

RESEARCH BRIEF | OCTOBER 2015

Planning for Resilience: The Challenge of Floodproofing Multifamily Housing

Portions of this brief are adapted from the NYU Furman Center's report *The Price of Resilience: Can Multifamily Housing Afford to Adapt?* Retrieved from <http://furmancenter.org/thestoop/entry/the-price-of-resilience-can-multi-family-housing-afford-to-adapt>



1. The Nature of the Problem

As sea levels rise and storms become more frequent and severe due to climate change, many urban areas along the coasts and rivers of the United States are facing a flood-prone future. Especially in the older urban areas along the eastern seaboard, there is a significant stock of multifamily housing that will be increasingly at risk. Much of this housing is out of compliance with federal flood-resistant design and construction standards. Some of these buildings have housing units that are out of compliance because, regardless of their age, they were only recently mapped into the floodplain. And, even buildings that have been in the floodplain for longer may be out of compliance with the rules because their construction predated their jurisdiction's adoption of the standards.

The design and financial challenges of retrofitting multifamily buildings are complex and distinct from the challenges posed by smaller, single-family homes. Retrofits for flood protection can be both impractical and very expensive to implement in a multifamily building. In addition, multifamily rental buildings, especially those that are subsidized or otherwise provide housing to low-income households, may have a hard time raising funds to implement expensive retrofits. However, failure to implement retrofits will leave buildings vulnerable to flooding damage that can result in expensive repairs and displacement of tenants while building systems remain off-line. It may also leave building owners facing growing flood insurance premiums, as the reform of the National Flood Insurance Program (NFIP) requiring the gradual imposition of actuarially sound insurance rates is phased in.

Currently, there are not adequate funding and practical design solutions available to address these challenges, leaving multifamily buildings,

especially those providing housing affordable to low-income households, vulnerable. As state and local governments undertake long-term planning aimed at increasing resilience in flood-vulnerable areas, understanding and addressing these challenges should be a priority. This brief describes the unique challenges of retrofitting multifamily housing, describes existing policies and design approaches and their shortfalls, and provides recommendations for state and local practitioners to improve resilience of multi-family housing in their communities.

2. The Scope of the Problem

The challenge of flood-proofing multifamily housing in the floodplain exists in many jurisdictions across the United States. In an earlier report, we described in depth the housing stock in New York City's floodplains.¹ We found that the vast majority of housing units (over 70 percent) in New York City's floodplains are in multifamily buildings. And over 90 percent of these multifamily buildings were built prior to the adoption of floodplain maps in the city in 1983. And, this is not only an issue for New York City; many other jurisdictions have significant numbers of multifamily housing units in the floodplain. To illustrate this, we have mapped the housing in a selection of metropolitan areas² facing flood risks along the east and gulf coasts in order to describe the multifamily housing stock in each area's floodplains. Maps showing the number of multifamily housing units in the floodplain in each of the eight metro areas we analyzed can be found in Appendix A. The methodology for our data analysis is described in Appendix B.

¹ Findlan, K., Vaghela, V., Weselcouch, M. and Yager, J. (2014). *The Price of Resilience: Can Multifamily Housing Afford to Adapt?* Retrieved from <http://furmancenter.org/thestoop/entry/the-price-of-resilience-can-multi-family-housing-afford-to-adapt>

² Throughout this brief, the geographies we refer to as metropolitan areas are core-based statistical areas.

Table 1: Housing Units in Multifamily (5+ Unit) Buildings in the Floodplain in Selected Metro Areas, 2009-2013

Metro Area	100-Year Floodplain		500-Year Floodplain		Multifamily Units as Share of Total Units in 100/500 Year Floodplains
	Total	Pre-1960	Total	Pre-1960	
Baltimore/Washington D.C.	71,673	19,737	18,954	4,155	33%
Boston	53,426	17,893	12,399	4,415	23%
Houston	15,732	1,170	10,288	666	16%
Miami	282,911	30,874	128,246	7,553	37%
Philadelphia	23,673	6,287	5,402	1,659	16%
Providence	9,920	4,122	1,610	584	14%
Tampa	77,449	3,727	7,415	354	23%
Virginia Beach	15,605	1,727	4,609	695	13%

Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Table 1 estimates the number of multifamily units in the 100-year floodplain³ and 500-year floodplain for each metro area we selected, and the share that multifamily units represent of the total number of housing units in the floodplain. The total number of multifamily units that are in the floodplain varies significantly across these met-ros. Of the jurisdictions we analyzed, Miami has both the largest number of multifamily units in the floodplain (over 400,000), and largest share of units in the floodplain that are in multifamily buildings (37%).

