

Planning for Increased Flooding Due to Climate Change: How the City of Boston will Protect its Shores and Strengthen its Communities

Gregory Campion, ND-GAIN Urban Ambassador

Author Bio

Greg Campion is a sophomore environmental engineering major and sustainability minor. His concern for the global scale of the injustice posed by climate change originally motivated him to choose an environmental-related course of study. He was glad that his work with ND-GAIN allowed him to explore the same concerns at a local level --and close to home, too-- since so much of the sustainability and adaptation work that needs to be done must happen at the local level.

Abstract

As climate change exacerbates extreme weather hazards, local governments the world over must rise to the challenge by planning and implementing a host of requisite infrastructure improvements and related social problems. This case study examines how the city of Boston has defined and analyzed vulnerability to climate hazards, particularly flood hazards, and then used its understanding of vulnerability to synchronize plans for physical safety from flood hazards and the promotion of social equity.

Introduction to the City of Boston

Boston is both the most populous city and the capital of the Commonwealth of Massachusetts. Boston is recognized as a global city because of its diverse population and progressive culture, its higher education, biotechnology, and financial industries, and its history as the birthplace of the American Revolution. Boston is home to about 667,000 residents, (United States Census Bureau 2016) but the city's economic activity has been known to approximately double the number of people in the city during work hours (Boston Redevelopment Authority 1996). Boston's seaport district is home to many of the businesses important to the city's economy, as well as residential neighborhoods. Because it is located at the mouths of the Charles, Mystic, and Chelsea rivers, the city is geographically vulnerable to the risks of future sea-level rise (SLR); in addition, its diverse population demonstrates a variety of risk factors which worsen the vulnerability of some members.

Background: City Leadership Vision

To prepare for climate hazards, Mayor Marty Walsh's office organized the Climate Ready Boston initiative. To start, a research team examined the city's vulnerability and to climate hazards and to make policy recommendations on how to protect against these hazards, summarized in the Climate Ready Boston Final Report. Climate Ready Boston functions as part of Mayor Walsh's larger social vision of social justice, which is outlined in a report titled Resilient Boston: An Equitable and Connected City." The stated "guiding principle" of Resilient Boston is that "[t]he only way to create citywide resilience is to embed racial equity, social justice, and social cohesion within infrastructure, environmental, social, and economic aspects of resilience" (Resilient Boston 2017, 38).

Types of Flood Hazards

Over the last century, global sea levels have risen, including in Boston, where the sea level has historically risen at an average of only 2.81 millimeters per year (NOAA 2017). By 2100, however, the city must prepare for a sea level rise of at least two feet, and perhaps over seven feet. Figure 1 shows the likely extent of likely SLR over the next century, depending on how effectively humans reduce greenhouse gas emissions.

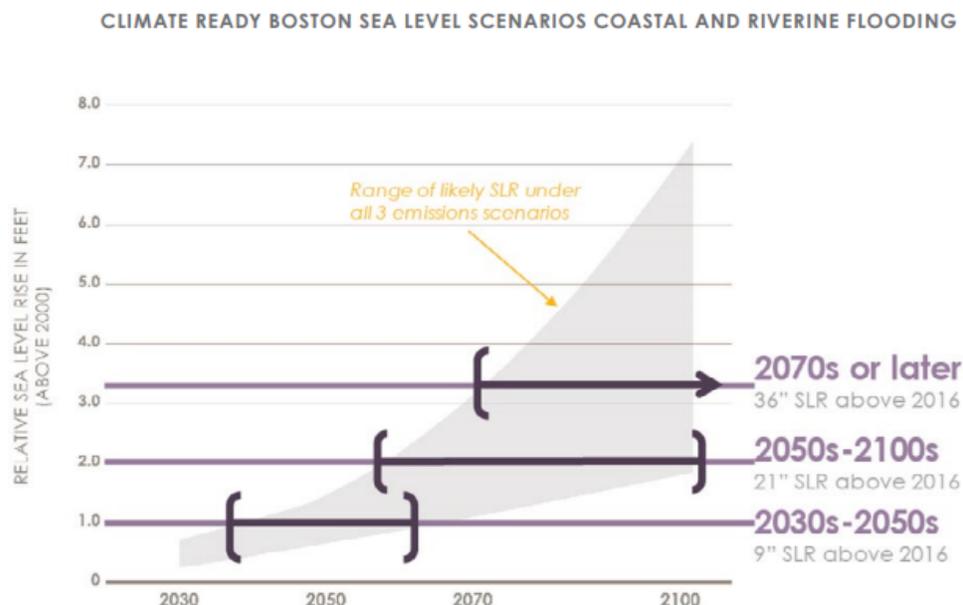


Figure 1: Sea Level Rise Scenarios and Coastal and Riverine Flooding. (Climate Ready Boston 2016a)

