

Financing Climate Resilience

Mobilizing Resources and Incentives to Protect Boston from Climate Risks



Sustainable Solutions Lab



Barr Foundation



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Introduction: Why We Need Action


The Boston region faces very real risks of substantial damage from storm surge, extreme precipitation, and sea level rise. In 2017, weather-related disasters caused \$306 billion in damages across the US as estimated by National Oceanic and Atmospheric Association (NOAA), 40% more than the previous record set in 2005.¹ If one of the major 2017 hurricanes in the North Atlantic had hit Boston during a high tide, there could have been widespread damage costing tens of billions of dollars.

Indeed, in early 2018, parts of Boston were flooded by two winter storms that produced storm-surge of nearly 3 feet. The storm surge, together with the astronomical high tides resulted in close to a 1% annual chance flood based on historical data. These major storms can disrupt power, transportation, communications, and supply chains, leading to lengthy recovery times and long-term economic impacts for residents and businesses. In fact, FEMA data indicates that about 40% of small businesses never open their doors after a disaster, and another 25% fail within a year.²

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Proactive investments in flood protection at a range of scales are needed to mitigate these economic losses, reduce loss of life, and enhance the resilience of vulnerable communities. These investments range from measures to protect individual homes and commercial buildings to neighborhood or “district-scale” flood mitigation projects to multi-billion dollar schemes for regional coastal flood protection. However, a systematic approach to fund or incentivize pre-disaster resilience at these various scales does not exist.

The City of Boston has recognized the challenges of meeting the goals of continued growth and development, while enhancing the resilience of the region in the face of climate risks. The Climate Ready Boston initiatives defined these risks and set out important strategies to advance climate resilience. This project aims to build on the work that has been done. While not a City of Boston report,³ the authors hope to further the conversation about how the region might prepare for the impacts of climate change. Here we present a strategic and integrated approach to investing in climate resilience, one that combines public and private capital sources,



Without investing in resilience, the power grid is vulnerable to climate change impacts.

appropriate incentives, innovative finance mechanisms, new revenue sources, and a common set of metrics and standards for climate resilience. The report addresses equity and fairness concerns, and focuses on pre-disaster climate resilience investments rather than finance for post-disaster recovery and reconstruction.

Fairness and Equity in Climate Resilience Finance

The type of financing has important implications for fairness and equity. These two goals are often in tension.

Climate change is likely to have disproportionate impacts on vulnerable communities and to exacerbate existing inequalities. The 2017 Resilient Boston report describes the many ways in which climate change intersects with racial and economic inequality.⁴ Low-income communities and communities of color tend to have lower rates of insurance and fewer resources to deal with disasters,

less resilient housing, fewer options for evacuation and relocation, and poorer access to healthcare.⁵ They also tend to be marginalized in decision making processes. Climate adaptation investments could potentially exacerbate these problems, for example, by stimulating redevelopment patterns that increase property prices and catalyze displacement.

Climate adaptation also offers a unique opportunity to channel investments in ways that interrupt persistent inequities and target local economic development, community inclusion, improved housing and infrastructure, and access to employment, transportation and healthcare. Other cities, such as Portland, Oregon, have taken a lead on prioritizing the needs of underserved communities. They are developing governance structures and accountability metrics to ensure community participation and to track progress in linking climate resilience plans to equity.⁶

2 Climate Resilience Finance Needs

There is a broad range of needs for climate resilience funding, for example, according to the type of investment, for projects at different scales, and over a range of time periods.

Climate resilience investments can be categorized in three broad types, according to the purpose of the investment:

1. Reduce Physical Exposure.
2. Reduce Social Vulnerability.
3. Increase capacity for emergency response and disaster recovery.

Reducing physical exposures is the primary focus of this report. The neighborhood studies that the City of Boston is conducting through Climate Ready Boston have not been completed yet, but a rough estimate of the total cost of near to mid-term district-level adapta-

tion measures in Boston is between \$1 and \$2.4 billion. This represents the sum of many smaller projects, each of which would need to secure funding from various sources and through different mechanisms.

TABLE ES1
Scale of Investments

	Individuals	Corporate	Public
Individual Buildings—Residential	\$10–100 thousand		
Buildings/parcel—Commercial*		\$0.1–8 million	
District-level projects		\$40–1500 million (per district)	
Region-level (e.g. Harbor Barrier)			\$7–15 billion

* Including commercial multi-family residential.

