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MANAGING “RETREAT”: THE CHALLENGES OF ADAPTING LAND USE TO CLIMATE CHANGE

*Andrea McArdle**

I. INTRODUCTION

Coastal cities of all sizes and levels of development face mounting governance challenges¹ in response to climate science’s projections² of continued ocean warming and sea-level rise.³ These challenges implicate a burgeoning set of responsibilities for protecting public health and safety, including food security, environmental quality, biodiversity, effective stewardship over the integrity of the built environment and infrastructure, and maintaining local economic well-being. Addressing these

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1. At the 2015 Sendai Framework for Disaster Risk Reduction, UN Member States recognized the role of local governments as stakeholders for participating in strategies to reduce the risk of natural and human-made disaster. *Sendai Framework for Disaster Risk Reduction 2015–2030*, U.N. OFF. FOR DISASTER RISK REDUCTION (2015), <http://www.unisdr.org/we/inform/publications/43291>.

2. The Intergovernmental Panel on Climate Change’s 2014 Synthesis Report, based on the reports of the Panel’s three Working Groups, including relevant Special Reports, as the final part of the Panel’s Fifth Assessment Report, underscores the risks in its Summary for Policymakers.

SPM 2.3 Future risks and impacts caused by a changing climate:

Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014 SYNTHESIS REPORT 13 (The Core Writing Team, Rajendra K. Pachauri & Leo Meyer eds., 2014), http://ar5-syr.ipcc.ch/ipcc/resources/pdf/IPCC_SynthesisReport.pdf [hereinafter SPM 2.3].

3. In one of the more urgent predictions concerning sea-level rise, the melting of ice on Antarctica alone could cause seas to rise more than 15 meters (49 feet) by 2500 if ongoing levels of greenhouse gas emissions persist. Brady Dennis & Chris Mooney, *Scientists Nearly Double Sea Level Rise Projections for 2100, Because of Antarctica*, WASH. POST (Mar. 30, 2016), https://www.washingtonpost.com/news/energy-environment/wp/2016/03/30/antarctic-loss-could-double-expected-sea-level-rise-by-2100-scientists-say/?utm_term=.044481386d88 (discussing Robert M. DeConto & David Pollard, *Contribution of Antarctica to Past and Future Sea-Level Rise*, 531 NATURE INT’L. J. OF SCI. 591 (2016)).

responsibilities, in turn, implicates cities' legal authority, political capacity—including the capacity and will to build acceptance of local governance responses—and ability to leverage funding for weather disaster reduction. This article adopts as a working definition of climate governance the range of policy-setting mechanisms by which cities engage these challenges and responsibilities, including legislation, executive action, participating in litigation, and involvement in multisectoral and transnational networks.

In the face of elevated urban climate risks, the concept of resilience has gained considerable ground as both a governance response and an increasingly pervasive discourse. With its definitional and conceptual breadth, resilience offers cities a range of tools for adapting to climate-related risks. To date, most cities have emphasized coastal and building-and-infrastructure resilience as climate governance strategies. They have not embraced land-use alternatives, collectively referred to as “managed retreat,” that discourage, limit, or seek to reverse development of areas that are vulnerable to coastal inundation, and that opt for natural reuses of land, based on the costs and risks associated with rebuilding. Given the projections of increased and new risks posed by climate change,⁴ this article considers the role that managed retreat might have in climate governance policies.

Recognizing the potentially substantial costs and practical barriers to implementing many aspects of managed retreat, especially in densely populated urban floodplains, the article argues that retreat options nonetheless should be included in the calculus of adaptive strategies that coastal cities consider. Public health, safety, environmental, equity, and economic concerns make retreat a highly salient consideration for any locality's climate governance policy. The extent to which it is feasible for a locality to apply managed retreat strategies, even in part, as a component of climate resilience will depend on the local context, economy, population, built environment, and infrastructure, including the extent to which retreat would entail, on the one hand, curtailing development on currently undeveloped, vulnerable areas or, on the other, condemning or buying out presently occupied properties.

To develop this analysis, Part II identifies key attributes of the discourse and practice of climate resilience, noting three central modalities of resilient climate governance: coastal resilience, resilient rebuilding, and managed retreat. Part III considers the approaches taken to climate governance by three coastal cities with recognized vulnerability to coastal inundation as suggestive of a general preference for coastal and structural-and-infrastructure-resilience strategies over managed retreat.

4. SPM 2.3, *supra* note 2.

Part IV addresses cities' contrastingly infrequent resort to managed retreat and considers in greater depth the implications of using managed retreat as a climate governance response. This section examines data detailing characteristics of housing and the demographic make-up of residents of the U.S. coastal areas that would be directly affected by implementing a retreat policy. Further, it considers factors that complicate the adoption of retreat as a strategy, including an ideology of urban growth and economic, logistical, and other practical obstacles to pursuing retreat as a form of climate governance.

Drawing on the analysis in Part IV, Part V considers New York's limited application of retreat principles following the effects of Superstorm Sandy, a destructive and costly tropical cyclone that struck the northeastern U.S. in 2012.⁵ Examining New York's experience in light of the factors that favor rebuilding and militate against an easy embrace of managed retreat, this section raises concern about the city's ongoing up-zoning and planned development in floodplain areas. The article concludes with an inventory of considerations relevant to potential use of managed retreat by localities at any scale as part of the calculus for developing sound, responsible, and environmentally equitable climate governance responses.

II. CLIMATE GOVERNANCE: MODALITIES OF CLIMATE RESILIENCE

A. Resilience as a Governance Discourse

The definitional and conceptual breadth of resilience has enabled it to operate across disciplines and discursive traditions as a "boundary object"⁶ and "pervasive idiom."⁷ It appears in the literature of a range of disciplines, including engineering, psychology, ecology, social systems, and disaster recovery.⁸ In an urban planning context, ideas associated with resilience have contributed to a comprehensive definition focusing on urban resilience as a methodology:

5. The National Hurricane Center of the National Oceanic and Atmospheric Administration ranks Sandy as the fourth costliest mainland U.S. tropical cyclone. *Costliest U.S. Tropical Cyclones Tables Updated*, NAT'L HURRICANE CTR. (Jan. 26, 2018), <https://www.nhc.noaa.gov/news/UpdatedCostliest.pdf>.

6. Sara Meerow, Joshua P. Newell & Melissa Stults, *Defining Urban Resilience: A Review*, 147 *LANDSCAPE & URB. PLAN.* 38, at 39, 46; Kathleen Tierney, *Resilience and the Neoliberal Project: Discourses, Critiques, Practices—And Katrina*, 59 *AM. BEHAV. SCI.* 1, at 5–6 (2015), <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1024.3276&rep=rep1&type=pdf>.

7. Tierney, *supra* note 6, at 5.

8. Patrick Martin-Breen & J. Marty Anderies, *Resilience: A Literature Review*, BELLAGIO INITIATIVE (2011), <https://opendocs.ids.ac.uk/opendocs/handle/123456789/3692>.

[T]he ability of an urban system—and all of its constituent socio-ecological and socio-technical networks across temporal and spatial scales—to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity.⁹

In the broader disaster-response literature, resilience has also been conceptualized as a process, in the sense of learning and improving decision-making to better respond to risks.¹⁰

The conceptual underpinnings of resilience have been central to the policy and technocratic discussions in the burgeoning field of climate governance. In the climate context, the Rockefeller Foundation has supported a range of initiatives to increase the capacity of localities to adapt to coastal risks.¹¹ Reflecting that orientation toward efficacious response to climate disturbance, the Foundation defines resilience as the “capacity of an individual, community, or institution to dynamically and effectively respond to shifting climate impact circumstances while continuing to function at an acceptable level.”¹²

Attributes associated with resilient city governance include systems that are reflective, robust, redundant, flexible, resourceful, inclusive, and integrated.¹³ Although, as a managerial practice, resilience can operate non-ideologically, the breadth and flexibility of resilience as a concept also have rhetorical and political dimensions. The orientation of resilience toward positive functioning and outcomes has led to a tendency in climate governance discourse to lapse into colloquial and political usage of the term

9. Meerow et al., *supra* note 6, at 45.

10. Susan Cutter et al., *A Place-based Model for Understanding Community Resilience to Natural Disasters*, 18 GLOBAL ENVTL. CHANGE 598, 600 (2008).

11. *See, e.g.*, 100 RESILIENT CITIES, <http://www.100resilientcities.org/about-us/> (last visited Aug. 31, 2018) (providing financial, logistical, and expert support for a network of selected cities to pursue resilience strategies that will address “not just the shocks—earthquakes, fires, floods, etc.—but also the stresses that weaken the fabric of a city on a day to day or cyclical basis”); *Asian Cities Climate Change Resilience Network*, ROCKEFELLER FOUNDATION, <https://www.rockefellerfoundation.org/our-work/initiatives/asian-cities-climate-change-resilience-network/> (last visited Aug. 31, 2018) (capacity building to assist cities in six Asian countries develop climate resilience strategies).

12. ROCKEFELLER FOUND., *Building Climate Change Resilience* 1 (Aug. 4, 2009), https://www.acccrn.net/sites/default/files/publication/attach/10_RF_WhitePaper_Resilience.pdf.

