No Building is an Island

Introduction

The ground on which the Prince Building now stands was once marshland, an ecosystem rich in diversity and productivity. The marsh was filled first with refuse, and later with rubble and soil in the late 19th century, part of Boston's ever-expanding land mass. The land became an extension of a neighborhood admired for its openness to successive waves of immigrants. The North End's sociability, culture, and architecture were immortalized by Jane Jacobs in *The Death And Life of Great American Cities*, who celebrated the "general street atmosphere of buoyancy, friendliness and good health." However, with looming threats of climate change and sea level rise, the future of the Prince Building and the North End are uncertain. By 2100, daily tides will reach Commercial Street. Boston's filled coastal areas face two distinct possible futures: steeply rising costs and ever-greater exclusivity in pockets with the means to adapt, and decaying or abandoned buildings and infrastructure in areas with fewer resources.

We propose a different future: a coordinated set of public actions at the city and state level – in communication, regulation, financing and design – will help guide and incentivize the resilience of individual properties. Resilience, as defined by the Rockefeller Foundation, is "the capacity of individuals, communities and systems to survive, adapt, and grow in the face of stress and shocks, and even transform when conditions require it." Resilience can be seeded in the Prince Building and others throughout Boston's waterfront, and gradually grow towards neighborhoods that can preserve their social vitality and built history under changing environmental conditions.

Our intervention requires major policy changes occurring progressively over time. Accordingly, those that occur closer to the present are more detailed, while actions further in the future are more speculative and would be subject to revision as climate predictions improve, socioeconomic forces shift, and an uncertain future reveals itself. Our proposal seeks to strengthen Boston's neighborhoods by building upon a solid foundation of equity.

Action 1: Resilience Report Card

A critical first step towards building a more resilient Boston is to acknowledge risk and explain its implications. Fragmented ownership, varying site conditions, and typological variety make building-level risk assessments a complicated task. Modeled off of Boston's Building Energy Reporting and Disclosure Ordinance, we propose a mandatory inspection and Resilience Report Card for every building in Boston's 500-year flood zone.[1] This will educate owners, landlords and tenants of their long-term

[1] We choose the FEMA 500-year flood zone as the regulatory boundary for our actions because FEMA Flood Insurance Rate Maps only take historical flooding into account; given increased precipitation and sea level rise, the current 500-year flood zone is on its way to becoming the actual 100-year flood zone. Although the Resilience Report Card covers non-flood related risks, flooding presents the most dire hazard, and buildings in the flood zone are therefore the primary targets of this policy.

risks, and will also allow public officials to map risk citywide. Publicly accessible data and mandatory disclosures to potential renters and homebuyers will introduce transparency and essentially create a market for resilience. A high resilience score will be awarded with a decorative plaque to proudly display on a building.

Buildings will be scored on three major categories – flood resilience, building resilience post-event, and building resilience in relation to climactic changes. Within each category, points are awarded to buildings that meet or exceed specific criteria. Flood resilience evaluates a building's lowest occupied floor elevation relative to the base flood elevation (BFE); floor area and use below the BFE; and value of mechanical equipment below the BFE. Post-event resilience considers emergency egress, passive systems, and structural integrity following flooding. Climactic building resilience assesses systems for water use reduction, heat reduction, and on-site energy production.

The Report Card is not just evaluative, however – it includes specific advice on actions that can make a building more resilient. General recommendations – wet floodproofing, dry floodproofing, demolition, etc. – are based on the building's foundation material and type, first floor use, and relationship between first occupied floor and BFE. For areas in which a building scores poorly, mitigating actions are listed along with approximate costs and relevant loans and grants for which the building would be eligible. In addition, information is gathered that indicates the building's ability to build additional floors if it qualifies for a future density bonus as a component of vertical retreat, as described below.

Report Cards will catalyze a public conversation that will be encouraged by the City through public art, interactive installations, and community-wide activities. By bringing long-timescale, abstract ecological issues to a tangible level, conversation can be encouraged in an engaging and playful way. Monthly artists-in-residence, in coordination with schools and institutions, will bring the issues to life for Bostonians to engage with and contribute to.