In Table 1 we also show the number of multifamily units at risk of flooding that were constructed before 1960 (before the National Flood Insurance Program was created in 1968), because it is very unlikely that housing of that age is compliant with FEMA design and construction standards. It is certainly the case that many newer units are also out of compliance either because they were built before their jurisdiction had flood maps, they were built before their specific locations were mapped

into the floodplain, or the flood maps changed over time showing them at greater risk than they originally were. Thus, the pre-1960 number provides a conservative order-of-magnitude count (likely a significant undercount) of units likely to be out of compliance. As we discuss in more detail below, out of compliance housing remains at risk for two reasons: physical damage it might suffer from future flooding and the prospect of escalating insurance costs in the coming years.

3. Overview of FEMA Rules and National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP), creates the maps of the nation's floodplains (Flood Insurance Rate Maps), and promulgates regulations defining the federal standard for flood-resistant construction and design. Currently, for most residential properties,

³ The 100-year floodplain is the area at risk for the one percent annual chance flood. The 500-year floodplain is the area at risk for a .2 percent annual chance flood. FEMA. (n.d.) Flood Zones: Definition/Description. Retrieved from <https://www.fema.gov/floodplain-management/flood-zones>



NFIP is the only flood insurance option available.⁴ A property owner may only purchase insurance from the NFIP if their jurisdiction has agreed to participate in the program. To opt in to the NFIP, jurisdictions must adopt the Flood Insurance Rate Map for their area and the floodplain management regulations promulgated by FEMA. For jurisdictions participating in the NFIP, the FEMA regulations set the standard for floodproofing because they are adopted into local building codes.

Any property owner in a participating community can purchase flood insurance through the NFIP, and some owners are required to do so. The owners of properties in the 100-year floodplain are required to buy flood insurance if they have a mortgage that is federally backed or issued by a federally regulated lending institution or if their lender otherwise requires it.⁵ This includes most multifamily mortgages. Owners without a mortgage on their property or located outside of the 100-year floodplain are generally not required to buy flood insurance, but may choose to do so. Additionally, all properties that are in the 100-year floodplain and receive an affordable housing subsidy from the federal government or have received FEMA aid in the past are required to have flood insurance.

⁴ The NFIP does not sell insurance directly to property owners. Rather, property owners purchase flood insurance through a private property or casualty insurance company. The losses are underwritten by the NFIP. There are also some private insurance companies that have begun to offer coverage in limited locations and others that provide supplemental coverage as a second layer of insurance above the NFIP's coverage cap (currently \$500,000 for a multifamily building). Simpson, A.G. (2014). Private Flood Insurance Agency Now Selling in 15 States. *Insurance Journal*. Retrieved from <http://www.insurancejournal.com/news/national/2014/02/10/320017.htm>

⁵ This covers the vast majority of mortgages, including those insured by the Federal Housing Administration or backed by either Fannie Mae or Freddie Mac. FEMA. Mandatory Purchase of Flood Insurance Guidelines. Retrieved from http://hazardmitigation.calema.ca.gov/docs/10040_NFIP.pdf

New buildings within the 100-year floodplain must comply with FEMA regulations in order to obtain reduced insurance premiums.⁶ Currently, buildings built before the area had floodplain maps (and the associated regulations) are grandfathered into the NFIP, meaning they are eligible for lower insurance rates even though their buildings are out of compliance with the FEMA regulations. They are typically grandfathered in under their building codes too. However, recent federal reforms will require that, over time, buildings in the 100-year floodplain begin paying insurance rates that reflect their actual flood risk.⁷

Owners of existing properties in the 100-year floodplain can avoid premium hikes by retrofitting their properties to comply with FEMA flood-resistant construction requirements. FEMA flood maps establish a Base Flood Elevation (BFE) for all properties in the 100-year floodplain, which is the “elevation to which floodwater is expected to rise” during a flood with a one percent chance of happening in any given year. FEMA regulations call for there to be no living space (including basements) or mechanical systems below the BFE in residential buildings. For detached, single-family homes, this is often accomplished by raising the entire house on a foundation above the BFE. However, for most multifamily buildings, this option is impractical. Attached row houses cannot be individually raised, and large, multifamily buildings are difficult, if not impossible, to elevate.