13. Brett Branco & John R. Waldman, *Resilience Practice in Urban Watersheds*, in PROSPECTS FOR RESILIENCE: INSIGHTS FROM NEW YORK CITY’S JAMAICA BAY 21, 28 (Eric W. Sanderson et al., eds., 2016) (discussing urban resilience formulation developed by ARUP, an independent group of designers, planners, and engineers, “working across every aspect of today’s built environment”).

and to conflate it with more precise disciplinary meanings,¹⁴ a practice evident in New York City's use of resilience as a signifier for "toughness."¹⁵ Some commentators have noted that resilience narratives can fit comfortably within neoliberal political and economic arrangements, emphasizing growth and privatization or public-private partnerships.¹⁶ In this view, resilience as a governance strategy contemplates a strong role for the private development sector in post-disaster campaigns.¹⁷

B. Strategies of Climate Resilience

In the context of urban climate governance, the principal resilient strategies comprise coastal protection, including hard¹⁸ and soft¹⁹ armoring; rebuilding structures to revised standards thought to withstand predicted effects of climate change; and managed retreat, that is, various land-use controls and legal mechanisms that limit or adapt development of coastal land in light of its vulnerability to sea-level rise and storm surges.²⁰ Retreat options encompass a range of land-use adaptations, including limits on rebuilding, acquiring coastal land to prevent further development, resettling residential populations further inland away from flood-prone areas,

14. Fiona Miller et al., *Resilience and Vulnerability: Complementary or Conflicting Concepts?*, 15 *ECOLOGY & SOC'Y* 3 (2010), <http://www.ecologyandsociety.org/vol15/iss3/art11/>.

15. PLANYC, A STRONGER, MORE RESILIENT NEW YORK 6 (2013), http://s-media.nyc.gov/agencies/sirr/SIRR_singles_Lo_res.pdf [hereinafter A Stronger, More Resilient New York].

16. Tierney, *supra* note 6, at 6–9.

17. *Id.* at 11–13.

18. Hard armoring generally is the use of physical structures such as seawalls, breakwaters, and riprap to hold back the flow of sea water and prevent erosion of shoreline sediment. *What is shoreline armoring?* NAT'L OCEAN SERV., <https://oceanservice.noaa.gov/facts/shoreline-armoring.html> (last visited Oct. 13, 2018). *See also* Megan M. Herzog & Sean B. Hecht, *Combatting Sea-Level Rise in Southern California: How Local Governments Can Seize Adaptation Opportunities While Minimizing Legal Risk*, 19 *HASTINGS W.-N.W. J. ENVTL. L. & POL'Y* 463, 492–97 (2013) (discussing methods of hard and soft shoreline armoring).

19. Soft armoring refers to nature-based buffering against flooding, such as restoring coastal wetlands or creating living shorelines. Executive Summary of *Soft Armoring and the Corps: The Impact of Army Corps of Engineers Permitting On State Coastal Protection Policies*, GEORGETOWN CLIMATE CTR. (Dec. 2011), https://www.law.georgetown.edu/wp-content/uploads/2017/07/GCC_ACOEpermittingES_12-11_Finalv2.pdf. Living shorelines are stabilization methods that establish or preserve species habitats and ecosystem benefits. *Living Shorelines*, VA. INST. MARINE SCI., CTR. FOR COASTAL RESOURCES MGMT., http://www.vims.edu/ccrm/outreach/living_shorelines/index.php (last visited Oct 13, 2018).

20. *See generally* ANNE SIDERS, *MANAGED COASTAL RETREAT: A LEGAL HANDBOOK ON SHIFTING DEVELOPMENT AWAY FROM VULNERABLE AREAS*, COLUM. LAW SCH. CTR. FOR CLIMATE CHANGE (Oct. 2013), https://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Publications/Fellows/ManagedCoastalRetreat_FINAL_Oct%2030.pdf.

discontinuing at-risk business and institutional uses, and developing nature-based reuses of coastal land, such as wetlands restoration and cultivating parkland, that can serve as natural buffers to the effects of storm surges.²¹

This suite of resilience strategies varies along a number of axes, such as whether they entail rebuilding or restrictions on development, whether they employ nature-based or human-made shoreline protections, and whether limitations on development apply prospectively or restrict continued use or redevelopment of currently occupied properties, which includes the possibility of relocating residents or businesses. Coastal cities choose climate governance approaches that reflect local geography, political economy, ideology, and political will, and thus the potential for variation is considerable, even among localities that are the most vulnerable to coastal inundation. Part III considers the approaches taken to climate governance by three coastal cities as suggestive of a general preference for structural- and infrastructural-resilience strategies within an overall orientation toward redeveloping and protecting the waterfront.

III. CLIMATE RESILIENCE STRATEGIES APPLIED: THREE FLOOD-VULNERABLE CITIES

The climate governance choices of flood-vulnerable cities necessarily will reflect local context, history, geography, ecology, economy, and cultural orientation toward risk, against the backdrop of requirements or guidelines included in state coastal development programs under the auspices of the federal Coastal Zone Management Act.²² Nonetheless, the adaptive approaches taken by the three illustrative cities discussed in this section—New Orleans, New York, and Rotterdam in the Netherlands—suggest shared preferences for hard armored protections of the waterfront and rebuilding waterfront structures over managed retreat options.

A. New Orleans: Rebuilding and Protecting Against Coastal Inundation

In August 2005, the ravages of Hurricane Katrina, ranked by the National Hurricane Center as the costliest tropical storm at \$125 billion in damages,²³ breached levees that inundated large portions of New Orleans' low-lying land and led to the evacuation of more than one-half of the city's

21. *Id.*

22. Coastal Zone Management Act of 1972, 16 U.S.C. § 1451 et seq.; Act of Oct. 27, 1972, 86 Stat. 1280 (codified as amended at 16 U.S.C. § 1451 et seq.) (1972); *See generally* SIDERS, *supra* note 20, at 21–35.

23. Hurricane Katrina is statistically tied with Hurricane Harvey as the costliest tropical storm in terms of total monetary damage. NAT'L HURRICANE CTR., *supra* note 5.

residents.²⁴ In the storm's aftermath, a policy storm raged within the city regarding whether the most vulnerable parts of the city should be rebuilt at all.²⁵ The ambivalent acceptance of the idea that New Orleans residents had the "right to return" to New Orleans²⁶ resolved the policy debate in favor of rebuilding and fortifying the city to withstand at least a 100-year storm.²⁷ As a consequence, the city's post-Katrina expenditures, mainly provided by federal or state funds, were dedicated to housing programs—with their own checkered history²⁸—and the construction of an elaborate system of levees, walls, and pumps.²⁹

Federally financed through Community Development Block Grant-Disaster Recovery funds and administered by state government, the Louisiana Road Home program distributed \$9 billion in grants to support rebuilding more than 70% of housing units damaged by Hurricane Katrina.³⁰ Using three tiers of cash grants as incentives, the program promoted rebuilding in heavily inundated neighborhoods.³¹

24. Allison Plyer, *Facts for Features: Katrina Impact*, DATA CTR. (Aug. 26, 2016), <https://www.datacenterresearch.org/data-resources/katrina/facts-for-impact/>.

25. See, e.g., Darryl Lorenzo Wellington, *New Orleans: A Right to Return?* 53 DISSENT 23, 32–34; Ray Taras, *After the Storm: Pathologies of Decision Making in New Orleans*, POL'Y OPTIONS (Dec. 1, 2005), <http://policyoptions.irpp.org/magazines/global-warming-a-perfect-storm/after-the-storm-pathologies-of-decision-making-in-new-orleans/>.

26. See, e.g., Lolita B. Inniss, *A Domestic Right of Return?: Race, Rights, and Residency in New Orleans in the Aftermath of Hurricane Katrina*, 27 B.C. THIRD WORLD L. J. 325 (2007), <http://lawdigitalcommons.bc.edu/twlj/vol27/iss2/2> (noting the financial, logistical, and programmatic impediments placed in the way of black New Orleans residents' return to their homes after Katrina).

27. See Amy Liu, BUILDING A BETTER NEW ORLEANS: A REVIEW OF AND PLAN FOR PROGRESS ONE YEAR AFTER HURRICANE KATRINA, BROOKINGS INST. (2006), https://www.brookings.edu/wp-content/uploads/2016/06/200608_katrinareview.pdf.

28. Kevin Fox Gotham, *Reinforcing Inequalities: The Impact of the CDBG Program on Post-Katrina Rebuilding*, 24:1 HOUSING POL'Y DEBATE 192, 199–205 (2014), <http://dx.doi.org/10.1080/10511482.2013.840666>.

29. John Schwartz, *How to Save a Sinking Coast? Katrina Created a Laboratory*, N.Y. TIMES (Aug. 7, 2015), <https://www.nytimes.com/2015/08/08/science/louisiana-10-years-after-hurricane-katrina.html>.

30. JESSE GREGORY, THE IMPACT OF POST-KATRINA REBUILDING GRANTS ON THE RESETTLEMENT CHOICES OF NEW ORLEANS HOMEOWNERS 5–6 (June 2017) (unpublished working paper), https://www.ssc.wisc.edu/~jmggregory/Gregory_katrina_dissertation2.pdf.

31. Although the grant amounts were capped, higher awards were given to residents who pledged either to rebuild a damaged home or build a new home in Louisiana within the three-year window provided by the program according to the following guidelines:

- (1) Grant to residential property owners to rebuild within three years; grant limited to difference between amount of damages and insurance proceeds received (up to \$150,000);
- (2) Grant in the same amount to finance building a new home within three years in Louisiana in exchange for turning over the current

Supplementing the program for homeowners, and reflecting the large number of rental properties that were damaged, the Small Rental Property Program paid 4,500 landlords \$435 million to build affordable units for low- to moderate-income families.³² The program led to the demolition of four public housing projects, which were replaced with mixed-income housing and a voucher system.³³

The rebuilding programs were open to the criticism that they essentially placed returning New Orleans residents in low-lying neighborhoods in the direct path of future severe flooding. However, \$14.5 billion was expended to construct 350 miles of levees, pumps, and gates around the city to withstand a 100-year storm.³⁴ Further, state-led efforts under the Coastal Protection and Restoration Authority³⁵ were launched as part of a master planning process that included restoring wetlands and building up barrier islands in part with “diversions” of silt and freshwater to nourish and raise up land.³⁶

property to the Louisiana Land Trust, which gave the properties to local redevelopment agencies;

(3) Similar to (2) but 40% smaller grant to reflect absence of rebuilding or location requirements.