Climate Ready Boston researchers and city planners distinguish between two types of flood hazards: stormwater flooding, and coastal and riverine flooding. Stormwater flooding occurs when drainage systems cannot carry water away from roads and buildings fast enough during heavy rainfall, causing backup into streets and sewers. The risk of stormwater flooding is increased by SLR and increased extreme precipitation events. Coastal and riverine flooding occur when storm surges, heavy rainfall, and/or high tides cause rivers and coastal waters to overtop their banks. Coastal and riverine flooding are categorized as one hazard because both are made more frequent and severe by SLR and coastal storms, and both call for similar infrastructure to mitigate hazards.

The areas at increased risk for flooding vary: both commercial and residential areas, as well as historical landmarks will be affected. Figures 2 and 3 show which areas of Boston will be at increased risk for flooding due to each category of flood hazards over the course of this century.

As the sea level continues to rise, the likelihood of major floods will increase from a 1% annual chance to a monthly reality

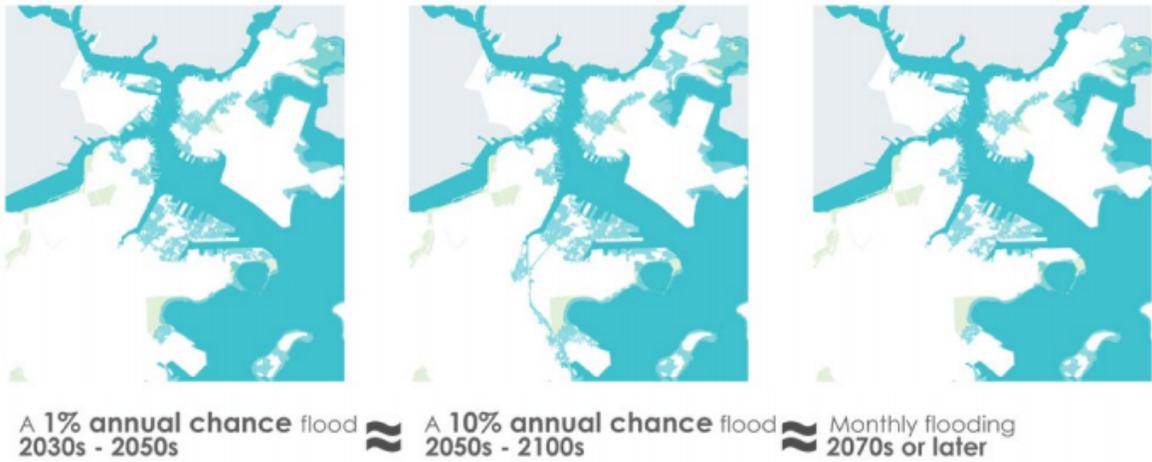


Figure 2: Change in Areas at Risk for Coastal and Riverine Flooding (Climate Ready Boston 2016a, 48)