Action 2: Mandatory Insurance and Resilience Retrofits

The next policy action is for Massachusetts to require flood insurance for all buildings in the revised 500-year flood zone, going beyond the National Flood Insurance Program's (NFIP) mandate for buildings in the 100-year zone with federally backed mortgages. This recommendation takes inspiration from the 2006 reforms to the health insurance market in Massachusetts, which required all residents to purchase health insurance. Mandatory flood insurance will be based on predictive mapping that accounts for sea level rise and increased storm activity, unlike FEMA maps that look at historic trends, and will require coverage for the full expected loss from flooding, above the $500,000 NFIP coverage limit. A mandate is necessary to correct for the current duration mismatch: building owners often have ownership time horizons that are shorter than the time horizon in which a hazard is likely to occur[2]. However, when rare events do occur, the public absorbs the cost for repairing the underinsured building, through federal post-disaster funds and long-lasting disruptions for individuals and neighborhoods.

[2] E.g., a building owner who plans to sell in five years would likely not, unless otherwise forced to, mitigate against a one-in-fifty year event.

The mandatory insurance program, building on the work done in the Report Card, will for each building estimate:

- The market value of the building
- The net present value (NPV)[3] of future flood damage to the building, incorporating the most recent probabilistic climate models
- The cost, in present dollars, to mitigate that damage.

For each building, an annual premium will be calculated to cover all expected losses and overhead. Once this rate is assessed, the building owner will have several options[4]:

1. **Resilience Retrofits:** If the cost to physically mitigate the risk – i.e. make capital improvements to the building to reduce the risk profile – is less than the NPV of future damage, then it makes sense to physically mitigate the risk. The state, working with a designated reinsurer, will give a Resilience Loan to the building owner to perform the mitigation. After the retrofit, the insurance premium will be very low, and the premium plus debt service on the loan will be set equal to the insurance premium that the building owner would have paid had she not retrofitted. These payments though, instead of being paid in perpetuity to financially mitigate the risk (i.e. through insurance), will only be paid until they pay off the value of the loan. The low-interest loan will be fully amortizing, allowing it to be fixed rate and fixed payment, and will be collateralized by the building itself. Once the loan is paid off, the owner is left with a resilient building and low flood insurance premium.

2. **Insure:** If the cost to physically mitigate is greater than the NPV of damage, then physical mitigation does not make sense. Instead, the risk will be financially mitigated through the payment of the insurance premium. In the event of a disaster, the insurer or reinsurer will be able to pay to fix the damage to the property.

3. **Waivers:**
   Finally, if the NPV of damage is greater than the value of the entire building – which may occur in the case of older and smaller buildings – then it does not make sense to insure against damage, and the building owner may obtain a flood insurance waiver. Instead, all post-disaster funds for the property, such as FEMA Hazard Mitigation Grants or Community Development Block Grants would go towards rebuilding to current resilient standards, or relocation.

[3] Details for calculating the NPV of potential losses is provided in Exhibit B.
[4] See Exhibit A for sample retrofit and insurance calculations.

Resilience Tax Credits/Surcharge

Just as Mayor Marty Walsh has made social equity the focus of Boston's Resilience agenda, we recognize that insurance mandates can represent an economic hardship for building owners and tenants. Owners who can prove hardship will receive a property tax credit, paid on a sliding scale based on need, to offset their increased insurance or Resilience Loan payments. Landlords with low- or middle-income tenants, or small businesses, can also receive this property tax credit so that they do not need to raise rents. In this sense, the credit functions like a tenant-based section 8 voucher that allows residents to stay in their homes.

The property tax credits can be funded by a small property tax surcharge for all property owners whose property value is above a certain cap. This is fair on both equity and economic grounds. On equity grounds, the burden is being placed on those most able to handle it. On economic grounds, the continued viability of the city of Boston, and the stabilization of waterfront neighborhoods, preserve and raise property values city- and statewide. It thus makes economic sense for wealthier property owners to pay a small surcharge to preserve the investments they have made in their properties.

Action 3: Boston's Recovery Program

Although we hope Boston does not experience its Superstorm Sandy for many decades, hoping is not planning. One of the most important lessons from Sandy has been that cities need to work with communities to design their own recovery plans and tailor them to their own needs and aspirations, beginning a robust public dialogue long before a disaster. Acknowledging this need for citizen engagement, we propose the following policy measures in the event of a major flooding disaster in Boston.

When a major storm does occur, buildings that undertook resilience retrofits should not suffer much damage or require much federal post-disaster relief. However, buildings that fell into categories two and three in the above insurance program, and thus did not retrofit, will experience a great deal of damage and be in need of repair. The City of Boston will change its building code to require that *all* affected buildings – not only those that were substantially damaged – be wet floodproofed to the projected flood level of the last year of the building's projected life span, taking climate change projections into account. In addition, Chapter 91, The Massachusetts Public Waterfront Act, can be expanded to require use conversions of all space at risk of flooding to uses that can withstand flooding. This will of course be expensive, but for buildings that were financially mitigating their risks, this new construction can be largely paid out of funds from their insurance policies.