Id.

32. David Hammer, *Examining Post-Katrina Road Home Program: 'It's more than the money. It's the hoops we had to jump through to do it,'* THE ADVOCATE (Aug. 23, 2015, 4:51 AM), http://www.theadvocate.com/baton_rouge/news/article_f9763ca5-42ba-5a62-9935-c5f7ca94a7c4.html.

33. For discussion of a report on the policy and its impact, see Dani McClain, *Former Residents of New Orleans's Demolished Housing Projects Tell Their Stories*, THE NATION (Aug. 28, 2015), <https://www.thenation.com/article/former-residents-of-new-orleans-demolished-housing-projects-tell-their-stories/>.

34. Miguel Llanos, *Will New Orleans' \$14.5 Billion Walls Stand Up to the Next Big Storm?*, NBC NEWS (Aug. 26 2015, 8:37 AM), <https://www.nbcnews.com/storyline/hurricane-katrina-anniversary/new-orleans-14-5-billion-walls-n415816>.

35. The Coastal Protection and Restoration Authority's 2017 Master Plan, projecting \$50 billion in coastal projects, includes the largest national investment in marsh creation from dredged material and sediment diversion, which are expected to build up land that has been disappearing along the coast as a result of erosion and subsidence, exacerbated by oil drilling and other economic activities, and sea-level rise. Kevin Sack & John Schwartz, *Left to Louisiana's Tides, A Village Fights for Time*, N.Y. TIMES (Feb. 24, 2018), https://www.nytimes.com/interactive/2018/02/24/us/100000005761606.app.html?emc=edit_ta_20180224&nl=top-stories&nid=27366739&ref=cta.

36. “The 2017 Coastal Master Plan includes 79 restoration, 13 structural protection, and 32 nonstructural risk reduction projects. . . .” The plan defines restoration projects as those that “build or maintain land and support productive habitat for commercially and recreationally important activities coast wide.” Structural protection projects serve as physical barriers against storm surge. Nonstructural risk reduction projects comprise other resilience strategies, such as raising and flood-proofing buildings and providing support for property owners. Here the plan mentions the possibility of relocating out of areas at high risk

Although the prospect was broached that New Orleans would adopt a policy of reduced development to avoid subjecting residents and businesses to repeat exposure to flooding,³⁷ the discourse of “return,” opportunism driven by privatization and gentrification goals,³⁸ and the availability of federal funding to finance rebuilding secured the opposite outcome.

B. New York City: A Rebuilding Imperative

Superstorm Sandy, an intense tropical storm³⁹ that struck the Caribbean and northeastern United States in late October 2012, accompanied by “major to record” storm surges in the New York metropolitan area and parts of New England, had a notable impact on New York City. The storm affected all major sectors, including health care, transportation, and communications;⁴⁰ the financial district and other institutional and residential structures in the southern half of Manhattan were immobilized and without electricity for five days.⁴¹ The storm also inflicted severe damage to residential properties, from high-rise buildings to beachfront bungalows throughout the city’s coastal areas. The storm heavily damaged the city’s waterfront structures and infrastructure, including boardwalks, landings, and terminals, and caused substantial beach erosion, with a loss of three million cubic yards of sand across the city.⁴²

The city’s principal policy blueprint in the aftermath of Sandy, *A Stronger, More Resilient New York*,⁴³ proposed more than 250 broadly formulated initiatives to strengthen coastal resilience and building-structural resilience.⁴⁴ The city vowed to reinforce its 520 miles of waterfront and adjust zoning and building code requirements to ensure that new buildings and substantial improvements would meet Federal Emergency Management

for flooding. COASTAL PROTECTION & RESTORATION AUTHORITY OF LA., LOUISIANA’S COMPREHENSIVE MASTER PLAN FOR A SUSTAINABLE COAST ES-15 (2017), http://coastal.la.gov/wp-content/uploads/2017/04/2017-Coastal-Master-Plan_Web-Single-Page_Final-with-Effective-Date-06092017.pdf.

37. The Times-Picayune Staff, *Plan Shrinks City Footprint*, NOLA, http://www.nola.com/politics/index.ssf/2005/12/plan_shrinks_city_footprint.html (last updated Aug. 13, 2010) (describing recommendation of Urban Land Institute to impose a temporary moratorium on building in neighborhoods especially vulnerable to flooding and returning flood-threatened areas to wetlands).

38. See Wellington, *supra* note 25, at 27, 32.

39. Sandy was considered to be post-tropical just prior to landfall. *Hurricane Sandy*, NAT’L WEATHER SERV., NAT’L OCEANIC & ATMOSPHERIC ADMIN., <https://www.weather.gov/okx/> (last visited Oct. 20, 2018).

40. A STRONGER, MORE RESILIENT NEW YORK ~~PLAN~~NYC, *supra* note 15, at 14–17.

41. *Id.* at 15.

42. *Id.* at 14.

43. *Id.* at 1.

44. *Id.* at 416–434.

Agency (FEMA) standards.⁴⁵ The city also prioritized repairing and elevating structurally vulnerable residential structures damaged during Sandy through Build It Back,⁴⁶ a costly and delay-ridden program whose costs have allegedly far outstripped the market value of many of the properties undergoing rehabilitation.⁴⁷

Contemplating that coastal residential, business, and institutional uses would be rebuilt,⁴⁸ the city explicitly rejected any suggestions “to wall the city in, or to retreat from the shore.”⁴⁹ Instead, the report included a Comprehensive Coastal Protection Plan,⁵⁰ proposing an array of initiatives to protect the rebuilt coastline: hard armoring to raise coastal edge elevations;⁵¹ soft shoreline armoring to reduce upland wave zones;⁵² and protecting against storm surge through integrated flood protections systems, floodwalls/levees, local storm surge barriers, and a multipurpose levee.⁵³ In conjunction with the Rebuild By Design competition,⁵⁴ which promotes resilient designs to mitigate the effects of sea-level rise and surges, the city is also helping to finance a project, dubbed “the BIG U,” comprising 10 miles of protective berms and “deployable walls” along lower (the southern half) Manhattan, where low lying waterfront areas are particularly

45. *Id.* at 50–52, 72–73, 78–79 (elevating foundations and critical systems, and raising living spaces above Design Flood Elevation level).

46. *Welcome to NYC Housing Recovery*, NYC RECOVERY, <http://www.nyc.gov/html/recovery/html/home/home.shtml> (last visited Aug. 9, 2018).

47. Bobby Cuza, *In Response to NY1 Special, de Blasio Acknowledges Failures of Build It Back Program*, NY1 (June 19, 2017, 10:30 PM), <http://www.ny1.com/nyc/all-boroughs/build-it-broke/2017/06/19/in-response-to-ny1-special-de-blasio-acknowledges-failures-of-build-it-back-program>. See also Amanda Farinacci, *Complaint Alleges Build It Back Wasted Millions of Dollars*, NY1 (June 12, 2017, 7:00 AM), <http://www.ny1.com/nyc/all-boroughs/news/2017/06/11/allegations-build-it-back-wasted-millions-of-dollars.html>.

48. Thus, the report proposed retrofitting existing nursing homes and adult care facilities in the 100-year floodplain and existing hospitals in the 500-year floodplain. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 15, at 153–54.

49. *Id.* at 7.

50. *Id.* at 50–66.

51. *Id.* at 50, 53, 58, 61 (beach nourishment, revetments, bulkheads, and tidal gates/drainage devices).

52. *Id.* at 53–54, 61–62 (dunes, offshore breakwaters, wetlands, living shorelines, reefs, and groins.)

53. *Id.* at 54–56, 63–64.

54. A collaborative, multi-sector venture dedicated to achieving resilience, the project originated as a design competition under the auspices of the U.S. Department of Housing and Urban Development to respond to the effects of Superstorm Sandy in northeastern U.S. coastal areas. *Who We Are*, REBUILD BY DESIGN, <http://www.rebuildbydesign.org/about> (last visited July 31, 2018).

vulnerable to surges.⁵⁵ To date, many of these initiatives have been plagued by delays.⁵⁶

Since 2016, the city has committed to a series of up-zoning initiatives,—undertaken in part to increase the city’s stock of below-market-rate housing⁵⁷—in which at least half of the areas to be rezoned are in 100-year flood zones or are likely to be remapped into those zones.⁵⁸ In 2017, however, the City Council created Special Coastal Risk Districts in the East Shore section of the borough of Staten Island⁵⁹ and in at-risk beachfront communities in the borough of Queens near Jamaica Bay.⁶⁰ These measures will restrict density in areas acknowledged to be at particular risk for coastal flooding, and will be discussed in Part V.⁶¹

Reflecting a development imperative that generally has been understood to benefit an urban economy and tax base,⁶² *A Stronger, More Resilient New York* and more recent initiatives have adopted an overall

55. Leanna Garfield, *Manhattan Plans to Build a Massive \$1 Billion Wall and Park to Guard Against the Next Inevitable Superstorm*, BUS. INSIDER (Apr. 27, 2018, 9:28 AM), <http://www.businessinsider.com/new-york-city-flooding-manhattan-coastal-barriers-2018-4>.

BIG is also the acronym for the Danish architectural firm that designed the system, Bjarke Ingels Group. *NYC: The Big U*, REBUILD BY DESIGN, <http://www.rebuildbydesign.org/our-work/all-proposals/winning-projects/big-u> (last visited July 31, 2018).

56. Robert Lewis, *Why ‘the Big U’ Storm Barrier Could End up as ‘Half a J,’* WNYC NEWS (Oct. 26, 2017), <https://www.wnyc.org/story/five-years-later-sandy-project-grinding/>.