⁶ NFIP flood insurance premiums can also be reduced if an owner's jurisdiction participates in NFIP's Community Rating System (CRS). CRS provides discounts on flood insurance to communities that implement certain community-wide floodplain management strategies. CRS is an important resource for some jurisdictions, but exploring implications of participation or participation requirements is outside the scope of this brief. For more information, visit FEMA's website, <https://www.fema.gov/national-flood-insurance-program-community-rating-system>

⁷ For multifamily buildings, rates can rise up to 25 percent per year until the full-risk rate is reached. The cap on yearly increases is lower (18 percent) for owner-occupied, single-family homes.



Alternatively, a residential building can comply with the regulations by moving all building systems and living space above the BFE, filling in the basement, and wet floodproofing the remaining space below the BFE. Wet floodproofing means that, during a flooding event, water can flow through the building without causing structural damage or affecting residential units or essential systems. Reconfiguring the ground floor or floors in this manner, however, can result in the costly loss of residential units, and can have negative impacts on the streetscape, neighborhood character, public safety, and underlying property values.

FEMA provides commercial and mixed-use buildings (commercial/residential) slightly more flexibility for retrofitting to lower flood insurance premiums. Unlike residential structures, these “non-residential” structures can use dry floodproofing (sealing enclosed areas or components to be watertight) to comply with NFIP regulations.⁸

4. Challenges of Complying

FEMA rules currently provide an all or nothing approach to making residential buildings safer. A residential building must move all units and systems above the BFE. Unfortunately, the major building systems and equipment in many multifamily buildings are currently located below the BFE, indeed often below grade in a basement, and moving them poses a number of challenges.

Design Challenges

Multifamily buildings may have residential units and common space below the BFE, and most often have mechanical systems located on floors below the BFE. Reconfiguring these buildings to move all of these spaces and functions above the

Wet and Dry Floodproofing Defined

Dry Floodproofing: Making a space watertight below the level that needs flood protection to prevent floodwaters from entering. Making the structure watertight requires sealing the walls and utility penetrations below the BFE with waterproof coatings, impermeable membranes, or a supplemental layer of masonry or concrete, incorporating backflow preventers on all plumbing penetrations, and designing the structure to resist hydrostatic forces. FEMA rules permit this strategy in commercial or mixed-use buildings, but not in purely residential buildings.

Wet Floodproofing: Permanent or contingent measures applied to a structure or its contents that prevent or provide resistance to damage from flooding while allowing floodwaters to enter the structure or area and exit as the water recedes. Generally, this includes properly anchoring the structure, using flood-resistant materials below the BFE, protection or relocation of mechanical and utility equipment, and use of openings like vents or break-away walls. This strategy requires positive drainage away from the structure. Application of wet floodproofing as a flood protection technique under FEMA regulations is limited to enclosures below elevated residential and non-residential structures and to accessory and agricultural structures that have been issued variances by the community.

floodwaters can be an expensive and complex renovation. And, where residential units are affected, it can also threaten the income of the building (either rent revenue in the case of a rental building or maintenance payments in the case of a condominium).

⁸ 44 C.F.R. § 60.3(c)(3) (2011).

The movement of building systems, however, poses a particularly challenging engineering and design problem. Moving the systems higher in the building may require sacrificing residential units and significant rent revenue in turn; if the roof is used, it may require expensive reinforcements to carry the weight of boilers and other equipment.

Relocating equipment from a basement to a space in a yard that is above the BFE along with use of the roof, as shown in Figure 1, may help some buildings avoid sacrificing residential units. However, the availability of this option will depend on local zoning codes, and may also present noise, sightline, and maintenance challenges.

For some buildings, dry floodproofing building systems below the BFE, as shown in Figure 2, may be a less disruptive solution to mitigate damage from flooding because it does not require finding new, appropriate space to relocate building equipment. Dry floodproofing in a fully residential building is not permitted under FEMA regulations. Notably, this strategy is permitted in non-residential buildings, which include mixed-use buildings with residential units.

Financial Challenges

In addition to these design challenges, flood retrofits can be expensive and hard to finance. Multifamily buildings, especially those that provide housing to low- and moderate-income households, are likely to struggle to fund these measures. It may be difficult to raise rents enough to cover these costs. And multifamily buildings are likely to be leveraged already, making borrowing additional large sums of debt impossible. Moreover, buildings would only be able to borrow if they can show that they have the cash flow to cover the debt service. These changes are not likely to