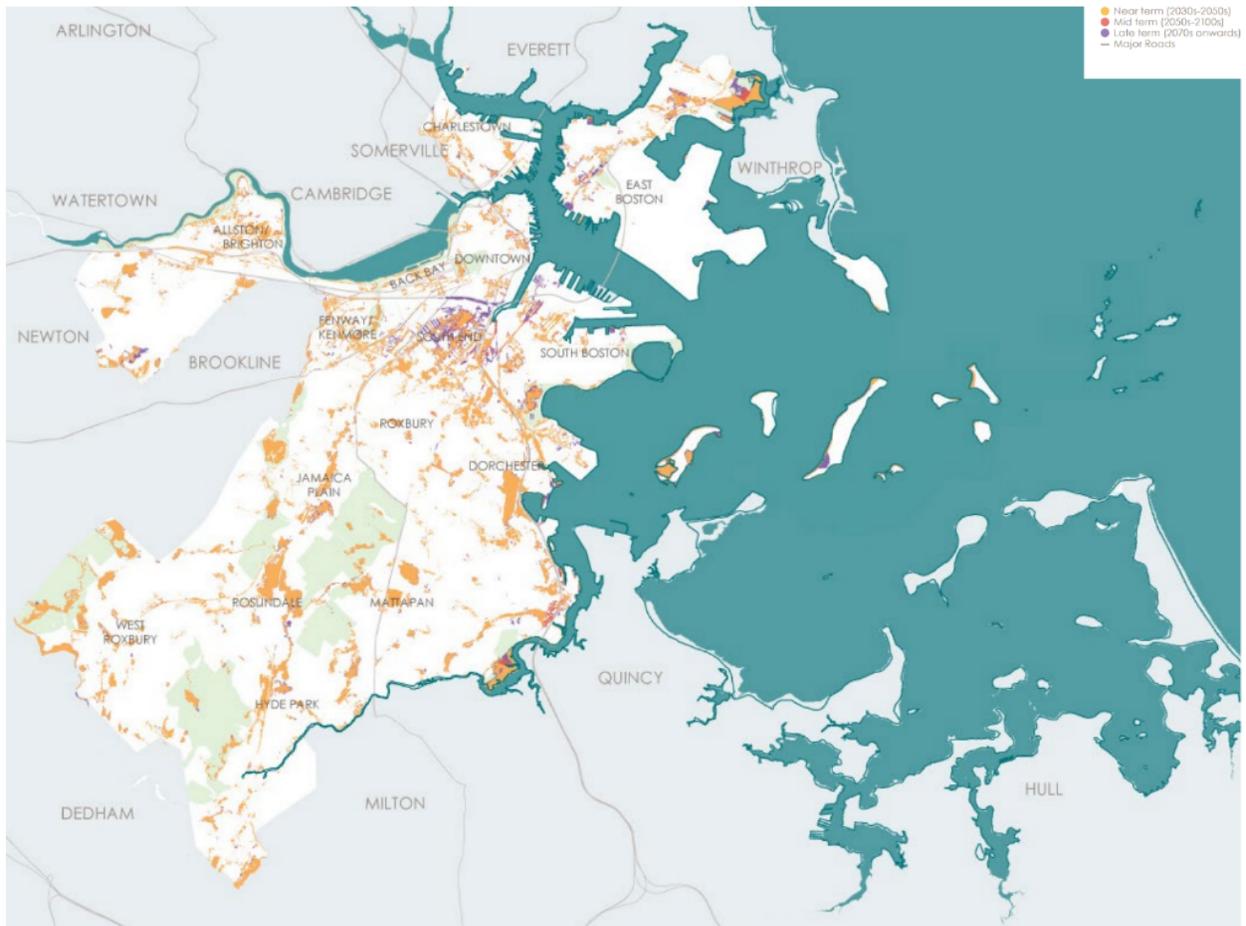


Figure 3: Change in Stormwater Flooding Risk Areas (Climate Ready Boston 2016a, 17)

Coordination for Equitable Adaptation

People throughout Boston will be impacted differently by flooding and other climate hazards. In a city as diverse as Boston, which has a majority-minority population, (Boston Redevelopment Authority 2011, 2) some groups are more vulnerable to these hazards; furthermore, the populations which carry any one of these additional risk factors often carry multiple factors. Resilient Boston emphasizes the need for equitable planning (City of Boston 2017, 124), while Climate Ready Boston analyzes this reality in its Climate Vulnerability Assessment.

Defining Vulnerable Populations

Climate Ready Boston defines social vulnerability as “the disproportionate susceptibility of some social groups to the impacts of hazards, including death, injury, loss, or disruption of livelihood” (Climate Ready Boston 2016a, 31). Figure 4 shows the prevalence of the social vulnerability factors in the population of each neighborhood in Boston. The social categories in Figure 4 were selected by the Climate Ready Boston team because each indicates elevated likelihood that an individual will be especially vulnerable during or after a climate-related disaster event.