Note: These are very rough estimates based on scenarios derived from interviews, draft reports, and comparable projects in other cities.

3 *Climate Resilience Finance Challenges— The Role of Market Failures*

Markets work well when decision-makers—whether private developers, banks and insurance companies, building owners, or public officials—have adequate information and face incentives to make appropriate decisions that serve the long-term interests, not just of private investors, but of society as a whole.

Climate resilience investments, however, are beset by multiple market failures that distort incentives and make it difficult to raise the funding needed for these projects. Addressing these market failures is not a

simple task and requires thoughtful policy measures.

The key sources of market failure for climate resilience financing and investment are:

- Inadequate information on costs and benefits
- Incorrect pricing of risk
- Collective action challenges
- Capital budget constraints
- Misaligned incentives

The full report elaborates on these market failures and discusses how some of these challenges might be addressed.

Key Principles for Climate Resilience Finance

Revenue generation potential: Ability of financing mechanism to generate sufficient incremental revenues that are predictable and sustainable to match the scale, timing and purpose of the specified project (or a share of it).

Economic effectiveness: The mechanism should have a low cost of capital, including associated transaction costs.

Public-private partnerships: Leverage public funding to mobilize private capital and to overcome collective action challenges to spur action at multiple scales.

Administrative effectiveness: The mechanism should be effective considering the capacity of a city or agency, the time and difficulty in securing any required changes to regulatory frameworks and institutions, and its political acceptability to a broad set of stakeholders. Prior experience with similar models or ability to imitate a program elsewhere with a successful track-record will increase administrative effectiveness.

Fairness and equity: Fairness means that the cost burden broadly reflects benefits provided, by geography, risk reduction, etc. Equity means that the cost burden reflects ability to pay, and the resilience projects

do not exacerbate inequalities, for example, by accelerating gentrification. Projects can potentially address equity concerns by providing opportunities for local economic development and workforce training.

Appropriate alignment of incentives: The mechanism should align incentives to help overcome market failures and facilitate flow of capital to projects where the overall benefits exceed the costs, including non-financial aspects, using relevant discount rates. In turn this requires:

- **Leveraging the price of risk**, so that insurance costs, property prices, and interest rates reflect future climate risks, and incentivize appropriate action.
- Using accurate **information and awareness** regarding climate risks and impacts, and the degree of resilience of buildings, infrastructure, and neighborhoods.
- Seeking opportunities to identify, quantify, and monetize **co-benefits**, such as greenhouse gas reductions, public amenities, and reduced risk of business disruption.

4 *Mechanisms for Financing and Incentivizing Resilience Investments*

There is no one way to fund the \$1–\$2.4 billion necessary to protect Boston from climate change impacts.⁷ Different mechanisms are appropriate for different types of projects, scales of funding needed, and type of entity, public or private. The report categorizes and describes mechanisms at three levels:

- Major region- or city-wide projects, such as a harbor barrier
- District-level funding, such as projects proposed for East Boston and South Boston
- Building- or parcel-level projects

Various types of financing mechanisms exist, which are described in more detail in the report. Major examples include:

- Financing instruments, including bonds, loans and forms of collateral
- Resilience fees, for example, based on property taxes, or water and sewer usage
- Pricing risk, for example, risk-based insurance and interest rates

These mechanisms are related. For example, revenues from taxes and fees can be used to support bonds. Hybrid mechanisms, such as catastrophe bonds, can combine financing and risk pricing/risk transfer.

These financial mechanisms have various functions, which can be related to the various mechanisms as represented in Table ES2.

It is important to note that even with innovative and sophisticated financial mechanisms, resilience investments still entail real resource costs and are likely to require new revenue sources.

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TABLE ES2

Functions of Various Types of Financial Mechanisms

Functions of Financial Mechanisms	Type of Financial Mechanism					
	Bonds	Property Taxes	Resilience Fees	Risk-based Insurance	DIF/BID	PACE/PAR
Transfer financial risks	X			X		
Align incentives			X	X	X	
Stimulate private investment			X	X	X	X
Spread payments over time and many parties	X	X	X		X	
Capture value from parties who benefit		X	X		X	X
Capitalize future benefits	X					X
Provide loan collateral						X

DIF = District Improvement Financing. BID = Business Improvement District. PACE = Property Assessed Clean Energy. PAR = Property Assessed Resilience

5 *Key Conclusions and Recommendations*

Key Conclusions

More Accurate Pricing of Risk Is Needed.