Figure 1: Relocation of Building Systems to Roof and Side Yard

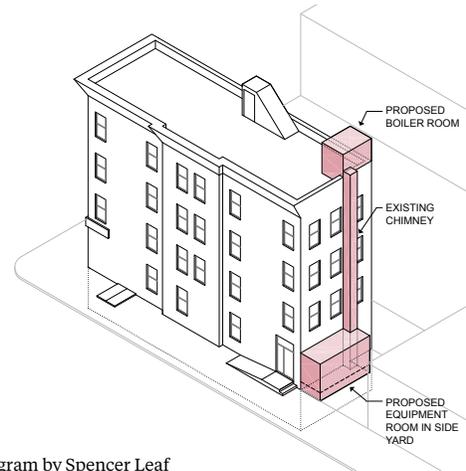
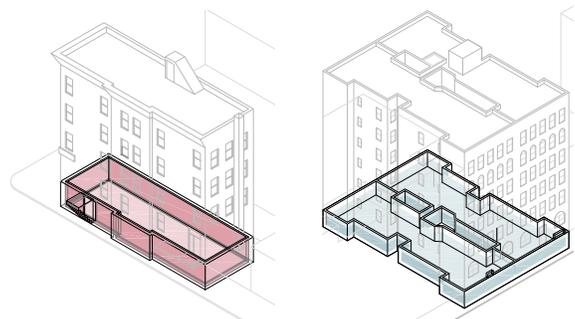


Diagram by Spencer Leaf

Figure 2: Dry Floodproofing the Cellar



a. Five-unit, walk-up building

b. 30-unit, elevator building

Diagrams by Spencer Leaf

result in sufficient operational savings to support loan payments. Even where a retrofit might result in some savings (e.g., energy upgrades), most banks do not yet recognize these savings in their underwriting.

Government-subsidized buildings face additional hurdles because of the rigid regulatory structures that govern them. Owners are bound by rules that limit rent increases, making it impossible in many cases to raise rents to contribute to the costs of



improvements. Owners of subsidized properties can also face challenges as they seek to obtain new financing or remove units at risk of flooding. Properties that receive Low Income Housing Tax Credits (LIHTC) face the greatest challenge related to their subsidy requirements. For a LIHTC building, removing units at risk of flooding or getting additional financing necessary to make resilience improvements can upset the calibration of the project's financial structure. They will likely require investor approval, and new loans or even government grants may trigger recapture of the tax credits by the IRS. Removing units from service can also trigger tax credit recapture. Buildings that receive subsidy through the Project-Based Section 8 program will also have to get approval from the U.S. Department of Housing and Urban Development if they wish to remove at-risk units from the building.

5. Lessons for Resilience Planning and Policymaking

As jurisdictions become more heavily affected by flooding, and as more properties are mapped into the nation's floodplains, there will be more multifamily housing that needs to adapt. In addition to understanding the challenges facing this stock of housing, there are steps that state and local governments can take to help these buildings and build more resilient communities.

a. Align Local Regulations with Resilience Goals

FEMA regulations and flood insurance rates will be a driving factor shaping what retrofits building owners undertake, and there is only so much local governments can do to influence decisions at the federal level. Local governments can, however, make sure that local zoning and building codes provide owners flexibility to implement smart resilience strategies.

Code Changes to Encourage Resilience

Communities participating in the NFIP are required to adopt FEMA design and construction standards. However, some communities have gone beyond federal regulations to require stricter standards or use their local codes to encourage or incentivize resilience measures.

New York City, New York: After Superstorm Sandy, New York City made a number of changes to its zoning resolution to encourage owners of buildings in the 100-year floodplain to undertake resilience retrofits. The city provided more flexibility for relocating mechanical systems to yards or the roof. And, to encourage owners to make the space below the flood elevation compliant with FEMA regulations, the city allowed owners to add space to the top of their buildings equivalent to what they had to give up below the flood elevation.¹

Norfolk, Virginia: In response to the serious flooding that effects the city not only during storms but also during regular high tides, Norfolk has amended its zoning ordinance in a number of ways to make the city more resilient. Like New York, Norfolk implemented a rule that changes how building height is measured, allowing buildings that have to raise their bottom floor to build higher in order to avoid penalizing owners for elevating.²

¹ New York City Department of Planning. (2013). New York City Flood Resilience Text Amendment, §§64-131, 64-322(c), 64-421(b).

² City of Norfolk, Virginia. (2014). Floodplain Ordinance § 2-3.

The challenge of retrofitting residential buildings of all sizes in the floodplain may require more zoning flexibility than current rules allow in some jurisdictions. For example, when owners are forced to raise their buildings, either by physically lifting the building or by functionally raising the lowest floor in multifamily buildings, localities may consider allowing owners to build higher to allow replacement of lost usable space. As an alternative or complementary measure, local governments can relax rules governing use of yards to permit building systems to be safely placed in spaces outside of the building if they cannot remain where they are below the BFE. Through zoning reforms like these, local governments can help reduce the costs associated with implementing floodproofing measures, and can also provide buildings with flexibility to implement the most cost-effective strategies.