For any remainder, and to cover those buildings that were in the third category of our insurance program, building owners will have two options. The first is to rebuild to a more resilient level by leveraging the vast amount of federal dollars that will likely come after a disaster[5]. Secondly, the city can offer a density bonus to provide building owners with an amount of capitalized rent equal or greater than the cost of reconstructing their buildings to the new standards, net of any federal dollars or

[5] E.g., regions affected by Superstorm Sandy received $60 billion in federal assistance.

insurance funds received. Additional floor area can be built on-site if conditions allow, or transferred to sites identified through a City-led planning process.[6]

Action 5: A new street life for the North End

Over the course of the next century, our proposal envisions a gradual strengthening of existing buildings against climate change threats, as well as new development built to meet new environmental conditions. However, as street-level flooding becomes a common occurrence, buildings move typical ground floor uses – retail, entrances, and lobbies – up one story in vertical retreat. In concert with building-level adaptation, the city reconfigures public spaces and infrastructure at the present-day second story elevation. The new North End public realm preserves the opportunities for spontaneous interaction that are key to healthy neighborhoods, while embracing a more intimate connection to an aquatic ecosystem. Flooding, vertical retreat, and transformation begin closest to the harbor, but slowly move inland as the sea rises and reclaims land.

Our speculative design for this phase proposes elevated granite sidewalks that encase buildings, protecting their foundations and building systems. Streets are excavated to create ecologically productive marshlands. The high tide depth in 2100 creates an ideal level for situating a saltwater marsh with *Spartina patens* and *Spartina* alternifolia. Dredging a circular channel through the streets promotes saltwater flow through the marsh.[7] Emergency vehicle access is maintained through short bridges spanning from the mainland, or through increased reliance on water-based craft.

The ecological and social benefits of embracing saltwater marshes are substantial. Pollution control is improved as biofiltration of rainwater occurs in roots and soils. Public shore access is enhanced and barriers between people and nature are removed as the existing Harborwalk system is strengthened through connections to a new boardwalk. Creating beautiful environments that connect people to natural rhythms not only improves quality of life, but can also foster greater environmental empathy and action. Tidal marshes connect residents and visitors to the daily rhythm of the tides, the lunar cycle of bi-monthly high tides, and the annual cycles of birds, wildlife, and vegetation. Educational opportunities are created around the estuary's diverse ecology, with opportunities including outdoor classrooms for public schools, research laboratories, and public programs.

The investment in the public infrastructure will be gradual, driven by rising sea levels and public-private coordination. All public infrastructure has a replacement lifecycle; streets are repaved every few

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[6] As another benefit, by mandating that all buildings be built to a new flood proof standard, the administration of the rebuilding effort will be greatly simplified. HUD and City officials often go to great lengths to determine income requirements of recipients, and to ensure that building owners are simply rebuilding what existed before, in order to prevent an unintended windfall for aid recipients. These concerns both go away once we simply mandate a new standard for all rebuilding, thus greatly simplifying and reducing the cost of administering the rebuilding effort.

[7] Precedents for this type of remediation include Crissy Field by Hargreaves Associates in San Francisco and Fresh Kills by James Corner Associates in Staten Island. Crissy Field is an excellent example of what can be achieved by public and non-profit coordination on coastal historic sites, including having tens of thousands of school children carry out the planting of marsh plants. Our proposal takes these precedents a step further, as something far more urban, woven through a neighborhood. Coastal ecologists we spoke to assured us that the North End context (road width and surrounding building height) provided ample space and adequate conditions for a thriving saltwater marsh habitat.

years, while pipes may be in the ground for a half a century or more. Our proposal is to periodically rewrite infrastructure guidelines to match the interventions necessary for climate resilient neighborhoods. For example, street-to-marshland conversions will be timed with the regular street replacement cycle. The marginal cost increases will be significant, though they will likely represent a small fraction of city and state capital transportation maintenance funding. The improvements can thus be financed by the typical mix of sources for infrastructure investments, including the gas tax, municipal bonds, or District Improvement Financing. In this way, building resiliently will be a gradual process that occurs as the city and state replace obsolete infrastructure.[8] This process is made possible by creating, adopting and continually maintaining a long-term plan for the neighborhood.