Risk needs to be priced more accurately in order to create appropriate incentives to individuals, businesses and municipalities for investments in climate resilience. Pricing risk more accurately will mobilize substantial amounts of private capital for climate resilience.

Stakeholders Need Standardized Metrics.

The development of widely-accepted metrics and standards for climate resilience at multiple scales, from buildings to businesses to cities, can play a key role in facilitating more accurate pricing of risk. Such metrics and standards will also serve as a governance tool that can be incorporated into regulations, loan underwriting standards, or as a private, normative mode of governance.

There is no single simple financial solution for climate resilience. As with climate mitigation, adaptation will require a range of policies and funding mechanisms from federal, state, municipal, and district levels.

There Is No Silver Bullet. There is no single simple financial solution for climate resilience. As with climate mitigation, adaptation will require a range of policies and funding mechanisms from federal, state, municipal, and district levels. These should leverage private capital as well as public sources of revenues, and include a range of funding streams.

Spread the Cost Burden. Spreading the burden over multiple levels and a range of funding mechanisms will make climate



Boston Harbor Now

Flooding at the MBTA Aquarium Station in downtown Boston. March 2018.

resilience investments (a) financially and politically feasible (b) affordable for households and businesses, without raising bills unduly, and (c) ensure that those who benefit more directly (i.e. at the district level) pay more, while those who benefit more indirectly pay less, but still contribute to the climate resilience of the region.

More Value Capture Mechanisms for

Climate Resilience Are Needed. Major projects to protect neighborhoods and the metro region will largely be designed and financed by public agencies, and the costs will exceed the current financial capacity of these agencies. There is a need for “value capture” mechanisms that generate new funding from those who benefit from the investments, primarily property owners and businesses, including private utilities and public agencies who own infrastructure in areas to be protected.

Ensure that New and Upgraded Infrastructure and Buildings Are Resilient. Very large amounts of capital will be spent by state and municipal agencies as well as businesses in coming decades on new and upgraded infrastructure and buildings. In Massachusetts, the MBTA and Massport will be spending substantial sums to upgrade their facilities. These sources of capital dwarf dedicated “climate resilience funds” and should be leveraged, in combination with available federal and state funding sources, to further climate resilience goals.

There Is No Free Lunch. Enhancing climate resilience will require mechanisms to generate new revenues. Climate resilience investments help avoid future losses but do not easily generate substantial cash flows. However creative the financing, investments have a real resource cost, and opportunities for co-benefits are more limited than with, for example, energy efficiency and clean energy.

Refine the Business Case. Making a clear business case is critical to leverage private investment in resilience. Similarly, benefit-cost analysis needs to demonstrate net benefits to justify public investment. The business case for resilience, however, is

not as clear as that for energy efficiency and clean energy. Existing studies indicate that incremental investments in resilient and green new buildings have a solid financial return, but that retrofits on existing buildings need to integrate energy efficiency with resilience to justify investment. Cost-benefit analysis of major infrastructure projects generally points to net benefits (benefit-cost ratios greater than 1) for medium to severe climate scenarios, and with low discount rates, but marginal or negative net benefits for nearer term, more modest climate impacts, and/or higher discount rates. More refined, comprehensive, and standardized metrics and estimation protocols would be valuable.

Solutions Need to Be Equitable and Fair. Climate resilience financing mechanisms need to take account of fairness and equity concerns. Fairness means that payments need to relate to benefits, primarily in terms of risk exposure, protection afforded by the investment, and also contribution to greenhouse emissions that drive the need for adaptation. Equity means that mechanisms need to account for ability to pay. Equity also entails community participation in decision making, and ensuring that climate resilience investments benefit local communities not



Green infrastructure can reduce stormwater runoff and decrease heat island effect.



Creative Commons/Diamond Geezer

Seawalls are an example of a shore-based solution that can provide protection against storm surge as well as safe access to the ocean.

just through flood protection, but also through improved housing and infrastructure, access to employment and healthcare, workforce development and the use of local contractors and labor, thereby recycling money into the local economy.