57. *Mandatory Inclusionary Housing*, NYC PLAN., <https://www1.nyc.gov/site/planning/plans/mih/mandatory-inclusionary-housing.page> (last updated Mar. 22, 2016) [hereinafter *Mandatory Inclusionary Housing*].

58. Abigail Savitch-Lew, *Retreat or Build Out? NYC’s Post-Sandy Development Dilemma*, CITY LIMITS (Oct. 27, 2017), <https://citylimits.org/2017/10/27/retreat-or-build-out-nycs-post-sandy-development-dilemma/>.

59. *East Shore Neighborhoods*, NYC PLAN., <http://www1.nyc.gov/site/planning/plans/resilient-neighborhoods/east-shore.page> (last updated Sept. 7, 2017) [hereinafter *East Shore Neighborhoods*].

60. *Old Howard Beach, Hamilton Beach and Broad Channel*, NYC PLAN., <https://www1.nyc.gov/site/planning/plans/resilient-neighborhoods/old-howard-beach-hamilton-beach-broad-channel-rezoning.page> (last updated June 21, 2017) [hereinafter *Old Howard Beach*].

61. See *infra* Part V.

62. See, e.g., Harvey Molotch, *The City as a Growth Machine: Toward a Political Economy of Place*, 82:2 Am. J. of Soc. 309, 309–332 (Sept. 1976). As of 2014, the value of property within the city’s 100-year flood zone was reported to be \$129.1 billion. David W. Chen, *As FEMA Revises the Maps to Account for Climate Change, Deciding Who Is in the Flood Zone Will Be a Battle with Millions of Dollars at Stake*, N.Y. TIMES (Jan. 8, 2018), <https://www.nytimes.com/2018/01/07/nyregion/new-york-city-flood-maps-fema.html>.

Currently, approximately one in eight new multi-family housing units are being built along the city’s flood-vulnerable waterfront using resilient construction methods, and they command accelerating sales prices, despite the known risks of locating in a flood zone. Stefanos Chen, *New Buildings Rise in Flood Zones*, N.Y. TIMES (July 6, 2018), <https://www.nytimes.com/2018/07/06/realestate/luxury/new-buildings-rise-in-flood-zones.html>.

rebuilding-as-resilience policy, with only limited consideration of retreat as part of the resilience calculus.⁶³

C. Rotterdam: Adapting to the Reality of Living with Water

A busy port situated in a delta of the Rhine and Meuse Rivers at the mouth of the North Sea, Rotterdam must contend with a geographic fact, shared by virtually all parts of the Netherlands, that approximately 90% of the city lies below sea level.⁶⁴ Reflected in a history of extensive flooding and loss,⁶⁵ that fact has led the city to take a holistic approach to resilience policy making. Climate governance in Rotterdam encompasses a broad-gauged adaptation approach to achieve 100% resiliency, the product of the multisectoral Rotterdam Climate Initiative, a collaboration among Port of Rotterdam, the City of Rotterdam, port and industries' association Deltalinqs, and the DCMR Environmental Protection Agency to reach a 50% decrease in carbon dioxide levels by 2025 and improve economic outcomes.⁶⁶ This governance initiative combines coastal protection, planning public and private space, social education, and even the use of online apps to promote continuing situational awareness of the sea level.⁶⁷

As with New Orleans and New York, Rotterdam relies in part on a massive protective apparatus to hold back a surging sea. The *Maeslantkering* floodgate has two vast arms resting on either side of a canal near the mouth of the North Sea and ball joints that are sunk into the banks on each side of the river leading to the sea to hold the force of the water as the gate closes off the sea.⁶⁸ Thirty pumps remove water from the two arms

63. The City did indicate that it would work with New York State to develop guidelines under which communities in vulnerable locations might qualify for home buyouts under a State-administered program, adding that it expected only a “relatively limited number” of areas to be eligible. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 15, at 81.

64. Dan Grossman, *A Tale of Two Northern European Cities: Meeting the Challenges of Sea Level Rise*, PULITZER CTR. (Nov. 6, 2015), <https://pulitzercenter.org/reporting/hamburg-rotterdam-flooding-climate-change-protection>.

65. Sarah Goodyear, *We're in This Together: What the Dutch Know About Flooding That We Don't*, CITYLAB (Jan. 9, 2013), <https://www.citylab.com/equity/2013/01/were-together-what-dutch-know-about-water-we-dont/4355/>.

66. BAREND VAN ENGELENBURG & PAUL NOOTHOUT, ROTTERDAM CCS CLUSTER PROJECT CASE STUDY ON ‘LESSONS LEARNT’, ROTTERDAM CLIMATE INITIATIVE 5–8 (Feb. 2012), <http://decarboni.se/sites/default/files/publications/37366/2012rcicasestudyfinalreport-opt.pdf>.

67. Michael Kimmelman, *The Dutch Have Solutions to Rising Seas. The World is Watching.*, N.Y. TIMES (June 15, 2017), <https://www.nytimes.com/interactive/2017/06/15/world/europe/climate-change-rotterdam.html>.

68. *The Maeslantkering Storm Surge Barrier*, HOLLAND, <https://www.holland.com/global/tourism/holland-stories/land-of-water/the-maeslantkering-storm-surge-barrier.htm> (last visited Aug. 13, 2018), *discussed in* Kimmelman, *supra* note 67.

when it is necessary to reopen the gate (if, for example, the rivers leading to the sea overflow).⁶⁹

Perhaps the most innovative aspect of Rotterdam's climate resilience policy is the program, and philosophy, named "Room for the River."⁷⁰ Through this initiative, the city has developed public infrastructure, such as garages and plazas that also serve as reservoirs for the overflow of the bodies of water that surround and run through the city.⁷¹ Thus, the city has built housing around a water plaza, a dike with a rooftop park and shopping center, known as *Dakpark*,⁷² and reclaimed fields and canals that serve as a sports site, known as *Eendragtspolder*, while also collecting floodwater.⁷³

With the recognition that the flow of water cannot completely be stopped, but must rather be accommodated, Rotterdam and other parts of the Netherlands have developed an adaptive approach that combines armoring at the mouth of the North Sea with a seemingly inconsistent concept that the city must be open to flowing water. With this accommodation, and a nationally promoted readiness to evacuate,⁷⁴ the city's approach to resilience has not closed off any part of the city for development, including commercial property at the waterfront.⁷⁵ Rather, it seeks to capitalize on its vulnerable geography through its formation of a public-private network, the Rotterdam Centre for Resilient Delta Cities (RDC).⁷⁶ Thus, resilience in Rotterdam is building-oriented and accommodative rather than retreat-based.

69. Kimmelman, *supra* note 67.

70. *How Water is Governed: What is Room for the River?*, ALTA. WATER PORTAL SOC'Y., <https://albertawater.com/how-is-water-governed/what-is-room-for-the-river> (last visited Aug. 13, 2018), *discussed in* Kimmelman, *supra* note 67.

71. Kimmelman, *supra* note 67.

72. *Dakpark Rotterdam*, LET IT GROW, <https://letitgrow.org/green-initiatives/dakpark-rotterdam/> (last visited Aug. 13, 2018), *discussed in* Kimmelman, *supra* note 67.

73. *Restructuring of the Eendragtspolder*, CONNECTED: STRATEGIC CHANGE PROCESSES, <http://www.toconnect.nl/en/a-few-examples/restructuring-of-the-eendragtspolder/> (last visited Aug. 13, 2018), *discussed in* Kimmelman, *supra* note 67.

74. NETH. U.S. WATER CRISIS RES. NETWORK, FLOOD PREPAREDNESS IN THE NETHERLANDS: A U.S. PERSPECTIVE (2012), https://www.preventionweb.net/files/30381_nuwcren2012floodpreparednessinthene.pdf (discussing evacuation planning and community participation in flood response); *see also* Kimmelman, *supra* note 67.

75. MARTIN AARTS ET AL., PORT-CITY DEVELOPMENT IN ROTTERDAM: A TRUE LOVE STORY, DEPARTEMENTO DE UBRANÍSTICA Y ORDENCIÓN DEL TERRITORIO (2012), http://urban-e.aq.upm.es/pdf/PortCityDevelopment_ATrueLoveStory.pdf.

76. The apparent goal of the organization is to serve as a resource for delta cities globally, to marry safety features with improved economic opportunities, and enhance environmental and social quality. ROTTERDAM CTR. FOR RESILIENT DELTA CITIES, <http://rdcroterdam.com/> (last visited Aug. 17, 2018).

IV. MANAGING RETREAT: UNPACKING RETREAT AS A CLIMATE RESILIENCE APPROACH

Compared to the coastal and building-structural approaches to resilience favored by the cities discussed in Part III, a policy grounded in whole or in part in retreat from the floodplain tends to be more disruptive of existing features of floodplain communities, and, for that reason, more challenging to implement.⁷⁷ It reflects an assessment that measures entailing “protection in place” are not sufficient to achieve community resilience. The range of measures comprising retreat offers some flexibility to municipalities seeking to develop a climate governance policy calibrated to community characteristics and needs. The suite of retreat mechanisms can be responsive to the degree of urgency of flooding risk, economic considerations, the logistical feasibility of pursuing retreat options, the openness of floodplain communities to retreat measures, and the political will needed to implement retreat.⁷⁸

At one end of the spectrum, retreat can entail a complete withdrawal and resettlement of populations and businesses away from the flood-prone area. In terms of cost and disruption to the existing community, this option often generates resistance, and to date has been pursued only when the safety risks seem imminent and when community members are open to resettlement.⁷⁹ Examples include the Catskill Mountains community of Sidney, New York, Isle de Jean Charles in Louisiana, and the Alaskan Eskimo village of Newtok. In each of these instances, the circumstances prompting relocation have been highly urgent. Sidney, New York’s state-funded relocation efforts to move its flood-vulnerable business district and residences to higher elevations have been discussed by John Nolon in his analysis of climate change land-use bubbles.⁸⁰ Isle de Jean Charles is the recipient of a federally funded “resilience grant” to cover the cost of resettling willing members of the Biloxi-Chitimacha-Choctaw community, whose coastal home has lost 90% of its original expanse as a result of the ravages of severe weather and incursions of coastal livelihoods.⁸¹ The

77. J. Peter Byrne & Jessica Grannis, *Coastal Retreat Measures*, in *THE LAW OF ADAPTATION TO CLIMATE CHANGE: U.S. AND INT’L. ASPECTS*, 268–270 (Michael B. Gerrard & Katrina Fischer Kuh eds., American Bar Association 2012).