Conclusion

When disaster strikes, the poor and the most vulnerable tend to suffer the most. The day-to-day stresses of a limited housing stock, aging infrastructure, and disruptive weather also affect us differently depending on our economic and social situations. Public policies like those described above must be enacted to strengthen buildings, neighborhoods, and the city as a whole, while lessening the burden on people who are already struggling. These programs have the potential to improve social and economic resilience by reducing risk and vulnerability across Boston, particularly for homeowners and renters who are less affluent. It should be understood as a coordinated effort with the City's broader economic, social, and land-use policies that promote equality, since improved individual capacity, access to resources, and community cohesion are all important factors that determine outcomes in individual neighborhoods.

While our proposal seeks to preserve the greatest qualities of Boston's neighborhoods, the city's resilient future does not depend on protecting the status quo. The city's history is a source of pride, strength, and character, but Boston's future depends on its ability to adapt and set collective priorities. To adapt, Boston must open opportunities to all its citizens and those citizens yet to come.

[8] While in some cases still connected to the grid, buildings are expected to be significantly or completely energy self-sufficient, through a combination of solar, wind, and tidal power.

Exhibit A

RISK INSURANCE MITIGIATION MODEL EXAMPLES

Discount Rate 5.0% <-- Figures in Blue are Estimates; Figures in Black are Calculated

MITIGATION ACTIONS	*Building Value*	*Mitigation Cost*	*Damage caused*	*% Damage*	*% Prob in a given year*	*Risk Increase per annum*	*NPV of Risk*	*Mitigation*	*Annual Premium*	*Loan Size*	*Building owner keeps premium after year X*
Move Mechanicals	$ 10,000,000	$ 400,000	$ 1,000,000	100%	1.0%	3.0%	$ 194,774	FINANCIAL	$ 9,739	$ -	N/A
Filling the Basement	$ 4,500,000	$ 500,000	$ 2,225,000	100%	2.5%	2.5%	$ 1,065,498	PHYSICAL	$ 53,275	$ 500,000	13
Elevate Building	$ 500,000	$ 200,000	$ 450,000	100%	5.0%	4.5%	$ 547,053	NO ACTION	$ -	$ -	

NPV of Risk Calculations in Next Exhibit

Mitigation is Determined:	If Building Value < NPV of Risk then No Action
	If Building Value > NPV of Risk AND Mitigation Cost > NPV of Risk then Financial Mitigation (e.g., just pay insurance premium)
	If Building Value > NPV of Risk AND Mitigation Cost < NPV of Risk then Perform Physical Mitigation
Annual Premium	= Discount Rate x Loan Size
Loan Size	= Cost of Mitigation in the case of Physical Mitigation
Building Owner Keeps Premium After Year X	= Number of Payments assuming annual payment = premium; loan is the loan size and loan is fully amortizing

Exhibit B

NET PRESENT VALUE OF LOSS CALCULATIONS

	2015	*2016*	*2017*	*2018*	*2019*	*2020*	...	*2045*	*2046*	*2047*	*2048*	*2049*	*2050*	*Terminal Value*
Move Mechanicals	$ 10,000	$ 9,810	$ 9,342	$ 8,898	$ 8,474	$ 8,070	...	$ 2,383	$ 2,270	$ 2,162	$ 2,059	$ 1,961	$ 1,867	$ 16,120
Filling the Basement	$ 55,625	$ 54,565	$ 51,967	$ 49,492	$ 47,136	$ 44,891	...	$ 13,256	$ 12,625	$ 12,024	$ 11,451	$ 10,906	$ 10,387	$ 71,734
Elevate Building	$ 22,500	$ 22,071	$ 21,020	$ 20,019	$ 19,066	$ 18,158	...	$ 5,362	$ 5,107	$ 4,864	$ 4,632	$ 4,411	$ 4,201	$ 145,081

Net Present Value of Loss in a given year =

$$\frac{((\text{Value of Object Destroyed} \times \%\ \text{of Object Destroyed} \times \text{Probability of Damage Occuring in a Given Year}) \times (1 + \text{Risk Increase Per Annum}))}{(1 + \text{Discount Rate})^{(\text{Year}_N - \text{Year}_0)}}$$

*Terminal Value in Year $_0$ *=*

$$\frac{((\text{NPV of Loss in Year}_N) / (\text{Discount Rate} - \text{Risk Increase per Annum}))}{(1 + \text{Discount Rate})^{(\text{Year}_N - \text{Year}_0)}}$$

*Terminal Value is based on a Gordon Perpetuity Growth Formula where 1/X --> 0 over time; brought backward in time to today's dollars