Finance and Insurance Can Be Creatively Combined. There is an opportunity to encourage the development of markets for low-cost climate resilience finance in combination with low-cost disaster insurance. The climate resilience investments would reduce risks, therefore leading to lower interest rates on the bonds as well as lower insurance premiums. The insurance would also ensure that cities or companies can respond well to future disasters and remain solvent, further reducing the rate on the bonds. An agency at the state or city level could facilitate low-cost parametric insurance that covers multiple agencies and districts on a bundled basis.

Financing Recommendations

This report has six specific recommendations for actions to advance climate resilience financing:⁸

1. Create a Climate Resilience Finance Implementation Working Group for the Boston metro region
2. Use a mix of funding sources to cover the costs of climate resilience investments

3. Establish a state-level Climate Resilience Fund
4. Issue general obligation bonds with new funding streams
5. Establish District Resilience Improvement (DRI) entities to finance district scale projects
6. Expand Mass Save program to incentivize building climate resilience improvements

1. CREATE A CLIMATE RESILIENCE FINANCE IMPLEMENTATION WORKING GROUP FOR THE BOSTON METRO AREA.

The creation of a Climate Resilience Finance Implementation Working Group for the Boston metropolitan (or wider) region would be a valuable step toward implementing climate adaptation measures, designing specific financing mechanisms and disclosure protocols, coordinating with municipal and state officials regarding regulatory changes needed, and facilitating communication with a wider group of stakeholders.

2. USE A MIX OF FUNDING SOURCES TO COVER THE FULL COSTS OF CLIMATE RESILIENCE INVESTMENTS.

The total short to medium-term needs in Boston are estimated at \$1–\$2.4 billion. It is not realistic for the City of Boston to finance 100% of its climate resilience needs

from existing general tax revenues and capital budgets. A mix of funding from different scales of government, as well as private capital, is needed. This report recommends considering a four-way split of funding from federal, state, city and district sources. Private capital will be more directly relevant at parcel level. Table ES3 provides an overview of one possible scenario for this cost sharing arrangement in this scenario:

Federal-level Funding. The federal government has traditionally funded about 50% or more of major infrastructure projects. However, this report assumes that federal support might only be 25–30% going forward, due to political and macroeconomic factors.

State-level Funding. As one scenario, Massachusetts could create a new carbon-based revenue source of \$150 million/year from 2021 to 2030, which would raise \$1.5 billion over that period. This could support a bond of \$2.15 billion (20 years, 3.5% interest rate). Municipalities in the Boston region would expect to secure a significant portion of that funding, in relation to their assets at risk and climate resilience plans.

City-level Funding. As one scenario, a general obligation bond issued by the City of Boston for \$260 million would cost approximately \$18 million a year to service (20 years, 3.5% interest). This would represent about 5.2% of Boston’s total water and sewer bills, or about 0.9% of total property tax revenues for the City.

District-level Funding. The districts requiring major investments would create Business Improvement Districts (BID) or similar vehicles. If the total funds needed for all the districts is about \$200 million, this would require revenues of about \$14 million a year to support a 20-year bond.

3. ESTABLISH A STATE-LEVEL CLIMATE RESILIENCE FUND

This report recommends that the Commonwealth of Massachusetts establish a climate resilience fund to assist municipalities, businesses, and homeowners with necessary investments. The funding would be channeled

The federal government has traditionally funded about 50% or more of major infrastructure projects, but we are assuming this support might only be 25% to 30% going forward, due to political and macroeconomic factors.

through existing programs, such as Mass Save, and new ones to be created for the purpose. Enhancing climate resilience benefits the state as a whole, and improves the security, quality of life, and competitiveness of the region. Projects that enhance the climate resilience of infrastructure of the wider region, such as the airport and transportation tunnels

TABLE ES3

Layered Funding Sources Scenario

Scenario	Proportion of Total	Total \$M for Boston	Annual Revenues to Service \$M	Revenue Source
Total	100%	1,000–2,400		
Federal	25–30%	250–720		Various existing programs
State	25–30%	250–720	17.2–49.8	Carbon or gasoline tax; RGGI
City	20–25%	200–600	13.8–41.5	Bond serviced by water/sewer fee
District	15–20%	150–480	10.3–33.2	Property tax-based, e.g. BID
Parcel/Building	Additional to est. total			Extended Mass Save program

in East Boston, should receive a larger share of revenues to reflect these benefits.

