize and set clear goals.

Governance and institutions. In addition to exploring the problem and setting goals, the City successfully, according to the framework, engaged various agencies and worked within the institutional context. The City engaged other cities, New York State, and the federal government, regularly taking a leadership role in conducting research, developing best practices, and defining agendas. There was a fairly clear shared policy vision that helped the City coordinate initiatives and work towards its goals, and this was clearly supported by both mayors who held office in the time frame considered in this investigation. Unfortunately, it seemed likely that the City missed an important opportunity to engage extant disaster management structures and individuals, which

could, and perhaps should, have played a central role in this disaster-oriented efforts. Indeed, the disaster management field already confronts almost all of risk addressed by this planning. One area where the City did seem to successfully build on disaster management efforts is through the use of the vulnerability perspective. A focus on vulnerability, as opposed to hazards, is a regular theme throughout most of the data considered in this work. However, it is important to note that a possible weakness was a lack of focus on weaknesses within the City government itself – an observation that closely relates to the conclusion that the City could have more effectively used existing disaster management resources.

Stakeholder involvement in planning. Another essential aspect of this kind of planning is engaging stakeholders, and the City did fairly well in this regard, according to the assessment framework. It engaged the public through a range of input mechanisms, getting valuations from a wide range of people, and making some clear efforts to include a diverse audience (e.g., non-English speakers, people with disabilities). Related to its clear use of the vulnerability perspective, the City also focused on vulnerable populations in its work, targeting initiatives at some of the most at-risk populations. A couple of potential weaknesses in the City's approach to including stakeholders are the use of stakeholder input and its willingness or ability to assign responsibility to local actors. It was not clear how stakeholder input was included in plans, and many questions could be asked about this process – how was input recorded? How was it processed and understood? How did officials decide what the priorities would be, and what competing considerations did they have in mind when choosing? The City's process for assigning

roles and responsibility to local actors was also unclear. While the City did a good job of supporting individuals and businesses during recovery from Hurricane Sandy, there were very few examples of responsibility for long-term resiliency building initiatives being given to non-government entities.

Strategy and measures. More generally, the City did a fairly good job selecting and using strategies and measures, though there are some notable exceptions. As mentioned previously, the City did not seem to engage the existing disaster management structure as it probably should have. Having experienced the September 11th attacks and Hurricane Sandy within the last 15 years, New York City has experienced disasters, and planning efforts focused on risk from extreme weather events related to climate change could likely benefit greatly from the structures, expertise, and other resources the City already has. However, planning was often led by specially-formed task forces (CCATF and BRTF), initiatives (SIRR), or offices (OLTPS and ORR), and non-emergency management agencies (DCP, DEP, DPR, and NYCHA) were tasked with implementation. With OEM's development of the City's hazard mitigation plan, and various relevant resources and abilities, there may have been lost efficiency or effectiveness in the failure to use this agency more. However, the City's development of strategies and measures was otherwise generally strong, according to the assessment framework. For example, the City, supported by the shared policy vision and collaborative approach, seemed to do a good job of addressing the broad impact measures might have. An excellent example of this was the focus on using green infrastructure to mitigate flood risk, which has multiple added environmental, aesthetic, and other

benefits. There was also a consideration of combined heat and power distributed generation, and using structural flood protection measures as space for other uses. Generally, the ways measures would impact quality of life, the economy, the environment, and a variety of other factors was part of the planning process. There was also consideration of the need for scalable strategies and measures that can adapt as future risk levels become clearer.

Sustainability. A final aspect of this planning process outlined in the assessment framework was the sustainability of the plan. Primarily, this criterion focused on financial sustainability, but it also considered environmental, economic, and technological development factors, as well as the ability for the plan to be monitored and revised over time. The financial sustainability of the plan was difficult to assess because it was not fully-funded, despite considerable financial support from the federal government in the form of Hurricane Sandy recovery funding. However, the City outlined many ways this funding gap could be addressed, and tasked agencies with securing additional funds, and this partial-funding approach may actually be appropriate as it gives the City more flexibility as risk from climate change becomes clearer. Some parts of the City's plans laid out very clear criteria and indicators by which efforts would be judged, including goals and dates for action, and it seems clear that the City has the ability to monitor and revise its efforts with relative ease.

Thus, despite limited use of established emergency management, alongside several other possible weaknesses in its planning, the City has taken a relatively comprehensive approach. A fascinating aspect of this approach was the clear use of

Hurricane Sandy as a focusing event that garnered support for preparing for future risk. While the City was already well into its efforts to address changing risk from climate change, the hurricane focused attention on this risk, and Mayor Bloomberg and other important parts of the City's government used this to move their agenda forward. Indeed, the City acted quickly to incorporate climate change considerations in its recovery efforts, which may have substantially reduced future risk by preventing rebuilding the way that allowed the storm to do the damage that it did. Of course, reducing the risks New York City clearly already faces is desirable, even if climate change does not increase risk as predicted, so it seems that the City did a good job of capitalizing on the attention on the hurricane in order to promote long-term resiliency and capacity building. No doubt another storm like Hurricane Sandy will strike the City again at some point in the future, and these planning efforts may play a critical role in reducing damage when it does. Disaster management researchers and practitioners in other areas should realize the climate change adaptation needs may impact their work, and address the issue accordingly.

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