Some vulnerabilities make it difficult for people to prepare for a disaster event: those with disabilities may be unable to adequately plan ahead for such an event, while those with low to no income may not be able to afford the long-term spending. Once a disaster does occur, people who are more physically vulnerable to the effects of the disaster include children, older adults, and those with medical illness. For example, people in these three categories are more likely to suffer heat-related illness during a heat wave.

Most of the chosen vulnerabilities indicate barriers to getting help during or after a disaster. Older people and those with medical illness or disability face mobility issues which make it more difficult to relocate to either evacuate or seek emergency relief resources at community distribution centers. In addition, older adults are more likely to be socially isolated, and therefore less likely to receive assistance from a friend or relative. People with low to no income might not be able to afford relocation after suffering flood damage to their homes. People with limited English proficiency are more likely to be unaware of their local emergency plans including evacuation routes and relief resources. In addition, immigrants with limited English proficiency are more likely to avoid seeking government assistance during an emergency for fear of deportation or general mistrust of government.

Finally, people of color are more likely than others to fall into one or more of the vulnerability categories (Climate Ready Boston 2017a, 30). The designation therefore serves as a general indicator of population vulnerability. By incorporating vulnerability, Climate Ready Boston’s flood-related planning works to dismantle systemic racism and “institutionalize racial equity within [Boston’s] programs and policies”, one of the stated visions of Resilient Boston (City of Boston 2017a).

SOCIALLY VULNERABLE GROUPS BY NEIGHBORHOOD

		OLDER ADULTS		CHILDREN		PEOPLE OF COLOR	
COMMUNITY	TOTAL POPULATION	#	%	#	%	#	%
Allston/ Brighton	75,000	6,100	8%	4,600	6%	25,400	34%
Back Bay/ Beacon Hill	22,600	2,800	12%	1,900	8%	3,600	16%
Charlestown	16,400	1,800	11%	3,300	20%	4,000	24%
Dorchester	87,400	8,500	10%	21,000	24%	62,500	72%
Downtown	30,000	4,100	14%	2,000	7%	9,400	31%
East Boston	40,500	4,100	10%	8,700	21%	25,500	63%
Fenway/ Kenmore	44,300	2,100	5%	600	1%	14,400	33%
Harbor Islands	-	-	-	-	-	-	-
Hyde Park	32,300	4,200	13%	7,000	22%	23,200	72%
Jamaica Plain	42,100	4,100	10%	6,300	15%	19,200	46%
Mattapan	33,700	3,900	11%	9,600	29%	32,100	95%
Roslindale	37,700	3,800	10%	7,100	19%	16,700	44%
Roxbury	71,600	5,800	8%	16,700	23%	59,200	83%
South Boston	31,800	3,200	10%	4,900	15%	7,100	22%
South End	38,600	3,300	9%	4,900	13%	16,500	43%
West Roxbury	30,400	5,400	18%	6,100	20%	8,100	27%
Boston Total	634,400	63,200		104,700		327,300	
Percent of Boston	100%	10%		17%		52%	

PEOPLE WITH LIMITED ENGLISH PROFICIENCY ⁴⁷		LOW-TO NO-INCOME		DISABILITY		MEDICAL ILLNESS ⁴⁸	
#	%	#	%	#	%	#	%
9,700	13%	21,000	28%	6,200	8%	29,200	n/a
600	3%	2,600	11%	1,000	5%	9,500	n/a
1,600	10%	4,200	25%	1,500	9%	6,500	n/a
35,100	40%	26,600	30%	12,400	14%	31,800	36%
4,000	13%	6,800	23%	2,600	9%	12,400	n/a
17,400	43%	13,700	34%	5,200	13%	14,800	n/a
3,700	8%	11,200	25%	2,700	6%	16,000	n/a
-	-	-	-	-	-	-	-
4,600	14%	5,700	18%	3,800	12%	12,500	n/a
4,900	12%	14,500	34%	4,200	10%	16,400	n/a
5,800	17%	11,900	35%	6,000	18%	12,500	n/a
5,400	14%	6,800	18%	4,100	11%	12,500	n/a
11,400	16%	27,700	39%	10,400	15%	24,000	n/a
2,600	8%	8,200	26%	3,000	9%	13,500	n/a
5,800	15%	11,600	30%	4,300	11%	12,800	n/a
3,000	10%	3,500	11%	3,000	10%	12,400	n/a
98,200		176,100		70,700		236,900	
15%		28%		11%		37%	

Figure 4: Socially Vulnerable Groups By Neighborhood. (Climate Ready Boston 2016a, 32).