Several sources of funding could generate substantial revenues for resilience while also reducing carbon emissions, the ultimate driver of climate risks:

A State-wide Carbon Tax. Massachusetts could become the first state in the US to create a state-wide carbon tax, and there are currently two legislative initiatives to do so. Both of them would recycle most of the money to taxpayers, but one of them (H1726) would dedicate 20% to a Green Infrastructure Fund, generating about \$200–\$300 million a year to finance transportation, climate resiliency, and clean energy projects.⁹ The tax could be designed to address fairness and equity concerns, depending on how revenues are used or recycled through lower income taxes.

Extending the Community Preservation Act would provide a mechanism to raise additional tax revenues for designated purposes, though using funds for adaptation might require an amendment to the Act to expand its definition of “community preservation.”

The Regional Greenhouse Gas Initiative (RGGI). The RGGI carbon cap-and-trade market has generated \$470 million for Massachusetts from its 2008 inception through 2017. These funds have promoted energy efficiency, renewable energy, and greenhouse gas mitigation programs. California uses some of the revenues from its cap-and-trade program for climate adaptation. The RGGI cap could be tightened and allowance prices could be increased to generate incremental revenues.

The State Gasoline Tax. Massachusetts’ current gas tax is 26.54 cents per gallon,

which generated approximately \$830 million for the state in FY2017.¹⁰ This rate is among the lowest in the Northeast and Mid-Atlantic, and ranked 30th among all US states.¹¹ If Massachusetts increased its tax by five cents to pay for climate resiliency, it would generate over \$156 million per year (though gasoline consumption is gradually declining).

4. ISSUE GENERAL OBLIGATION BONDS WITH NEW FUNDING STREAMS FOR SOME PORTION OF CLIMATE RESILIENCE INVESTMENTS

Once the City of Boston completes the neighborhood climate resilience strategies, funding from municipal bonds would be an effective way to fund some elements of these projects. Municipal bonds could also help fund efforts to coordinate investments for adapting infrastructure to future climate conditions.

The City of Boston could issue general obligation bonds backed by property taxes or a new climate resilience fee based on water and sewer bills. Water and sewer fees are paid by all facilities, unlike property taxes.

The Community Preservation Act (CPA) could provide a mechanism to raise additional tax revenues for designated purposes, though using funds for adaptation might require an amendment to the CPA to expand its definition of “community preservation.”

5. ESTABLISH DISTRICT RESILIENCE IMPROVEMENT ENTITIES TO FINANCE DISTRICT-SCALE PROJECTS

The key districts requiring substantial climate resilience investment will need to create District Resilience Improvement (DRI) entities that levy fees on the properties that benefit most directly from the proposed investments. A separate DRI should be established in each district, such as East Boston, South Boston, and Downtown. Due to the concerns with District Improvement Financing discussed in the report, the authors suggest that Business Improvement Districts or a similar framework be used as a vehicle, perhaps with modifications tailored for this purpose. The charge should be levied in

relation to risk exposure and benefit afforded by the investment. A key function of the DRI would be to coordinate with the City on the master plan for the district and combine funding from multiple sources, including property developers and owners at the parcel level, to finance the plan.

6. EXPAND MASS SAVE TO INCENTIVIZE BUILDING-LEVEL CLIMATE RESILIENCE

One of the key challenges with climate resilience is addressing the current building stock. To provide incentives and finance for climate resilience upgrades for all buildings, the authors propose an extension of the Mass Save program. This program currently relies on a small systems-benefit charge on electricity bills to offer free audits, zero-interest loans and subsidies for energy-efficiency retrofits. This program could be

extended to improve climate resilience and to support smaller commercial buildings. There is a strong business case for integrating energy efficiency and climate resilience into new building design and retrofits.

Looking to the Future

There is a growing realization that the future growth and prosperity of the region demand that sound investments be made to enhance climate resilience and reduce the risk of major disruptions to the economy and dislocation of vulnerable communities. Moving forward will require political will, courageous leadership, and closer collaboration with local communities and businesses. Together we can develop the regulatory and market frameworks needed to address this challenge and ensure the future sustainability and wellbeing of the region.



Flooding of the Harbor Walk in Dorchester, Boston. March 2018.

ENDNOTES

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