78. *Id.*

79. John R. Nolon, *Land Use and Climate Change Bubbles: Resilience, Retreat, and Due Diligence*, 39 WM. & MARY ENVTL. L. & POL’Y REV. 321, 337–39 (2014).

80. *Id.*

81. Coral Davenport & Campbell Robinson, *Resettling the First American ‘Climate Refugees’*, N.Y. TIMES (May 2, 2016), <https://www.nytimes.com/2016/05/03/us/resettling-the-first-american-climate-refugees.html>. The community joined the Grounded Solutions Network in 2016, which provides support and capacity building for members to adopt a community land trust model that removes land from the market and enables long-term

community of Newtok, is currently embarking on a long-delayed effort to relocate its village, which is losing land at the rate of seventy feet per year as a result of erosion and thawing permafrost, to a settlement nine miles away.⁸²

Where inundation and land loss are less imminent but neighborhoods that are low-lying or built on wetlands are susceptible to the effects of recurrent flooding, some residents may seek or accept government buyouts.⁸³ Examples include programs offered by New York State after Superstorm Sandy,⁸⁴ and buyouts offered to flood-prone, largely rural communities in Iowa and Missouri in the mid-1990s.⁸⁵ These voluntary buyouts allow the acquired land to serve as natural buffers to coastal flooding, and depend in part for their success on the ability to remove adjacent parcels from development to achieve the hoped-for buffering effects.⁸⁶

A third category of retreat responses entails efforts to delay or limit development in occupied or currently undeveloped at-risk coastal areas, such as by imposing land-use restrictions on the timing, extent, and density of building,⁸⁷ exactions accompanying the grant of permission to develop that limit or mitigate the impact of development,⁸⁸ or “rolling” easements or

housing affordability. Adam Abraham, *Isle de Jean Charles Band of Biloxi-Chitimacha Choctaw Indians*, GROUNDED SOLUTIONS NETWORK https://groundedsolutions.org/member_spotlight/isle-de-jean-charles-band-biloxi-chitimacha-choctaw-indians/ (last updated 2006). Decades in the making, the resettlement process reflects painstaking efforts to adapt to environmental risk and preserve the community’s tribal traditions and culture. *Tribal Resettlement*, ISLE DE JEAN CHARLES, LA., <http://www.isledejeancharles.com/our-resettlement/> (last visited Aug. 17, 2018).

82. Blake Essig, *Newtok Relocation Making Progress*, KTUU (Aug. 11, 2017, 12:36 PM), <http://www.ktuu.com/content/news/Newtok-relocation-effort-making-progress-439797923.html>; Robin Bronen, *Climate-Induced Community Relocations: Creating an Adaptive Governance Framework Based in Human Rights Doctrine*, 35 N.Y.U. REV. L. & SOC. CHANGE 357, 388-392 (2011) (discussing challenges encountered in Newtok’s efforts to relocate).

83. See *infra* notes 84–85 and accompanying text.

84. The Buyout program converts purchased properties to wetlands, open space, or storm water management systems, allowing the land to serve as nature-based buffers to flooding; the Acquisition Program contemplates resilient re-development of the properties. *Notice of Change of Use of Acquisition Properties by New York Rising*, N.Y. ST. GOVERNOR’S OFF. OF STORM RECOVERY, <https://stormrecovery.ny.gov/housing/buyout-acquisition-programs> (last visited Aug. 17, 2018).

85. Byrne & Grannis, *supra* note 77, at 284–85.

86. *Id.*

87. *Id.* at 272–74.

88. *Id.* at 273–74. To avoid takings liability, mitigating exactions must demonstrate an “essential nexus” with the underlying land use under application and the “rough proportionality” of the exaction to the extent of the burden imposed by the development. *SIDERS*, *supra* note 20, at 14–15 (citing *Nollan v. California Coastal Comm’n*, 483 U.S. 825 (1987); *Dolan v. City of Tigard*, 512 U.S. 374 (1994)).

development restrictions that link limits on development to the landward movement of the high tide line as a result of sea-level rise.⁸⁹

Local governments have a range of powers and legal mechanisms at their disposals with which to pursue a climate policy of managed retreat, starting with a municipality's own land-use and eminent domain authority, in addition to other legal remedies entailed in its police powers to safeguard public health and safety.⁹⁰ A local government can pursue a negotiated buyout of privately held land,⁹¹ or, if needed, exercise its eminent domain power by demonstrating that removing property from developable use serves a public safety and health purpose. Localities can arrange a transfer of development rights further inland,⁹² or acquire a conservation easement,⁹³ or a rolling easement that permits upland development but limits later use of the property as sea-level rise affects the shoreline.⁹⁴

Local governments can also use public nuisance doctrine to challenge or curtail risk-creating uses.⁹⁵ In the context of sea-level rise, they can ground regulation restricting uses of property on the need to prevent interference with land covered by the public trust doctrine, typically land beneath navigable waters and tidelands.⁹⁶ Additionally, local governments can impose building restrictions to bar redevelopment in flood-prone areas, or place coastal property in a land trust to insulate it from development.⁹⁷ To

89. SIDERS, *supra* note 20, at 54–57; J. Peter Byrne, *The Cathedral Engulfed: Sea-level Rise, Property Rights, and Time*, 73 LA. L. REV. 69, 109–12 (2012) [hereinafter *The Cathedral Engulfed*].

90. Robin Kundis Craig, *Of Sea Level Rise and Superstorms: The Public Health Police Power as a Means of Defending Against “Takings” Challenges to Coastal Regulation*, 22 N.Y.U. ENVTL. L.J. 84, 114 (2014) (arguing that in the context of takings challenges, courts are likely to be more receptive to measures addressing threat of coastal inundation that are framed as exercise of the public health police power rather than land-use regulation takings challenges).

91. Byrne & Grannis, *supra* note 77, at 283–85.

92. SIDERS, *supra* note 20, at 107–08; Byrne & Grannis, *supra* note 77, at 287–89.

93. SIDERS, *supra* note 20, at 104–08.

94. Byrne & Grannis, *supra* note 77, at 285–86; SIDERS, *supra* note 20, at 54–61.

95. Byrne & Grannis, *supra* note 77, at 276.

96. *The Cathedral Engulfed*, *supra* note 89, at 99–100. The public trust follows the landward progression of the tide line such that privately-owned land will be subordinate to the public trust. Under these circumstances, regulation of public trust lands will not result in a “taking” requiring compensation. Byrne & Grannis, *supra* note 77, at 276.

97. See, e.g., SIDERS, *supra* note 20, at 85–102 (discussing rebuilding restrictions); *Climate Change: Land and Climate Program*, LAND TRUST ALLIANCE <https://www.landtrustalliance.org/topics/climate-change> (last visited Oct. 28, 2018) (outlining developing strategies for using land trusts to conserve land from development that would otherwise exacerbate harmful effects associated with climate change), cited in Jessica Owley et al., *Climate Change Challenges for Land Conservation: Rethinking Conservation Easements, Strategies, and Tools*, 95 DEN. U. L. REV. 727, 732 n.18 (2018).

the extent that any of these mechanisms entails physical entry upon or limiting the economic value of privately owned land that is not itself creating a nuisance or violating public safety or health standards, local governments presumably would be required to compensate property owners under the regulatory takings doctrine.⁹⁸

A. A Calculus of Vulnerability: Who Lives in the Floodplain?

Congress created the National Flood Insurance Program in 1968; participating jurisdictions adopt a floodplain management ordinance setting design and construction standards.⁹⁹ FEMA flood insurance rate maps divide the U.S. into 100-year-flood (1% probability of flooding in any given year) and 500-year-flood zones (.02% annual probability).¹⁰⁰ Given the projections of increased sea-level rise and climate change-related severe weather, the extent of residential occupancy in floodplains is a revealing indicator of climate vulnerability.

A study of the housing stock in the 100-year floodplain and the combined 100-year and 500-year floodplains in the U.S. in 2011–2015 indicates that more than 30 million people lived in the combined floodplain.¹⁰¹ The study also pinpoints the coastal areas that are heavily occupied. During this period, Florida had the highest number of occupied housing units in the 100-year and combined 100-year and 500-year floodplains.¹⁰² Texas, California, New York, and Louisiana round out the top five states for occupied housing in the 100-year and combined floodplains.¹⁰³ “Two-thirds of the population living in the nation’s combined floodplains lived either in California, Florida, Arizona, Texas, or New York in 2011-2015.”¹⁰⁴

The housing units located in the floodplains bear a number of earmarks of vulnerability relating both to the attributes of the housing and its occupants. Out of all housing units in the 100-year and combined 100-year and 500-year floodplains, 22% were built before 1960 and thus are less

98. See, e.g., Byrne & Grannis, *supra* note 77, at 274–78; SIDERS, *supra* note 20, at 13–20; Craig, *supra* note 90, at 89–99.