Prioritizing Focus Area Implementation

The Climate Ready Boston team has started devising a unique flood control plan for each neighborhood (referred to as “focus areas”) in Boston. The first two chosen to be developed from goals into action plans were East Boston and Charleston (City of Boston 2017b). Judging from the vulnerability information in Figure 4 alone, it is difficult to identify one or a few “most vulnerable” neighborhoods: should one consider the total number or the portion of vulnerable citizens in each neighborhood? Do some vulnerability indicators demand priority above others?

To begin implementing the coastal and riverine flood control measures recommended by the Climate Ready Boston Report, The Boston Planning and Redevelopment Agency (BPDA) made this choice primarily by considering the climate hazards themselves. East Boston is home to more vulnerable people than Charleston, and neither East Boston nor Charleston is the most socially vulnerable neighborhood in the city. The decisive factor is that both have low-lying areas that will become flood pathways within a few decades due to SLR. If inundated, these new flood pathways would transport water into other areas. Figure 6 shows how future coastal flooding in Charleston could also affect neighboring Cambridge. Likewise, Figure 7 shows how future coastal flooding in East Boston could compromise vital transportation infrastructure including subway lines and Boston Logan International Airport. These potential flood hazards are not only serious because of their extent, but are also likely to occur in the relatively near future: as early as 2030 (Campion 2017).

Protecting and Enhancing Neighborhoods

The Climate Ready East Boston and Climate Ready Charleston focus area plans are still under development, and they focus on district-scale flood protection such as dams and floodwalls. However, planners intend to incorporate green stormwater infrastructure with both flood-protective and social benefits. Examples include increased tree plantings and rain squares. Green urban spaces serve as gathering places, which improve social resilience by enhancing community cohesion; furthermore, research shows that the presence of trees in urban spaces discourages crime (American Planning Association 2003, 3). Rain squares serve as public playground or amphitheater space until a heavy rainfall event, in which they fill with rainwater diverted from streets and buildings (De Urbanisten). Figure 5 illustrates the function of a water square.

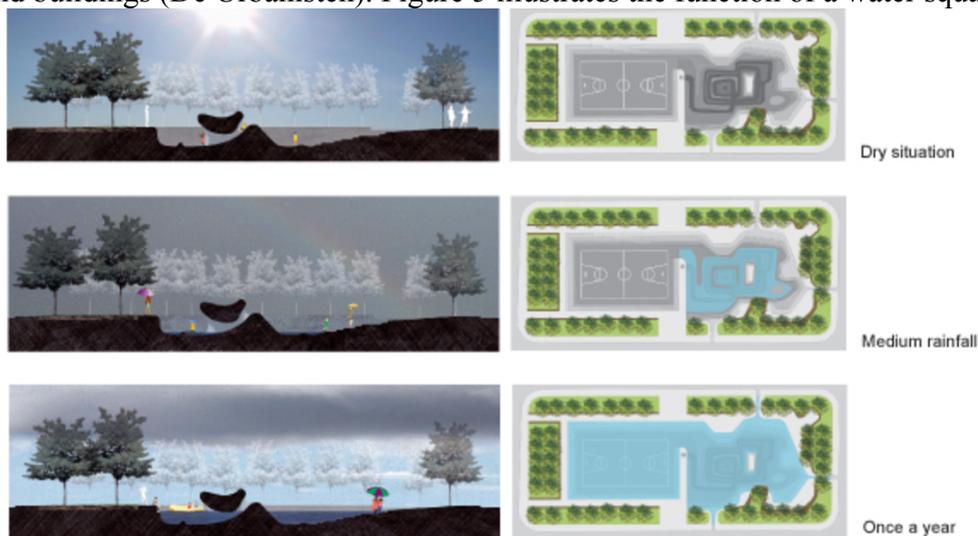


Figure 5: Water Square in Action (De Urbanisten)