Jurisdictions can also be more forward looking than the federal regulations demand, requiring that new and existing buildings that are substantially renovated implement measures that take into account the risk of future sea level rise. Many local building codes simply adopt the FEMA definition of base flood elevation, which is based on current flood risk. However, this definition of the BFE will become outdated as sea levels continue to rise, necessitating that buildings retrofit again in the future. Some jurisdictions, including New York City, Norfolk, and Hoboken, New Jersey, have decided to take into account future risk in their regulations by requiring that buildings elevate slightly higher than what is required by FEMA standards.⁹ This additional requirement is called “freeboard.”

In addition to imposing a freeboard requirement for buildings within the 100-year floodplain,

⁹ New York City Administrative Code, Building Code, § G304.1.1.1 & Table 2.1 (2013); City of Norfolk, Virginia. (2014). Floodplain Ordinance § 11-3.10; City of Hoboken. (2013). Code of the City of Hoboken, Chapter 104, § 104-16(E).

Definition: Freeboard

An additional amount of height above the BFE to factor in safety for the elevation or floodproofing of a structure to compensate for factors such as wave action, usually expressed in feet above a flood level.

Norfolk, Virginia has imposed a requirement that properties in FEMA “X shaded zones,” which are in the 500-year floodplain, have to be flood-proofed 18 inches above grade.¹⁰ This is an innovative effort to build in protection for future flood risk in the 500-year floodplain where BFE measurements and mitigation requirements do not apply (they only apply in the 100-year floodplain).

Notably, the federal government is in the process of implementing an executive order that would create a freeboard requirement for federal government activity in the nation’s floodplains.¹¹

b. Help Owners Understand and Plan to Mitigate Flood Risk

Municipalities should engage in resilience planning that looks at the long-term and plans for the incremental reduction of risk over time. Local property owners should do the same thing. And, where the government engages with property owners, it should be incentivizing, or requiring, this kind of planning. This is particularly important in the case of multifamily buildings, where fully retrofitting a building for long-term climate risk can be complex and expensive. Owners are unlikely to be able to

¹⁰ City of Norfolk, Virginia. (2014). Floodplain Ordinance § 11-3.13.

¹¹ Federal activities include “(1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to, water and related land use resource planning, regulating, and licensing activities.” Fema. Federal Flood Risk Management Standard. Retrieved from http://www.fema.gov/media-library-data/1422649643416-c0ff9e51d11442790ab18bae8dc5df4b/Federal_Flood_Risk_Management_Standard.pdf



make the jump to resilience in one big leap. Instead, most owners will need to plan out reasonable steps that can be taken as part of their long-term capital improvement plan for the building. Local governments, as they work with owners, can support this planning. And, when they provide subsidies to housing providers, they can require it.

Not only should local policy encourage owners to plan, but local policies can also support owners by helping to make available the technical resources and information they need to plan. The work of the city and local groups in New York in the aftermath of Superstorm Sandy provide a range of models for how information and support can be provided to owners. We highlight a few examples below. Notably, these efforts also highlight the important role that non-governmental actors can play in creating and funding the creation of these resources.

Provide Access to Free or Low-Cost Technical Experts: Local governments should think about ways to organize and fund technical assistance for owners to identify risks and opportunities to implement resilience improvements. This could take the form of resilience audits of buildings by architects and engineers or less intensive consultations with technical experts where owners can come and ask questions about their buildings. While sophisticated property owners may have ready access to specialized expertise, free or low-cost professional consultations are valuable to smaller landlords, who often need help in understanding what decisions they face and what options are available to them.

Sandy Neighborhood Design Helpdesk, prattcenter.net/sandy-design-help-desk-supports-resiliency-rockaway, was a collaboration between local non-profit groups and city agencies after Superstorm Sandy that created and staffed a helpdesk where owners could go for advice from architects and insurance and mortgage experts.

Create Guidance for How to Retrofit Common Local Building Types to Minimize Risk: Local governments can also assist property owners by providing guidance about how to retrofit buildings with an eye toward the building and risk typologies specific to their jurisdictions.

Retrofitting Buildings for Flood Risk, www.nyc.gov/retrofitting, is New York City's guide to floodproofing buildings in the city. The manual focuses on the specific buildings types common in New York City and grapples with the specific challenges owners in this jurisdiction face.

Create Easy-to-Use Tools to Educate Owners about Risk and Resources: Local governments should explore ways to disseminate information about risk, retrofit options, emergency preparedness,¹² and other resources widely and by multiple mediums.