99. STEPHANIE ROSOFF & JESSICA YAGER, HOUSING IN THE U.S. FLOODPLAINS, NYU FURMAN CTR. 4 (May 2017), http://furmancenter.org/files/NYUFurmanCenter_HousingInTheFloodplain_May2017.pdf.

100. *Id.* at 2.

101. CAROLINE PERI, STEPHANIE ROSOFF & JESSICA YAGER, POPULATION IN THE U.S. FLOODPLAINS, NYU FURMAN CTR. 2 (DEC. 2017), http://furmancenter.org/files/Floodplain_PopulationBrief_12DEC2017.pdf.

102. ROSOFF & YAGER, *supra* note 99, at 6.

103. *Id.* at 6–7.

104. PERI ET AL., *supra* note 101, at 2.

likely to be built to FEMA standards.¹⁰⁵ The study also indicated the extent to which coastal areas housed lower-income individuals living in public housing (5% of all public housing units are located in the 100-year floodplain and 9% in the combined floodplains),¹⁰⁶ and in privately-owned subsidized housing units (4% are located in the 100-year floodplain and 8% are in the combined floodplain area).¹⁰⁷ As a further indicator of the economic wherewithal of floodplain residents, the data showed, among the census tracts located in the 100-year floodplain, that a higher proportion of the population lived in moderate-poverty U.S. Census Bureau tracts¹⁰⁸ compared to non-floodplain areas, and in the combined floodplain area, a higher proportion of the population lived in high-poverty¹⁰⁹ Census Bureau tracts than in non-floodplain tracts.¹¹⁰ In terms of ethnicity, which often serves as a proxy for vulnerability, the study highlighted that a higher proportion of the population living in the combined floodplains identified as Hispanic/Latino (25%) compared to the proportion of Latinos in the U.S. population (17%);¹¹¹ a lower proportion of the population living in the combined floodplain identified as white (55%) compared to the proportion of persons so identifying in the U.S. population as a whole (62%).¹¹²

That 10% of the U.S population is exposed to the risk of living in the combined floodplain is a significant geographic index of vulnerability. Given the projections for continued sea-level rise, the additional indicators of vulnerability noted here, relating to populations and housing associated with poverty, and older housing that is less likely to meet federal flood-

105. ROSOFF & YAGER, *supra* note 99, at 4–5.

106. *Id.* at 5.

107. *Id.*

108. The U.S. Census Bureau defines moderate-poverty tracts as comprising tracts where between 10–30% of the residents live in poverty. PERI ET AL., *supra* note 101, at 4.

109. The U.S. Census Bureau defines high-poverty tracts as those tracts in which the proportion of the population in poverty exceeds 30%. *Id.* The Census Bureau designates households as in poverty according to the *Office of Management and Budget's (OMB's) Directive 14*, using a set of money income thresholds that vary by family size and make-up. “If the total income for a family or unrelated individual falls below the relevant poverty threshold, then the family (and every individual in it) or unrelated individual is designated to be in poverty.” The Census Bureau also uses a Supplemental Poverty Measure, which extends the official poverty measure by considering government benefits and expenses such as taxes that are not included in the official measure. *Glossary*, U.S. CENSUS BUREAU, https://www.census.gov/glossary/#term_Poverty (last visited Aug. 1, 2018).

110. PERI ET AL., *supra* note 101, at 4–5.

111. *Id.* at 3.

112. *Id.* The numbers were revealing for Arkansas, where, during the study period, 27% of residents in the combined floodplain were identified as “Black, Non-Hispanic,” whereas 15% of the statewide population fell into that category. *Id.* at 9. With respect to poverty, Arkansas was among a number of states in which the poverty rate in the combined floodplain was at least three percentage points higher than the statewide poverty rate during the study period. *Id.* at 4.

proofing requirements, underscore the relevance of including these data in the calculus for considering retreat options among other climate governance approaches.

B. A Calculus of Costs: Economic Implications of Retreat

If the risks of continued coastal settlement are significant, the public costs of undertaking coastal retreat to augment a community's resilience to risk can at first blush seem staggering. Where relocation of an existing community is under consideration, these costs include acquiring property, relocation costs, and the prospect of lost tax revenues if the relocating residents and businesses do not settle in the same taxing jurisdiction.¹¹³ The risk that discontinuing coastal development would depress surrounding property values could further reduce tax revenues.¹¹⁴ Infrastructure adjustments needed as a result of resettlement must be added in the calculus as well.¹¹⁵

However, a policy of retreat that limits development in favor of nature-based reuses of land also averts costs. Choosing not to develop or redevelop coastal land can be restorative of coastal ecosystems, which, if allowed to thrive, provide a range of benefits, including flood protection in upland areas and preventing or slowing coastal erosion by absorbing wave energy resulting from ocean movements.¹¹⁶ A recent study examining data from sixty-nine field measurements of coastal habitats for impact on reducing wave height furnished evidence of the wave-reduction effects of coastal habitats.¹¹⁷ These protective wave-reduction effects were also found to reduce the economic losses otherwise caused by flooding.¹¹⁸ A number of

113. ROBERT FREUDENBERG, ELLIS CALVIN, LAURA TOLKOFF & DARE BRAWLEY, BUY-IN FOR BUYOUTS: THE CASE FOR MANAGED RETREAT FROM FLOOD ZONES, LINCOLN INST. OF LAND POL'Y 38–39 (2016), <https://www.lincolninst.edu/sites/default/files/pubfiles/buy-in-for-buyouts-full.pdf>.

114. *Id.* at 16.

115. *See, e.g.*, DEPT' OF CITY PLAN., VISION 2020: NEW YORK CITY COMPREHENSIVE WATERFRONT PLAN 106–13 (2011), http://www1.nyc.gov/assets/planning/download/pdf/plans-studies/vision-2020-cwp/vision2020/chapter3_goal8.pdf [hereinafter NEW YORK CITY COMPREHENSIVE WATERFRONT PLAN]

116. *Coastal Wetlands*, U.S. ENVTL. PROTECTION AGENCY, <https://www.epa.gov/wetlands/coastal-wetlands> (last updated June 13, 2018).

117. Siddharth Narayan et al., *The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences*, PLOS ONE (May 2, 2016), <https://doi.org/10.1371/journal.pone.0154735>. Among other findings, the study concluded that “coastal habitats—particularly coral reefs and salt-marshes—have significant potential for reducing wave heights and providing protection at the shoreline.” *Id.* at 9.

118. *See, e.g.*, Robert Costanza et al., *The Value of Coastal Wetlands for Hurricane Protection*, 37 AMBIO 241 (June 2008), http://www.robertcostanza.com/wp-content/uploads/2017/02/2008_J_Costanza_HurricaneProtection.pdf.

studies suggest that the natural protections afforded by coastal wetlands can be more cost-effective than built protective structures. To this point, wetlands have been likened to “horizontal levees.”¹¹⁹

Recognizing that the incidence of wetlands is one of a number of factors that can affect the risk of flooding, one recent study of marsh wetlands in the northeastern United States estimated that wetlands reduced flood damage across twelve states from Hurricane Sandy, which struck in late October 2012, by slightly more than 1%, and avoided \$625 million in direct flood damages from the hurricane.¹²⁰ Another branch of the study, focused on a single county in New Jersey, predicted a 16% average reduction in yearly flood losses.¹²¹ The study noted that states having more extensive wetland cover were “strongly correlated with avoided damages”; among the four Sandy states in the study with the most extensive wetlands cover, wetlands were estimated to reduce flood damages by 20% to 30%.¹²²

This evidence of the cost benefits of ecosystem services suggests a greater role for nature-based coastal defenses vis-à-vis hard armoring as well as greater consideration of the value of buying out high-risk coastal areas and pursuing nature-based reuses in place of redevelopment. Another economic benefit of buyouts linked to nature-based defenses of flood-prone land is that they avoid the use of payouts of subsidized wind and flood insurance to rebuild repetitively damaged coastal properties. As public-health and environmental law scholar Ed Richards has argued, given the evidence that both state-regulated private insurance practices and public programs such as the National Flood Insurance Program set property insurance in vulnerable areas below its actual cost, insurance rates do not accurately communicate risk or provide incentives to adapt to the increasing risks of sea-level rise.¹²³ Disaster relief programs further enable, if not

119. *Id.* at 241. *See also* Narayan et al., *supra* note 117 (concluding that “restoration projects for which data are available—i.e., mangrove and marsh projects—can be cost-effective relative to submerged breakwaters in attenuating low waves and become more cost-effective at higher water depths”).

120. Siddharth Narayan et al., *The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA*, 7 *Sci. Rep.* 1, 2 (Aug. 31, 2017).

121. *Id.* at 5. The study concluded that sites with salt marshes had “significantly lower annual flood losses” than locations without marshes. *Id.* at 4–5.

122. *Id.* at 2.

123. Edward P. Richards, *Applying Life Insurance Principles to Coastal Property Insurance to Incentivize Adaptation to Climate Change*, 43 *B.C. ENVTL. AFF. L. REV.* 427, 450–51, 459 (2016), <http://lawdigitalcommons.bc.edu/ealr/vol43/iss2/8> (proposing a life insurance model for insuring properties facing an increasing risk of loss to sea-level rise, arguing that true risk-based insurance with a rising premium would more accurately communicate the climate change risk for the property, reduce the value of the property as a result of the increasing cost of the insurance, and ultimately encourage retreat-based adaptation).

encourage, property owners to rebuild in high-risk areas.¹²⁴ These costly practices must be accounted for in any cost-benefit calculus considering the economic feasibility of retreat.