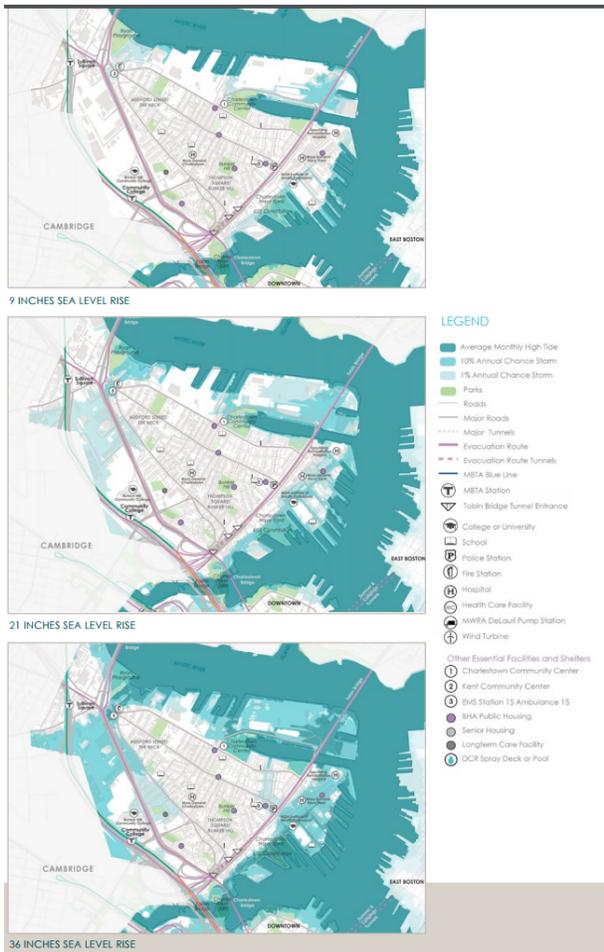


Figure 6: Coastal Flooding in Charleston due to SLR (Climate Ready Boston 2016c, 2)

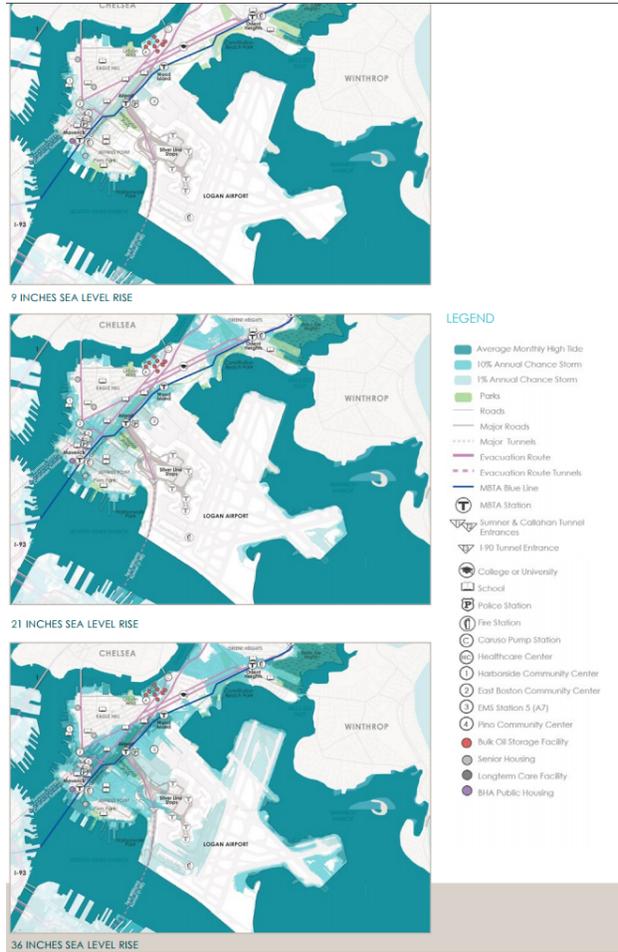


Figure 7: Coastal Flooding in East Boston due to SLR (Climate Ready Boston 2016d, 2)

Conclusion

Climate Ready Boston is an excellent example of the adaptation work that municipal governments around the world have ahead of them. The attention paid to equity throughout and consideration as part of a larger effort to achieve social justice are admirable, but the short-term demands of hazards had to take priority.