FloodHelpNY, floodhelpny.org, is an example of a website created in New York City to provide general information to one- to four-unit property owners about the city's flood zones, flood insurance requirements and how to comply, and local resources and funding sources. It was created by local non-profit groups, led by the Center for New York City Neighborhoods, and funded by Capital One and JPMorgan. Local government agencies were an important partner in the creation of the site, helping to create the content and disseminating information about the site to the public in their outreach efforts.

¹² While the focus of this report is the retrofitting of multifamily buildings, emergency preparedness can be just as important, if not more important, to long-term resilience than changes to a physical structure of a building. Operational preparedness is a critical part of a multifamily building or community's ability to withstand a flooding event. In addition to helping owners make their physical structures safer, local jurisdictions should also put resources into helping building owners, managers, and residents create emergency management plans based on best practices.



c. Help Property Owners Fund Retrofits

Retrofitting multifamily buildings to protect them from flooding can be expensive, and it will be challenging for many building owners to finance these improvements. The cost of not implementing them, however, will be born in part by local governments that will bear the costs that flow from having buildings off-line and large numbers of residents displaced after a flood— which can include temporary housing costs, medical and other social service assistance, and costs to the local economy. Thus, in addition to making it easier to implement resilience measures through local codes and helping owners understand and plan for risk, local governments should also be looking for creative ways to help owners fund resilience measures.

At minimum, local governments should encourage owners to include resilience upgrades in their long-term capital improvement plans for their buildings. As they embark on implementing and financing regular building upgrades and maintenance, resilience retrofits should be on the list of work to complete over time and accounted for in the private financing owners obtain.

Local governments should also look for ways to help fund resilient retrofits directly, at least in buildings where owners would have difficulty funding improvements otherwise. Policymakers can explore the possibility of creating a dedicated resilience/retrofit fund to allow owners who would not otherwise be able to fund improvements access to low cost capital to do resilience upgrades. Jurisdiction could approach community investment groups or local lenders about supporting such a fund. It may also be possible to interest local or national philanthropic organizations in contributing to a fund, especially if it is targeted at improving safety and resilience in housing that serves vulnerable populations. State and local governments should also think about

how to add resources to their existing housing subsidy programs, to the extent that they exist, to increase capacity in light of the enormous need for assistance that flood risk has created.

6. Conclusion

As the nation’s floodplains expand, the number and types of housing units at risk of flooding also grows. Multifamily housing makes up a larger share of the at-risk housing in the floodplain than was previously understood, and mitigating the risk to this housing and its residents presents unique challenges that local governments must be prepared to face. While there is no easy answer to how to fund the often costly and disruptive retrofit measures needed in these buildings, there are steps that local governments can take to make it easier for buildings to adapt, such as educating owners about risks, providing them with information about retrofit strategies, and helping them finance improvements. Including strategies like these in a long-term resilience plan will make communities stronger and will ensure that multifamily buildings and their residents are not left behind as flood-prone areas adapt.

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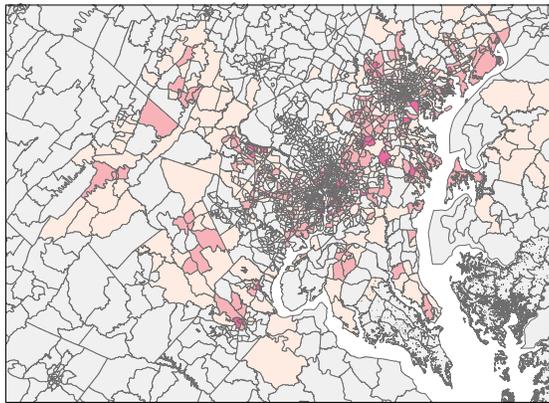
Appendix A

Maps of the Number of Multifamily Housing Units in the Floodplain in Select Metropolitan Areas

Baltimore-Columbia-Towson, MD Metro Area & Washington-Arlington-Alexandria, DC-VA-MD-WV Metro Area

Number of Multifamily Units

< 10 10-100 100-500 500-1,000 > 1,000

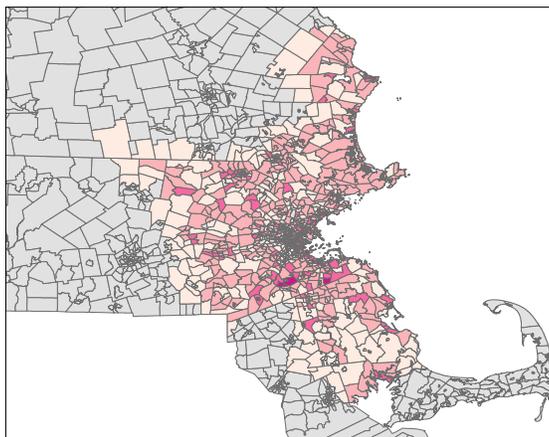


Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Boston-Cambridge-Newton, MA-NH Metro Area