C. Complicating the Calculus: Beyond Economics

Beyond the economic implications of embracing retreat policies, the confluence of logistical considerations, geography, and the psychology of place also influences the extent to which climate governance will take retreat options into account. Where retreat would require withdrawal and relocation of current settlements, whether relocation within reasonable proximity of the coastal settlement is feasible depends in part on the geography and topography of the surrounding area. The impact of relocation on existing public infrastructure and patterns of residential and business settlement, particularly in densely populated areas,¹²⁵ must be considered. Further, residents' attachment to place,¹²⁶ and the documented psychological effects of mandated relocations,¹²⁷ may fuel strong community reactions against managed retreat as a policy. The fragmentation of existing community affiliations can be destabilizing, and the effects of relocation can be particularly disruptive of the cultural traditions and cohesiveness of long-established settlements, such as the indigenous communities relocating from Isle de Jean Charles in Louisiana¹²⁸ and Newtok, Alaska.¹²⁹

The nature and extent of building typology and the housing availability in coastal areas also complicate the feasibility of community-based retreat. For example, the prevalence of one-story frame bungalows along the coastal landscape, conspicuous in parts of New York City, is tied to the affordability of this housing form.¹³⁰ Where housing markets are competitive, favoring sellers, the absence of comparably affordable housing farther inland can become a barrier to relocation.¹³¹ Where, also in New

124. *Id.* at 448–49.

125. NEW YORK CITY COMPREHENSIVE WATERFRONT PLAN, *supra* note 115, at 106.

126. SHERI BROKOPP BINDER, RESILIENCE AND POSTDISASTER RELOCATION: A STUDY OF NEW YORK'S HOME BUYOUT PLAN IN THE WAKE OF HURRICANE SANDY (Aug. 2013), https://hazards.colorado.edu/uploads/quick_report/binder_2013.pdf.

127. MINDY THOMPSON FULLILOVE, ROOT SHOCK: HOW TEARING UP CITY NEIGHBORHOODS HURTS AMERICA AND WHAT WE CAN DO ABOUT IT 9–20, 52–70, 165–96 (2005) (2004).

128. *See* Davenport & Robinson, *supra* note 81.

129. *See* Essig, *supra* note 82.

130. *See generally* A.F. Brady, *Building Back the Bungalow*, URBAN OMNIBUS (July 13, 2016), <http://urbanomnibus.net/2016/07/build-back-bungalow>.

131. *Id.*; Elizabeth Rush, *Leaving the Sea: Staten Islanders Experiment with Managed Retreat*, URBAN OMNIBUS (Feb. 11, 2015), <http://urbanomnibus.net/2015/02/leaving-the-sea-staten-islanders-experiment-with-managed-retreat/>.

York City, high-rise public housing developments seem to stand sentinel along highly vulnerable coastal areas,¹³² a policy of resettlement would need to address the costs and logistical challenges of relocating thousands of low-income residents of multi-family housing, often with special needs, where comparable affordable housing is at a premium.¹³³

Undoubtedly, retreat-as-relocation can present particularly daunting challenges to discrete communities, encompassing environmental harm, potential loss of community cohesiveness and cultural identity, as well as economic factors tied to loss of coastal livelihood or access to more affordable housing. When the complicating factor of scale manifests in large-city scenarios, the barriers can seem insurmountable. Despite these challenges, the projections for continued sea-level rise and the associated risk of damage from storm surges make even retreat-as-relocation an increasingly salient consideration for coastal cities. Moreover, a more tailored application of retreat-as-relocation may be feasible, even in the context of large urban areas, that achieves public health and safety goals and ecological benefits, while also reaching a sounder macro-economic outcome, closing the spigot of public expenditure for repetitive loss properties. The discussion in Part V turns to recent indications that New York City may be open to pursuing a tailored approach to retreat within a larger framework of continued development.¹³⁴

V. RETREAT REVISITED: NEW YORK'S LIMITED RESORT TO RETREAT

It is estimated that New York City has a larger number of people inhabiting flood-vulnerable areas than any other U.S. city.¹³⁵ Following Superstorm Sandy's devastating impact, New York City has emphasized repairing, rebuilding, retrofitting, and elevating coastal structures as part of

132. *Hurricane Sandy After Action*, CITY OF N.Y. (May 2013), http://www.nyc.gov/html/recovery/downloads/pdf/sandy_aar_5.2.13.pdf (referring throughout to the impact on public housing residents and structures).

133. Any such policy of retreat from the coastline would reverse the policy of an earlier era, when New York City's low-income families displaced as a result of "slum clearance" were assigned to the city's periphery, far from transportation arteries and employment opportunities, out of considerations of cost, to make way for urban renewal developments closer to the city's Manhattan core. Jonathan Mahler, *How the Coastline Became a Place to Put the Poor*, N.Y. TIMES (Dec. 3, 2012), <http://www.nytimes.com/2012/12/04/nyregion/how-new-york-citys-coastline-became-home-to-the-poor.html>. See also NICHOLAS DAGEN BLOOM, PUBLIC HOUSING THAT WORKED: NEW YORK IN THE TWENTIETH CENTURY 59, 62, 70–72, 130–31, 141 (2008).

134. See *infra* Part V.

135. Rush, *supra* note 131. That number might increase when FEMA completes its negotiated revision of New York City's flood zone maps in light of recognized climate change risks such as sea-level rise. *Id.*

an overall rebuilding approach to resilience governance.¹³⁶ Although New York has not embraced retreat as a land-use strategy, the city has launched a Resilient Neighborhoods¹³⁷ Initiative that in selected areas incorporates limited aspects of retreat in combination with other resilience approaches. This willingness to link the idea of resilience with modest retreat measures along parts of the coastline considered to be particularly at risk reflects some effort by the city, if belated, to calibrate its resilience policy-setting with closer consideration of local geography and neighborhood contexts along the city's 520 miles of waterfront. The following discussion addresses these recent developments and their implications for climate governance for large, heavily developed and populated urban areas.¹³⁸

A. Aligning State-Government Buyouts with Local Zoning Measures

In Sandy's aftermath, a discrete number of New York City residents in three high-risk neighborhoods along the eastern shore of Staten Island availed themselves of the New York Rising Buyout Program.¹³⁹ The program is a fairly circumscribed aspect of what is essentially a rebuilding and recovery initiative administered by the New York State Governor's Office of Storm Recovery and funded by a federal Community Development Block Grant-Disaster Recovery grant.¹⁴⁰ Under the program, the State of New York has purchased properties mainly in the city's borough of Staten Island and in the suburban Long Island region east of New York City at pre-storm values, with a commitment not to redevelop the purchased land but to allow it to serve, as in its predeveloped state, as a natural buffer against flooding.¹⁴¹ The New York Governor's Office of Storm Recovery has reported that, as of October 2016, the State of New York had purchased

136. See *supra* notes 43–63 and accompanying text.

137. *Resilient Neighborhoods*, NYC PLAN., <https://www1.nyc.gov/site/planning/plans/resilient-neighborhoods.page> (last updated Sept. 7, 2017) [hereinafter *Resilient Neighborhoods*].

138. See *infra* Part V.A.

139. N.Y. ST. GOVERNOR'S OFF. OF STORM RECOVERY, *supra* note 84.

140. N.Y. ST. GOVERNOR'S OFF. OF STORM RECOVERY, NY RISING 4TH ANNIVERSARY REPORT 2012–2016, 4, 12 (2016), https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/10292016_GOSR4thAnniversary.pdf. The program is described as pursuing two principal goals: “The first: to address damage, quickly dispense aid to homeowners and small businesses, and satisfy immediate rebuilding needs. The second: to build back better while instituting smart long-term resiliency measures to maximize and further fortify such precious and critical gains.” *Id.* at 4.

141. *Id.* at 12.

more than 600 properties statewide, at a cost of \$240 million, through the program.¹⁴²

The three Staten Island communities that participated in these voluntary buyouts—Oakwood Beach, Ocean Breeze, and Graham Beach—were located in the East Shore, a four-mile, low-elevation area heavily damaged by Superstorm Sandy.¹⁴³ These Staten Island residents were proactive in forming a buyout committee, gauging the interest of other residents, and identifying vulnerable properties to be included in a buyout plan.¹⁴⁴ Although the buyout with natural re-use of land was not a city initiative, the New York City Council has since amended its Zoning Code to limit the density of future development in the buyout areas.¹⁴⁵

As part of the city's Resilient Neighborhoods initiative, the East Shore is one of ten neighborhoods located in the floodplain that the city has earmarked for a more tailored land-use approach to resilience planning.¹⁴⁶ In the East Shore Special Risk District and Rezoning, the Council enacted provisions proposed by the city's Department of Planning that aligned with the State's determination that these East Shore communities qualified for buyouts.¹⁴⁷ The zoning measure's key provisions recognized the East Shore's vulnerability to flood damage, in part because of its location and its "aging" housing stock, as well as the buffering value of its "hundreds of acres of wetlands, Bluebelts, and parks."¹⁴⁸

The main restrictions on development, limiting building in the district to single-family detached residences, were intended to ensure consistency with the area's open space and infrastructure plans and limit encroachments on wetlands.¹⁴⁹ This attention to protecting wetlands and open space while lowering the density of future East Shore development is a significant, if limited, departure from the city's *A Stronger, More Resilient New York*; it incorporates components of retreat in a program that nonetheless remains committed to safe and contextual development in the East Shore area.¹⁵⁰

142. *Id.*

143. Rush, *supra* note 131.

144. *Id.*

145. *East Shore Neighborhoods*, *supra* note 59.

146. *Resilient Neighborhoods*, *supra* note 137.

147. *East Shore Neighborhoods*, *supra* note 59.