Appendix: Laying Policy Foundation Through Community Outreach

In order to gain residents' involvement in adaptation efforts, the city has initiated the Climate Ready Boston Leaders Program. The goal of the program is to spread awareness of climate change risks and to gain community input for the city's adaptation measures. The program trains residents to lead discussions on the city's adaptation process, and even provides financial assistance for residents to hold said conversations (City of Boston 2017c). The discussion materials are publicly available online in six different languages, but to become a designated Climate Ready Boston Leader one must complete a weekend-long training.

Community Conversation Materials: Form and Content

A review of the provided discussion-leading materials reveal an emphasis on the importance of community involvement in municipal adaptation efforts. The Climate Ready Boston Dialogue Support Tool advises that the tone for these conversations "should be one of realistic hope." (City of Boston 2017d, 5). The guide advises leaders to emphasize that the imperative to adapt to climate threats both poses a challenge and offers an opportunity. Finally, the guide reminds users that ongoing climate change mitigation efforts (cutting GHG emissions) are a key part of adaptation.

Community Conversation Materials: Analysis and Evaluation

The Climate Ready Boston Leaders Program allows the city to consistently distribute its message and prime residents for future involvement in adaptation measures via the most valuable communication channels available: residents who already have the trust of their peers. The power of peer influence is well known; furthermore, ethnic groups tend to exhibit different concepts of social responsibility concerning flood risk (Mullins and Soetanto 2013, 122). Residents are presumably more sensitive to these and other nuances within their own communities, and therefore more effective at communicating risks to individuals and inspiring community involvement in future Climate Ready Boston initiatives.

Trust and mutual involvement of all the parties involved in the implementation of climate adaptation policies is required in order to establish a "positive working relationship" leading to the most successful implementation (Scheberle 1997, 18). The educational and outreach materials surveyed contain a well-balanced message of information and warnings about risks, coupled with information about the potential social benefits of adaptation measures. The hope is presumably that informing individuals about the dangers of climate change *and* presenting adaptation as an opportunity will prompt them to become and remain engaged with policy implementation in the future. This balance in messaging avoids overemphasis of the city government's responsibility to protect its citizens from climate risks, which could discourage residents from taking personal measures to reduce risk, (Birkholz et. al 2014, 14) and presumably reduce future community engagement. Figure 4 shows a slide communicating climate risks included in Climate Ready Boston Leaders program materials.