Number of Multifamily Units

< 10 10-100 100-500 500-1,000 > 1,000

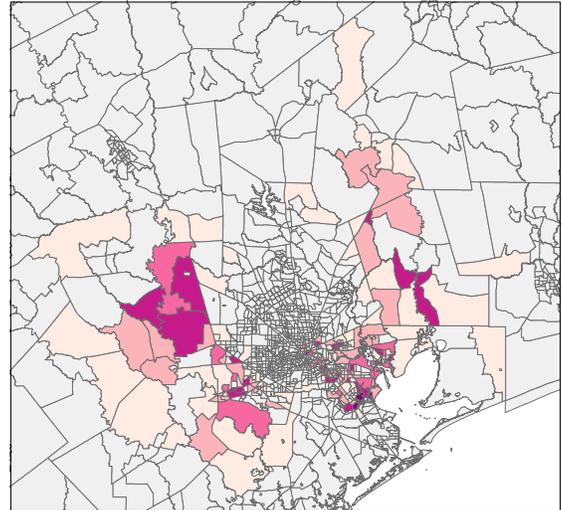


Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Houston-The Woodlands-Sugar Land, TX Metro Area

Number of Multifamily Units

< 10 10-50 50-100 100-500 > 500

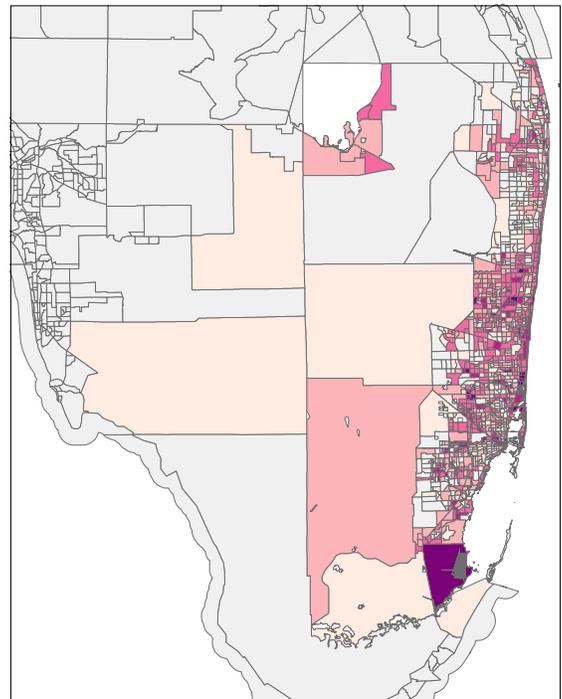


Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Miami-Fort Lauderdale-West Palm Beach, FL Metro Area

Number of Multifamily Units

< 10 10-100 100-500 500-1,000 > 1,000

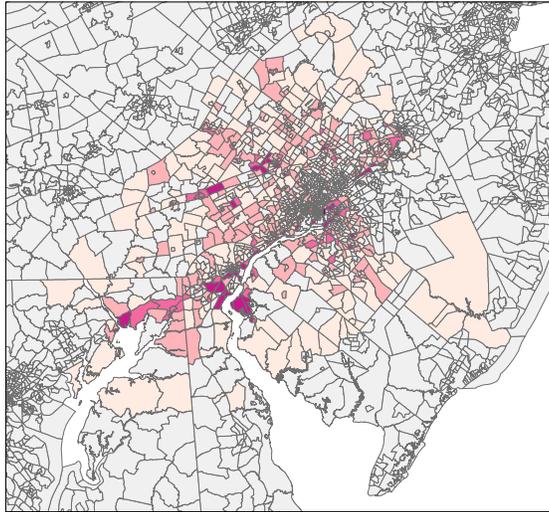


Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Philadelphia-Camden-Wilmington, PA-NJ-DE-MD Metro Area