148. *Id.*

149. *Id.*

150. The East Shore rezoning contemplates "changes to residential zoning to help ensure that future development is resilient to coastal flooding, safe and accessible for residents, and in line with the character of the surrounding neighborhood, while promoting mixed-use residential and commercial development in areas where growth may be desirable." *Id.*

B. Planning and Zoning in the Jamaica Bay Watershed

A recently announced community planning initiative, Resilient Edgemere in the city's borough of Queens, reflects a more locally specific approach to resilience planning in place of a blanket embrace of rebuilding that characterized New York City's first responses to Sandy.¹⁵¹ Edgemere is part of the Jamaica Bay Watershed, a highly urbanized estuary and wildlife refuge located at the site of an international airport, exposed to high levels of greenhouse gas emissions, and vulnerable by its location to Atlantic storms and coastal flooding.¹⁵² In developing Edgemere's resilience initiative, which followed seventeen months of community engagement, the city committed to a suite of land-use investments: increasing flood protection; constructing resilient housing farther inland, away from low lying coastal neighborhoods, including some proposed resettlement of residents to these areas; maintaining open space; and creating street and infrastructure improvements.¹⁵³

The city's relatively modest, neighborhood-based relocations away from the coastal area entail moving "eligible and willing" residents onto city-owned land and limiting housing development in a to-be-created Hazard Mitigation Zone by placing deed restrictions on lots that the city would acquire.¹⁵⁴ The Plan prompted concern and resistance from some community members,¹⁵⁵ which suggests the strong attachment to place that complicates use of managed retreat with resettlement, even when access to retreat is offered on a voluntary basis. Perhaps anticipating these responses, the city seems scrupulously to have avoided the rhetoric of retreat in the Edgemere proposal; instead, it uses "de-densifying" to capture the idea of resettling residents further inland to avoid flooding.¹⁵⁶

The lead agency for the Edgemere Community Plan is the city's Department of Housing Preservation and Development, highlighting the extent to which a central plan to provide, but control, housing options has shaped this community-based initiative. In tandem with this broader-based

151. N.Y.C. DEP'T OF HOUS. PRES. & DEV., RESILIENT EDMERERE COMMUNITY PLAN 16 (2017), <http://www1.nyc.gov/assets/hpd/downloads/pdf/community/resilient-edgemere-report.pdf>.

152. William D. Solecki et al., *Why Prospects for Resilience for Jamaica Bay?*, in PROSPECTS FOR RESILIENCE: INSIGHTS FROM NEW YORK CITY'S JAMAICA BAY, 3, 8–12 (2016).

153. NYC Department of Housing Preservation and Development Releases the Resilient Edgemere Community Plan, N.Y.C. DEP'T OF HOUS. PRES. & DEV. (May 20, 2017), <http://www1.nyc.gov/site/hpd/about/press-releases/2017/03/03-20-17.page>.

154. N.Y.C. DEP'T OF PRES. & DEV., *supra* note 151, at 24.

155. See, e.g., Nathan Kensinger, *A Long-Neglected Queens Neighborhood Grapples with the Effects of Climate Change in NYC*, CURBED N.Y. (Apr. 13, 2017, 1:15 PM), <https://ny.curbed.com/2017/4/13/15280808/climate-change-queens-edgemere-photo-essay>.

156. *Id.*

community planning in Edgemere, the city has exercised its zoning authority in nearby Jamaica Bay communities, adopting a Special Coastal Risk District and Rezoning for Hamilton Beach and Broad Channel.¹⁵⁷ Noting the area's "exceptional flood risk," the rezonings limit development to detached houses and one-family (Broad Channel) or two-family (Hamilton Beach) residences.¹⁵⁸

The zoning amendment creating the Special Coastal Risk District ties the enactment to the City's public health, safety, and welfare powers; at the same time, it includes the goal of maintaining the city's tax base by "promot[ing] the most desirable use of land and . . . the value of land and buildings."¹⁵⁹ Thus, the city has developed a flexible mechanism to decelerate development in at-risk coastal areas without effecting a complete withdrawal from these regulated areas; the city has integrated land-use controls within a framework that contemplates continued productive uses of the rezoned areas, when feasible.

These resilience planning and zoning regulations are modest and do not alter the city's overall orientation in climate governance to rebuilding. This is especially evident in the city's commitment to up-zone neighborhoods, including neighborhoods located in the city's floodplain, as a key strategy for spurring both market-based development and creation of below-market-rate housing units.¹⁶⁰ However, the more targeted responses to areas that

157. *Mandatory Inclusionary Housing*, *supra* note 57.

158. *Id.*

159. The Zoning Amendment stated the following "general goals" and "specific purposes":

- (a) to limit the population in areas that are vulnerable to frequent flooding, including those areas exceptionally at risk from projected future tidal flooding;
- (b) to reduce the potential for property damage and disruption from regular flood events and support the City's capacity to provide infrastructure and services;
- (c) to promote consistency with planned improvements, neighborhood plans, and other measures to promote drainage, coastal protection, open space and other public purposes;
- (d) provide sound planning in areas that have historically been occupied by wetlands and, where plans exist, for such areas to be maintained as open space; and
- (e) to promote the most desirable use of land and thus conserve the value of land and buildings, and thereby protect the City's tax revenue.

DEP'T OF CITY PLAN., ARTICLE XIII: SPECIAL PURPOSE DISTRICTS, CHAPTER 7: SPECIAL COASTAL RISK DISTRICT, IN ZONING RESOLUTION: THE CITY OF NEW YORK § 137-200 (Sept. 7, 2017), <http://www1.nyc.gov/assets/planning/download/pdf/zoning/zoning-text/art13c07.pdf>.

160. *See Mandatory Inclusionary Housing*, *supra* note 57.

present a heightened risk of flooding stand in contrast to the city's earlier blanket rejection of retreat in *A Stronger, More Resilient New York*. These recent responses suggest that the city is shifting—if slowly and only slightly—to a more nuanced spatial assessment of vulnerability.

VI. CONCLUSION: AN INVENTORY FOR CONSIDERING RETREAT

Coastal cities must navigate, literally and metaphorically, the uncharted waters produced by sea-level rise and storm surges. Developing effective governance responses benefits from understanding coastal areas as “socio-ecological systems,”¹⁶¹ or multilayered systems that form “literal edges of ecological and cultural zones.”¹⁶² Crafting climate governance entails processes that take appropriate account of the interplay between the physical and social dimensions of coastal communities, and that recognize, in turn, the importance of community-based learning and social integration.¹⁶³ Informed by a socio-ecological systems approach, a coastal community's vulnerability to climate risk builds from a complex, multi-faceted set of conditions, including “characteristics of exposure, susceptibility, and coping capacity, shaped by dynamic historical processes, differential entitlements, political economy, and power relations, rather than as a direct outcome of a perturbation or stress.”¹⁶⁴ A sound approach to resilience governance is thus a broad-gauged inquiry, one that is equally attentive to equity and environmental concerns.

Using a socio-ecological systems lens, an inquiry into whether and how retreat can be integrated into a locality's climate governance scheme calls for a careful assessment of a range of factors: ecological, public health, and safety considerations; implications of retreat for infrastructure and the built environment; the source and extent of federal, state, and local legal authority to pursue retreat; political capacity/will to engage retreat; the extent of expenditure of public money for retreat (acquisition and relocation costs, foregone tax revenues) vis-à-vis rebuilding (cost of reconstruction that meets enhanced code and insurance requirements, regulatory oversight); identifying sources of public and private money available to underwrite resettlement; effective stewardship of the social infrastructure (drawing here

161. A socio-ecological system may be defined as a “multilevel or nested system that exhibits interactions to physical, ecological systems and human or social systems.” Shorna Allred et al., *Social-Ecological System Transformation in Jamaica Bay*, in PROSPECTS FOR RESILIENCE: INSIGHTS FROM NEW YORK CITY'S JAMAICA BAY 43 (Sanderson et al., eds. 2016).

162. *Id.* at 44.

163. *Id.* at 44–45.

164. Fiona Miller et al., *Resilience and Vulnerability: Complementary or Conflicting Concepts?*, 15:3 *ECOLOGY & SOC'*Y 11 (2010), <http://www.ecologyandsociet y.org/vol15/iss3 /art11/>.

on sociologist Eric Klinenberg's use of the term);¹⁶⁵ relatedly, community education and engagement concerning the variables that make the need for relocation more urgent; sociological and psychological dimensions of policies that encourage or require retreat; and short-term versus long-term approaches to retreat.¹⁶⁶

Although none of these factors, on their own, would likely be sufficient to support a determination to initiate retreat measures, these interrelated considerations engage a broad, landscape-mapping perspective that includes sociological and psychological aspects of community resilience crucial to climate governance. As localities confront the increasing urgency of rising sea levels and the consequences of coastal flooding, they must develop a contextualized understanding of the range of strategies encapsulated in managed retreat. Coastal communities must commit to a governance process that more centrally incorporates, rather than subordinates, consideration of retreat mechanisms in climate resilience planning, such that managing retreat becomes as integral to climate governance as resilient rebuilding and hard armoring the coastline.

165. Eric Klinenberg, *Adaptation: How Can Cities be "Climate-Proofed?"*, NEW YORKER (Jan. 7, 2013), <https://www.newyorker.com/magazine/2013/01/07/adaptation-2> (defining "social infrastructure" as "the people, places, and institutions that foster cohesion and support").

166. This inventory draws, in part, on the work of the National Association for the Advancement of Colored People, which has developed an equity-based climate change adaptation planning approach. *NAACP Equity in Building Resilience in Adaptation Planning*, ADAPTATION CLEARINGHOUSE (Jan. 26, 2015), <http://www.adaptationclearinghouse.org/resources/naacp-equity-in-building-resilience-in-adaptation-planning.html>, discussed in Andrea McArdle, *Climate Risk and Resilience Planning in an Urban Governance Context*, 3 IGLUS QUARTERLY 2, 4–6 (Sept. 2017), <http://fsr.eui.eu/iglus-quarterly-vol-3-no-2-local-governance/>.