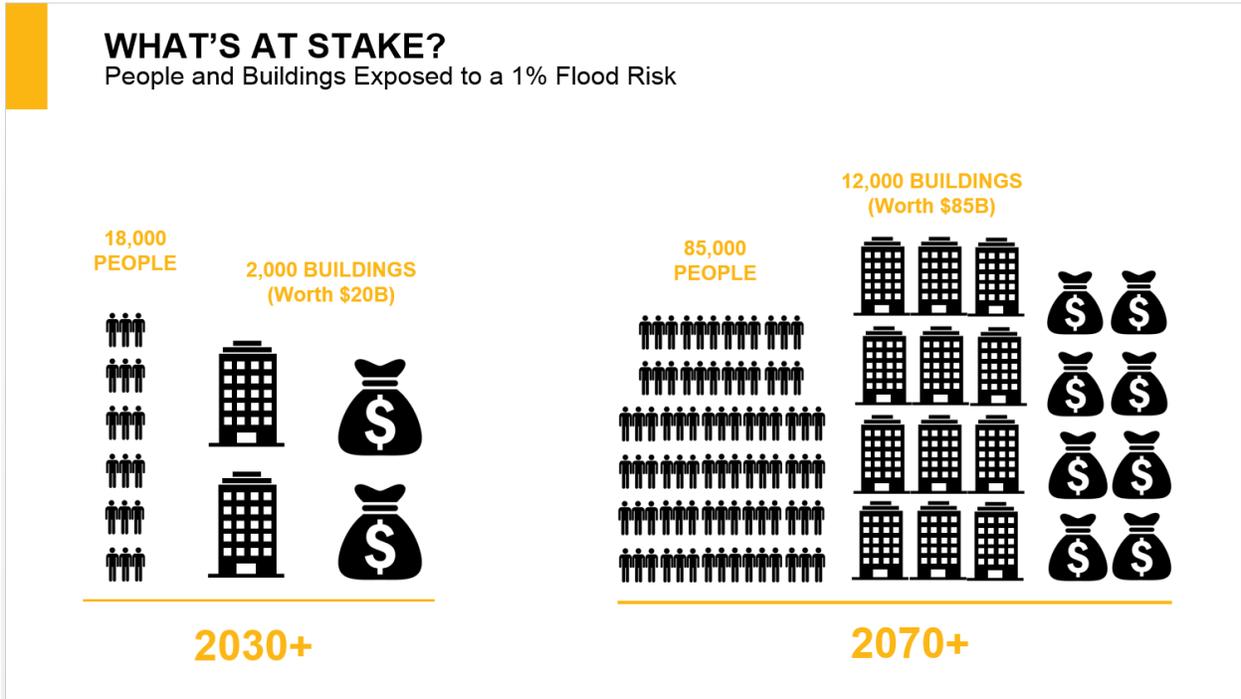


Figure 4: Climate Ready Boston Leaders Slide (City of Boston 2017e)

References

- American Planning Association. "[How cities use parks to... Make Neighborhoods Safer.](#)" City Parks Forum Papers, vol. 4. 2003. Accessed 10 Aug 2017.
- Birkholz, Muro, Jeffrey, and Smith. "Rethinking the Relationship between Flood Risk Perception and Flood Management." *Science of the Total Environment* 478 (2014): 12-20. Web.
- Boston Redevelopment Authority. "[Boston's Population Doubles - Every Day.](#)" *Insight: A Briefing Report on a Topic of Current Interest*. Boston Redevelopment Authority Policy Development & Research Department, Nov 1996. Wayback Machine Internet Archive. Accessed 17 Jul 2017.
- Boston Redevelopment Authority. "[Boston: Measuring Diversity in a Changing City.](#)" Boston Redevelopment Authority Research Division, N.D.
- Campion, Gregory. Personal interview with Chris Busch, BPDA engineer. 20 Jul 2017.
- City of Boston 2017a. "[Resilient Boston: An Equitable and Connected City.](#)" Mayor's Office of Resilience and Racial Equality. Accessed 5 Aug 2017.
- City of Boston 2017b. "[Climate Ready Boston/Current Projects.](#)" Office of Mayor Martin J. Walsh. Accessed 10 Aug 2017.
- City of Boston 2017c. "[Climate Ready Boston Leaders Program.](#)" Boston Environment Department, 2017. Accessed 18 Jul 2017.
- City of Boston 2017d. "[Climate Ready Boston Dialogue Support Tool.](#)" Boston Environment Department, 2017. Accessed 18 Jul 2017.
- City of Boston 2017e. "[Climate Ready Boston Presentation.](#)" Boston Environment Department, 2017. Accessed 18 Jul 2017.
- Climate Ready Boston 2016a. "[Climate Vulnerability Assessment.](#)" Accessed 10 Aug 2017.
- Climate Ready Boston 2016b. "[Climate Ready Boston: Final Report.](#)" Accessed 10 Aug 2017.
- Climate Ready Boston 2016c. "[Climate Ready Charleston.](#)" Accessed 10 Aug 2017.
- Climate Ready Boston 2016d. "[Climate Ready East Boston.](#)" Accessed 10 Aug 2017.
- De Urbanisten. "[Water squares.](#)" N.D. Accessed 10 Aug 2017.

Mullins, Aaron, and Robby Soetanto. "Ethnic Differences in Perceptions of Social Responsibility." *Disaster Prevention and Management*, vol. 22, no. 2, 2013, pp. 119-131, *ABI/INFORM Global; Materials Science & Engineering Database*, <http://proxy.library.nd.edu/login?url=https://search-proquest-com.proxy.library.nd.edu/docview/1355293640?accountid=12874>, doi:<http://dx.doi.org.proxy.library.nd.edu/10.1108/09653561311325271>.

National Oceanic and Atmospheric Administration (NOAA). "[Mean Sea Level Trends for Northwest Atlantic Oceans and Seas Stations](#)." Northwest Atlantic Region 2. Accessed 10 Jul 2017.

Scheberle, Denise. *Trust and the Politics of Implementation: Federalism and Environmental Policy*. Georgetown University Press, 1997.

United States Census Bureau. "[QuickFacts: Boston city, Massachusetts](#)." 1 Jul. 2016. Accessed 17 Jul 2017.

This case study reflects the opinion and sole research of the author, an Urban Ambassador who participated in ND-GAIN's pilot program. Published August 2017.