Number of Multifamily Units

< 10 10-50 50-100 100-500 > 500

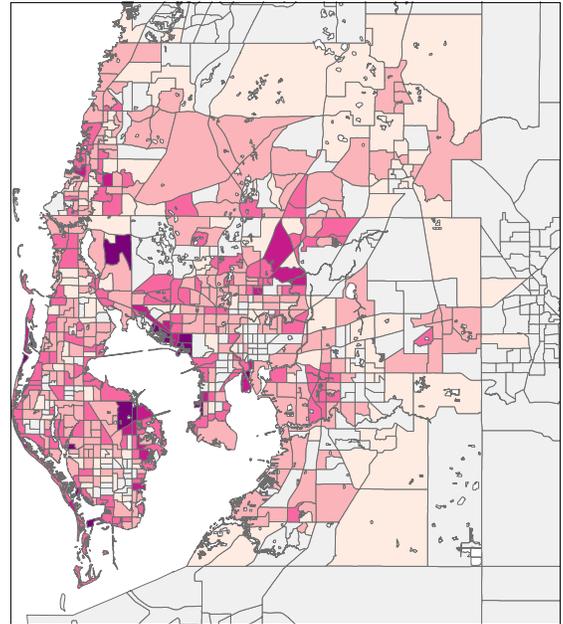


Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Tampa-St. Petersburg-Clearwater, FL Metro Area

Number of Multifamily Units

< 10 10-100 100-500 500-1,000 > 1,000

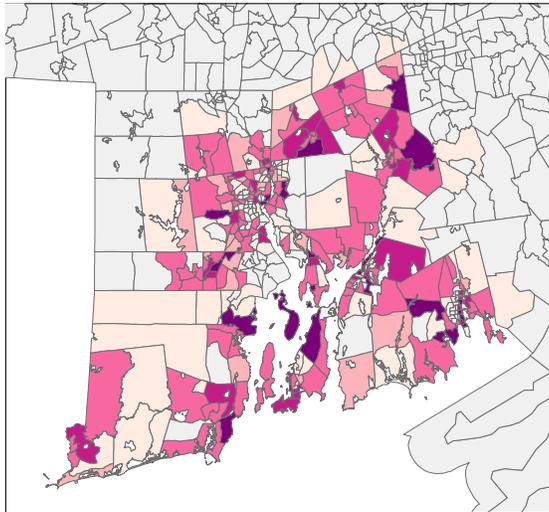


Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Providence-Warwick, RI-MA Metro Area

Number of Multifamily Units

< 5 5-10 10-50 50-100 > 100

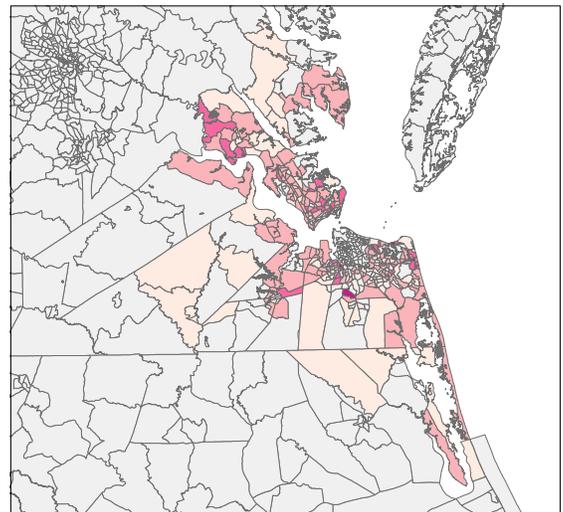


Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center

Virginia Beach-Norfolk-Newport News, VA-NC Metro Area

Number of Multifamily Units

< 10 10-100 100-500 500-1,000 > 1,000



Sources: American Community Survey, Federal Emergency Management Agency, NYU Furman Center



Appendix B

Floodplain Housing Unit Methodology

For Table 1 and in the maps in Appendix A, tabulations of housing units for selected metropolitan areas come from the American Community Survey's five-year estimates for 2009-2013 obtained from the National Historical Geographic Information System. We define multifamily housing as any renter- or owner-occupied units in a building with five or more units.

We use geographic information systems techniques to analyze the number of housing units within floodplains defined by the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRMs). We overlaid Census tracts with FIRMs delineating 100- and 500-year floodplains. Because floodplains might partially cover tracts or multiple floodplains might cover a tract, we assign each tract's multifamily housing units to floodplains according to the proportion of the tract's land that each floodplain covers. For example, if only the 500-year floodplain covers half a tract's area, we consider half the tract's housing units to be within that floodplain and the other half not to be in a floodplain.

All the metropolitan areas we studied have effective FIRMs. In some areas, FEMA has defined preliminary FIRMs, which are more up-to-date and may supersede current effective FIRMs. Where this occurs, our analysis uses the more recent preliminary FIRMs.